WARNING: ALL INDIVIDUALS INTERESTED IN BIDDING ON THIS PROJECT MUST OBTAIN THE FINAL PLANS AND SPECIFICATIONS FROM THE DEPARTMENT MANAGING THE PROJECT OR AS OTHERWISE STATED IN THE ADVERTISEMENT FOR BIDS FOR THE PROJECT. DO NOT USE THE PLANS AND SPECIFICATIONS POSTED ON THE CLERK OF THE BOARD'S WEBSITE FOR BIDDING ON THIS PROJECT.

Building knowledge

Job Order Contract Technical Specifications

CSI Divisions 01 - 46 April 2023

San Bernardino County

GORDIAN®

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01 General Requirements

02 Existing Conditions

03 Concrete

04 Masonry

05 Metals

06 Wood, Plastics, and Composites

07 Thermal And Moisture Protection

08 Openings

09 Finishes

10 Specialties

11 Equipment

12 Furnishings

13 Special Construction

14 Conveying Equipment

21 Fire Suppression

22 Plumbing

23 Heating, Ventilating, and Air-Conditioning (HVAC)

26 Electrical

27 Communications

28 Electronic Safety and Security

31 Earthwork

32 Exterior Improvements

33 Utilities

34 Transportation

35 Waterway and Marine Construction

41 Material Processing and Handling Equipment

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SECTION 01 22 16 00 - NO SPECIFICATION REQUIRED

1.1 GENERAL

A. A separate specification is not required for this item. The description given in the line item of the Construction Task Catalog completely defines the item.

1.2 PRODUCTS - (Not Used)

1.3 EXECUTION - (Not Used)

END OF SECTION 01 22 16 00

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Task	Specification	Specification Description
01 22 20 00	01 22 16 00	No Specification Required
01 22 23 00	01 22 16 00	No Specification Required
01 35 33 00	01 22 16 00	No Specification Required

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SECTION 01 51 13 00 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Power panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Load centers.
4. Electronic-grade panelboards.
5. Disconnecting and overcurrent protective devices.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

A. GFEP: Ground-fault equipment protection.

B. MCCB: Molded-case circuit breaker.

C. VPR: Voltage protection rating.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Power panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Load centers.
4. Electronic-grade panelboards.
5. Disconnecting and overcurrent protective devices.
6. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
7. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.

3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series rating of installed devices.
7. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for SPD as installed in panelboard.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include wiring diagrams for power, signal, and control wiring.
10. Key interlock scheme drawing and sequence of operations.
11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include Internet link for electronic access to downloadable PDF of coordination curves.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Panelboard Schedules: For installation in panelboards.[**Submit final versions after load balancing.**]

B. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Recommended procedures for installing panelboards.
2. Recommended torque settings for bolted connections on panelboards.
3. Recommended temperature range for energizing panelboards.

C. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts: Furnish to Owner spare parts, for repairing panelboards, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Keys: [**Two**] <**Insert number**> spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and GFEP Types: [**Two**] <**Insert number**> spares for each panelboard.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
5. <**Insert extra materials**>.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to panelboards, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
2. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation in accordance with [**NECA 407**] [**NEMA PB 1**].

1.8 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed panelboards perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**] <**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that panelboards perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. [**Initial**]Extended-Warranty Period: [**Three**] [**Four**] <**Insert number**> years from date of Substantial Completion; [**full**] [**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Five**] <**Insert number**> years from date of Substantial Completion; [**full**] [**prorated**] coverage for materials[**that failed because of transient voltage surges**] only, free on board [**origin**] [**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS[**TO BE MODIFIED**] [**TO BE REMOVED AND RE-INSTALLED**]

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.2 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

A. Fabricate and test panelboards in accordance with IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing agency recognized by authorities having jurisdiction, and marked for intended location and application.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

F. Enclosures: [**Flush**] [**and**] [**Surface**]-mounted, dead-front cabinets.

1. Rated for environmental conditions at installed location.

    a. Indoor Dry and Clean Locations: UL 50E, [**Type 1**] <**Insert type**>.
    b. Outdoor Locations: UL 50E, [**Type 3R**] <**Insert type**>.
    c. [**Kitchen**] [**Wash-Down**] Areas: UL 50E, [**Type 4X**] <**Insert type**>, [**stainless steel**] <**Insert material**>.
    d. Other Wet or Damp Indoor Locations: UL 50E, [**Type 4**] <**Insert type**>.
    e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: UL 50E, [**Type 5**] [**Type 12**].

2. Height: 7 ft (2.13 m) maximum.
3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims must cover live parts and may have no exposed hardware.
4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims must cover live parts and may have no exposed hardware.
5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
7. Finishes:

    a. Panels and Trim: [**Steel**] [**and**] [**galvanized steel**], factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    b. Back Boxes: [**Galvanized steel**] [**Same finish as panels and trim**].
    c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

8. <**Insert optional features**>.

G. Incoming Mains:

1. Location: [**Top**] [**Bottom**] [**Convertible between top and bottom**].
2. Main Breaker: Main lug interiors up to 400 A must be field convertible to main breaker.

H. Phase, Neutral, and Ground Buses:

1. Material: [**Tin-plated aluminum**] [**Hard-drawn copper, 98 percent conductivity**].

   a. Plating must run entire length of bus.
   b. Bus must be fully rated for entire length.

2. Interiors must be factory assembled into unit. Replacing switching and protective devices may not disturb adjacent units or require removing main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
5. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure.
6. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors must be sized for double-sized or parallel conductors as indicated on Drawings.
7. Do not mount neutral bus in gutter.
8. Split Bus: Vertical buses divided into individual vertical sections.
9. <**Insert optional features**>.

I. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: [**Tin-plated aluminum**] [**Hard-drawn copper, 98 percent conductivity**].
2. Terminations must allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: [**Compression**] [**Mechanical**] type, with lug on neutral bar for each pole in panelboard.
5. Ground Lugs and Bus-Configured Terminators: [**Compression**] [**Mechanical**] type, with lug on bar for each pole in panelboard.
6. Feed-Through Lugs: [**Compression**] [**Mechanical**] type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
7. Subfeed (Double) Lugs: [**Compression**] [**Mechanical**] type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
8. Gutter-Tap Lugs: [**Compression**] [**Mechanical**] type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
9. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
10. <**Insert optional features**>.

J. Quality-Control Label: Panelboards or load centers must be labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers must have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

K. Future Devices: Panelboards or load centers must have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

1. Percentage of Future Space Capacity: [**5**] [**10**] [**20**] <**Insert number**> percent.

L. Panelboard Short-Circuit Current Rating:

1. Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by qualified electrical testing laboratory recognized by authorities having jurisdiction. Include label or manual with size and type of allowable upstream and branch devices listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series-connected short-circuit rating.

   a. Panelboards rated 240 V or less must have short-circuit ratings as shown on Drawings, but not less than 10 000 A(rms) symmetrical.
   b. Panelboards rated above 240 V and less than 600 V must have short-circuit ratings as shown on Drawings, but not less than 14 000 A(rms) symmetrical.

2. Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for 100 percent interrupting capacity.

   a. Panelboards and overcurrent protective devices rated 240 V or less must have short-circuit ratings as shown on Drawings, but not less than 10 000 A(rms) symmetrical.
   b. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V must have short-circuit ratings as shown on Drawings, but not less than 14 000 A(rms) symmetrical.

M. Surge Suppression: Factory installed as integral part of indicated panelboards, complying with UL 1449 SPD [**Type 1**] [**Type 2**].

2.3 POWER PANELBOARDS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Listing Criteria: NEMA PB 1, distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

   1. For doors more than [**36 inch (914 mm)**] <**Insert dimension**> high, provide two latches, keyed alike.

D. Mains: [**Circuit breaker**] [**Fused switch**] [**Lugs only**].

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: [**Plug-in circuit breakers**] [**Bolt-on circuit breakers**] [**Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal**].

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: [**Bolt-on circuit breakers**] [**Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal**].

G. Branch Overcurrent Protective Devices: Fused switches.

H. Contactors in Main Bus: NEMA ICS 2, Class A, [**electrically**] [**mechanically**] held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

   1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

2. External Control-Power Source: [**120 V branch circuit**] [**24 V control circuit**] <**Insert requirement**>.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Listing Criteria: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: [**Circuit breaker**] [**or**] [**lugs only**].

D. Branch Overcurrent Protective Devices: [**Plug-in**] [**Bolt-on**] circuit breakers, replaceable without disturbing adjacent units.

E. Contactors in Main Bus: NEMA ICS 2, Class A, [**electrically**] [**mechanically**] held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
2. External Control-Power Source: [**120 V branch circuit**] [**24 V control circuit**] <**Insert requirement**>.

F. Doors: Door-in-door construction with concealed hinges; secured with [**flush**] [**or**] [**multipoint**] latch with tumbler lock; keyed alike.[**Outer door must permit full access to panel interior. Inner door must permit access to breaker operating handles and labeling, but current carrying terminals and bus must remain concealed.**]

G. Column-Type Panelboards: Single row of overcurrent devices [**with narrow gutter extension**] [**and**] [**overhead junction box equipped with ground and neutral terminal buses**].

1. Column-Type Panelboard Doors: Concealed hinges secured with multipoint latch with tumbler lock; keyed alike.

2.5 LOAD CENTERS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Listing Criteria: Comply with UL 67.

C. Mains: [**Circuit breaker**] [**or**] [**lugs only**].

D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges secured with flush latch with tumbler lock; keyed alike.

F. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

2.6 ELECTRONIC-GRADE PANELBOARDS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Listing Criteria: NEMA PB 1; UL 67; and UL 1449 after installing SPD.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

D. Main Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.

E. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.

F. Factory-Installed, Integral SPD:

1. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase may not be less than [**100 kA**] <**Insert value**>. Peak surge current rating must be arithmetic sum of ratings of individual MOVs in given mode.
2. Protection modes and UL 1449 VPR for grounded wye circuits with [**480Y/277 V**] [**208Y/120 V**], three-phase, four-wire circuits may not exceed the following:

   a. Line to Neutral: [**1200 V for 480Y/277 V**] [**700 V for 208Y/120 V**].
   b. Line to Ground: [**1200 V for 480Y/277 V**] [**700 V for 208Y/120 V**].
   c. Neutral to Ground: [**1200 V for 480Y/277 V**] [**700 V for 208Y/120 V**].
   d. Line to Line: [**2000 V for 480Y/277 V**] [**1200 V for 208Y/120 V**].

3. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits may not exceed the following:

   a. Line to Neutral: 700 V.
   b. Line to Ground: 700 V.
   c. Neutral to Ground: 700 V.
   d. Line to Line: 1200 V.

4. SCCR: Equal to [**SCCR of panelboard in which installed**] [**or exceed 100 kA**] [**or exceed 200 kA**] [**or exceed** <**Insert value**>].
5. Inominal Rating: [**20 kA**] [**10 kA**].

G. Buses:

1. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
2. Copper equipment and isolated ground buses.

2.7 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. MCCB: Comply with UL 489, with [**series-connected rating**] [**interrupting capacity**] to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:

   a. Inverse time-current element for low-level overloads.
   b. Instantaneous magnetic trip element for short circuits.
   c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

3. Electronic Trip Circuit Breakers:

    a. RMS sensing.
    b. Field-replaceable rating plug or electronic trip.
    c. Digital display of settings, trip targets, and indicated metering displays.
    d. Multi-button keypad to access programmable functions and monitored data.
    e. Ten-event, trip-history log. Each trip event must be recorded with type, phase, and magnitude of fault that caused trip.
    f. Integral test jack for connection to portable test set or laptop computer.
    g. Field-Adjustable Settings:

        1) Instantaneous trip.
        2) Long- and short-time pickup levels.
        3) Long and short time adjustments.
        4) Ground-fault pickup level, time delay, and I squared T response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6 mA trip).
6. GFEP Circuit Breakers: Class B ground-fault protection (30 mA trip).
7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240 V, single-pole configuration.
8. Subfeed Circuit Breakers: Vertically mounted.
9. MCCB Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Breaker handle indicates tripped status.
    c. UL listed for reverse connection without restrictive line or load ratings.
    d. Lugs: [**Compression**] [**Mechanical**] style, suitable for number, size, trip ratings, and conductor materials.
    e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
    f. Ground-Fault Protection: [**Integrally mounted**] [**Remote-mounted**] relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    g. Communication Capability: [**Circuit-breaker-mounted**] [**Universal-mounted**] [**Integral**] [**Din-rail-mounted**] communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
    h. Shunt Trip: [**120 V**] [**24 V**] <**Insert voltage**> trip coil energized from separate circuit, set to trip at [**55**] [**75**] percent of rated voltage.
    i. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in [**on**] [**off**] [**on or off**] position.
    j. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
    k. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage [**without intentional**] [**with field-adjustable 0.1- to 0.6-second**] time delay.
    l. Rating Plugs: Three-pole breakers with ampere ratings greater than [**150**] <**Insert value**> A must have interchangeable rating plugs or electronic adjustable trip units.
    m. Auxiliary Contacts: [**One, SPDT switch**] [**Two, SPDT switches**] with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
    n. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
    o. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.

p. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
q. Multipole units enclosed in [**single housing with single handle**] [**or**] [**factory assembled to operate as single unit**].

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

1. Fuses and Spare-Fuse Cabinet: Comply with requirements specified in Section 262813 "Fuses."
2. Fused Switch Features and Accessories:

a. Standard ampere ratings and number of poles.
b. Mechanical cover interlock with manual interlock override, to prevent opening of cover when switch is in on position. Interlock must prevent switch from being turned on with cover open. Operating handle must have lock-off means with provisions for three padlocks.
c. Auxiliary Contacts: [**One**] [**Two**] normally open and normally closed contact(s) that operate with switch handle operation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards in accordance with [**NECA 407**] [**NEMA PB 1.1**].

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Panelboards: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with [**NECA 407**] [**NEMA PB 1.1**].
2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Equipment Mounting:

a. Install panelboards on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

b. Attach panelboard to vertical finished or structural surface behind panelboard.
c. Mount surface-mounted panelboards to steel slotted supports [**5/8 inch (16 mm)**] [**1-1/4 inch (32 mm)**] in depth. Orient steel slotted supports vertically.
d. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
3. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
4. Mount top of trim [**7.5 ft (2.3 m)**] <**Insert height**> above finished floor unless otherwise indicated.
5. Mount panelboard cabinet plumb and rigid without distortion of box.
6. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
7. Install overcurrent protective devices and controllers not already factory installed.

a. Set field-adjustable, circuit-breaker trip ranges.
b. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver in accordance with manufacturer's published instructions.

8. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
9. Install filler plates in unused spaces.
10. Stub four 1 inch (25 mm) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in future. Stub four 1 inch (25 mm) empty conduits into raised floor space or below slab not on grade.
11. Arrange conductors in gutters into groups and bundle and wrap with wire ties[**after completing load balancing**].
12. Mount spare fuse cabinet in accessible location.

D. Interfaces with Other Work:

1. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."

B. Panelboard Nameplates: Label each panelboard with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Device Nameplates: Label each branch circuit device in power panelboards with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

E. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles must be located on interior of panelboard door.

F. Breaker Labels: Faceplate must list current rating, UL and IEC certification standards, and AIC rating.

G. Circuit Directory:

1. Provide directory card inside panelboard door, mounted in [**transparent card holder**] [**metal frame with transparent protective cover**].

    a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.

2. Provide computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.

    a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.

3. Create directory to indicate installed circuit loads[**after balancing panelboard loads**]; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

3.4 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Field tests and inspections must be witnessed by [**Architect**] [**Tenant**] [**authorities having jurisdiction**] <**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers[**and low-voltage surge arrestors**] stated in NETA ATS, Paragraph 7.6 Circuit Breakers[**and Paragraph 7.19.1 Surge Arrestors, Low-Voltage**]. [**Do not perform**] [**Perform**] optional tests. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
    c. Instruments and Equipment:

        1) Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Nonconforming Work:

1. Panelboards will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Collect, assemble, and submit test and inspection reports, including certified report that identifies panelboards included and that describes scanning results, with comparisons of two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

F. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**] [**supervise**] field tests and inspections.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges [**as indicated.**] [**as specified in Section 260573.16 "Coordination Studies."**]

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.

1. Measure loads during period of normal facility operations.
2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
4. Tolerance: Maximum difference between phase loads, within panelboard, may not exceed 20 percent.

3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature in accordance with manufacturer's published instructions.

END OF SECTION 01 51 13 00

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SECTION 01 52 13 00 - TEMPORARY FACILITIES AND CONTROLS

1.1 GENERAL

A. Summary
1. This Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

B. Definitions
1. Permanent Enclosure: As determined by the Owner, permanent or temporary roofing is complete, insulated, and weathertight; exterior walls are insulated and weathertight; and all openings are closed with permanent construction or substantial temporary closures.

C. Use Charges
1. General: Cost or use charges for temporary facilities shall be included in the Contract Sum. Allow other entities to use temporary services and facilities without cost, including, but not limited to, the Owner's construction forces, the Owner, occupants of Project, testing agencies, and authorities having jurisdiction.
2. Water Service: Water from the Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
3. Electric Power Service: Electric power from the Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

D. Submittals
1. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.

E. Quality Assurance
1. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
2. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

F. Project Conditions
1. Temporary Use of Permanent Facilities: Installer of each permanent service shall assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before the Owner's acceptance, regardless of previously assigned responsibilities.

1.2 PRODUCTS

A. Materials
1. Pavement: Comply with Division 32 Section(s) "Asphalt Paving" OR "Concrete Paving", **as directed**.
2. Chain-Link Fencing: Minimum 2-inch (50-mm), 0.148-inch- (3.76-mm-) thick, galvanized steel, chain-link fabric fencing; minimum 6 feet (1.8 m) high with galvanized steel pipe posts; minimum 2-3/8-inch- (60-mm-) OD line posts and 2-7/8-inch- (73-mm-) OD corner and pull posts, with 1-5/8-inch- (42-mm-) OD top rails **OR** with galvanized barbed-wire top strand, **as directed**.
3. Portable Chain-Link Fencing: Minimum 2-inch (50-mm), 9-gage, galvanized steel, chain-link fabric fencing; minimum 6 feet (1.8 m) high with galvanized steel pipe posts; minimum 2-3/8-inch- (60-mm-) OD line posts and 2-7/8-inch- (73-mm-) OD corner and pull posts, with 1-5/8-inch- (42-

mm-) OD top and bottom rails. Provide concrete **OR** galvanized steel, **as directed**, bases for supporting posts.
4. Wood Enclosure Fence: Plywood, 6 feet (1.8 m) **OR** 8 feet (2.4 m), **as directed**, high, framed with four 2-by-4-inch (50-by-100-mm) rails, with preservative-treated wood posts spaced not more than 8 feet (2.4 m) apart.
5. Lumber and Plywood: Comply with requirements in Division 06 Section(s) "Rough Carpentry" OR "Miscellaneous Rough Carpentry", **as directed**.
6. Gypsum Board: Minimum 1/2 inch (12.7 mm) thick by 48 inches (1219 mm) wide by maximum available lengths; regular-type panels with tapered edges. Comply with ASTM C 36/C 36M.
7. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
8. Paint: Comply with requirements in Division 09.

B. Temporary Facilities
1. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
2. Common-Use Field Office: Of sufficient size to accommodate needs of construction personnel. Keep office clean and orderly. Furnish and equip offices as follows:
   a. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
   b. Conference room of sufficient size to accommodate meetings of 10 individuals. Provide electrical power service and 120-V ac duplex receptacles, with not less than 1 receptacle on each wall. Furnish room with conference table, chairs, and 4-foot- (1.2-m-) square tack board.
   c. Drinking water and private toilet.
   d. Coffee machine and supplies.
   e. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F (20 to 22 deg C).
   f. Lighting fixtures capable of maintaining average illumination of 20 fc (215 lx) at desk height.
3. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
   a. Store combustible materials apart from building.

C. Equipment
1. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
2. HVAC Equipment: Unless the Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
   a. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
   b. Heating Units: Listed and labeled for type of fuel being consumed, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   c. Permanent HVAC System: If the Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return air grille in system and remove at end of construction.

1.3 EXECUTION

A. Installation, General
1. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

a. For greenfield sites if reduced site disturbance is required for LEED-NC Credit SS 5.1: Locate facilities to limit site disturbance as specified in General Requirements.

2. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

B. Temporary Utility Installation

1. General: Install temporary service or connect to existing service.
   a. Arrange with utility company, the Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
2. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.
   a. Connect temporary sewers to municipal system **OR** private system indicated, **as directed**, as directed by authorities having jurisdiction.
3. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.
   OR
   Water Service: Use of the Owner's existing water service facilities will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to the Owner. At Final Completion, restore these facilities to condition existing before initial use.
   a. Where installations below an outlet might be damaged by spillage or leakage, provide a drip pan of suitable size to minimize water damage. Drain accumulated water promptly from pans.
4. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
   a. Toilets: Use of the Owner's existing toilet facilities will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to the Owner. At Final Completion, restore these facilities to condition existing before initial use.
5. Heating **OR** Heating and Cooling, **as directed**: Provide temporary heating **OR** heating and cooling, **as directed**, required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
6. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.
7. Electric Power Service: Use of the Owner's existing electric power service will be permitted, as long as equipment is maintained in a condition acceptable to the Owner.
   OR
   Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
   a. Install electric power service overhead **OR** underground, **as directed**, unless otherwise indicated.
   b. Connect temporary service to the Owner's existing power source, as directed by the Owner.
8. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
   a. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
   b. Install lighting for Project identification sign.
9. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install one telephone line for each field office.
   a. Provide additional telephone lines for the following:
      1) Provide a dedicated telephone line for each facsimile machine and computer in each field office.

b. At each telephone, post a list of important telephone numbers.
1) Police and fire departments.
2) Ambulance service.
3) Contractor's home office.
4) the Owner's office.
5) the Owner's office.
6) Principal subcontractors' field and home offices.

c. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.

10. Electronic Communication Service: Provide temporary electronic communication service, including electronic mail, in common-use facilities.
a. Provide DSL **OR** T-1 line, **as directed**, in primary field office.

C. Support Facilities Installation

1. General: Comply with the following:
a. Provide incombustible construction for offices, shops, and sheds located within construction area or within 30 feet (9 m) of building lines. Comply with NFPA 241.
b. Maintain support facilities until near Final Completion. Remove before Final Completion. Personnel remaining after Final Completion will be permitted to use permanent facilities, under conditions acceptable to the Owner.

2. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas as indicated **OR** within construction limits indicated, **as directed**, on Drawings.
a. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.

OR

3. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas in same location as permanent roads and paved areas. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
a. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
b. Prepare subgrade and install subbase and base for temporary roads and paved areas according to Division 31 Section "Earth Moving".
c. Recondition base after temporary use, including removing contaminated material, regrading, proofrolling, compacting, and testing.
d. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Final Completion. Repair hot-mix asphalt base-course pavement before installation of final course according to Division 32 Section "Asphalt Paving".

4. Traffic Controls: Comply with requirements of authorities having jurisdiction.
a. Protect existing site improvements to remain including curbs, pavement, and utilities.
b. Maintain access for fire-fighting equipment and access to fire hydrants.

5. Parking: Provide temporary **OR** Use designated areas of the Owner's existing, **as directed**, parking areas for construction personnel.

6. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
a. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties nor endanger permanent Work or temporary facilities.
b. Remove snow and ice as required to minimize accumulations.

7. Project Identification and Temporary Signs: Provide Project identification and other signs as indicated on Drawings, **OR as directed**. Install signs where indicated to inform public and individuals seeking entrance to Project. Unauthorized signs are not permitted.
a. Provide temporary, directional signs for construction personnel and visitors.
b. Maintain and touchup signs so they are legible at all times.

8. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with General Requirements for progress cleaning requirements.
9. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
    a. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
10. Temporary Elevator Use: Refer to Division 14 for temporary use of new elevators.
11. Existing Elevator Use: Use of the Owner's existing elevators will be permitted, as long as elevators are cleaned and maintained in a condition acceptable to the Owner. At Final Completion, restore elevators to condition existing before initial use, including replacing worn cables, guide shoes, and similar items of limited life.
    a. Do not load elevators beyond their rated weight capacity.
    b. Provide protective coverings, barriers, devices, signs, or other procedures to protect elevator car and entrance doors and frame. If, despite such protection, elevators become damaged, engage elevator Installer to restore damaged work so no evidence remains of correction work. Return items that cannot be refinished in field to the shop, make required repairs and refinish entire unit, or provide new units as required.
12. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.
13. Existing Stair Usage: Use of the Owner's existing stairs will be permitted, as long as stairs are cleaned and maintained in a condition acceptable to the Owner. At Final Completion, restore stairs to condition existing before initial use.
    a. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If, despite such protection, stairs become damaged, restore damaged areas so no evidence remains of correction work.
14. Temporary Use of Permanent Stairs: Cover finished, permanent stairs with protective covering of plywood or similar material so finishes will be undamaged at time of acceptance.

D. Security And Protection Facilities Installation
1. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
2. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.
    a. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
3. Stormwater Control: Comply with authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
4. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
5. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Final Completion. Obtain extended warranty for the Owner. Perform control operations lawfully, using environmentally safe materials.
6. Site Enclosure Fence: Before construction operations begin **OR** When excavation begins, **as directed**, furnish and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates.
    a. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations **OR** As indicated on Drawings, **as directed**.
    b. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Provide the Owner with one set of keys, **as directed**.

7. Security Enclosure and Lockup: Install substantial temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.
8. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
9. Covered Walkway: Erect structurally adequate, protective, covered walkway for passage of individuals along adjacent public street(s). Coordinate with entrance gates, other facilities, and obstructions. Comply with regulations of authorities having jurisdiction and requirements indicated on Drawings, **OR as directed**.
   a. Construct covered walkways using scaffold or shoring framing.
   b. Provide wood-plank overhead decking, protective plywood enclosure walls, handrails, barricades, warning signs, lights, safe and well-drained walkways, and similar provisions for protection and safe passage.
   c. Extend back wall beyond the structure to complete enclosure fence.
   d. Paint and maintain in a manner approved by the Owner.
10. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
    a. Where heating or cooling is needed and permanent enclosure is not complete, insulate temporary enclosures.
11. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by the Owner and tenants from fumes and noise.
    a. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire-retardant plywood on construction operations side.
    b. If containment of airborne particles and dust generated by construction activities is critical to occupants of other spaces in building, e.g., occupied healthcare facilities: Construct dustproof partitions with 2 layers of 3-mil (0.07-mm) polyethylene sheet on each side. Cover floor with 2 layers of 3-mil (0.07-mm) polyethylene sheet, extending sheets 18 inches (460 mm) up the sidewalls. Overlap and tape full length of joints. Cover floor with fire-retardant plywood.
       1) Construct vestibule and airlock at each entrance through temporary partition with not less than 48 inches (1219 mm) between doors. Maintain water-dampened foot mats in vestibule.
    c. Insulate partitions to provide noise protection to occupied areas.
    d. Seal joints and perimeter. Equip partitions with dustproof doors and security locks.
    e. Protect air-handling equipment.
    f. Weather strip openings.
    g. Provide walk-off mats at each entrance through temporary partition.
12. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241.
    a. Prohibit smoking in hazardous fire-exposure **OR** construction, **as directed**, areas.
    b. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
    c. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
    d. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

E. Operation, Termination, And Removal
   1. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
   2. Maintenance: Maintain facilities in good operating condition until removal.

a. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

3. Operate Project-identification-sign lighting daily from dusk until 12:00 midnight.
4. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Final Completion.
5. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Final Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
    a. Materials and facilities that constitute temporary facilities are property of Contractor. the Owner reserves right to take possession of Project identification signs.
    b. Remove temporary paving not intended for or acceptable for integration into permanent paving. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
    c. At Final Completion, clean and renovate permanent facilities used during construction period. Comply with final cleaning requirements specified in General Requirements

END OF SECTION 01 52 13 00

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Task	Specification	Specification Description
01 52 13 00	01 22 16 00	No Specification Required
01 52 19 00	01 22 16 00	No Specification Required
01 52 19 00	01 52 13 00	Temporary Facilities and Controls
01 53 16 00	01 22 16 00	No Specification Required

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SECTION 01 54 23 00 - SCAFFOLDING TUBULAR STEEL

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of scaffolding-tubular steel. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals

1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Tubular steel or aluminum scaffolding system shall comply with OSHA Safety and Health Standards, Section 29 CFR, 1926/1910.

1.3 EXECUTION - (Section not used.)

END OF SECTION 01 54 23 00

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SECTION 01 54 23 00a - UNIT MASONRY ASSEMBLIES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for unit masonry assemblies. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes unit masonry assemblies consisting of the following:
      a. Concrete masonry units (CMUs).
      b. Decorative concrete masonry units.
      c. Pre-faced concrete masonry units.
      d. Concrete brick.
      e. Face brick.
      f. Building (common) brick.
      g. Hollow brick.
      h. Glazed brick.
      i. Structural-clay facing tile.
      j. Firebox brick.
      k. Clay flue lining units.
      l. Stone trim units.
      m. Mortar and grout.
      n. Reinforcing steel.
      o. Masonry joint reinforcement.
      p. Ties and anchors.
      q. Embedded flashing.
      r. Miscellaneous masonry accessories.
      s. Masonry-cell insulation.
      t. Cavity-wall insulation.

C. Definitions
   1. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

D. Performance Requirements
   1. Provide structural unit masonry that develops indicated net-area compressive strengths (f'_m) at 28 days.
   2. Determine net-area compressive strength (f'_m) of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602 **OR** Tables 2105.2 in the International Building Code, **as directed**.
      OR
      Determine net-area compressive strength (f'_m) of masonry by testing masonry prisms according to ASTM C 1314 **OR** IBC Standard, **as directed**.

E. Submittals
   1. Product Data: For each type of product indicated.
   2. Shop Drawings: For reinforcing steel. Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.
   3. Samples for each type and color of exposed masonry units and colored mortars.

4. Material Certificates: For each type of product indicated. Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards.
5. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
   a. For masonry units include material test reports substantiating compliance with requirements.
6. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.

F. Quality Assurance
1. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing indicated below.
   a. Clay Masonry Unit Test: For each type of unit required, per ASTM C 67.
   b. Concrete Masonry Unit Test: For each type of unit required, per ASTM C 140.
   c. Mortar Test (Property Specification): For each mix required, per ASTM C 780 **OR** IBC Standard, **as directed**.
   d. Grout Test (Compressive Strength): For each mix required, per ASTM C 1019 **OR** IBC Standard, **as directed**.
2. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by other means, as acceptable to authorities having jurisdiction.
3. Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects.
   a. Build sample panels for each type of exposed unit masonry construction **OR** typical exterior wall, **as directed,** in sizes approximately 48 inches (1200 mm) long by 48 inches (1200 mm) high.

G. Delivery, Storage, And Handling
1. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
2. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
3. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
4. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.
5. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

H. Project Conditions
1. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602 **OR** Section 2104.3 in the International Building Code, **as directed**.
2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1.2 PRODUCTS

A. Concrete Masonry Units (CMUs)
1. Shapes: Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Integral Water Repellent: Provide units made with liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength for exposed units and where indicated.
3. Concrete Masonry Units: ASTM C 90 **OR** IBC Standard, **as directed**.
a. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi (13.1 MPa) **OR** 2150 psi (14.8 MPa) **OR** 2800 psi (19.3 MPa) **OR** 3050 psi (21.0 MPa), **as directed**.
b. Weight Classification: Lightweight **OR** Medium weight **OR** Normal weight, **as directed**.
4. Decorative Concrete Masonry Units: ASTM C 90 **OR** IBC Standard, **as directed**.
a. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi (13.1 MPa) **OR** 2150 psi (14.8 MPa) **OR** 2800 psi (19.3 MPa) **OR** 3050 psi (21.0 MPa), **as directed**.
b. Weight Classification: Lightweight **OR** Medium weight **OR** Normal weight, **as directed**.
c. Pattern and Texture:
1) Standard pattern, ground finish.
2) Standard pattern, split-face finish.
3) Standard pattern, split-ribbed finish.
4) Scored vertically, standard finish.
5) Triple scored vertically, standard finish.
5. Pre-faced Concrete Masonry Units: Lightweight hollow **OR** solid, **as directed,** concrete units complying with ASTM C 90 **OR** IBC Standard, **as directed**, with manufacturer's standard smooth resinous facing complying with ASTM C 744.
a. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi (13.1 MPa) **OR** 2150 psi (14.8 MPa) **OR** 2800 psi (19.3 MPa) **OR** 3050 psi (21.0 MPa), **as directed**.
b. Size: Manufactured with pre-faced surfaces having 1/16-inch- (1.5-mm-) wide returns of facing to create 1/4-inch- (6.5-mm-) wide mortar joints with modular coursing.
6. Concrete Building Brick: ASTM C 55 **OR** IBC Standard, **as directed**.
a. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2500 psi (17.3 MPa) **OR** 3500 psi (24.1 MPa), **as directed**.
b. Weight Classification: Lightweight **OR** Medium weight **OR** Normal weight, **as directed**.

B. Concrete And Masonry Lintels
1. General: Provide either concrete or masonry lintels, at Contractor's option, complying with requirements below.
2. Concrete Lintels:
a. Precast units matching concrete masonry units and with reinforcing bars indicated or required to support loads indicated.
OR
Precast or formed-in-place concrete lintels complying with requirements in Division 03 Section "Cast-in-place Concrete".
3. Masonry Lintels: Made from bond beam concrete masonry units with reinforcing bars placed as indicated and filled with coarse grout.

C. Brick
1. General: Provide shapes indicated and as follows:
a. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
b. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

2. Face Brick: ASTM C 216 **OR** IBC Standard, **as directed**, Grade SW **OR** MW or SW, **as directed**, Type FBX **OR** FBS **OR** FBA, **as directed**.
   a. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3000 psi (20.7 MPa) **OR** 4400 psi (30.3 MPa) **OR** 5500 psi (37.9 MPa) **OR** 6400 psi (44.1 MPa) **OR** 8000 psi (55.2 MPa) **OR** 8400 psi (57.9 MPa), **as directed**.
   b. Initial Rate of Absorption: Less than 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested per ASTM C 67.
   c. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
   d. Surface Coating: Brick with colors or textures produced by application of coatings shall withstand 50 cycles of freezing and thawing per ASTM C 67 with no observable difference in the applied finish when viewed from 10 feet (3 m).
   e. Size: **As directed**.
3. Building (Common) Brick: ASTM C 62 **OR** IBC Standard, **as directed**, Grade SW **OR** MW or SW **OR** NW, MW, or SW, **as directed**.
   a. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3000 psi (20.7 MPa) **OR** 4400 psi (30.3 MPa) **OR** 5500 psi (37.9 MPa) **OR** 6400 psi (44.1 MPa) **OR** 8000 psi (55.2 MPa) **OR** 8400 psi (57.9 MPa), **as directed**.
   b. Size: Match size of face brick.
4. Hollow Brick: ASTM C 652 **OR** IBC Standard, **as directed**, Grade SW **OR** MW or SW, **as directed**, Class H40V (void areas between 25 and 40 percent of gross cross-sectional area) **OR** H60V (void areas between 40 and 60 percent of gross cross-sectional area) , **as directed**, Type HBX **OR** HBS **OR** HBA **OR** HBB, **as directed**.
   a. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3000 psi (20.7 MPa) **OR** 4400 psi (30.3 MPa) **OR** 5500 psi (37.9 MPa) **OR** 6400 psi (44.1 MPa) **OR** 8000 psi (55.2 MPa) **OR** 8400 psi (57.9 MPa), **as directed**.
   b. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
   c. Surface Coating: Brick with colors or textures produced by application of coatings shall withstand 50 cycles of freezing and thawing per ASTM C 67 with no observable difference in the applied finish when viewed from 10 feet (3 m).
   d. Size: **As directed**.
5. Glazed Face Brick: ASTM C 216 **OR** IBC Standard, **as directed**, Grade SW **OR** MW or SW, **as directed**, Type FBX **OR** FBS **OR** FBA, **as directed**; with glaze complying with ASTM C 126.
6. Glazed Face Brick: ASTM C 1405, Class Exterior **OR** Interior, **as directed**, Grade S (Select) **OR** SS (Select Sized or Ground Edge), **as directed**.
7. Glazed Face Brick: Either ASTM C 1405, Class Exterior **OR** Interior, **as directed**, Grade S (Select) or ASTM C 216 **OR** IBC Standard, **as directed**, Grade SW **OR** MW or SW, **as directed**, Type FBX; with glaze complying with ASTM C 126.
8. Glazed Hollow Brick: Hollow brick complying with ASTM C 652 **OR** IBC , **as directed**, Grade SW **OR** MW or SW, **as directed**, Class H40V (void areas between 25 and 40 percent of gross cross-sectional area) **OR** H60V (void areas between 40 and 60 percent of gross cross-sectional area), **as directed**, Type HBX **OR** HBS **OR** HBA, **as directed**; with glaze complying with ASTM C 126.
   a. Size: **As directed**.
   b. Provide Type I (single-faced units) where only one finished face is exposed when units are installed, and Type II (double-faced units) where two opposite finished faces are exposed when units are installed.

D. Structural-Clay Facing Tile
1. General:
   a. Provide solid, multicored, or hollow units, with shape and direction of cores optional, unless otherwise indicated.
   b. Provide multicored units designed for use in reinforced, grouted masonry.
   c. Provide special shapes where required for corners, jambs, coved bases, sills, and other special conditions indicated that cannot be produced by sawing standard units.

2. Glazed Structural-Clay Facing Tile: ASTM C 126, Grade S (Select) **OR** SS (Select Sized or Ground Edged), **as directed**.
   a. Size: **As directed**.
   b. Provide Type I (single-faced units) where only one finished face is exposed when units are installed, and Type II (double-faced units) where two opposite finished faces are exposed when units are installed.
3. Unglazed Structural-Clay Facing Tile: ASTM C 212, Type FTX **OR** FTS, **as directed**, Standard **OR** Special-Duty, **as directed,** class.
   a. Number of Faces: Single faced where only one finished face is exposed when units are installed **OR** Double faced where both finished faces are exposed when units are installed, **as directed**.

E. Fireplace And Chimney Lining Units
1. Firebox Brick: ASTM C 1261, size required to produce lining thickness indicated.
2. Clay Flue Lining Units: ASTM C 315.

F. Stone Trim Units
1. Granite: ASTM C 615.
   a. Description: Fine **OR** Medium, **as directed**,-grained, white **OR** pink **OR** gray **OR** black, **as directed,** stone. Uniform pattern, without veining.
2. Limestone: ASTM C 568, Classification I Low **OR** II Medium **OR** III High, **as directed**,-Density.
3. Marble: ASTM C 503, Classification I Calcite **OR** II Dolomite **OR** III Serpentine **OR** IV Travertine, **as directed**.
   a. Description: Uniform, fine- to medium-grained, white stone with only slight veining.
4. Quartz-Based Stone: ASTM C 616, Classification I Sandstone **OR** II Quartzitic Sandstone **OR** III Quartzite, **as directed**.
5. Finish: Polished **OR** Honed **OR** Smooth **OR** Machine tooled, 4 bats per 1 inch (25 mm) **OR** Machine tooled, 6 bats per 1 inch (25 mm) **OR** Machine tooled, 8 bats per 1 inch (25 mm) **OR** Chat sawed **OR** Split face **OR** Rock face (pitched face), **as directed**.
   a. Finish for Tops of Sills and Soffits of Lintels: Sand rubbed **OR** Split face, **as directed**.
6. Provide stone units accurately shaped, with exposed faces dressed true, and with beds and joints at right angles to faces.
   a. For granite, comply with recommendations in NBGQA's "Specifications for Architectural Granite."
   b. For limestone, comply with recommendations in ILI's "Indiana Limestone Handbook."
   c. For marble, comply with recommendations in MIA's "Dimensional Stone--Design Manual IV."

G. Mortar And Grout Materials
1. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction.
2. Hydrated Lime: ASTM C 207 **OR** IBC Standard, **as directed**, Type S.
3. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207, Type S.
4. Masonry Cement: ASTM C 91 **OR** IBC Standard, **as directed**.
5. Mortar Cement: ASTM C 1329 **OR** IBC Standard, **as directed**.
6. Mortar Pigments: Iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar.
7. Colored Cement Product: Packaged blend made from portland cement and lime or masonry cement and mortar pigments, all complying with specified requirements, and containing no other ingredients.
   a. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
   b. Pigments shall not exceed 10 percent of portland cement by weight.
   c. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.
8. Aggregate for Mortar: ASTM C 144.

a. For joints less than 1/4 inch (6.5 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.
b. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
c. White-Mortar Aggregates: Natural white sand or crushed white stone.
d. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

9. Aggregate for Grout: ASTM C 404.
10. Epoxy Pointing Mortar: ASTM C 395, epoxy-resin-based material formulated for use as pointing mortar for structural-clay tile facing units.
11. Refractory Mortar Mix: Ground fireclay or non-water-soluble, calcium aluminate, medium-duty refractory mortar that passes ASTM C 199 test; or an equivalent product acceptable to authorities having jurisdiction.
12. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
13. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with concrete masonry units, containing integral water repellent by same manufacturer.
14. Water: Potable.

H. Reinforcement

1. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60 (Grade 420).
2. Masonry Joint Reinforcement, General: ASTM A 951 **OR** IBC Standard, **as directed**.
   a. Interior Walls: Mill- **OR** Hot-dip, **as directed,** galvanized, carbon steel.
   b. Exterior Walls: Hot-dip galvanized, carbon **OR** Stainless, **as directed,** steel.
   c. Wire Size for Side Rods: W1.7 or 0.148-inch (3.8-mm) **OR** W2.8 or 0.188-inch (4.8-mm), **as directed,** diameter.
   d. Wire Size for Cross Rods: W1.7 or 0.148-inch (3.8-mm) **OR** W2.8 or 0.188-inch (4.8-mm), **as directed** diameter.
   e. Wire Size for Veneer Ties: W1.7 or 0.148-inch (3.8-mm) **OR** W2.8 or 0.188-inch (4.8-mm), **as directed** diameter.
   f. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches (407 mm) o.c.
   g. Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.
   h. Multiwythe Masonry:
      1) Ladder type with 1 side rod at each face shell of hollow masonry units more than 4 inches (100 mm) in width, plus 1 side rod at each wythe of masonry 4 inches (100 mm) or less in width.
      2) Tab type, with 1 side rod at each face shell of backing wythe and with rectangular tabs sized to extend at least halfway through facing wythe but with at least 5/8-inch (16-mm) cover on outside face.
      3) Adjustable (two-piece) type, with one side rod at each face shell of backing wythe and with ties that extend into facing wythe. Ties engage eyes or slots in reinforcement and extend at least halfway through facing wythe but with at least 5/8-inch (16-mm) cover on outside face. Ties have hooks or clips to engage a continuous wire in the facing wythe.
   i. Veneers Anchored with Seismic Masonry-Veneer Anchors: Single 0.188-inch- (4.8-mm-) diameter, hot-dip galvanized, carbon-steel continuous wire.

I. Ties And Anchors

1. Materials:
   a. Mill-Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 641/A 641M, Class 1 coating.
   b. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153/A 153M, Class B-2 coating.

c. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304 **OR** 316, **as directed**.
d. Galvanized Steel Sheet: ASTM A 653/A 653M, Commercial Steel, G60 (Z180) zinc coating.
e. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, hot-dip galvanized after fabrication to comply with ASTM A 153/A 153M.
f. Stainless-Steel Sheet: ASTM A 666, Type 304 **OR** 316, **as directed**.
g. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
h. Stainless Steel bars: ASTM A 276 or ASTM a 666, Type 304.

2. Corrugated Metal Ties: Metal strips not less than 7/8 inch (22 mm) wide with corrugations having a wavelength of 0.3 to 0.5 inch (7.6 to 12.7 mm) and an amplitude of 0.06 to 0.10 inch (1.5 to 2.5 mm) made from steel sheet, galvanized after fabrication **OR** stainless-steel sheet, **as directed**, not less than 0.043 inch (1.1 mm) **OR** 0.053 inch (1.3 mm) **OR** 0.067 inch (1.7 mm) **OR** 0.097 inch (2.5 mm), **as directed**, thick. Ties made from galvanized steel sheet may be used in interior walls, unless otherwise indicated.
3. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch (16-mm) cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches (50 mm) parallel to face of veneer.
4. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches (100 mm) wide.
   a. Z-shaped ties with ends bent 90 degrees to provide hooks not less than 2 inches (50 mm) long may be used for masonry constructed from solid units or hollow units laid with cells horizontal.
   b. Where wythes do not align **OR** are of different materials, **as directed**, use adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches (32 mm).
   c. Wire: Fabricate from 3/16-inch- (4.8-mm-) **OR** 1/4-inch- (6.4-mm-), **as directed,** diameter, hot-dip galvanized steel **OR** stainless-steel, **as directed,** wire. Mill-galvanized wire ties may be used in interior walls, unless otherwise indicated.
5. Adjustable Anchors for Connecting to Structure: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
   a. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- (6.4-mm-) diameter, hot-dip galvanized steel **OR** stainless-steel, **as directed,** wire. Mill-galvanized wire may be used at interior walls, unless otherwise indicated.
   b. Tie Section for Steel Frame: Triangular-shaped wire tie, sized to extend within 1 inch (25 mm) of masonry face, made from 0.188-inch- (4.8-mm-) **OR** 0.25-inch- (6.4-mm-), **as directed**, diameter, hot-dip galvanized steel **OR** stainless-steel, **as directed** wire. Mill-galvanized wire may be used at interior walls, unless otherwise indicated.
   c. Connector Section for Concrete: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.053-inch- (1.3-mm-) thick, steel sheet, galvanized after fabrication **OR** 0.097-inch- (2.5-mm-) thick, steel sheet, galvanized after fabrication **OR** 0.062-inch- (1.6-mm-) thick, stainless-steel sheet **OR** 0.109-inch- (2.8-mm-) thick, stainless-steel sheet, **as directed**. 0.064-inch- (1.6-mm-) **OR** 0.108-inch- (2.7-mm-), **as directed**, thick, galvanized sheet may be used at interior walls, unless otherwise indicated.
   d. Tie Section for Concrete: Corrugated metal ties with dovetail tabs for inserting into dovetail slots in concrete and sized to extend to within 1 inch (25 mm) of masonry face.
6. Partition Top anchors: 0.097-inch- (2.5-mm-) thick metal plate with 3/8-inch- (10-mm-) diameter metal rod 6 inches (150 mm) long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication **OR** stainless-steel, **as directed**.
7. Rigid Anchors: Fabricate from steel bars 1-1/2 inches (38 mm) wide by 1/4 inch (6.4 mm) thick by 24 inches (600 mm) long, with ends turned up 2 inches (50 mm) or with cross pins.
   a. Corrosion Protection: Hot-dip galvanized to comply with ASTM A 153/A 153M **OR** Epoxy coating 0.020 inch (0.51 mm) thick **OR** Rust-inhibitive paint, **as directed**.
8. Stone Anchors: Fabricate dowels, cramps, and other stone anchors from stainless steel.
9. Adjustable Masonry-Veneer Anchors

a. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:
   1) Structural Performance Characteristics: Capable of withstanding a 100-lbf (445-N) load in both tension and compression without deforming or developing play in excess of 0.05 inch (1.3 mm).
b. Screw-Attached, Masonry-Veneer Anchors: Units consisting of a wire tie and a metal anchor section.
   1) Anchor Section:
      a) Rib-stiffened, sheet metal plate with screw holes top and bottom, and slotted holes for inserting wire tie.
      b) Sheet metal plate with screw holes top and bottom and with raised rib-stiffened strap, stamped into center to provide a slot between strap and plate for inserting wire tie.
      c) Gasketed sheet metal plate with screw holes top and bottom; top and bottom ends bent to form pronged legs of length to match thickness of insulation or sheathing; and raised rib-stiffened strap, stamped into center to provide a slot between strap and plate for inserting wire tie. Provide anchor manufacturer's standard, self-adhering, modified bituminous gaskets manufactured to fit behind anchor plate and extend beyond pronged legs.
   2) Fabricate sheet metal anchor sections and other sheet metal parts from 0.067-inch- (1.7-mm-) thick, steel sheet, galvanized after fabrication **OR** 0.097-inch- (2.5-mm-) thick, steel sheet, galvanized after fabrication **OR** 0.078-inch- (2.0-mm-) thick, stainless-steel sheet **OR** 0.109-inch- (2.8-mm-) thick, stainless-steel sheet, **as directed**.
   3) Wire Ties: Triangular-, rectangular-, or T-shaped wire ties fabricated from 0.188-inch- (4.8-mm-) **OR** 0.25-inch- (6.4-mm-), **as directed**, diameter, hot-dip galvanized steel **OR** stainless-steel, **as directed,** wire.
c. Slip-in, Masonry-Veneer Anchors: Units consisting of a wire tie section and an anchor section designed to interlock with metal studs and be slipped into place as sheathing is installed.
   1) Wire-Type Anchor: Bent wire anchor section with an eye to receive the wire tie. Wire tie has a vertical leg that slips into the eye of anchor section and allows vertical adjustment. Both sections are made from 3/16-inch (4.8-mm), hot-dip galvanized wire.
   2) Strap-and-Wire Type Anchor: Flat metal strap with notch to interlock with flange of metal stud and two holes for inserting vertical legs of wire tie specially formed to fit anchor section. Strap is made from 0.067-inch- (1.7-mm-) thick, steel sheet, galvanized after fabrication; anchor wire tie is made from 3/16-inch (4.8-mm), hot-dip galvanized wire.
d. Seismic Masonry-Veneer Anchors: Units consisting of a metal anchor section and a connector section designed to engage a continuous wire embedded in the veneer mortar joint.
   1) Anchor Section: Rib-stiffened, sheet metal plate with screw holes top and bottom, and slotted holes for inserting connector section.
   2) Connector Section: Rib-stiffened, sheet metal bent plate; sheet metal clip; or wire tie and rigid extruded vinyl clip designed to engage continuous wire. Size connector to extend at least halfway through veneer but with at least 5/8-inch (16-mm) cover on outside face.
   3) Fabricate sheet metal anchor sections and other sheet metal parts from 0.067-inch- (1.7-mm-) thick, steel sheet, galvanized after fabrication **OR** 0.097-inch- (2.5-mm-) thick, steel sheet, galvanized after fabrication **OR** 0.078-inch- (2.0-mm-) thick, stainless-steel sheet **OR** 0.109-inch- (2.8-mm-) thick, stainless-steel sheet, **as directed**.

4) Fabricate wire connector sections from 0.188-inch- (4.8-mm-) -**OR** 0.25-inch- (6.4-mm-), **as directed**, diameter, hot-dip galvanized, carbon **OR** stainless, **as directed,**- steel wire.

e. Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C 954 except manufactured with hex washer head and neoprene washer, No. 10 (4.8-mm) diameter by length required to penetrate steel stud flange with not less than 3 exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours per ASTM B 117.

f. Stainless-Steel Drill Screws for Steel Studs: Proprietary fastener consisting of carbon-steel drill point and 300 Series stainless-steel shank, complying with ASTM C 954 except manufactured with hex washer head and neoprene washer, No. 10 (4.8-mm) diameter by length required to penetrate steel stud flange with not less than three exposed threads.

J. Miscellaneous Anchors

1. Unit Type Inserts in Concrete: Cast-iron or malleable-iron wedge-type inserts.
2. Dovetail Slots in Concrete: Furnish dovetail slots with filler strips, of slot size indicated, fabricated from 0.034-inch (0.9-mm), galvanized steel sheet.
3. Anchor Bolts: Headed or L-shaped steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.
4. Postinstalled Anchors: Provide chemical or torque-controlled expansion anchors, with capability to sustain, without failure, a load equal to six times the load imposed when installed in solid or grouted unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
   a. Corrosion Protection:
      1) Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (5 microns) for Class SC 1 service condition (mild).
      2) Stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Alloy Group 1 or 4) for bolts and nuts; ASTM A 666 or ASTM A 276, Type 304 or 316, for anchors.

K. Embedded Flashing Materials

1. Metal Flashing: Provide metal flashing, where flashing is exposed or partly exposed and where indicated, complying with SMACNA's "Architectural Sheet Metal Manual OR Division 07 Section "Sheet Metal Flashing And Trim" as directed.
   a. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch (0.4 mm) thick.
   b. Copper: ASTM B 370, Temper H00 or H01, cold-rolled copper sheet, 10-oz./sq. ft. (3-kg/sq. m) weight or 0.0135 inch (0.34 mm) thick for fully concealed flashing; 16-oz./sq. ft. (5-kg/sq. m) weight or 0.0216 inch (0.55 mm) thick elsewhere.
   c. Fabricate continuous flashings in sections 96 inches (2400 mm) long minimum, but not exceeding 12 feet (3.6 m). Provide splice plates at joints of formed, smooth metal flashing.
   d. Fabricate through-wall metal flashing embedded in masonry from stainless steel **OR** copper, **as directed**, with ribs at 3-inch (75-mm) intervals along length of flashing to provide an integral mortar bond.
   e. Metal Drip Edges: Fabricate from stainless steel. Extend at least 3 inches (75 mm) into wall and 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed.
   f. Metal Flashing Terminations: Fabricate from stainless steel. Extend at least 3 inches (75 mm) into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch (19 mm) and down into joint 3/8 inch (10 mm) to form a stop for retaining sealant backer rod.
   g. Metal Expansion-Joint Strips: Fabricate from stainless steel **OR** copper, **as directed,** to shapes indicated.
2. Flexible Flashing: For flashing not exposed to the exterior, use one of the following, unless otherwise indicated:

a. Copper-Laminated Flashing: 5-oz./sq. ft. (1.5-kg/sq. m) **OR** 7-oz./sq. ft. (2-kg/sq. m), **as directed**, copper sheet bonded with asphalt between 2 layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.

b. Asphalt-Coated Copper Flashing: 5-oz./sq. ft. (1.5-kg/sq. m) **OR** 7-oz./sq. ft. (2-kg/sq. m), **as directed**, copper sheet coated with flexible asphalt. Use only where flashing is fully concealed in masonry.

c. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.030 inch (0.8 mm) **OR** 0.040 inch (1.0 mm), **as directed**.

d. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymer alloy 0.025 inch (0.6 mm) thick, with a 0.015-inch- (0.4-mm-) thick coating of rubberized-asphalt adhesive.

e. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D 4637, 0.040 inch (1.0 mm) thick.

3. Single-Wythe CMU Flashing System: System of CMU cell flashing pans and interlocking CMU web covers made from high-density polyethylene incorporating chemical stabilizers that prevent UV degradation. Cell flashing pans have integral weep spouts that are designed to be built into mortar bed joints and weep collected moisture to the exterior of CMU walls and that extend into the cell to prevent clogging with mortar.

4. Solder and Sealants for Sheet Metal Flashings:

a. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.

b. Solder for Copper: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.

c. Elastomeric Sealant: ASTM C 920, chemically curing urethane **OR** polysulfide silicone **as directed,** sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

5. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer.

L. Miscellaneous Masonry Accessories

1. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; formulated from neoprene, urethane or PVC.

2. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall.

3. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

4. Weep/Vent Products: Use one of the following, unless otherwise indicated:

a. Wicking Material: Absorbent rope, made from cotton or UV-resistant synthetic fiber, 1/4 to 3/8 inch (6 to 10 mm) in diameter, in length required to produce 2-inch (50-mm) exposure on exterior and 18 inches (450 mm) in cavity between wythes. Use only for weeps.

b. Round Plastic Weep/Vent Tubing: Medium-density polyethylene, 3/8-inch (9-mm) OD by 4 inches (100 mm) long.

c. Rectangular Plastic Weep/Vent Tubing: Clear butyrate, 3/8 by 1-1/2 by 3-1/2 inches (9 by 38 by 89 mm) long.

d. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch (3 mm) less than depth of outer wythe, in color selected from manufacturer's standard.

e. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch (3 mm) less than depth of outer wythe; in color selected from manufacturer's standard.

f. Aluminum Weep Hole/Vent: One-piece, L-shaped units made from sheet aluminum, designed to fit into a head joint and consisting of a vertical channel with louvers stamped in web and with a top flap to keep mortar out of the head joint; painted before installation to comply with Division 09 Section(s) "Exterior Painting" OR "Interior Painting", in color approved to match that of mortar.

g. Vinyl Weep Hole/Vent: One-piece, offset, T-shaped units made from flexible, injection-molded PVC, designed to fit into a head joint and consisting of a louvered vertical leg, flexible wings to seal against ends of masonry units, and a top flap to keep mortar out of the head joint; in color approved by Architect to match that of mortar.

5. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
   a. Provide one of the following configurations:
      1) Strips, full-depth of cavity and 10 inches (250 mm) wide, with dovetail shaped notches 7 inches (175 mm) deep.
      2) Strips, not less than 1-1/2 inches (38 mm) thick and 10 inches (250 mm) wide, with dimpled surface designed to catch mortar droppings and prevent weep holes from being clogged with mortar.
      3) Sheets or strips full depth of cavity and installed to full height of cavity.
6. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells. Units are formed from 0.142-inch (3.6-mm) steel wire, hot-dip galvanized after fabrication. Provide units with either two loops or four loops as needed for number of bars indicated.

M. Insulation
1. Loose-Granular Fill Insulation: Perlite complying with ASTM C 549, Type II (surface treated for water repellency and limited moisture absorption) or Type IV (surface treated for water repellency and to limit dust generation).
2. Molded-Polystyrene Insulation Units: Rigid, cellular thermal insulation formed by the expansion of polystyrene-resin beads or granules in a closed mold to comply with ASTM C 578, Type I. Provide specially shaped units designed for installing in cores of masonry units.
3. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV **OR** X, **as directed**, closed-cell product extruded with an integral skin.
4. Molded-Polystyrene Board Insulation: ASTM C 578, Type I.
5. Polyisocyanurate Board Insulation: ASTM C 1289, Type I (aluminum-foil-faced), Class 2 (glass-fiber-reinforced).
6. Adhesive: Type recommended by insulation board manufacturer for application indicated.

N. Masonry Cleaners
1. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains from new masonry without damaging masonry. Use product approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

O. Mortar And Grout Mixes
1. General: Do not use admixtures, unless otherwise indicated.
   a. Do not use calcium chloride in mortar or grout.
   b. Limit cementitious materials in mortar for exterior and reinforced masonry to portland cement and lime.
   c. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
2. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
3. Mortar for Unit Masonry: Comply with ASTM C 270 **OR** BIA Technical Notes 8A **OR** IBC Standard, **as directed,** Proportion Specification.
4. Mortar for Unit Masonry: Comply with ASTM C 270 **OR** BIA Technical Notes 8A **OR** IBC Standard, **as directed,** Property Specification.
   a. For masonry below grade or in contact with earth, use Type M **OR** S, **as directed**.
   b. For reinforced masonry, use Type S **OR** N, **as directed**.
   c. For mortar parge coats, use Type S or N.

d. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.
e. For interior non-load-bearing partitions, Type O may be used instead of Type N.

5. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
   a. Pigments shall not exceed 10 percent of portland cement by weight.
   b. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.
6. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
7. Grout for Unit Masonry: Comply with ASTM C 476 **OR** IBC Standard, **as directed**.
   a. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 **OR** Table 21-C in the International Building Code, **as directed,** for dimensions of grout spaces and pour height.
   b. Provide grout with a slump of 8 to 11 inches (200 to 280 mm) as measured according to ASTM C 143/C 143M.
8. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's written instructions.

1.3 EXECUTION

A. Installation, General
1. Use full-size units without cutting if possible. If cutting is required, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
2. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
3. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.
4. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.
5. Comply with tolerances in ACI 530.1/ASCE 6/TMS 602 and with the following:
   a. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
   b. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.

B. Laying Masonry Walls
1. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
2. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.
3. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
4. Fill space between steel frames and masonry solidly with mortar, unless otherwise indicated.
5. Fill cores in hollow concrete masonry units with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

C. Mortar Bedding And Jointing

1. Lay hollow brick and concrete masonry units as follows:
   a. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
   b. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
   c. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
   d. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
2. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
3. Lay structural-clay tile as follows:
   a. Lay vertical-cell units with full head joints, unless otherwise indicated. Provide bed joints with full mortar coverage on face shells and webs.
   b. Lay horizontal-cell units with full bed joints, unless otherwise indicated. Keep drainage channels, if any, free of mortar. Form head joints with sufficient mortar so excess will be squeezed out as units are placed in position.
   c. Maintain joint thicknesses indicated except for minor variations required to maintain bond alignment. If not indicated, lay walls with 1/4- to 3/8-inch- (6- to 10-mm-) thick joints.
   d. Where epoxy-mortar pointed joints are indicated, rake out setting mortar to a uniform depth of 1/4 inch (6 mm) and point with epoxy mortar.
4. Set firebox brick in full bed of refractory mortar with full head joints. Form joints by buttering both surfaces of adjoining brick and sliding it into place. Make joints just wide enough to accommodate variations in size of brick, approximately 1/8 inch (3 mm). Tool joints smooth on surfaces exposed to fire or smoke.
5. Install clay flue liners to comply with ASTM C 1283. Install flue liners ahead of surrounding masonry. Set clay flue liners in full bed of refractory mortar 1/16 to 1/8 inch (1.6 to 3 mm) thick. Strike joints flush on inside of flue to provide smooth surface. Maintain expansion space between flue liner and surrounding masonry except where surrounding masonry is required to provide lateral support for flue liners.
6. Set stone **OR** cast-stone, **as directed,** trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.
7. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.
8. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint), unless otherwise indicated.

D. Composite Masonry
1. Bond wythes of composite masonry together using one of the following methods:
   a. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 4.5 sq. ft. (0.42 sq. m) **OR** 2.67 sq. ft. (0.25 sq. m), **as directed**, of wall area spaced not to exceed 36 inches (914 mm) **OR** 24 inches (610 mm), **as directed**, o.c. horizontally and 16 inches (406 mm) o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches (305 mm) of openings and space not more than 36 inches (915 mm) apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches (610 mm) o.c. vertically.
      1) Where bed joints of wythes do not align, use adjustable (two-piece) type ties.
   b. Masonry Joint Reinforcement: Installed in horizontal mortar joints.
      1) Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes **OR** tab-type reinforcement, **as directed**.
      2) Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties.
2. Collar Joints: Solidly fill collar joints by parging face of first wythe that is laid and shoving units of other wythe into place.
3. Collar Joints in Clay Tile Masonry: After each course is laid, fill the vertical, longitudinal joint between wythes solidly with mortar at exterior walls, except cavity walls, and interior walls and partitions.

4. Corners: Provide interlocking masonry unit bond in each wythe and course at corners, unless otherwise indicated.
5. Intersecting and Abutting Walls: Unless vertical expansion or control joints are shown at juncture, bond walls together as follows:
   a. Provide individual metal ties not more than 8 inches (203 mm) **OR** 16 inches (406 mm), **as directed**, o.c.
   b. Provide continuity with masonry joint reinforcement by using prefabricated T-shaped units.
   c. Provide rigid metal anchors not more than 24 inches (610 mm) **OR** 48 inches (1220 mm), **as directed**, o.c. If used with hollow masonry units, embed ends in mortar-filled cores.

E. Cavity Walls
1. Bond wythes of cavity walls together using one of the following methods:
   a. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 4.5 sq. ft. (0.42 sq. m) **OR** 2.67 sq. ft. (0.25 sq. m), **as directed**, of wall area spaced not to exceed 36 inches (914 mm) **OR** 24 inches (610 mm), **as directed**, o.c. horizontally and 16 inches (406 mm) o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches (305 mm) of openings and space not more than 36 inches (915 mm) apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches (610 mm) o.c. vertically.
   b. Masonry Joint Reinforcement: Installed in horizontal mortar joints.
      1) Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes **OR** tab-type reinforcement, **as directed**.
      2) Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties.
      3) Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align.
   c. Masonry Veneer Anchors: Comply with requirements for anchoring masonry veneers.
2. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.
3. Parge cavity face of backup wythe in a single coat approximately 3/8 inch (10 mm) thick. Trowel face of parge coat smooth.
   OR
   Coat cavity face of backup wythe to comply with Division 07 Section "Bituminous Dampproofing".

F. Installing Cavity-Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches (300 mm) o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit insulation between wall ties and other confining obstructions, with edges butted tightly. Press units firmly against inside wythe of masonry.

G. Masonry-Cell Insulation
1. Pour granular insulation into cavities to fill void spaces. Maintain inspection ports to show presence of insulation at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of insulation to 1 story in height, but not more than 20 feet (6 m).
2. Install molded-polystyrene insulation units into masonry unit cells before laying units.

H. Masonry Joint Reinforcement
1. General: Install in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).
2. Interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.
3. Provide continuity at wall intersections by using prefabricated T-shaped units.
4. Provide continuity at corners by using prefabricated L-shaped units.

I. Anchoring Masonry To Structural Members
1. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:
a. Provide an open space not less than 1/2 inch (13 mm) **OR** 1 inch (25 mm), **as directed**, in width between masonry and structural member, unless otherwise indicated.
b. Anchor masonry to structural members with anchors embedded in masonry joints and attached to structure.
c. Space anchors as indicated, but not more than 24 inches (610 mm) o.c. vertically and 36 inches (915 mm) o.c. horizontally.

J. Anchoring Masonry Veneers
1. Anchor masonry veneers to wall framing **OR** concrete and masonry backup, **as directed,** with seismic masonry-veneer anchors to comply with the following requirements:
a. Fasten screw-attached and seismic anchors through sheathing to wall framing and to concrete and masonry backup with metal fasteners of type indicated. Use two fasteners.
b. Insert slip-in anchors in metal studs as sheathing is installed. Provide one anchor at each stud in each horizontal joint between sheathing boards.
c. Embed tie sections **OR** connector sections and continuous wire, **as directed,** in masonry joints. Provide not less than 2 inches (50 mm) of air space between back of masonry veneer and face of sheathing.
d. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
e. Space anchors as indicated, but not more than 16 inches (406 mm) o.c. vertically and 32 inches (813 mm) **OR** 24 inches (610 mm), **as directed**, o.c. horizontally with not less than 1 anchor for each 3.5 sq. ft. (0.33 sq. m) **OR** 2.67 sq. ft. (0.25 sq. m), **as directed**, of wall area. Install additional anchors within 12 inches (305 mm) of openings and at intervals, not exceeding 36 inches (914 mm), around perimeter.

K. Control And Expansion Joints
1. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
2. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Division 07 Section "Joint Sealants", but not less than 3/8 inch (10 mm).
a. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

L. Lintels
1. Provide concrete or masonry lintels where shown and where openings of more than 12 inches (305 mm) for brick-size units and 24 inches (610 mm) for block-size units are shown without structural steel or other supporting lintels.
2. Provide minimum bearing of 8 inches (200 mm) at each jamb, unless otherwise indicated.

M. Flashing, Weep Holes, Cavity Drainage, And Vents
1. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.
2. Install flashing as follows, unless otherwise indicated:
a. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing as recommended by flashing manufacturer.
b. At lintels and shelf angles, extend flashing a minimum of 6 inches (150 mm) into masonry at each end. At heads and sills, extend flashing 6 inches (150 mm) at ends and turn up not less than 2 inches (50 mm) to form end dams.

c. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall and adhere flexible flashing to top of metal drip edge.

d. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall and adhere flexible flashing to top of metal flashing termination.

3. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.
4. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.
5. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
   a. Use specified weep/vent products or open head joints to form weep holes.
   b. Space weep holes 24 inches (600 mm) o.c., unless otherwise indicated.
   c. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.
6. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in Part 2 "Miscellaneous Masonry Accessories" Article.
7. Install vents in head joints in exterior wythes at spacing indicated. Use specified weep/vent products or open head joints to form vents.
   a. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

N. Reinforced Unit Masonry Installation

1. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
   a. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
   b. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.
2. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602 **OR** Section 2104.5 in the International Building Code, **as directed**.
   a. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
   b. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 **OR** Section 2104.6 in the International Building Code, **as directed,** for cleanouts and for grout placement, including minimum grout space and maximum pour height.
   c. Limit height of vertical grout pours to not more than 60 inches (1520 mm).

O. Field Quality Control

1. Inspectors: Engage qualified independent inspectors to perform inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform inspections.
   a. Place grout only after inspectors have verified compliance of grout spaces and grades, sizes, and locations of reinforcement.
2. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections indicated below and prepare test reports:
3. Testing Frequency: One set of tests for each 5000 sq. ft. (465 sq. m) of wall area or portion thereof.
4. Clay Masonry Unit Test: For each type of unit provided, per ASTM C 67.

5. Concrete Masonry Unit Test: For each type of unit provided, per ASTM C 140.
6. Mortar Test (Property Specification): For each mix provided, per ASTM C 780 **OR** IBC Standard, **as directed**. Test mortar for mortar air content and compressive strength.
7. Grout Test (Compressive Strength): For each mix provided, per ASTM C 1019 **OR** IBC Standard, **as directed**.

P. Parging
1. Parge exterior faces of below-grade masonry walls, where indicated, in 2 uniform coats to a total thickness of 3/4 inch (19 mm) with a steel-trowel finish. Form a wash at top of parging and a cove at bottom. Damp-cure parging for at least 24 hours and protect parging until cured.

Q. Cleaning
1. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
2. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
   a. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
   b. Protect adjacent surfaces from contact with cleaner.
   c. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
   d. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
   e. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
   f. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

R. Masonry Waste Disposal
1. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
   a. Do not dispose of masonry waste as fill within 18 inches (450 mm) of finished grade.
   b. Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off the Owner's property.

END OF SECTION 01 54 23 00a

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Task	Specification	Specification Description
01 54 23 00	01 22 16 00	No Specification Required
01 54 26 00	01 22 16 00	No Specification Required
01 55 23 00	01 22 16 00	No Specification Required

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SECTION 01 55 26 00 - TRAFFIC SIGNS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of traffic signs. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCT

A. Sign Foundations:
   1. Replacement Foundation Footing Concrete shall be a mixture of cement complying with ASTM C 150 and aggregate complying with ASTM C 33. Compressive strength shall be 2,800 psi at 28 days.
   2. Sulfur Mortar shall comply with ASTM C 287.
   3. Reinforcing Steel shall comply with ASTM A 615.

B. Sign Supports shall be of the "break-away" type. Supports shall be strong enough to resist applicable wind forces without damage, but shall be designed to experience a brittle rupture type failure or a "quick separation" type joint.
   1. Sign Support, Aluminum:
      a. Replacement Castings shall be Alloy A356.0-T6 in compliance with ASTM B 108.
      b. Replacement Structural Members shall comply with ASTM B 308.
      c. Replacement Bars, Rods, Shapes, and Tubes shall comply with ASTM B 221, alloy 6061-T6.
      d. Replacement Bolts, Nuts, and Screws shall match items being replaced and shall be alloy 2024-T4 with anodic coating complying with ASTM B 580, or 6061-T6 in compliance with ASTM B 211. Bolt heads shall be hexagon. Bolt threads shall be Class 2, 2A, or 2B in compliance with ANSI B18.2.1. Nuts shall be hexagon shaped in compliance with ANSI B18.2.2.
      e. Replacement washers shall be furnished from sheet metal complying with ASTM B 209, alloy Alclad 2024-T3 or T4.
   2. Sign Support, Steel:
      a. Replacement Structural Members shall comply with ASTM A 36.
      b. Replacement Bars shall comply with ASTM A 108.
      c. Replacement Pipe shall comply with ASTM A 53 standard weight.
      d. Replacement Fasteners shall comply with ASTM A 307 and ASTM A 325.
      e. Replacement Anchor Bolts for anchoring base plates to concrete bases and nuts and washers shall be galvanized in compliance with ASTM A 153.
   3. Sign Support, Wood:
      a. Replacement Wood Sign Post shall be of the species listed in AASHTO M168, dressed four sides and having a pyramidal top cut before being treated.
      b. Replacement Sign Post shall be pressure treated with creosote or creosote-tar solution complying with AWPB LP-55.

C. Sign Face:
   1. Replacement Plywood Sign Face shall be grade HDOAB G-1 EXTERIOR, in compliance with DOC PS 1. Material shall be cut to size in compliance with ANSI D6.1E.
   2. Replacement Galvanizing Steel Sign Face shall comply with USDOT FHA MUTCD.

D. Reflective Sheeting shall be enclosed lens unless otherwise directed by the Owner.

1. Enclosed Lens Reflective Sheeting shall comply with Fed. Spec. L-S-300.
2. Reflective Sheeting shall comply with FP-79 minimum reflective intensity. Measurements shall comply with Fed. Spec. L-S-300.
3. Color shall be matched visually and within the limits shown on the Color Tolerance Charts issued by the Federal Highway Administration. The diffuse day color of the reflective sheeting shall be determined in compliance with ASTM E 97.
4. Film:
   a. General: Reflective sheeting shall be sufficiently flexible to be easily cut to shape and permit application over, and conformance to, moderate shallow embossing characteristic of certain sign borders and symbols.
   b. Surface: Sheeting surface shall be smooth and flat, shall facilitate cleaning and wet performance, and shall exhibit 85 degrees glossmeter rating of not less than 40, as specified in ASTM D 523. The sheeting surface shall withstand cleaning with gasoline, VM&P Naphtha, mineral spirits, turpentine, methanol, and xylol.

E. Demountable Sign Face Materials:
1. Acrylic Plastic Reflectors: Replacement demountable sign letters, digits, arrows, borders, and alphabet accessories shall be reflectorized and shall consist of acrylic plastic reflectors supported by embossed aluminum frames. They shall comply with the Standard Alphabet for Highway Signs, of the Federal Highway Administration, Series E.
2. Design and Fabrication: The letters shall be modified as necessary to accommodate the required reflectors. All items except border strips shall be fabricated from 0.040-inch minimum sheet aluminum. Border strips shall be of 0.032-inch minimum sheet aluminum. Mounting holes shall be provided within the frames to permit the use of screws, rivets or other acceptable fasteners. The size and spacing of the reflector holes shall provide maximum night legibility and visibility of the finished cutout figure.
3. General Requirements: The reflectors shall be of acrylic plastic meeting the requirements of Fed. Spec. L-P-380, Type I, Class 3. The reflectors shall be yellow or colorless. The lens shall consist of a smooth front surface, free from projections or indentations other than for identification, and a rear surface bearing a prismatic configuration that will effect total internal reflection of light.
4. Reflective Sheeting:
   a. Demountable Sign Letters, Digits, Arrows, Borders, and Alphabet Accessories, when so specified, shall be reflectorized with reflective sheeting supported by flat aluminum backing and shall comply with the Standard Alphabet Highway Signs of the Federal Highway Administration.
   b. Design and Fabrication: Letter design shall be Series E, modified for legibility. All items except border strips shall be fabricated from 0.040-inch sheet aluminum, 6061-T6 alloy, with mounting holes to permit use of screws, rivets, or other acceptable fasteners.

F. Highway Delineators, Enclosed Lens Type: Replacement reflectors shall be of acrylic plastic and a minimum of 3 inches in diameter. They shall be mounted in a heavy-duty housing with a back plate. The reflector shall consist of a clear and transparent plastic lens, which shall be colorless, and a plastic back of the same material, fused to the lens under heat and pressure around the entire perimeter to form a homogeneous unit, permanently sealed against dust, water, and water vapor. The acrylic plastic shall comply with Fed. Spec. L-P-380, Type I, Class 3.

G. Highway Delineators, High Intensity Type:
1. Replacement Reflectorized Delineators shall consist of a reflective sheeting compound of glass spheres, embedded in a weatherproof, synthetic, noncellulose material. The overall size of the plastic reflectors shall be 4 inches by 5 inches, with a reflective area of at least 17.5 square inches.
2. Delineators shall be silver-white when viewed with reflected light.

H. Highway Delineators Including Posts and Attachments:

1. Reflective Sheeting: Replacement reflective sheeting for delineators shall match delineators being replaced.
2. Delineator Posts and Accessories shall be of steel or aluminum. They shall have the necessary holes for attachment of the delineator housing. The assembly shall be furnished with the necessary bolts, nuts, and washers for attaching to the posts.
3. Insulating Materials: Neoprene, for separation of aluminum and steel parts, shall contain at least 60 percent, by volume, of pure neoprene. Other material may be used, subject to the approval of the Owner as to pliability and ability to withstand wear caused by stretching or distortion.
4. Reflector Units for guardrail installation shall match existing reflector being replaced in size and color.
5. Highway Delineators shall be supplemented with directional guidance signs as directed by the Owner. Signs shall be the chevron alignment type and shall comply with ANSI D6.1E, Type W 1-8.

I. Painting Panels for Nonreflectorized Background:
1. Replacement Metal Panels for sign categories not required to be reflectorized shall have a nonreflectorized background composed of one spray coat of primer and two finish coats of baked enamel.
2. Finish Coats shall be baked alkyd resin enamels meeting Fed. Spec. TT-E-529, Class B, of a composition that affects the finished background surface. When thoroughly dry, the colors shall match those described in the current Highway Blue Color Tolerance Chart, PR Color No. 3, or in Highway Green Color Tolerance Chart, PR Color No. 4, of the Federal Highway Administration.
3. Wood Signs shall have two coats of oil paint complying with Fed. Spec. TT-P-52. Message paint shall be a single coat of oil paint. All colors shall comply with ANSI D6.1E.

J. Sign Wash Detergent shall comply with ASTM D 3399.

K. Street, Wayside, Utility Location, And Parking Lot Signs; Decals
1. Blanks: aluminum of type, size, and shape indicated.
2. Reflective sheeting: Type 1 sheeting having Level A reflective intensity.
3. Silk screen lettering paint and transparent process colors: as directed by the Owner.
4. Posts
   a. Drive type: as directed by the Owner.
   b. Pipe type: Two-inch inside diameter.
5. Hardware: as directed by the Owner.
6. Fabrication
   a. Dimensions, colors, and reflectorizing: As indicated, and in accordance with MUTCD.
   b. Size, style, and spacing of letters, numerals, symbols, and borders: As indicated, and the Owner; as supplemented by DOT/FHA's publication entitled Standard Highway Signs as specified in MUTCD 1978.
   c. Workmanship: as directed by the Owner.

1.3 EXECUTION

A. Footings for Signs, Posts, and Supports:
1. Backfill Material shall be at or near optimum moisture and neither dry nor saturated. It shall be tamped thoroughly in place.
2. Concrete Footings may be cast in place or precast. Hand mixing of concrete will be permitted where the quantity does not exceed one-half cubic yard.

B. Erection of Signs and Sign Supports: Sign posts shall be erected vertically. Posts erected in sleeves shall be anchored with sulphur mortar. Mortar shall comply with ASTM C 287. Sign faces shall be positioned to be generally perpendicular to the line-of-sight for the observer. Reflectorized signs shall be inspected at night. If specular reflection is apparent on any sign, its position shall be adjusted by the Contractor to eliminate the condition.

C. Delineators and Hazard Markers: Delineator posts shall be driven to a depth of 30 inches.

D. Removal of Existing Signs and Posts:
   1. Damaged, Obsolete, or Change of Purpose Signs and Posts shall be removed and delivered to a storage area designated by the Owner. Post hole shall be backfilled, tamped, and made level with the adjacent surface. Disturbed paving, sidewalks, and grassed areas shall be replaced with matching material of same quality and quantity as existing.
   2. Signs and Posts to be Replaced shall be removed and replaced by new signs and posts in identical locations. Backfill around post shall be thoroughly compacted to hold posts securely in a vertical position.

E. Installation: Install in accordance with manufacturer's recommendations and as directed by the Owner. Unless otherwise indicated, install not more than one sign on each post.

END OF SECTION 01 55 26 00

Task	Specification	Specification Description
01 55 26 00	01 22 16 00	No Specification Required
01 56 16 00	01 22 16 00	No Specification Required

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SECTION 01 56 26 00 - SEDIMENT REMOVAL

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing of labor and equipment for sediment removal.

1.2 PRODUCTS - (Not Used)

1.3 EXECUTION

A. The Contractor shall remove all material from areas as required to meet project requirements. Water and sediment removed from these areas shall be discharged to a sedimentation basin constructed and maintained by the Contractor. All work shall be in strict compliance with Pollution Control requirements and Dewatering requirements. All material removed shall be disposed of in an approved landfill in accordance with all State and Federal Regulations.

END OF SECTION 01 56 26 00

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SECTION 01 56 26 00a - EROSION CONTROL

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of mesh or netting for erosion control. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCTS

A. Materials

1. Jute Mesh: Fed. Spec. CCC-C-467.
2. Plastic Mesh: Manufacturer's recommendation.
3. Plastic Netting: Manufacturer's recommendation.
4. Polypropylene Mesh: Manufacturer's recommendation.
5. Woven Fabric Fence: EPA specifications.
6. Hay-Bales: EPA specifications.

1.3 EXECUTION:

A. Preparation: Grade, compact, fertilize, and seed the area to be protected.

B. Installation: Apply blankets either horizontally or vertically to the slope. In ditches, apply blanket in direction of water flow. Lap and anchor blankets according to the manufacturer's instructions. Install woven fabric fence and hay bales adjacent to all excavated areas.

END OF SECTION 01 56 26 00a

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Task	Specification	Specification Description
01 56 26 00	01 22 16 00	No Specification Required
01 56 29 00	01 22 16 00	No Specification Required
01 56 33 00	01 22 16 00	No Specification Required
01 56 39 00	01 22 16 00	No Specification Required
01 57 13 00	01 56 26 00	Sediment Removal

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SECTION 01 58 13 00 - SIGNAGE

1.1 GENERAL

A. Description Of Work:

1. This specification covers the furnishing and installation of materials for signage. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes the following:
   a. Plaques.
   b. Dimensional illuminated and non-illuminated characters.
   c. Panel signs.
   d. Illuminated panel signs.
   e. Photoluminescent markings and signs.

C. Definitions

1. ADA-ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines."

D. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings: Show fabrication and installation details for signs.
   a. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
   b. Provide message list, typestyles, graphic elements, including tactile characters and Braille, and layout for each sign.
   c. Wiring Diagrams: Power, signal, and control wiring.
3. Samples: For each sign type and for each color and texture required.

E. Quality Assurance

1. Regulatory Requirements: Comply with applicable provisions in ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
3. Provide exit signs in accordance with NFPA 101, Building Code, and Fire Code.
4. Comply with National Fire Protection Association (NFPA) 101 - Life Safety Code.
5. Comply with Underwriters Laboratories, Inc. (UL) - 924 - Standard for Emergency Lighting and Power Equipment.

F. Field Quality Control

1. With room light fixtures illuminated, measure amount of illumination on face of each exit sign using handheld light meter.
2. Ensure that each location has minimum of 5 foot-candles of illumination.

G. Warranty

1. Manufacturer's standard form in which manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within Five years from date of Final Completion.

1.2 PRODUCTS

A. Materials
1. Aluminum Castings: ASTM B 26/B 26M, of alloy and temper recommended by sign manufacturer for casting process used and for use and finish indicated.
2. Aluminum Sheet and Plate: ASTM B 209 (ASTM B 209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with at least the strength and durability properties of Alloy 5005-H32.
3. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with at least the strength and durability properties of Alloy 6063-T5.
4. Brass Castings: ASTM B 584, Alloy UNS No. C85200 (high-copper yellow brass).
5. Brass, Yellow, Sheet: ASTM B 36/B 36M, Alloy UNS No. C26000.
6. Bronze Castings: ASTM B 584, Alloy UNS No. C86500 (No. 1 manganese bronze).
7. Bronze Plate: ASTM B 36/B 36M.
8. Copper Sheet: ASTM B 152/B 152M.
9. Steel:
   a. Galvanized Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating, either commercial or forming steel.
   b. Steel Sheet: Uncoated, cold-rolled, ASTM A 1008/A 1008M, commercial steel, Type B, exposed **OR** Electrolytic zinc-coated, ASTM A 591/A 591M, with steel sheet substrate complying with ASTM A 1008/A 1008M, commercial steel, exposed, **as directed**.
   c. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304 **OR** 316, **as directed**, stretcher-leveled standard of flatness.
   d. Steel Members Fabricated from Plate or Bar Stock: ASTM A 529/A 529M or ASTM A 572/A 572M, 42,000-psi (290-MPa) minimum yield strength.
   e. For steel exposed to view on completion, provide materials having flat, smooth surfaces without blemishes. Do not use materials whose surfaces exhibit pitting, seam marks, roller marks, rolled trade names, or roughness.
10. Fiberglass Sheet: Molded, seamless, thermosetting, glass-fiber-reinforced polyester panels with a minimum tensile strength of 15,000 psi (103 MPa) when tested according to ASTM D 638 and with a minimum flexural strength of 30,000 psi (207 MPa) when tested according to ASTM D 790.
11. Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet), Type UVA (UV absorbing).
12. Polycarbonate Sheet: Of thickness indicated, manufactured by extrusion process, coated on both surfaces with abrasion-resistant coating:
   a. Impact Resistance: 16 ft-lbf/in. (854 J/m) per ASTM D 256, Method A.
   b. Tensile Strength: 9000 lbf/sq. in. (62 MPa) per ASTM D 638.
   c. Flexural Modulus of Elasticity: 340,000 lbf/sq. in. (2345 MPa) per ASTM D 790.
   d. Heat Deflection: 265 deg F (129 deg C) at 264 lbf/sq. in. (1.82 MPa) per ASTM D 648.
   e. Abrasion Resistance: 1.5 percent maximum haze increase for 100 revolutions of a Taber abraser with a load of 500 g per ASTM D 1044.
13. Applied Vinyl: Die-cut characters from vinyl film of nominal thickness of 3 mils (0.076 mm) with pressure-sensitive adhesive backing, suitable for exterior applications.

B. Plaques
1. Cast Plaques: Provide castings free of pits, scale, sand holes, and other defects, as follows:
   a. Plaque Material: Aluminum **OR** Bronze, **as directed**.
   b. Background Texture: Manufacturer's standard pebble **OR** leatherette **OR** matte **OR** stipple, **as directed**, texture.
   c. Border Style: Square, polished **OR** Plain bevel **OR** Projected bevel **OR** Raised flat band **OR** Double-raised line border, **as directed**.
   d. Mounting: Rosettes and fasteners matching plaque finish **OR** Concealed studs, **as directed**, noncorroding, **as directed**, for substrates encountered.
2. Etched Plaques: Provide metal sheet or plate for etching, as follows:
   a. Plaque Material: Aluminum **OR** Brass **OR** Bronze, **as directed**.

b. Custom Paint Colors: Match Pantone, **as directed**, color matching system.
c. Color(s): As indicated **OR** As selected from manufacturer's full range, **as directed**.
d. Edge Style: Square, polished **OR** Plain bevel, **as directed**.
e. Mounting: Concealed studs **OR** Exposed fasteners, **as directed**, noncorroding, **as directed**, for substrates encountered.
f. Thickness: 0.125 inch (3.18 mm) **OR** 0.250 inch (6.35 mm), **as directed**, thick.

C. Dimensional Characters
1. Cast Characters: Produce characters with smooth flat faces, sharp corners, and precisely formed lines and profiles, free of pits, scale, sand holes, and other defects. Cast lugs into back of characters and tap to receive threaded mounting studs. Alloy and temper recommended by sign manufacturer for casting process used and for use and finish indicated. Comply with the following requirements.
   a. Character Material: Aluminum **OR** Brass **OR** Bronze, **as directed**.
   b. Thickness: As indicated.
   c. Color(s): As indicated **OR** As selected from manufacturer's full range, **as directed**.
   d. Mounting: Rosettes and fasteners matching character finish **OR** Concealed studs, **as directed**, noncorroding, **as directed**, for substrates encountered.
2. Aluminum Extrusions: Comply with the following requirements:
   a. Finish: Anodized **OR** Painted, **as directed**.
   b. Thickness: As indicated.
   c. Custom Paint Colors: Match Pantone, **as directed**, color matching system.
   d. Color(s): As indicated **OR** As selected from manufacturer's full range, **as directed**.
   e. Mounting: Concealed studs, noncorroding, **as directed**, for substrates encountered.
3. Fabricated Channel Characters: Form exposed faces and sides of characters to produce surfaces free from warp and distortion. Include internal bracing for stability and attachment of mounting accessories. Comply with the following requirements:
   a. Illuminated Backlighted **OR** Frontlighted, **as directed**, Channel Characters: Manufacturer's standard fluorescent tube **OR** fiber-optic **OR** LED **OR** neon tube, **as directed**, lighting including transformers, insulators, and other components. Make provisions for servicing and concealing connections to building electrical system.
   b. Aluminum Sheet: Not less than 0.090 inch (2.29 mm) thick.
      1) Finish: Anodized **OR** Painted, **as directed**.
      2) Custom Paint Colors: Match Pantone, **as directed**, color matching system.
      3) Color: As indicated **OR** As selected from manufacturer's full range, **as directed**.
   c. Bronze Sheet: Not less than 0.032 inch (0.81 mm) thick.
   d. Brass Sheet: Not less than 0.032 inch (0.81 mm) thick.
   e. Copper Sheet: Not less than 0.032 inch (0.81 mm) **OR** 0.048 inch (1.22 mm), **as directed**, thick.
   f. Steel Sheet: Painted, not less than 0.050 inch (1.27 mm) thick for face and 0.031 inch (0.78 mm) thick for returns.
      1) Color: As indicated **OR** As selected from manufacturer's full range, **as directed**.
   g. Stainless-Steel Sheet: Not less than 0.050 inch (1.27 mm) thick for face and 0.031 inch (0.78 mm) thick for returns.
      1) Finish: No. 4 **OR** No. 8, **as directed**.
   h. Provide manufacturer's hardware for projection mounting of backlighted, **as directed**, channel characters at distance from wall surface indicated.
   i. Provide translucent acrylic face sheet of thickness indicated. Attach characters to sheet metal back channels. Provide required to illuminate sign faces evenly.
      1) Color: As indicated **OR** As selected from manufacturer's full range, **as directed**.
   j. Provide open-front, sheet metal channel characters.
4. Molded Plastic Characters: Thermoformed **OR** Injection molded, **as directed**, and as follows:
   a. Illuminated Characters: Manufacturer's standard fluorescent tube **OR** fiber-optic **OR** LED **OR** neon tube, **as directed**, lighting including transformers, insulators, and other components. Make provisions for servicing and concealing connections to building electrical system.

b. Integral Color **OR** Painted Finish, **as directed**: As indicated **OR** As selected from manufacturer's full range, **as directed**.

5. Cutout Characters: Provide characters with square-cut, smooth, eased, **as directed**, edges. Comply with the following requirements:
   a. Acrylic: 0.25 inch (6.35 mm) **OR** 0.50 inch (12.7 mm), **as directed**, thick.
      1) Metal face laminated to acrylic base with painted edges, **as directed**.
         a) Brass Face: Satin **OR** Polished, **as directed**, finish.
         b) Stainless-Steel Face: No. 4 **OR** No. 8, **as directed**, finish.
         c) Metal Thickness: 0.030 inch (0.76 mm).
      2) Custom Paint Colors: Match Pantone, **as directed**, color matching system.
      3) Color: As indicated **OR** As selected from manufacturer's full range, **as directed**.
   b. Aluminum Sheet: 0.125 inch (3.18 mm) **OR** 0.25 inch (6.35 mm), **as directed**, thick.
      1) Finish: Anodized **OR** Painted, **as directed**.
      2) Custom Paint Colors: Match Pantone, **as directed**, color matching system.
      3) Color: As indicated **OR** As selected from manufacturer's full range, **as directed**.
   c. Brass Sheet, Yellow: 0.125 inch (3.18 mm) **OR** 0.25 inch (6.35 mm), **as directed,** thick.
   d. Bronze Sheet: 0.125 inch (3.18 mm) **OR** 0.25 inch (6.35 mm), **as directed**, thick.
   e. Vinyl: Pressure sensitive, 3.5 mils (0.09 mm) thick.
      1) Custom Paint Colors: Match Pantone, **as directed**, color matching system.
      2) Color: As indicated **OR** As selected from manufacturer's full range, **as directed**.
   f. Mounting: Adhesive **OR** Flush **OR** Projected **OR** Back bar **OR** Bracket, **as directed**, with concealed noncorroding studs, **as directed**, for substrates encountered.

D. panel signs

1. Interior Panel Signs: Provide smooth sign panel surfaces constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16 inch (1.5 mm) measured diagonally from corner to corner, complying with the following requirements:
   a. Aluminum Sheet: 0.050 inch (1.27 mm) **OR** 0.080 inch (2.03 mm), **as directed**, thick.
   b. Laminated, Aluminum-Faced Sheet: 0.020-inch- (0.51-mm-) thick aluminum sheet laminated to each side of 0.197-inch- (5.0-mm-) **OR** 0.394-inch- (10.0-mm-), **as directed**, thick, corrugated **OR** phenolic **OR** acrylic, **as directed**, backing with painted edges, **as directed**.
   c. Laminated, Polycarbonate-Faced Sheet: 0.060-inch- (1.52-mm-) thick, polycarbonate face sheet laminated to each side of 0.197-inch- (5.0-mm) **OR** 0.394-inch- (10.0-mm-), **as directed**, thick phenolic backing.
   d. Acrylic Sheet: 0.060 inch (1.52 mm) **OR** 0.080 inch (2.03 mm), **as directed**, thick.
   e. PVC Sheet: 0.060-inch- (1.52-mm-) **OR** 0.080-inch- (2.03-mm-), **as directed**, thick, extruded, high-impact PVC plastic in color to match face color **OR** with painted finish, **as directed**.
   f. High-Pressure Decorative Laminate: 0.048 inch (1.21 mm) thick.
   g. Phenolic-Backed Photopolymer Sheet: Provide light-sensitive, water-wash photopolymer face layer bonded to a phenolic base layer to produce a composite sheet with overall, face layer, and base-layer thicknesses, respectively, of 0.120, 0.040, and 0.080 inch (3.0, 1.0, and 2.03 mm) **OR** 0.160, 0.040, and 0.120 inch (4.06, 1.0, and 3.04 mm), **as directed**.
   h. Laminated Sheet: High-pressure engraved stock with contrasting color, **as directed**, face laminated to acrylic core in finishes and color combinations indicated **OR** as selected from manufacturer's full range, **as directed**.
   i. Laminated, Etched Photopolymer: Raised graphics with Braille, **as directed**, 1/32 inch (0.8 mm) above surface with contrasting colors in finishes and color combinations indicated **OR** as selected from manufacturer's full range, **as directed**, and laminated to acrylic back.
   j. Laminated, Sandblasted Polymer: Raised graphics with Braille, **as directed**, 1/32 inch (0.8 mm) above surface with contrasting colors in finishes and color combinations indicated **OR** as selected from manufacturer's full range, **as directed**, and laminated to acrylic back.
   k. Edge Condition: Square cut **OR** Beveled **OR** Bullnose, **as directed**.
   l. Corner Condition: Square **OR** Rounded to radius indicated, **as directed**.

m. Mounting: Framed **OR** Unframed **OR** As indicated, **as directed**.
 1) Wall **OR** Ceiling **OR** Projection, **as directed**, mounted with concealed anchors **OR** magnetic tape **OR** two-face tape, **as directed**.
 2) Manufacturer's standard anchors for substrates encountered.
n. Custom Paint Colors: Match Pantone, **as directed**, color matching system.
o. Color: As indicated **OR** As selected from manufacturer's full range, **as directed**.
p. Tactile Characters: Characters and Grade 2 Braille raised 1/32 inch (0.8 mm) above surface with contrasting colors.

2. Exterior Panel Signs: Provide smooth sign panel surfaces constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16 inch (1.5 mm) measured diagonally from corner to corner, complying with the following requirements:
 a. Aluminum Sheet: 0.050 inch (1.27 mm) **OR** 0.080 inch (2.03 mm), **as directed**, thick.
 b. Laminated, Aluminum-Faced Sheet: 0.020-inch- (0.51-mm-) thick aluminum sheet laminated to each side of 0.197-inch- (5.0-mm-) **OR** 0.394-inch- (10.0-mm-), **as directed**, thick, corrugated **OR** phenolic **OR** acrylic, **as directed**, backing with painted edges, **as directed**.
 c. Acrylic Sheet: 0.060 inch (1.52 mm) **OR** 0.080 inch (2.03 mm), **as directed,** thick.
 d. Fiberglass Sheet: 0.090-inch- (2.29-mm-) **OR** 0.125-inch- (3.18-mm-), **as directed**, thick sheet.
 e. Edge Condition: Square cut **OR** Beveled **OR** Bullnose, **as directed**.
 f. Corner Condition: Square **OR** Rounded to radius indicated, **as directed**.
 g. Mounting: Framed **OR** Unframed **OR** As indicated, **as directed**.
  1) Wall **OR** Soffit **OR** Projection, **as directed**, mounted.
  2) Manufacturer's standard noncorroding, **as directed**, anchors for substrates encountered.
 h. Custom Paint Colors: Match Pantone, **as directed**, color matching system.
 i. Color: As indicated **OR** As selected from manufacturer's full range, **as directed**.

3. Laminated Interior **OR** Exterior, **as directed**, Signs: Solid phenolic panel core with graphic image covered with thermosetting resin face layer.
 a. Surface Finish: Mat **OR** Beaded **OR** Gloss **OR** UV resistant, outdoor, **as directed**.
 b. Edge Condition: Square cut **OR** Beveled **OR** Bullnose, **as directed**.
 c. Corner Condition: Square **OR** Rounded to radius indicated, **as directed**.
 d. Thickness: 1/8 inch (3 mm) **OR** 1/4 inch (6 mm), **as directed**.

4. Brackets: Fabricate brackets and fittings for bracket-mounted signs from extruded aluminum to suit panel sign construction and mounting conditions indicated. Factory paint brackets in color matching background color of panel sign **OR** matching sample, **as directed**.

5. Panel Sign Frames:
 a. PVC Frames: Extruded, high-impact PVC plastic.
  1) Color: As indicated **OR** As selected from manufacturer's full range **OR** Match face color, **as directed**.
  2) Depth: As indicated.
  3) Profile: Square **OR** Beveled **OR** Rounded, **as directed**.
  4) Corner Condition: Square **OR** Rounded to radius indicated, **as directed**.
  5) Mounting: As indicated.
   a) Wall **OR** Ceiling **OR** Projection, **as directed**, mounted with concealed anchors **OR** magnetic tape **OR** two-face tape, **as directed**.
   b) Manufacturer's standard noncorroding, **as directed**, anchors for substrates encountered.
 b. Extruded-Aluminum Frames: Mitered with concealed anchors and welded, **as directed**.
  1) Color: As indicated **OR** As selected from manufacturer's full range, **as directed**.
  2) Depth: As indicated.
  3) Profile: Square **OR** Beveled **OR** Rounded, **as directed**.
  4) Corner Condition: Square **OR** Rounded to radius indicated, **as directed**.
  5) Mounting: As indicated.
   a) Wall **OR** Ceiling **OR** Projection, **as directed**, mounted with concealed anchors **OR** magnetic tape **OR** two-face tape, **as directed**.

b) Manufacturer's standard noncorroding, **as directed**, anchors for substrates encountered.

c. Metal Frames:

1) Bronze Plate: Not less than 0.032 inch (0.81 mm) thick.

2) Brass Plate: Not less than 0.032 inch (0.81 mm) thick.

3) Steel Sheet: Painted, not less than 0.050 inch (1.27 mm) thick for face and 0.031 inch (0.78 mm) thick for returns.

a) Color: As indicated **OR** As selected from manufacturer's full range, **as directed**.

4) Stainless-Steel Sheet: Not less than 0.050 inch (1.27 mm) thick for face and 0.031 inch (0.78 mm) thick for returns.

5) Depth: As indicated.

6) Corner Condition: Square **OR** Rounded to radius indicated, **as directed**.

7) Mounting: As indicated.

a) Wall **OR** Ceiling **OR** Projection, **as directed**, mounted with concealed anchors **OR** magnetic tape **OR** two-face tape, **as directed**.

b) Manufacturer's standard noncorroding, **as directed**, anchors for substrates encountered.

6. Changeable Message Inserts: Fabricate signs to allow insertion of changeable messages in the form of slide-in inserts **OR** transparent covers with paper inserts printed by the Owner **OR** changeable panel inserts for use in fixed frames, **as directed**.

a. Furnish insert material and software for creating text and symbols for PC-Windows **OR** Macintosh, **as directed**, computers for the Owner production of paper inserts.

b. Furnish insert material cut-to-size for changeable message insert.

7. Tactile and Braille Sign: Manufacturer's standard process for producing text and symbols complying with ADA-ABA Accessibility Guidelines and with ICC/ANSI A117.1. Text shall be accompanied by Grade 2 Braille. Produce precisely formed characters with square-cut edges free from burrs and cut marks; Braille dots with domed or rounded shape.

a. Panel Material: Opaque acrylic sheet **OR** Photopolymer **OR** Clear acrylic sheet with opaque color coating, subsurface applied, **as directed**.

b. Raised-Copy Thickness: Not less than 1/32 inch (0.8 mm).

8. Engraved Copy: Machine engrave letters, numbers, symbols, and other graphic devices into panel sign on face indicated to produce precisely formed copy, incised to uniform depth.

a. Engraved Plastic Laminate: Engrave through exposed face ply of plastic-laminate sheet to expose contrasting core ply.

b. Engraved Metal: Fill engraved copy with enamel.

c. Engraved Opaque Acrylic Sheet: Fill engraved copy with enamel.

d. Face-Engraved Clear Acrylic Sheet: Fill engraved copy with enamel. Apply opaque background color coating to back face of acrylic sheet.

9. Subsurface Copy: Apply minimum 4-mil- (0.10-mm-) thick vinyl copy to back face of clear acrylic sheet forming panel face to produce precisely formed opaque image. Image shall be free of rough edges.

10. Subsurface Engraved Acrylic Sheet: Reverse-engrave back face of clear acrylic sheet. Fill resulting copy with enamel. Apply opaque background color coating over enamel-filled copy.

11. Applied Vinyl: Die-cut characters from vinyl film of nominal thickness of 3 mils (0.076 mm) with pressure-sensitive adhesive backing. Apply copy to exposed face of panel sign **OR** glass **OR** doors **OR** wall surfaces, **as directed**.

a. Panel Material: Opaque acrylic sheet **OR** Clear acrylic sheet with opaque color coating, subsurface applied, **as directed**.

12. Colored Coatings for Acrylic Sheet: For copy and background and frame colors, provide colored coatings, including inks, dyes, and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and are UV and water resistant for three **OR** five, **as directed**, years for application intended.

a. Custom Paint Colors: Match Pantone, **as directed**, color matching system.

b. Color: As indicated **OR** As selected from manufacturer's full range, **as directed**.

E. Photoluminescent Markings and Signs
1. All photoluminescent exit path markings, signs and materials shall be approved by Authorities having jurisdiction and meet minimum performance requirements.
2. Photoluminescent Signs: Self-contained, single **OR** double, **as directed**, face, as follows:
a. Manufacturer's standard aluminum **OR** plastic, **as directed**, frame with translucent lettering and transparent polycarbonate face.
b. Exit sign, UL 924.
c. Mounting: As indicated.
1) Wall **OR** Ceiling **OR** Projection, **as directed**, mounted with concealed anchors.
d. Face Color: Red **OR** Green **OR** Black, **as directed**.
e. Frame Color: As indicated **OR** As selected from manufacturer's full range, **as directed**.
f. Service Life: 10 **OR** 15 **OR** 20, **as directed**, years.
g. New Buildings.
1) All new buildings of three or more stories in height shall be provided with approved photoluminescent exit path markings in all enclosed exit stairwells.
h. Existing buildings.
1) All Group E, I, R-1 and R-2 occupancies in buildings of three or more stories in height shall be provided with approved photoluminescent exit path markings in all enclosed exit stairwells.
i. All other occupancies in buildings four or more stories in height shall be provided with approved photoluminescent exit path markings in all enclosed exit stairwells.
j. Exception: Exit path markings in existence at the time of the adoption and or at the time of this ordinance may continue to exist as installed as long as they are in proper working order.

F. Accessories
1. Anchors and Inserts: Provide nonferrous-metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion-bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.
2. Fasteners: Stainless or corrosion-resistant; type best suited to application.

G. Fabrication
1. General: Provide manufacturer's standard signs of configurations indicated.
a. Welded Connections: Comply with AWS standards for recommended practices in shop welding. Provide welds behind finished surfaces without distortion or discoloration of exposed side. Clean exposed welded surfaces of welding flux and dress exposed and contact surfaces.
b. Mill joints to tight, hairline fit. Form joints exposed to weather to exclude water penetration.
c. Preassemble signs in the shop to greatest extent possible. Disassemble signs only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation, in location not exposed to view after final assembly.
d. Conceal fasteners if possible; otherwise, locate fasteners where they will be inconspicuous.

H. Finishes, General
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

I. Aluminum Finishes
1. Clear Anodic Finish: Manufacturer's standard Class 1 clear anodic coating, 0.018 mm or thicker, over a satin (directionally textured) **OR** polished (buffed) **OR** nonspecular as fabricated, **as directed**, mechanical finish, complying with AAMA 611.
2. Color Anodic Finish: Manufacturer's standard Class 1 integrally colored or electrolytically deposited color anodic coating, 0.018 mm or thicker, in light bronze **OR** medium bronze **OR** dark bronze **OR** gold **OR** black, **as directed**, applied over a satin (directionally textured) **OR** polished (buffed) **OR** nonspecular as fabricated, **as directed**, mechanical finish, complying with AAMA 611.
3. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.
   a. Organic Coating: Thermosetting, modified-acrylic enamel primer/topcoat system complying with AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm), medium gloss.

J. Steel Finishes
1. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
2. Factory Priming for Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment.
   a. Shop Primer: Manufacturer's or fabricator's standard, fast-curing, lead- and chromate-free, universal primer, selected for resistance to normal atmospheric corrosion, for compatibility with substrate and field-applied finish paint system indicated, and for capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.
3. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).

K. Stainless-Steel Finishes
1. Remove tool and die marks and stretch lines or blend into finish. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
2. Directional Satin Finish: No. 4 finish.
3. Mirrorlike Reflective, Nondirectional Polish: No. 8 finish.
4. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

L. Copper-Alloy Finishes
1. Sheet or Plate Finish: Medium satin (directionally textured) **OR** Smooth specular (mirrorlike), buffed, **as directed**, finish.
   a. Raised Finish: Satin **OR** Polished **OR** Painted, **as directed**.
   b. Recessed Finish: Etched, painted, **as directed**.
2. Cast-Bronze **OR** Cast-Brass, **as directed**, Character Finishes: Manufacturer's standard satin finish, **as directed**, with exposed surfaces free from porosity, burrs, and rough spots; with returns finished with fine-grain air blast.
3. Cast-Bronze Plaque Finishes: Exposed surfaces free of porosity, burrs, and rough spots; with returns finished with fine-grain air blast.
   a. Raised Areas: Hand-tool and buff borders and raised copy to produce manufacturer's standard satin **OR** polished, **as directed**, finish.
   b. Background Finish: Painted **OR** Dark oxidized **OR** Green patina, **as directed**.
4. Clear Protective Coating: Coat exposed surfaces of copper alloys with manufacturer's standard, clear organic coating specially designed for coating copper-alloy products.

M. Acrylic Sheet Finishes
1. Colored Coatings for Acrylic Sheet: For copy and background and frame colors, provide colored coatings, including inks, dyes, and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and that are UV and water resistant for three **OR** five, **as directed**, years for application intended.

1.3 EXECUTION

A. Installation
1. Locate signs and accessories where indicated, using mounting methods of types described and complying with manufacturer's written instructions.
   a. Install signs level, plumb, and at heights indicated, with sign surfaces free of distortion and other defects in appearance.
   b. Interior Wall Signs: Install signs on walls adjacent to latch side of door where applicable. Where not indicated or possible, such as double doors, install signs on nearest adjacent walls. Locate to allow approach within 3 inches (75 mm) of sign without encountering protruding objects or standing within swing of door.
2. Wall-Mounted Signs: Comply with sign manufacturer's written instructions except where more stringent requirements apply.
   a. Two-Face Tape: Mount signs to smooth, nonporous surfaces. Do not use this method for vinyl-covered or rough surfaces.
   b. Hook-and-Loop Tapes: Mount signs to smooth, nonporous surfaces.
   c. Magnetic Tape: Mount signs to smooth, nonporous surfaces.
   d. Silicone-Adhesive Mounting: Attach signs to irregular, porous, or vinyl-covered surfaces.
   e. Shim Plate Mounting: Provide 1/8-inch- (3-mm-) thick, concealed aluminum shim plates with predrilled and countersunk holes, at locations indicated, and where other mounting methods are not practicable. Attach plate with fasteners and anchors suitable for secure attachment to substrate. Attach panel signs to plate using method specified above.
   f. Mechanical Fasteners: Use nonremovable mechanical fasteners placed through predrilled holes. Attach signs with fasteners and anchors suitable for secure attachment to substrate as recommended in writing by sign manufacturer.
   g. Signs Mounted on Glass: Provide matching opaque plate on opposite side of glass to conceal mounting materials.
3. Bracket-Mounted Signs: Provide manufacturer's standard brackets, fittings, and hardware for mounting signs that project at right angles from walls and ceilings. Attach brackets and fittings securely to walls and ceilings with concealed fasteners and anchoring devices to comply with manufacturer's written instructions.
4. Dimensional Characters: Mount characters using standard fastening methods to comply with manufacturer's written instructions for character form, type of mounting, wall construction, and condition of exposure indicated. Provide heavy paper template to establish character spacing and to locate holes for fasteners.
   a. Flush Mounting: Mount characters with backs in contact with wall surface.
   b. Projected Mounting: Mount characters at projection distance from wall surface indicated.
5. Cast-Metal Plaques: Mount plaques using standard fastening methods to comply with manufacturer's written instructions for type of wall surface indicated.
   a. Concealed Mounting: Mount plaques by inserting threaded studs into tapped lugs on back of plaque. Set in predrilled holes filled with quick-setting cement.
   b. Face Mounting: Mount plaques using exposed fasteners with rosettes attached through face of plaque into wall surface.
6. Photoluminescent Marking and Signs
   a. Approved stair markings shall be provided for all enclosed stairways in buildings three or more stories above grade or three or more levels below grade and in any exit pathways leading from the stairways with the exception of ground floor lobbies leading to the exterior of the building in the following manner:
   b. Horizontal Leading Edge of each stair step shall be marked by Option 1 or Option 2.

1) Option 1: A minimum one inch and a maximum of two inches (25 mm) shaped contrasting marker of photoluminescent material on both side edges of the step. These markers shall be placed a minimum of 0inch to a maximum of 1/2inch (13 mm) from the leading edge of the step parallel to the nose of the step or landing.
2) Option 2: A minimum one inch and a maximum of two inches (25mm) "zig-zag" pattern contrasting marker of photoluminescent material on both sides of the step. This shall be a continuous pattern along the walls of the stair step. (See Option 1 & 2 attachments)

c. Stair Landings shall also be marked with a contrasting photoluminescent pathway marker located around the perimeter wall and across the face or floor in front of non-exit doors, on or within four inches (102 mm) of the floor. The dimensions, distances and locations shall be consistent and uniform throughout the same exit. Any spaces intervening between portions of the stairwell shall be marked as directed by the Owner. (See attachments)

d. Photoluminescent Directional Signs shall be placed in the following locations:
1) Stairwell or exit: directional arrow visible upon opening the door into the stairwell or exit indicating the direction of travel.
2) Transfer levels: A directional arrow on the wall. Exception: Markings shall be as directed by the Owner if walls are not available.
3) Wherever egress direction is not clear, (turns along horizontal extensions; at transitions from vertical to horizontal direction; at "T" intersections; etc.) a directional arrow or outlined path (or both as determined by the Owner) shall be installed.

e. Door frames (top and sides) of all stair entry, intermediate and final exit doors of the enclosed stairway shall be marked with a solid and continuous contrasting one inch minimum and a two inch maximum (25 mm) stripe of photoluminescent material.

f. An approved photoluminescent "exit" sign shall be mounted on all stair entry, intermediate and final exit doors or adjacent to the door (on the latch side) within 18 inch (455 mm) of the floor. The sign shall state "EXIT", "FINAL EXIT", "EXIT THROUGH LOBBY", or "EXIT TO STREET". These signs shall be required to be UL 924 listed if they are to be viewed at a distance of 50 feet or more.

g. Handrails shall be marked with a minimum one inch and a maximum of two inches (25 mm) solid and continuous stripe of photoluminescent material either on the handrail or on the wall adjacent to handrail.

h. Obstacles at or below six feet six inches (1981 mm) in height and projecting more than four inches (102 mm) into the egress path shall be outlined with markings no less than one inch (25 mm) in width and not more than a two inches maximum comprised of a pattern of alternating equal bands of photoluminescent material and black, with the alternating bands no more than two inches in width and angled at 45 degrees. Examples of such obstacles include standpipes, hose cabinets, wall projections, and restricted height areas.

i. Exit pathways shall be marked with a minimum one inch and a maximum of two inches (25 mm) solid and continuous stripe of photoluminescent pathway marking material on or within four inches of the floor along each side of the pathway. Pathways more than 50 feet in length shall have directional arrows along the wall at intervals not exceeding 50 feet.

j. Minimum Lighting Requirements:
1) All installed photoluminescent materials shall be exposed to a minimum of two foot candles of fluorescent light illumination at all times while the building is occupied or if incandescent lighting is used, the photoluminescent material chosen must be capable of meeting the minimum brightness rating required by this standard with the lighting provided.
2) Motion sensor activated lighting is prohibited in the stairwells addressed by this standard.
3) Timers on stairwell lighting, if used, shall be set to turn on the lights not less than one hour before the building is occupied each day.

k. Maintenance Requirements:
1) Owners shall maintain the required photoluminescent signs and markings in good repair. Every 12 months owners shall perform a visual inspection of the signs and

markings with the normal lighting turned on. Signs and/or markings that are missing, damaged, loose or that show signs of wear shall be noted and properly repaired or replaced.

B. Cleaning And Protection
   1. After installation, clean soiled sign surfaces according to manufacturer's written instructions. Protect signs from damage until acceptance by the Owner.

END OF SECTION 01 58 13 00

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Task	Specification	Specification Description
01 58 13 00	01 22 16 00	No Specification Required
01 66 19 00	01 22 16 00	No Specification Required
01 71 13 00	01 22 16 00	No Specification Required

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SECTION 01 71 23 16 - CUTTING AND PATCHING

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for cutting and patching. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes procedural requirements for cutting and patching.

C. Definitions

1. Cutting: Removal of in-place construction necessary to permit installation or performance of other Work.
2. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

D. Submittals

1. Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:
   a. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
   b. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
   c. Products: List products to be used and firms or entities that will perform the Work.
   d. Dates: Indicate when cutting and patching will be performed.
   e. Utility Services and Mechanical/Electrical Systems: List services/systems that cutting and patching procedures will disturb or affect. List services/systems that will be relocated and those that will be temporarily out of service. Indicate how long services/systems will be disrupted.
   f. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.
   g. the Owner's Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

E. Quality Assurance

1. LEED Requirements for Building Reuse:
   a. Credit MR 1.1 and 1.2, **as directed**: Maintain existing building structure (including structural floor and roof decking) and envelope (exterior skin and framing, excluding window assemblies and nonstructural roofing material) not indicated to be removed; do not cut such existing construction beyond indicated limits.
   b. Credit MR 1.3: Maintain existing interior nonstructural elements (interior walls, doors, floor coverings, and ceiling systems) not indicated to be removed; do not cut such existing construction beyond indicated limits.
   c. Credit MR 1.2 and 1.3, **as directed**: Maintain existing nonshell, nonstructural components (walls, flooring, and ceilings) not indicated to be removed; do not cut such existing construction beyond indicated limits.

2. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.
   a. **Refer to the Owner for list of elements that might otherwise be overlooked as structural elements and that require Architect's or Construction Manager's approval of a cutting and patching proposal**.
3. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operating elements include the following:
   a. Primary operational systems and equipment.
   b. Air or smoke barriers.
   c. Fire-suppression systems.
   d. Mechanical systems piping and ducts.
   e. Control systems.
   f. Communication systems.
   g. Conveying systems.
   h. Electrical wiring systems.
   i. Operating systems of special construction in Division 13.
4. Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Miscellaneous elements include the following:
   a. Water, moisture, or vapor barriers.
   b. Membranes and flashings.
   c. Exterior curtain-wall construction.
   d. Equipment supports.
   e. Piping, ductwork, vessels, and equipment.
   f. Noise- and vibration-control elements and systems.
5. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
6. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

F. Warranty
1. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void existing warranties.

1.2 PRODUCTS

A. Materials
1. General: Comply with requirements specified in other Sections.
2. In-Place Materials: Use materials identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
   a. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of in-place materials.

1.3 EXECUTION

A. Preparation
1. Temporary Support: Provide temporary support of Work to be cut.
2. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
3. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
4. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to minimize **OR** prevent, **as directed**, interruption to occupied areas.

B. Performance
1. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
   a. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
2. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
   a. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
   b. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
   c. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
   d. Excavating and Backfilling: Comply with requirements in applicable Division 31 where required by cutting and patching operations.
   e. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
   f. Proceed with patching after construction operations requiring cutting are complete.
3. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.
   a. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
   b. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
      1) Clean piping, conduit, and similar features before applying paint or other finishing materials.
      2) Restore damaged pipe covering to its original condition.
   c. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
      1) Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

d. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.

e. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.

4. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

END OF SECTION 01 71 23 16

Task	Specification	Specification Description
01 74 16 00	01 22 16 00	No Specification Required

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SECTION 01 74 19 00 - CONSTRUCTION WASTE MANAGEMENT

1.1 GENERAL

A. Summary

1. This Section includes administrative and procedural requirements for the following:
   a. Salvaging nonhazardous demolition and construction waste.
      Note: All salvageable materials remain the property of the Owner and shall be turned over as directed when specified in the Job Order.
   b. Recycling nonhazardous demolition and construction waste.
   c. Disposing of nonhazardous demolition and construction waste.

B. Definitions

1. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
2. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.
3. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.
4. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
5. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
6. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

C. Performance Goals **OR** Requirements, **as directed**

1. General: Develop waste management plan that results in end-of-Project rates for salvage/recycling of 50 **OR** 75, **as directed**, percent by weight of total waste generated by the Work.
2. Salvage/Recycle Goals **OR** Requirements, **as directed**: Owner's goal is to salvage and recycle as much nonhazardous demolition and construction waste as possible including the following materials:
   OR
   Salvage/Recycle Goals **OR** Requirements, **as directed**: Owner's goal is to salvage and recycle as much nonhazardous demolition and construction waste as possible. Owner has established minimum goals for the following materials:
   a. Demolition Waste:
      1) Asphaltic concrete paving.
      2) Concrete.
      3) Concrete reinforcing steel.
      4) Brick.
      5) Concrete masonry units.
      6) Wood studs.
      7) Wood joists.
      8) Plywood and oriented strand board.
      9) Wood paneling.
      10) Wood trim.
      11) Structural and miscellaneous steel.
      12) Rough hardware.
      13) Roofing.
      14) Insulation.
      15) Doors and frames.

16) Door hardware.
17) Windows.
18) Glazing.
19) Metal studs.
20) Gypsum board.
21) Acoustical tile and panels.
22) Carpet.
23) Carpet pad.
24) Demountable partitions.
25) Equipment.
26) Cabinets.
27) Plumbing fixtures.
28) Piping.
29) Supports and hangers.
30) Valves.
31) Sprinklers.
32) Mechanical equipment.
33) Refrigerants.
34) Electrical conduit.
35) Copper wiring.
36) Lighting fixtures.
37) Lamps.
38) Ballasts.
39) Electrical devices.
40) Switchgear and panelboards.
41) Transformers.

b. Construction Waste:
1) Site-clearing waste.
2) Masonry and CMU.
3) Lumber.
4) Wood sheet materials.
5) Wood trim.
6) Metals.
7) Roofing.
8) Insulation.
9) Carpet and pad.
10) Gypsum board.
11) Piping.
12) Electrical conduit.
13) Packaging: Regardless of salvage/recycle goal indicated above, salvage or recycle 100 percent of the following uncontaminated packaging materials:
a) Paper.
b) Cardboard.
c) Boxes.
d) Plastic sheet and film.
e) Polystyrene packaging.
f) Wood crates.
g) Plastic pails.

D. Submittals

1. Waste Management Plan: Submit 3 copies of plan within 7 **OR** 30, **as directed**, days of date established for commencement of the Work **OR** the Notice to Proceed **OR** the Notice of Award, **as directed**.

2. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit three copies of report. Include separate reports for demolition and construction waste, **as directed**. Include the following information:
   a. Material category.
   b. Generation point of waste.
   c. Total quantity of waste in tons (tonnes).
   d. Quantity of waste salvaged, both estimated and actual in tons (tonnes).
   e. Quantity of waste recycled, both estimated and actual in tons (tonnes).
   f. Total quantity of waste recovered (salvaged plus recycled) in tons (tonnes).
   g. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.
3. Waste Reduction Calculations: Before request for Final Completion, submit three copies of calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.
4. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
5. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
6. LEED Submittal: LEED letter template for Credit MR 2.1 and 2.2, **as directed**, signed by Contractor, tabulating total waste material, quantities diverted and means by which it is diverted, and statement that requirements for the credit have been met.
7. Qualification Data: For Waste Management Coordinator and refrigerant recovery technician.
8. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

E. Quality Assurance
1. Waste Management Coordinator Qualifications: LEED Accredited Professional by U.S. Green Building Council. Waste management coordinator may also serve as LEED coordinator.
2. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.
3. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.
4. Waste Management Conference: Conduct conference at Project site. Review methods and procedures related to waste management including, but not limited to, the following:
   a. Review and discuss waste management plan including responsibilities of Waste Management Coordinator.
   b. Review requirements for documenting quantities of each type of waste and its disposition.
   c. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
   d. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
   e. Review waste management requirements for each trade.

F. Waste Management Plan
1. General: Develop plan consisting of waste identification, waste reduction work plan, and cost/revenue analysis. Include separate sections in plan for demolition and construction waste if Project requires selective demolition or building demolition. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.
2. Waste Identification: Indicate anticipated types and quantities of demolition, site-clearing, and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.
3. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.

a. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
b. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
c. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
d. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location on Project site where materials separation will be located.

4. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there was no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Include the following:
a. Total quantity of waste.
b. Estimated cost of disposal (cost per unit). Include hauling and tipping fees and cost of collection containers for each type of waste.
c. Total cost of disposal (with no waste management).
d. Revenue from salvaged materials.
e. Revenue from recycled materials.
f. Savings in hauling and tipping fees by donating materials.
g. Savings in hauling and tipping fees that are avoided.
h. Handling and transportation costs. Include cost of collection containers for each type of waste.
i. Net additional cost or net savings from waste management plan.

1.2 PRODUCTS (Not Used)

1.3 EXECUTION

A. Plan Implementation
1. General: Implement waste management plan as approved by the Owner. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
a. Comply with Division 01 Section "Temporary Facilities And Controls" for operation, termination, and removal requirements.
2. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan. Coordinator shall be present at Project site full time for duration of Project.
3. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at Project site.
a. Distribute waste management plan to everyone concerned within three days of submittal return.
b. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
4. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
a. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
b. Comply with Division 01 Section "Temporary Facilities And Controls" for controlling dust and dirt, environmental protection, and noise control.

B. Salvaging Demolition Waste

1. Salvaged Items for Reuse in the Work:
   a. Clean salvaged items.
   b. Pack or crate items after cleaning. Identify contents of containers.
   c. Store items in a secure area until installation.
   d. Protect items from damage during transport and storage.
   e. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.
2. Salvaged Items for Sale and Donation: Not permitted.
3. Salvaged Items for Owner's Use:
   a. Clean salvaged items.
   b. Pack or crate items after cleaning. Identify contents of containers.
   c. Store items in a secure area until delivery to Owner.
   d. Transport items to Owner's storage area on-site **OR** off-site **OR** designated by Owner, **as directed**.
   e. Protect items from damage during transport and storage.
4. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.

C. Recycling Demolition And Construction Waste, General
1. General: Recycle paper and beverage containers used by on-site workers.
2. Recycling Receivers and Processors: Refer to the Owner for available recycling receivers and processors.
3. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Owner **OR** accrue to Contractor **OR** be shared equally by Owner and Contractor, **as directed**.
4. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical.
   a. Provide appropriately marked containers or bins for controlling recyclable waste until they are removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
      1) Inspect containers and bins for contamination and remove contaminated materials if found.
   b. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
   c. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
   d. Store components off the ground and protect from the weather.
   e. Remove recyclable waste off Owner's property and transport to recycling receiver or processor.

D. Recycling Demolition Waste
1. Asphaltic Concrete Paving: Grind asphalt to maximum 1-1/2-inch (38-mm) **OR** 4-inch (100-mm), **as directed**, size.
   a. Crush asphaltic concrete paving and screen to comply with requirements in Division 31 Section "Earth Moving" for use as general fill.
2. Asphaltic Concrete Paving: Break up and transport paving to asphalt-recycling facility.
3. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.
   a. Pulverize concrete to maximum 1-1/2-inch (38-mm) **OR** 4-inch (100-mm), **as directed**, size.
   b. Crush concrete and screen to comply with requirements in Division 31 Section "Earth Moving" for use as satisfactory soil for fill or subbase.
4. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.
   a. Pulverize masonry to maximum 3/4-inch (19-mm) **OR** 1-inch (25-mm) **OR** 1-1/2-inch (38-mm) **OR** 4-inch (100-mm), **as directed**, size.

1) Crush masonry and screen to comply with requirements in Division 31 Section "Earth Moving" for use as general fill **OR** satisfactory soil for fill or subbase, **as directed**.
2) Crush masonry and screen to comply with requirements in Division 32 Section "Plants" for use as mineral mulch.

b. Clean and stack undamaged, whole masonry units on wood pallets.

5. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.
6. Metals: Separate metals by type.
   a. Structural Steel: Stack members according to size, type of member, and length.
   b. Remove and dispose of bolts, nuts, washers, and other rough hardware.
7. Asphalt Shingle Roofing: Separate organic and glass-fiber asphalt shingles and felts. Remove and dispose of nails, staples, and accessories.
8. Gypsum Board: Stack large clean pieces on wood pallets and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.
9. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.
   a. Separate suspension system, trim, and other metals from panels and tile and sort with other metals.
10. Carpet and Pad: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.
    a. Store clean, dry carpet and pad in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.
11. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.
12. Plumbing Fixtures: Separate by type and size.
13. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.
14. Lighting Fixtures: Separate lamps by type and protect from breakage.
15. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.
16. Conduit: Reduce conduit to straight lengths and store by type and size.

E. Recycling Construction Waste

1. Packaging:
   a. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
   b. Polystyrene Packaging: Separate and bag materials.
   c. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
   d. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.
2. Site-Clearing Wastes: Chip brush, branches, and trees on-site **OR** at landfill facility, **as directed**.
   a. Comply with requirements in Division 32 Section "Plants" for use of chipped organic waste as organic mulch.
3. Wood Materials:
   a. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
   b. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.
      1) Comply with requirements in Division 32 Section "Plants" for use of clean sawdust as organic mulch.
4. Gypsum Board: Stack large clean pieces on wood pallets and store in a dry location.
   a. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.
      1) Comply with requirements in Division 32 Section "Plants" for use of clean ground gypsum board as inorganic soil amendment.

F. Disposal Of Waste
1. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
   a. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
   b. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
2. Burning: Do not burn waste materials.
   OR
   Burning: Burning of waste materials is permitted only at designated areas on Owner's property, provided required permits are obtained. Provide full-time monitoring for burning materials until fires are extinguished.
3. Disposal: Transport waste materials and dispose of at designated spoil areas on Owner's property.
   OR
   Disposal: Transport waste materials off Owner's property and legally dispose of them.

END OF SECTION 01 74 19 00

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Task	Specification	Specification Description
01 74 19 00	01 22 16 00	No Specification Required

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SECTION 02 32 13 00 - SUBSURFACE DRILLING, SAMPLING, AND TESTING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing of labor and equipment for drilling, sampling and testing for subsurface investigation of soils.

B. System Description: The purpose of the work specified herein is to determine the type, nature, and characteristics of subsurface materials and the extent and conditions of the various materials as they exist to the depths and at the locations specified. This is to be accomplished by means of auger borings, drive sample borings, undisturbed sample borings, core drilling, pressure testing, or test pits.
1. Auger Borings and Sampling: An auger boring is any boring made in unconsolidated soils with a conventional manually or power-driven earth auger for the purpose of obtaining samples of subsurface materials. Auger boring and sampling shall be performed in accordance with ASTM D 1452.
2. Drive Sample Borings and Sampling: A drive sample boring is a boring made through unconsolidated or partly consolidated sediments or decomposed rock by means of a mechanically driven sampler. The purpose of these borings is to obtain knowledge of the composition, the thickness, the depth, the sequence, the structure, and the pertinent physical properties of foundation or borrow materials. Drive sample boring and sampling shall be performed in accordance with ASTM D 1587. Standard Penetration Tests (SPT) shall be performed in accordance with ASTM D 1586.
3. Undisturbed Sample Borings and Sampling: An undisturbed sample boring is a boring made to obtain soil samples which, when tested, will show properties as close to the in situ (in place) properties as any sample which can be obtained. All undisturbed sampling shall be accomplished in accordance with ASTM D 1587.
4. Core Drilling: Drilling of cores shall be performed as per ASTM D 2113. The method used shall provide equally good recovery of cores from both hard and soft rocks.
5. Pressure Testing (Hydraulic): Hydraulic pressure testing is the process of forcing water under pressure into subsurface rock formations through pre-drilled holes for the purpose of determining the subsurface leakage conditions and possible grouting requirements.
6. Test Pit Excavation and Sampling: A test pit is any excavation in soil, hardpan, decomposed rock, or other unconsolidated or partially consolidated overburden materials which has an open cross-sectional area large enough to permit efficient excavation and shoring/lining, engineering and geological inspection and photographing of the subsurface soils and manual undisturbed sampling from within the test pit. All test pits shall be excavated, dewatered (if necessary), shored/lined and protected from surface water drainage in accordance with all applicable Federal, State, local, and OSHA safety regulations.
7. Bearing Capacity: ASTM D 1149.
8. Soils Classification: ASTM D 2487, ASTM D 2488, MIL-STD 619.

C. Submittals
1. Permits, Certifications, and Licenses: Comply with all Federal, State and local laws, regulations and ordinances relating to the performance of this work. The Contractor shall, at its own expense, procure all required permits, certifications and licenses required of him by Federal, State, and local law for the execution of this work. Furnish copies of all such documents to the Owner prior to starting work.
2. Drilling, Sampling, and Testing Plan: Prior to starting work, submit a plan for drilling, sampling, testing, and safety. The plan shall include, but not be limited to, the proposed method of drilling and sampling including a description of the equipment and sampling tools that will be used, a listing of any subcontractors to include a description of how the subcontractors will be used and a description of all methods and procedures that will be utilized to ensure a safe operation and to protect the environment. This submittal shall also include a statement of the prior experience, in

the type of work described in these specifications, of the person or persons designated to perform the work specified herein. No work shall be performed until this plan has been approved and no deviation from the approved plan will be permitted without prior approval by the Owner.

3. Drilling Log: Submit complete, legible copies of drilling log and records to the Owner within 5 days after a hole or test pit is completed.

D. Care And Delivery Of Samples

1. General: The Contractor shall be solely responsible for preserving all samples in good condition. Keep samples from freezing and from undue exposure to the weather, and shall keep all descriptive labels and designations on sample jars, tubes, and boxes clean and legible until final delivery. Except as otherwise specified, deliver samples safely to test facility, **as directed**. Deliver samples within the time limits specified for each type of investigation or in accordance with schedules prepared by the Owner.
2. Undisturbed Samples: Take every precaution to avoid damage to samples as a result of careless handling and undue delay in shipping. Ship samples in containers approved by the Owner, of sufficient durability to protect the samples from any damage during shipment. Pack sample tubes in vermiculite or other equal material approved by the Owner to protect the samples against vibration. Avoid exposing sealed and crated samples to precipitation, direct sunlight, freezing and temperatures in excess of 100 degrees F (38 degrees C). Samples permitted to freeze, even partially, shall be replaced by the Contractor at its expense. In general, no undisturbed samples shall remain on the site of sampling for more than one week before shipment. Store and ship samples with the tube in a horizontal **OR** vertical, **as directed**, position in order to prevent consolidation and segregation or change of water content.

E. Project/Site Conditions

1. Environmental Requirements
   a. In order to prevent and to provide for abatement and control of any environmental pollution arising from Contractor activities in the performance of this contract, the Contractor and its subcontractors shall comply with all applicable Federal, State, and local laws, regulations, and ordinances concerning environmental pollution control and abatement.
      1) The Contractor shall be responsible for keeping informed of all updates and changes in all applicable laws, regulations, and ordinances.
      2) The Contractor shall not pollute lakes, ditches, rivers, springs, canals, waterways, groundwaters, or reservoirs with drill fluids, fuels, oils, bitumens, calcium chloride, insecticides, herbicides, or other materials that may be harmful to the environment or a detriment to outdoor recreation.
2. Field Measurements: The approximate locations of drill holes or test pits shall be as directed. The actual locations will be established in the field by the Owner prior to the start of work. The elevations of the established locations will also be provided by the Owner prior to the start of work. The Contractor will provide access to the locations as it deems necessary for the prosecution of the work. Since no separate payment will be made for access construction, all costs associated with this shall be included in the cost of drilling or excavating.

F. Sequencing And Scheduling

1. Schedule of Drilling, Sampling and Testing: The schedule of Drilling, Sampling, and Testing is listed in the following schedule:

SCHEDULE OF DRILLING, SAMPLING AND TESTING

HOLE NO. or PIT NO.	METHOD	DEPTH FT(M)	VERTICAL or INCLINED	SPECIAL INSTRUCTIONS

2. Order of Work: The order in which the work is to be accomplished will be determined in the field by the Owner.

1.2 PRODUCTS

A. Containers: Furnish jars, tubes, and boxes that meet the following requirements. All such containers will become the property of the Owner and the cost thereof shall be included in the contract price for the applicable item for which payment is provided.
   1. Sample Jars: Sample jars shall be 1 pint (0.5 L) **OR** 1 quart (1.0 L), **as directed**, capacity, wide-mouth over 2-1/4 inches (57 mm) in diameter, glass **OR** plastic, **as directed**, jars with moisture-tight screw tops.
   2. Shipping Boxes: Boxes for shipping sample jars shall be corrugated cardboard **OR** wooden, **as directed**, boxes that have the capacity to hold no more than 12 sample jars and the strength to contain and protect the jars and their contents under ordinary handling and environmental conditions.
   3. Tubes and Crates: Undisturbed samples shall be shipped in thin walled Shelby tubes packed in crates.
   4. Core Boxes: Longitudinally partitioned, hinged top, wooden core boxes constructed of plywood and dressed lumber or other approved materials shall be used for all rock cores. As many core boxes as may be required shall be used to box all core. Core boxes shall be completely equipped with all necessary partitions, hinges, and a hasp for holding down the cover. In addition, the Contractor shall provide wood spacers made of surfaced lumber (not plywood) and having dimensions that are 1/8 inch (3 mm) less than the inside dimensions of the individual core box troughs and no less than 3/4 inch (19 mm) thick for blocking the core in the boxes and for providing a marking space to identify core runs and pull depths/elevations. The quantities of these blocks that are required are: ten blocks per core box for 3-inch (75-mm) or smaller core, five blocks per core box for 4-inch (100-mm) and PQ core, and three blocks per core box for 6-inch (150-mm) core. The box should have the following capacities:

6-inch (150-mm) core	single row of core
4-inch (100-mm) or PQ core	2 rows of core
3-inch (75-mm) or smaller core	3 or 4 rows of core

   The maximum length of a core box shall be 4 feet (1.2 m) for 3-inch (75 mm) or smaller core and shall be dimensioned so that a box will hold 12 to 16 feet (3.6 to 4.9 m) of core. The maximum length of a core box for core that is larger than 3 inches (75 mm) shall be 5 feet (1.5 m).

B. Labels
   1. Sample Jar Labels: A printed or type-written, fade resistant and waterproof label shall be affixed to the outside of each jar and shall contain the following information:
      PROJECT____________________________LOCATION____________________________
      (Such as Table Rock Dam) (Such as Borrow Area B)
      HOLE NO. _________________________ STATION______________________________
      JAR NO. __________ of _________ JARS
      TOP ELEV. OF HOLE_______________ DEPTH OF SAMPLE __________________
      DESCRIPTION OF MATERIAL____
      (Such as moist, silty, medium sand)
   2. Shipping Box Labels: Each box of jar samples shall be identified with weatherproof and wear-proof labels indicating the following:
      PROJECT: [_____]
      LOCATION: [_____]
      JAR SAMPLES FROM HOLE OR HOLES: [_____]
   3. Core Box Labels: Core boxes shall be identified with stenciled labels. The information on this label shall contain the following:
      PROJECT: [_____]
      HOLE NO. [_____]
      BOX NO. [_____]
      TOTAL NUMBER OF BOXES FOR THE HOLE: [_____]

1.3 EXECUTION

A. Mobilization and Demobilization
   1. Mobilization: Mobilization shall consist of the delivery to the site of all plant, equipment, materials and supplies to be furnished by the Contractor, the complete assembly in satisfactory working order of all such plant and equipment at the jobsite and the satisfactory storage at the site of all such materials and supplies.
   2. Demobilization: Demobilization shall consist of the removal from the site of all plant, equipment, materials and supplies after completion of the work and also includes, at the direction of the Owner, the cleanup and removal of all scrap, waste backfill material, waste drilling fluid, soil contaminated with engine/hydraulic oil, backfilling all sumps or excavations resulting from the operations and, in general, returning the site as close to its original condition as possible.

B. Equipment and Supplies
   1. Auger Boring and Sampling: The equipment to be furnished by the Contractor for making auger borings shall include, but not be limited to, standard continuous flight augers and/or standard cup-type earth augers, similar or equal to the Iwan Auger and not less than 4 inches (100 mm) in diameter unless otherwise approved. The augers shall be completely equipped with all the accessories necessary for boring and sampling of overburden materials to the depths and diameters specified or shown on the drawings.
   2. Drive Sample Boring and Sampling: Equipment to be furnished by the Contractor for making drive sample borings shall include, but not be limited to, standard 2-inch (50 mm) split barrel **OR** solid barrel, **as directed**, drive samplers and power-driven drilling machinery of a type or types approved by the Owner, complete with a drive-hammer of the weight as required to meet project requirements, and all other accessories for taking samples of all types of soils or decomposed rock at the locations and to the depths indicated in the schedule in paragraph SCHEDULE OF DRILLING, SAMPLING, AND TESTING. The drive shoe for the split barrel samplers shall be of hardened steel and shall be replaced or repaired when it becomes dented or distorted. Supplies shall include, but not be limited to, all casing, drill stem, drill bits, drill fluid and additives, pumps, and power necessary to accomplish the required boring and sampling.
   3. Undisturbed Sample Boring and Sampling: Equipment to be furnished by the Contractor for making undisturbed sample borings shall include, but not be limited to, power-driven drilling machinery of an approved type or types complete with the special devices and accessories enumerated and described hereinafter. Drilling machinery shall be of the hydraulic feed type. Supplies shall include, but not be limited to, all samplers, casing, drill stem, drill bits, drill fluid and additives, pumps, and power necessary to accomplish the required boring and sampling. Drill casing, if used, shall be of such minimum inside diameter as to allow use of the selected sampler.
      a. Sands and Cohesive Soils: The sampling device used to sample fine to medium grain sands and cohesive soils shall be a fixed or stationary piston type that uses a 3-inch (75-mm) **OR** 5-inch (125-mm), **as directed**, diameter thin wall Shelby tube. Subject to the approval of the Owner, floating or free piston and non-piston type samplers may be used provided adequate means, such as check valve or vacuum system, are provided to prevent loss of samples.
      b. Stiff and Dense Soils: The sampling device for obtaining samples of stiff and dense soils shall be similar or equal to a Denison double tube, swivel head core barrel, or a Pitcher sampler and must be approved by the Owner prior to use.
   4. Core Drilling - Size BX and NX Core: Equipment to be furnished by the Contractor for core drilling shall include core-drilling machinery of a type or types approved by the Owner complete with all the accessories needed to take continuous rock cores of a diameter consistent with bit size to the depths specified. The Contractor shall use, as a minimum, a standard ball-bearing, swivel-head, double-tube core barrel, or equivalent. The capacity of the core barrel shall not exceed 10.5 feet (3.2 m) of core. Supplies for core drilling to be furnished by the Contractor shall include, but not be limited to, all casing, drill rods, core barrels, coring bits, piping, pumps, water, tools, and power required for drilling and all boxes and containers required for core samples. Selection of the type of bit shall be at the Contractor's discretion provided that the selected bit produces high quality rock core. (see paragraph SUPPLEMENTAL BORINGS or PITS). The

Contractor's drilling equipment shall be capable of drilling inclined as well as vertical core holes as specified.

5. Pressure Testing (Hydraulic): Pressure testing equipment to be furnished by the Contractor shall include, but not be limited to, a water pump with a minimum capacity of 50 gallons per minute (3.15 liters per second) that is capable of delivering a constant discharge pressure with double expander packers with rubber expansion elements set 5 feet (1.5 m) **OR** 10 feet (3 m), **as directed**, apart with piping so arranged that water may be admitted either below the bottom packer element or between the two packer elements, a pressure relief valve, a pressure gage capable of measuring water pressures to the nearest 10 psi (1.45 kPa) and water meter capable of measuring flows to the nearest 1.6 gallon(s) per minute (0.1 liter(s) per second). Supplies shall include, but not be limited to, all accessory valves, gages, surge tanks, stopcocks, plugs, expanders, potable water for testing, standby pumps, fuels, pipes, pressure hose, and tools necessary for maintaining uninterrupted tests for each boring to be tested. The pressure test equipment shall be configured so that the pressure gage is located at the top of the hole, a by-pass water line and valve are located between the pump and the gage, a flow meter is located between the by-pass and the pressure gage, and a valve is located in the line between the flow meter and the pressure gage. All equipment and supplies used for pressure testing shall be approved by the Owner prior to use.
6. Test Pit Excavation and Sampling: Selection of the test pit excavation, shoring/lining and dewatering (if necessary) methods and equipment shall be at the Contractor's discretion but must be approved by the Owner. When the number of test pits to be excavated is large, and when adaptable mechanical trenching equipment is available, the Owner may require that such mechanical excavating equipment be used to expedite completion of the pits. Supplies which the Contractor shall furnish for obtaining undisturbed samples shall include, but not be limited to, split metal cylinders and/or metal or wooden boxes of acceptable sizes and types. Accessories to be supplied by the Contractor shall include, but not be limited to, a small sample trimming shovel or spade, hatchet, trimming knife, wax and facilities for melting and brushing same, trowels, labels, and boxes for shipping samples. The Contractor shall also furnish all materials required for shoring/lining to comply with all applicable safety regulations. The Owner may require the Contractor to salvage and re-use this shoring/lining material in successive test pits.

C. Identifying Samples: Sample jars, shipping boxes, and labels shall comply with paragraphs SAMPLE JARS, SHIPPING BOXES, and LABELS, respectively. The Contractor shall take all precautions required to insure that the shipping boxes are not subjected to rough handling or damaging environmental conditions, and complies with paragraph CARE AND DELIVERY OF SAMPLES. A copy of the boring log for the portion of the boring that the samples came from shall be enclosed in the shipping box.

D. Auger Boring and Sampling: Samples shall be labeled in accordance with paragraph IDENTIFYING SAMPLES. Samples shall be obtained for each change of overburden material and at maximum vertical intervals as directed by the Owner. In order to retain the natural moisture content of the material to the fullest extent possible, all samples shall be of sufficient volume to completely fill the sample jars and the samples shall be placed in the sample jars as soon as possible after they are taken from the hole. All sample jars shall be labeled. In general, no sample shall remain on the site of boring for more than 1 week after being taken from the boring and placed in a jar.

E. Drive Sample Boring and Sampling: Samples shall be labeled in accordance with paragraph IDENTIFYING SAMPLES. Drive sample borings drilled through overburden materials shall be suitably cased to permit obtaining drive samples of the size or sizes specified or as directed. Samples shall be taken either continuously or at a change in materials in accordance with instructions contained in the SCHEDULE OF DRILLING, SAMPLING, AND TESTING or as otherwise directed by the Owner. To minimize the compacting effect of casing driving when casing is used to stabilize a boring, the bottom of the casing shall be kept as high above the soil sampling zone as conditions permit. If hollow stem auger is used as a casing and/or to advance the boring, a plug assembly must be used to keep soil from entering the inside of the auger. Above the water table, samples shall be obtained from a dry hole. Below the water table, water shall be maintained within the hole at or above the groundwater level.

Where information on the natural water content of soils above the water table is not needed and when approved by the Owner, boreholes may be drilled without casing by using a suitable drilling fluid to prevent collapse of sidewalls. When a drilling fluid is used, soil sampling shall be done by such means that will prevent inclusion of drilling fluid in the samples. The samples shall be placed in sample jars as soon as possible after they are taken from the hole and, when possible, the volume of the sample shall be large enough to completely fill the sample jar in order that the natural moisture content of the material may be retained to the fullest extent possible. All samples shall be labeled. No sample shall remain at the site of boring for more than one week after being taken from the hole.

F. Undisturbed Sample Boring And Sampling: In general, labeling of undisturbed samples shall conform to paragraph IDENTIFYING SAMPLES. Particular care shall be taken to indicate the top and bottom of each sample tube. Tubes and crates for undisturbed samples shall be labeled "DO NOT JAR OR VIBRATE" and "HANDLE, HAUL, AND SHIP IN A HORIZONTAL **OR** VERTICAL POSITION," **as directed**.

1. Procedure: The procedure for Undisturbed Sample Boring and Sampling shall be the same as outlined in paragraph DRIVE SAMPLE BORING AND SAMPLING, except that the sampling device shall be advanced downward by one continuous, smooth drive using the drill rig's hydraulic feed system. The hydraulic down pressure shall be read and recorded at 6 inch (150 mm) intervals during each sample drive. The sampling device for stiff and dense soils shall be advanced by continuous rotation of the outer cutting barrel in conjunction with use of drill fluid circulation. Driving of any undisturbed sampling device by means such as a drop hammer will not be permitted.
2. Sealing
    a. Alternate 1: The soil sample obtained in a thin wall Shelby tube shall be retained in the tube and sealed on both ends with a mechanically expandable O-ring sealing disk of the appropriate size.
    b. Alternate 2: The soil sample obtained in a thin wall Shelby tube shall be extruded from the tube in the field as soon as the tube is removed from the boring by a method approved by the Owner. The extruded soil sample shall immediately be wrapped in aluminum foil or thin plastic wrap and placed in the center of a metal bottomed, waxed cardboard or plastic tube that has a diameter of at least 1 inch (25 mm) larger than the diameter of the soil sample, is at least 1-inch (25 mm) longer than the length of the soil sample, and has at least 1/2-inch (13 mm) of congealed 50/50 mixture of paraffin and microcrystalline wax in the bottom. The annular space between the soil sample and the tube shall be filled with a 50/50 mixture of paraffin and microcrystalline wax to a distance of at least 1/2-inch (13 mm) above the top of the soil sample.
    c. Alternate 3: Both ends of the soil sample tube/liner obtained with a Denison barrel, or its equivalent, shall be cleaned out to remove all drill fluid contaminated and/or disturbed soil or to a minimum distance of 2 inches (50 mm) from the ends of the tube/liner. Any material removed that is not contaminated with drill fluid shall be placed in a sample jar and labeled in accordance with paragraph IDENTIFYING SAMPLES. The cleaned out ends of the sample liner tube shall then be sealed with a 50/50 mixture of paraffin and microcrystalline wax. A metal or wooden disk, having a diameter just slightly smaller than the inside diameter of the liner tube shall be inserted into the wax to a distance of 1/4-inch (6 mm) from the end of the soil sample. The wax plugs shall be flush with the ends of the tube and a final seal consisting of a metal cap or tape shall be placed over the ends of the tube.

G. Core Hole Overburden Drilling: Where samples of overburden materials are required in connection with core drilling, the soil overburden shall be drilled and sampled in accordance with the applicable provisions for the type of samples required. Where sampling of the overburden materials is not required, the Contractor may utilize any method and equipment for drilling and, if required, casing through the overburden that will not affect the quality of the core drilling from the rock surface downward in accordance with these specifications. The method chosen must be approved by the Owner prior to starting any overburden drilling.

H. Core Drilling - Size BX and NX core.

1. Procedure: All holes shall be drilled vertically **OR** at the inclined angles listed in paragraph SCHEDULE OF DRILLING, SAMPLING, AND TESTING, **as directed**, to the bottom elevations or depths specified unless indicated in the schedule of borings or directed to be drilled otherwise. Off-setting of borings from the locations specified in the Plan of Borings or as shown on the drawings, will not be permitted without prior approval. Casing through the overburden may be required. This casing shall be sealed in the rock at the elevation where rock is encountered prior to commencement of rock coring. The Contractor shall operate its drills at such speeds and with such down pressures and shall control drill fluid pressures and quantities to insure maximum core quality and recovery in whatever kind of rock is encountered. Where soft or broken rock is encountered, the Contractor shall reduce the length of runs to 5 feet (1.5 m) or less in order to reduce and/or keep core loss and core disturbance to the minimum. Failure to comply with the foregoing procedures shall constitute justification for the Owner to require redrilling, at the Contractor's expense, of any boring from which the core recovery is unsatisfactory. The Contractor shall exercise particular care in recording zones of water loss, cavities, rod jerks, rough drilling and other unusual and non-ordinary coring experiences that, supplementing the core record, will throw light on the nature and the extent of any fracturing or abnormalities.
2. Arrangement of Core: Core boxes shall comply with paragraph CORE BOXES. All cores shall be arranged neatly in the partitioned boxes in the same sequence in which they occurred before removal from the hole. Facing the open box with the hinged cover above and the open box below, cores shall be arranged in descending sequence beginning at the left end of the trough nearest the hinges and continuing in the other troughs from left to right. The highest part of the core shall be placed in box 1, and the lower portions of the core shall be placed in the other boxes in consecutive order.
3. Preservation of Core: Representative samples of core shall be wrapped in aluminum foil or thin plastic wrap or cheese cloth and then sealed by applying paraffin wax to the outside of the wrapping material prior to placing the core in the core box. This sealing process shall be accomplished as soon as possible after the core is removed from the core barrel. The minimum length of core that is preserved from each boring shall be no less than 2.5 times the core diameter. Spacer blocks shall be marked and placed in the core box to show where samples have been removed.
4. Labeling, Marking and Packing Core: Stenciled labels for core boxes complying with paragraph CORE BOX LABELS shall be placed on the inside and outside of the top cover in addition to each end. In addition, the depths (or elevations) of each core run/pull shall be marked with a black waterproof pen on the spacer blocks that are placed between core pulls. When a box is full, the space between the core and the trough sides shall be filled with finely ground vermiculite or other packing material approved by the Owner.
5. Disposition of Core: While on site, the Contractor shall protect the filled core boxes from direct sunlight, precipitation, and freezing by some form of the Owner approved shelter that allows ventilation to the boxes. Upon completion of core drilling and sampling operations, core boxes containing cores shall be stored in an area provided by the Owner near the site of drilling **OR** shipped or delivered to address provided by the Owner, **as directed**.

I. Pressure Testing (Hydraulic): The Contractor shall pressure-test each hole commencing at the top of bedrock and progressing downward to the bottom of the hole or to such depths as determined by the Owner below which testing of the hole is not necessary. Where core data from the test holes indicate only isolated zones that are open or fractured, pressure testing may be limited by the Owner to these zones only. Water pressure employed for each lift shall be determined in the field by the Owner and shall not exceed of depth one pound per square inch per foot (22.6 kPa per meter) of depth to the upper expander. The pressure test will be divided into two phases; the first phase will be a flow test which shall then be followed by the second phase which is a duration test. In performing the first phase, water is pumped slowly at first, and the flow then gradually increased to the point where the predetermined maximum pressure is maintained, by adjusting the valve on the by-pass line. The allowable pressure shall be held for 1 minute before any readings are taken. The volume of flow into the test section shall be measured for a period of 5 minutes during which time the pressure shall not vary by more than 5 psi (34.5 kPa). After this 5-minute test, the second phase shall be started by closing the valve located between the flow meter and the pressure gage. The drop in pressure is then read for a period of 5 minutes at 15 to 30-second intervals. In some situations, such as in a very tight formation, the Owner may eliminate phase one of the test. The Contractor may be required to make check tests at its own expense if the testing equipment or its assembly and arrangement are found to be faulty during or after the testing of any holes. The Contractor shall record all gage and meter readings made during a pressure test on a suitable form approved by the Owner.

J. Test Pit Excavation And Sampling

1. Excavation: The test pits shall be excavated in the order scheduled in paragraph SCHEDULE OF DRILLING, SAMPLING, AND TESTING, and shall be excavated to depths and dimensions indicated in paragraph SCHEDULE OF DRILLING, SAMPLING, AND TESTING. Before excavating pits, the Contractor shall thoroughly familiarize itself with work site and with all available subsurface data, particularly groundwater conditions. Regardless of the method of excavation employed, the pits shall be excavated, dewatered and shored/lined in conformance with all applicable safety regulations.
2. Sampling: Soil samples shall be obtained from each pit at the depths/elevations indicated in paragraph SCHEDULE OF DRILLING, SAMPLING, AND TESTING **OR** at depths determined by the Owner, **as directed**. In obtaining samples from test pits, the undisturbed in situ (in place) natural physical and structural characteristics of the sampled materials shall be preserved insofar as possible both while samples are being taken and during shipment to the point of testing. In cohesive and partially cohesive soils this may be accomplished by isolating the soil column or cube to be sampled by gently trenching around it and knife-trimming it to the required dimensions of the split cylinder or box. A thin coating of melted 50/50 mixture of paraffin and microcrystalline wax shall then be applied quickly but gently to the sample with a paint brush to seal it against loss of moisture. The metal or wooden sample container, with the top and bottom removed shall then be placed over the wax coated sample such that the sample is centered within the container and the top of the container sides are at least 1 inch (25 mm) above the top of the sample. The spaces between the sample and the side walls of the container shall then be filled with melted wax. After this wax has congealed, the space between the top of the sample container sides and the top of the sample shall be filled with wax. After this wax has congealed, it shall be trimmed so that when the top of the sample container is installed there is no void between the container top and the wax. After the container top is installed, the soil column or cube shall then be cut off a few hundred inches (millimeters) below the container, the sample and container inverted and removed from the pit and the sample trimmed at the base so that the bottom of the sample is at least 1 inch (25 mm) below the bottom of the container. This space shall be filled with wax and, after the wax has congealed, it shall be trimmed so that when the bottom of the container is installed, there shall be no void between the wax and the bottom of the container. Where overburden materials to be sampled are only partially cohesive, it is best not to expose the entire soil column before waxing. By exposing and waxing small sections at a time, the sample will be subjected to less disturbance. Where natural moisture content is an important factor, delay shall be avoided in taking the sample in order that the natural moisture content of the material may be retained to the fullest extent.
3. Disposition of Samples: Samples shall be packed in vermiculite or a packing material approved by the Owner and shipped in sturdy wooden boxes of strength and construction sufficient to guarantee against damage during shipment. Boxes should be no larger than is required for shipping two such samples. All sample boxes shall be marked FRAGILE-HANDLE WITH CARE and shall be identified by labels, similar to those as specified in paragraph IDENTIFYING SAMPLES, attached to the outside of each box. Extreme care shall be taken to indicate the top and bottom of each sample. The Contractor shall avoid exposing sealed and crated samples to precipitation and extremes of temperature. Undisturbed samples permitted to freeze, even partially, shall be replaced by the Contractor at its expense. The Contractor shall not hold these samples at the site of sampling for a period in excess of one week. Prior to shipment, each sealed and boxed sample shall be checked for correct labeling.

K. Supplemental Borings or Pits: Borings or Pits that are abandoned or from which unsatisfactory samples or cores are obtained will be supplemented by other borings or pits adjacent to the original in order that satisfactory samples or the required information will be obtained. Actual locations of any supplemental borings or pits will be established by the Owner. Penetration to the depth where the original was abandoned or to the depths where unsatisfactory samples were obtained may be made by any method selected by the Contractor that in the opinion of the Owner will permit satisfactory completion and sampling below the elevation where the last satisfactory sample was obtained in the abandoned or satisfactory sampling in the reaches where satisfactory samples were not obtained in the original borings or pits. No payment will be made for supplemental borings or pits that are required to be drilled or excavated to replace borings or pits that were abandoned or from which satisfactory samples were not obtained because of mechanical failure of drilling and sampling equipment, negligence on the part of the Contractor, or other preventable cause for which the Contractor is responsible except that payment will be made for acceptable portions of these supplementary borings or pits below the depths or outside the reaches for which payment was made for the original borings or pits.

L. Backfilling
1. Drill Holes: Unless otherwise noted in these specifications or directed by the Owner, all drill holes shall be backfilled and abandoned in accordance with all Federal, State, and local laws, regulations and ordinances. The Contractor shall preserve all holes in good condition until final measurement and until the records and samples have been accepted. As a minimum, all holes shall be grouted from the bottom of the hole to within 2 feet (600 mm) of the ground. All grout shall be pumped through a tremie pipe that is inserted to the bottom of the boring to ensure that the grout fills the full extent of the hole. The remaining ungrouted portion of the hole shall be backfilled with local soil and tamped. All backfilling operations shall be performed in the presence of the Owner and, if required by regulation, Federal, State, and local officials. No separate payment will be made for backfilling drill holes. The cost of this work shall be included in the drilling costs.
2. Test Pits: The Contractor shall backfill all test pits with local soil compacted to original densities as directed by the Owner. No separate payment will be made for backfilling test pits. The cost of this work shall be included in the test pit excavation costs.

M. Records: The Contractor shall keep accurate driller's logs and records of all work accomplished under this contract and shall deliver complete, legible copies of these logs and records to the Owner upon completion of the work or at such other time or times as it may be directed. All such records shall be recorded during the actual performance of the work and shall be preserved in good condition and order by the Contractor until they are delivered and accepted. The Owner shall have the right to examine and review all such records at any time prior to their delivery to him and shall have the right to request changes to the record keeping procedure. The following information shall be included on the logs or in the records for each hole or test pit:
1. Hole or Test Pit number or designation and elevation of top of hole or test pit.
2. Driller's name and Geologist's name.
3. Make, size, and manufacturer's model designation of drilling, sampling, pressure testing, and test-pit excavating equipment.
4. Type of drilling, sampling, and pressure testing operation by depth.
5. Hole diameter.
6. Dates and time by depths when test-pit excavation, drilling, sampling, and pressure testing operations were performed.
7. Time required for drilling each run and pressure testing each interval tested.
8. Drill action, rotation speed, hydraulic pressure, water pressure, tool drops, and any other unusual and non-ordinary experience which could indicate the subsurface conditions encountered.
9. Depths at which samples or cores were recovered or attempts made to sample or core including top and bottom depth of each run and of each interval pressure tested.
10. Classification or description by depths of the materials sampled, cored, or penetrated using the Unified Soil Classification System (ASTM D 2487) and including a description of moisture conditions, consistency and other appropriate descriptive information described in paragraph

SUPPLEMENTAL BORINGS or PITS of ASTM D 2488. This classification or description shall be made immediately after the samples or cores are retrieved.

11. Classification and description by depths of rock materials sampled or cored including rock type, composition, texture, presence and orientation of bedding, floiation, or fractures, presence of vugs or other interstices, and the RQD for each cored interval.
12. Indication of penetration resistance such as drive-hammer blows given in blows per foot for driving sample spoons and casing and the pressure in applied to push thin-wall or piston-type samplers.
13. Weight (Force) of drive hammer.
14. Percentage of sample or core recovered per run.
15. Depth at which groundwater is encountered initially and when stabilized.
16. Depths at which drill water is lost and regained and amounts.
17. Depths at which the color of the drill water return changes.
18. Type and weight of drill fluid.
19. Depth of bottom of hole.
20. Pressures employed in pressure testing.

TABLE 1 - COMMON CORE DIAMETERS

	CORE DIAMETER in.	(mm)	HOLE DIAMETER in.	(mm)
Conventional Core Barrels				
AWG	1.185	(30.1)	1.890	(48.0)
BWG	1.655	(42.0)	2.360	(60.0)
NWG	2.155	(54.7)	2.980	(75.7)
HWG	3.000	(76.2)	3.907	(99.2)
Wireline Core Barrels*				
A	1.064	(27.0)	1.890	(48.0)
B	1.432	(36.5)	2.360	(60.0)
N	1.875	(47.6)	2.980	(75.7)
H	2.450	(62.2)	3.716	(94.4)
	3.345	(85.0)	4.827	(122.6)
Large Diameter Series				
2-3/4" X 3-7/8"	2.690	(68.3	3.875	(98.4)
4" X 5-1/2"	3.970	(100.8)	5.495	(139.6)
6" X 7-3/4"	5.970	(151.6)	7.750	(196.9)

*No Industry Standard for Wireline Sizes. Diameters shown for wireline core barrels are nominal and vary between manufacturers.

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Task	Specification	Specification Description
02 32 13 00	01 22 16 00	No Specification Required

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SECTION 02 41 13 13 - SELECTIVE DEMOLITION

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for selective demolition. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Demolition and removal of selected portions of building or structure.
      b. Demolition and removal of selected site elements.
      c. Salvage of existing items to be reused or recycled.

C. Definitions
   1. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.
   2. Remove and Salvage: Detach items from existing construction and deliver them to the Owner ready for reuse, **as directed**.
   3. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
   4. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

D. Materials Ownership
   1. Historic items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to the Owner that may be encountered during selective demolition remain the Owner's property. Carefully remove and salvage each item or object in a manner to prevent damage and deliver promptly to the Owner.
      a. Coordinate with the Owner's archaeologist **OR** historical adviser, **as directed**, who will establish special procedures for removal and salvage.

E. Submittals
   1. Qualification Data: For demolition firm, professional engineer, refrigerant recovery technician, **as directed**.
   2. Schedule of Selective Demolition Activities: Indicate the following:
      a. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure the Owner's building manager's and other tenants' on-site operations are uninterrupted.
      b. Interruption of utility services. Indicate how long utility services will be interrupted.
      c. Coordination for shutoff, capping, and continuation of utility services.
      d. Use of elevator and stairs.
      e. Locations of proposed dust- and noise-control temporary partitions and means of egress, including for other tenants affected by selective demolition operations.
      f. Coordination of the Owner's continuing occupancy of portions of existing building and of the Owner's partial occupancy of completed Work.
      g. Means of protection for items to remain and items in path of waste removal from building.
   3. Inventory: After selective demolition is complete, submit a list of items that have been removed and salvaged.

4. Predemolition Photographs or Videotapes: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by selective demolition operations. Submit before Work begins.
5. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.
   a. Comply with submittal requirements in Division 01 Section "Construction Waste Management And Disposal".

F. Quality Assurance
1. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.
2. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.
3. LEED Requirements for Building Reuse:
   a. Credit MR 1.1 and 1.2, **as directed**: Maintain existing building structure (including structural floor and roof decking) and envelope (exterior skin and framing, excluding window assemblies and nonstructural roofing material) not indicated to be demolished; do not demolish such existing construction beyond indicated limits.
   b. Credit MR 1.3: Maintain existing interior nonstructural elements (interior walls, doors, floor coverings, and ceiling systems) not indicated to be demolished; do not demolish such existing construction beyond indicated limits.
   c. Credit MR 1.2 and 1.3, **as directed**: Maintain existing nonshell, nonstructural components (walls, flooring, and ceilings) not indicated to be demolished; do not demolish such existing construction beyond indicated limits.
4. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
5. Standards: Comply with ANSI A10.6 and NFPA 241.
6. Predemolition Conference: Conduct conference at Project site. Review methods and procedures related to selective demolition including, but not limited to, the following:
   a. Inspect and discuss condition of construction to be selectively demolished.
   b. Review structural load limitations of existing structure.
   c. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
   d. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
   e. Review areas where existing construction is to remain and requires protection.

G. Project Conditions
1. the Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so the Owner's operations will not be disrupted.
2. Conditions existing at time of inspection for bidding purpose will be maintained by the Owner as far as practical.
   a. Before selective demolition, items will be removed as directed by the Owner.
3. Notify the Owner of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
4. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
   a. Hazardous materials will be removed by the Owner before start of the Work **OR** have been removed by the Owner under a separate contract, **as directed**.
   b. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify the Owner. the Owner will remove hazardous materials under a separate contract.

OR

5. Hazardous Materials: It is unknown whether hazardous materials will be encountered in the Work.
    a. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify the Owner and the Owner. the Owner will remove hazardous materials under a separate contract.
6. Hazardous Materials (if asbestos abatement is part of Work of this Contract): Hazardous materials are present in construction to be selectively demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
    a. Hazardous material remediation is specified elsewhere in the Contract Documents.
    b. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
7. Storage or sale of removed items or materials on-site is not permitted.
8. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
    a. Maintain fire-protection facilities in service during selective demolition operations.

H. Warranty
1. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

1.2 PRODUCTS (Not Used)

1.3 EXECUTION

A. Utility Services And Mechanical/Electrical Systems
1. Existing Services/Systems: Maintain services/systems indicated to remain and protect them against damage during selective demolition operations.
2. Service/System Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
    a. the Owner will arrange to shut off indicated services/systems when requested by Contractor.
    b. Arrange to shut off indicated utilities with utility companies.
    c. If services/systems are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
    d. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.
        1) Where entire wall is to be removed, existing services/systems may be removed with removal of the wall.

B. Preparation
1. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
2. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
    a. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
    b. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.

c. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
d. Cover and protect furniture, furnishings, and equipment that have not been removed.
e. Comply with requirements for temporary enclosures, dust control, heating, and cooling.

3. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
   a. Strengthen or add new supports when required during progress of selective demolition.

C. Selective Demolition, General

1. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
   a. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
   b. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
   c. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
   d. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
   e. Maintain adequate ventilation when using cutting torches.
   f. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
   g. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
   h. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
   i. Dispose of demolished items and materials promptly. Comply with requirements in Division 01 Section "Construction Waste Management And Disposal".
2. Reuse of Building Elements: Project has been designed to result in end-of-Project rates for reuse of building elements as follows. Do not demolish building elements beyond what is indicated on Drawings without the Owner's approval.
   a. Building Structure and Shell: 75 **OR** 100, **as directed**, percent.
   b. Nonshell Elements: 50 percent.
3. Removed and Salvaged Items:
   a. Clean salvaged items.
   b. Pack or crate items after cleaning. Identify contents of containers.
   c. Store items in a secure area until delivery to the Owner.
   d. Transport items to the Owner's storage area on-site **OR** off-site **OR** designated by the Owner **OR** indicated on Drawings, **as directed**.
   e. Protect items from damage during transport and storage.
4. Removed and Reinstalled Items:
   a. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.
   b. Pack or crate items after cleaning and repairing. Identify contents of containers.
   c. Protect items from damage during transport and storage.

d. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

5. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by the Owner, items may be removed to a suitable, protected storage location during selective demolition and cleaned, **as directed**, and reinstalled in their original locations after selective demolition operations are complete.

D. Selective Demolition Procedures For Specific Materials

1. Concrete: Demolish in small sections. Cut concrete to a depth of at least 3/4 inch (19 mm) at junctures with construction to remain, using power-driven saw. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete indicated for selective demolition. Neatly trim openings to dimensions indicated.

   OR

   Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals, using power-driven saw, then remove concrete between saw cuts.
2. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.
3. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.
4. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI-WP and its Addendum.
   a. Remove residual adhesive and prepare substrate for new floor coverings by one of the methods recommended by RFCI.
5. Roofing: Remove no more existing roofing than can be covered in one day by new roofing and so that building interior remains watertight and weathertight. Refer to Division 07 for new roofing requirements.
   a. Remove existing roof membrane, flashings, copings, and roof accessories.
   b. Remove existing roofing system down to substrate.
6. Air-Conditioning Equipment: Remove equipment without releasing refrigerants.

E. Disposal Of Demolished Materials

1. General: Except for items or materials indicated to be recycled, **as directed**, reused, salvaged, reinstalled, or otherwise indicated to remain the Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.
   a. Do not allow demolished materials to accumulate on-site.
   b. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
   c. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
   d. Comply with requirements specified in Division 01 Section "Construction Waste Management And Disposal".
2. Burning: Do not burn demolished materials.

   OR

   Burning: Burning of demolished materials will be permitted only at designated areas on the Owner's property, **as directed**, provided required permits are obtained. Provide full-time monitoring for burning materials until fires are extinguished.
3. Disposal: Transport demolished materials and dispose of at designated spoil areas on the Owner's property.

   OR

   Disposal: Transport demolished materials off the Owner's property and legally dispose of them.

F. Cleaning

1. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

G. Selective Demolition Schedule
1. Existing Items **OR** Construction, **as directed**, to Be Removed, as directed by the Owner.
2. Existing Items to Be Removed and Salvaged, as directed by the Owner.
3. Existing Items to Be Removed and Reinstalled, as directed by the Owner.
4. Existing Items to Remain, as directed by the Owner.

END OF SECTION 02 41 13 13

SECTION 02 41 13 13a - PORTLAND CEMENT CONCRETE REMOVAL

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for portland cement concrete removal. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Section Includes:
   1. Provide all labor, materials and equipment required for the removal work and disposal of existing Portland Cement Concrete indicated on the drawings and specified, including but not limited to the following:
      a. Saw cutting existing concrete pavements, sidewalks, driveways, curbs and gutters noted on drawings to be removed.
      b. Saw cutting existing concrete sidewalks for new tree pit openings (refer to drawings for locations).
      c. Saw cutting existing bituminous paving noted on drawings to be removed.
      d. Removal and disposal of demolished concrete sidewalks, driveways, curbs and gutters, including concrete removed for new tree pit openings.
      e. Removal and disposal of demolished bituminous paving.
      f. All excavating, rough grading and compacting as required to establish subgrade for new sidewalks, and Subgrade and Sub-Base for driveways.
      g. Providing, placing and grading sand fill under new sidewalks. Top of compacted subgrades shall allow for the placement of sidewalks plus thickness of sand fill.
      h. Removal and disposal of excavated material.

C. Special Requirements:
   1. Protection: Provide protection barricades, maintain all lights and signals and other measures as required by federal, state, and municipal laws, for the full period of demolition operations and remove same when directed. In removing work, perform all work required to protect and maintain adjacent property, streets, alleys, sidewalks, curbs, and other structures remaining in place.

1.2 PRODUCTS

A. Backfilling Material:
   1. Sand: Natural sand, with the following gradation: 100% passing the 1 sieve-, 65-100% passing the No. 4 sieve; 40-90% passing the No. 10 sieve- 30-80% passing the No. 16 sieve- 10-50% passing the No. 50 sieve; 0-30% passing the No. 100 sieve, and 0-10% passing the No. 200 sieve.
   2. Crushed Stone: Crushed stone having a #57 crusher run gradation.

1.3 EXECUTION

A. Demolition:
   1. The contractor shall accept the site as it finds it and shall inform itself as to the character and types of work to be removed. The Owner assumes no responsibility for the condition of the existing construction to be removed or demolished.
   2. No demolition shall be commenced until a program of operations has been coordinated with the Owner, except that preparatory work may be started if specifically approved by the Owner.

3. Operations shall be done in such manner as to avoid hazards to persons and property and interference with use of adjacent areas or interruption of free passage to and from such areas. Maintain Pedestrian access to all private entrances where construction of new sidewalks is in progress. Provide temporary walk ways or other means as required to maintain entry into the private properties, complying with all laws and ordinances and as approved by the Owner. Care shall be taken to prevent the spread of dust and flying particles.
4. Demolition and removal work shall be executed in a careful and orderly manner. Accumulation of rubbish will not be permitted.
5. After work is started, it shall be continued to completion at a rate that will allow the balance of the work to be completed within the time specified. If extra shifts are necessary beyond regular working hours, the work shall proceed with a minimum of nuisance to surrounding properties.
6. Contractor shall determine the nature and extent of demolition that will be necessary by comparing the drawings with the existing field conditions. It is expressly understood that this contract includes all work of a demolition nature that may be required or necessary for a full and complete execution of the work, whether particularly referred to herein or not.

B. Removal And Excavation:
1. When removing existing sidewalks, driveways, curbs and gutters provisions shall be made for satisfactory transition between replacements and the portion remaining in place. The contractor shall saw cut to a minimum depth of 1-1/2 inches with a concrete sawing machine to prevent the surface from spalling when the concrete is broken out. This work shall be done in such a manner that a straight joint will be secured.
2. It shall be the responsibility of the contractor to determine the thickness of the existing sidewalk to be removed. No additional compensation will be allowed because of variations from the assumed thickness or from the thickness shown on the plans.
3. After existing concrete sidewalks and driveways have been removed, excavate to depth required for sand fill.
4. The bottoms of all excavations shall be properly leveled off and all loose materials shall be removed from excavations. All wood, timber and organic materials, that are exposed at the bottom of all excavations, shall be removed and the area backfilled with sand and compacted.
5. Any excess or unauthorized excavation shall be backfilled with sand and compacted, at no additional cost to the Owner.
6. No backfill shall be placed in standing water, on frozen ground or on surfaces which have not been approved by the Commissioner.
7. Backfilling for all areas shall be approved material. Backfill shall be compacted to 95% maximum density in accordance with ASTM D 1557.
8. Contractor shall determine the nature and extent of excavation work that will be necessary by comparing the drawings with the existing areas to be excavated. It is expressly understood that this contract includes all work of an excavation nature that may be required or necessary for a complete execution of all excavation work, whether particularly referred to herein or not.

C. Disposal Of Materials:
1. All demolished and unsuitable materials, including excavated earth removed to establish required grade elevations shall be disposed of legally in such a manner that public or private property will not be damaged or endangered.

D. Clean-Up:
1. On completion of the demolition work, excavation work and before acceptance by the Owner, clean the areas affected, including areas outside the limits of the contractor's work area where permission to work has been granted. Remove surplus construction material or debris resulting from the demolition work and excavation work, and dispose of legally off the site.
2. Access routes to and from the site shall be kept clean of debris resulting from the work.

END OF SECTION 02 41 13 13a

SECTION 02 41 16 13 - BUILDING DEMOLITION

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for building demolition. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
    a. Demolition and removal of buildings and site improvements.
    b. Abandoning in place **OR** Removing, **as directed**, below-grade construction.
    c. Disconnecting, capping or sealing, and abandoning in-place **OR** removing, **as directed**, site utilities.
    d. Salvaging items for reuse by the Owner.

C. Definitions
1. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged.
2. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to the Owner ready for reuse. Include fasteners or brackets needed for reattachment elsewhere.

D. Materials Ownership
1. Unless otherwise indicated, demolition waste becomes property of Contractor.
2. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to the Owner that may be uncovered during demolition remain the property of the Owner.
    a. Carefully salvage in a manner to prevent damage and promptly return to the Owner.

E. Informational Submittals
1. Qualification Data: For refrigerant recovery technician.
2. Proposed Protection Measures: Submit informational report, including drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control, **as directed**. Indicate proposed locations and construction of barriers.
    a. Adjacent Buildings: Detail special measures proposed to protect adjacent buildings to remain.
3. Schedule of Building Demolition Activities: Indicate the following:
    a. Detailed sequence of demolition work, with starting and ending dates for each activity.
    b. Temporary interruption of utility services.
    c. Shutoff and capping or re-routing of utility services.
4. Inventory: Submit a list of items to be removed and salvaged and deliver to the Owner prior to start of demolition.
5. Predemolition Photographs **OR** Video, **as directed**: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by building demolition operations. Submit before the Work begins.
6. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.
7. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that

recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

F. Quality Assurance
1. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.
2. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
3. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.
4. Predemolition Conference: Conduct conference at Project site.
   a. Inspect and discuss condition of construction to be demolished.
   b. Review structural load limitations of existing structures.
   c. Review and finalize building demolition schedule and verify availability of demolition personnel, equipment, and facilities needed to make progress and avoid delays.
   d. Review and finalize protection requirements.
   e. Review procedures for noise control and dust control.
   f. Review procedures for protection of adjacent buildings.
   g. Review items to be salvaged and returned to the Owner.

G. Project Conditions
1. Buildings to be demolished will be vacated and their use discontinued before start of the Work.
2. Buildings immediately adjacent to demolition area will be occupied. Conduct building demolition so operations of occupied buildings will not be disrupted.
   a. Provide not less than 72 hours' notice of activities that will affect operations of adjacent occupied buildings.
   b. Maintain access to existing walkways, exits, and other facilities used by occupants of adjacent buildings.
      1) Do not close or obstruct walkways, exits, or other facilities used by occupants of adjacent buildings without written permission from authorities having jurisdiction.
3. the Owner assumes no responsibility for buildings and structures to be demolished.
   a. Conditions existing at time of inspection for bidding purpose will be maintained by the Owner as far as practical.
   b. Before building demolition, the Owner will remove certain items, as directed by the Owner.
4. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
   a. Hazardous materials will be removed by the Owner before start of the Work.
   b. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and the Owner. Hazardous materials will be removed by the Owner under a separate contract.

   OR

   Hazardous Materials: Hazardous materials are present in buildings and structures to be demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
   a. Hazardous material remediation is specified elsewhere in the Contract Documents.
   b. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
   c. the Owner will provide material safety data sheets for materials that are known to be present in buildings and structures to be demolished because of building operations or processes performed there.
5. On-site storage or sale of removed items or materials is not permitted.

H. Coordination
1. Arrange demolition schedule so as not to interfere with the Owner's on-site operations **OR** operations of adjacent occupied buildings, **as directed**.

1.2 PRODUCTS

A. Soil Materials
1. Satisfactory Soils: Satisfactory Soils: For soils which is to be used for backfilling voids that result from demolition operations in below-grade areas, comply with requirements in Division 31 Section "Earth Moving".

1.3 EXECUTION

A. Examination
1. Verify that utilities have been disconnected and capped before starting demolition operations.
2. Review Project Record Documents of existing construction provided by the Owner. the Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
3. Inventory and record the condition of items to be removed and salvaged. Provide photographs **OR** video, **as directed**, of conditions that might be misconstrued as damage caused by salvage operations.
4. Perform **OR** Engage a professional engineer to perform, **as directed**, an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during building demolition operations.
   a. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.
5. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

B. Preparation
1. Refrigerant: Remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction before starting demolition.
2. Existing Utilities: Locate, identify, disconnect, and seal or cap off indicated utilities serving buildings and structures to be demolished.
   a. the Owner will arrange to shut off indicated utilities when requested by Contractor.
      OR
      Arrange to shut off indicated utilities with utility companies, **as directed**.
   b. If removal, relocation, or abandonment of utility services will affect adjacent occupied buildings, then provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures.
   c. Cut off pipe or conduit a minimum of 24 inches (610 mm) below grade. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing according to requirements of authorities having jurisdiction.

   OR

   Existing Utilities: Refer to Division 22 AND Division 26 for shutting off, disconnecting, removing, and sealing or capping utilities. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing, **as directed**.
3. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent unexpected movement or collapse of construction being demolished.
   a. Strengthen or add new supports when required during progress of demolition.
4. Salvaged Items: Comply with the following:
   a. Clean salvaged items of dirt and demolition debris.
   b. Pack or crate items after cleaning. Identify contents of containers.
   c. Store items in a secure area until delivery to the Owner.
   d. Transport items to storage area designated by the Owner **OR** indicated on Drawings, **as directed**.
   e. Protect items from damage during transport and storage.

C. Protection
1. Existing Facilities: Protect adjacent walkways, loading docks, building entries, and other building facilities during demolition operations. Maintain exits from existing buildings.
2. Existing Utilities: Maintain utility services to remain and protect from damage during demolition operations.
a. Do not interrupt existing utilities serving adjacent occupied or operating facilities unless authorized in writing by the Owner and authorities having jurisdiction.
b. Provide temporary services during interruptions to existing utilities, as acceptable to the Owner and authorities having jurisdiction.
1) Provide at least 72 hours' notice to occupants of affected buildings if shutdown of service is required during changeover.
3. Temporary Protection: Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction, and as indicated. Comply with requirements in Division 01 Section "Temporary Facilities And Controls".
a. Protect adjacent buildings and facilities from damage due to demolition activities.
b. Protect existing site improvements, appurtenances, and landscaping to remain.
c. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
d. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
e. Provide protection to ensure safe passage of people around building demolition area and to and from occupied portions of adjacent buildings and structures.
f. Protect walls, windows, roofs, and other adjacent exterior construction that are to remain and that are exposed to building demolition operations.
g. Erect and maintain dustproof partitions and temporary enclosures to limit dust, noise, and dirt migration to occupied portions of adjacent buildings.
4. Remove temporary barriers and protections where hazards no longer exist. Where open excavations or other hazardous conditions remain, leave temporary barriers and protections in place.

D. Demolition, General
1. General: Demolish indicated existing buildings and site improvements completely. Use methods required to complete the Work within limitations of governing regulations and as follows:
a. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
b. Maintain fire watch during and for a specified time after flame cutting operations as directed by the Owner.
c. Maintain adequate ventilation when using cutting torches.
d. Locate building demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
2. Engineering Surveys: During demolition, perform surveys to detect hazards that may result from building demolition activities.
3. Site Access and Temporary Controls: Conduct building demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
a. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from the Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
b. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.
4. Explosives: Use of explosives is not permitted, **unless directed otherwise**.

E. Demolition By Mechanical Means

1. Proceed with demolition of structural framing members systematically, from higher to lower level. Complete building demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Remove debris from elevated portions of the building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
   a. Remove structural framing members and lower to ground by method suitable to minimize ground impact and dust generation.
3. Salvage: Items to be salvaged are indicated on Drawings **OR** below, **as directed**:
   a. Doors and door hardware.
   b. Windows.
   c. Cabinets.
   d. Mirrors.
   e. Chalkboards.
   f. Tackboards.
   g. Marker boards.
   h. Plumbing fixtures.
   i. Other items as directed.
4. Below-Grade Construction: Abandon foundation walls and other below-grade construction. Cut below-grade construction flush with grade.

   OR

   Below-Grade Construction: Demolish foundation walls and other below-grade construction that are within footprint of new construction and extending 5 feet (1.5 m) outside footprint indicated for new construction. Abandon below-grade construction outside this area.
   a. Remove below-grade construction, including basements, foundation walls, and footings, completely **OR** to at least 6 inches (150 mm) below grade **OR** to at least 12 inches (300 mm) below grade **OR** to depths indicated, **as directed**.

   OR

   Below-Grade Construction: Demolish foundation walls and other below-grade construction.
   b. Remove below-grade construction, including basements, foundation walls, and footings, completely **OR** to at least 6 inches (150 mm) below grade **OR** to at least 12 inches (300 mm) below grade **OR** to depths indicated, **as directed**.
5. Existing Utilities: Abandon existing utilities and below-grade utility structures. Cut utilities flush with grade.

   OR

   Existing Utilities: Demolish existing utilities and below-grade utility structures that are within 5 feet (1.5 m) outside footprint indicated for new construction. Abandon utilities outside this area.
   a. Fill abandoned utility structures with satisfactory soil materials **OR** recycled pulverized concrete, **as directed**, according to backfill requirements in Division 31 Section "Earth Moving".
   b. Piping: Disconnect piping at unions, flanges, valves, or fittings.
   c. Wiring Ducts: Disassemble into unit lengths and remove plug-in and disconnecting devices.

   OR

   Existing Utilities: Demolish and remove existing utilities and below-grade utility structures.
   a. Piping: Disconnect piping at unions, flanges, valves, or fittings.
   b. Wiring Ducts: Disassemble into unit lengths and remove plug-in and disconnecting devices.

F. Demolition By Explosives – ONLY IF APPROVED BY THE OWNER

1. Explosives: Perform explosive demolition according to governing regulations.
   a. Obtain written permission from authorities having jurisdiction before bringing explosives to, or using explosives on, Project site.
   b. Do not damage adjacent structures, property, or site improvements when using explosives.
2. Comply with recommendation in Explosives Consultant's report.

G. Site Restoration
   1. Below-Grade Areas: Rough grade below-grade areas ready for further excavation or new construction.
      OR
      Below-Grade Areas: Completely fill below-grade areas and voids resulting from building demolition operations with satisfactory soil materials **OR** recycled pulverized concrete **OR** recycled pulverized masonry, **as directed**, according to backfill requirements in Division 31 Section "Earth Moving".
   2. Site Grading: Uniformly rough grade area of demolished construction to a smooth surface, free from irregular surface changes. Provide a smooth transition between adjacent existing grades and new grades.

H. Repairs
   1. Promptly repair damage to adjacent buildings caused by demolition operations.

I. Disposal Of Demolished Materials
   1. Remove demolition waste materials from Project site and legally dispose of them in EPA approved landfill acceptable to authorities having jurisdiction. See Division 01 Section "Construction Waste Management And Disposal" for recycling and disposal of demolition waste.
      a. Do not allow demolished materials to accumulate on-site.
      b. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
   2. Do not burn demolished materials.

J. Cleaning
   1. Clean adjacent structures and improvements of dust, dirt, and debris caused by building demolition operations. Return adjacent areas to condition existing before building demolition operations began.
      a. Clean roadways of debris caused by debris transport.

END OF SECTION 02 41 16 13

Task	Specification	Specification Description
02 41 16 13	02 41 13 13	Selective Demolition
02 41 16 13	02 41 13 13a	Portland Cement Concrete Removal
02 41 19 13	02 41 13 13	Selective Demolition
02 41 19 13	01 71 23 16	Cutting and Patching
02 41 19 13	02 41 16 13	Building Demolition
02 41 19 13	02 41 13 13a	Portland Cement Concrete Removal
02 41 19 16	02 41 13 13	Selective Demolition
02 41 19 16	02 41 16 13	Building Demolition
02 41 19 16	02 41 13 13a	Portland Cement Concrete Removal
02 42 21 35	02 41 13 13	Selective Demolition
02 42 21 47	02 41 13 13	Selective Demolition
02 43 13 13	01 22 16 00	No Specification Required

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SECTION 02 58 13 00 - FARM-TYPE WIRE FENCING

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of farm-type wire fencing. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Fabric shall be galvanized steel wire complying with ASTM A 116.

B. Framework
   1. Steel
      a. Posts shall comply with ASTM A 702, T-section, zinc-coated.
      b. Stays shall be 9-1/2 gauge twisted wire, galvanized in compliance with ASTM A 641, Class 3.
   2. Wood: Posts shall be cut from cedar, Douglas fir, pine, or other approved species of timber. Posts shall be peeled, treated, dressed, and cured and shall contain no unsound knots. All posts shall match existing post dimensions. All wood posts and braces shall be given a pressure preservative treatment in a closed retort. The treatment shall comply with AWPA C2.
      a. Preservative. Wood cut or sawed after treatment shall have the cut surfaces well-coated with the preservative used in the treatment. All wood shall be pressure treated in accordance with AWPA C1 or AWPA C2, as applicable.

C. Braces: Steel braces shall have the same configuration as line posts and uprights without the anchor plate. Braces shall meet all of the requirements for wood posts.

D. Connectors
   1. Wire for Attaching Fabric to Posts shall be 12-1/2 gauge or coarser, galvanized in compliance with ASTM A 641, Class 3.
   2. Staples and Nails shall comply with Fed. Spec. FF-N-105. Staples and nails shall be zinc-coated and of sufficient length for purpose required.

E. Gates
   1. Tubular Steel:
      a. Frame shall be a minimum of 1-3/8 inch outside diameter tubular steel, braced with a sturdy center bar and diagonal adjustable brace wire to prevent sagging. Gates shall be fitted with hinges. All material shall be hot-dipped zinc-coated.
      b. Fabric for Gates shall be as specified for the fence and shall be securely tied to the framework at top, bottom, and sides with 9-gauge wire.
   2. Angle Iron
      a. Frame shall be fabricated of angle iron with cross ties and stays of light angle iron. Frame shall be zinc-coated in compliance with ASTM A 120 or A 153.
      b. Fabric for Gates shall be as specified for the fence and shall be securely tied to the framework at top, bottom, and sides with 9-gauge wire.
   3. Wood: Provide a 3/8-inch minimum diameter galvanized steel truss rod and turnbuckle.

F. Barbed Wire shall comply with ASTM A 121 and shall be made from 2 strands of 12-1/2 gauge galvanized steel wire, twisted, with four-point barbs spaced five inches apart. Wire shall have Class 2 zinc coating.

G. Hardware:
1. Gate Hardware shall include the following:
   a. Bottom Hinge shall be designed to carry the weight of the gate.
   b. The Upper Hinge shall be adjustable.
   c. Lock with Chain shall be 1-3/4 inch size complying with ASTM F 883.
   d. Keeper shall automatically engage and hold the gate leaf open until manually released.
   e. Center Plunger Rod.
   f. Center Stop.
   g. Vertical Lift.
   h. Sliding Track.
2. Lightning Arresters, Insulators and Insulator Clamps, Fasteners, Signs, and Other Accessories shall be provided and installed as required.

1.3 EXECUTION

A. Installation
1. Wood Posts: Hold in line in a true vertical position by temporary bracing until backfilling is completed. Compact by hand tamping or other suitable methods to a density comparable to that of adjacent ground. Refasten all braces, gates, hardware, fabric, and other accessories.
2. Steel Posts: Steel posts shall be held in a vertical position and driven to the required depths by an approved post driver. Tops of posts shall not be damaged by driving operation.
3. Corner, Brace, or End Panels: Corner, brace, or end panels shall be constructed at the beginning and terminal ends, at gate openings, at all intersections, at all corners or changes in horizontal alignment of fences, in existing fence on both sides of junction with new fence, (except when junction is at a corner already braced), and on both sides of cattle guards.
4. Pull Posts shall be constructed when the distance of unbraced fencing exceeds 640 feet. Pull posts shall be spaced equidistant in the fence at intervals of 640 feet or less.
5. Wire Installation: Barbed and/or woven wire fabric shall be stretched to proper tension and securely fastened to posts. Top and bottom wires of fabric shall be tied or stapled to each post. Tie or staple every other wire to alternating posts. Every wire shall be tied to corner, pull, end, and gate posts. Wire for tying woven wire fabric and barbed wire shall be 9-gauge.
6. Restretching Existing Fabric: Fabric indicated to be restretched shall be restretched to proper tension and refastened to posts. Excess fabric extending beyond the post shall be removed.
7. Alignment: Finished fencing shall be plumb and in proper alignment with posts, and all wire work shall be taut.

END OF SECTION 02 58 13 00

SECTION 02 58 13 00a - SNOW AND OTHER TEMPORARY FENCING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of snow and other temporary fencing. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.
2. Shop drawings shall be submitted for approval.

1.2 PRODUCTS

A. Pickets:
1. Size: Wood pickets shall be 3/8 inch thick, 1-1/2 inches wide, and 48 inches high.
2. Coating: Red oil paint or stain.
3. Spacing: Approximately 2 inches apart.
4. Attachment: Bind together with 3 double strands of wire.

B. Framework:
1. Materials: Wire shall be 13 ga. galvanized steel, complying with ASTM A 641.
2. Types: The framework shall consist of 3 parallel double strands of wire twisted between pickets to hold them securely in place.
3. Wire Connectors: Wire for attaching fabric to metal posts shall be 9 ga.
4. Staples and Nails shall comply with Fed. Spec. FF-N-105. Staples and nails shall be zinc-coated and of sufficient length for purpose required.

C. Gates:
1. Frame: Frame shall consist of 2 parallel horizontal wooden members with pickets attached at two-inch spacing.
2. Bracing: 2 wooden members laced diagonally on the gate between the frame boards.
3. Hardware shall include 2 strap hinges, latching device, and stop bar, all of zinc-coated steel, in compliance with ASTM A 153.

D. Supports:
1. Steel: Line posts and uprights shall be drive type, T sections, and provided with suitable anchor plate. The sections shall be hot-rolled steel complying with ASTM A 702, galvanized in compliance with ASTM A 123. The T sections shall have the following minimum sizes:

Post Length (Feet)	Post Weight (Pounds)
5	7.32
5 1/2	7.99
6	8.65
6 1/2	9.32
7	9.98
7 1/2	10.64
8	11.31
9	12.64
10	13.97

2. Wood: Posts shall be cut from cedar, Douglas fir, pine, or other approved species of timber. Posts shall be peeled, treated, dressed, and cured. All wood posts and braces shall be given a pressure preservative treatment in a closed retort. The treatment shall comply with Fed. Spec. TT-W-571. Wood cut or sawed after treatment shall have the cut surfaces well brush-coated with the preservative used in the treatment.
3. Braces: Steel braces shall have same configuration as line posts and uprights without the anchor plate. Wood braces shall be treated No. 2 or better grade, Douglas fir or southern yellow pine. Braces shall meet all of the requirements for wood posts.
4. Location: Posts shall be evenly spaced to adequately support the fence framework.

1.3 EXECUTION

A. Installation
1. Wood Posts: Hold in line in a true vertical position by temporary bracing until backfilling is completed. Compact by hand tamping or other suitable methods to a density comparable to that of adjacent ground.
2. Steel Posts: Hold in a vertical position and drive to the required depths by an approved post driver. Post tops shall not be damaged during driving.
3. Corner, Brace, Or End Panels: Construct corner, brace, or end panels at the beginning and terminal ends, at gate openings, at all intersections, and at all corners or changes in horizontal alignment of fences, in existing fence on both sides of junction with new fence (except when junction is at a corner already braced).
4. Pull Posts shall be constructed when the distance of unbraced fencing exceeds 640 feet. Pull posts shall be spaced equidistant in the fence at intervals of 640 feet or less.
5. Framework Installation: Stretch to proper tension and securely fasten to posts. Top and bottom wires of fabric shall be tied or stapled to each post. Tie or staple every other wire to alternating posts. Every wire shall be tied or stapled to corner, pull, end, and gate posts. Wire for tied fabrics shall be 9 ga.
6. Picket Replacement: Where required, new pickets shall be securely fastened into the existing wire framework using 13 ga. galvanized wire.
7. Restretching Existing Fabric: Fabric designated to be restretched shall be restretched to proper tension and refastened to posts. Excess fabric extending beyond the post shall be removed.

END OF SECTION 02 58 13 00a

SECTION 02 61 00 00 - EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for excavation and handling of contaminated material. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals

1. Shop Drawings: Separate cross-sections of each area before and after excavation and after backfilling.
2. Product Data: Work Plan within 30 calendar days after notice to proceed. No work at the site, with the exception of site inspections and surveys, shall be performed until the Work Plan is approved. The Contractor shall allow 30 calendar days in the schedule for the Owner's review. No adjustment for time or money will be made if resubmittals of the Work Plan are required due to deficiencies in the plan. At a minimum, the Work Plan shall include:
   a. Schedule of activities.
   b. Method of excavation and equipment to be used.
   c. Shoring or side-wall slopes proposed.
   d. Dewatering plan.
   e. Storage methods and locations for liquid and solid contaminated material.
   f. Borrow sources and haul routes.
   g. Decontamination procedures.
   h. Spill contingency plan.
3. Closure Report: Three (3) copies of the Closure Report within 14 calendar days of work completion at the site.
4. Test Reports
   a. Backfill
   b. Surveys
   c. Confirmation Sampling and Analysis
   d. Sampling of Stored Material
   e. Sampling Liquid
   f. Compaction
   g. Test results.

C. Surveys

1. Surveys shall be performed immediately prior to and after excavation of contaminated material to determine the volume of contaminated material removed. Surveys shall also be performed immediately after backfill of each excavation. The Contractor shall provide cross-sections on 25 foot (7.6 meter) intervals and at break points for all excavated areas. Locations of confirmation samples shall also be surveyed and shown on the drawings.

D. Regulatory Requirements

1. Permits and Licenses: The Contractor shall obtain required federal, state, and local permits for excavation and storage of contaminated material. Permits shall be obtained at no additional cost the Owner.
2. Air Emissions: Air emissions shall be monitored and controlled in accordance with the Owner's Environmental Requirements.

E. Chemical Testing

1. Required sampling and chemical analysis shall be conducted in accordance with local requirements and the Owner's requirements.

F. Scheduling

1. The Contractor shall notify the Owner five (5) calendar days prior to the start of excavation of contaminated material. the Owner will **OR** The Contractor shall, **as directed**, be responsible for contacting regulatory agencies in accordance with the applicable reporting requirements.

1.2 PRODUCTS

A. Backfill

1. Backfill material shall be obtained from the location indicated on the drawings **OR** offsite sources approved by the Owner, **as directed**. Backfill shall be classified in accordance with ASTM D 2487 as GW, GP, GM, GC, SW, SP, SM, SC, ML, MH, CL, or CH and shall be free from roots and other organic matter, trash, debris, snow, ice or frozen materials. Backfill material shall be tested for the parameters listed below at a frequency of once per 3000 cubic yards (cubic meters). A minimum of one set of classification tests shall be performed per borrow source. One backfill sample per borrow source shall also be collected and tested for the chemical parameters listed below.

Physical Parameter	Test Method
Grain Size	ASTM D 422
Compaction	ASTM D 698

Backfill shall not be used until borrow source chemical and physical test results have been submitted and approved.

B. Spill Response Materials

1. The Contractor shall provide appropriate spill response materials including, but not limited to the following: containers, adsorbents, shovels, and personal protective equipment. Spill response materials shall be available at all times when contaminated materials/wastes are being handled or transported. Spill response materials shall be compatible with the type of materials and contaminants being handled.

1.3 EXECUTION

A. Existing Structures And Utilities

1. No excavation shall be performed until site utilities have been field located. The Contractor shall take the necessary precautions to ensure no damage occurs to existing structures and utilities. Damage to existing structures and utilities resulting from the Contractor's operations shall be repaired at no additional cost to the Owner. Utilities encountered that were not previously shown or otherwise located shall not be disturbed without approval from the Owner.

B. Clearing

1. Clearing shall be performed to the limits shown on the drawings in accordance with Division 2 Section “Site Clearing.”

C. Contaminated Material Removal

1. Excavation: Areas of contamination shall be excavated to the depth and extent shown on the drawings and not more than 0.2 feet (60 mm) beyond the depth and extent shown on the drawings unless directed by the Owner. Excavation shall be performed in a manner that will limit spills and the potential for contaminated material to be mixed with uncontaminated material. An excavation log describing visible signs of contamination encountered shall be maintained for each area of excavation. Excavation logs shall be prepared in accordance with ASTM D 5434.
2. Shoring: If workers must enter the excavation, it shall be evaluated, shored, sloped or braced as required by U.S. Army Corps of Engineers (USACE) EM 385-1-1 and U.S. National Archives and Records Administration (NARA) 29 CFR 1926 section 650.

3. Dewatering: Surface water shall be diverted to prevent entry into the excavation. Dewatering shall be limited to that necessary to assure adequate access, a safe excavation, prevent the spread of contamination, and to ensure that compaction requirements can be met. No dewatering shall be performed without prior approval of the Owner.

D. Confirmation Sampling And Analysis

1. the Owner shall be present to inspect the removal of contaminated material from each site. After all material suspected of being contaminated has been removed, the excavation shall be examined for evidence of contamination. If the excavation appears to be free of contamination, field analysis shall be used to determine the presence of contamination using a real time vapor monitoring instrument **OR** immunoassay field kits, **as directed**. Excavation of additional material shall be as directed by the Owner. After all suspected contaminated material is removed, confirmation samples shall be collected and analyzed.
2. Samples shall be collected at a frequency as directed by the Owner. A minimum of one sample shall be collected from the bottom and each side wall of the excavation. Based on test results, the Contractor shall propose any additional excavation which may be required to remove material which is contaminated above action levels. Additional excavation shall be subject to approval by the Owner. Locations of samples shall be marked in the field and documented on the as-built drawings.

E. Contaminated Material Storage

1. Material shall be placed in temporary storage immediately after excavation **OR** after treatment while awaiting test results, **as directed**. The following paragraphs describe acceptable methods of material storage. Storage units shall be in good condition and constructed of materials that are compatible with the material or liquid to be stored. If multiple storage units are required, each unit shall be clearly labeled with an identification number and a written log shall be kept to track the source of contaminated material in each temporary storage unit.
2. Stockpiles
   a. Stockpiles shall be constructed to isolate stored contaminated material from the environment. The maximum stockpile size shall be as directed by the Owner. Stockpiles shall be constructed to include:
      1) A chemically resistant geomembrane liner free of holes and other damage. Non-reinforced geomembrane liners shall have a minimum thickness of 20 mils (0.5 mm). Scrim reinforced geomembrane liners shall have a minimum weight of 40 lbs. per 1000 square feet (20 kg/100 square meters). The ground surface on which the geomembrane is to be placed shall be free of rocks greater than 0.5 inches (12 mm) in diameter and any other object which could damage the membrane.
      2) Geomembrane cover free of holes or other damage to prevent precipitation from entering the stockpile. Non-reinforced geomembrane covers shall have a minimum thickness of 10 mils (0.25 mm). Scrim reinforced geomembrane covers shall have a minimum weight of 26 lbs. per 1000 square feet (13 kg/100 square meters). The cover material shall be extended over the berms and anchored or ballasted to prevent it from being removed or damaged by wind.
      3) Berms surrounding the stockpile, a minimum of 12 inches (300 mm) in height. Vehicle access points shall also be bermed.
      4) The liner system shall be sloped to allow collection of leachate. Storage and removal of liquid which collects in the stockpile, in accordance with paragraph Liquid Storage.
3. Roll-Off Units: Roll-off units used to temporarily store contaminated material shall be water tight. A cover shall be placed over the units to prevent precipitation from contacting the stored material. The units shall be located as shown on the drawings. Liquid which collects inside the units shall be removed and stored in accordance with paragraph Liquid Storage.
4. Liquid Storage: Liquid collected from excavations and stockpiles shall be temporarily stored in 55 gallon barrels (220 L barrels) **OR** 500 gallon tanks (2000 L tanks), **as directed**. Liquid storage containers shall be water-tight and shall be located as shown on the drawings.

F. Sampling

1. Sampling of Stored Material
   a. Samples of stored material shall be collected at a frequency as directed by the Owner.
   b. Stored material with contaminant levels that exceed the action levels shall be treated offsite. Analyses for contaminated material to be taken to an offsite treatment facility shall conform to local, state, and federal criteria as well as to the requirements of the treatment facility. Documentation of all analyses performed shall be furnished to the Owner. Additional sampling and analyses to the extent required by the approved offsite treatment, storage or disposal (TSD) facility shall be the responsibility of the Contractor and shall be performed at no additional cost to the Owner **OR** subject to approval by the Owner, **as directed**.
      OR
      Stored material with contaminant levels that exceed the action levels shall be treated onsite.
2. Sampling Liquid
   a. Liquid collected from excavations **OR** storage areas **OR** decontamination facilities, **as directed**, shall be sampled at a frequency of once for every 500 gallons (2,000 L) of liquid collected.
   b. Liquid with contaminant levels that exceed action levels shall be treated offsite. Analyses for contaminated liquid to be taken to an offsite treatment facility shall conform to local, state, and federal criteria as well as to the requirements of the treatment facility. Documentation of all analyses performed shall be furnished to the Owner. Additional sampling and analysis to the extent required by the approved offsite treatment, storage or disposal (TSD) facility receiving the material shall be the responsibility of the Contractor and shall be performed at no additional cost to the Owner **OR** subject to approval by the Owner.
      OR
      Liquid with contaminant levels that exceed action levels shall be treated onsite.
3. Sampling Beneath Storage Units
   a. Samples from beneath each storage unit shall be collected prior to construction of and after removal of the storage unit. Samples shall be collected at a frequency as directed by the Owner from a depth interval of 0 to 0.5 feet (0 to 0.15 m).
   b. Based on test results, soil which has become contaminated above action levels shall be removed at no additional cost to the Owner. Contaminated material which is removed from beneath the storage unit shall be handled in accordance with paragraph Sampling of Stored Material. as directed by the Owner and at no additional cost to the Owner, additional sampling and testing shall be performed to verify areas of contamination found beneath stockpiles have been cleaned up to below action levels.

G. Spills

1. In the event of a spill or release of a hazardous substance (as designated in NARA 40 CFR 302), pollutant, contaminant, or oil (as governed by the Oil Pollution Act [OPA], 33 U.S.C. 2701 et seq.), the Contractor shall notify the Owner immediately. If the spill exceeds the reporting threshold, the Contractor shall follow the pre-established procedures as described in the Contingency Plan for immediate reporting and containment. Immediate containment actions shall be taken to minimize the effect of any spill or leak. Cleanup shall be in accordance with applicable federal, state, and local regulations. as directed by the Owner, additional sampling and testing shall be performed to verify spills have been cleaned up. Spill cleanup and testing shall be done at no additional cost to the Owner.

H. Backfilling

1. Confirmation Test Results: Excavations shall be backfilled immediately after all contaminated materials have been removed and confirmation test results have been approved. Backfill shall be placed and compacted to the lines and grades shown on the drawings.

2. Compaction: Approved backfill shall be placed in lifts with a maximum loose thickness of 8 inches (200 mm). Soil shall be compacted to 90 percent of ASTM D 698 **OR** ASTM D 1557, **as directed**, maximum dry density. Density tests shall be performed at a frequency of once per 10,000 square feet (930 square meters) per lift. A minimum of one density test shall be performed on each lift of backfill placed. Field in-place dry density shall be determined in accordance with ASTM D 1556, ASTM D 2167, or ASTM D 2922. If ASTM D 2922 is used, a minimum of one in ten tests shall be checked using ASTM D 1556 or ASTM D 2167. Test results from ASTM D 1556 or ASTM D 2167 shall govern if there is a discrepancy with the ASTM D 2922 test results.

I. Disposal Requirements
1. Offsite disposal of contaminated material shall be in accordance with Division 2 Section "Disposal of Hazardous Materials."

J. Closure Report
1. Three copies of a Closure Report shall be prepared and submitted within 14 calendar days of completing work at the site. The report shall be labeled with the contract number, project name, location, date, and name of general contractor. The Closure Report shall include the following information as a minimum:
   a. A cover letter signed by a responsible company official **OR** Professional Engineer registered in the state of the work who is a responsible company official, **as directed**, certifying that all services involved have been performed in accordance with the terms and conditions of the contract documents and regulatory requirements.
   b. A narrative report including, but not limited to, the following:
      1) site conditions, ground water elevation, and cleanup criteria;
      2) excavation logs;
      3) field screening readings;
      4) quantity of materials removed from each area of contamination;
      5) quantity of water/product removed during dewatering;
      6) sampling locations and sampling methods;
      7) sample collection data such as time of collection and method of preservation;
      8) sample chain-of-custody forms; and
      9) source of backfill.
   c. Copies of all chemical and physical test results.
   d. Copies of all manifests and land disposal restriction notifications.
   e. Copies of all certifications of final disposal signed by the responsible disposal facility official.
   f. Waste profile sheets.
   g. Scale drawings showing limits of each excavation, limits of contamination, known underground utilities within 50 feet (15 m) of excavation, sample locations, and sample identification numbers. On-site stockpile, storage, treatment, loading, and disposal areas shall also be shown on the drawings.
   h. Progress Photographs. Color photographs shall be used to document progress of the work. A minimum of four views of the site showing the location of the area of contamination, entrance/exit road, and any other notable site conditions shall be taken before work begins. After work has been started, activities at each work location shall be photographically recorded daily **OR** weekly, **as directed**. Photographs shall be a minimum of 3 x 5 inches (76.2 x 127.0 mm) and shall include:
      1) Soil removal and sampling.
      2) Dewatering operations.
      3) Unanticipated events such as spills and the discovery of additional contaminated material.
      4) Contaminated material/water storage, handling, treatment, and transport.
      5) Site or task-specific employee respiratory and personal protection.
      6) Fill placement and grading.

7) Post-construction photographs. After completion of work at each site, the Contractor shall take a minimum of four views of each excavation site. A digital version of all photos shown in the report shall be included with the Closure Report. Photographs shall be a minimum of 3 inches by 5 inches (76mm by 127 mm) and shall be mounted back-to-back in double face plastic sleeves punched to fit standard three ring binders. Each print shall have an information box attached. The box shall be typewritten and arranged as follows:

Project Name: Direction of View:
Location: Date/Time:
Photograph No.: Description of View:

END OF SECTION 02 61 00 00

SECTION 02 61 13 00 - UNDERGROUND STORAGE TANK REMOVAL

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing of labor and equipment for the underground storage tank removal. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. Work Plan: The Work Plan within 30 days after notice to proceed. The Contractor shall allow 30 days in the schedule for the Owner's review and approval. No adjustment for time or money will be made for resubmittals required as a result of noncompliance.
   2. Qualifications: A document indicating that the Contractor meets the specified requirements.
   3. Reports
      a. Backfill Material.
      b. Tank Contents Verification.
      c. Contaminated Water Disposal.
      d. Soil Examination, Testing, and Analysis.
      e. Reports including the chain-of-custody records.
      f. Backfilling.
      g. Copies of all laboratory and field test reports.
      h. Tank Closure Report: 3 copies of the report for each UST site opened, prepared in a standard 3-ring binder, within 14 days of completing work at each site. Each binder shall be labeled with contract number, project name, location and tank number; each binder shall be indexed. A copy of the report shall be furnished to the Installation Environmental Coordinator.
   4. Records
      a. Salvage Rights: A record of the disposition of salvaged materials at the end of the contract.
   5. Qualifications
      a. The Contractor shall have a minimum of 2 years of tank removal experience and shall be certified by the State in which the Project is located for tank removal work.
      b. Laboratory Services: For laboratory services the Contractor shall be validated in accordance with state certification requirements.
      c. Support Staff: The Contractor shall identify all staff involved for the various components, including personnel collecting and shipping samples. The qualifications of these staff members shall be detailed by the Contractor.

C. Regulatory Requirements
   1. Permits and Licenses: The Contractor, as required or as directed by the Owner, shall obtain local, state, or federal permits and licenses that directly impact the Contractor's ability to perform the work prior to commencing removal operations.
   2. Statutes and Regulations: Tank closures shall be carried out in accordance with 40 CFR 280, 40 CFR 262, 40 CFR 264, and 40 CFR 265 as well as the applicable local and State regulations. Hazardous material and/or waste shall be transported in accordance with applicable local and State regulations.

D. Project/Site Conditions: See the Detailed Scope of Work
   1. Sequencing and Scheduling: The Contractor shall notify the Installation Environmental Coordinator and the Owner 5 days prior to tank removal. The Contractor shall be responsible for contacting the Implementation Agency (IA) in accordance with the applicable reporting requirements.

2. Work Plan
   a. The Contractor shall develop, implement, maintain, and supervise as part of the work, a comprehensive plan for tank removal and related operations. As a minimum the plan shall include, but not be limited to, excavation, removal, and ultimate disposal of the tank, its contents, and any contaminated materials. The Work Plan shall be based on work experience, on the requirements of this specification, and on the following references from the American Petroleum Institute:
      API RP 1604.
      API Standard 2015.
      API RP 2003.
      API Publication 2217A.
      API Publication 2219.

      No work at the site, with the exception of site inspections and mobilization, shall be performed until the Work Plan is approved. At a minimum, the Work Plan shall include:
      1) Discussion of the removal approach, tank cleaning, and tank cutting procedures.
      2) A Sampling and Analysis Plan.
      3) Methods to be employed for product, sludge, vapor, and pumpable liquid removal; purging and inerting; and storage methods proposed for control of surface water.
      4) Treatment options.
      5) Identification of waste, tank and contaminated soil transporters and means of transportation.
      6) Treatment, disposal, and alternate facilities, and means of treatment, disposal or remediation.
      7) Borrow source.
      8) Spill prevention plan.
      9) Spill contingency plan.
      10) Decontamination procedures, shoring plan, and safety measures.

1.2 PRODUCTS

A. Backfill Material
   1. Backfill shall be classified in accordance with ASTM D 2487 as GW, GP, GM, GC, SW, SP, SM, SC, MH, CL, or CH and shall be free from roots and other organic matter, trash, debris, snow, ice or frozen materials. If off-site materials are used, soil classification test results shall be approved prior to bringing the material onsite. The testing frequency for backfill material shall be 1 per 1000 cubic yards or a minimum of 1 test. Non-contaminated material removed from the excavation shall be used for backfill in accordance with Paragraph BACKFILLING.

1.3 EXECUTION

A. General Requirements
   1. Safety Guidelines: Personnel shall abide by the safety guidelines specified in Division 01.
   2. Burning and Explosives: Use of explosives or burning debris will not be allowed.
   3. Protection of Existing Structures and Utilities: The Contractor shall take all necessary precautions to avoid damage to existing structures, their appurtenances, monitoring wells, or utilities that may be affected by work activities. Any damage to utilities or monitoring wells resulting from the Contractor's operations shall be repaired at no expense to the Owner. The Contractor shall coordinate with the installation to locate underground utilities prior to beginning construction. Utilities encountered which were not previously shown or otherwise located shall not be disturbed without approval from the Owner.
   4. Shoring: Shoring requirements shall be provided.

B. Tank Contents Verification

1. Sampling: Tank product, pumpable liquids, tank coatings and sludge shall be sampled by the Contractor. If the data is not adequate, additional sampling and analysis to the extent required by the approved permitted treatment, storage or disposal (TSD) facility receiving the material shall be the responsibility of the Contractor. Meeting all regulatory requirements, including the preparation of hazardous materials and waste for transportation shall be the responsibility of the Contractor.
2. Analysis: Tank contents shall be tested by the Contractor for the parameters listed herein. Analyses shall include total petroleum hydrocarbons (TPH), benzene, ethylbenzene, toluene and xylene (BETX), and lead.
3. Characterization: Prior to removing any of the tank contents, the contents shall be characterized to determine if the tank contents must be disposed as a hazardous or special waste or in a special manner based on local, state, and Federal disposal regulations. Tank product, pumpable liquids, and sludge shall be characterized in accordance with 40 CFR 261 and 40 CFR 279. The waste contents determination and accompanying test results for each phase present in the tank shall be submitted to the Owner. The Contractor shall be responsible for any additional requirements identified by the disposal facility. The tank contents shall not be removed until approval is given by the Owner.

C. Clearing, Grubbing And Removals
1. Areas designated for clearing and grubbing shall be cleared of all trees, stumps, down timber, brush, rubbish, roots larger than 75 mm (3 inches) in diameter, and matted roots prior to commencing operations. Concrete or asphalt pavement shall be saw cut at the limits of removal, broken and removed with the resulting debris disposed of as directed by the Owner. Chain link fence shall be removed and salvaged for reuse or disposed of off-site, as directed by the Owner.

D. Topsoil
1. Uncontaminated topsoil shall be stripped and stockpiled separately for reuse at a location approved by the Owner if it meets the requirements of clean fill given in Paragraph BACKFILLING. Additional topsoil in excess of that produced by excavation shall be obtained where directed by the Owner. All areas disturbed by tank removal operations, other than areas to receive pavement or similar surface under this contract, shall be topsoiled. Topsoil shall be used wherever directed by the Owner.

E. Preparations For Excavation: Before excavating, the Contractor shall drain product piping back to the tank, remove residual liquids trapped in the product lines, and remove all product from the tank; and the tank shall be purged and vented in accordance with API RP 1604, and as specified herein.
1. Removal of Product, Pumpable Liquids, and Sludge: Tank product, pumpable liquids, and sludge shall be contained, and stored onsite, prior to disposal. Contaminated water shall be treated as specified. Tank product, pumpable liquids, and sludge shall be analyzed and segregated to recover reusable products by the Owner prior to being transported to the designated location or treatment, storage and disposal (TSD) facility. Tank product, pumpable liquids, and sludge shall be removed and disposed of by the Contractor. No Owner facilities shall be used for permanent storage or disposal of the wastes. Temporary storage on Owner's facilities will be allowed only until testing is complete, manifests (if necessary) are complete, and transportation is arranged. The Contractor shall be responsible for obtaining all required permits. Usable product shall be the property of the Contractor. The Contractor shall provide approved containers, vehicles, equipment, labor, signs, labels, placards and manifests and associated land disposal restriction notices and notifications, necessary for accomplishment of the work, including materials necessary for cleaning up spills that could occur from tank removal operations.
2. Contaminated Water Disposal:
   a. Sampling, Analysis, and Containment
      1) Contaminated water shall be sampled and analyzed both prior to and after treatment. Contaminated water produced from excavation operations and tank pumping treated onsite, shall be analyzed for pH; benzene, ethylbenzene, toluene, and xylene (BETX); total lead; oil and grease; total petroleum hydrocarbons (TPH). Sampling and analysis shall be performed prior to disposal for every 200,000 L

(50,000 gallons) of contaminated water treated. Analysis for contaminated water to be taken to an off-site treatment facility shall conform to the requirements of the treatment facility with documentation of all analyses performed furnished to the Owner in accordance with paragraph RECORDS.

2) Contaminated water shall be contained, stored onsite, and analyzed and disposed of by the Contractor in accordance with applicable Federal and state disposal regulations. The Contractor shall provide approved containers, vehicles, equipment, labor, signs, labels, placards and manifests and associated land disposal notices and notifications, necessary for accomplishment of the work.

b. Treatment: Contaminated water shall be treated by oil water separation, filtering, air stripping and activated carbon,or other means as approved by the Owner. If contaminated water is to be treated onsite, the proposed treatment shall be specified in the Work Plan and submitted for approval. Temporary storage and treatment equipment shall be installed at a location approved by the Owner. Treated effluent shall be sampled and analyzed and the results approved by the Owner before discharge to the sanitary sewer or the surface. Effluent shall be treated and discharged in accordance with the discharge permit.

F. Purging And Inerting: After the tank and piping contents have been removed, but prior to excavation beyond the top of the tank, the Contractor shall disconnect all the piping (except the piping needed to purge or inert the tank). Flammable and toxic vapors shall be purged from the tank or the tank made inert in accordance with API RP 1604, with the exceptions that filling with water shall not be used and, if dry ice is employed, the Contractor shall use a minimum of 1.8 kg per 500 L (3 pounds per 100 gallons) of tank volume. The tank atmosphere shall be continuously monitored for combustible vapors if the tank is purged, or continuously monitored for oxygen if the tank is inerted.

G. Excavation: Excavation areas, as well as work near roadways, shall be marked as directed by the Owner.

1. Exploratory Trenches: Exploratory trenches shall be excavated as necessary to determine the tank location, limits and the location of ancillary equipment.
2. Tank Excavation: Excavation around the perimeter of the tank shall be performed limiting the amount of potentially petroleum contaminated soil that could be mixed with previously uncontaminated soil. Petroleum contaminated soil shall be segregated in separate stockpiles. The Contractor shall maintain around the tank an excavation of sufficient size to allow workers ample room to complete the work, but also protect the workers from sliding or cave-ins. Sheeting, bracing, or shoring shall be installed in the absence of adequate side slopes if there is a need for workers to enter the excavated area. Surface water shall be diverted to prevent direct entry into the excavation. Dewatering of the excavation may require a discharge permit by the State and shall be limited to allow adequate access to the tank and piping, to assure a safe excavation, and to ensure that compaction and moisture requirements are met during backfilling. Dewatering may result in the production of petroleum contaminated water and/or free product. Free product shall be recovered from the groundwater only as part of necessary dewatering.
3. Piping Excavation: Excavation shall be performed as necessary to remove tank piping and ancillary equipment in accordance with paragraphs: Shoring, Tank Excavation, and Open Excavations.
4. Open Excavations: Open excavations and stockpile areas shall be secured while awaiting confirmation test results from the soil beneath the tank. The excavation shall be backfilled as soon as possible after tank and contaminated soil removals have been completed and confirmation samples have been taken. The Contractor shall divert surface water around excavations to prevent water from directly entering into the excavation.
5. Stockpiles: Uncontaminated excavated soil and petroleum contaminated soil that is not a state-regulated hazardous waste shall be stockpiled and used for backfill in the tank excavation prior to using borrow material or disposed of off-site. Excavated material that is regulated by the state as a hazardous waste shall be considered contaminated and shall be placed in containers such as drums, roll-offs or dumpsters for sampling in accordance with paragraph Stockpiled Material

Sampling. Uncontaminated soil shall be stockpiled separately from the contaminated soil, a safe distance away from, but adjacent to, the excavation.

H. Removal Of Piping, Ancillary Equipment, And Tank
1. Piping and Ancillary Equipment: All piping and ancillary equipment shall be disconnected from the tank. The piping shall be removed completely (interior and exterior of the tank). All tank ancillary equipment and piping connections shall be capped, except those connections necessary to inert the tank within the excavation zone. The piping exterior and ancillary equipment shall be cleaned to remove all soil and inspected for signs of corrosion and leakage. The Contractor shall ensure no spillage of the piping contents occurs, as specified in the Work Plan, and as required in paragraph SPILLS. If the soil under and around the tank pad is contaminated, the tank pad shall be removed and disposed of off-site at an approved non-hazardous or hazardous waste facility, as required. If the soil under and around the tank pad is not contaminated, the tank pad shall remain in place.
2. Tank: The tank shall be removed from the excavation and the exterior cleaned to remove all soil and inspected for signs of corrosion, structural damage, or leakage. All materials coming into contact with the tank, or in the vicinity of the excavation such as shovels, slings and tools shall be of the non-sparking type. After removal from the excavation, the tank shall be placed on a level surface at an approved location and secured with wood blocks to prevent movement.
3. Contaminated Soil, Tank and Piping Excavation Examination: After the tank has been removed from the ground, the adjacent and underlying soil shall be examined for any evidence of leakage. The soil shall be visually inspected for staining after removal of all obviously contaminated soil, then screened for the presence of volatile and/or semi-volatile contamination using a real time vapor monitoring instrument or immunoassay field kits, as required. Uncontaminated soil or petroleum contaminated soil not regulated by the state as hazardous waste shall be transported off-site for disposal. Contaminated soil or suspected contaminated soil shall be containerized. the Owner shall determine the extent of the contaminated soil to be removed from each site. The Contractor shall report any evidence indicating that the amount of contaminated soil may exceed the individual site limit specified, to the Owner the same day it is discovered. If minimal additional excavation is required, the Owner may allow the Contractor to proceed. If extensive contamination is encountered, the excavation shall be sampled and backfilled in accordance with paragraph BACKFILLING. After the known contaminated soil is removed, the excavation shall be sampled and analyzed.

I. Tank Cleaning
1. Exterior: Soil shall be removed from the exterior of the tank, piping, and associated equipment to eliminate soil deposition on roadways during transportation to a temporary storage area, ensure markings will adhere to the surfaces, and simplify tank cutting. Soil shall be removed using non-sparking tools. Removed uncontaminated soil and soil not regulated by the state as a hazardous waste shall be recovered and used as backfill in the former tank excavation. Soil believed to be contaminated shall be removed and containerized.
2. Temporary Storage: If the tank is stored after the tank exterior is cleaned and ancillary equipment is removed, and prior to being cut into sections, the tank shall be labeled as directed in API RP 1604, placed on blocks, and temporarily stored in the area of the existing tank site. Prior to cleaning the tank interior the tank atmosphere shall be monitored for combustible vapors and purged or inerted if combustible vapors are detected.
3. Interior:
   a. The tank interior shall be cleaned using a high pressure (greater than 500 psi (3.45 Mpa)), low volume (less than 2 gpm (0.13 L/s)) water spray or steam cleaned until all loose scale and sludge is removed, and contamination, in the form of a sheen, is no longer visible in the effluent stream. The interior surfaces of piping shall also be cleaned, to the extent possible, using the same method used for cleaning the tank. Contaminated water generated from interior cleaning operations (of both piping and tank) shall not exceed the following quantities for each UST cleaned:

UST VOLUME (LITERS) PERCENT OF UST VOLUME

3,785 or less	5
37,850 or less	5 or 378 L, whichever is less
75,700 or less	1 or 568 L, whichever is less
greater than 75,700	1 or 946 L, whichever is less

UST VOLUME (GALLONS)	PERCENT OF UST VOLUME
1,000 or less	5
10,000 or less	5 or 100 gal., whichever is less
20,000 or less	1 or 150 gal., whichever is less
greater than 20,000	1 or 250 gal., whichever is less.

b. All contaminated water resulting from cleaning operations shall be handled in accordance with paragraph Contaminated Water Disposal. Cleaning shall be accomplished eliminating, to the greatest extent possible, the need for personnel to enter the tank. Cleaning shall be done using specially designed tank cleaning equipment which allows the tank to be cleaned prior to cutting into sections without requiring personnel to enter the tank or, if less specialized equipment is used, the tank shall be partially dissected to overcome confined space entry hazards.

J. Soil Examination, Testing, And Analysis

1. Tank Excavation Sampling Procedures: After soil known to be contaminated has been removed or after soil excavation is complete, the excavation shall be sampled with procedures, number, location, and methodology in accordance with state regulations. Samples shall be obtained from the pits, in accordance with ASTM D 1587, using a backhoe with a Shelby tube attached to the bucket.
2. Stockpiled Material Sampling: Sampling locations, number and specific procedures shall be as required by the implementing agency and the disposal facility.
3. Analysis: Soil samples from the excavation and stockpiled material shall be tested in accordance with the approved Sampling and Analysis Plan for the following parameters: total petroleum hydrocarbon (TPH); benzene, ethylbenzene, toluene, xylene (BETX); toxicity characteristic leaching procedure (TCLP). Copies of all test results shall be provided to the Owner.

K. Backfilling: The tank area and any other excavations shall be backfilled only after the soil test results have been approved. Contaminated soil removal shall be complete after the bottom of the tank excavation is determined to have soil contamination levels below the state standards of approval by the Owner. The excavation shall be dewatered if necessary. Stockpiled material subjected to chemical confirmation testing shall be used as backfill if it is found to conform to the requirements of clean fill per appropriate state and local regulations. Backfill consisting of clean fill shall be placed in layers with a maximum loose thickness of 200 mm (8 inches) and compacted to 90 percent maximum density for cohesive soils and 95 percent maximum density for cohesionless soils. Density tests shall be performed by an approved commercial testing laboratory or by facilities furnished by the Contractor. Test results shall be attached to contractor's Quality Control Report. A minimum of 1 density test shall be performed on each lift. Laboratory tests for moisture density relations shall be determined in accordance with ASTM D 1557, Method B, C, or D, or ASTM D 3017. A mechanical tamper may be used provided that the results are correlated with those obtained by the hand tamper. Field in-place density shall be determined in accordance with ASTM D 1556, ASTM D 2922, or ASTM D 2167.

L. Disposal Requirements

1. Treatment, Disposal, and Recycling: Disposal of hazardous or special wastes shall be in accordance with all local, State, and Federal solid and hazardous waste laws and regulations; and conditions specified herein. This work shall include all necessary personnel, labor, transportation, packaging, detailed analyses (if required for disposal, manifesting or completing waste profile sheets), equipment, and reports. Product and pumpable liquids removed from the tank shall be recycled to the greatest extent practicable. The tanks removed shall be disposed of

at one of the state approved facilities. Each tank disposed of in this manner shall be manifested as required by the State to document delivery and acceptance at the disposal facility.

2. Tank and Ancillary Equipment Disposal: After the tank, piping, and ancillary equipment have been removed from the excavation and the tank cleaned, the tank shall be cut into sections with no dimension greater than 1500 mm (5 feet). Tank and piping sections shall be disposed of in a State approved off-site disposal facility or in a salvage yard. The tank shall be cut into sections prior to being taken from the tank removal site. The Contractor shall not sell the tank intact. Ancillary equipment shall be disposed of at an approved off-site disposal facility or a salvage yard. Piping shall be disconnected from the tank and removed or grouted full of a portland cement and water slurry consisting of 22.7 L (6 gallons) of clean water per 42.6 kg (94 pound) sack of portland cement, thoroughly mixed and free of lumps, unless otherwise indicated.
3. Transportation of Wastes: Transportation shall be provided in accordance with Department of Transportation (DOT) Hazardous Material Regulations and State and local requirements, including obtaining all necessary permits, licenses, and approvals. Evidence that a State licensed hazardous waste or waste transporter is being used shall be included in the SUBMITTALS.
4. Salvage Rights: The Contractor shall retain the rights to salvage value of recycled or reclaimed product and metal not otherwise identified, so long as the requirements of 40 CFR 266 and 40 CFR 279, or the applicable State requirements are met. At the end of the contract, the Contractor shall provide documentation on the disposition of salvaged materials.
5. Records: Records shall be maintained of all waste determinations, including appropriate results of analyses performed, substances and sample location, the time of collection, and other pertinent data as required by 40 CFR 280, Section 74 and 40 CFR 262 Subpart D. Transportation, treatment, disposal methods and dates, the quantities of waste, the names and addresses of each transporter and the disposal or reclamation facility, shall also be recorded and available for inspection, as well as copies of the following documents:
   a. Manifests.
   b. Waste analyses or waste profile sheets.
   c. Certifications of final treatment/disposal signed by the responsible disposal facility official.
   d. Land disposal notification records required under 40 CFR 268 for hazardous wastes.
6. Hazardous/Special Waste Manifests: Manifesting shall conform to Federal, State and local requirements.
7. Documentation of Treatment or Disposal: The wastes, other than recyclable or reclaimable product or metal, shall be taken to a treatment, storage, or disposal facility which has EPA or appropriate state permits and hazardous or special waste identification numbers and complies with the provisions of the disposal regulations. Documentation of acceptance of special waste by a facility legally permitted to treat or dispose of those materials shall be furnished to the Owner not later than 5 working days following the delivery of those materials to the facility; and a copy shall be included in the Tank Closure Report. A statement of agreement from the proposed treatment, storage or disposal facility and certified transporters to accept hazardous or special wastes shall be furnished to the Owner not less than 14 days before transporting any wastes. If the Contractor selects a different facility than is identified in the contract, documentation shall be provided for approval to certify that the facility is authorized and meets the standards specified in 40 CFR 264.

M. Spills: Immediate containment actions shall be taken as necessary to minimize effect of any spill or leak. Cleanup shall be in accordance with applicable Federal, State, local laws and regulations, and district policy at no additional cost to the Owner.

N. Tank Closure Report: Tank Closure Reports shall include the following information as a minimum:
1. A cover letter signed by a Professional Engineer registered in the State in which the Project is located certifying that all services involved have been performed in accordance with the terms and conditions of this specification.
2. A narrative report describing what was encountered at each site, including:
   a. condition of the UST.
   b. any visible evidence of leaks or stained soils.
   c. results of vapor monitoring readings.

d. actions taken including quantities of materials treated or removed.
e. reasons for selecting sample locations.
f. sample locations.
g. collection data such as time of collection and method of preservation.
h. reasons for backfilling site.
i. whether or not groundwater was encountered.

3. Copies of all analyses performed for disposal.
4. Copies of all waste analyses or waste profile sheets.
5. Copies of all certifications of final disposal signed by the responsible disposal installation official.
6. Information on who sampled, analyzed, transported, and accepted all wastes encountered, including copies of manifests, waste profile sheets, land disposal restriction, notification and certification forms, certificates of disposal, and other pertinent documentation.
7. Copies of all analyses performed for confirmation that underlying soil is not contaminated, with copies of chain-of-custody for each sample. Analyses shall give the identification number of the sample used. Sample identification numbers shall correspond to those provided on the one-line drawings.
8. Scaled one-line drawings showing tank locations, limits of excavation, limits of contamination, underground utilities within 15 m (50 feet) sample locations, and sample identification numbers.
9. Progress Photographs. The Contractor shall take a minimum of 4 views of the site showing such things as the location of each tank, entrance/exit road, and any other notable site condition before work begins. After work has been started at the site, the Contractor shall photographically record activities at each work location daily. Photographs shall be 76.2 x 127.0 mm (3 x 5 inches) and shall include:
   a. Soil removal, handling, and sampling.
   b. Unanticipated events such as discovery of additional contaminated areas.
   c. Soil stockpile area.
   d. Tank.
   e. Site or task-specific employee respiratory and personal protection.
   f. Fill placement and grading.
   g. Post-construction photographs. After completion of work at each site, the Contractor shall take a minimum of four (4) views of the site. Prints shall illustrate the condition and location of work and the state of progress. The photographs shall be mounted and enclosed back-to-back in a double face plastic sleeve punched to fit standard three ring binders. Each color print shall show an information box, 40 x 90 mm (1-1/2 x 3-1/2 inches). The information box for the 76.2 x 127.0 mm (3 x 5 inch) photographs shall be scaled down accordingly, or taped to the bottom of the photo. The box shall be typewritten and arranged as follows:

      Project No.
      Contract No.
      Location
      Contractor/Photographer
      Photograph No. Date/Time:
      Description
      Direction of View

END OF SECTION 02 61 13 00

SECTION 02 61 13 00a - PRECISION TESTING OF UNDERGROUND FUEL OIL TANKS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing of labor and equipment for the precision testing of underground fuel oil tanks. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCTS - (Not Used)

1.3 EXECUTION

A. The Contractor shall furnish all the necessary labor and equipment to complete the Precision Fuel Oil Tank Testing at various buildings under the jurisdiction of the Owner. The pertinent quantity and the capacity of the tanks will be listed on each Job Order. When the contractor elects to use a volumetric tank tester, it shall be responsible to fill up and "top off" tank to a maximum of 100 gallons prior to the start of testing. The cost to "top off" tank will be the contractor's responsibility.

B. The Contractor shall provide the material and labor necessary for the drilling and tapping of the existing oil tank manhole cover and the installation of new air bleeder valves. The air bleeder valve shall be a Hoffman Specialty #40 or #41 or their approved equal.

C. Coordination of Work: Prior to performing any test, the contractor shall notify the Owner of the scheduled test date. Designated personnel from the Owner shall take necessary actions to coordinate fuel oil delivery and shall inform the contractor of the date and time of the fuel delivery. The contractor shall ascertain that the tanks are filled to capacity and shall be responsible to have the tanks “topped off” up to a maximum of 100 gallons prior to the start of testing. The contractor shall make arrangements to perform the testing within forty-eight (48) hours of notification that the oil tank has been filled. The Contractors responsibility to “top off” tank only applies when the contractor elects to utilize a volumetric tank tester.

D. Test Equipment: The Contractor shall be limited to using state approved Precision Testing methods equal to the following:

Ainlay Tank Tegrity Tester
Horner EZY 3
Hunter Leak Lokator
Tank Auditor
Petro Tite

E. Test Results: The Contractor will be required to submit written reports of test results as noted below.

1. The test reports’ format shall be approved by the testing equipment manufacturer and the state.
2. The Contractor shall submit one (1) type written report within seven (7) days of completion of the testing to the Owner.
3. The Contractor shall submit one copy of the report to the state within thirty (30) days of completion of the testing. Proof of submission shall be appended to the request for payment.
4. The test results shall include, but not be limited to:
    a. Name and/or Number of Building
    b. Address of Building

c. Date and Time of Test
d. Results of test including (Actual Data Calculations Graphs)
e. Test Method
f. Name and address of Contractor
g. Signature of test technician

5. Should the test indicate a leakage condition, the contractor shall perform the following:
   a. Initiate procedure to isolate piping from tank and determine the source of the leak. This work shall be performed after notification of the Owner.
   b. Submit a written proposal and cost estimate for work required to be performed to repair leak. Recommended proposal shall be submitted to the Owner within 48-hours after determining source of leak. No repair work shall proceed without authorization by the Owner.
   c. Notify the state of leak discovered in underground buried tank. This notification shall take place within 2 hours of determining source of leak.
   d. In these cases, the Owner may direct the Contractor to complete the work or exercise its option to perform the required work by its own forces or under separate contract.
6. After completion of the remedial work when applicable, the contractor shall perform a re-test, and shall issue a final test report in aforementioned format. The contractor shall be paid 50% of the bid unit price for the re-test.

END OF SECTION 02 61 13 00a

SECTION 02 61 13 00b - HYDROSTATIC PRESSURE TESTING OF AIR RECEIVING TANKS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing of labor and equipment for the hydrostatic pressure testing of air receiving tanks. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCTS - (Not Used)

1.3 EXECUTION

A. General

1. Disconnect all piping and remove safety valve from air receiving tank and temporarily plug all openings on the disconnected tank.
2. Perform hydrostatic test at not less than twice the charging pressure, at 70 degrees Fahrenheit, for fifteen (15) minutes in accordance with the Administrative Code of the applicable Authority.
3. Test shall be performed in the presence of a representative of the Inspection Unit. Contractor shall notify the Owner‘s Inspection Unit seventy-two (72) hours prior to test.
4. At the completion of each test, contractor shall reconnect all piping and reinstall all removed equipment.
5. The Contractor shall issue an affidavit of test to the Owner. The affidavit shall state the date of test, testing pressure and the maximum working pressure allowable until the next test.
6. Furnish and install a glass enclosed aluminum frame of suitable size to display affidavit. Frame shall be open at the top for easy access to affidavit. Frame shall be firmly affixed in a permanent location adjacent to receiver tank as directed by the Owner.

B. Intent: Pursuant to the provisions of the Administrative Code of applicable Authority, and in the interest of public safety, the Owner requires that:

1. All compressed air tanks shall be tested by a person who has received a Certificate of Fitness from the Owner to conduct such a test in the manner and to the pressure set forth in the code before being continued in use.
2. Licensed testers shall submit ten (10) day notice of appointments to the Owner.
3. A sworn statement by the person conducting the test, in proper affidavit form, attesting to the completion of such test, shall be filed with the Owner‘s office and a copy thereof posted on the premises.
4. The submission of such an affidavit or posting a copy thereof, where the required test has not been carried out in accordance with the foregoing provisions of law, shall be cause for the revocation of the Certificate of Fitness, denial of the required permits to maintain and operate equipment and may also subject the individual to criminal liability for filing a false affidavit and a fine of up to five hundred dollars, imprisonment of up to six months, or both.

END OF SECTION 02 61 13 00b

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Task	Specification	Specification Description
02 61 13 00	02 41 13 13	Selective Demolition
02 61 13 00	02 61 00 00	Excavation And Handling Of Contaminated Material

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SECTION 02 61 26 00 - DISPOSAL OF HAZARDOUS MATERIALS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for disposal of hazardous materials. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Definition

1. Hazardous materials shall be defined as asbestos containing materials, lead-based paint, PCBs, bird waste, and other materials categorized as hazardous by the EPA.

C. Submittals

1. Before start of work: At the pre-construction meeting, the Contractor shall submit the following to the Owner's Representative for review. Do not start work until these submittal are returned with Owner's Representative stamp indicating that the submittal is returned for unrestricted use.
   a. Copy of State or local license for hazardous waste hauler.
   b. Certificate of at least one on-site supervisor which has satisfactorily completed the OSHA 40 hour Health and Safety course for handling hazardous materials.
   c. Certificates of workers which have successfully completed the OSHA 40-Hour Health and Safety Course for Hazardous Materials.
   d. List of the employees scheduled to perform this work.
   e. Schedule of start and finish times and dates for this work.
   f. Name and address of landfill where these waste materials are to be deposited. Include contact person and telephone number.
   g. Material Safety Data Sheet (MSDS) for all materials to be removed.
   h. If contractor introduces any chemical into the work environment, a MSDS for that chemical must be presented to the Owner's Representative prior to use.
   i. Transporter must have notified the EPA and/or other appropriate local government agency in advance of its intentions to transport hazardous materials and, if applicable, receive an identification number.
   j. Contingency Plan for handling emergencies with spills or leaks.
   k. Certificates of workers which have successfully completed the OSHA 24-Hour Health and Safety Course for Hazardous Materials.

1.2 PRODUCTS

A. Materials

1. Drums: Recovery or salvage drums acceptable for disposal of hazardous waste. Prior approval of drums is required. Drums or containers must meet the required OSHA, EPA (40 CFR Parts 264-264 and 300), and DOT Regulations (49 CFR Parts 171-178). Use of damaged containers shall not be allowed.
2. Labels: As required by the EPA and OSHA for handling, transportation, and disposal of hazardous waste.
3. Absorbent Material: Clay, soil or any commercially available absorbent used for the purpose of absorbing hazardous or potentially hazardous materials.

1.3 EXECUTION

A. All waste shall be transported and disposed of in accordance with all federal, state and local guidelines and regulations. The contractor is to obtain all permits, licenses, etc., which are necessary for the transporting and disposal of hazardous waste.

B. Waste haulers shall maintain waste manifest and shipment record forms.

END OF SECTION 02 61 26 00

SECTION 02 61 26 00a - REMOVAL OF FRIABLE ASBESTOS-CONTAINING MATERIALS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for removal of friable asbestos-containing materials. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Description

1. Furnish all labor, materials, facilities, equipment, services, employee training and testing, permits and agreements necessary to perform the work required for asbestos removal, encapsulation, repair, clean-up, decontamination, re-insulation and all other work in accordance with these specifications, in accordance with the latest regulations from the U.S. Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), the recommendations of National Institute of Occupational Safety and Health (NIOSH), and any other applicable federal, state and local government regulations. Whenever there is a conflict or overlap of the above references, the most stringent provision is applicable.
2. The work specified herein shall be performed by competent persons trained, knowledgeable and qualified in the state-of-the-art techniques of asbestos abatement, handling and subsequent cleaning of contaminated areas.

C. Scope

1. The quantities of materials and limits of abatement work area(s) shall be verified by the asbestos contractor.

D. Asbestos Hazard

1. Asbestos-containing material when damaged or disturbed is subject to fiber releases. Wet methods are a primary means of controlling fiber release.
2. Strict compliance with each of the provisions outlined in these specifications for the encapsulation, repair and handling of asbestos-containing material is of great importance, because:
   a. The inhalation of airborne asbestos fibers can cause a very serious and often fatal disease.
   b. Workers may not be aware they are inhaling asbestos fibers.
   c. Symptoms of the disease do not appear for many years.
   d. Only the Contractor and its employees can prevent the inhalation of asbestos fibers, which can lead to the development of asbestos-related disease.
   e. No insurance is available to provide for asbestos-related disease.

E. Other Hazardous Material

1. Contractor shall comply with OSHA 29 CFR 1926.62 - Lead in Construction when demolishing any equipment or architectural component identified as lead-containing or lead-based paint. The work of this project is considered a demolition activity.
2. the Owner anticipates that a substantial amount of the Project will involve lead paint.

F. Qualifications

1. the Owner and the Owner's Representative will verify and approve the experience of the Asbestos Abatement Contractor based upon submission at the time of bidding by Contractor evidence of the following:
   a. Experience: Provide the names and locations of at least three asbestos abatement projects of comparable size and complexity comparable with this work. Provide the names

and telephone numbers of contact person at previous projects. Provide the final air monitoring decontamination fiber levels achieved.

b. Personnel: Provide the name(s) of "Competent Person" as defined by OSHA 29 CFR 1926.32(f) - Asbestos. Demonstrate the education and specialized training with successful completion of examination of an EPA approved course. Provide evidence of participation in five projects of complexity comparable with this project.

c. Licensing and Certification: The Contractor must hold a current, valid asbestos license issued by the State in which the work is to be performed.

G. Notices And Record Keeping

1. Contractor shall maintain for at least 30 years, a record for each asbestos project in which the Contractor engages. Each record shall include the following information: name, address, and social security number of all personnel involved with the project, the name address and social security number of the OSHA "Competent Person" who will supervise the work, the amount of asbestos material that was removed, repaired, encapsulated or disturbed, the commencement and completion date of the work, copies of Hazardous Waste Manifest(s), personal air monitoring results and any other appropriate information.

2. The Contractor shall send written notification as required by USEPA National Emission Standards for Hazardous Air Pollutants (NESHAPS) Asbestos Regulations (40 CFR 61, Subpart M) to the Owner, at least 10 working days prior to beginning any work on asbestos-containing materials.

3. Include the following information:

a. Name and address of the Owner or operator.

b. Description of the facility being demolished or renovated, including the size, age, and prior use of the facility.

c. Estimate of the approximate amount of asbestos material present in the facility in terms of linear feet of pipe, and surface area on other facility components. For facilities in which the amount of asbestos materials is less than 80 linear meters (260 linear feet) on pipes and less than 15 square meters (160 square feet) on other facility components, explain techniques of estimation.

d. Location of the facility being demolished or renovated.

e. Scheduled starting and completion dates of demolition or renovation.

f. Nature of planned demolition or renovation and method(s) to be used.

g. Procedures to be used to comply with the requirements of USEPA National Emission Standards for Hazardous Air Pollutants (NESHAPS) Asbestos Regulations (40 CFR 61 Subpart M).

h. Name and location of the waste disposal site where the asbestos waste material will be deposited.

4. Prior to commencement of work, the Contractor shall submit the following documents to the Owner's Representative. No work will be allowed to start until these documents have been approved:

a. The schedule of the work, including manpower, length and number of work shifts. Schedule shall be coordinated with the Owner's full occupancy of all areas of the building.

b. Satisfactory proof that written notification has been provided to the EPA regional office and the Owner.

c. Proof that all required permits, disposal site locations, and arrangements for transportation and disposal of asbestos-contaminated materials, supplies and the like have been obtained.

d. Complete a worker certificate indicating that all employees have had instruction and training on the hazards of asbestos exposure, the use and fitting of respirators, protective dress, wet and dry decontamination procedures, entry and exit from work areas, and all aspects of work procedures and protective measures.

e. Documentation indicating that all employees have received appropriate medical examinations and have successfully passed fit testing for the respirator to be worn. As a minimum, medical exams must be consistent with OSHA 29 CFR 1926.1101(K)(9)(viii)(G)- Asbestos Regulation.

f. Samples of signs to be used in and around the work area to comply with 0SHA 29 CFR 1926.1101(K)(9)(viii)(I)- Asbestos regulations and as required by federal, state and municipal regulations.

g. Material Safety Data Sheets (OSHA form 174 or equivalent) for all chemicals used during work performed under this section.

h. Encapsulation data and encapsulation procedures.

i. Design of pressure differential system including calculation used to arrive at the number of machines necessary to achieve one air change per every 10 minutes.

j. Location of personnel and material decontamination units for each work area.

5. Contractor shall provide written notification to the Owner's Representative of its intent to start work at least five days in advance. In no case will the Contractor start work until authorization to proceed is given.

6. During the work, Contractor shall maintain a daily log which will be kept at the job site. Items to be included in the daily log shall include but are not limited to the following:
   a. Meetings, purpose, attendees, discussions, items of resolution.
   b. Visitations, authorized and unauthorized.
   c. Sign-in sheets of all personnel entering and leaving the work area.
   d. Special or unusual events (i.e., barrier breeching equipment failures).
   e. Personal air monitoring results.
   f. Two copies of the daily log are required for Project Closeout.

H. Terminology (Definitions)

1. Abatement - Procedures to control fiber release from asbestos-containing materials. Includes removal, enclosure or encapsulation.
2. Air Lock - A system for permitting ingress or egress without permitting air movement between any two adjacent areas consisting of two curtained doorways. The air lock must be maintained in an uncontaminated condition at all times.
3. Air Monitoring; - The process of measuring the asbestos fiber content of a specific volume of air in a stated period of time using methods approved or recommended by OSHA, EPA, NIOSH or other method approved by the Owner or the Owner's Representative.
4. Amended water - Water to which a surfactant has been added.
5. Asbestos - A generic name given to a number of naturally occurring hydrated mineral silicates that possess a unique crystalline structure, are incombustible in air, and are separable into fibers. Asbestos includes the asbestiform varieties of Chrysotile (serpentine), Crocidolite (Riebeckite), Amosite (Cummingtonite-Grunente), Anthophyllite, Actinolite, and Tremolite.
6. Asbestos-containing. material (ACM) - Any material that contains more than 1 percent asbestos by weight as determined by Polarized Light Microscopy (PLM).
7. Authorized Visitor - the Owner or its designated representative, or a representative of any regulatory or other agency having jurisdiction over the project.
8. Class I - Asbestos work means activities involving the removal of thermal systems insulation (TSI) and surfacing ACM and PACM.
9. Class II - Asbestos work means activities involving the removal of ACM which is not TSI or surfacing material. This includes, but is not limited to, the removal of asbestos-containing wallboard, floor tile and sheeting, roofing and siding shingles, and construction mastics.
10. Class III - Asbestos work means repair and maintenance operations where "ACM" including TSI and surfacing ACM and PACM is likely to be disturbed.
11. Class IV - Asbestos work means maintenance and custodial activities during which employees contact but do not disturb ACM or PACM and activities to clean-up dust, waste and debris resulting from Class I, II and III activities.
12. Critical Barrier - A unit of temporary construction which provides the only separation between an asbestos work area and an adjacent, potentially occupied, space. The critical barrier is composed of at least one intact sheet of polyethylene sheeting.

13. Decontamination Enclosure System - A series of connected rooms with curtained doorways between any two adjacent rooms, for the decontamination of workers or of materials and equipment. A decontamination system contains at least two air locks.
14. Disposal - All procedures necessary to transport and deposit the asbestos-contaminated material stripped and removed from the building in a waste disposal site in compliance with applicable federal, state, and local regulations.
15. Disposal Site - A site approved by the EPA for the disposal of asbestos-containing wastes.
16. Encapsulant - A liquid which can be applied to asbestos-containing materials and which controls the possible release of fibers from the materials.
17. Encapsulation - The use of an agent to seal the surface (bridging encapsulant) or penetrate the bulk (penetrating encapsulant) of the asbestos-containing material.
18. HEPA -High Efficiency Particulate Air - A type of filter which is 99.97% efficient at filtering particles of 0.3 micrometers in diameter.
19. HEPA Vacuum Equipment - Vacuuming equipment equipped with a HEPA filter in the exhaust outlet, and so designed and maintained that 99.97% of all particles of 0.3 micrometer in diameter in the inlet air are collected and retained.
20. Negative Pressure Respirators - Respirators which function by the wearer breathing in air through a filter.
21. NIOSH - National Institute of Occupational Safety and Heath.
22. the Owner's Representative - Authorized Consultants
23. Permissible Exposure Level (PEL) - A level of airborne fibers specified by OSHA as an occupational exposure standard for asbestos. It is 0.1 f/cc of air, eight-hour TWA, as measured by Phase Contrast Microscopy.
24. Repair - The restoration of damaged or deteriorated asbestos-containing material to intact condition.
25. Respirator Protection Program - A set of procedures and equipment required by OSHA if employees wear negative pressure respirators or if fiber levels are above the PEL.
26. Surfactant - Chemical wetting agent added to water to improve penetration, thus reducing the amount of water required for a given operation or area, and enhancing the effect of the water in reducing fiber release.
27. Thermal Systems Insulation - Material applied to pipes, fittings, boilers, breeching, tanks, ducts or other interior structural components to prevent heat loss or gain, or water condensation, or for other purposes.
28. Wet Cleaning - The process of eliminating asbestos contamination from building surfaces and objects by using cloths and mops or other cleaning tools that have been dampened with clean water and afterwards disposing of these cleaning tools as asbestos-contaminated waste.

I. Permits And Licenses:
1. The Contractor must maintain current licenses as required by applicable state or local jurisdictions for the removal, transporting, disposal or other regulated activity relative to the work of this contract.

J. Regulations
1. This section sets forth governmental regulations and industry standards which are included and incorporated herein by reference and made a part of the specifications. This section also sets forth those notices and permits which are known to the Owner and which either must be applied for and received, or which must be given to governmental agencies before start of work.
2. Except to the extent that more explicit or more stringent requirements are written directly into the contract documents, all applicable codes, regulations, and standards have the same force and effect (and are made a part of the contract documents by reference) as if copied directly into the contract documents, or as if published copies are bound herewith.
3. The Contractor shall assume full responsibility and liability for the compliance with all applicable federal, state, and local regulations pertaining to work practices, hauling, disposal, and protection of workers, visitors to the site, and persons occupying areas adjacent to the site. The Contractor

is responsible for providing medical examinations and maintaining medical records of personnel as required by the applicable federal, state, and local regulations. The Contractor shall hold the Owner and the Owner's Representative harmless for failure to comply with any applicable work, hauling, disposal, safety, health or other regulation on the part of itself, its employees, or its Sub-Contractors.

4. Federal requirements which govern asbestos abatement work or hauling and disposal of asbestos waste materials include but are not limited to the following regulations:
   a. U.S. Department of Labor, Occupational Safety and Health Administration, (OSHA), including but not limited to:
      1) U.S. Department of Labor, OSHA, including, but not limited to:
         a) Occupational Exposure to Asbestos, Tremolite, Anthophyllite and Actinolite; Final Rules
            Title 29, Part 1910, Section 1001
            Part 1926, Section 1101 of the Code of Federal Regulations
         b) Respiratory Protection
            Title 29, Part 1910, Section 134 of the Code of Federal Regulations
         c) Construction Industry
            Title 29, Part 1926.1011, of the Code of Federal Regulation
         d) Access to Employee Exposure and Medical Records
            Title 29, Part 1910, Section 2 of the Code of Federal Regulations
         e) Hazard Communication
            Title 29, Part 1910, Section 1200 of the Code of Federal Regulations
         f) Specifications for Accident Prevention Signs and Tags
            Title 29, Part 1910, Section 145 of the Code of Federal Regulations
      2) U.S. Environmental Protection Agency (EPA) including, but not limited to:
         a) Asbestos Abatement Projects Rule
            40 CFR Part 762
            CPTS 62044, FRL 2843-9
            Federal Register, Vol. 50 No. 134, July 12,1985
            P28530-28540
         b) Regulation for Asbestos
            Title 40, Part 61, Subpart A of the Code of Federal Regulations
         c) National Emission Standard for Asbestos
            Title 40, Part 61, Subpart M (Revised Subpart B) of the Code of Federal Regulations
      3) State requirements which govern asbestos abatement work and/or hauling and disposal of asbestos waste materials.
      4) Contractor shall abide by all local requirements which govern asbestos abatement work or hauling and disposal of asbestos waste materials including the following:
         a) American National Standards Institute (ANSI)
            1430 Broadway
            New York, NY 10018
            (212) 354-3300
         b) Fundamentals Governing the Design and Operation of Local Exhaust Systems Publication Z9.2-79
         c) Practices for Respiratory Protection Publication Z288.2-80
         d) American Society for Testing and Materials (ASTM)
            1916 Race Street
            Philadelphia, PA 19103
            (215) 299-5400
         e) Specification for Encapsulants for Friable Asbestos-Containing Building Materials
         f) Safety and Health Requirements Relating to Occupational Exposure to Asbestos

K. the Owner's Representative

1. the Owner's Representative is authorized by the Owner to perform the following:
   a. Have free access to all asbestos work areas.
   b. To assist in interpretation of procedures.
   c. To advise on all provisions of the contract documents pertaining to the control of asbestos.
   d. To stop work if, in the course of performing their monitoring duties, an instance of substantial nonconformance with the contract documents is observed.
   e. To stop work if a situation presenting a health hazard to workers or the Owner's employees or occupants of the building is observed.
   f. To act as the Owner's liaison in technical matters involving the asbestos-related work.
   g. To perform air sampling inside and outside the asbestos work area during the project. The Contractor shall cooperate fully with the Owner's Representative, its agents and employees, and ensure cooperation of its workers during collection of air samples and work area inspections.
   h. the Owner's Representative role in advising the Owner on environmental health matters does not relieve the Contractor's obligation to comply with all applicable health and safety regulations. Air monitoring results generated by the Owner's Representative shall not be used by the Contractor to represent compliance with regulatory agency requirements for monitoring of worker's exposure to airborne asbestos, nor shall any other activity on the part of the Owner's Representative represent the Contractor's compliance with applicable health and safety regulations.

L. Pre-Construction Conference

1. An initial progress meeting recognized as "Pre-Construction Conference" shall be held prior to start of any work. Contractor shall meet at project site, with General Superintendent, the Owner, the Owner's Representative, and other entities concerned with asbestos abatement work. Record discussions and agreements and furnish copy to each participant. Provide at least 72 hours advance notice to all participants prior to convening Pre-Construction Conference.
2. This is an organizational meeting, to review responsibilities and personnel assignments, to locate the containment and decontamination areas; and temporary facilities including power, light, water, etc.
3. Submit waivers on forms, and executed in a manner acceptable to the Owner. Administrative requirements that must proceed or coincide with Contractor's submittal for final payment shall consist of the following:
   a. Completion of project closeout requirements.
   b. Completion of items specified for completion beyond time of Final Completion (regardless of whether special payment application was previously made).
   c. Assurance, satisfactory to the Owner, that unsettled claims will be settled and that work not actually completed and accepted will be completed without undue delay.
   d. Transmittal of required project construction records to the Owner.
   e. Landfill receipts for all asbestos-containing material.
   f. Proof, satisfactory to the Owner, that taxes, fees and similar obligations of Contractor have been paid.
   g. Removal of temporary facilities, services, surplus materials, rubbish and similar elements.
   h. Consent of surety for final payment.

M. Project Closeout

1. Project closeout is the term used to describe certain collective project requirements that indicate completion of the work to be fulfilled near the end of the contract time. Also, in preparation for final acceptance of the work by the Owner, as well as, final payment to the Contractor and the normal termination of the Contract.
2. Include supporting documentation for completion as indicated in these contract documents.
3. Submit a statement on accounting of changes to the Contract Sum.
4. Advise the Owner of pending insurance change-over requirements.

5. Submit specific warranties, workmanship and maintenance bonds, maintenance agreements, final certifications and similar documents.
6. Obtain and submit releases enabling the Owner's full, unrestricted use of the work area and access to services and utilities. Where required, include occupancy permits, operating certificates and similar releases.
7. Results of the completed inspection will form the initial "punch-list" for final acceptance.
8. A complete record, certified by the testing laboratory, of all personal air monitoring results.
9. Complete the following cleaning operations as outlined in Paragraph “Decontamination Procedures” before requesting the Owner's Representative inspection for certification of Final Completion.
    a. Remove exposed labels in finished spaces which are not required as permanent labels on materials supplied as part of the work, except for "Asbestos", "Asbestos Free", or Thermal Insulation Labels specified elsewhere.
    b. Clean transparent materials, affected by the work including mirrors and window/door glass, to a polished condition, removing substances which are noticeably vision-obscuring materials. Replace broken glass and damaged transparent materials.
    c. Clean exposed hard-surfaced finishes affected by the work, to a dirt-free condition, free of dust, stains, films and similar distracting substances. Except as otherwise indicated, avoid disturbance of natural weathering of exterior surfaces. Restore reflective surfaces to original reflective condition.
    d. Clean plumbing fixtures affected by the work to a sanitary condition, free of stains including those resulting from water exposure.
    e. Replace all HVAC filters using materials supplied by the Owner or clean non-replaceable filters after minimum of two days of operation of HVAC equipment.
    f. Clean light fixtures and lamps, which have been affected by the work so as to function with full efficiency. Replace lamps where inoperable.
    g. Repair any damage to wall, ceiling and floor surfaces caused by installation and removal of the polyethylene sheeting.

N. Personnel Protection
1. Prior to commencement of work, the workers shall be instructed and be knowledgeable in the areas described in Paragraph "Submittals and Notices" having to do with employees.
2. Worker Protection - shall comply with 29 CFR 1910.134 (Respiratory Protection).
    a. Because there is no known safe level of exposure to asbestos, it is prudent to reduce worker's exposures to as low a level as possible. Proper respiratory protection is critical in minimizing exposure.
    b. Workers shall be provided, as a minimum, with personally issued and marked respirators equipped with high efficiency particulate filters approved by NIOSH to be worn in the designated work area and/or whenever a potential exposure to asbestos exists. Sufficient filters shall be provided for replacement as required by the workers or applicable regulations. Disposable respirators shall not be used.
    c. No worker shall be exposed to levels greater than 0.01 f/cc as determined by the protection factor of the respirator worn and the work area fiber levels.
    d. Whenever powered purifying respirator protection is used, a sufficient supply of replacement batteries and HEPA filter cartridges shall be provided to the workers.
    e. Air monitoring required by OSHA is work of the Contractor and not covered in this specification. Contractor shall post, on a daily basis, results of the air monitoring results from the previous shift. A complete record, certified by the testing laboratory, of all personal air monitoring tests and results will be furnished to the Owner and the Owner's Representative prior to Contractor's Request for Final Payment.
    f. During encapsulation operations or usage of other organic base aerosols (e.g., spray glue, expanding foam), workers shall be provided with combination cartridges consisting of organic vapor and HEPA sections.

g. Workers shall be provided with sufficient sets of protective full-body clothing to be worn in the designated work area and/or whenever potential exposure to asbestos exists. Such clothing shall include, but not be limited to, full-body coveralls, headgear and gloves. Workers shall assure that hoods covering their hair are worn in the designated work areas at all times. Eye protection and hard hats shall be provided as required by applicable safety regulations. Eye protection shall be worn during encapsulation operations. Non-disposable type protective clothing and footwear shall be left in the work area until the end of the asbestos abatement work, at which time such items will be disposed of as asbestos waste.

h. Non-skid footwear shall be provided to all abatement workers. Disposable clothing shall be adequately sealed to the footwear to prevent body contamination.

i. Protective clothing shall not be worn in lieu of street clothing outside the work area.

j. Visitor Clothing: The Contractor shall provide authorized visitors with suitable respirator, protective clothing, headgear, eye protection, and footwear as described herein, whenever they enter the work area.

3. Decontamination and Work Procedures: The decontamination and work procedures to be followed by workers shall be posted as described in these specifications.

4. Worker and Authorized Visitor Protection Procedures:

a. Each worker and authorized visitor shall, upon entering the job site, remove street clothes in a designated clean change area and put on a respirator with new filters and clean protective clothing before entering the work area.

b. The Contractor's employees shall perform a positive/negative respirator fit test each time it enters the work area. If leakage occurs, the respirator must be re-adjusted or replaced.

c. Workers shall maintain their respirators in a safe operating condition. The condition of respirators shall be checked daily.

d. Workers and visitors shall complete the decontamination procedures as outlined in the specification upon exiting the work area.

e. Workers shall not eat, drink, smoke, or chew gum or tobacco in or near the asbestos work areas.

f. Workers shall be fully protected with respirators and protective clothing immediately prior to the first disturbance of asbestos-containing or contaminated materials and until final cleanup is completed.

O. Air Monitoring

1. The airborne fiber counts outside the work area will be monitored to detect faults in the work area isolation such as contamination of the building outside of the work areas with airborne asbestos fibers, failure of filtration or rupture in the negative pressure system.

Should any of the above occur, the Contractor shall immediately cease asbestos abatement activities until the fault is corrected. Work shall not recommence until authorized by the Owner's Representative. In the case of mini-enclosures the Owner's Representative will monitor air in a remote location of the residence to determine the baseline of asbestos.

2. The airborne fiber counts in the work area will be monitored. The purpose of this air monitoring will be to detect airborne fiber counts which may significantly challenge the ability of the work area isolation procedures to protect the balance of the building or outside of the building from contamination by airborne fibers. In the case of mini-enclosures the Owner's representative may monitor air outside of several enclosures if they are in close proximity.

3. Contractor shall maintain an average airborne count inside the work area of less than 0.5 f/cc. If the fiber counts rise above this figure for any sample taken, revise work procedures to lower fiber counts. If the TWA fiber count for any work shift or eight-hour period exceeds 0.5 f/cc, stop all work, leave pressure differential system in operation and notify the Owner's Representative. Do not recommence work until authorized in writing by the Owner's Representative.

4. If airborne fiber counts exceed 1.0 f/cc for any period of time cease all work until fiber counts fall below 0.5 f/cc and notify the Owner's Representative. Do not recommence work until authorized in writing by the Owner's Representative.

5. If any air sample taken outside of the work area exceeds the 0.01 f/cc of air, Contractor shall immediately and automatically stop all work. If this air sample was taken inside the building and outside of critical barriers around the work area, immediately erect new critical barriers to isolate the affected area from the balance of the building. Erect Critical Barriers at the next existing structural isolation of the involved space (e.g., wall, ceiling, and floor). Leave Critical Barriers in place until completion of work and insure that the operation of the negative pressure system in the work area results in a flow of air from the balance of the building into the affected area.
6. If the exit from the clean room of the personnel decontamination unit enters the affected area, establish a temporary decontamination facility consisting of a shower room and changing room. After cleaning and decontamination of the affected area remove the shower room and leave the changing room in place as an air lock.
7. After certification of visual inspection in the work area, remove critical barriers separating the work area from the affected area. Final air samples will be taken within the entire area.
8. The following procedure will be used to resolve any disputes regarding fiber types when a project has been stopped due to excessive airborne fiber counts. "Airborne Fibers" referred to above include all fibers regardless of composition as counted in the Phase Contrast Microscopy (PCM) NIOSH 7400 Method procedures. If work has stopped due to high airborne fiber counts, air samples will be secured in the same area by the Owner's Representative for analysis by electron microscopy. "Airborne fibers" counted in samples analyzed by Scanning or Transmission Electron Microscopy (TEM) shall be only asbestos fibers, but of any diameter and length. Subsequent to analysis by Electron Microscopy the number of airborne fibers shall be determined by multiplying the number of fibers, regardless of composition, counted by the PCM NIOSH 7400 Method procedure by a number equal to asbestos fibers counted divided by all fibers counted in the electron microscopy analysis.
9. If electron microscopy is used to arrive at the basis for determining airborne fiber counts in accordance with the above paragraph, and if the average of airborne asbestos fibers in all samples taken exceeds 0.1 f/cc, or if any one sample exceeds 0.2 f/cc, then the cost of such analysis will be born by the Contractor, at no additional cost to the Owner.
10. the Owner's Representative will secure at least the following air samples to establish a base line before start of work involving large enclosures:

Location Sampled	**Number of Samples**	**Analysis Method**	**Detection Limit f/cc**	**Minimum Volume Liters**	**Rate LPM**
Each Work Area	1	PCM	0.01	1,900	2-16
Outside Each Work Area	1-3	PCM	0.01	1,900	2-16

11. Base Line is an action level expressed in f/cc, which is ten percent greater than the largest of the following:
    a. Average of the samples collected on cellulose ester filters outside each work area.
    b. Average of the samples collected on cellulose ester filters outside the building.
    c. 0.01 fibers per cubic centimeter.
12. Daily: From start of work of Paragraph "Temporary Enclosure" through the work of Paragraph "Project Decontamination," the Owner may be taking the following samples on a daily basis. The location of each air sample will be determined by the Owner's Representative.
    a. Baseline
    b. Work Area
13. For larger enclosures samples will be collected on 25 mm cassettes with the following filter medial:
    PCM: 0.8 micrometer mixed cellulose ester.

Location Sampled	Number of Samples	Analysis Method	Detection Limit f/cc	Minimum Volume Liters	Rate LPM

Each Work Area	2	PCM	0.01	1,900 as required by conditions	2-16
Outside Each Work Area Critical Barrier	1	PCM	0.01	1,900	2-16
Clean Room	1	PCM	0.01	1,900	2-16
Equip Decon	1	PCM	0.01	1,900	2-16

14. Additional samples may be taken at the Owner or the Owner's Representative discretion. If airborne fiber counts exceed allowed limits, additional samples will be taken as necessary to monitor fiber levels.
15. The services of a testing laboratory will be employed by the Owner to perform laboratory analysis of the air samples. Samples will be sent daily so that verbal reports on air samples can be obtained in a timely manner. A complete record, certified by the testing laboratory, of all air monitoring tests and results will be furnished to the Owner's Representative, the Owner and the Contractor.
16. Air samples may be analyzed on site by the Owner's Representative, if they are to be analyzed by the NIOSH 7400 Method.
17. Cellulose ester filters will be analyzed using the PCM NIOSH 7400 Method. Thus analysis will be carried out at a laboratory located off the job site.
18. At the completion of the work in occupied areas and prior to the dismantling of the isolation system, final air clearance will be conducted by the Owner's Representative.
19. Decontamination of the work area will be considered complete when all samples indicate fiber levels are less than 0.0l f/cc of air as analyzed by PCM NIOSH 7400 Method or an average of less than 70 structures per square millimeter of filter area as analyzed by TEM; Level II AHERA Method.
20. The Contractor may conduct its own air monitoring and laboratory testing. If it elects to do this the cost of such air monitoring and laboratory testing shall be included in the Contract Sum.

P. Equipment Removal Procedures
1. Clean all external surfaces of contaminated waste containers and equipment thoroughly by wet sponging or HEPA vacuuming before moving such items into the equipment decontamination enclosure system washroom for final cleaning and removal to uncontaminated areas. Ensure that personnel do not leave the work areas through the equipment decontamination enclosure system.

Q. Disposal Activities
1. It is the responsibility of the Contractor to comply with current federal, state and local regulations concerning the waste handling, transportation, and disposal of asbestos-containing material (ACM) and accompanying solvents or residues.
2. The Contractor will document actual disposal of the waste at the designated landfill by completing Disposal Certificate or submitting proof of landfill receipt.

1.2 PRODUCTS

A. Materials
1. All Contractor's equipment delivered to the site shall be free of asbestos contamination.
2. Store all materials subject to damage off the ground, away from wet or damp surfaces, and under cover sufficient to prevent damage or contamination.
3. Damaged or deteriorating materials shall not be used and shall be removed from the premises. Materials that become contaminated shall be disposed of in accordance with applicable regulations.

4. Polyethylene flame retardant sheet of 6-mil thickness shall be used unless otherwise specified. Polyethylene sheeting shall be sized to minimize the frequency of joints. Polyethylene sheeting must satisfy the National Fire Prevention Association Standard 701, "Small Scale Fire Test for Flame Resistant Textile and Film."
5. Adhesive tape shall be capable of sealing joints of adjacent sheets of polyethylene and for use in attachment of polyethylene sheet to finished or unfinished surfaces of similar materials and shall be capable of adhering under dry and wet conditions, including use of amended water. Contractor shall use adhesive tape compatible with finished surfaces.
6. Protective devices such as, but not limited to, disposable clothing, respirators, gloves, hard hats, etc. shall be used.
7. Wetting agent shall be a mixture of 50/50 polyoxyethylene ether and polyglycol ester or equivalent commercial product.
8. Encapsulant materials shall be the bridging and penetrating type and conform with the following characteristics:
   a. Encapsulants shall not be solvent-based or utilize a hydrocarbon in the liquid in which the solid parts of the encapsulant are suspended.
   b. Encapsulant shall not be flammable.
9. A non-hardening lagging sealer for enclosing and sealing raw exposed edges and surfaces of asbestos-containing materials.
10. Pre-mixed or job mixed insulating plaster manufactured for use on plumbing equipment shall be used when repairing damaged thermal insulation material.
11. Non-woven fibrous glass mat and open weave glass fiber mat cloth for repair of thermal systems insulation.
12. Fire retardant sealant shall prevent fire, smoke, water and toxic fumes from penetrating through sealants. Sealant shall have a flame spread, smoke and fuel contribution of zero, and shall be ASTM and Underwriter's Laboratory (UL) rated for three hours for standard method of fire test for fire stop systems.

B. Tools And Equipment
1. Provide suitable tools for repair and encapsulation of asbestos-containing materials and for removal of asbestos-containing materials that are beyond repair. Wire brushes shall not be used as a means of removing or cleaning asbestos-containing materials from surfaces, if they are used as the surface is being sprayed with water or amended water.
2. Provide sufficient number of HEPA-filtered vacuum cleaners equipped with pick-up adapters, steel floor wands, crevice tools, and carpet tools.
3. Airless sprayers capable of spraying amended water shall be provided in sufficient number to allow continuous uninterrupted work.
4. Asbestos filtration devices shall utilize high efficiency particulate air (HEPA) filtration systems.
5. Transportation equipment, as required, shall be suitable for loading, temporary storage, and unloading of contaminated waste without exposure to persons or property, and shall be quiet in motion if used within the building.

1.3 EXECUTION

A. Safety Procedures For Power And Lighting
1. The use of wet methods for removal, repair, encapsulation or cleaning procedures increases the potential for electrical shock when working around electrical panels, conduit, light fixtures, alarm systems, junction boxes, transformers, etc. In coordination with the Owner, de-energize as much electrical equipment as possible to prevent electrical shock to employees performing the work. The Contractor shall use the following precautions:
   a. Use non-conductive tools and vacuum attachments.
   b. Utilize "hot line" covers over energized cables and power lines when possible.

c. Ensure all electrical equipment in use is properly grounded before the job starts. Check outlets, wiring, extension cords and power pickups.
d. Avoid stringing wiring across floors. Elevate wiring if possible.
e. Ensure electrical outlets are tightly sealed and taped to avoid water spray.
f. Determine operating voltages of equipment and lines before working on or near energized parts.
g. Energized parts must be insulated or guarded from employee contact and other conductive objects. Extension cords must be three-wire type and connected to a Ground Fault Interrupter (GFI) circuit.
h. Lock or secure de-energized circuits at panel and post warning signs.
i. Seal heating vents with two layers of polyethylene sheeting prior to the start of work. The Contractor shall repair any damage caused by Contractor's operations to duct work, grilles, dampers, louvers or HVAC equipment at the completion of the work at Contractor's expense. Coordinate all lock out and or de-energizing with the Owner.

B. Temporary Facilities
1. Use qualified tradesmen for installation of temporary services and facilities. Locate temporary services and facilities where they will serve the entire project adequately and result in minimum interference with the performance of the work and operations of the building. Coordinate all installations and shut downs with building owner.
2. Relocate, modify and extend services and facilities as required during the course of work so as to accommodate the entire work of the project.
3. Provide new or used materials and equipment that are undamaged and in serviceable condition. Provide only materials and equipment that are recognized as being suitable for the intended use, by compliance with appropriate standards.
4. During the erection and/or moving of scaffolding, care must be exercised so that the polyethylene floor covering is not damaged.
5. Clean, as necessary, debris from non-slip surfaces.
6. At the completion of abatement work, clean all construction aids within the work area, wrap in one layer of 6-mil polyethylene sheet and seal before removal from the work area.
7. Temporary water service connections to the Owner's water system shall include back flow protection. Valves shall be temperature and pressure rated for operation of the temperatures and pressures encountered.
8. Employ heavy-duty abrasion-resistant hoses with a pressure rating 50 percent greater than the maximum pressure of the water distribution system to provide water into each work area and to each Decontamination Unit. Provide fittings as required to allow for connection to existing wall hydrants or spouts, as well as temporary water heating equipment, branch piping, showers, shut-off nozzles and equipment.
9. Electrical Services shall comply with applicable NEMA, NECA and UL standards and governing regulations for materials and layout of temporary electric service.
10. Provide a weatherproof, grounded temporary electric power service and distribution system of sufficient size, capacity, and power characteristics to accommodate performance of work during the construction period. Install temporary lighting adequate to provide sufficient illumination for safe work and traffic conditions in every area of work.
11. Provide receptacle outlets equipped with ground fault circuit interrupters, reset button and pilot light, for plug-in connection of power tools and equipment.
12. Use only grounded extension cords; use "hard-service" cords where exposed to abrasion and traffic. Use single lengths or use waterproof connectors to connect separate lengths of electric cords, if single lengths will not reach areas of work. All cords shall be elevated off the floor inside the containment area.
13. Temporary wiring in the work area shall be type UL non-metallic sheathed cable located overhead and exposed for surveillance. Do not wire temporary lighting with plain, exposed (insulated) electrical conductors. Provide liquid tight enclosures or boxes for wiring devices.

14. Provide Type "A" fire extinguishers for temporary offices and similar spaces where there is minimal danger of electrical or grease-oil-flammable liquid fires. In other locations provide type "ABC" dry chemical extinguishers, or a combination of several extinguishers of NFPA recommended types for the exposures in each case.
15. Use of the Owner's existing toilet facilities, as indicated, will be permitted, so long as these facilities are properly cleaned and maintained in a condition acceptable to the Owner. At Final Completion, restore these facilities to the condition prevalent at the time of initial use. All provisions of these specifications regarding leaving the work area must be met.
16. When mini-enclosures area being used all of the requirements above will be enforced by the Owner's Representative. The construction and set-up of the mini-enclosures may be done by the Abatement Contractor.

C. Pressure Differential System

1. Before start of work Contractor shall submit design of pressure differential system to the Owner's Representative for review. Do not begin work until system has been approved by the Owner's Representative. Include in the submittal the following:
    a. Number of pressure differential machines required and the calculations necessary to determine the number of machines.
    b. Description of projected air-flow within work area and methods required to provide adequate air flow in all portions of the work area.
2. If the enclosure is not a mini-enclosure, the Contractor must supply the required number of asbestos air filtration units to the site in accordance with these specifications. Each unit shall include the following:
    a. Cabinet constructed of steel or other durable materials able to withstand damage from rough handling and transportation. The width of the cabinet should be less than 30 inches to fit through standard-size doorways. Cabinet shall be factory sealed to prevent asbestos-containing dust from being released during use, transport, or maintenance. Access to and replacement of all air filters shall be from intake end. Unit shall be mounted on casters or wheels.
    b. Rate capacity of fan according to useable air-moving capacity under actual operating conditions. Use centrifugal-type fan.
    c. The final filter shall be the HEPA type. The filter media (folded into closely pleated panels) must be completely sealed on all edges with a structurally rigid frame.
    d. A continuous rubber gasket shall be located between the filter and the filter housing to form a tight seal.
    e. Provide HEPA Units that are individually tested and certified on site by an independent testing agency to have an efficiency of not less than 99.97 percent when challenged with 0.3 m dioctylphthlaate (DOP) particles when tested in accordance with Military Standard Number 2182 and Army Instruction Manual 136-300-175A. Provide filters that bear a UL586 label to indicate ability to perform under specified conditions.
    f. Pre-filters, which protect the final filter by removing the larger particles, are required to prolong the operating life of the HEPA filter. Two stages of pre-filtration are required. The first-stage pre-filter shall be a low-efficiency type (e.g., for particles 10 microns and larger). The second-stage (or intermediate) filter shall have a medium efficiency (e.g., effective for particles down to 5 microns). Pre-filters and intermediate filters shall be installed either on or in the intake grid of the unit and held in place with special housings or clamps.
    g. Each unit shall be equipped with a Magnahelic gauge or manometer to measure the pressure drop across filters and indicate when filters have become loaded and need to be changed. A table indicating the useable air-handling capacity for various static pressure readings on the Magnahelic gauge shall be affixed near the gauge for reference, or the Magnahelic reading indicating at what point the filters should be changed, noting Cubic Feet per Minute (CFM) air delivery at that point. Provide units equipped with an elapsed time meter to show the total accumulated hours of operation.

h. The unit shall have an electrical (or mechanical) lockout to prevent fan from operating without a HEPA filter. Units shall be equipped with automatic shutdown system to stop fan in the event of a major rupture in the HEPA filter or blocked air discharge. Warning lights are required to indicate normal operation, too high a pressure drop across the filters (i.e., filter overloading), and too low of a pressure drop (i.e., major rupture in HEPA filter or obstructed discharge).

i. Electrical components shall be approved by the National Electrical Manufacturers Association (NEMA) and Underwriters' Laboratories (UL). Each unit shall be equipped with overload protection sized for the equipment. The motor, fan, fan housing, and cabinet shall be grounded.

j. If a mini-enclosure is used the air filtration unit may be a HEPA filtered vacuum with a flow rate of at least 100 cubic feet per minute (CFM).

3. Provide a fully operational pressure differential system within the work area maintaining continuously a pressure differential across work area enclosures of 0.02 inches of water for glove bag operations and mini-containments. Demonstrate to the Owner's Representative the pressure differential by use of pressure differential meter or a manometer, before disturbance of any asbestos-containing materials. In the case of a mini-enclosure visual evidence of pressure differential through the use of a smoke generation tube shall be sufficient as in paragraph C.13 of this section.
4. Continuously monitor and record the pressure differential between the work area and the building outside of the work area.
5. Provide fully operational negative pressure systems supplying a minimum of one air change every ten minutes (six changes per hour), less in the instance of a mini-enclosure. Determine the volume in cubic feet of the work area by multiplying floor area by ceiling height. Determine total ventilation requirement in cubic feet per minute (cfm) for the work area by dividing this volume by the air change rate.
6. Ventilation Required (CFM) = Volume of work area (cu. ft.)/10 min.
7. Determine number of units needed to achieve ten-minute change rate by dividing the ventilation requirement (CFM) above capacity of exhaust unit(s) used. Capacity of a unit for purposes of this section is the capacity in cubic feet per minute with fully loaded filters (pressure differential which causes loaded filter warning light to come on) in the machines labeled operating characteristics.
8. Add one additional unit as a backup in case of equipment failure or machine shutdown for filter changing.
9. Locate exhaust unit(s) so that makeup air enters work area primarily through decontamination facilities and traverses work area as much as possible. This may be accomplished by positioning the unit(s) at a maximum distance from the worker access opening or other makeup air sources.
10. Vent to outside of building, unless authorized in writing by the Owner's Representative.
11. Each unit shall be serviced by a dedicated minimum 115v-20A circuit with overload device tied into an existing building electrical panel which has sufficient spare capacity to accommodate the load of all pressure differential units connected. Dedication of an existing circuit may be accomplished by shutting down existing loads on the circuit.
12. Test pressure differential system before any asbestos-containing material is wetted or removed. After the work area has been prepared, the decontamination facility set up, and the exhaust unit(s) installed, start the unit(s) (one at a time). Demonstrate operation and testing of pressure differential system to the Owner's Representative.
13. Demonstrate of operations of the pressure differential system to the Owner's Representative will include, but not be limited to, the following:
    a. Plastic barriers and sheeting move lightly in toward work area.
    b. Curtain of decontamination units move lightly in toward work area.
    c. There is a noticeable movement of air through the decontamination unit. Use stroke tube to demonstrate air movement from clean room, and from equipment room to work area.
    d. Use smoke tubes to demonstrate a positive motion of air across all area in which work is to be performed.

e. Use a differential pressure meter or manometer to demonstrate a pressure difference of at least 0.02 inches (as allowed) of water across every barrier separating the work area from the balance of the building or outside. This is not required in the case of a mini enclosure.

14. Start exhaust units before beginning work (before any asbestos-containing material is disturbed). After abatement work has begun, run units continuously to maintain a constant negative pressure until decontamination of the work area is complete. Do not turn off units at the end of the work shift or when abatement operations temporarily stop.
15. Do not shut down pressure differential system during encapsulating procedures, unless authorized by the Owner's Representative in writing. Start abatement work at a location farthest from the exhaust units and proceed toward them. If an electric power failure occurs, immediately stop all abatement work and do not resume until power is restored and exhaust units are operating again.
16. At completion of abatement work, allow exhaust units to run as specified to remove airborne fibers that may have been generated during abatement work and cleanup and to purge the work area with clean makeup air. The units may be required to run for a longer time after decontamination, if dry or only partially wetted asbestos material was encountered during any abatement work. In the case of a mini-enclosure the vacuum may be removed and the entrance sealed following encapsulation until the clearance sample is collected.
17. Prior to final air test, remove pre-filter and wipe out inside lip of negative air machine.
18. When a final inspection and the results of final air tests indicate that the area has been decontaminated, exhaust units may be removed from the work area. Before removal from the work area, remove and properly dispose of pre-filter, and seal Intake to the machine with 6-mil polyethylene to prevent environmental contamination from the filters.

D. Work Area Preparation

1. The work area is the location where asbestos-abatement work occurs. It is a variable of the extent of work of the contract. It may be a portion of a room, a single room, or a complex of rooms. A "work area" is considered contaminated during the work, and must be isolated from the balance of the building, and decontaminated at the completion of the asbestos-control work.
2. Pre-clean fixed objects, walls and floor surfaces within the proposed work areas using HEPA filtered vacuum equipment and wet cleaning methods as appropriate.
3. Seal all openings, supply and exhaust vents, and convectors within ten feet of the work area with 6-mil polyethylene sheeting secured and completely sealed with plastic adhesion tape.
4. Contact fire control agencies to review procedures prior to start of work.
5. Provide flame resistant polyethylene sheeting that conforms to requirements set forth by the National Fire Protection Association Standard 701, Small Scale Fire Test for Flame-resistant Textiles and Films. Provide largest size possible to minimize seams, four- or six- mils thick, frosted or black.
6. Provide spray adhesive in aerosol cans which is specifically formulated to stick tenaciously to sheet polyethylene and supporting surface.
7. Completely isolate the work area from other parts of the building so as to prevent asbestos-containing dust or debris from passing beyond the isolated area. Should the area beyond the work area(s) become contaminated with asbestos-containing dust or debris as a consequence of the work, clean those areas in accordance with the procedures indicated in Paragraph "Decontamination Procedures." All such required cleaning or decontamination shall be performed at no additional cost to the Owner.
8. Place all tools (i.e., scaffolding, staging) necessary for the work in the area to be isolated prior to erection of plastic sheeting temporary enclosure.
9. Disable ventilation systems or any other system bringing air into or out of the work area. Disable system by disconnecting wires, removing circuit breakers, by lockable switch or other positive means that will prevent accidental premature restarting of equipment.
10. Remove and dispose of all electrical and mechanical items, such as lighting fixtures, clocks, diffusers, registers, escutcheon plates, etc., which cover any part of the surface on which work is to be performed.

11. All general construction items such as cabinets, casework, doors and window trim, moldings, ceilings, trim, etc., which cover the surface of the work as required to prevent interference with the work. To be performed by the Owner: clean, decontaminate and reinstall all such materials, upon completion of all removal work with materials, finishes, and workmanship to match existing installations before start of work.
12. Permit Access to the work area only through the Decontamination Unit. All other means of access shall be closed off and sealed and warning signs displayed on the clean side of the sealed access.
13. Provide Warning Signs at each visual and physical barriers reading as follows in both English and Spanish:

Legend	Notation
KEEP OUT	3" Sans Serif Gothic or Block
BEYOND THIS POINT	1" Sans Serif Gothic or Block
ASBESTOS ABATEMENT WORK	1" Sans Serif Gothic or Block
IN PROGRESS	1" Sans Serif Gothic or Block
BREATHING ASBESTOS DUST MAY BE HAZARDOUS TO YOUR HEALTH	14 Point Gothic

14. Alternate methods of containing the work area may be submitted to the Owner's Representative for approval. Do not proceed with any such method(s) without prior written approval of the Owner's Representative.
15. Individually seal all ventilation openings (supply and exhaust), lighting fixtures, clocks, doorways, windows, convectors and speakers, and other openings into the work area with plastic adhesion tape alone or with polyethylene sheeting at least 4-mil in thickness, taped securely in place with plastic adhesion tape. Maintain seal until all work including Project Decontamination is completed. Take care in sealing off lighting fixtures to avoid melting or burning of sheeting.
16. Provide sheet plastic barriers at least 6-mil in thickness as required to completely seal openings from the work area into adjacent areas. Seal the perimeter of all sheet plastic barriers with plastic adhesion tape or spray cement.
17. Where applicable, construct framing of the containment out of fire treated wood or aluminum studs. Mini-enclosure frames may be constructed of Polyvinyl Chloride (PVC) tubing.
18. Cover all walls in work area extending to the underside of the ceiling grid system with one layer of polyethylene sheeting, at least 6-mil in thickness, mechanically supported and sealed with plastic adhesion tape or spray-glue in the same manner as "Critical Barrier" sheet plastic barriers. Tape all joints with plastic adhesion tape. Contractor shall be responsible for repair of damaged wall finishes.
19. Cover floor with two layers of 6-mil polyethylene sheeting (exclude for floor tile and adhesive).
20. Provide Pressure Differential System per Paragraph “Pressure Differential System.”
21. If the enclosure barrier is breached in any manner that could allow the passage of asbestos debris or airborne fibers, then add the affected area to the work area, enclose it as required by this section of the specification and decontaminate it as described in Paragraph “Decontamination Procedures.”
22. Establishing a Mini-Containment area:
    a. Establish work area so that unauthorized entry is prevented; Construct a two-compartment fire treated wood frame around work area; install one layer 6-mil polyethylene sheeting to structural members and two layers 6 mil polyethylene sheeting to the floor. Exception: no floor required if mini-containment is being constructed to perform a floor tile activity. Seal all edges to wall, ceiling, and floor surfaces with duct tape. Install viewing inspection windows, where feasible.
    b. Seal all penetrations with duct tape such as pipes, electrical conduit, or ducts contained within the mini-containment.

c. Install triple 6-mil polyethylene flaps at both doorways. Place portable sprayer with clean water, disposable towels, and pre-labeled disposal bag in air lock.
d. Install appropriate signs on outside of mini-containment area.
e. Install HEPA vacuum; extend hose into mini-containment area for general vacuuming, negative air, and cleaning of disposal suit.
f. Accumulate all loose materials for disposal. Place in approved container. Apply appropriate labels. Adequately wet clean all wall, floor, tool and equipment surfaces.
g. Abatement worker must wear two disposable suits. Remove outer suit in work area and place in a plastic bag. Enter air lock.
h. In air lock, wet wipe respirator and wash hands with clean water. Remove respirator and place in a clean plastic bag. Proceed to remote shower unit where inner suit may be removed.

E. Worker Protection
1. This section describes the equipment and procedures required for protecting workers against asbestos contamination and other work place hazards except for respiratory protection.
2. Respiratory Protection is specified in Paragraph “Respiratory Protection.”
3. Train in accordance with EPA’s Model Accreditation Plan, 40 CFR 763 - Asbestos, all workers in the dangers inherent in handling asbestos and breathing asbestos dust and in proper work procedures and personal and area protective measures. Include but do not limit the topics covered in the course to the following:
   a. Methods of recognizing asbestos.
   b. Health effects associated with asbestos.
   c. Relationship between smoking and asbestos in producing lung cancer.
   d. Nature of operations that could result in exposure to asbestos.
4. Importance of and instruction in the use of necessary protective controls, practices and procedures to minimize exposure including:

   Engineering controls
   Work practices
   Respirators
   Housekeeping procedures
   Hygiene facilities
   Protective clothing
   Decontamination procedures
   Emergency procedures
   Waste disposal procedures
   Appropriate work practices for the work
   Requirements of medical surveillance program
   Review of OSHA 29 CFR 1926.1101(k)(9)(viii)(G) - Asbestos
   Pressure differential systems
   Work practices including hands on or on job training
   Personal decontamination procedures
   Air monitoring, personal and area

5. Provide medical examinations for all workers who may encounter an airborne fiber level of 0.1 f/cc or greater for an 8 hour time weighted average. In the absence of specific airborne fiber data, provide medical examination for all workers who will enter the work area for any reason. Examination shall, at minimum, meet OSHA requirements as set forth in 29 CFR 1926.1101(k)(9)(viii)(G) - Asbestos. In addition, provide an evaluation of the individual’s ability to work in environments capable of producing heat stress in the worker.
6. Before start of work Contractor shall submit the following to the Owner's Representative for review. Do not start work until receipt of the Owner’s Representative.

a. An original signed copy of the Certificate of Worker's Acknowledgement found at the end of this specification, for each worker who is to be at the job site or enter the work area.
b. Courses outline or name of institution providing the worker training course.
c. Report from medical examination conducted within last 12 months as part of compliance with OSHA medical surveillance requirements for each worker who is to enter the work area.

7. Provide disposable full-body coveralls and disposable head covers, and require that they be worn by all workers in the work area. Provide a sufficient number for all required changes, for all workers in the work area.
8. Provide work boots with non-skid soles, and where required by OSHA, foot protectives, for all workers. Provide boots at no cost to workers. Paint uppers of all boots red with water proof enamel. Do not allow boots to be removed from the work area for any reason, after being contaminated with asbestos-containing material. Dispose of boots as asbestos contaminated waste at the end of the work.
9. Provide head protectives (hard hats) as required by OSHA for all workers, and provide four spares for use by the Owner's Representative, and the Owner. Label hats with same warning labels as used on disposal bags. Require hard hats to be worn at all times that work is in progress that may potentially cause head injury. Provide hard hats with plastic strap type suspension. Require hats to remain in the work area throughout the work. Thoroughly clean, decontaminate and bag hats before removing them from work area at the end of the work.
10. Provide eye protectives (goggles) as required by OSHA for all workers involved in scraping, spraying, or any other activity which may potentially cause eye injury.
11. Provide work gloves to all workers and require that they be worn at all times in the work area. Do not remove gloves from work area. Dispose of gloves as asbestos contaminated waste at the end of the work.
12. Respirators, disposable coveralls, head covers, and footwear covers shall be provided by the contractor for the Owner, the Owner's Representative, and other authorized representatives who may inspect the job site.
13. Provide worker protection as required by the most stringent OSHA and/or EPA standards applicable to the work. The following procedures are minimums to be adhered to regardless of fiber count in the work area.
14. Each time work is entered, remove <u>all</u> street clothes in the changing room of the Personnel Decontamination Unit and put on new disposable coverall, new head cover, and a clean respirator. Proceed through shower room to equipment room and put on work boots.
15. In the event a mini-enclosure is used refer to Paragraph "Work Area Preparation" for personal decontamination procedures.

F. Respiratory Protection

1. Instruct and train each worker involved in asbestos abatement or maintenance and repair of friable asbestos-containing materials in proper respiratory use and require that each worker always wear a respirator, properly fitted on the face in the work area from the start of any operation which may cause airborne asbestos fibers until the work area is completely decontaminated. Use respiratory protection appropriate for the fiber level encountered in the work place or as required for other toxic or oxygen-deficient situations encountered.
2. Except to the extent that more stringent requirements are written directly into the Contract Documents, the following regulations and standards have the same force and effect (and are made a part of the Contract Documents by reference) as if copied directly into the Contract Documents, or as if published copies were bound herewith. Where there is a conflict in requirements set forth in these regulations and standards meet the more stringent requirement.
   a. OSHA - U.S. Department of Labor Occupational Safety and Health Administration, Safety and Health Standards 29 CFR 1910, Section 1001 and Section 1910.134.29 CFR 1926.
   b. ANSI - American National Standard Practices for Respiratory Protection. ANSI Z88.2-1980.
   c. NIOSH - National Institute for Occupational Safety and Health.

d. MSHA - Mine Safety and Health Administration.

G. Type Of Respiratory Protection Required

1. Provide Respiratory Protection as indicated in paragraph below. Where paragraph below does not apply, determine the proper level of protection by dividing the expected or actual airborne fiber count in the work area by the "protection factors" given below. The level of respiratory protection which supplies an airborne fiber level inside the respirator, at the breathing zone of the wearer, at or below 0.01 fibers/cubic centimeter is the minimum level of protection allowed.
2. Eight-hour Time Weighted Average (TWA) of asbestos fibers to which any worker may be exposed shall not exceed 0.1 fibers/cubic centimeter.
3. For purposes of this section fibers are defined as all fibers regardless of composition as counted in the OSHA Reference Method (ORM), NIOSH P&CAM 239 or 7400 procedure, or asbestos fibers of any size as counted using either a scanning or transmission electron microscope.
4. Require that respiratory protection be used at all times that there is any possibility of disturbance of asbestos-containing materials whether intentional or accidental.
5. Require that a respirator be worn by anyone in a work area at all tunes, regardless of activity, during a period that starts with any operation which could cause airborne fibers until the area has been cleared for re-occupancy.

H. Respiratory Protection Factor

Respirator Type	Protection Factor
Air purifying: Negative pressure respirator High efficiency filter Half facepiece	10
Air purifying: Negative pressure respirator High efficiency filter Full facepiece	50
Powered-air purifying (PAPR): Positive pressure respirator High efficiency filter Half or Full facepiece	100
Type C supplied air: Positive pressure respirator continuous-flow Half or full facepiece	100
Type C supplied air: Positive pressure respirator pressure demand Full facepiece	1000
Type C supplied air: Positive pressure respirator pressure demand Full facepiece Equipped with an auxiliary positive pressure Self-contained breathing apparatus (SCBA)	over 1000
Self-contained breathing apparatus (SCBA): Positive Pressure respirator	over 1000

Pressure demand
Full facepiece

I. Air Purifying Respirator
1. Provide half face or full face type respirators. Equip full-face respirators with a nose cup or other anti-fogging device as would be appropriate for use in air temperatures less than 32 degrees Fahrenheit.
2. Provide, at a minimum, HEPA type filters labeled with NIOSH and MSHA certification for "Radionuclides, Radon Daughters, Dust, Fumes, Mists including Asbestos-Containing Dusts and Mists" and color coded in accordance with ANSI Z228.2 (1980). In addition, a chemical cartridge section may be added, if required, for solvents, etc., in use. In this case, provide cartridges that have each section of the combination canister labeled with the appropriate color code and NIOSH/MSHA Certification.
3. Supply with a sufficient quantity of respirator filters approved for asbestos, so that workers can change filters during the work day. Require that respirators be wet-rinsed, and filters discarded, each time a worker leaves the work area. Require that new filters be installed each time a worker re-enters the work area. Store respirators and filters at the job site in the changing room and protect totally from exposure to asbestos prior to their use. Do not use single use, disposable or quarterface respirators.

J. Powered Air Purifying Respirator (PAPR)
1. Provide full-facepiece type respirators. Provide nose-cups for full-facepiece respirators. Provide, at a minimum, HEPA type cartridges approved by NIOSH/MSHA and certified for use in atmospheres containing asbestos dusts.
2. Provide, at a minimum, one extra battery pack for each respirator so that one can be charging while one is in use.
3. Provide non-cloth belts capable of being decontaminated in shower.
4. Supply with a sufficient quantity of high efficiency respirator filters approved for asbestos so that workers can change filters at any time that flow through the face piece decreases to the level at which the manufacturer recommends filter replacement. Require that regardless of flow, filter cartridges be replaced after 40 hours of use. Require that HEPA elements in filter cartridges be protected from wetting during showering. Require entire exterior housing of respirator including blower unit, filter cartridges, hoses, battery pack, face mask, belt, and cords to be washed each time a worker leaves the work area. Caution should be used to avoid shorting battery pack during washing.

K. Required Respiratory Protection
1. Regardless of airborne fiber levels, require the following minimum level of respiratory protection:
   a. Half-face air purifying respirators may be used during set-up of the containment and removal of the material so long as fiber counts inside the respirator do not exceed .01 f/cc fibers per cubic centimeter.

L. Decontamination Units -Three-Stage
1. Provide a Personnel Decontamination Unit consisting of a serial arrangement of rooms or spaces, Changing Room, Shower Room, Equipment Room adjacent to each full containment area.
2. Require all persons without exception to pass through this decontamination unit for entry into and exiting from the work area for any purpose. Do not remove equipment or materials through Personnel Decontamination Unit.
3. Changing (Clean) Room:
   a. Provide a room that is physically and visually separated from the rest of the building for the purpose of changing into protective clothing.
   b. Locate so that access to work area from changing room is through shower room.

c. Separate changing room from the building by a double-sheeted polyethylene flapped doorway.
d. Provide sub-panel at changing room to accommodate all removal equipment. Power sub-panel directly from a building electrical panel. Connect all electrical branch circuits in decontamination unit and particularly any pumps in shower room to a ground-fault circuit protection device.

4. Shower Room:
   a. Provide a completely water tight operational shower to be used for transit by cleanly dressed workers heading for the work area from the changing room, or for showering by workers headed out of the work area after undressing in the equipment room.
   b. Construct room by providing a shower pan and two shower walls in a configuration that will cause water running down walls to drip into pan. Install a freely draining wood floor in shower pan at elevation of top of pan.
   c. Separate this room from rest of building, drying room and airlock with airtight walls fabricated of 6-mil polyethylene.
   d. Provide splash proof entrances to Drying Room and Airlock.
5. Equipment Room (contaminated area):
   a. Require work equipment, footwear and additional contaminated work clothing to be left here. This is a change and transit area for workers. Separate this room from the work area by a 6-mil polyethylene flap doorway.
   b. Separate this room from the rest of the building, the shower room and work area with air tight walls fabricated of 6-mil polyethylene.
6. Clean Room: Provide Clean Room to isolate the holding room from the building exterior.
7. Load-out Area:
   a. The load-out area is the transfer area from the building to a truck or dumpster.
   b. Wet wipe bags before they are passed through the equipment decon-chamber.
   c. When cleaning is complete pass items into holding room. Close all doorways except the doorway between the holding room and the Clean Room.
   d. Workers from the area outside the containment area enter holding area and remove decontaminated equipment and/or containers for disposal.
   e. Require these workers to wear full protective clothing and appropriate respiratory protection.
   f. At no time is a worker from an uncontaminated area to enter the enclosure when a removal worker is inside.
   g. Post an approximately 20 inch x 14 inch manufactured caution sign at each entrance to the work area displaying the following legend with letter sizes and styles of a visibility required by OSHA 29 CFR 1926.1101(k)(9)(viii)(J) - Asbestos.

<u>LEGEND</u>

DANGER

ASBESTOS

CANCER AND LUNG DISEASE HAZARD

RESPIRATORS AND PROTECTIVE CLOTHING ARE REQUIRED
IN THIS AREA

   h. Provide spacing between respective lines at least equal to the height of the respective upper line.
   i. <u>Additional Signage:</u> Shall also be posted in accordance with OSHA 29 CFR 1926.1101(k)(9)(viii)(J) - Asbestos

DANGER
ASBESTOS
CANCER AND LUNG DISEASE HAZARD

AUTHORIZED PERSONNEL ONLY
RESPIRATORS AND PROTECTIVE CLOTHING
ARE REQUIRED IN THIS AREA
DANGER
ASBESTOS
CANCER AND LUNG HAZARD
KEEP OUT

j. Post an approximately 10 inch by 14 inch manufactured sign at each entrance to each work area displaying the following legend with letter sizes and styles of a visibility at least equal to the following:

LEGEND	NOTATION
No Food, Beverages or Tobacco Permitted	3/4 inch Block
All Persons Shall Don Protective Clothing (Coverings) Before Entering the Work Area	3/4 inch Block
All Persons Shall Shower Immediately After Leaving Work Area and Before Entering the Changing Area	3/4 inch Block

M. Decontamination Procedures

1. Contractor shall require all workers and visitors to adhere to the following personal decontamination procedures whenever they leave the work area:

a. Require that all workers use the following decontamination procedure as a minimum requirement whenever leaving the work area.

b. When exiting area, remove disposable coveralls, disposable head covers, and disposable footwear covers or boots in the Equipment Room.

c. Still wearing respirators, proceed to showers. Showering is <u>mandatory</u>. Care must be taken to follow reasonable procedures in removing the respirator to avoid asbestos fibers while showering. The following procedure is required as a minimum:

1) Thoroughly wet body including hair and face. If using a PAPR, hold blower unit above head to keep canisters dry.
2) With respirator still in place thoroughly wash body, hair, respirator face piece, and all parts of the respirator except the blower unit and battery pack on a PAPR. Pay particular attention to seal between face and respirator and under straps.
3) Take a deep breath, hold it and/or exhale slowly, completely wet hair, face, and respirator. While still holding breath, remove respirator and hold it away from face before starting to breathe.
4) Carefully wash face-piece of respirator inside and out.

d. If using PAPR, shut down in the following sequence, first cap inlets to filter cartridges, then turn off blower unit (this sequence will help keep debris which has collected on the inlet side of filter from dislodging and contaminating the outside of the unit). Thoroughly wash blower unit and hoses. Carefully wash battery pack with wet rag. Be extremely cautious of getting water in battery pack as this will short out and destroy battery.

1) Shower completely with soap and water.
2) Rinse thoroughly.
3) Rinse shower room walls and floor prior to exit.
4) Proceed from shower to changing room and change into street clothes or into new disposable work items.

e. Require that all workers use the following decontamination procedure as a minimum requirement whenever leaving the work area with a half or full face cartridge type respirator:
   1) When exiting area, remove disposable coveralls, disposable headcovers, and disposable footwear covers or boots in the equipment room.
   2) Still wearing respirators, proceed to showers. Showering is mandatory. Care must be taken to follow reasonable procedures in removing the respirator and filters to avoid asbestos fibers while showering. The following procedure is required as a minimum:
   3) Thoroughly wet body from neck down.
   4) Wet hair as thoroughly as possible without wetting the respirator filter if using an air purifying type respirator.
   5) Take a deep breath, hold it and/or exhale slowly, complete wetting of hair, thoroughly wetting face, respirator and filter (air purifying respirator). While still holding breath, remove respirator and hold it away from face before starting to breath.
   6) Dispose of wet filters from air purifying respirator.
   7) Carefully wash facepiece of respirator inside and out.
   8) Shower completely with soap and water.
   9) Rinse thoroughly.
   10) Rinse shower room walls and floor prior to exit.
   11) Proceed from shower to changing room and change into street clothes or into new disposable work items.

N. Project Decontamination
1. If the asbestos abatement work is on damaged or friable materials, then the building space is deemed contaminated before start of the work and in need of decontamination. In this case, the procedure includes two cleanings of the primary barrier plastic prior to its removal and two cleanings of the room surfaces to remove any new or existing contamination.
2. Work of this section includes the decontamination of air in the work area which has been, or may have been contaminated by the elevated airborne asbestos fiber levels generated during abatement activities, or which may previously have had elevated fiber levels due to friable materials in the space.
3. Work of this section also includes the cleaning, decontamination, and removal of temporary facilities installed prior to abatement work and decontamination of all surfaces (ceiling, walls, floor) of the work area, and all furniture or equipment in the work area.
4. First Cleaning
   a. Carry out a first cleaning of all surfaces of the work area including items of remaining sheeting, tools, scaffolding and/or staging by use of damp-cleaning and mopping, and/or a HEPA filtered vacuum. (Note: A HEPA vacuum will fail if used with wet material). Do not perform dry dusting or dry sweeping. Use each surface of a cleaning cloth one time only and then dispose as contaminated waste. Continue this cleaning until there is no visible debris from removed materials on plastic sheeting or other surfaces. Upon authorization of the Owner's Representative proceed with encapsulation of substrate.
   b. Perform encapsulation of substrate where required at this time. Maintain pressure differential system in operation during encapsulation work. Allow encapsulant to dry before proceeding with removal of Secondary layer of plastic.
5. Second Cleaning
   a. Upon authorization of the Owner's Representative, remove all Primary Barrier sheeting and Material Decontamination Unit, if there is one, leaving only the following:
      1) Critical Barrier which forms the sole barrier between the work area and other portions of the building or outside.
      2) Critical Barrier Sheeting over lighting fixtures and clocks, ventilation openings, doorways, convectors, speakers and other openings.

3) Personnel Decontamination Unit.
4) Pressure Differential System in continuous operation.

b. Remove all filters in Air Handling System(s) and dispose of as asbestos-containing waste.

6. Final Cleaning: Carry out a final cleaning of all surfaces in the work in the same manner as the first cleaning immediately after removal of primary plastic. This cleaning is now being applied to existing room surfaces. Take care to avoid water marks or other damage to surfaces.
7. Visual Inspection: Perform a complete visual inspection with the Owner's Representative of the entire work area including decontamination unit, all plastic sheeting, seals over ventilation openings, doorways, windows, and other openings; look for debris from any sources, residue on surfaces, dust or other matter. If any such debris, residue, dust or other matter is found repeat cleaning and continue decontamination procedure from that point. When the area is visually clean, complete the certification at the end of this section.
8. Final Air Sampling
   a. After the work area is found to be visually clean, air samples will be taken and analyzed in accordance with the procedures set forth in Paragraph “Powered Air Purifying Respirator (PAPR).
   b. If Release Criteria are not met, repeat cleaning and continue decontamination procedure from that point.
   c. If Release Criteria is met, remove the interior of the decontamination unit leaving in place only the Critical Barriers separating the work area from the rest of the building and the operating negative pressure system.
   d. Any small quantities of residual material found upon removal of the plastic sheeting shall be removed with a HEPA filtered vacuum cleaner and local area protection. If significant quantities, as determined by the Owner's Representative, are found then the entire area affected shall be decontaminated as specified herein for the cleaning.

O. Work Area Clearance
1. Air Monitoring
   a. Visual Inspection is required as a prerequisite of air testing.
   b. To determine if the elevated airborne asbestos structure concentration during abatement operations have been reduced to the specified level, the Owner's Representative will secure samples and analyze them according to the following procedures.
2. Aggressive Sampling
   a. All air samples will be taken using aggressive sampling techniques as follows. (There are no standards available for flow rate of leaf blowers or large fans. However, this information is not critical to the success of the procedure).
   b. Before sampling pumps are started, the exhaust from forced-air equipment (leaf blower with at least 1 horsepower electric motor) will be swept against all walls, ceilings, floors, ledges and other surfaces in the room. This procedure will be continued for five minutes per 10,000 cubic feet of room volume.
   c. Air samples will be collected in areas subject to normal air circulation away from room corners, obstructed locations, and sites near windows, doors or vents.
3. Schedule of Air Samples
   a. General: The number and volume of air samples taken and analytical methods used by the Owner's Representative will be in accordance with the following schedule. Sample volumes given may vary depending upon the analytical instruments used. In each homogeneous work area after completion of all cleaning work, samples will be taken and analyzed by either PCM of TEM analysis.
   b. Transmission Electron Microscopy (TEM) Samples:
      1) In each homogeneous work area after completion of all cleaning work, samples will be taken and analyzed by either PCM or TEM analysis as follows:
      2) Samples will be collected on 25 mm cassettes with filter media: <u>TEM </u>- 0.45 micrometer mixed cellulose ester or 0.40 micrometer polycarbonate, with 5.0 micron mixed cellulose ester backing filter.

Location **Sampled**	Number of **Samples**	Detection **Limit** (f/cc)	**Minimum** Volume (Liters)	**Rate** LPM
Each Work Area	5	0.005	1,300	2-10

3) TEM Analysis_will be performed using the analysis method set forth in the AHERA Regulation 40 CFR Part 763 Appendix A.
4) Asbestos Structures referred to in this Section include asbestos fibers, bundles, clusters, or matrices, as defined by method of analysis.
5) Decontamination of the work site is complete when all the sample results are below 0.01 fibers per cubic centimeters (f/cc) of air or 70 structures per square millimeter.

c. Phase Contrast Microscopy (PCM) Samples:
1) In each homogeneous work area after completion of all cleaning work, samples may be taken and analyzed as follows:
2) Samples will be analyzed by PCM for clearance in areas where ceiling tile and/or pipe insulation are removed
3) Samples will be collected on 25 mm cassettes with filter media: PCM - 0.8 micrometer mixed cellulose ester.

Location Sampled	**Number of Samples**	**Detection Limit** (s/cc)	**Minimum Volume** (Liters)	**Rate** LPM
Each Work Area	1-5	0.01	2,400	2-10

4) PCM Analysis: Fibers on each filter will be measured using the NIOSH 7400 Method entitled "Fibers" published in the NIOSH Manual of Analytical Methods, 3rd Edition, Second Supplement, August 1987.
5) Fibers: Referred to in this section include fibers regardless of composition as counted by the phase contrast microscopy method used
6) Decontamination of the work site is complete when all the sample results are below 0.01 fibers per cubic centimeters (f/cc) of air or 70 structures per square millimeter.

4. Failure of Clearance Sampling: Should results from analysis of final clearance air samples not meet the specified criteria, Contractor will be responsible for the payment of all costs, including Consultant's time for subsequent clearance air sampling. The costs associated with subsequent re-sampling for final clearance shall be deducted from the Contractor's final payment of the contract amount.

P. Removal Of Pipe Insulation
1. The work of this section applied to the removal of asbestos-containing Pipe Insulation.
a. Place one layer of 6-mil fire retardant polyethylene sheeting directly below the work. The sheet shall be of sufficient size to completely wrap the pipe once it has been removed.
b. Thoroughly wet the ends of the pipe with amended water and scrape off a minimum of 6 inches of asbestos wrap from both ends of the pipe. Immediately place the wetted material into pre-labeled asbestos disposal bag(s).
c. Detach the pipe at each scraped end and place the pipe onto one sheet of 6-mil fire retardant polyethylene sheeting. Wrap the pipe with the 6-mil fire retardant polyethylene sheeting. Contractor shall wrap the pipe with a second sheet of 6-mil, fire retardant polyethylene sheeting and label as asbestos-containing material. Dispose of the bag(s) and duct in accordance with the Paragraph "Handling and Disposal of Asbestos Contaminated Waste" of this specification.
d. Upon clearance from the Owner's Representative, Contractor shall remove the 6-trail, fire retardant polyethylene sheeting from the openings.

Q. Glove Bag Removal

1. The work of this section applies to full containment or glovebag removal.
2. Isolate the area in accordance with Paragraph "Temporary Facilities."
3. Construct a decontamination unit as described in Paragraph "Decontamination Units" and attach to the work area.
4. Set up pressure differential isolation and ventilation of the work area in accordance to Paragraph "Pressure Differential System."
   a. Upon approval of the enclosure by the Owner's Representative, Contractor may proceed to remove the material using the following method.
   b. Thoroughly wet to satisfaction of the Owner's Representative, asbestos-containing insulation to be removed prior to stripping and/or tooling to reduce fiber dispersal into the air. Accomplish wetting by a fine spray (mist) of amended water or removal encapsulant. Saturate material sufficiently to wet the substrate without causing excess dripping. Allow time for removal encapsulant to penetrate material thoroughly. If amended water is used, spray material repeatedly during the work process to maintain a continuously wet condition. If a removal encapsulant is used, apply in strict accordance with manufacturer's written instructions. If insulation is covered with canvas, Contractor will wet the exterior covering and slice it with utility knife while saturating the material.
   c. Mist work area continuously with amended water whenever necessary to reduce airborne fiber levels using commercially available "foggers."
   d. Remove saturated asbestos-containing material in small sections from all areas. Do not allow material to dry out. As it is removed, simultaneously pack material while still wet into disposal bags. Twist neck of bags, bend over and seal with minimum three wraps of duct tape. Clean outside and move to wash down station adjacent to material decontamination unit.
   e. Evacuate air from disposal bags with a HEPA filtered vacuum cleaner before sealing.
   f. Contractor must always clean area of visible asbestos debris prior to end of shift.
5. These procedures shall be followed to remove pipe insulation elbows:
   a. Install critical barriers to isolate the work site. Install 2 or 3 Stage Decontamination Units.
   b. HEPA vacuum the work site.
   c. Provide negative air machine in addition to those required, in the vicinity of the work. Arrange so that exhaust is into the work area, oriented in a direction away from the work. Extend a 2-inch diameter flexible non-collapsing duct from the intake end to a point no more than 4'-0" from any scraping or brushing activity.
   d. Locate intake of duct so that airflow is horizontally and slightly downward into intake. Replace primary filter on negative air machine at an interval of no greater than 30 minutes. Allow no more than one scraping or brushing activity per negative air machine.
   e. Check pipe where the work will be performed. Wrap damaged (broken lagging, hanging, etc.), pipe in 6 mil plastic and "candy-stripe" with duct tape. Place one layer of duct tape around undamaged pipe at each end where the glovebag will be attached.
   f. Place necessary tools into pouch located inside glovebag. This will usually include: bone saw, utility knife, rags, scrub brush, wire cutters, tin snips and pre-wetted cloth.
   g. Place one strip of plastic adhesion tape along the edge of the open top slit of glove bag for reinforcement.
   h. Place the glove bag around section of pipe to be worked on and staple top together through reinforcing tape. Next, tape the ends of glovebag to pipe itself, where previously covered with plastic or tape.
   i. Use smoke tube and aspirator bulb to test seal. Place tube into water sleeve (two-inch opening to glovebag) squeezing bulb and filling bag with visible smoke. Remove smoke tube and twist water sleeve closed. While holding the water sleeve tightly, gently squeeze glovebag and by using a flashlight, look for smoke leaking out, (especially at the top and ends of the glovebag). If leaks are found, tape closed using plastic adhesion tape and re-test.
   j. Insert wand from garden sprayer through water sleeve. Plastic adhesion tape water sleeve tightly around the wand to prevent leakage.

k. One person places its hands into the long-sleeved gloves while the second person directs garden sprayer at the work.
l. Use bone saw, if required, to cut insulation at each end of the section to be removed. A bone saw is a serrated heavy gauge wire with ring-type handles at each end. Throughout this process, spray amended water or removal encapsulant on the cutting area to keep dust to a minimum.
m. Remove insulation using putty knives or other tools. Place pieces in bottom of bag without dropping.
n. Rinse all tools with water inside the bag and place back into pouch.
o. Using scrub brush, rags and water, scrub and wipe down the exposed pipe. (Inexpensive horse rub-down mittens work well for this).
p. Remove water wand from water sleeve and attach the small nozzle from HEPA-filtered vacuum. Turn on the vacuum only briefly to collapse the bag.
q. Remove the vacuum nozzle, twist water sleeve closed and seal with plastic adhesion tape.

R. Handling And Disposal Of Asbestos-Containing Waste
1. All waste and asbestos contaminated waste shall be double bagged in pre-labeled 6-mil airtight puncture resistant bags. Labeling shall be in accordance with OSHA and EPA requirements.
a. Bags of asbestos-containing waste shall be sealed with tape in the work area. Asbestos waste shall not be allowed to dry out prior to sealing bags. While in the work area, bags shall be decontaminated of any bulk debris by wet wiping. Bags shall be pre-labeled in accordance with OSHA and EPA.
b. The Contractor shall ensure that the sealed bags are transported to the waste disposal site.
2. The Contractor shall establish a manifest system to enable the Owner to report the quantity of asbestos waste being deposited at the landfill. Contractor shall report the quantity of waste in pounds or tons as appropriate. The Contractor must be able to demonstrate custody over all asbestos waste from the time it is removed from the work area until it is deposited at the land fill.
a. Copies of the manifest and any receipts generated during the handling and disposal process shall be provided to the Owner's Representative and the Owner.
b. Final manifest and documents must be provided to the Owner's Representative and the Owner within two weeks of the removal of the asbestos materials from the site by the waste hauler.

S. Encapsulation Of Asbestos-Containing Materials
1. General provisions of Contract, including General and Supplementary Conditions and Division 01, apply to work of this section.
a. The work includes the sealing of all piping or vessels from which asbestos-containing insulation has been removed with one coat of a lock down encapsulant.
b. Where repair work is being performed, the end will be sealed with a minimum of one coat of bridging encapsulant.
2. Submittals
a. Product Data: Submit manufacturer's technical information including label analysis and application instructions for each material proposed for use.
b. Installation Instructions: Submit manufacturer's installation instructions with specific project requirements noted.
c. Performance Warrantee: Submit manufacturer's performance guarantee.
d. Certification: Submit written approval of entity installing the encapsulant from encapsulant manufacturer.
e. Material Safety Data Sheet: Submit the Material Safety Data Sheet, or equivalent, in accordance with the OSHA Hazard Communication Standard (29 CFR 1910.1200) for each surfactant and encapsulating material proposed for use on the work. Include a separate attachment for each sheet indicating the specific worker protective equipment proposed for use with the material indicated.

3. Deliver materials to the job site in original, new and unopened packages and containers bearing manufacturer's name and label, and following information:
   a. Name or title of material
   b. Manufacturer's stock number and date of manufacture
   c. Manufacturer's name
   d. Thinning Instructions
   e. Application Instructions
4. Deliver materials together with a copy of the OSHA Material Safety Data Sheet for the material.
5. Job Conditions
   a. Apply encapsulating materials only when environmental conditions in the work area are as required by the manufacturer's instructions.
6. Quality Assurance
   a. Installation of Spray-on Encapsulation Materials: Install spray-on materials by a firm and personnel approved by the manufacturer of the primary materials.
   b. Testing: Test material to be encapsulated using methods set forth in ASTM E1494 "Standard Practice for Encapsulants Spray-or-Trowel-Applied for Friable Asbestos-Containing Building Materials."
   c. Performance Warranty: Submit written Performance Warranty, executed by the manufacturer and co-signed by the Contractor, agreeing to repair/replace spray-on work which has cracked, fallen from substrate, or otherwise deteriorated to a condition where it would not perform effectively for its intended purposes due substantially to defective materials or workmanship and not due to abuse by occupants, improper maintenance, non-foreseeable ambient exposures or other causes beyond anticipated conditions and manufacturer's/contractor's control.
   d. Compatibility: Selection and use of encapsulant shall be compatible with replacement materials. Submit manufacturer's data indicating compatibility with replacement materials.
7. Product Selection
   a. Encapsulants: Provide penetrating or bridging type encapsulants specifically designed for application to asbestos-containing material.
   b. Standards: Product shall be rated as acceptable for use intended when field tested in accordance with ASTM E1494 "Standard Practice for Encapsulants Spray-or-Trowel-Applied for Friable Asbestos-Containing Building Materials."
   c. Fire Safety: Use only materials that have a flame spread index of less than 25, when dry, when tested in accordance with ASTM E84.
8. Manufacturers
   a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products, which may be incorporated in the work, include, but are not limited to the following:
      1) Penetrating Encapsulants: As currently accepted by the EPA. Refer to most recent EPA approval list.
      2) Bridging Encapsulants: As currently accepted by the EPA. Refer to most recent EPA approval list.
9. General
   a. Prior to applying any encapsulating material, ensure that application of the sealer will not cause the base material to fail and allow the sealed material to fall of its own weight or separate from the substrate. Should Contractor doubt the ability of the installation to support the sealant, request direction from the Owner's Representative before proceeding with the encapsulating work.
   b. Do Not Commence Application of encapsulating materials until all removal work within the work area has been completed.
10. Worker Protection
   a. Before beginning work with any material for which a Material Safety Data Sheet has been submitted, provide workers with the required protective equipment. Require that appropriate protective equipment be used at all times.

b. In addition to protective breathing equipment required by OSHA requirements or by this specification, use painting pre-filters on respirators to protect the dust filters when organic solvent based encapsulants are used.

11. Substrate

a. Apply lock down encapsulant to all substrate after all asbestos-containing materials have been removed. Apply in strict accordance with the manufacturer's printed instructions for use of the encapsulation as an asbestos coating. Any deviations from such printed instructions shall be approved by the Owner's Representative in writing prior to commencing work.

b. Apply encapsulant with an airless spray gun with air pressure and nozzle orifice as recommended by the encapsulant manufacturer.

T. Removal Of Floor Tile

1. This section applies to the removal of floor tile.

a. Prior to start of work, wet wipe all surfaces including floor tile to remove any visible dust.

b. Isolate the room by sealing hallway or doors and installing critical barriers on all ducting, windows and other penetrations of the room, in the specified area. Install a splash guard a minimum of 4 feet high on the walls of the room with one layer of 6-mil fire retardant poly.

c. Install a two-stage decontamination configuration contiguous (under certain conditions may be remote) with the work in accordance with Paragraph “Decontamination Units.”

d. Using water or amended water in a Hudson-type sprayer or garden sprayer, lightly mist the area where the material is to be removed. This may take several passes with the hose of the sprayer. Allow time for the water to soak into the material.

e. Immediately place individual tiles in proper asbestos disposal bags. Vacuum collapse the bag, twist the neck of the bag, tape with duct tape, fold the twisted portion over onto itself and tape again. Wipe the outside of the bag with clean damp cloths and place the bag into a second prelabeled disposal bag. Tape shut the second bag.

U. Removal Of Fireproofing

1. The work of this section applies to the removal of all asbestos containing fireproofing including all over-spray that may be located on concrete block, columns, metal deck, beams, fixtures conduit and ducting.

a. Isolate the floor per Paragraph “Temporary Enclosure.”

b. Construct a decontamination unit as described in Paragraph “Decontamination Units” and attach to the work area.

c. Set up pressure differential isolation and ventilation of the work area in accordance to Paragraph “Temporary Pressure Differential and Air Circulation System.”

d. Upon approval of the enclosure by the Owner's Representative, contractor may proceed to remove the material using the following method.

e. Pre-clean columns, beams, electrical, mechanical and plumbing systems in the work area using wet wipe and HEPA vacuuming methods. Mask off with flame retardant polyethylene sheeting to protect from contamination during bulk abatement.

f. Thoroughly wet to satisfaction of the Owner's Representative, asbestos-containing fireproofing to be removed prior to stripping and/or tooling to reduce fiber dispersal into the air. Accomplish wetting by a fine spray (mist) of amended water or removal encapsulant. Saturate material sufficiently to wet the substrate without causing excess dripping. Allow time for removal encapsulant to penetrate material thoroughly. If amended water is used, spray material repeatedly during the work process to maintain a continuously wet condition. If a removal encapsulant is used, apply in strict accordance with manufacturer's written instructions.

g. Mist work area continuously with amended water whenever necessary to reduce airborne fiber levels using commercially available "foggers."

h. Remove saturated asbestos-containing material in small sections from all areas. Do not allow material to dry out. As it is removed, simultaneously pack material while still wet into disposal bags. Twist neck of bags, bend over and seal with minimum three wraps of duct tape. Clean outside and move to wash down station adjacent to material decontamination unit.

i. Evacuate air from disposal bags with a HEPA filtered vacuum cleaner before sealing.

j. Provide Pressure Differential Machine in addition to those required in Paragraph "Pressure Differential System," in the vicinity of the work. Arrange so that exhaust is into the work area, oriented in a direction away from the work. Extend a 12" diameter flexible non-collapsing duct from the intake end to a point no more than 4'-0" from any scraping or brushing activity.

k. Locate intake of duct so that air flow is horizontally and slightly down-ward into intake. Replace primary filter on pressure differential machine at an interval of no greater that 30 minutes. Allow no more than one scraping or brushing activity per pressure differential machine.

V. Removal Of Wall Plaster: HEPA vacuum work site.

1. Place two layers of 6-mil flame retardant polyethylene sheeting on the floor adjacent to the wall to be demolished. Pull the wall down in manageable sections onto the polyethylene sheeting. Control dust and fiber release by misting the air and lightly wetting the material with amended water from a Hudson-type sprayer or garden sprayer as it is demolished.
2. Wrap the first layer of polyethylene sheeting around the material and seal with duct tape. Wrap the second layer of polyethylene sheeting around the bundle and seal with duct tape.
3. Label and dispose of the entire bundle.
4. Provide Pressure Differential Machine in addition to those required in Paragraph "Pressure Differential System," in the vicinity of the work. Arrange so that exhaust is unto the work area, oriented in a direction away from the work. Extend a 12-inch diameter flexible non-collapsing duct from the intake end to a point no more than 4'-0" from any scraping or brushing activity.
5. Locate intake of duct so that air flow is horizontally and slightly down-ward into intake. Replace primary filter on negative air machine at an interval of no greater that 30 minutes.

W. Clean-Up Of Asbestos-Containing Debris On Ceiling Tile Or Solid Ceiling

1. This section applies to the decontamination of the entire plaster ceiling, removal of existing fiberglass on duct work and removal of all batt insulation covering the existing plaster ceiling.
   a. Isolate the floor per Paragraph "Temporary Facilities."
   b. Construct a decontamination unit as described in Paragraph "Decontamination Units" and attach to the work area. General Contractor will give direction regarding exact location of decontamination unit(s).
   c. Set up pressure differential isolation and ventilation of the work area in accordance to Paragraph "Temporary Pressure Differential and Air Circulation System."
   d. Upon approval of the enclosure by the Owner's Representative, contractor may proceed to remove the material using the following method:
2. These procedures shall be followed to for clean up of asbestos-containing debris on existing plaster ceiling:
   a. This work will be performed prior to the removal of fireproofing. The isolation of the work area is considered essential to the pre-cleaning activities for the total area. Isolate the area in accordance with Paragraph "Temporary Facilities."
   b. Remove asbestos-containing debris and fiberglass batt and duct insulation and decontaminate the area using the following procedures:
      1) Remove all small debris with the HEPA vacuum.
      2) Gently mist all fiberglass insulation, remove from ducts and ceiling and place into pre-labeled hazardous disposal bags and dispose of in accordance with Paragraph "Disposal of Asbestos Containing Waste Material."
      3) Exposure of ducting will expose all fireproofing overspray, this material may be removed during the removal of fireproofing from decks and beams.

4) Pick up all large visible debris on the ceiling or any horizontal surfaces and place in the bottom of a 6-mil polyethylene disposal bag conforming to the requirements of Paragraph "Disposal of Asbestos-Containing Waste." Place pieces in the bag without dropping and avoiding unnecessary disturbance and release of material.
5) HEPA vacuum the entire plaster ceiling surface.

c. Upon completion of the decontamination of the area request a visual inspection of the ceiling and other horizontal surfaces. This area will be considered a portion of work area for the duration of the work and will be included in the final encapsulation of the area.

X. Removal Of Adhesive: This section applies to the removal of all asbestos-containing floor tile and adhesive, sheet vinyl flooring, vinyl floor tile, and baseboard adhesive, etc.

1. Ensure that workers are equipped with proper respiratory protection. In addition to the HEPA cartridges, respirators must also be equipped with organic solvent cartridges.
2. Provide HEPA filtered fan units in the vicinity of the work. Arrange so that units exhaust outside the building. Replace primary filters on HEPA filtered fan units at an interval of no greater than 30 minutes.
3. Apply adhesive removal solvent as recommended by manufacturer after removal of floor tile has been completed.
4. Provide tile adhesive (mastic) remover that meets the following criteria:
   a. Flash Point: 122E or greater.
   b. Special Precautions: No heavy smoke generated if ignited.
   c. Health Effects: Limited to mild skin rash or eye irritation.
   d. Respiratory Protection: MSHA - NIOSH approved Organic vapor cartridges in conjunction with standard HEPA filters.
   e. Petroleum Distillates: None.
   f. Odor: Pine, Citrus or none.

Use of diesel fuel in the removal of tile and baseboard adhesive is strictly prohibited.

5. Remove adhesive in small sections from all areas. Do not allow material to dry out. As adhesive is removed, simultaneously pack rags contaminated with adhesive material into disposal bags. Twist neck of bags, bend over and seal with minimum three wraps of duct tape. Clean outside of bag and move to material decontamination unit.
6. Upon completion of adhesive removal, thoroughly clean bare substrate of all solvent residue.
7. Place adhesive residue in proper asbestos disposal bags. Vacuum collapse the bag, twist the neck of the bag, tape with duct tape, fold the twisted portion over onto itself and tape again. Wipe the outside of the bag with clean damp cloths and place bag into second prelabeled disposal bag. Tape shut the second bag.

SAN BERNARDINO COUNTY

CERTIFICATE OF WORKER'S ACKNOWLEDGEMENT

PROJECT NAME: ____

PROJECT ADDRESS: ____

CONTRACTOR: ____

WORKING WITH ASBESTOS CAN BE DANGEROUS. INHALING ASBESTOS FIBERS HAS BEEN LINKED WITH VARIOUS TYPES OF CANCER IF YOU SMOKE AND INHALE ASBESTOS FIBERS, THE CHANCE THAT YOU WILL DEVELOP LUNG CANCER IS GREATER THAN THAT OF THE NON-SMOKING PUBLIC.

Your employer's contract with the Owner for the above project requires that: You be supplied with the proper respirator and be trained in its use. You be trained in safe work practices and in the use of the equipment found on the job. You receive a medical examination. These things are to have been done at no cost to you. By signing this certification you are assuring the Owner that your employer has met these obligations to you.

RESPIRATORY PROTECTION: I have been trained in the proper use of respirators, and informed ofthe type respirator to be used on the above referenced project. I have a copy of the written respiratory protection manual issued by my employers. I have been equipped at no cost with the respirator to be used on the above project.

TRAINING COURSE: I have been trained in the dangers inherent in handling asbestos and breathing asbestos dust and in proper work procedures and personal and area protective measures. The topics covered in the course included the following:

- Physical characteristics of asbestos
- Health hazards associated with asbestos
- Respiratory protection
- Use of protective equipment
- Pressure differential systems
- Work practices including hands-on or on-the-job training
- Personal decontamination procedures
- Air monitoring, personal and area

MEDICAL EXAMINATION: I have had a medical examination within the last 12 months which was paid for by my employer. This examination included: health history, pulmonary function tests and may have included an evaluation of a chest x-ray.

Signature ______________________ Witness ______________________________

Printed Name ____________________ Social Security Number ______________________

CERTIFICATION OF VISUAL INSPECTION

AREA ______________________

In accordance with Paragraph "Project Decontamination" the Contractor hereby certifies that it has visually inspected the work area (all surfaces including pipes, beams, ledges, walls, ceiling and floor, Decontamination Unit, sheet plastic, etc.) and has found no dust, debris or residue.

By: ____________________________________

Signature _______________________________ Date ______________________

Print Name ______________________________

Print Title ______________________________

<u>OWNER'S REPRESENTATIVE CERTIFICATION</u>

the Owner's Representative hereby certifies that it has accompanied the Contractor on its visual inspection and verifies that this inspection has been thorough and to the best of its knowledge and belief, the Contractor's certification above is a true and honest one.

Signature _______________________________ Date ______________________

Print Name ______________________________________

Print Title ______________________________________

RESPIRATORY PROTECTION PROGRAM

Project Name ______________________________

Location ______________________________

Date ______________________________

Based upon airborne asbestos-fiber counts encountered on previous projects of similar type working on materials similar to those found on the above referenced project. The following level of respiratory protection is proposed for the indicated operations to maintain an Airborne Fiber Count (as measured by the NIOSH 7400 Method) below the specified Permissible Exposure Limit (PEL) inside the respirator face piece.

Operation	Anticipated f/cc	Respiratory Protection	Protection Factor	f/cc in Mask
Installing sheet plastic				
Removing trim in contact with asbestos-containing material				
Removal of architectural finish or fireproofing				
Removal of pipe insulation				
Removal of fitting insulation				
Encapsulation of pipe and boiler insulation				
Gross debris removal				
Cleaning "primary" sheet plastic				
Cleaning "critical" barrier				
Removing Decontamination Unit				
Other				

The Contractor certifies that to the best of its knowledge and belief the above represent a true and accurate representation of Airborne Fiber Counts to be expected for the operations indicated, and are based upon airborne fiber data from past projects with similar materials and operations.

Contractor ______________________________

Signature ______________________________ Date ____________________

Print Name ______________________________ Title ____________________

END OF SECTION 02 61 26 00a

Task	Specification	Specification Description
02 65 00 00	02 41 13 13	Selective Demolition
02 65 00 00	02 61 00 00	Excavation And Handling Of Contaminated Material
02 65 00 00	02 61 13 00	Underground Storage Tank Removal
02 65 00 00	02 61 13 00a	Precision Testing Of Underground Fuel Oil Tanks
02 65 00 00	02 61 13 00b	Hydrostatic Pressure Testing Of Air Receiving Tanks
02 81 00 00	02 61 00 00	Excavation And Handling Of Contaminated Material
02 81 00 00	02 61 26 00	Disposal Of Hazardous Materials

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SECTION 02 82 16 00 - ENCAPSULATION (LOCK-DOWN) OF ASBESTOS-CONTAINING MATERIALS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for encapsulation (lock-down) of asbestos-containing materials. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. Product Data: Manufacturers technical information including label analysis and application instructions for each material proposed for use.
   2. Installation Instructions: Manufacturer's installation instructions with specific project requirements noted.
   3. Performance Warrantee: Manufacturers performance guarantee.
   4. Material Safety Data Sheet: Material Safety Data Sheet in accordance with the OSHA Hazard Communication Standard (29 CFR 1910.1200) for each surfactant and encapsulating material proposed for use on the work. Include a separate attachment for each sheet indicating the specific worker protective equipment proposed for use with the material indicated.

C. Delivery And Storage: Deliver materials to the job site in original, new and unopened packages and containers bearing manufacturer's name and label, and following information:
   1. Name or title of material
   2. Manufacturer's stock number and date of manufacture
   3. Manufacturer's name
   4. Thinning instructions
   5. Application instructions
   6. Deliver materials together with a copy of the OSHA Material
   7. Safety Data Sheet for the material.

D. Job Conditions: Apply encapsulating materials only when environmental conditions in the work area are as required by the manufacturer's instructions.

E. Quality Assurance
   1. Testing: Test material to be encapsulated using methods set forth in ASTM E1494 “Standard Practice for Encapsulants for Spray-or-Trowel-Applied Friable Asbestos- Containing Building Materials."

F. Warranty
   1. Performance Warranty: Contractor shall submit written Performance Warranty, executed by the contractor, agreeing to repair/replace spray-on work which has cracked, fallen from substrate, or otherwise deteriorated to a condition where it would not perform effectively for its intended purposes due substantially to defective materials or workmanship and not due to abuse by occupants, improper maintenance, unforeseeable ambient exposures or other causes beyond anticipated conditions and contractors control. Warranty period shall be for at least one year after date of Final Completion.

1.2 PRODUCTS

A. Materials

1. Encapsulant system shall be an acrylic, elastomeric type, spray, brush or roller-applied, tinted penetrating or tinted bridging type, specifically designed for application to asbestos-containing material. System shall be equal to Global Encasement System as manufactured by GLOBAL Encasement Inc., 132-32nd Street, Union City, NJ 07087 U.S.A., Tel. (800) 266-3982/(201) 902-9770.
   a. All encasement topcoat materials shall be warranted to be heavy-bodied, from the same manufacturer, and shall be long lasting, highly-pure (low VOC) materials that remain flexible, chalk resistant and resist cracking, peeling, algae and fungus that can cause future indoor air quality concerns.
   b. To allow for building movement without cracking or disturbing fibrous materials, coating systems shall have passed testing to ASTM standards for adhesion, permeability, aged flexibility and with aged elasticity for the encasement system of over 250%.
   c. Coatings shall be Class A Fire Rated, water-based, non-toxic, safe and easy to use, contain no hazardous ingredients by OSHA definition, comply with all known building codes and be non-flammable.
   d. Coating materials shall have low VOC (Volatile Organic Compound) content.
   e. Coating materials shall not release health threatening toxic smoke and fumes in a fire and shall comply with all known building codes.
   f. Coating materials shall have passed the following testing standards:
      1) ASTM E 119 fire tests demonstrating that applying a multi-layer system over fireproofing does not adversely affect the fireproof rating of the fireproofing (3 hour test).
      2) UPITT Combustion Toxicity Test proving nothing toxic is released in a fire.
      3) ASTM E 84 and E162 fire tests for "Class A" - Surface Flammability and Burning Characteristics (Flame Spread = 0, Smoke Developed = 5).
      4) "Pull-off Adhesion" test per ASTM E736 equals or exceeds 9,950 lbs./sq. ft. (89.1 lbs./sq. in.).
      5) ASTM D 1653 and E96 "Water Vapor Permeability" (showing the rate that water vapor can pass through the system).
      6) Impact Resistance, "Tensile Strength" shall exceed 150 psi; "Elongation" shall exceed 250%.
      7) System shall be mildew resistant, impact resistant, scrub resistant, non-yellowing, non-chalking, highly blister resistant, rust resistant, highly chemical resistant and shall remain flexible after 1000 hour ASTM Accelerated Weather testing.
      8) Water-Based materials (low VOC) Volatile Organic Content of Primer-Sealer-Neutralizer = 0.1 g/L (0.001 lb./gal.) and Encasement Top Coat = 0.1 g/L (0.001 lb./gal.) as tested by EPA Method 24.
      9) Materials comply with applicable standards for installation on interior and/or exterior surfaces of a building.
      10) Encasement Systems shall provide additional water-proofing protection.

B. Related Materials:
   1. Elastomeric architectural sealants, caulking compounds, primers, and similar materials shall be approved by the manufacturer of the encasement coatings. All materials used shall be applied in accordance with its manufacturer's recommendations.

C. Applicable Standards
   1. Product shall be rated as acceptable for use intended when field tested in accordance with ASTM E 1494.

1.3 EXECUTION

A. General

1. Prior to applying any encapsulating material in Work Areas, Contractor shall obtain final visual inspection approval by the Project Administrator.
2. Prior to applying any encapsulating material, Contractor shall ensure that application of the sealer will not cause the base material to fail and allow the sealed material to fall of its own weight or separate from the substrate. Should Contractor doubt the ability of the installation to support the sealant, request direction from the Owner's Representative before proceeding with the encapsulating work.
3. Do Not Commence Application of encapsulating materials until all removal work within the work area has been completed.

B. Worker Protection
1. Before beginning work with any material for which a Material Safety Data Sheet has been submitted provide workers with the required protective equipment. Require that appropriate protective equipment be used at all times.

C. Application
1. Comply with all manufacturer's instructions for particular conditions of installation. Consult with manufacturer's technical representative for conditions not covered.
2. Encapsulate all surfaces in full compliance with manufacturer's procedures.
3. At completion of Encapsulation and before removal of Work Area enclosures and Pressure Differential System, decontaminate space in accordance with requirements of manufacturer’s instructions.
4. Remove all debris from the project site and restore area to proper conditions by cleaning all surfaces in accordance with manufacturer’s written recommendations.
5. At completion of work submit manufacturer’s record of inspection of completed work and Manufacturers Performance Guarantee executed by both manufacturer and Contractor.

END OF SECTION 02 82 16 00

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SECTION 02 82 33 00 - REMOVAL OF NONFRIABLE ASBESTOS-CONTAINING MATERIALS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for removal of nonfriable asbestos-containing materials. Products shall be as follows or as directed by the the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Definitions

1. ACM: Asbestos Containing material which is any material containing more than one percent asbestos.
2. Amended Water: Water containing a wetting agent or surfactant with a maximum surface tension of 2.9 Pa 29 dynes per centimeter when tested in accordance with ASTM D 1331.
3. Area Sampling: Sampling of asbestos fiber concentrations which approximates the concentrations of asbestos in the theoretical breathing zone but is not actually collected in the breathing zone of an employee.
4. Asbestos: The term asbestos collectively refers to a naturally occurring mineral known by the following specific names: chrysotile, amosite, crocidolite, tremolite, anthophyllite, and actinolite.
5. Asbestos control Area: That area where asbestos removal operations are performed. The area shall be isolated by physical boundaries to assist in the prevention of the uncontrolled access by non-qualified persons.
6. Asbestos Fibers: Those fibers having an aspect ratio of at least 3:1 and longer than-5 micrometers as determined by National Institute for Occupational Safety and Health (NIOSH) Method 7400.
7. Asbestos Permissible Exposure Limit: 0.1 fibers per cubic centimeter of air as an e-hour time weighted average measured in the breathing zone as by defined 29 CFR 1926.1101 or other Federal legislation having legal jurisdiction for the protection of workers health.
8. Background: The ambient airborne asbestos concentration in an uncontaminated area as measured prior to any asbestos hazard abatement efforts. Background concentrations for contaminated areas are measured in similar but asbestos free locations.
9. Contractor: The Contractor is that individual, or entity under contract to the Owner to perform the herein listed work.
10. Contractor/Supervisor (Asbestos abatement): A person who has successfully completed training and is therefore accredited as a Contractor/Supervisor under a State Model Accreditation Plan or EPA Model Accreditation Plan as described in 40 CFR 763.
11. Critical Barrier: The layer of polyethylene sheeting that covers an opening or penetration in a room or area that is to become a negative pressure enclosure.
12. Encapsulation: The abatement of an asbestos hazard through the appropriate use of chemical encapsulants.
13. Encapsulants: Specific materials in various forms used to chemically or physically entrap asbestos fibers in various configurations to prevent these fibers from becoming airborne. There are four types of encapsulants as follows which must comply with performance requirements as specified herein.
    a. Removal Encapsulant (can be used as a wetting agent)
    b. Bridging Encapsulant (used to provide a tough, durable surface coating to asbestos containing material)
    c. Penetrating Encapsulant (used to penetrate the asbestos containing material encapsulating all asbestos fibers and preventing fiber release due to routine mechanical damage)
    d. Lock-Down Encapsulant (used to seal off or "lock-down" minute asbestos fibers left on surfaces from which asbestos containing material has been removed).

14. Friable Asbestos Material: Any material containing more than one percent asbestos that can be crumbled, pulverized, or reduced to powder by hand pressure when dry.
15. Glovebag Technique: Those asbestos removal and control techniques put forth in 29 CFR 1926.1101.
16. HEPA Filter Equipment: High efficiency particulate air (HEPA) filtered vacuum and/or exhaust ventilation equipment with a filter system capable of collecting and retaining asbestos fibers. Filters shall retain 99.97 percent of particles 0.3 microns or larger as indicated in UL 586.
17. the Owner: That qualified person employed directly by the Owner to monitor, sample, inspect the work, and advise the Owner.
18. Negative Pressure Enclosure (NPE): That engineering control technique described as a negative pressure enclosure in 29 CFR 1926.1101.
19. Non-friable Asbestos Material: Material that contains asbestos in which the fibers have been immobilized by a bonding agent, coating, binder, or other material so that the asbestos is well bound and will not normally release asbestos fibers during any appropriate use, handling, storage or transportation. It is understood that asbestos fibers may be released under other conditions such as demolition, renovation, removal, or mishap.
20. Personal Sampling: Air sampling which is performed to determine asbestos fiber concentrations within the breathing zone of a specific employee, as performed in accordance with 29 CFR 1926.1101.
21. Competent Person (CP): A person who has successfully completed training and is therefore accredited under a legitimate State Model Accreditation Plan or EPA Model Accreditation Plan as described in 40 CFR 763 as a Contractor/Supervisor and shall be appropriately licensed according to the Statutes of the State in which the work is to be performed.
22. TEM: Refers to Transmission Electron Microscopy.
23. Time Weighted Average (TWA): The TWA is an 8-hour time weighted average airborne concentration of asbestos fibers.
24. Wetting Agent: A chemical added to water to reduce the water's surface tension thereby increasing the water's ability to soak into the material to which it is applied. An equivalent wetting agent must have a surface tension of at most 2.9 Pa 29 dynes per centimeter when tested in accordance with ASTM D 1331.

C. Requirements

1. Description of Work: The work covered by this section includes the handling and control of asbestos containing materials and describes some of the resultant procedures and equipment required to protect workers, the environment and occupants of the building or area, or both, from contact with airborne asbestos fibers. The work also includes the disposal of any asbestos containing materials generated by the work. More specific operational procedures shall be outlined in the Asbestos Hazard Abatement Plan called for elsewhere in this specification. The asbestos work includes the use of non-friable removal technique(s) which is governed by 40 CFR 763 as indicated. Provide non-friable removal technique(s) as outlined in this specification for the locations indicated.
2. Medical Requirements: Provide medical requirements including but not limited to medical surveillance and medical record keeping as listed in 29 CFR 1926.1101.
   a. Medical Examinations: Before exposure to airborne asbestos fibers, provide workers with a comprehensive medical examination as required by 29 CFR 1926.1101 or other pertinent State or local directives. This requirement must have been satisfied within the 12 months prior to the start of work on this contract. The same medical examination shall be given on an annual basis to employees engaged in an occupation involving asbestos and within 30 calendar days before or after the termination of employment in such occupation. Specifically identify x-ray films of asbestos workers to the consulting radiologist and mark medical record jackets with the word "ASBESTOS."
   b. Medical Records: Maintain complete and accurate records of employees' medical examinations, medical records, and exposure data for a period of 30 years after termination of employment and make records of the required medical examinations and

exposure data available for inspection and copying to: The Assistant Secretary of Labor for Occupational Safety and Health (OSHA), or authorized representatives of them, and an employee's physician upon the request of the employee or former employee.

c. Medical Certification: Submit written certification for each worker and contractor/supervisor, signed by a licensed physician indicating that the worker and contractor/supervisor has met or exceeded all of the medical prerequisites listed herein and in 29 CFR 1926.1101 and 29 CFR 1910.134 as prescribed by law.

3. Training: Train all personnel involved in the asbestos control work in accordance with United States Environmental Protection Agency (USEPA) Asbestos Hazard Emergency Response Act (AHERA) training criteria or State training criteria whichever is more stringent. The Contractor shall document the training by providing a copy of a current training certification to the the Owner for each person assigned to work on this project. Furnish each employee with respirator training and fit testing documentation as required by 29 CFR 1910.134. Provide instruction on the engineering and other hazard control techniques and procedures to be used on this project.

a. Employee Training: Submit copies of training certificates for each employee indicating that the employee has received training at the appropriate level in accordance with 40 CFR 763.

4. Permits, Licenses, and Notifications: Notify the local air pollution control district/agency and the the Owner in writing 10 working days prior to commencement of work in accordance with 40 CFR 61-SUBPART M or applicable state and local regulations. Obtain necessary permits or licenses in conjunction with asbestos removal, encapsulation, hauling, and disposal. Post the permit and/or license at the work site, visible from a non-controlled area. Notify the local fire department 3 days prior to removing fire-proofing material from the building including notice that the material contains asbestos.

5. Environment, Safety and Health Compliance: Comply with the applicable requirements of the current issue of 29 CFR 1926.1101, 40 CFR 61-SUBPART A, and 40 CFR 61-SUBPART M or applicable State or local regulations regarding handling, storing, transporting, and disposing of asbestos waste materials. Submit matters of interpretation of standards to the appropriate administrative agency for resolution before starting the work. Where the requirements of this specification, applicable regulations, or referenced documents vary, the most stringent requirement shall apply.

a. Site Inspection: While performing asbestos engineering control work, the Contractor shall be subject to on-site inspection by the Federal, State, or local regulatory agencies and the Contracting Officer or its designated representative. If the work is found to be in violation of Federal, State, or local regulations or this specification, the Contracting Officer or its representative will issue a stop work order to be in effect immediately and until the violation is resolved. All related costs including standby time required to resolve the. violation shall be at the Contractor's expense.

6. Respiratory Protection Program: Establish and implement a respirator program as required by ANSI 288.2 and 29 CFR 1910.134. Submit a written program manual or operating procedure including methods of compliance with regulatory statutes.

a. Respirator Program Records: Submit records of the respirator program as required by ANSI 288.2 and 29 CFR 1910.134.

7. Contractor/Supervisor (Asbestos Abatement): The Contractor shall be represented on-site by a trained contractor/Supervisor. This person shall be on-site at all times when asbestos work is in progress. The Qualified Person, as defined herein, can be the Contractor/Supervisor.

8. Hazard Communication: Adhere to all parts of 29 CFR 1910.1200 and 29 CFR 1926.59. Provide the Contracting Officer with a copy of the Material Safety Data Sheets (MSDS) for all materials brought to the site. Review the Asbestos Survey Report(s) provided by the the Owner, if any.

9. Asbestos Hazard Abatement Plan: Submit a detailed plan of the safety precautions such as lockout, tag-out, tryout, fall protection, and confined space entry procedures and equipment and work procedures to be used in the removal of materials containing asbestos. The plan shall be prepared by the Contractor (and reviewed and signed by an asbestos consultant (LAC) licensed according to the Statutes of the State in which the work is to be performed) for review and

recommendation for approval by the the Owner. The plan shall be forwarded to the the Owner for final approval at least 10 days prior to beginning abatement activities. The plan shall include but not be limited to the detailed description of personal protective equipment and work practices to be used including, but not limited to, respiratory protection, type of whole-body protection , the location of asbestos control areas including clean and dirty areas, buffer zones, showers, storage areas, change rooms, removal method, interface of trades involved in the construction, sequencing of asbestos related work, disposal plan, type of wetting agent and asbestos encapsulant to be used, locations of local exhaust equipment, planned air sampling strategies, and a detailed description of the method to be employed in order to control environmental pollution. The plan shall also include both fire and medical emergency response plans. The Asbestos Hazard Abatement Plan must be approved in writing prior to starting any asbestos work.

10. Testing Laboratory: Submit the name, address, and telephone number of each testing laboratory selected for the sampling, analysis, and reporting of airborne concentrations of asbestos fibers along with evidence that each laboratory selected holds the appropriate State license and/or permits and certification that each laboratory is American Industrial Hygiene Association (AIHA) accredited and that persons counting the samples have been judged proficient by current inclusion on the AIHA Asbestos Analysis Registry (AAR) and successful participation of the laboratory in the Proficiency Analytical Testing (PAT) Program. Where analysis to determine asbestos content in bulk materials or transmission electron microscopy is required, submit evidence that the laboratory is accredited by the National Institute of Science and Technology (NIST) under National Voluntary Laboratory Accreditation Program (NVLAP) for asbestos analysis.
11. Landfill Approval: Submit written evidence that the landfill for disposal is approved for asbestos disposal by the USEPA and State and local regulatory agency(s).
12. Waste Shipment Records/Asbestos Waste Manifest: Submit waste shipment records and/or asbestos manifest records, prepared in accordance with applicable Federal, State, or local regulations, signed and dated by an agent of the landfill, certifying the amount of asbestos materials delivered to the landfill, within 3 days after delivery.
13. Negative Exposure Assessment: Submit objective data demonstrating that the method(s) used for the specified non-friable ACM removal does not release airborne concentrations of asbestos fibers exceeding the TWA PEL or excursion limit. This data may be from previous work within the last 12 months or from initial exposure assessments on this project. Data from previous work must have been gathered by the firm employed on this contract, using workers trained to the same level, with the ACM and workplace conditions "closely resembling" the conditions for this contract.
14. Contractor Daily Reports: Prepare a written report for each day that asbestos work is being accomplished. The report should be submitted to the the Owner monthly. The report as a minimum shall include the following, where applicable:
    a. Daily Visual Inspection Reports: Prepare a written report documenting compliance with the Asbestos Hazard Abatement Plan and Federal, State, or local regulations.
    b. Air Sampling Reports: Complete fiber counting within 24 hours of the "time off" of the sample pump. Notify the the Owner immediately of any airborne levels of asbestos fibers in excess of the acceptable limits. Sampling results shall be submitted to the the Owner the day following receipt. The affected employees will be provided copies of the results where required by law within 3 working days. These results shall be signed by the air sampler and the testing laboratory employee that analyzed the sample.
    c. Pressure Differential Recordings for Local Exhaust System-Not Used
    d. Asbestos Disposal Quantity Report: The Contractor shall record and report daily the amount of asbestos containing material removed and the amount transported for disposal. Deliver the report for the previous day and cumulative totals with amounts of material removed reported in linear meters or square meters linear feet or square feet as described initially in this specification and the amounts of material transported for disposal reported in cubic meters yards.

D. Submittals
   1. Submit the following in accordance with Section "Submittal Procedures."
      a. Vacuums and tools
      b. Respirators
      c. Wetting Agent
      d. Material Safety Data Sheets (MSDS) for all materials proposed for transport to the project site
      e. Local exhaust system
      f. Pressure differential automatic recording instrument
      g. Daily Reports
      h. Asbestos hazard abatement plan
      i. Testing laboratory
      j. Training Certificates
      k. Landfill approval
      l. Employee training
      m. Medical certification requirements
      n. Waste shipment records/Asbestos waste manifest
      o. Respiratory Protection Program
      p. Negative Exposure Assessment
      q. Local Exhaust system
      r. Show compliance with ANSI Z9.2 by providing manufacturers' certifications.
      s. Permits, licenses, and Notifications
      t. Rental equipment
      u. Respirator program records
      v. Protective clothing decontamination quality control records
      w. Protective clothing decontamination facility notification.

E. Quality Assurance
   1. Glovebags-Not Used
   2. Rental Equipment: Provide a copy of the written notification to the rental company concerning the intended use of the equipment and the possibility of asbestos contamination of the equipment.
   3. Protective Clothing Decontamination Quality Control Records: Provide all records that document quality control for the decontamination of reusable outer protective clothing.
   4. Protective Clothing Decontamination Facility Notification: Submit written evidence that persons who decontaminate, store, or transport asbestos contaminated clothing used in the performance of this contract were duly notified in accordance with 29 CFR 1926.1101.

1.2 PRODUCTS

A. Encapsulants
   1. See Division 21 Section "Facility Fire-suppression Water-service Piping".

1.3 EXECUTION

A. Equipment
   1. Respirators: Select respirators from those approved by the National Institute for Occupational Safety and Health (NIOSH). Provide personnel engaged in pre-cleaning, cleanup, handling, and removal of asbestos containing materials with the appropriate respiratory protection as specified in 29 CFR 1910.134.
   2. Exterior Whole Body Protection

a. Outer Protective Clothing: Provide personnel exposed to asbestos with disposable "non-breathable," or reusable "non-breathable" whole body outer protective clothing, head coverings, gloves, and foot coverings. Provide disposable plastic or rubber gloves to protect hands. Cloth gloves may be worn inside the plastic or rubber gloves for comfort, but shall not be used alone. Make sleeves secure at the wrists, make foot coverings secure at the ankles, and make clothing secure at the neck by the use of tape. Reusable whole body outer protective clothing shall be either disposed of as asbestos contaminated waste upon exiting from the asbestos regulated work area or be properly decontaminated.

b. Work Clothing-Not Used

c. Decontamination of Reusable Outer Protective Clothing: When reusable outer protective clothing is used, transport the double bagged clothing to a previously notified commercial/industrial decontamination facility for decontamination. Perform non-destructive testing to determine the effectiveness of asbestos decontamination. If representative sampling is used, ensure the statistical validity of the sampling results. If representative sampling is used, reject any entire batch in which any of the pieces exceed 40 fibers per square millimeter. Inspect reusable protective clothing prior to use to ensure that it will provide adequate protection and is not or is not about to become ripped, torn, deteriorated, or damaged, and that it is not visibly contaminated. Notify, in writing, all personnel involved in the decontamination of reusable outer protective clothing as indicated in 29 CFR 1926.1101.

d. Eye Protection: Provide goggles to personnel engaged in asbestos abatement operations when the use of a full face respirator is not required.

3. Warning Signs and Labels: Provide bilingual warning signs printed in English and Spanish at all approaches to asbestos control areas. Locate signs at such a distance that personnel may read the sign and take the necessary protective steps required before entering the area. Provide labels and affix to all asbestos materials, scrap, waste, debris, and other products contaminated with asbestos.

a. Warning Sign: Provide vertical format conforming to 29 CFR 1926.1101 minimum 20 by 14 inches (500 by 355 mm) displaying the following legend in the lower panel:

DANGER
ASBESTOS
MAY CAUSE CANCER
CAUSES DAMAGE TO LUNGS
AUTHORIZED PERSONNEL ONLY
WEAR RESPIRATORY PROTECTION AND
PROTECTIVE CLOTHING IN THIS AREA

b. Warning Labels: Provide labels conforming to 29 CFR 1926.1101 of sufficient size to be clearly legible, displaying the following legend:

DANGER
CONTAINS ASBESTOS FIBERS
MAY CAUSE CANCER
CAUSES DAMAGE TO LUNGS
DO NOT BREATHE DUST
AVOID CREATING DUST

c. Provide the following asbestos labels, of sufficient size to be clearly legible, for display on waste containers (bags or drums) which will be used to transport asbestos contaminated material in accordance with United States Department of Transportation 49 CFR Parts 171 and 172.

NA2212, (WASTE) ASBESTOS, 9, PGIII

4. Vacuums and Tools: Vacuums shall be leak proof to the filter and equipped with HEPA filters. Filters on vacuums shall conform to ANSI Z9.2 and UL 586. Do not use power tools to remove asbestos containing materials unless the tool is equipped with effective, integral HEPA filtered exhaust ventilation systems. Remove all residual asbestos from reusable tools prior to storage or reuse.

B. General
   1. Pre-Asbestos Work Conference: The Contractor and the Contractor/Supervisor shall meet with the Contracting officer prior to beginning work, to discuss in detail the Asbestos Hazard Abatement Plan, including work procedures and safety precautions. Once approved by the Owners Engineer, the plan will be enforced as if a part of this specification. Any changes required in the specification as a result of the plan shall be identified specifically in the plan to allow for free discussion and approval by the Owners Engineer prior to starting work.
   2. Asbestos Control Area Requirements: The Contractor shall demarcate the asbestos control area(s) using physical barriers and signs to prevent access by unauthorized personnel. This area is defined by 29 CFR 1926.1101 as the regulated area.
   3. Work Procedure: Perform asbestos related work in accordance with 29 CFR 1926.1101, 40 CFR 61-SUBPART M, applicable State or local regulation, and as specified herein. Use wet removal procedures. Personnel shall wear and utilize protective clothing and equipment as specified herein. Eating, smoking, drinking, chewing gum or tobacco, or applying cosmetics shall not be permitted in the asbestos control area(s). Personnel of other trades not engaged in the removal of asbestos containing material shall not be exposed at any time to airborne concentrations of asbestos. If an asbestos fiber release or spill, stop work immediately, correct the condition to the satisfaction of the Owners Engineer, including clean-up and clearance sampling, if appropriate, prior to resumption of work.
   4. Furnishings: Furniture will be removed from the area of work by the Owner before asbestos work begins.
   5. Pre-cleaning: Wet wipe and HEPA vacuum all surfaces potentially contaminated with asbestos prior to establishment of an enclosure.

C. Removal Procedures: Wet asbestos containing material with a fine spray of amended water during removal, cutting, or other handling so as to reduce the emission of airborne fibers. Remove material and immediately place in 0.15 mm 6 mil plastic disposal bags. Remove asbestos containing material in a gradual manner, with continuous application of the amended water in such a manner that no asbestos material is disturbed prior to being adequately wetted. Where unusual circumstances prohibit the use of 0.15 mm 6 mil plastic bags, submit an alternate proposal for containment of asbestos fibers to the Owner's Engineer for approval. Asbestos containing material shall be containerized while wet. At no time shall asbestos containing material be allowed to accumulate or become dry. Handle asbestos containing material as indicated in 40 CFR 61-SUBPART M, applicable State or local regulation, and 29 CFR 1926.1101.
   1. Exposed Pipe Insulation Edges-Not Used
   2. Negative Pressure Enclosure: Block and seal openings in areas where the release of airborne asbestos fibers can be expected. Establish an asbestos negative pressure enclosure with the use of curtains, portable partitions, or other enclosures in order to prevent the escape of asbestos fibers from the contaminated asbestos work area.
      a. Personnel/Equipment Decontamination Unit: Provide a temporary facility with a separate equipment/dirty change room and clean change room. Provide a shower that complies with 29 CFR 1926.51 in between the dirty room and clean room for personnel required to wear whole body protective clothing. Provide two separate lockers for each asbestos worker, one in each locker room. Keep street clothing and street shoes in the clean locker. HEPA

vacuum and remove asbestos contaminated disposable protective clothing while still wearing respirators at the boundary of the asbestos work area and seal in impermeable bags or containers for disposal. Do not wear work clothing between home and work. All employees shall shower before changing into street clothes. Collect used shower water and filter with approved water filtration equipment to remove asbestos contamination. Dispose of filters and residue as asbestos waste. Discharge clean water to the sanitary system. Dispose of asbestos contaminated work clothing as asbestos contaminated waste or properly decontaminate as specified in the Asbestos Hazard Abatement Plan.

b. Waste Load-Out Unit: Provide a separate temporary area expressly for short-term storage of bagged asbestos containing material that is ready for disposal. The unit shall be the only port used to transfer waste to a truck, dumpster, or other approved on-site storage facility. It shall not be used for personnel egress. A waste load-out unit shall be integral to each negative pressure enclosure.

3. Non-friable Removal Procedures:

a. Under normal conditions EPA Category II, non-friable asbestos containing materials may not be considered hazardous; however, this material may release airborne asbestos fibers during demolition and removal; therefore it must be handled in a manner to prevent the release of asbestos fibers. At no time will this material be mechanically chipped, sawed, sanded, or ground.

b. Prior to beginning removal, establish an Asbestos Control Area and install Critical Barriers as specified elsewhere in this section. Submit a Negative Exposure Assessment which is less than 12 months old to the the Owner for approval or conduct air sampling as specified elsewhere in this section to establish the exposure levels for the exact removal method being used. The Contractor will establish the correct level of Personal Protective Equipment required.

c. Acceptable methods of removal include, but are not limited to, the use of dry ice, a heat gun or lamp, citrus-based solvents, and hand tools with amended water. Removal shall be accomplished to keep the ACM substantially intact. Breakage into small pieces is an unacceptable work practice. The method shall-be detailed in the Asbestos Abatement Plan and shall not be changed during the removal without Contracting Officer approval.

d. Upon completion of the removal and clean-up, but prior to removal of critical barriers, the Contractor Testing company shall conduct a visual inspection of all areas affected by the removal. Re-clean as required.

D. Field Quality Control Requirements

1. Visual Inspections: The the Owner will conduct periodic inspections of all areas where asbestos removal and activities are in progress to ensure compliance with the approved Asbestos Hazard Abatement Plan and Federal/State regulatory requirements. This inspection shall include confirmation of proper control/containment/enclosure, worker protection, housekeeping, exhaust equipment operation, decontamination procedures, proper wetting and disposal, and inspection of work progress and work practices. Each activity will be documented as acceptable or noted as unacceptable with justification for the non-compliance.

2. Air Sampling: Sampling of airborne concentrations of asbestos fibers shall be performed in accordance with 29 CFR 1926.1101 and as specified herein. Unless otherwise specified, use NIOSH Method 7400 for sampling and analysis. Air Sampling may be duplicated by the Government at the discretion of the Contracting Officer. If the air sampling results obtained by the Government differ from those results obtained by the Contractor, the Government will determine which results predominate.

a. Sampling Prior to Asbestos Work (Not Used)

b. Sampling During Asbestos Work

1) The Contractor's testing company shall perform area sampling as indicated in 29 CFR 1926.1101 and governing environmental regulations. Perform area sampling at least once every week close to the work inside the enclosure, outside the personnel/equipment decontamination unit entrance to the enclosure.

2) If sampling outside the enclosure shows airborne levels have exceeded background or 0.01 fibers per cubic centimeter, whichever is greater, stop all work, correct the condition(s) causing the fiber release, and notify the the Owner immediately. Determine by testing if adjacent areas are contaminated. If so the Contractor shall clean the contaminated areas, visually inspect, and sample the areas as specified herein.

3) The Contractor shall conduct personal sampling of at least 25% of the workers engaged in asbestos handling (removal, disposal, transport and other associated work) throughout the duration of the project. If the quantity of airborne asbestos fibers monitored at the breathing zone of the workers at any time exceeds 0.1 fibers per cubic centimeter, notify the PQP immediately, evaluate work practices, and take corrective action to reduce airborne asbestos fibers.

E. Clean-Up And Disposal

1. Housekeeping

a. Essential parts of asbestos dust control are housekeeping and clean-up procedures. Maintain surfaces of the asbestos control area free of accumulations of asbestos fibers. Give meticulous attention to restricting the spread of dust and debris; keep waste from being distributed over the general area. Use HEPA filtered vacuum cleaners. DO NOT BLOW DOWN THE SPACE WITH COMPRESSED AIR. All asbestos waste shall be placed in an approved on-site storage facility or transported for disposal daily. When asbestos removal is complete, all asbestos waste is removed from the work-site, and final clean-up is completed, the PQP shall visually inspect the asbestos control area for cleanliness. After final clean-up and acceptable pre-clearance airborne concentrations are attained but before the local exhaust system is turned off and the negative pressure enclosure removed), remove all pre-filters on the building HVAC system and provide new pre-filters.

b. Dispose of filters as asbestos contaminated materials. Reestablish HVAC,. mechanical, and electrical systems in proper working order.

2. Title to Materials: All waste materials, except as specified otherwise, shall become the property of the Contractor and shall be disposed of as specified in applicable Federal, State, and local regulations and herein.

3. Disposal of Asbestos

a. Collect all removed asbestos containing material, contaminated materials, contaminated water, scrap, debris, bags, containers, expendable equipment, and asbestos contaminated clothing which may produce airborne asbestos fibers and place in sealed fiber-proof, waterproof, non-returnable containers (e.g. double plastic bags 0.15 mm 6 mils thick, cartons, drums or cans). Wastes within the containers must be adequately wet in accordance with 40 CFR 61-SUBPART M. Affix a warning and Department of Transportation (DOT) label to each container including the bags or use at least 0.15 mm 6 mils thick bags with the approved warnings and DOT labeling preprinted on the bag.

b. Each container or bag shall clearly indicate that the waste generator is the Owner and the development at which the waste is generated, and the Job Order number of the project.

c. Prevent contamination of the transport vehicle (especially if the transport vehicle is a rented truck likely to be used in the future for non-asbestos purposes). These precautions include lining the vehicle cargo area with plastic sheeting (similar to work area enclosure) and thorough cleaning of the cargo area after transport and unloading of asbestos debris is complete. Dispose of waste asbestos material at an Environmental Protection Agency (EPA) or State-approved asbestos landfill off the Owner's property. For temporary storage, store sealed impermeable bags in asbestos waste drums or skids. An area for interim storage of asbestos waste-containing drums or skids will be coordinated with the the Owner. Procedure for hauling and disposal shall comply with 40 CFR 61-SUBPART M, State, regional, and local standards. Sealed plastic bags may be dumped from drums into the burial site unless the bags have been broken or damaged. Damaged bags shall remain in the drum and the entire contaminated drum shall be buried. Uncontaminated drums may be recycled. Workers unloading the sealed drums shall wear appropriate respirators and personal protective equipment when handling asbestos materials at the disposal site.

END OF SECTION 02 82 33 00

SECTION 02 82 33 00a - REMOVAL AND DISPOSAL OF LEAD-CONTAINING PAINT

1.1 GENERAL

A. Description Of Work

1. This specification covers the removal and disposal of lead-based or lead-containing paint. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Definitions

1. Action Level: Employee exposure, without regard to use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air averaged over an 8 hour period in an occupational/industrial environment.
2. Area Sampling: Sampling of lead concentrations within the lead control area and inside the physical boundaries which is representative of the airborne lead concentrations but is not collected in the breathing zone of personnel.
3. Competent Person (CP): As used in this section, refers to a person employed by the Contractor who is trained in the recognition and control of lead hazards in accordance with current federal, State, and local regulations. An industrial hygienist or safety professional certified for comprehensive practice by the American Board of Industrial Hygiene or by the Board of Certified Safety Professionals is the best choice.
4. Contaminated Room: Room for removal of contaminated personal protective equipment (PPE).
5. Decontamination Shower Facility: That facility that encompasses a clean clothing storage room, and a contaminated clothing storage and disposal rooms, with a shower facility in between.
6. Eight-Hour Time Weighted Average (TWA): Airborne concentration of lead to which an employee is exposed, averaged over an 8 hour workday as indicated in 29 CFR 1926.62.
7. High Efficiency Particulate Air (HEPA) Filter Equipment: HEPA filtered vacuuming equipment with a UL 586 filter system capable of collecting and retaining lead-contaminated paint dust. A high efficiency particulate filter means 99.97 percent efficient against 0.3 micron or larger size particles.
8. Lead: Metallic lead, inorganic lead compounds, and organic lead soaps.
9. Lead-Based Paint (LBP): Paint or other surface coating that contains lead in excess of 1.0 milligrams per centimeter squared or 0.5 percent by weight.
10. Lead-Based Paint Hazard (LBP Hazard): Any condition that causes exposure to lead from lead-contaminated dust, lead-contaminated soil, lead-based paint that is deteriorated or present in accessible surfaces, friction surfaces, or impact surfaces that would result in adverse human health effects.
11. Lead-Containing Paint (LCP): Lead-based paint or other similar surface coating containing lead or lead compound in excess of 0.06 percent by weight of the total nonvolatile content of the paint.
12. Lead Control Area: An enclosed area or structure, constructed as a temporary containment equipped with HEPA filtered local exhaust, which prevents the spread of lead dust, paint chips, or debris existing as a condition of lead-based paint removal operations. The lead control area is also isolated by physical boundaries to prevent unauthorized entry of personnel.
13. Lead Permissible Exposure Limit (PEL): Fifty micrograms per cubic meter of air as an 8 hour time weighted average as determined by 29 CFR 1926.62. If an employee is exposed for more than eight hours in a work day, the PEL shall be determined by the following formula:

    PEL (micrograms/cubic meter of air) = 400/No. hrs. worked per day.
14. Personal Sampling: Sampling of airborne lead concentrations within the breathing zone of an employee to determine the 8 hour time weighted average concentration in accordance with 29 CFR 1926.62. Samples shall be representative of the employees' work tasks. Breathing zone shall be considered an area within a hemisphere, forward of the shoulders, with a radius of 6 to 9 inches (150 to 225 mm) and centered at the nose or mouth of an employee.

15. Physical Boundary: Area physically roped or partitioned off around an enclosed lead control area to limit unauthorized entry of personnel. As used in this section, "inside boundary" shall mean the same as "outside lead control area but inside boundary."

C. Submittals: Submit the following:
1. Product Data:
   a. Vacuum filters
   b. Respirators
2. Test Reports
   a. Sampling results
   b. Assessment data report
3. Certificates
   a. Qualifications of CP
   b. Testing laboratory</SUB> qualifications
   c. Third party consultant qualifications
   d. Lead-Based Paint/Lead-Containing Paint Removal Plan including CP approval (signature, date, and certification number)
   e. Rental equipment notification
   f. Respiratory protection program
   g. Hazard communication program
   h. EPA approved hazardous waste treatment or disposal facility for lead disposal
   i. Hazardous waste management plan
   j. Vacuum filters
4. Manufacturer's Instructions
   a. Chemicals and equipment
   b. Materials
   c. Material safety data sheets for all chemicals
5. Closeout Submittals
   a. Completed and signed hazardous waste manifest from treatment or disposal facility
   b. Certification of medical examinations
   c. Employee training certification

D. Qualifications Of CP
1. Submit name, address, and telephone number of the CP selected to perform responsibilities specified in paragraph entitled "Competent Person (CP) Responsibilities." Provide previous experience of the CP. Submit proper documentation that the CP is trained and licensed and certified in accordance with Federal, State, and local laws.

E. Third Party Consultant Qualifications
1. Submit the name, address, and telephone number of the third party consultant selected to perform the wipe sampling for determining concentrations of lead in dust or soil sampling. Submit proper documentation that the consultant is trained and certified as an inspector technician or inspector/risk assessor by the USEPA authorized State (or local) certification and accreditation program.

F. Testing Laboratory
1. Submit the name, address, and telephone number of the testing laboratory selected to perform the air and wipe and soil sampling, testing, and reporting of airborne concentrations of lead. Use a laboratory accredited under the EPA National Lead Laboratory Accreditation Program (NLLAP) by either the American Association for Laboratory Accreditation (A2LA) or the American Industrial Hygiene Association (AIHA) and that is successfully participating in the Environmental Lead Proficiency Analytical Testing (ELPAT) program to perform sample analysis.

G. Lead-Based Paint/Lead-Containing Paint Removal Plan (LBP/LCPRP)

1. Submit a detailed job-specific plan of the work procedures to be used in the removal of LBP/LCP. The plan shall include a sketch showing the location, size, and details of lead control areas, location and details of decontamination facilities, viewing ports, and mechanical ventilation system. Include in the plan, eating, drinking, smoking and sanitary procedures, interface of trades, sequencing of lead related work, collected waste water and paint debris disposal plan, air sampling plan, respirators, personal protective equipment, and a detailed description of the method of containment of the operation to ensure that airborne lead concentrations of 30 micrograms per cubic meter of air and baseline lead dust/soil concentrations are not reached or exceeded outside of the lead control area. Include site preparation and cleanup procedures. Include occupational and environmental sampling, training and strategy, sampling methodology, frequency, duration of sampling, and qualifications of sampling personnel in the air sampling portion of the plan.

H. Occupational And Environmental Sampling Results
1. Submit occupational and environmental sampling results to the the Owner within three working days of collection, signed by the testing laboratory responsible official, the employee that performed the sampling, and the CP.
   a. The sampling results shall represent each job classification, or if working conditions are similar to previous jobs by the same employer, provide previously collected exposure data that can be used to estimate worker exposures in accordance with 29 CFR 1926.62. The data shall represent the worker's regular daily exposure to lead.
   b. Submit worker exposure data conducted during the task based trigger operations of 29 CFR 1926.62.
   c. The initial monitoring shall determine the requirements for further monitoring and the need to fully implement the control and protective requirements including the compliance program (LBP/LCP) in accordance with 29 CFR 1926.62.

I. Occupational And Environmental Assessment Data Report:
1. Some LBP/LCP removal work may not require full implementation of the requirements of 29 CFR 1926.62. Based on the experience of the Contractor and/or the use of a specific process or method for performing the work, the Contractor may be able to provide historic data (previous 12 months) to demonstrate that airborne exposures are controlled below the action level. Such methods or controls shall be fully presented in the LBP/LCPRP. To reduce the full implementation of 29 CFR 1926.62, the Contractor shall provide documentation in an Assessment Data Report.
2. Submit occupational and environmental assessment report to the the Owner prior to start of work, signed by the testing laboratory responsible official, and the CP.
   a. Submit a report that supports the determination regarding the reduction of the need to fully implement the requirements of 29 CFR 1926.62 and supporting the LBP/LCP. The exposure assessment shall represent each job classification, or if working conditions are similar to previous jobs by the same employer, provide previously collected exposure data that can be used to estimate worker exposures in accordance with 29 CFR 1926.62. The data shall represent the worker's regular daily exposure to lead for stated work.
   b. Submit worker exposure data conducted during the task based trigger operations of 29 CFR 1926.62 with a complete process description in supporting a negative assessment.
   c. The initial assessment shall determine the requirement for further monitoring and the need to fully implement the control and protective requirements including the compliance program (LBP/LCPRP) in accordance with 29 CFR 1926.62.

J. Quality Assurance
1. Medical Examinations: Initial medical surveillance as required by 29 CFR 1926.62 shall be made available to all employees exposed to lead at any time (1 day) above the action level. Full medical surveillance shall be made available to all employees on an annual basis who are or may be exposed to lead in excess of the action level for more than 30 days a year or as required by 29 CFR 1926.62. Adequate records shall show that employees meet the medical surveillance requirements of 29 CFR 1926.33, 29 CFR 1926.62, and 29 CFR 1926.103.

a. Medical Records: Maintain complete and accurate medical records of employees for a period of at least 30 years or for the duration of employment plus 30 years, whichever is longer.
b. Medical Surveillance: Provide medical surveillance to all personnel exposed to lead as indicated in 29 CFR 1926.62.

2. Competent Person (CP) Responsibilities
   a. Certify training as meeting all federal, State, and local requirements.
   b. Review and approve lead-based paint/lead-containing paint removal plan for conformance to the applicable referenced standards.
   c. Continuously inspect lead-based paint removal work for conformance with the approved plan.
   d. Perform air and wipe sampling.
   e. Ensure work is performed in strict accordance with specifications at all times.
   f. Control work to prevent hazardous exposure to human beings and to the environment at all times.
   g. Certify the conditions of the work as called for elsewhere in this specification.
3. Training: Train each employee performing paint removal, disposal, and air sampling operations prior to the time of initial job assignment and annually thereafter, in accordance with 29 CFR 1926.21, 29 CFR 1926.62, and State and local regulations.
   a. Training Certification: Submit a certificate for each employee, signed and dated by the approved training source, stating that the employee has received the required lead training.
4. Respiratory Protection Program
   a. Furnish each employee required to wear a negative pressure respirator or other appropriate type with a respirator fit test at the time of initial fitting and at least annually thereafter as required by 29 CFR 1926.62.
   b. Establish and implement a respiratory protection program as required by ANSI Z88.2, 29 CFR 1926.103, 29 CFR 1926.62, and 29 CFR 1926.55.
5. Hazard Communication Program: Establish and implement a Hazard Communication Program as required by 29 CFR 1926.59.
6. Hazardous Waste Management: The Hazardous Waste Management Plan shall comply with applicable requirements of federal, State, and local hazardous waste regulations and address:
   a. Identification and classification of hazardous wastes associated with the work.
   b. Estimated quantities of wastes to be generated and disposed of.
   c. Names and qualifications of each contractor that will be transporting, storing, treating, and disposing of the wastes. Include the facility location and operator and a 24-hour point of contact. Furnish two copies of EPA, or State and local hazardous waste permit applications or permits or manifests, as required, and EPA Identification numbers.
   d. Names and qualifications (experience and training) of personnel who will be working on-site with hazardous wastes.
   e. List of waste handling equipment to be used in performing the work, to include cleaning, volume reduction, and transport equipment.
   f. Spill prevention, containment, and cleanup contingency measures including a health and safety plan to be implemented in accordance with 29 CFR 1926.65.
   g. Work plan and schedule for waste containment, removal and disposal. Wastes shall be cleaned up and containerized daily.
   h. Unit cost for hazardous waste disposal according to this plan.
7. Environmental, Safety and Health Compliance: In addition to the detailed requirements of this specification, comply with laws, ordinances, rules, and regulations of Federal, State, and local authorities regarding removing, handling, storing, transporting, and disposing of lead waste materials. Comply with the applicable requirements of the current issue of 29 CFR 1926.62. Submit matters regarding interpretation of standards to the the Owner for resolution before starting work. Where specification requirements and the referenced documents vary, the most stringent requirement shall apply.

8. Pre-Construction Conference: Along with the CP, meet with the the Owner to discuss in detail the hazardous waste management plan and the lead-based paint/lead-containing paint removal plan, including work procedures and precautions for the removal plan.

K. Equipment
1. Respirators: Furnish appropriate respirators approved by the National Institute for Occupational Safety and Health (NIOSH), Department of Health and Human Services, for use in atmospheres containing lead dust. Respirators shall comply with the requirements of 29 CFR 1926.62.
2. Special Protective Clothing: Furnish personnel who will be exposed to lead-contaminated dust with proper disposable uncontaminated, reusable protective whole body clothing, head covering, gloves, and foot coverings as required by 29 CFR 1926.62. Furnish proper disposable plastic or rubber gloves to protect hands. Reduce the level of protection only after obtaining approval from the CP.
3. Rental Equipment Notification: If rental equipment is to be used during lead-based paint handling and disposal, notify the rental agency in writing concerning the intended use of the equipment. Furnish a copy of the written notification to the the Owner.
4. Vacuum Filters: UL 586 labeled HEPA filters.
5. Equipment for Owner's Personnel: Furnish the the Owner with two complete sets of personal protective equipment (PPE) daily, as required herein, for entry into and inspection of the paint removal work within the lead controlled area. Personal protective equipment shall include disposable whole body covering, including appropriate foot, head, and hand protection. PPE shall remain the property of the Contractor. Respiratory protection for the the Owner will be provided by the Owner.

L. Removal
1. Title to Materials: Materials resulting from demolition work, except as specified otherwise, shall become the property of the Contractor and shall be disposed of in accordance with Division 02 Section(s) "Selective Structure Demolition" OR "Structure Demolition", except as specified herein.

1.2 PRODUCT

A. Chemicals
1. Submit applicable Material Safety Data Sheets for all chemicals used in paint removal work. Use the least toxic product approved by the the Owner.

B. Materials
1. The soluble metal content and the total metal content shall not exceed values which would cause a material to be classified as a hazardous waste.

1.3 EXECUTION

A. Protection
1. Notification: Notify the the Owner 20 days prior to the start of any paint removal work.
2. Lead Control Area Requirements
   a. If LBP will be removed by means which will not likely create airborne, lead-containing dust (such as careful wet scraping or chemical stripping), establish a lead control area by situating critical barriers and physical boundaries around the area or structure where LBP/LCP removal operations will be performed.
   b. If removal practice will create airborne, lead-containing dust (such as sanding, abrasive blasting, thermal cutting, demolition, or needle gun use), utilize full containment procedures - Contain removal operations by the use of critical barriers and HEPA filtered exhaust **OR** a negative pressure enclosure system with decontamination facilities and with HEPA filtered exhaust if required by the CP, **as directed**. For containment areas larger than 1,000 square feet (100 square meters) install a minimum of two 18 inch (450 mm) square viewing

ports. Locate ports to provide a view of the required work from the exterior of the enclosed contaminated area. Glaze ports with laminated safety glass.

3. Protection of Existing Work to Remain: Perform paint removal work without damage or contamination of adjacent areas. Where existing work is damaged or contaminated, restore work to its original condition or better.
4. Boundary Requirements: Provide physical boundaries around the lead control area by roping off the area designated in the work plan or providing curtains, portable partitions or other enclosures to ensure that airborne concentrations of lead will not reach 30 micrograms per cubic meter of air outside of the lead control area.
    a. Physical Boundary: Provide physical boundaries around the lead control area by roping off the area designated in the work plan or providing curtains, portable partitions or other enclosures to ensure that airborne concentrations of lead will not reach 30 micrograms per cubic meter of air outside of the lead control area.
    b. Warning Signs: Provide warning signs at approaches to lead control areas. Locate signs at such a distance that personnel may read the sign and take the necessary precautions before entering the area. Signs shall comply with the requirements of 29 CFR 1926.62.
5. Furnishings:
    a. The Owner will remove furniture and equipment from the building before lead-based paint removal work begins.
       OR
       Furniture and equipment will remain in the building. Protect and cover furnishings or remove furnishings from the work area and store in a location approved by the the Owner.
       OR
       Existing furniture and equipment is lead contaminated, decontaminate, dispose of as lead contaminated waste.
6. Heating, Ventilating and Air Conditioning (HVAC) Systems: Shut down, lock out, and isolate HVAC systems that supply, exhaust, or pass through the lead control areas. Seal intake and exhaust vents in the lead control area with 6 mil (0.15 mm) plastic sheet and tape. Seal seams in HVAC components that pass through the lead control area. Provide temporary HVAC system for areas in which HVAC has been shut down outside the lead control area.
7. Decontamination Shower Facility: Provide clean and contaminated change rooms and shower facilities in accordance with this specification and 29 CFR 1926.62.
8. Eye Wash Station: Where eyes may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes shall be provided within the work area.
9. Mechanical Ventilation System
    a. Use adequate ventilation to control personnel exposure to lead in accordance with 29 CFR 1926.62.
    b. To the extent feasible, use fixed local exhaust ventilation connected to HEPA filters or other collection systems, approved by the CP. Local exhaust ventilation systems shall be designed, constructed, installed, and maintained in accordance with ANSI Z9.2.
    c. Vent local exhaust outside the building only and away from building ventilation intakes.
    d. Use locally exhausted, power actuated, paint removal tools.
10. Personnel Protection: Personnel shall wear and use protective clothing and equipment as specified herein. Eating, smoking, or drinking or application of cosmetics is not permitted in the lead control area. No one will be permitted in the lead control area unless they have been appropriately trained and provided with protective equipment.

B. Work Procedures: Perform removal of lead-based paint in accordance with approved lead-based paint/lead-containing paint removal plan. Use procedures and equipment required to limit occupational and environmental exposure to lead when lead-based paint is removed in accordance with 29 CFR 1926.62, except as specified herein. Dispose of removed paint chips and associated waste in compliance with Environmental Protection Agency (EPA), federal, State, and local requirements.
1. Personnel Exiting Procedures: Whenever personnel exit the lead-controlled area, they shall perform the following procedures and shall not leave the work place wearing any clothing or equipment worn during the work day:

a. Vacuum themselves off.
b. Remove protective clothing in the contaminated change room, and place them in an approved impermeable disposal bag.
c. Shower **OR** Wash hands and face at the site, **as directed**, don appropriate disposable or uncontaminated reusable clothing; move to an appropriate facility; shower.
d. Change to clean clothes prior to leaving the physical boundary designated around the lead control area.

2. Air and Wipe Sampling
   a. Air sample for lead in accordance with 29 CFR 1926.62 and as specified herein. Air and wipe sampling shall be directed or performed by the CP.
      1) The CP shall be on the job site directing the air and non-clearance wipe sampling and inspecting the lead-based paint removal work to ensure that the requirements of the contract have been satisfied during the entire lead-based paint removal operation.
      2) Collect personal air samples on employees who are anticipated to have the greatest risk of exposure as determined by the CP. In addition, collect air samples on at least 25 percent of the work crew or a minimum of two employees, whichever is greater, during each work shift.
      3) Submit results of air samples, signed by the CP, within 72 hours after the air samples are taken. Notify the the Owner immediately of exposure to lead at or in excess of the action level of 30 micrograms per cubic meter of air outside of the lead control area.
      4) For high profile, sensitive work such as present in family housing, child care facilities, administrative buildings, kitchens, barracks, etc., surface dust sampling to determine clearance (i.e., that the work has not contaminated surfaces within and adjacent to the control area) should be performed by a third party to reduce a conflict of interest. Samples must be conducted by an individual not paid or employed or otherwise compensated by the LBP/LCP removal Contractor. State or local regulations may require third party testing if the LBP/LCP removal operation is considered a lead hazard reduction activity.
      5) Before any work begins, collect and analyze baseline or soil wipe samples in accordance with methods defined in federal, State, and local standards inside and outside of the physical boundary to assess the degree of dust contamination in the facility prior to lead-based paint removal.
   b. Air Sampling During Paint Removal Work: Conduct area air sampling daily, on each shift in which lead-based paint removal operations are performed, in areas immediately adjacent to the lead control area. Sufficient area monitoring shall be conducted to ensure unprotected personnel are not exposed at or above 30 micrograms per cubic meter of air. If 30 micrograms per cubic meter of air is reached or exceeded, stop work, correct the conditions(s) causing the increased levels. Notify the the Owner immediately. Determine if condition(s) require any further change in work methods. Removal work shall resume only after approval is given by the CP and the the Owner. For outdoor operations, at least one sample on each shift shall be taken on the downwind side of the lead control area.

3. Lead-Based Paint Removal
   a. Manual or power sanding of interior and exterior surfaces is not permitted. Provide methodology for removing LBP in work plan. Remove paint within the areas designated on the drawings in order to completely expose the substrate. Take whatever precautions necessary to minimize damage to the underlying substrate.
   b. Avoid flash rusting or deterioration of the substrate. Provide surface preparations for painting in accord with Division 07.
   c. Provide methodology for removing LBP/LCP removal processes to minimize contamination of work areas outside the control area with lead-contaminated dust or other lead-contaminated debris/waste and to ensure that unprotected personnel are not exposed to hazardous concentrations of lead. Describe this LBP/LCP removal process in the LBP/LCPRP.

d. Indoor Lead Paint Removal: Perform manual **OR** mechanical **OR** thermal **OR** chemical, **as directed**, paint removal in lead control areas using enclosures, barriers, or containments and powered locally exhausted paint removal tools. Collect residue and/or debris for disposal in accordance with federal, State, and local requirements.

e. Outdoor Lead Paint Removal: Perform outdoor removal as indicated in federal, State, and local regulations and in the LBP/CPRP. The worksite preparation (barriers or containments) shall be job dependent and presented in the LBP/LCPRP.

f. Sampling After Paint Removal: After the visual inspection, conduct soil sampling if bare soil is present during external removal operations and collect air samples inside and outside the lead control area to determine the airborne levels of lead inside and outside the work area. Collect wipe samples according to the HUD protocol contained in HUD Guidelines to determine the lead content of settled dust and dirt in micrograms per square foot (square meter) of surface area and parts per million (ppm) or micrograms per gram (µg/g) for soil.

4. Cleanup and Disposal

a. Cleanup: Maintain surfaces of the lead control area free of accumulations of paint chips and dust. Restrict the spread of dust and debris; keep waste from being distributed over the work area. Do not dry sweep or use compressed air to clean up the area. At the end of each shift and when the paint removal operation has been completed, clean the area of visible lead paint contamination by vacuuming with a HEPA filtered vacuum cleaner, wet mopping the area and wet wiping the area as indicated by the CP. Reclean areas showing dust or residual paint chips or debris. After visible dust, chips and debris is removed, wet wipe and HEPA vacuum all surfaces in the work area. If adjacent areas become contaminated at any time during the work, clean, visually inspect, and then wipe sample all contaminated areas. The CP shall then certify in writing that the area has been cleaned of lead contamination before restarting work.

b. Clearance Certification

1) The CP shall certify in writing that the final air samples collected inside and outside the lead control area are less than 30 micrograms per cubic meter of air; the respiratory protection used for the employees was adequate; the work procedures were performed in accordance with 29 CFR 1926.62 and 40 CFR 745; and that there were no visible accumulations of material and dust containing lead left in the work site. Do not remove the lead control area or roped off boundary and warning signs prior to the the Owner's acknowledgement of receipt of the CP certification.

2) A third party consultant shall certify surface wipe sample results collected inside and outside the work area are less than 100 micrograms per square foot (0.1 square meter) on uncarpeted floors, less than 500 micrograms per square foot (0.1 square meter) on interior window sills and less than 800 micrograms per square foot (0.1 square meter) on window troughs **OR** not significantly greater than the initial surface loading determined prior to work, **as directed**.

3) For exterior paint removal work, soil samples taken at the exterior of the work site shall be sued to determine if soil lead levels had increased at a statistically significant level (significant at the 95 percent confidence limit) from the soil lead levels prior to the work. If soil lead levels do show a statistically significant increase above any applicable Federal or State standard for lead in soil, the soil shall be remediated back to the pre-work level.

c. Testing of Lead-Based Paint Residue and Used Abrasive: Test paint residue and used abrasive in accordance with 40 CFR 261 for hazardous waste.

d. Disposal

1) Collect lead-contaminated waste, scrap, debris, bags, containers, equipment, and lead-contaminated clothing which may produce airborne concentrations of lead particles. Label the containers in accordance with 29 CFR 1926.62 and 40 CFR 261. Dispose of lead-contaminated waste material at an EPA or State approved hazardous waste treatment, storage, or disposal facility off Owner's property.

2) Store waste materials in U.S. Department of Transportation (49 CFR 178) approved 55 gallon (208 liter) drums. Properly label each drum to identify the type of waste (49 CFR 172) and the date the drum was filled. The the Owner or an authorized representative will assign an area for interim storage of waste-containing drums. Do not store hazardous waste drums in interim storage longer than 90 calendar days from the date affixed to each drum.

3) Handle, store, transport, and dispose lead or lead-contaminated waste in accordance with 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, and 40 CFR 265. Comply with land disposal restriction notification requirements as required by 40 CFR 268.

4) All material, whether hazardous or non-hazardous shall be disposed in accordance with laws and provisions and Federal, State, or local regulations. Ensure waste is properly characterized. The result of each waste characterization (TCLP for RCRA materials) will dictate disposal requirements.

5. Disposal Documentation: Submit written evidence that the hazardous waste treatment, storage, or disposal facility (TSD) is approved for lead disposal by the EPA and State or local regulatory agencies. Submit one copy of the completed manifest, signed and dated by the initial transporter in accordance with 40 CFR 262.

6. Payment for Hazardous Waste: Payment for disposal of hazardous waste will not be made until a signed copy of the manifest from the treatment or disposal facility certifying the amount of lead-containing materials delivered is returned and a copy is furnished to the Owner.

END OF SECTION 02 82 33 00a

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Task	Specification	Specification Description
02 82 33 00	01 22 16 00	No Specification Required
02 82 33 00	02 61 26 00	Disposal Of Hazardous Materials
02 82 33 00	02 61 26 00a	Removal Of Friable Asbestos-Containing Materials
02 82 33 00	02 82 16 00	Encapsulation (Lock-Down) Of Asbestos-Containing Materials

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SECTION 02 83 19 13 - LEAD PAINT RELATED ABATEMENT PROCEDURES

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for lead paint related abatement procedures. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. General Provisions

1. The site of this work will be occupied while work is being done. Perform the abatement work with the least inconvenience to the residents.
2. Take all necessary precautions to protect the property of the the Owner and its residents. Damaged property shall be repaired and restored to its original condition. If the damage is beyond repair, the Contractor shall replace it with new materials to match existing, at the Contractor's expense.
3. Hazardous waste generated during the abatement process (including lead-base paint) when carted away from the developments shall not be transferred from one vehicle to another except at a licensed transfer station.
4. Develop a work plan to be performed as requested by the the Owner. The detailed plan shall include sequencing of abatement work in a manner that will be least disruptive to the normal use of the non-work areas in the building. The plan should also include emergency procedures in case of fire.
5. The Contractor shall include all supplementary miscellaneous items not specified but implied or required in order to complete the work.
6. Workmanship required in the execution of the work herein specified shall be of good quality and subject to the approval of the the Owner.
7. Make in a timely fashion all applicable and necessary notifications to relevant Federal, State and Local authorities. The Contractor shall indemnify the the Owner and the the Owner's representative from, and pay all claims resulting from failure to adhere to these provisions.
8. the Owner may retain an independent Monitoring Contractor to monitor the abatement contract and conduct all wipe sampling and clearance tests.
9. Contractor performing lead-based paint abatement or renovation activities involving lead-based paint shall be a Certified Lead Abatement Contractor and shall ensure that supervisors and workers are trained and certified by U.S. EPA approved state program or equivalent, to perform lead paint removal operations.
10. Establish and implement a Chemical Hazard Communication Program as required by OSHA regulations 29 CFR 1926.59.
11. Provide workers with a comprehensive medical examination as required by OSHA regulations 29 CFR 1926.62 before exposure to lead contaminated dust. The medical examination shall be conducted to approve use of appropriate respirators and shall include biological monitoring NIOSH/MSHA approved respirators shall be utilized.
12. For employees required to wear a negative pressure respirators: conduct a respirator fit test at the time of initial fitting and at least once every six (6) months thereafter as required by OSHA regulations 29 CFR 1926.62.
13. Determine if any worker will be exposed to lead at or above the action level in accordance with OSHA regulation 29 CFR 1926.62 and 29 CFR 1910.1025. Conduct an exposure assessment to identify the level of exposure a worker would be subjected to without respiratory protection. Assess the exposure level by obtaining personal monitoring samples representative of a full shift of at least an 8-hour TWA.
14. Furnish appropriate respirators approved by NIOSH/MSHA for use in atmospheres containing lead aerosols. Instruct workers in all aspects of respiratory protection. Maintain an adequate supply of HEPA filter elements and spare parts on site for all types of respirators in use.

15. For manual demolition, scraping, sanding, use of heat gun or power tool paint removal with HEPA collection systems, workers shall minimally use the half-mask negative pressure respirator with high efficiency filters (for airborne concentrations not in excess of 500µg/m³).
16. Ensure that work area preparation, work practices, and clean-up procedures comply with these specifications and applicable Federal, State and Local regulations.
17. Notify all applicable agencies five days prior to the date the abatement will begin and provide evidence of notifications to the the Owner at the pre-start meeting.

C. Submissions

1. Within ten (10) consecutive calendar days calculated from the date of the the Owner's Job Order, the Contractor shall tender all required submissions. Six (6) sets of each submission are required. Where physical samples are required two (2) physical samples shall be submitted for each item. In general, items shall include but not be restricted to the following:
   a. Paint remover - corner cutter/Vac-Pac System by Pentek Inc; Decontamination Products Division 1026 Fourth Avenue, Corapolis, PA. 15108. Telephone No. (412) 262-0725 or approved equal.
   b. Description of removal method to be used on each substrate condition including manufacturer's operating instructions and recommendation for equipment usage.
   c. Copies of current training certificates of Staff to be assigned to the contract.
   d. List of three previous lead abatement jobs performed successfully by Contractor and name, address, and telephone number of contact person for verification.
2. In the event that all or any portion of the submitted material is rejected by the the Owner, the Contractor shall tender new submissions. All submissions returned for corrections shall be resubmitted with the required corrections within ten(10) consecutive calendar days calculated from the date of rejection, until final submissions are obtained that require no further correction. In no event shall the Contractor be permitted to tender submissions hereunder beyond twenty (20) days from the the Owner's Job Order, unless duly extended in writing by the the Owner.
3. No work shall begin, nor shall the materials be ordered or delivered to the site until final approval of all submissions.

D. Applicable Regulations

1. 24 CFR Part 35
2. HUD "Guidelines For the Evaluation and Control of Lead-Based Paint Hazards in Housing"
3. Abatement work shall also be in accordance with applicable regulations of the Environmental Protection Agency (EPA), Occupational Safety & Health Agency (OSHA) and any State or Local LBP standards. Where there is a conflict between Federal, State or Local regulations, the more stringent requirement shall prevail.
4. OSHA Standards
   a. 29 CFR 1926.20 General safety and health provisions;
   b. 29 CFR 1926.21 Safety training and education;
   c. 29 CFR 1925.25 Housekeeping;
   d. 29 CFR 1926-28 Personal protective equipment;
   e. 29 CFR 1926.51(f) Washing facilities;
   f. 29 CFR 1926.55 Gases, vapors, fumes, dusts, and mists;
   g. 29 CFR 1926.57 Ventilation
   h. 29 CFR 1926.59 Hazardous Communication Standards;
   i. 29 CFR 1926.103 Respiratory protection, and
   j. 29 CFR 1926.62 Lead in Construction
5. The Contractor must comply with all applicable requirements of the Resource Conservation & Recovery Act (RCRA) of 1976 as amended in 1980 and 1984 by the Hazardous & Solid Waste Amendments (HSWA).
6. These Specifications refer to many requirements found in the preceding references but in no way is it intended to cite or reiterate all provisions therein or elsewhere. It is the Contractor's responsibility to obtain a copy, and know, understand and abide by all such regulations, guidelines and common practices.

1.2 PRODUCTS – (not used)

1.3 EXECUTION

A. Abatement

1. Have risk assessment or paint inspection performed by certified risk assessor or a certified inspector technician who is independent of the abatement contractor.
2. Develop a site specific lead hazard control plan, reviewed and signed by an asbestos consultant (LAC) who is licensed in the State in which the work is to be performed, and submit for review and approval to the the Owner.
3. Obtain any necessary building or waste permits, notify local authorities as required by applicable codes and laws.
4. Select specific building component replacement items, enclosure materials, paint removal equipment and/or chemicals, tools, and cleaning supplies. Consider waste management and historical preservation implications of selected treatment.
5. Develop project specific specifications.
6. Schedule other work so that leaded surfaces are not inadvertently disturbed and unprotected workers are not place at risk. Include time for clearance examinations and laboratory dust sample analysis in the scheduling process.
7. Select a certified abatement subcontractor.
8. Conduct a pre-construction conference to ensure that the subcontractor fully understands the work involved.
9. Notify residents of the dwelling and adjacent dwellings of the work and date it will begin. Coordinate this with the the Owner.
10. Correct any existing conditions that could impede the abatement work (i.e. trash removal, structural deficiencies).
11. Post warning signs and restrict entry to work area to authorized personnel. Implement worksite preparation procedures.
    a. Place proper warning signs required by OSHA regulations at all entrances to the work area. Signage shall be minimum of 12" x 20" and shall state the following:

WARNING
LEAD WORK AREA
POISON
NO SMOKING OR EATING

12. Coordinate test, pilot or sample portion approach to the project with the Owner.
13. Shut-down forced air heating, ventilation and air conditioning systems and cover all vents, diffusers, windows etc., with a single layer six-mil polyethylene sheet secured with duct tape. Exceptions shall be for minor disturbances of area less than 2 square feet and where if vents, diffusers, and windows are more than 5 feet away from surface being disturbed, they need not be covered.
14. Collect preabatement soil samples, which may not have to be analyzed until post abatement soil samples have been collected, analyzed, and compared to clearance standards. If postabatement soil levels are below applicable limits, the preabatement samples need not be analyzed.
15. Cover entrances to the work area with a single layer of 6 mil polyethylene sheets taped to the top and weighted at bottom.
16. Rig a containment non-flammable polyethylene sheet underneath the work area. This containment method should catch all stripped paint for proper disposal.
17. Execute abatement work.
18. Avoid spreading dust and debris outside the work area.
19. Store all waste in a secure area and make sure it is properly labeled with an accumulation start date.
20. Conduct daily and final cleanup.
21. Execute waste disposal procedures.

22. Maintain appropriate records.

B. Paint Removal
1. Do not use the following prohibited paint removal methods:
   a. Dry scraping or sanding (except for limited areas)
   b. Use of heat gun over 1,100°F
   c. Open flame burning or torching
   d. Machine sanding or grinding without HEPA vacuum exhaust tool
   e. Abrasive blasting or sandblasting without HEPA vacuum exhaust tool
   f. Uncontained hydro blasting or high-pressure wash
   g. Use of chemical strippers containing Methylene chloride.
2. Select the appropriate worksite preparation level.
3. For heat gun work, provide fire extinguishers in the work area and ensure that adequate electrical power is available. Use for limited areas only. Train workers to avoid gouging or abrading the substrate.
4. For mechanical removal methods, use tools equipped with HEPA exhaust capability. Be sure workers keep the shroud against the surface being treated. Vacuum blasting and needle guns should not be used on wood, plaster, drywall, or other soft substrates. Observe all manufacturers directions for the amount of vacuum airflow required.
5. For wet scraping, use a spray bottle or wet sponge attached to the scraper to keep the surface wet while scraping. Apply enough water to moisten the surface completely, but not so much that large amounts of water run onto the ground or floor. Do not moisten areas near electrical circuits.
6. For chemical paint removers, determine if the building component can be removed and stripped offsite. Offsite stripping is generally preferred to onsite paint removal. Observe all manufacturers' directions for use of paint removers.
7. For offsite stripping, determine how to remove the component. Score the edges with a knife or razor blade to minimize the damage to adjacent surfaces. Punch or tag the building component, if similar building components are also being stripped offsite (i.e. doors). This will ensure that the individual component is reinstalled in the same location. Inform the offsite paint remover that the lead-based paint component is present for shipping. Wrap the component in plastic and send to the offsite stripping location. Clean all surfaces before reinstallation and remove any lead residue by HEPA vacuuming all surfaces, cleaning with other lead-specific cleaners, or phosphate detergents, and HEPA vacuuming again.
8. For onsite paint removal, first test the product on a small area to determine its effectiveness. Chemical paint removers may not be effective or desirable on exterior, deteriorated wood surfaces, aluminum, and glass. Provide neoprene, nitrile, rubber, or polyvinyl chloride (PVC) gloves (or other type of glove recommended by the manufacture); face shields; respirators with combination filter cartridges for lead dust and organic vapors(if appropriate); and chemically resistant clothing. Be sure to select the right type of organic vapor filter cartridge, gloves, and clothing for the specific chemical being used. Portable eyewash stations capable of providing a 15-minute flow must be on-site. Apply the chemical and wait the required period of time. Securely store chemical s overnight. For caustic chemical paint removers, neutralize the surface before repainting using glacial acetic acid (not vinegar). Repaint.
9. Make sure all debris is caught in the containment sheet for proper disposal.
10. Mark and legally dispose of waste in accordance with all applicable Federal, State and Local regulations. Most wastes from paint removal projects, such as paint chips and paint remover sludge, will need to be managed as hazardous waste.
11. Conduct clean-up
12. Have a certified risk assessor or inspector technician conduct a clearance examination and provide documentation and a Statement of Lead-Based Paint Compliance.

C. Building Component Replacement
1. Prepare work area by selecting proper worksite preparation level.
2. Prepare the hazardous material building component for removal. Turn off and disconnect any electrical circuits inside or near the building component to be removed.

3. Lightly mist the component to be removed (unless electrical circuits are located nearby).
4. Score all painted seams with a sharp knife.
5. Remove any screw, nails, or other fasteners.
6. Use flat pry instrument and hammer to pry component from the substrate.
7. Remove or bend back all nails.
8. Wrap and seal all bulk components in plastic and take them to a covered truck or secured waste storage area along a pathway covered in plastic. Shovel any debris. Dispose of properly.
9. HEPA vacuum any dust or chips in the area where the component was located.
10. Conduct cleaning and clearance activities.

D. Soil and Exterior Dust Abatement

1. Determine if soil lead hazard exists. For hazard to exist, a total of at least 9 square feet of soil in a single yard or area must be bare and soil concentrations must exceed 2,000µg/gram lead for the yard or building perimeter or 400µg/gram of lead for small, high-contact play areas (pending the development of an EPA soil standard). Bare soil above these levels shall be treated by either interim controls or abatement. Soil abatement is most appropriate when levels of lead are extraordinarily high (greater than 5,000µg/gram lead) and when use patterns indicate contact frequency and exposure will be high.
2. Collect Preabatement soil samples to determine baseline levels. These samples need not be analyzed if post abatement samples are below applicable clearance levels.
3. Determine the method of soil abatement (soil removal and replacement, soil cleaning, or paving). Soil cultivation (rototilling or turning over the soil) is not permitted.
4. If paving, use a high quality concrete or asphalt. Observe normal precautions associate with traffic load weight and thermal expansion and contraction. Obtain necessary permits. Keep soil cultivation to a minimum.
5. If removing and replacing soil.
   a. Determine if waste soil will be placed in an offsite burial pit. Prepare vehicle operation and soil movement plan. Test new replacement soil (should not contain more than 200 µg/gram lead).
   b. Contact local utilities to determine location of underground utilities including water, gas, cable TV, electric, telephone, and sewer. Mark all locations to be avoided
   c. Remove fencing, if necessary to allow equipment access and define set limits with temporary fencing, signs, or yellow caution tape.
   d. Tie and protect existing trees, shrubs, and bushes.
   e. Have enough tools to avoid handling clean soil with contaminated tools.
   f. Remove soil.
   g. Clean all walkways, driveways, and street areas near abatement area.
   h. Replace soil at proper grade to allow drainage. Replacement soil should be at least 2 inches above existing grade to allow for settling.
   i. Install new soil covering (grass or sod) and maintain it through the growing season.
   j. Determine if soil waste is hazardous and manage it accordingly
   k. Conduct clean-up and clearance.
   l. Provide walk-off doormats.
   m. Maintain proper documentation.

E. Encapsulation

1. Determine if the applicable regulations aloe encapsulates to be used. Do not encapsulate the following surfaces:
   a. Friction surfaces, such as window jambs and door jambs.
   b. Surfaces that fail patch tests.
   c. Surfaces with substrates or existing coatings that have a high level of deterioration.
   d. Surfaces I which there is a known incompatibility between two existing paint layers.
   e. Surfaces that cannot support the additional weight stress of encapsulation due to existing paint thickness.
   f. Metal surfaces that are prone to rust or corrosion.
2. Conduct field tests of surfaces to be encapsulated for paint film integrity.

3. Consider special use and environmental requirements (i.e. abrasion resistance and ability to span base substrate cracks).
4. Provide to the the Owner encapsulant test data provided by the manufacturer.
5. Conduct at least one test patch on each type of building component where the encapsulant will be used. Report the results to the the Owner.
6. For both nonreinforced and reinforced coatings, use a 6" x 6" test patch area. Prepare the surface in the manner selected to complete the job. Prepared surfaces for patch testing should be at least 2" larger in each direction than the patch area.
7. For fiber-reinforced wall coverings, use 3" x 3" patch. For rigid coatings that cannot be cut with a knife, use soundness test. For all encapsulants, carry out the appropriate adhesion tests.
8. For liquid coating encapsulants, allow coating to cure, then visually examine it for wrinkling, blistering, cracking, bubbling, or other chemical reaction with the underlying paint.
9. Record results of all patch tests and provide to the the Owner.
10. Implement proper work site preparation level.
11. Repair all building components and substrates as needed (i.e. caulk cracks and repair sources of water leaks).
12. Prepare surfaces. Remove all dirt, grease, chalking paint, mildew and other surface contaminants, remnants of cleaning solutions, and loose paint. All surfaces should be deglossed, as needed.
13. Ventilate the contaminated area whenever solvents or chemicals are used.
14. During encapsulant application or installation, monitor temperature and humidity. For liquid coatings monitor coating thickness to ensure that the encapsulant manufacturer's installation/application specifications are followed.
15. Conduct clean up and clearance.
16. Provide the the Owner information on how to care for the encapsulation system properly.
17. Maintain records on the exact detailed locations of encapsulant applications, patch test specifications and results, product name, subcontractor, date of application, a copy of the product label and material Data Safety sheet (MSDS) for the product and provide to the the Owner.

F. Enclosure
1. Stamp, label or stencil all lead-based painted surfaces that will be enclosed with a warning approximately every 2 feet both horizontally and vertically on all components. The Warning shall read "**Danger Lead-Based Paint**". Deteriorated paint should not be removed from the surface to be enclosed.
2. Select the proper worksite preparation level.
3. Attach a durable drawing to the utility room closet showing where lead-based paint has been enclosed in the dwelling.
4. An independent inspector or technician or risk assessor should evaluate the integrity of the enclosure.
5. Repair any unsound substrates and structural members that will support the enclosure, if necessary.
6. Utilize appropriate enclosure material (drywall or fiberboard, wood paneling, laminated products, ridged tile and brick veneers, vinyl, aluminum m, or plywood).
7. Install extension rings for all electrical switches and outlets that will penetrate the enclosure.
8. If enclosing floors, remove all dirt with a HEPA vacuum to avoid small lumps in the new flooring.
9. Seal and back-caulk all seams and joints. Back-caulk means applying caulk to the underside of the enclosure.
10. When installing enclosure directly to painted surfaces, use adhesive and then anchor with mechanical fasteners (screws or nails).
11. Conduct clean up and clearance activities.
12. Maintain proper records and submit a Statement of Lead-Based Paint Compliance.

G. Final Cleaning Procedures
1. Use the following step-by-step procedures

a. Assign responsibilities to specific workers for cleaning and for maintaining the cleaning equipment.
b. Have sufficient cleaning equipment and supplies before beginning work.
c. If contamination is extensive, conduct precleaning of the dwelling unit.
d. Conduct ongoing cleaning during the job, including regular removal of large and small debris and dust. Decontamination of all tools, equipment and worker protection gear is required before it leaves contaminated areas. Electrical equipment should be wiped and high-efficiency particulate air (HEPA) vacuumed, not wetted down, to minimize electrocution hazards.
e. Schedule sufficient time (usually 30 minutes to an hour) for complete daily cleaning, starting at the same time near the end of every workday after lead hazard control activity has stopped.
f. For final cleaning, wait at least 1 hour after active lead hazard control activity has ceased to let dust particles settle.
g. Use a vacuum cleaner equipped with a HEPA exhaust filter. HEPA vacuum all surfaces in the room (ceilings, walls, trim, and floors). Start with the ceiling and work down, moving toward the entry door. Completely clean each room before moving on.
h. Wash all surfaces with lead-specific detergent, high-phosphate detergent, or other suitable cleaning agent to dislodge any ground-in contamination, then rinse. Change the cleaning solution after every room is cleaned.
i. Repeat step g above. To meet clearance standards consistently, a HEPA vacuum, wet wash, and HEPA vacuum cycle is recommended. For interim control projects involving dust removal only, the final HEPA vacuuming step is usually not needed. Other cleaning methods are acceptable, as long as clearance criteria are met and workers are not over exposed.
j. After final cleaning perform visual examination to ensure that all surfaces requiring lead hazard control have been addressed and all visible dust and debris have been removed. Record findings and correct any incomplete work.
k. If other construction work will disturb the lead-based paint surfaces, it should be completed at this point. If those surfaces are disturbed, repeat the final cleaning step after construction work has been completed.
l. Paint and otherwise seal treated surfaces and interior floors.
m. Conduct clearance examination.
n. If clearance is not achieved, repeat final cleaning.
o. Continue clearance testing and repeated cleanings until dwelling unit achieves compliance with all clearance standards. The cost of repeated cleaning, after failure to achieve clearance is to be borne by the contractor.
p. Do not allow residents to enter work area until final cleaning is completed and clearance is established.
q. Cleaning equipment list is as follows:
    1) HEPA Vacuums
    2) Detergent
    3) Waterproof gloves
    4) Rags
    5) Sponges
    6) Mops
    7) Buckets
    8) HEPA vacuum attachments (crevice tools, beater bar for cleaning rugs)
    9) 6-mil plastic bags
    10) Debris containers
    11) Waste water containers
    12) Shovels
    13) Rakes
    14) Water-misting sprayers
    15) 6-mil polyethylene sheeting (or equivalent)

2. Order of execution for final cleaning steps should be as follows:

a. As the first stage in final cleaning, floor plastic shall be misted and swept.
b. Upper level plastic, such as on cabinets and counters should be removed first, after it has been misted and cleaned. All plastic should be carefully folded from the corners/ends to the middle to trap any remaining dust. Next remove both layers of plastic from the floor.
c. Plastic sheets used to isolate contaminated rooms from noncontaminated rooms should remain in place until after cleaning and removal of other plastic sheeting, these sheets may then be misted, cleaned and removed last.
d. Removed plastic should be placed into double 4-mil or single 6-mil plastic bags, or plastic bags with equivalent (or better) performance characteristics, which are sealed and removed from the premises. As with daily cleanings, this plastic removal process usually requires workers to use protective clothing and respirators.
e. After plastic has been removed from the contaminated area, the entire area should be cleaned using the HEPA/wet wash/HEPA cycle.

H. Waste Testing And Disposal

1. General: All materials, whether hazardous or non-hazardous shall be properly disposed of. the Owner may hire an independent Monitoring Consultant to perform TCLP test to determine which of the wastes are hazardous. Contractor shall cooperate in this test. If less than 100kg (200 lbs) or 1/2 of a 55 gallon drum of hazardous waste per month will be generated, it is considered "conditionally exempt" abatement waste, and may be managed as solid non-hazardous waste. The RCRA hazardous waste manifest is not required when shipping this waste to an offsite disposal facility.
2. Separate Abatement Waste into The Following Four Categories:
   a. <u>Category I</u>. Low lead waste (typically non-hazardous) e.g. Filtered personal and commercial wash water.
   b. <u>Category II.</u> Architectural components - (painted finish carpentry items) e.g. Doors, windows, window trim and sills, baseboards, railings, moldings. (May do a TCLP to determine if they are hazardous).
   c. <u>Category III</u>. Concentrated lead waste e.g. sludge from stripping, lead-base paint chip and dust, HEPA vacuum debris and filter, unfiltered wash waste, any waste included in EPA's list of hazardous waste.
   d. <u>Category IV</u>. Material that cannot be determined to be either hazardous or non-hazardous must be tested by TCLP.

   If the hazardous waste generated is greater than 100kg per month, dispose according to the referenced guidelines and RCRA hazardous waste management requirements including those listed below.
3. Disposal Requirements: Contact the regional EPA, state, local and all other pertinent authorities to determine lead-based paint debris disposal requirements. Comply with requirements of the Resource Conservation and Recovery Act (RCRA) and with applicable federal, state, county, or local waste requirements.
4. EPA ID Numbers: Obtain a Generator RCRA Hazardous Material ID number and coordinate this action through the State and secure any additional number as required.
5. Storage Requirements: Keep all hazardous items in a secure area or lockable container that is inaccessible to all persons other than the Contractor's personnel. Label all hazardous waste "Hazardous Waste" with the date that the Contractor began to collect the waste in that container. Keep hazardous and non-hazardous waste in separate containers. Until TCLP testing is completed, considered all items hazardous and store in a secured area or lockable container.
6. Waste Transportation: Transport hazardous waste using a RCRA/DOT/EPA certified Hazardous Waste Transporter. Submit names and qualifications of certified transporter/hauler for the Owner approval. The Contractor shall be responsible for all actions of the waste hauler as pertaining to waste removal and disposal under these procedures and all EPA, DOT and other applicable regulations.
7. Disposal Facility: Supply documents that detail the site(s) to be used for ultimate disposal. Submit documents from these sites proving that they are licensed/permitted to accept such waste and shall accept the waste proposed by the Contractor for treatment or ultimate disposal.

8. Waste Containers: Comply with EPA and DOT regulations for waste containers. Contact the state and local authorities to determine their criteria for containers. In the case of any conflict in regulations, the more stringent shall apply.
9. Emergencies: Contact local fire, police, hospitals or local emergency response teams and inform them of the type of hazardous waste activity and ask for assistance in the event of any accident. Additionally, the container shall provide the following:
    a. Keep and properly maintain a suitable fire extinguisher(s) on site.
    b. Have a immediate means of communication with the regulatory agency in the event of an emergency.
    c. Keep a list of phone numbers of regulatory agencies on site.
    d. Appoint an emergency coordinator and ensure the coordinator is on site to supervise emergency procedures to be carried out in the event of an emergency.
    e. Keep and maintain a "right to know" manual that is in an easily accessible location and in an area that is known to all employees.
10. Transporting Waste: Provide certifications that the transporter is registered with the U.S. Department of Transportation is required by 49 CFR Part 107(a) transport hazardous waste.
    a. Provide certifications that each vehicle dedicated to haul hazardous waste has been assigned a "U.S. DOT Hazardous Material Registration Number" as required by 49 CFR Part 107.
    b. Be responsible for all other applicable permits pertaining to hauling, transport, reduction, and disposal of hazardous waste as they may apply to this project.
    c. Vehicle: Ensure that all non-hazardous waste is transported in covered vehicles to a landfill, or lined landfill, if required.
    d. Container Handling: Carefully place the containers into the truck or dumpster used for disposal. At no time shall debris or containers be thrown or dropped.
    e. Liquid Wastes: Contain and properly dispose of all liquid wastes, including lead-contaminated wash water.
    f. Containers: HEPA vacuum the exterior of all waste containers prior to removing the waste containers from the work area. Wet wipe the containers to ensure that there is no residual contamination. Then move containers out of the work area into the designated storage area.

I. Clearance
1. Clearance on all abatement projects must be done by an independent certified risk assessor or inspector technician. Follow all jurisdictional law with regard to licensure requirements for personnel conducting clearance activities.
2. Clearance step-by-step procedures are as follows:
    a. Finish the lead hazard control clean-up effort. Seal floors before clearance (if necessary).
    b. Wait 1 hour to allow any airborne dust to settle. Do not enter work area during that hour.
    c. Conduct visual examination
        1) Determine if all required work has been completed and all lead-based paint hazards have been controlled.
        2) Determine if there is visible settled dust, paint chips, or debris in the interior or around the exterior.
    d. Complete the Visual Clearance Form required by the the Owner; if all work is not completed inform the the Owner and order completion of the work and repeat cleanup, if necessary.
    e. Conduct clearance dust sampling of the floors, interior window sills, and window troughs using approved protocol.
    f. Conduct soil sampling if bare soil is present that was not sampled previously, or if exterior paint work was completed as part of the lead hazard control effort. Whenever exterior work has been don, it may be necessary to take samples from the soil that is not bare to determine if contamination has occurred. If results are above 1,000 µg/g (or 400 µg/g in high contact play area), compare the results to baseline soil sampling results to determine what additional measures are needed.
    g. Complete the Dust and Soil Sampling Clearance Form required by the the Owner.

h. Submit samples to a U.S. Environmental Protection Agency (EPA) recognized laboratory participating in the National Lead Laboratory Accreditation program (NLLAP) for analysis.

i. Interpret results by comparing them to Interim Clearance Standards as listed below:

1)	Floors	400 µg/ft2
2)	Window sills	250 µg/ft2
3)	Window Troughs	800 µg/ft2
4)	Soils (Play area with children under 6 years of age)	400 µg/gram

j. If clearance is achieved go to step N.

k. Order repeated cleanings or soil treatments if results are above applicable standards. Clean all surfaces the sample represents.

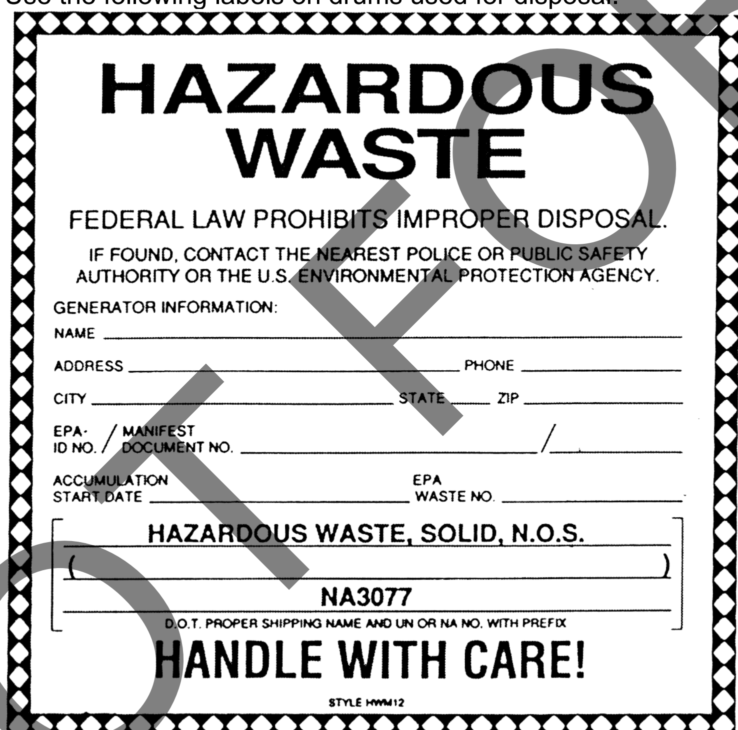
l. Continue sampling and repeated cleanings until the dwelling achieves compliance with all applicable clearance standards.

m. Complete any related construction work that does not disturb a surface with lead-based paint (all work that does disturb painted surfaces or that could generate lead dust should be completed as part of the lead hazard control effort).

n. Issue any necessary statements of lead-based paint compliance or releases and maintain appropriate records.

J. Labels

1. Use the following labels on drums used for disposal.



HAZARDOUS WASTE

FEDERAL LAW PROHIBITS IMPROPER DISPOSAL.

IF FOUND, CONTACT THE NEAREST POLICE OR PUBLIC SAFETY AUTHORITY OR THE U.S. ENVIRONMENTAL PROTECTION AGENCY.

GENERATOR INFORMATION:

NAME ______

ADDRESS ______ PHONE ______

CITY ______ STATE ______ ZIP ______

EPA-ID NO. / MANIFEST DOCUMENT NO. ______ / ______

ACCUMULATION START DATE ______ EPA WASTE NO. ______

HAZARDOUS WASTE, SOLID, N.O.S.

(______)

NA3077

D.O.T. PROPER SHIPPING NAME AND UN OR NA NO. WITH PREFIX

HANDLE WITH CARE!

STYLE HWM12

WORKPLACE ACCUMULATION CONTAINER

Proper D.O.T. Shipping Name: ____________

UN or NA# ____________

Generator Information:
Name: ____________
Facility: ____________
Address: ____________
Phone: ____________
City: ____________
State: ________ Zip: ________
EPA ID No. / Manifest Document No. ____________
State Manifest Document No. ____________
EPA Waste No.

HAZARDOUS WASTE

FEDERAL LAW PROHIBITS IMPROPER DISPOSAL.

IF FOUND, CONTACT THE NEAREST POLICE OR PUBLIC SAFETY AUTHORITY OR THE U.S. ENVIRONMENTAL PROTECTION AGENCY.

HANDLE WITH CARE!

Workplace Accumulation Start Date: ____________

Waste Accumulation Area: ____________

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K. Disposal of lead-based paint waste.

1. Follow the RCRA and HUD recommended practices as defined in the table below:

Waste Management Practices	Category I: Low Lead Waste	Category II: Architectural Components	Category III: Concentrated Lead Waste	Category IV: Other waste
RCRA Requirements	Manage as nonhazardous Waste	Depending upon knowledge or TCLP testing results, manage as solid hazardous or nonhazardous waste	If more than 100 kg/ month, manage as hazardous waste. If less than 100 kg/month manage as solid waste.	Use TCP to determine if waste is hazardous.
HUD Recommended Practices	Applicable	Applicable, if knowledge or TCLP testing indicates that it is nonhazardous.	Applicable if less than 100 kg/month otherwise subject to full RCRA regulations	Only applicable if TCLP testing shows waste is nonhazardous
Wrapped in plastic; seal all seams with tape (if acceptable to the disposal facility).	X	X	X	X
Stored in designated, secure area.	X	X	X	X
Covered During Transport	X	X	X	X
Prohibit cutting/breaking outside work area.	X	X	X	X
Cover ground with 6-mil plastic if handling outside.	X	X	X	X
Prohibit disposal in solid waste incinerators and reuse recycling for mulch	X	X	X	X
Recommended disposal in State licensed/permitted	X	X	If appropriate.	X

solid waste landfill.				

L. Safety Requirements

1. To protect the health and safety of all persons involved, it is of the utmost importance that deleading is safely and correctly done in a timely manner. The following specific safety requirements are the responsibility of the Deleading Contractor.

K. General Safety:

1. General
   a. NO ONE is to be allowed in the work area without an approved respirator except for methods that have been documented not requiring a respirator.
   b. Each work area must be sealed from the remainder of the dwelling by taping plastic sheets (6 mil thick). Work areas must remain sealed off until both work and clean-up are completed.
   c. Cover all floors, carpets, furniture and appliances with 6 mil plastic within the work area. Use automotive masking tape (2 inches wide) to seal all edges and seams.
   d. Make certain all electrical connections are properly grounded.
   e. At least three days prior to the start of any deleading work, post appropriate warning signs at all entrances and exits of work areas and leave in place until all clearance testing indicates that these areas are safe for re-occupancy. The signs must include the following phrase: "CAUTION LEAD HAZARD-KEEP OUT". Post bilingual signs when necessary.
2. Worker Safety: The Deleading Contractor shall take the following minimum precautions to protect the health of all individuals involved in the deleading process.
   a. Pre-Abatement Medical Exam: Each employee shall undergo a medical examination to determine both respiratory fitness capability and also pre-existing/current blood lead level. Said results shall be provided to the employee and also to the Owner within 3 days of receipt of same, and in all cases, prior to employee's commencement to active abatement. Records of same are required to be kept by the Contractor for 40 years.
   b. Medical Surveillance is the monitoring of worker blood levels. It is required that the Contractor have blood level monitoring of all active abatement and clean-up workmen and on-site supervisors performed and said results provided to the Owner.
      1) Before assignment to active abatement activity for each worker.
      2) 30 days after active abatement has begun.
      3) At least every two months during the first six months and every six months throughout the deleading job.
      4) At least every two months for each employee whose blood lead analysis indicated a blood lead level at or above 25 micrograms per deciliter. (20 micrograms per deciliter for women of child bearing age).
      5) At termination of employment.
      6) Contractor shall reassign any employee whose blood lead has reached 25 µg/dl (20 µg/dl for women of child bearing age) to a job function deemed safe from lead exposure. Said employee shall remain away from active abatement until such time as 2 consecutive months' blood tests indicate µg/dl below 20 µg/dl.
   c. Respiratory Protection Programs must be established by the Contractor in accordance with OSHA regulations and qualitative respirator fit testing must be conducted daily by the on-site supervisor. Medical examinations must be performed by a physician prior to fit testing and at anytime when a worker demonstrates any difficulty breathing during the use of or the fit testing of respirators. The following are minimal acceptable respiratory protection program requirements as set up and administered by the Contractor:
      1) Written standard operating procedures which oversees the selection and use of respirators.
      2) Selection of respirators on the basis of hazards to which the worker is exposed.
      3) Worker training on the limitations and use of respirators (includes fit testing).
      4) Individual workers assigned respirators for their exclusive use only.

5) Daily cleaning and disinfecting of respirators.
6) Proper storage of all respirators.
7) Proper inspection of all respirators for wear and tear.
8) Continual surveillance of work area conditions and level of worker exposure or stress.
9) Use of approved respirators only, modified as needed by the weekly exposure monitoring results.
10) Supply weekly report covering items 1-9 to the Owner or its Lead Consultant.

d. Exposure Monitoring is the measured concentration of lead in the workers breathing zones. The Contractor shall perform personnel monitoring during active abatement using the NIOSH 7072 method and-shall be responsible for:
1) Monitoring the level of worker protection needed during the abatement process;
2) Evaluating, modifying and improving any engineering and work practice control(s) as needed;
3) Evaluating each employee's personal quality of work and any need for additional worker training or safety instruction;
4) Providing the Owner results of all personnel monitoring tests within 10 days of testing; and
5) Providing half-face APR respirators with HEPA filters unless said monitoring test results dictate differently. OSHA guidelines shall be used to determine respirator PEL protection factors.

e. Protective Clothing Equipment must be provided to all workers to help assure that lead dust is contained to the work areas. The following must be supplied/enforced by the Deleading Contractor:
1) Full body protective clothing and shoe covers of appropriate sizes on a daily basis or as needed.
2) Clean changing areas separated from the dirty/contaminated clothes storage area.
3) Water and wash facilities for washing of hands and face and shower facilities if deemed necessary by the Owner's Lead Advisor.
4) Instructing worker on proper maintenance of clothing and equipment.
5) Proper disposal of disposable clothing and proper permanent work clothes.
6) Enforcing the removal of protective clothing at the end of each work day and before eating, drinking and smoking.
7) Enforcement of the removal of protective shoe covers before leaving work area.

3. Contractor/Worker Daily Safe-Work Procedures

a. Daily Start-Up:
1) Workers to put on protective gear prior to entering work areas.
2) All garment seams to be sealed with duct tape.
3) All non-working garments must be stored in designated changing area.
4) Respirators, as required, must be properly fitted before entering work area. Perform qualitative fit test.

b. Temporary depart:
1) All protective clothing to be HEPA vacuumed while still being worn.
2) All shoe covers to be removed and left in the work area (immediate departure upon removing).
3) Remove all protective gear in designated "contaminated" changing area before eating, drinking, and smoking or before leaving work site.
4) Wash hands and face.
5) Clean respirators.

c. Daily Shut-Down:
1) Dispose of protective clothing with abatement waste by sealing in a 6 mil poly bag.
2) Laundered clothes must be placed in closed container.
3) Wash hands and face.
4) Shower if facilities allow and circumstances dictate.
5) Clean all protective gear (respirators included).

4. Tenant's Safety: Temporary relocation of the tenants is necessary if the lead paint surface is broken. Temporary relocation of the tenants and their belongings is the responsibility of the Owner. However, the Contractor has the joint responsibility to administer and enforce the following safety practices on behalf of the occupants:
   a. Adults
      1) NO OCCUPANT is allowed to enter the work area during paint removal and initial clean-up. A three day clean-up and settlement period may be imposed depending upon the abatement procedures used, at the discretion of the Owner or their Lead Consultant.
      2) the Owner shall notify all occupants in writing when they are allowed to return to their post-abated residence. Contractor shall abide by these notices.
      3) Every resident who has received prior notice of abatement is responsible for placing all personal items (clothing, dishes, linens, etc.) in closed, easy to handle containers; and move such items to the center of each room as requested.
      4) As long as visible dust remains, occupants may not occupy dwelling, and all surfaces within the dwelling must be re-washed with trisodium phosphate and HEPA vacuumed by deleading contractor.
      5) Persons reoccupying dwellings following abatement are required to report any visible dust or debris to the Owner immediately for additional Contractor clean-up.
   b. Pregnant Women and Children
      1) Absolutely no pregnant women nor children under the age of twelve years of age may be allowed in the building while any part of the abatement process is going on.

END OF SECTION 02 83 19 13

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SECTION 02 83 19 13a - XRF TESTING FOR LEAD-BASED PAINT

1.1 DESCRIPTION OF WORK

A. This specification covers the furnishing and installation of materials for XRF testing for lead-based paint. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 SUMMARY

A. The Contractor shall perform work in accordance with the latest HUD Guidelines, in accordance with all applicable regulations of the Environmental Protection Agency (EPA), Occupational Safety & Health Agency (OSHA) and any applicable State or Local standards that may be more stringent than the Federal Standards except, as such guidelines are modified by the Owner in writing in this contract or any contract pursuant to this contract.

B. Workmanship required in the execution of the work herein specified shall be of good quality and subject to the approval of the the Owner.

1.3 SUBMITTALS

A. Notification Before Start of Work

1. The Contractor shall send notices to the Project Superintendent, Residents, and the Department of Planning and Development 48 hours before the scheduled start of work. The Contractor shall make three (3) attempts to gain entry to each apartment, with proper 48 hour notification to the resident each time.
2. The Contractor shall begin work no later than 48 hours after receiving a work proceed order.

B. Copies of the submissions listed below must be tendered with the bid:

1. Ability to perform XRF testing and paint chip sampling by submitting evidence of the successful completion of lead inspector training by all staff to be assigned to the job including inspector technicians. Training must be provided through a State approved EPA-Model program. All staff assigned to the Contract must also demonstrate training in the use of the XRF testing machines to be dedicated to this contract. The serial number of such XRF machine shall be provided to the the Owner.
   a. Contractor or Subcontractor performing the work must have at least 3 years of satisfactory experience (documented) in performing XRF testing for a City, State or Federal Agency.
2. Laboratory certification by the State Department of Health (or other responsible agency) and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"), or as an alternative having accreditation application pending before NLLAP, and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided. Indicate if the laboratory is an independent entity from the Contractor.
3. If a subcontractor will be used for any of the laboratory work of this contract, evidence of certification stated above must also be provided for the subcontractor.

C. XRF Testing Report Format

a. All XRF report must be made after a formal submittal and approval by the Owner.

b. A faxed summary report must be provided to the the Owner within 48 hours after completion of testing for a work Authorization. For XRF testing requiring confirmation by laboratory analysis of paint chip samples, the faxed summary report must be provided within 48 hours after the the Owner gives approval for testing of the collected paint chip samples.

c. A detailed report must be provided to the the Owner within 5 business days after completion of the testing.

1.4 QUALITY ASSURANCE

A. The work shall consist of furnishing all labor, material, insurance and all other incidental items required to do the following:

1. XRF Testing

a. Random or comprehensive testing of various components in single family housing units, multi-family housing units, common areas and exterior sites, using any of the approved X-ray Fluorescence ("XRF") machines, to determine if the lead-based paint concentration is within permissible limits.

Note: Testing may be for entire apartments or selected rooms or components within the apartment.

b. The permissible limit shall be defined as a final reading showing a lead concentration of less than 1.0 mg/cm².

c. Refer to the Manufacturer's manual, as well as the "XRF Performance Characteristic Sheet" when determining calibration check tolerance, and other instrument specific information. Use the adjusted "XRF Performance Characteristic Sheets" in this contract when determining the inconclusive range.

d. In addition to the manufacturer's recommended warm up and quality control procedures, a set of three nominal XRF calibration check readings must be taken before the inspection begins and after the inspection has been completed in a particular unit, or every 4 hours, whichever occurs first. All reference material values and calibration check readings must be included in the report provided to the Owner.

e. Do not use the XRF to test highly curved or ornate surfaces, or surfaces inaccessible to the XRF, due to poor reliability of results. For such surfaces, laboratory analysis of paint chips must be done.

f. Only one XRF reading is required per testing combination. A unique testing combination is characterized by the room equivalent, the component, the substrate and the visible color of the paint. However, testing combinations with different colors on the same component and substrate may be combined into a single component type.

g. All inconclusive results must be treated according to the inspection rules using multi-family inspection or single family inspection rules as appropriate.

h. XRF field data sheets shall be filled out as they appear on completed Form 7.1("Single-Family Housing LBP Testing Data Sheet") and 7.5 (""Multifamily Housing LBP Testing Data Sheet") in HUD Guidelines.

i. Room equivalents or sections thereof that are not accessible for testing (i.e. locked bedrooms) shall be noted in the final report to the Owner.

2. Laboratory testing of paint chips.

a. Collection of paint chips from various painted components for laboratory analysis due to XRF substrate corrected inconclusive and/or positive readings as directed by the the Owner.

b. Laboratory preparation and testing by Flame Atomic Absorption Spectrometry (FAAS) or Graphite Furnace Atomic Absorption Spectrometry (GFAAS) to determine if the lead paint concentration is within permissible limits.
c. The permissible limit shall be defined as a lead concentration less than 0.5% by weight.
d. Collect paint chips in accordance with ASTM ES28-94.
e. Prepare paint chips in the laboratory for testing in accordance with ASTM ES37-94.
f. Repair and repaint areas from which paint chips have been collected, to match adjacent areas, unless notified by the the Owner in writing to utilize a temporary covering for the tested surfaces. The Contractor shall provide water based latex paint for this purpose. Colors shall be limited to white and off-white; and other colors if provided by the tenant.
g. Only one paint chip is required per testing combination. A unique testing combination is characterized by the room equivalent, the component, the substrate, and the visible color of the paint. However, testing combinations with different colors on the same component and substrate may be combined into a single component type.
h. Field data sheets and signed chain of custodies must be attached to the final report to the Owner.

B. Occupied Residences
1. Some of the work of this contract will be in occupied apartments. The Contractor shall perform all of the work of this contract with the least inconvenience to the tenants.
2. The Contractor shall take all necessary precautions to protect the property of the the Owner, its residents and the public. The contractor must repair any damaged property, whether of the the Owner, its residents, or the public, and restore such property to its original condition. If the damage is beyond repair, the Contractor shall replace it with new, that in the judgement of the the Owner, match the existing materials and are of equal quality and workmanship. All such repairs shall be at the Contractor's expense.

C. Applicable Regulations
1. ASTME Standards
a. ASTM E 1583 on evaluating laboratories used to determine lead levels;
b. ASTM E 1605 on terminology;
c. ASTM E 1613 on determining lead by atomic emission or atomic absorption spectroscopy;
d. ASTM E 1645 on laboratory preparation of paint-chip samples;
e. ASTM E 1775 on-site extraction and field portable stripping voltammetry analysis for lead;
f. ASTM PS 53 on identifying and managing lead in facilities;
g. ASTM PS 87 on ultrasonic extraction for later analysis for lead;
h. ASTM PS 88 on determining lead by portable electro analysis
2. OSHA Standards (without limitation), include:
a. 29 CFR 1926.20 - General safety and health provisions;
b. 29 CFR 1926.21 - Safety training and education;
c. 29 CFR 1925.25 - Housekeeping;
d. 29 CFR 1926.28 - Personal protective equipment;
e. 29 CFR 1926.51(f) - Washing facilities;
f. 29 CFR 1926.55 - Gases, vapors, fumes, dusts, and mists;
g. 29 CFR 1926.57 - Ventilations;
h. 29 CFR 1926.59 - Hazardous Communication Standards;
i. 29 CFR 1926.10 - Respiratory protection; and
j. 29 CFR 1926.62 - Lead in Construction
3. The Contractor must comply with all applicable requirements of the Resource Conservation & Recovery Act (RCRA) of 1976 as amended in 1980 and 1984 by the Hazardous & Solid Waste Amendments (HSWA).

4. The Contractor must follow the XRF Performance Characteristic Sheet (PCS) for all inspection activities. XRF PCSs are available from the National Lead Information Center Clearinghouse or through the HUD website at http://www.hud.gov/offices/lead/lbp/hudguidelines/allpcs.pdf.

1.5 PRODUCTS

A. XRF Instruments and Testing Protocols
   1. The Contractor shall use XRF instruments that are approved by the Owner.
   2. XRFs must be used in accordance with the manufacturer's instructions and the XRF Performance Characteristic Sheet. If discrepancies exist between the XRF Performance Characteristic Sheet, the HUD Guidelines and the manufacturer's instructions, the most stringent guidelines should be followed.

1.6 EXECUTION

A. Inspection and Testing
   1. Single Family Testing Rules
      a. If the housing development has less
         1) than 10 units built between 1960-1970 or
         2) 20 units built before 1960 or
         3) the random testing rules in a multi-family development are not being used then single family testing rules must be followed.
      b. List all testing combinations (see HUD Guidelines Table for an example) in all interior rooms, on all exterior building surfaces, and on surfaces in other exterior areas, such as fences, playground equipment, and garages. The “SingleFamily Housing LBP Testing Data Sheet” (see HUD Guidelines) or a comparable data collection instrument may be used for this purpose.
         1) Test all room equivalents inside and outside the dwelling unit. The final report must include a final determination of the presence or absence of lead-based paint on each testing combination in each room equivalent.
         2) Inspect each testing combination in each room equivalent, unless similar building component types with identical substrates (such as windows) are all found to contain lead-based paint in the first five interior room equivalents. In that case, testing of that component type in the remaining room equivalents may be discontinued, if and only if the Owner agrees beforehand to such a discontinuation. The inspector should then conclude that similar building component types in the rest of the dwelling unit also contain lead-based paint.
         3) Painted furniture that is physically attached to the unit (for example, a desk or dresser that is built-in) should be included in the inspection as a testing combination.
         4) Results of an inspection may be summarized by classifying component types across room equivalents if patterns or trends are supported by the data.
         5) All substrates across all room equivalents should be grouped into one of the six substrate categories (brick, concrete, drywall, metal, plaster, or wood).
      c. Number and Location of XRF Readings
         1) XRF testing is required for at least one location per layers of paint should be included and the XRF probe testing combination, except for interior and exterior faceplate should be able to lie flat against the surface walls, where four readings should be taken, one on of the test location each wall.
         2) For interior and exterior walls: take at least four readings (one of ea. wall). If there are more than four walls test the four largest walls, calculate the average of the

readings, round the result to same number of decimal places as the XRF instrument displays, and classify the remaining walls with the same painting history as the tested walls, based on this rounded average. When the remaining walls in a room equivalent clearly do not have the same painting history as that of the tested walls, test and classify the remaining walls individually.

3) Select areas of paint which are most likely to have old paint or coatings, where areas of paint appear thickest. Avoid testing where paint has worn away, chipped; or over pipes, electrical surfaces, nails, and any other possible interferences.

4) A numbering system, floor plan, sketch or other system may be used to document which testing combinations were tested and sufficiently detailed enough for another individual to find them.

a) Side identification Identify perimeter wall sides with letters A, B, C, and D (or numbers or Roman numerals). Side A for single-family housing is the street side for the address. Side A in multi-family housing is the apartment entry door side. Side B, C, and D are identified clockwise from Side A as one faces the dwelling; thus Wall B is to the left, Wall C is across from Side A, and Side D is to the right of Side A. Each room equivalent's side identification follows the scheme for the whole housing unit. Because a room can have two or more entries, sides should not be allocated based on the entry point. For example, giving a closet a side allocation based on how the room is entered would make it difficult for another person to make an easy identification, especially if the room had two closets and two entryways.

b) Room Equivalent Identification Room equivalents should be identified by both a number and a use pattern (for example, Room 5-Kitchen). Room 1 can always be the first room, at the A-D junction at the entryway, or it can be the exterior. Rooms are consecutively numbered clockwise. If multiple closets exist, they are given the side allocation: for example, Room 3, Side C Closet. The exterior is always assigned a separate room equivalent identifier.

c) Sides in a Room Sides in an interior room equivalent follow the overall housing unit side allocation. Therefore, when standing in any four-sided room facing Side C, the room's Side A will always be to the rear, Side B will be to the left, and Side D will be to the right.

d) Building Component Identification Individual building components are first identified by their room number and side allocation (for example, the radiator in Room 1, Side B is easily identified). If multiple similar component types are in a room (for example, three windows), they are differentiated from each other by side allocation. If multiple components are on the same wall side, they are differentiated by being numbered left to right when facing the components. For example, three windows on Wall D are identified as windows D1, D2, and D3, left to right. If window D3 has the only old original sash, it is considered a separate testing combination from the other two windows. Codes or abbreviations for building components and/or locations may be used in order to shorten the time needed for data entry. If codes or abbreviations are used, the inspection records and the inspection report must include a table showing their meaning.

d. XRF Instrument Reading Time

1) The recommended time to open an XRF instrument's shutter to obtain a single XRF result for a testing location depends on the specific XRF instrument model and the mode in which the instrument is operating. Follow manufacturer's instructions per HUD Guidelines.

e. XRF Calibration Check Readings

1) Follow manufacturer's instructions per HUD Guidelines.

f. Substrate Correction

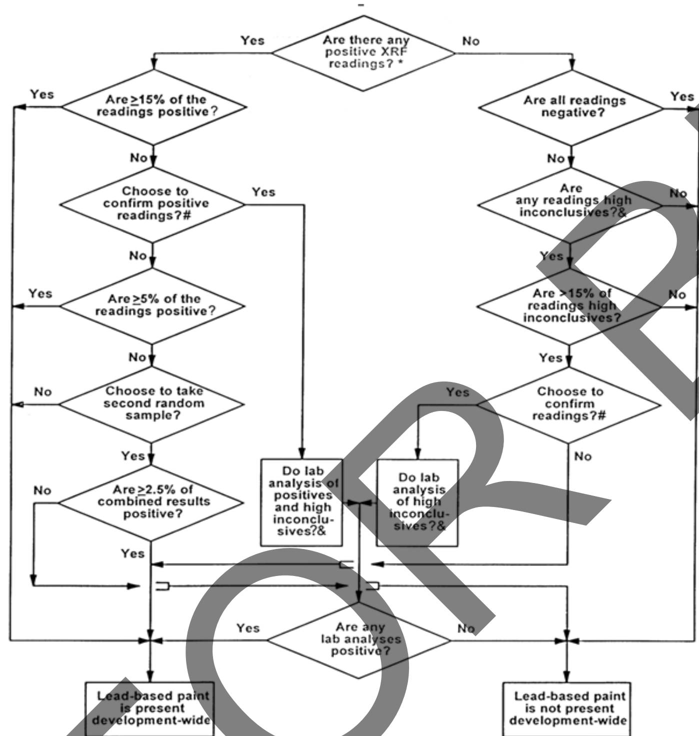
1) The XRF measurements, corrected for substrate contribution, if required by the Performance Characteristic Sheet ("PCS") for the particular type of instrument being used, should be sorted by the inspector by component type into the following categories:

a) Positive- A positive XRF reading in accordance with the XRF's Performance Characteristic Sheet.

b) Negative- A negative XRF reading in accordance with the XRF's Performance Characteristic Sheet.

c) High Inconclusive- An inconclusive XRF reading equal to or greater than the midpoint of the XRF's inconclusive range, in accordance with the XRF's Performance Characteristic Sheet.

g. The following Decision analyses will be used to determine which components are positive, negative or inconclusive:



* *"Positive," "negative," and "inconclusive" XRF readings are determined in accordance with the XRF instrument's Performance Characteristics Sheet as described in the HUD Guidelines for the Evaluation and Control of Lead Hazards in Housing, chapter 7.*
& *A high inconclusive reading is an XRF reading at or above the midpoint of the inconclusive range. For example, if the inconclusive range is 0.41 to 1.39, its midpoint (average) is 0.90; a reading in the range from 0.90 to 1.39 would be a high inconclusive reading.*
\# *Any paint or coating may be assumed to be lead-based paint, even without XRF or laboratory analysis. Similarly, any XRF reading may be confirmed by laboratory analysis.*

1)
2) All inconclusive results must be confirmed with laboratory analysis, or as an alternative must be classified as positive. the Owner may also wish to confirm positive XRF results with laboratory analysis. Therefore the Contractor must make a field determination of which XRF readings falls in the inconclusive or positive ranges and take paint chip samples during the XRF testing for possible laboratory analysis. If the majority of XRF readings are positive in the first few units, the inspector must consult with the Owner on whether to continue taking paint chip samples. Only the Owner may determine whether to submit collected paint chip samples for laboratory analysis or to classify the element as positive.

2. Multi-family Housing Testing Rules (Random Sampling)

a. In order to use the Multi-family housing testing rules, there must multi-family housing is defined as any group of more than four units that are similar in construction from unit to unit

b. Determine the number of randomly selected units to be tested in accordance with Table 7.3, below. Chapter 7 of the HUD Guidelines also describes how to select the units randomly. If a unit or units which were selected as part of the original random sample cannot be entered for a particular reason, a replacement unit(s) must be randomly selected in accordance with the HUD Guidelines.

Table 7.3 Number of Units to be Tested in Multi-family Building or Developments*

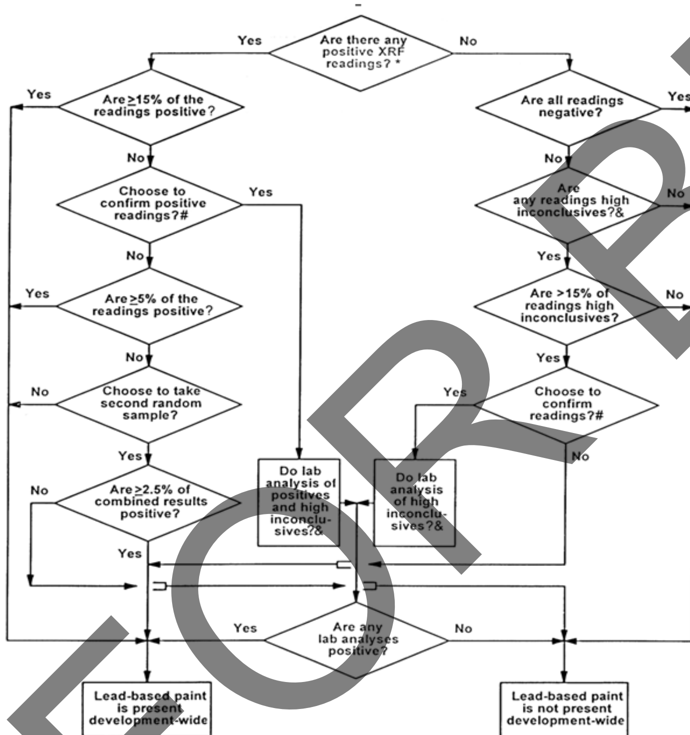
Number of Similar Units, Similar Common Areas, or Similar Exterior Sites	Pre-1960 or Unknown-Age Building or Development: Number of Units to Test *	1960-1977 Building or Development: Number of Units to Test *
1-10	All	All
11-13	All	10
14	All	11
15	All	12
16-17	All	13
18	All	14
19	All	15
20	All	16
21-26	20	16
27	21	17
28	22	18
29	23	18
30	23	19
31	24	19
32	25	19
33-34	26	19
35	27	19
36	28	19
37	29	19
38-39	30	20
40-48	31	21
49-50	31	22
51	32	22
52-53	33	22
54	34	22
55-56	35	22
57-58	36	22
59	37	23
60-69	38	23
70-73	38	24
74-75	39	24
76-77	40	24

Number of Similar Units, Similar Common Areas, or Similar Exterior Sites	Pre-1960 or Unknown-Age Building or Development: Number of Units to Test *	1960-1977 Building or Development: Number of Units to Test *
78-79	41	24
80-88	42	24
89-95	42	25
96-97	43	25
98-99	44	25
100-109	45	25
110-117	45	26
118-119	46	26
120-138	47	26
139-157	48	26
158-159	49	26
160-177	49	27
178-197	50	27
198-218	51	27
219-258	52	27
259-279	53	27
280-299	53	28
300-379	54	28
380-499	55	28
500-776	56	28
777-939	57	28
940-1004	57	29
1005-1022	58	29
1023-1032	59	29
1033-1039	59	30
1500	87	44
2000	116	58
2500	145	73
3000	174	87
3500	203	102
4000	232	116

* For brevity, "Number of Units" and "Number of Units to Test" are used, but the number to test is the same for similar units, similar common areas, and similar exterior sites.

c. An assessment on each tested component must note four attributes, also called a testing combination.
   1) The room equivalent (where the testing took place i.e. bedroom, bathroom, etc.)
   2) The component type (door, wall #1 - upper left, etc.)
   3) The substrate (brick, wood, concrete, drywall, plaster or metal).
   4) The color of the paint.
d. These attributes must be included as part of the report.
e. For each testing combination, the condition of the painted surfaces should be noted as either intact, fair or poor.
f. One reading with the X-ray fluorescence (XRF) instrument on each testing combination is all that is required.
g. At least 40 components of a given type must be tested to obtain the desired level of confidence in the results throughout the multi-family development. If less than 40 components of a given type exist in the buildings to be tested i.e. they are unique components, then the measurement should be taken using single family testing rules (described below). If less than 40 components of a given type exist in the units to be tested, additional components of this type can be identified in other units in the complex and tested to bring the total up to 40 so that multi-family testing rules can be used. The decision of which option the Contractor should use will be made by the the Owner.
h. To increase the number of tested components of a given type, testing combinations with different colors on the same component and substrate may be combined into a single component type. For example, if "wood doors" is the component type, all wood doors tested for lead-based paint could belong to the same component type, regardless of color.
i. A component type may be differentiated by color as long as there are 40 tested and there is a good reason for differentiation.
j. The XRF measurements, corrected for substrate contribution, if required by the Performance Characteristic Sheet ("PCS") for the particular type of instrument being used, should be sorted by the inspector by component type into the following categories:
   1) Positive- A positive XRF reading in accordance with the XRF's Performance Characteristic Sheet.
   2) Negative- A negative XRF reading in accordance with the XRF's Performance Characteristic Sheet.
   3) High Inconclusive- An inconclusive XRF reading equal to or greater than the midpoint of the XRF's inconclusive range, in accordance with the XRF's Performance Characteristic Sheet.

k. The following Decision analyses will be used to determine which components are positive, negative or inconclusive:



* *"Positive," "negative," and "inconclusive" XRF readings are determined in accordance with the XRF instrument's Performance Characteristics Sheet as described in the HUD Guidelines for the Evaluation and Control of Lead Hazards in Housing, chapter 7.*

& *A high inconclusive reading is an XRF reading at or above the midpoint of the inconclusive range. For example, if the inconclusive range is 0.41 to 1.39, its midpoint (average) is 0.90; a reading in the range from 0.90 to 1.39 would be a high inconclusive reading.*

\# *Any paint or coating may be assumed to be lead-based paint, even without XRF or laboratory analysis. Similarly, any XRF reading may be confirmed by laboratory analysis.*

l. If there are readings on a component type(s) equal to or greater than 1.0 mg/cm² and paint chip samples are submitted to the laboratory, there are two possible results:

1) If all lab samples on a component type are below 0.5% lead by weight, the component type can be classified as negative throughout the development.
2) If one or more lab results are positive, (equal to or greater than 0.5% lead by weight for a component) the the Owner will take one of three options:
   a) Treat the component type as positive throughout the development, or
   b) Test the component type throughout the development, or
   c) If 5% or less of the component type are positive, take a second random sample, just testing that component type.
3) If option 2)c) above is selected by the Owner and the combined results of the first and second random sample are less than 2½% positive, the following additional options are available depending on the results.
   a) If no positives are found in the second sample, no further testing is necessary. Those positives in the first random sample will be monitored/abated (not by this Agreement), but the rest of the component type can be classified as negative.

b) If positives are found on a component type in the second sample, the the Owner has the option to classify the component type as positive throughout the development or comprehensively test it.

c) If the combined results of the two random samples are equal to or greater than 2½%, the the Owner also has the option to comprehensively test the remaining components of that type or classify them as positive.

m. Paint Chip Sample Size: The Paint chip samples should be taken from a 4 square inch (25 square centimeter) area that is representative of the paint on the testing combination, as close as possible to any XRF reading locations and, if possible, unobtrusive. This area may be a 2" x 2" (5 x 5 centimeters) square, or a 1" x 4" (2.5 x 10 centimeters) rectangle, or have any other dimensions that equal at least 4 square inches (25 square centimeters). Regardless of shape, the dimensions of the surface area must be accurately measured (to the nearest millimeter or 1/16th of an inch) so that the laboratory results can be reported in mg/cm^2. Results should be reported as percent by weight if the surface area cannot be measured accurately or if all paint within the sampled area cannot be removed. In these cases, lead should be reported in ppm or percent weight, not in mg/cm^2. Smaller surface area can be used if acceptable to the laboratory. (See ASTME 1729). In all cases those who take the samples should consult with the NLAAP recognized laboratory selected regarding the requirements for the submission samples for lead-based paint analysis.

n. If the the Owner decides to test in search of these hard-to-find components coated with lead based paint, the inspector must use the single family testing rules described in the previous section.

3. Common Areas and Exterior Sites Testing Rules

a. Similar common areas and similar exterior sites must always be tested, but in some cases they can be sampled in much the same way that dwelling units are. Common areas and building exteriors typically have a similar painting history from one building to the next. In multifamily housing, each common area (such as building lobby, laundry room, or hallway) can be treated as a dwelling unit. If there are multiple similar common areas, they may be grouped for sampling purposes I exactly the same way as regular dwelling units. However, dwelling units, common areas and exterior sites cannot be all mixed together in a single group. All testing combinations within each common area or building exteriors selected for testing must be inspected. This includes playground equipment, benches and miscellaneous testing combinations located throughout the development. The specific common areas and building exteriors to test should be randomly selected, in much the same way as specific units are selected using random numbers. The number of common areas to be tested should be taken from table 7.3 (HUD Guidelines). In this instance, common areas and building exteriors can be treated in the same way as housing units (although they are not to be confused with true housing units).

4. Unit and Common Area Drawings

a. Mark-ups of as built drawings depicting room equivalents that are tested must be provided as part of the report.

b. The Contractor should test in a clockwise path starting from the door through the space and room equivalents so that the approximate location of each component tested can be easily established by referencing the room equivalent and sides.

c. Each space must have a reference point (side A, B, C, D or wall 1, 2, 3 or 4). The wall with the door should always be referenced as wall 1 or side A. If there is more than one door, wall 1 or side A should be used to refer to the wall with the door through which the room is first entered when moving in a clockwise fashion through the unit.

B. Evaluation of the Inspection by the the Owner

1. The Contractor will be required to carry out retesting at no additional cost to the the Owner, after completion of the Inspection at each the Owner's development as described in the HUD Guidelines, for single family housing, multi-family housing and common areas. The the Owner shall randomly select the testing combinations to be retested and the Contractor shall perform the retesting using the same XRF instrument(s) which was/were used to take the original readings. An the Owner's inspector shall be present to observe all retesting. The retesting shall be limited to ten (10) testing combinations, and if necessary to repeat the retest, the testing combinations randomly selected for repeating the retest shall also be limited to ten.
2. If the retest tolerance limit computed from the information provided in the "XRF Performance Characteristics Sheet" (see HUD Guidelines) is exceeded, the retest will be repeated as described in the HUD Guidelines for single family, multi-family housing and common areas. If the retest tolerance limit is exceeded again, the the Owner may require the Contractor to retest the entire development at no additional cost to the the Owner, or the the Owner may withhold all payments and terminate its agreement with the Contractor.

C. Option to do Laboratory Testing only
   1. The the Owner may, for a specific testing assignment, request in writing that the Contractor, when utilizing the multi-family housing testing rules for random sampling, or the single family housing testing rules, do all testing through laboratory analysis of paint chips rather than through XRF Spectrum Analyzer testing with laboratory confirmation as needed. Please note that under the single family housing testing rules, only one paint chip must be taken and analyzed for each component type.

D. Waste Disposal
   1. All waste generated must be legally disposed in accordance with Federal, State and Local regulations.

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SECTION 02 83 19 13b - LEAD DUST WIPE, AIR AND TCLP SAMPLING AND ANALYSIS

1.1 DESCRIPTION OF WORK

A. This specification covers the furnishing and installation of materials for lead dust wipe, air and TCLP sampling and analysis. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 GENERAL

A. Definitions: Unless otherwise specified the following definitions shall apply:

1. **"Approved"**: shall mean approved by all public agencies having jurisdiction, and the Owner.
2. **"The Owner"**: shall mean the Owner and its designated authorized representatives.
3. **"Contractor"**: shall mean the firm that is awarded this contract and is responsible to ensure compliance with Federal, State and City regulations as well as these Contract documents.
4. **"Development or Project"**: a group of buildings in one or more designated geographical locations, owned or operated by the Owner and referred to by a common name by the Owner.
5. **"Dust Cleaning Firm"**: shall mean the contractor under a separate contract or the Owner responsible for cleaning of lead dust, as directed by the Owner, until the clearance levels are achieved, as defined in the "Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing, June 1995" or latest edition published by the United States Department of Housing and Urban Development (HUD).
6. **"Equal or Approved Equal"**: shall mean equal in the opinion of the Owner.
7. **"HUD"**: the United States Department of Housing and Urban Development.
8. **"HUD Guidelines"**: shall mean Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing issued by HUD'S Office of Lead-Based Paint Abatement and Poisoning Prevention in June 1995 except as such guidelines are later modified by HUD and/or modified by the Owner in writing pursuant to this contract.
9. **"Inspector"**: an individual who has completed training from an accredited program and been licensed or certified by the appropriate State or local agency to (1) perform inspections to determine and report the presence of lead-based paint on a surface-by-surface basis through on-site testing, (2) report the findings of such an inspection, (3) collect environmental samples for laboratory analysis, (4) perform clearance testing, and (5) document successful compliance with lead-based paint hazard control requirements or standards.
10. **"Lead-Based Paint"**: any paint, varnish, shellac, or other coating that contains lead equal to or greater than 1.0 mg/cm² as measured by XRF or laboratory analysis, or 0.5 percent by weight (5,000 µg/g, 5,000 PPM, or 5,000 mg/kg) as measured by laboratory analysis.
11. **"Lead-Based Paint Hazard"**: a condition in which exposure to lead from lead-contaminated dust, lead-contaminated soil or deteriorated lead-based paint would have an adverse effect on human health (as established by the EPA Administrator under Title IV of the Toxic Substance Control Act). Lead-based paint hazards include for example, deteriorated lead-based paint, leaded dust levels above applicable standards and bare leaded soil above applicable standards.
12. **"Lead-Based Paint Hazard Control"**: activities to control or eliminate lead-based paint hazards, including interim controls and complete abatement.
13. **"Lead-Contaminated Dust"**: surface dust in residences that contain an area or mass concentration of lead in excess of the standard established by the EPA Administrator, pursuant to Title IV of the Toxic Substance Control Act. Until the EPA standards are set, the HUD recommended clearance and risk assessment standards for leaded dust are 40 µg/ft² on floors, 250 µg/ft² on interior window sills, and 800 µg/ft² on window troughs.

14. **"Monitoring"**: shall refer to inspection to ensure compliance with all Federal, State and City Standards or guidelines, and contractual specifications.
15. **"Provide"**: shall mean furnish and install.
16. **"Risk Assessor"**: a certified individual who has completed training with an accredited training program and who has been certified to (1) perform risk assessments, (2) identify acceptable abatement and interim control strategies for reducing identified lead-based paint hazards, (3) perform clearance testing and reevaluations, and (4) document the successful completion of lead-based paint hazard control activities.

B. Applicable Regulations/References

1. The work conducted shall comply with all applicable Federal, State and City regulations. Applicable guidelines and standards listed in the scope of work include, but are not limited to:

24 CFR Parts 35,36,37	HUD Lead-Based Paint Regulations
Guidelines for the Evaluation and Control of Lead-Based Paint in Housing (HUD Guidelines June 1995) & 1997 Revisions	
29 CFR 1910	General Industry Standard
29 CFR 1910.1025	Lead Standard for General Industry
29 CFR 1910.134	Respiratory Protection
29 CFR 1910.1200	Hazard Communication
29 CFR 1910.245	Specification for Accident Prevention
29 CFR 1926	Construction Industry Standards
29 CFR 1926.20	General Safety & Health Provisions
29 CFR 1926.21	Safety Training & Education
29 CFR 1926.25	Housekeeping
29 CFR 1926.28	Personal Protective Equipment
29 CFR 1926.51	Washing Facilities
29 CFR 1926.55	Gases, Vapors, Fumes, Dusts & Mists
29 CFR 1926.59	Hazard Communication Standard
29 CFR 1926.62	Construction Industry Lead Standard
29 CFR 1926.103	Respiratory Protection
40 CFR 61 Subpart A	General Provisions
40 CFR 241	Guidelines for the Land Disposal of Solid Waste
40 CFR 257	Criteria for the Land Disposal of Solid Waste
40 CFR 261/262	Waste Disposal Facilities & Practices
American National Standards Institute (ANSI) Z87.1	Eye Protection
ANSI Z88.2-80	Practices for Respiratory Protection
American Society For Testing Materials (ASTM)	All Applicable Standards

2. The contractor shall ensure that any programs, certifications, licenses or other documentation in accordance with the above and/or any other applicable Federal, State, and Local Regulations/Guidelines are provided.

C. Scope Of Work

1. The work shall consist of furnishing labor, materials, insurance and all other incidental items required to perform the following:
   a. Dust wipe sampling and analysis
      1) Collect dust wipe samples from various horizontal surfaces, such as floors, window sills, window troughs, etc., as directed by the Owner.
      2) Dust wipe samples shall be collected in accordance with ASTM ES30-94.

3) Analyze dust wipe sample in the laboratory using Flame Atomic Absorption Spectrometry ("FAAS") or Graphite Furnace Atomic Absorption Spectrometry("GFAAS").
4) Provide result of analysis in micrograms per square foot.
5) A faxed summary of results must be provided to the Owner within 24 hours after the Owner authorizes the Contractor to perform the laboratory analysis of the collected dust wipe sample. Contractor shall also have the ability to provide results in 4 hours for clearance, following lead-based paint abatement work, if requested by the Owner. The sampling result must be provided in a form approved by the Owner and must include for each dust wipe sample, the Project, the building address, the sample number, the room or room equivalent, the surface type, dimensions of sample areas, total micrograms, micrograms per square feet, and an indication of pass or fail.
6) Turn-around time for results shall be counted from the time the Contractor performs collection of dust wipe samples to the time the results are actually presented to the Owner. This includes travel time from the site to the laboratory of the Contractor and back to the site.
7) A detailed final report covering the results of all dust wipe samples taken and analyzed must be submitted within 5 days from the time the Owner authorizes the performance of the laboratory analysis. The sampling report must include for each dust wipe sample, the Project, the building address, the sample number, the room or room equivalent, the surface type, dimensions of sample areas, total micrograms, micrograms per square feet, and indicate pass or fail in a form approved by the Owner. Also include in the report the method of analysis, i.e. "FAAS" or "GFAAS", and the detection limits. The laboratory test results in the final report must be signed by the Laboratory Director.
8) The sampling data report must contain all required data fields as specified by the Owner. The sampling data report shall be provided to the Owner on 3.5 inch high density diskettes in ASCII file form. The required data fields will be provided by the Owner to the Contractor.
9) The laboratory used for the analysis of the dust wipe samples must be certified by the State Department of Health (or other responsible agency) and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"), or as an alternative having accreditation application pending before NLLAP, and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided. Indicate if the laboratory is an independent entity from the Contractor.

b. Dust Spiked Samples
1) Provide dust spiked samples to the Owner. Dust spiked samples shall be prepared in accordance with the HUD Guidelines.

NOTE: These samples are separate from the ones required by the Contractor for its own QA/QC

2) Prepare dust spiked samples in a manner such that they are indistinguishable from the field samples.
3) Prepare dust spiked samples using the same lot as that to be used in the field.
4) Dust spiked samples shall be inserted into the sample stream, randomly, by the Owner Inspector.
5) Blind analysis of dust spiked samples must fall within 80%-120% of the true value. If the laboratory fails to obtain readings within these limits, two more spiked samples shall be sent immediately to the lab for analysis.
6) If the two additional spiked samples fail, the sample batch shall be considered invalid, and the Owner may, at its sole discretion, terminate this contract as well as withhold payment for services already rendered.

c. Air Sampling and Analysis

1) Collect area air samples at various locations and various projects for personal exposure assessment as directed by the Owner.
2) Air samples shall be collected in accordance with ASTM E1553-93.
3) Prepare air samples for analysis in accordance with ASTM E33-94
4) Analyze air samples using FAAS or GFAAS.
5) All equipment required for personal air sampling, <u>including pumps</u> shall be provided by the Contractor <u>at no extra cost</u> to the Owner.
6) Provide results of air samples in micrograms per cubic meter.
7) A faxed summary of result must be provided to the Owner within 24 hours after the Owner authorizes the Contractor to perform the laboratory analysis of the collected air sample. The sampling result must include for each air sample taken the Project, the building address, the sample number, the room or room equivalent, and the reading.
8) Turn-around time shall start after collection of the air samples, and includes travel time to and from the laboratory.
9) A detailed final report covering the results of all air samples taken and analyzed must be submitted within 5 days from the time the Owner authorizes the performance of the laboratory analysis. The sampling report must include for each air sample, the Project, the building address, the sample number, the room or room equivalent, and the reading. The laboratory report contained in the final report must be signed by the Laboratory Director.
10) <u>The sampling data report must contain all required data fields as specified by the Owner. The sampling data report shall be provided to the Owner on 3.5 inch high density diskettes in ASCII file form. The required data fields will be provided by the Owner to the Contractor.</u>
11) The laboratory used for the analysis of the dust wipe samples must be certified by the State Department of Health (or other responsible agency) and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"),or as an alternative having accreditation application pending before NLLAP, and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided. Indicate if the laboratory is an independent entity from the Contractor.
12) Air sampling technician shall be present during the entire shift of the air sampling.

d. TCLP Sampling and Analysis

1) Take core samples of construction waste as directed by the Owner and analyze by TCLP testing to determine if waste is hazardous.
2) Waste shall be classified as hazardous if the concentration of lead is greater than 5 parts per million by TCLP testing.
3) The laboratory used for the analysis of the TCLP samples must be certified by the State Department of Health (or other responsible agency) and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"), or as an alternative having accreditation application pending before NLLAP, and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided. Indicate if the laboratory is an independent entity from the Contractor.
4) A faxed summary of result must be provided to the Owner within 48 hours after the Owner authorizes the Contractor to perform the TCLP analysis of the waste. Provide results in parts per million (ppm).
5) Final results provided to the Owner by the Contractor must include written sample preparation procedure and laboratory specific written procedures for performing TCLP, including quality control procedures used for performing the TCLP, and a table listing the sample numbers, description of the construction waste, and the

result of the TCLP. The laboratory report contained in the final report must be signed by the Laboratory Director.

6) Final report must also specify detection limits.

7) Final report must be provided within 5 days from the time the authorization to perform the TCLP is given by the Owner.

D. General Provisions

1. Some of the work of this contract may be in occupied apartments. The Contractor shall perform all of the work of this contract with the least inconvenience to the tenants.
2. The Contractor shall take all necessary precautions to protect the property of the Owner, its residents, and the public. The Contractor must repair any damaged property, whether of the Owner, its residents, or the public, and restore such property to its original condition. If the damage is beyond repair, the Contractor shall replace it with new, that in the judgment of the Owner, match the existing materials and/or of equal quality and workmanship. All such repairs shall be at the Contractor's expense.
3. The Contractor shall develop a work plan to be performed as requested by the Department of Planning and Development. The detailed plan shall include coordination of the monitoring and sampling work with the Contractor in a manner that will be least disruptive to the normal use of the non-work areas in the building. The plan should also include emergency procedures in case of fire.
4. The Contractor shall perform work in accordance with the latest HUD Guidelines, except as such Guidelines are modified by the Owner in writing in this Contract, or any Contract pursuant to this Contract, and in accordance with all applicable Federal, State and Local regulations.
5. The Contractor shall include in the bid price all supplementary miscellaneous items not specified but implied or required in order to complete the work.

E. Submissions

1. Six (6) copies of the submissions listed below must be submitted to the Owner by the Contractor or Subcontractor performing the Work:
   a. Ability to perform lead dust wipe sampling by submitting evidence of the successful completion of lead inspector and/or risk assessor training by all staff to be assigned to the job including inspector technicians. As stated previously, training must be provided through an approved program.
   b. Laboratory certification by the State Department of Health (or other responsible agency) through its ELAP program and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"), or as an alternative having accreditation application pending before NLLAP and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided.
   c. If a subcontractor will be used for any of the laboratory work of this contract, evidence of certification stated in (2) above must also be provided for the subcontractor.

F. Waste Disposal

1. All waste generated must be legally disposed in accordance with the Federal, State and Local Regulations.

END OF SECTION 02 83 19 13b

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Task	Specification	Specification Description
02 83 19 13	01 22 16 00	No Specification Required
02 83 19 13	02 61 26 00a	Removal Of Friable Asbestos-Containing Materials
02 83 19 13	02 82 33 00	Removal Of Nonfriable Asbestos-Containing Materials
02 83 19 13	02 82 33 00a	Removal And Disposal Of Lead-Containing Paint
02 83 33 13	02 82 33 00a	Removal And Disposal Of Lead-Containing Paint
02 83 33 13	02 83 19 13	Lead Paint Related Abatement Procedures
02 83 33 13	02 83 19 13a	XRF Testing For Lead-Based Paint
02 83 33 13	02 83 19 13b	Lead Dust Wipe, Air And Tclp Sampling And Analysis

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SECTION 02 84 16 00 - REMOVAL OF FLUORESCENT LIGHT BALLASTS/CAPACITORS AND FLUORESCENT LIGHT TUBES

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for removal of fluorescent light ballasts/capacitors and fluorescent light tubes. Products shall be as follows or as directed by the the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals

1. Before Start of Work: Submit the following to the Owner's Representative for review. Do not start work until these submittals are returned with Owner's Representative's approval.
   a. Copy of State or local license for hazardous waste hauler;
   b. Certification of at least one on-site supervisor which has satisfactorily completed the OSHA 40 Hour Health and Safety Course for Handling Hazardous Materials;
   c. Certificates of workers which have successfully completed at least the OSHA 40-Hour Health and Safety Course for Hazardous Materials;
   d. List of employees scheduled to perform this work;
   e. Schedule of start and finish times and dates for this work;
   f. Name and address of landfill where these waste materials are to be deposited (include contact person and telephone numbers);
   g. Material Safety Data Sheets for all materials requiring removal;
   h. If contractor introduces any chemical into the work environmental, a MSDS for that chemical is required before use;
   i. Transporter must have notified the EPA and/or the appropriate local government agency in advance of its intentions to transport PCB's, mercury and cadmium, and receive an identification number pursuant to the Toxic Substance Control Act (TSCA); and
   j. Contingency Plan for handling emergency spills or leaks.

1.2 PRODUCTS

A. Materials

1. Polyethylene Sheet: A single polyethylene film in the largest sheet size possible to minimize seams, 4.0 and 6.0 mil thick, clear, frosted, or black.
2. Duct Tape: Provide duct tape in 3" widths, witty an adhesive which is formulated to stick aggressively to sheet polyethylene.
3. Spray Cement: Provide spray adhesive in aerosol cans which is specifically formulated to stick tenaciously to sheet polyethylene.
4. Disposal Bays: Provide 6 mil thick leak-tight polyethylene bags.
5. Labels: As required by the EPA and OSHA for handling, transportation, and disposal of hazardous waste.
6. **Drums:** Recovery or salvage drums acceptable for disposal of hazardous waste. Prior approval of drums is required. Drums or containers must meet the required OSHA EPA (40 CFR Parts 264265 and 300), and DOT regulations (49 CFR Parts 171-178). Use of damaged drums will not be allowed.

1.3 EXECUTION

A. General
1. Where necessary, scaffolding shall be erected to fully access all applicable fluorescent light ballasts/capacitors and tubes. At no time will the ballasts/capacitors and tubes be allowed to drop onto the floor. Contractor must take care to protect from dropping the ballasts/capacitors and fluorescent tubes.
2. Prior to removing ballasts/capacitors and fluorescent tubes, contractor shall ensure that all electrical service to lights has been shut off, and locked out. Temporary lighting shall be erected to adequately illuminate work areas.
3. Depending on height of light fixtures, contractor shall utilize at least a 2-person per team system. The fluorescent light tubes shall be removed and passed to the appropriate number of workers required to lower the tubes to the floor without breaking them.
4. The worker on the floor shall lay the tubes in cardboard boxes large enough to hold a small quantity of tubes. Worker shall take care to not damage the tubes while they are lowered into the box. Once the box is full, it shall be wrapped with two layers of 6 mil thick polyethylene sheeting and sealed with duct tape.
5. Contractor may choose to either remove the fluorescent light ballasts/capacitors in-place or lower the lighting fixtures for easy access. The ballasts/capacitors shall be removed from the fixtures. Electrical wiring leading from the ballasts/capacitors shall be cut away. Ballasts/capacitors shall be placed in 55-gallon drums lined with at least two 6 mil thick polyethylene bags. Be careful not to overfill the drums so that they remain manageable. Once the drums have been filled to the acceptable level, seal the lid onto the top of the drum, and affix appropriate labels. Transport drums via hand dollies.

B. Worker Protection
1. As a minimum, while working with the ballasts/capacitors and light tubes, workers shall utilize impervious gloves adequate for the use with hazardous materials. If light ballasts/capacitors and/or light tubes are damaged, and/or exposure to these materials may reach the OSHA PEL or AGGIH threshold limit value (TLV), the contractor shall be required to provide impervious full body protection and respiratory protection. However, contractor is required to verify the type of protection required prior to working with these materials, and have written approval by Owner's Representative prior to beginning.
2. In addition, workers shall not smoke, drink or eat in these areas during work activities.

C. Storage Of Fluorescent Light Ballasts/Capacitors And Light Tubes
1. Once the containers holding the ballasts/capacitors and light tubes have been filled and sealed, they shall be stored in designated areas as agreed upon by the Owners Representative and Contractor. They shall not be allowed to be stored on-site in transportation vehicles until the time for them to be transported to the hazardous waste incinerators or landfill facility.

END OF SECTION 02 84 16 00

SECTION 02 84 16 00a - INTERIOR LIGHTING

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for interior lighting. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Interior lighting fixtures, lamps, and ballasts.
   b. Emergency lighting units.
   c. Exit signs.
   d. Lighting fixture supports.
   e. Retrofit kits for fluorescent lighting fixtures.

C. Definitions

1. BF: Ballast factor.
2. CCT: Correlated color temperature.
3. CRI: Color-rendering index.
4. HID: High-intensity discharge.
5. LER: Luminaire efficacy rating.
6. Lumen: Measured output of lamp and luminaire, or both.
7. Luminaire: Complete lighting fixture, including ballast housing if provided.

D. Submittals

1. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
   a. Physical description of lighting fixture including dimensions.
   b. Emergency lighting units including battery and charger.
   c. Ballast, including BF.
   d. Energy-efficiency data.
   e. Air and Thermal Performance Data: For air-handling lighting fixtures. Furnish data required in "Submittals" Article in Division 23 Section "Diffusers, Registers, And Grilles".
   f. Sound Performance Data: For air-handling lighting fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Division 23 Section "Diffusers, Registers, And Grilles".
   g. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
   h. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
      1) Testing Agency Certified Data: For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by manufacturer.
         OR
         Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
2. Shop Drawings: For nonstandard or custom lighting fixtures. Include plans, elevations, sections, details, and attachments to other work.

a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
b. Wiring Diagrams: For power, signal, and control wiring.

3. Samples: For each lighting fixture indicated in the Interior Lighting Fixture Schedule. Each Sample shall include the following:
   a. Lamps and ballasts, installed.
   b. Cords and plugs.
   c. Pendant support system.
4. Installation instructions.
5. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   a. Lighting fixtures.
   b. Suspended ceiling components.
   c. Partitions and millwork that penetrate the ceiling or extends to within 12 inches (305 mm) of the plane of the luminaires.
   d. Ceiling-mounted projectors.
   e. Structural members to which suspension systems for lighting fixtures will be attached.
   f. Other items in finished ceiling including the following:
      1) Air outlets and inlets.
      2) Speakers.
      3) Sprinklers.
      4) Smoke and fire detectors.
      5) Occupancy sensors.
      6) Access panels.
   g. Perimeter moldings.
6. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.
7. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.
8. Field quality-control reports.
9. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
   a. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.
10. Warranty: Sample of special warranty.

E. Quality Assurance
1. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
   OR
   Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, complying with the IESNA Lighting Measurements Testing & Calculation Guides.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Comply with NFPA 70.
4. FM Global Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

F. Coordination
1. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

G. Warranty
1. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
a. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Final Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
b. Warranty Period for Emergency Fluorescent Ballast and Self-Powered Exit Sign Batteries: Seven years from date of Final Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

1.2 PRODUCTS

A. General Requirements For Lighting Fixtures And Components
1. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
2. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.
3. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
4. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.
5. Metal Parts: Free of burrs and sharp corners and edges.
6. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
7. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
8. Diffusers and Globes:
a. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
1) Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
2) UV stabilized.
b. Glass: Annealed crystal glass unless otherwise indicated.
9. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
a. Label shall include the following lamp and ballast characteristics:
1) "USE ONLY" and include specific lamp type.
2) Lamp diameter code (T-4, T-5, T-8, T-12, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
3) Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
4) Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent luminaires.
5) ANSI ballast type (M98, M57, etc.) for HID luminaires.
6) CCT and CRI for all luminaires.
10. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic interference as required by MIL-STD-461E. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.
11. Air-Handling Fluorescent Fixtures: For use with plenum ceiling for air return and heat extraction and for attaching an air-diffuser-boot assembly specified in Division 15 Section "Diffusers, Registers, and Grilles."
a. Air-Supply Units: Slots in one or both side trims join with air-diffuser-boot assemblies.

b. Heat-Removal Units: Air path leads through lamp cavity.
c. Combination Heat-Removal and Air-Supply Unit: Heat is removed through lamp cavity at both ends of the fixture door with air supply same as for air-supply units.
d. Dampers: Operable from outside fixture for control of return-air volume.
e. Static Fixture: Air-supply slots are blanked off, and fixture appearance matches active units.

B. Ballasts For Linear Fluorescent Lamps
1. General Requirements for Electronic Ballasts:
a. Comply with UL 935 and with ANSI C82.11.
b. Designed for type and quantity of lamps served.
c. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
d. Sound Rating: Class A **OR** Class A except Class B for T8/HO and T12/Slimline lamp ballasts, **as directed**.
e. Total Harmonic Distortion Rating: Less than 10 **OR** 20, **as directed**, percent.
f. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
g. Operating Frequency: 42 kHz or higher.
h. Lamp Current Crest Factor: 1.7 or less.
i. BF: 0.88 or higher.
j. Power Factor: 0.95 **OR** 0.98, **as directed**, or higher.
k. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.
2. Luminaires controlled by occupancy sensors shall have programmed-start ballasts.
3. Electronic Programmed-Start Ballasts for T5 **OR** T8 **OR** T5HO **OR** T5 and T5HO, **as directed**, Lamps: Comply with ANSI C82.11 and the following:
a. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
b. Automatic lamp starting after lamp replacement.
4. Electromagnetic Ballasts: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.
a. Ballast Manufacturer Certification: Indicated by label.
5. Single Ballasts for Multiple Lighting Fixtures: Factory wired with ballast arrangements and bundled extension wiring to suit final installation conditions without modification or rewiring in the field.
6. Ballasts for Low-Temperature Environments:
a. Temperatures 0 Deg F (Minus 17 Deg C) and Higher: Electronic or electromagnetic type rated for 0 deg F (minus 17 deg C) starting and operating temperature with indicated lamp types.
b. Temperatures Minus 20 Deg F (Minus 29 Deg C) and Higher: Electromagnetic type designed for use with indicated lamp types.
7. Ballasts for Residential Applications: Fixtures designated as "Residential" may use low-power-factor electronic ballasts having a Class B sound rating and total harmonic distortion of approximately 30 percent.
8. Ballasts for Low Electromagnetic-Interference Environments: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for consumer equipment.
9. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
a. Dimming Range: 100 to 5 percent of rated lamp lumens.
b. Ballast Input Watts: Can be reduced to 20 percent of normal.
c. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
d. Control: Coordinate wiring from ballast to control device to ensure that the ballast, controller, and connecting wiring are compatible.
10. Ballasts for Bi-Level Controlled Lighting Fixtures: Electronic type.

a. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
   1) High-Level Operation: 100 percent of rated lamp lumens.
   2) Low-Level Operation: 30 percent of rated lamp lumens.
b. Ballast shall provide equal current to each lamp in each operating mode.
c. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

11. Ballasts for Tri-Level Controlled Lighting Fixtures: Electronic type.
   a. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
      1) High-Level Operation: 100 percent of rated lamp lumens.
      2) Low-Level Operation: 30 and 50 **OR** 30 and 60, **as directed**, percent of rated lamp lumens.
   b. Ballast shall provide equal current to each lamp in each operating mode.
   c. Compatibility: Certified by manufacturer for use with specific tri-level control system and lamp type indicated.

C. Ballasts For Compact Fluorescent Lamps
   1. Description: Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
      a. Lamp end-of-life detection and shutdown circuit.
      b. Automatic lamp starting after lamp replacement.
      c. Sound Rating: Class A.
      d. Total Harmonic Distortion Rating: Less than 20 percent.
      e. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
      f. Operating Frequency: 20 kHz or higher.
      g. Lamp Current Crest Factor: 1.7 or less.
      h. BF: 0.95 or higher unless otherwise indicated.
      i. Power Factor: 0.95 **OR** 0.98, **as directed**, except fixtures designated as "Residential" may use low-power-factor electronic ballasts, **as directed**, or higher.
      j. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

D. Emergency Fluorescent Power Unit
   1. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.
      a. Emergency Connection: Operate one fluorescent lamp(s) continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
      b. Nightlight Connection: Operate one fluorescent lamp continuously.
      c. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
         1) Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
         2) Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
      d. Battery: Sealed, maintenance-free, nickel-cadmium type.
      e. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
      f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more fluorescent lamps, remote mounted from lighting fixture. Comply with UL 924.
   a. Emergency Connection: Operate one fluorescent lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
   b. Nightlight Connection: Operate one fluorescent lamp in a remote fixture continuously.
   c. Battery: Sealed, maintenance-free, nickel-cadmium type.
   d. Charger: Fully automatic, solid-state, constant-current type.
   e. Housing: NEMA 250, Type 1 enclosure.
   f. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   g. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
   h. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
   i. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

E. Ballasts For HID Lamps

1. Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. Include the following features unless otherwise indicated:
   a. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
   b. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C) for single-lamp ballasts.
   c. Rated Ambient Operating Temperature: 104 deg F (40 deg C).
   d. Open-circuit operation that will not reduce average life.
   e. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.
2. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:
   a. Minimum Starting Temperature: Minus 20 deg F (Minus 29 deg C) for single-lamp ballasts.
   b. Rated Ambient Operating Temperature: 130 deg F (54 deg C).
   c. Lamp end-of-life detection and shutdown circuit.
   d. Sound Rating: Class A.
   e. Total Harmonic Distortion Rating: Less than 20 percent.
   f. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
   g. Lamp Current Crest Factor: 1.5 or less.
   h. Power Factor: 0.90 or higher.
   i. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
   j. Protection: Class P thermal cutout.
   k. Bi-Level Dimming Ballast: Ballast circuit and leads provide for remote control of the light output of the associated fixture between high- and low-level and off.
      1) High-Level Operation: 100 percent of rated lamp lumens.
      2) Low-Level Operation: 35 **OR** 50, **as directed**, percent of rated lamp lumens.
      3) Compatibility: Certified by ballast manufacturer for use with specific bi-level control system and lamp type indicated. Certified by lamp manufacturer that ballast operating modes are free from negative effect on lamp life and color-rendering capability.
   l. Continuous Dimming Ballast: Dimming range shall be from 100 to 35 percent of rated lamp lumens without flicker.

1) Ballast Input Watts: Reduced to a maximum of 50 percent of normal at lowest dimming setting.

3. High-Pressure Sodium Ballasts: Electromagnetic type, with solid-state igniter/starter. Igniter/starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.
   a. Instant-Restrike Device: Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts, and mogul sockets up to 150 W.
   b. Minimum Starting Temperature: Minus 40 deg F (Minus 40 deg C).

F. Quartz Lamp Lighting Controller
1. General Requirements for Controllers: Factory installed by lighting fixture manufacturer. Comply with UL 1598.
2. Standby (Quartz Restrike): Automatically switches quartz lamp on when a HID lamp in the fixture is initially energized and during the HID lamp restrike period after brief power outages.
3. Connections: Designed for a single branch -circuit connection.
4. Switching Off: Automatically switches quartz lamp off when HID lamp strikes.
   OR
   Switching Off: Automatically switches quartz lamp off when HID lamp reaches approximately 60 percent light output.

G. Exit Signs
1. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
2. Internally Lighted Signs:
   a. Lamps for AC Operation: Fluorescent, two for each fixture, 20,000 hours of rated lamp life.
      OR
      Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
   b. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
      1) Battery: Sealed, maintenance-free, nickel-cadmium type.
      2) Charger: Fully automatic, solid-state type with sealed transfer relay.
      3) Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
      4) Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
      5) LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
      6) Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
      7) Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
   c. Master/Remote Sign Configurations:
      1) Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply **OR** ballast **OR** battery, **as directed**, for power connection to remote unit.
      2) Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

3. Self-Luminous Signs: Powered by tritium gas, with universal bracket for flush-ceiling, wall, or end mounting. Signs shall be guaranteed by manufacturer to maintain the minimum brightness requirements in UL 924 for 10 **OR** 15 **OR** 20, **as directed**, years.
OR
Self-Luminous Signs: Using strontium oxide aluminate compound to store ambient light and release the stored energy when the light is removed. Provide with universal bracket for flush-ceiling, wall, or end mounting.

H. Emergency Lighting Units
1. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.
   a. Battery: Sealed, maintenance-free, lead-acid type.
   b. Charger: Fully automatic, solid-state type with sealed transfer relay.
   c. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
   d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
   f. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
   g. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
   h. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
   i. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

I. Fluorescent Lamps
1. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches (1220 mm), 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life 20,000 hours unless otherwise indicated.
2. T8 rapid-start lamps, rated 17 W maximum, nominal length of 24 inches (610 mm), 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life of 20,000 hours unless otherwise indicated.
3. T5 rapid-start lamps, rated 28 W maximum, nominal length of 45.2 inches (1150 mm), 2900 initial lumens (minimum), CRI 85 (minimum), color temperature 3000 K, and average rated life of 20,000 hours unless otherwise indicated.
4. T5HO rapid-start, high-output lamps, rated 54 W maximum, nominal length of 45.2 inches (1150 mm), 5000 initial lumens (minimum), CRI 85 (minimum), color temperature 4100 K, and average rated life of 20,000 hours unless otherwise indicated.
5. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 3500 K, average rated life of 10,000 hours at three hours operation per start, and suitable for use with dimming ballasts, **as directed**.

J. HID Lamps
1. High-Pressure Sodium Lamps: ANSI C78.42, CRI 21 (minimum), color temperature 1900 K, and average rated life of 24,000 hours, minimum.

a. Dual-Arc Tube Lamps: Arranged so only one of two arc tubes is lighted at one time and, when power is restored after an outage, the cooler arc tube, with lower internal pressure, lights instantly, providing an immediate 8 to 15 percent of normal light output.
2. Metal-Halide Lamps: ANSI C78.43, with minimum CRI 65, and color temperature 4000 K.
3. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000 K.
4. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and color temperature 4000 K.
5. Low-Pressure Sodium Lamps: ANSI 78.41, CRI 0, and color temperature 1800 K.

K. Lighting Fixture Support Components
1. Comply with Division 26 Section "Hangers And Supports For Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
2. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
3. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
4. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).
5. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage (2.68 mm).
6. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
7. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

L. Retrofit Kits For Fluorescent Lighting Fixtures
1. Reflector Kit: UL 1598, Type I. Suitable for two- to four-lamp, surface-mounted or recessed lighting fixtures by improving reflectivity of fixture surfaces.
2. Ballast and Lamp Change Kit: UL 1598, Type II. Suitable for changing existing ballast, lamps, and sockets.

1.3 EXECUTION

A. Installation
1. Lighting fixtures:
a. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
b. Install lamps in each luminaire.
2. Temporary Lighting: If it is necessary, and approved by the Owner, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.
3. Remote Mounting of Ballasts: Distance between the ballast and fixture shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.
4. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.
a. Install ceiling support system rods or wires, independent of the ceiling suspension devices, **as directed**, for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.
b. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
c. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
d. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
5. Suspended Lighting Fixture Support:
a. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.

b. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
c. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
d. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

6. Air-Handling Lighting Fixtures: Install with dampers closed and ready for adjustment.
7. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

B. Identification

1. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".

C. Field Quality Control

1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
2. Verify that self-luminous exit signs are installed according to their listing and the requirements in NFPA 101.
3. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

D. Startup Service

1. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by the Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

E. Adjusting

1. Occupancy Adjustments: When requested within 12 months of date of Final Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
   a. Adjust aimable luminaires in the presence of the Owner.

END OF SECTION 02 84 16 00a

SECTION 02 84 16 00b - EXTERIOR LIGHTING

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for exterior lighting. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Exterior luminaires with lamps and ballasts.
      b. Luminaire-mounted photoelectric relays.
      c. Poles and accessories.
      d. Luminaire lowering devices.

C. Definitions
   1. CCT: Correlated color temperature.
   2. CRI: Color-rendering index.
   3. HID: High-intensity discharge.
   4. LER: Luminaire efficacy rating.
   5. Luminaire: Complete lighting fixture, including ballast housing if provided.
   6. Pole: Luminaire support structure, including tower used for large area illumination.
   7. Standard: Same definition as "Pole" above.

D. Structural Analysis Criteria For Pole Selection
   1. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.
   2. Live Load: Single load of 500 lbf (2224 N), distributed as stated in AASHTO LTS-4-M.
   3. Ice Load: Load of 3 lbf/sq. ft. (145 Pa), applied as stated in AASHTO LTS-4-M Ice Load Map.
   4. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.
      a. Basic wind speed for calculating wind load for poles exceeding 49.2 feet (15 m) in height is 100 mph (45 m/s) **OR** 90 mph (40 m/s), **as directed**.
         1) Wind Importance Factor: 1.0.
         2) Minimum Design Life: 50 years.
         3) Velocity Conversion Factors: 1.0.
      b. Basic wind speed for calculating wind load for poles 50 feet (15 m) high or less is 100 mph (45 m/s) **OR** 90 mph (40 m/s).
         1) Wind Importance Factor: 1.0.
         2) Minimum Design Life: 25 years.
         3) Velocity Conversion Factors: 1.0.

E. Submittals
   1. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
      a. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
      b. Details of attaching luminaires and accessories.
      c. Details of installation and construction.
      d. Luminaire materials.
      e. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.

1) Testing Agency Certified Data: For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
OR
Manufacturer Certified Data: Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

f. Photoelectric relays.
g. Ballasts, including energy-efficiency data.
h. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.
i. Materials, dimensions, and finishes of poles.
j. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
k. Anchor bolts for poles.
l. Manufactured pole foundations.

2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   b. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
   c. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
   d. Wiring Diagrams: For power, signal, and control wiring.
3. Samples: For products designated for sample submission in the Exterior Lighting Device Schedule. Each Sample shall include lamps and ballasts.
4. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.
5. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.
6. Field quality-control reports.
7. Operation and Maintenance Data: For luminaires and poles **OR** luminaire lowering devices, **as directed**, to include in emergency, operation, and maintenance manuals.
8. Warranty: Sample of special warranty.

F. Quality Assurance

1. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
   OR
   Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Comply with IEEE C2, "National Electrical Safety Code."
4. Comply with NFPA 70.

G. Delivery, Storage, And Handling

1. Package aluminum poles for shipping according to ASTM B 660.
2. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
3. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4 inch (6 mm) deep. Do not apply tools to section of pole to be installed below ground line.

4. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.
5. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

H. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
   a. Warranty Period for Luminaires: Five years from date of Final Completion.
   b. Warranty Period for Metal Corrosion: Five years from date of Final Completion.
   c. Warranty Period for Color Retention: Five years from date of Final Completion.
   d. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Final Completion.

1.2 PRODUCTS

A. General Requirements For Luminaires
1. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
   a. LER Tests Incandescent Fixtures: Where LER is specified, test according to NEMA LE 5A.
   b. LER Tests Fluorescent Fixtures: Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
   c. LER Tests HID Fixtures: Where LER is specified, test according to NEMA LE 5B.
2. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
3. Metal Parts: Free of burrs and sharp corners and edges.
4. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.
5. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
6. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
7. Exposed Hardware Material: Stainless steel.
8. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
9. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
10. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
    a. White Surfaces: 85 percent.
    b. Specular Surfaces: 83 percent.
    c. Diffusing Specular Surfaces: 75 percent.
11. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
12. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
13. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

a. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
b. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
    1) Color: As selected from manufacturer's standard catalog of colors **OR** As selected from manufacturer's full range, **as directed**.

14. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
    a. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
    b. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
    c. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
    d. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
        1) Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black, **as directed**.

15. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
    a. Label shall include the following lamp and ballast characteristics:
        1) "USES ONLY" and include specific lamp type.
        2) Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
        3) Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
        4) Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires.
        5) ANSI ballast type (M98, M57, etc.) for HID luminaires.
        6) CCT and CRI for all luminaires.

B. Luminaire-Mounted Photoelectric Relays

1. Comply with UL 773 or UL 773A.
2. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc (16 to 32 lx) and off at 4.5 to 10 fc (48 to 108 lx) with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff, **as directed**.
    a. Relay with locking-type receptacle shall comply with ANSI C136.10.
    b. Adjustable window slide for adjusting on-off set points.

C. Fluorescent Ballasts And Lamps

1. Ballasts for Low-Temperature Environments:
    a. Temperatures 0 Deg F (Minus 17 Deg C) and Higher: Electronic or electromagnetic type rated for 0 deg F (minus 17 deg C) starting and operating temperature with indicated lamp types.
    b. Temperatures Minus 20 Deg F (Minus 29 Deg C) and Higher: Electromagnetic type designed for use with indicated lamp types.
2. Ballast Characteristics:
    a. Power Factor: 90 percent, minimum.

b. Sound Rating: Class A **OR** Class A except Class B for T8/HO ballasts, **as directed**.
c. Total Harmonic Distortion Rating: Less than 10 **OR** 20, **as directed**, percent.
d. Electromagnetic Ballasts: Comply with ANSI C82.1, energy-saving, high power factor, Class P, automatic-reset thermal protection.
e. Case Temperature for Compact Lamp Ballasts: 65 deg C, maximum.
f. Transient-Voltage Protection: Comply with IEEE C62.41.1 and IEEE C62.41.2, Category A or better.

3. Low-Temperature Lamp Capability: Rated for reliable starting and operation with ballast provided at temperatures 0 deg F (minus 18 deg C) **OR** minus 20 deg F (minus 29 deg C), **as directed**, and higher.

D. Ballasts For HID Lamps
1. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp life. Include the following features unless otherwise indicated:
   a. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
   b. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C).
   c. Normal Ambient Operating Temperature: 104 deg F (40 deg C).
   d. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.
2. Auxiliary, Instant-On, Quartz System: Factory-installed feature automatically switches quartz lamp on when fixture is initially energized and when momentary power outages occur. System automatically turns quartz lamp off when HID lamp reaches approximately 60 percent of light output.
3. High-Pressure Sodium Ballasts: Electromagnetic type with solid-state igniter/starter and capable of open-circuit operation without reduction of average lamp life. Igniter/starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.
   a. Instant-Restrike Device: Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts, and mogul sockets up to 150 W.
      1) Restrike Range: 105- to 130-V ac.
      2) Maximum Voltage: 250-V peak or 150-V ac rms.
   b. Minimum Starting Temperature: Minus 40 deg F (Minus 40 deg C).

E. HID Lamps
1. High-Pressure Sodium Lamps: ANSI C78.42, CRI 21 (minimum), CCT color temperature 1900 K, and average rated life of 24,000 hours, minimum.
   a. Dual-Arc Tube Lamp: Arranged so only one of two arc tubes is lighted at one time and, when power is restored after an outage, the cooler arc tube, with lower internal pressure, lights instantly, providing an immediate 8 to 15 percent of normal light output.
2. Low-Pressure Sodium Lamps: ANSI C78.43.
3. Metal-Halide Lamps: ANSI C78.43, with minimum CRI 65, and CCT color temperature 4000 K.
4. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and CCT color temperature 4000 K.
5. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and CCT color temperature 4000 K.

F. General Requirements For Poles And Support Components
1. Structural Characteristics: Comply with AASHTO LTS-4-M.
   a. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
   b. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
2. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.
3. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

a. Materials: Shall not cause galvanic action at contact points.
b. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
c. Anchor-Bolt Template: Plywood or steel.

4. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches (65 by 130 mm), with cover secured by stainless-steel captive screws. Provide on all, except wood poles.
5. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete."
6. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.
7. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4-M.

G. Steel Poles

1. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); one-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.
   a. Shape: Round, tapered **OR** Round, straight **OR** Square, tapered **OR** Square, straight, **as directed**.
   b. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
2. Steel Mast Arms: Single-arm **OR** Truss **OR** Davit, **as directed**, type, continuously welded to pole attachment plate. Material and finish same as pole.
3. Brackets for Luminaires: Detachable, cantilever, without underbrace.
   a. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with stainless **OR** galvanized, **as directed**,-steel bolts.
   b. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
   c. Match pole material and finish.
4. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
5. Steps: Fixed steel, with nonslip treads, positioned for 15-inch (381-mm) vertical spacing, alternating on opposite sides of pole; first step at elevation 10 feet (3 m) above finished grade.
6. Intermediate Handhole and Cable Support: Weathertight, 3-by-5-inch (76-by-127-mm) handhole located at midpoint of pole with cover for access to internal welded attachment lug for electric cable support grip.
7. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Division 26 Section "Grounding And Bonding For Electrical Systems", listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
8. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.
9. Platform for Lamp and Ballast Servicing: Factory fabricated of steel with finish matching that of pole.
10. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
11. Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A 123/A 123M.
12. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
    a. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."

b. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
c. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
1) Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

H. Aluminum Poles
1. Poles: Seamless, extruded structural tube complying with ASTM B 429/B 429M, Alloy 6063-T6 with access handhole in pole wall.
2. Poles: ASTM B 209 (ASTM B 209M), 5052-H34 marine sheet alloy with access handhole in pole wall.
a. Shape: Round, tapered **OR** Round, straight **OR** Square, tapered **OR** Square, straight, **as directed**.
b. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
3. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
4. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Division 26 Section "Grounding And Bonding For Electrical Systems", listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
5. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
a. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
b. Finish: Same as pole **OR** luminaire, **as directed**.
6. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
7. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
a. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
b. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
c. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
d. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
1) Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from manufacturer's full range, **as directed**.

I. Fiberglass Poles
1. Poles: Designed specifically for supporting luminaires, with factory-formed cable entrance and handhole. Not less than 65 percent fiberglass, with resin and pigment making up the remainder.
a. Resin Color: Dark bronze; provide uniform coloration throughout entire wall thickness.
b. Surface Finish: Pigmented polyurethane, with a minimum dry film thickness of 1.5 mils (0.04 mm). Polyurethane may be omitted if the surface layer of pole is inherently UV inhibited.

J. Decorative Poles
1. Pole Material:
a. Cast ductile iron.
b. Cast gray iron, according to ASTM A 48/A 48M, Class 30.
c. Cast aluminum.
d. Cast concrete.

e. Spun concrete.
f. Steel tube, covered with closed-cell polyurethane foam, with a polyethylene exterior.

2. Mounting Provisions:
   a. Bolted to concrete foundation.
   b. Embedded.
3. Fixture Brackets:
   a. Cast ductile iron.
   b. Cast gray iron.
   c. Cast aluminum.
4. Pole Finish: <**Insert finish**>.

K. Laminated Wood Poles

1. Species and Grades for Structural Glulam Timber: Engineer and fabricate structural laminated wood poles, complying with ANSI A190.1. Use southern pine **OR** Douglas fir **OR** Alaska cedar **OR** any species listed in AITC 117, **as directed**, to withstand indicated structural loads without exceeding allowable design working stresses according to AITC 117.
2. Features: Include wood bracket **OR** wood crossarm **OR** pole-top adapter, **as directed**, for mounting luminaire(s), metal pole cap, **as directed**, and concealed raceway path connected to access handhole.
3. Mounting Provisions: Embedded.
4. Appearance Grade: Architectural appearance grade complying with AITC 110.
5. Preservative Treatment: Pressure treat lumber before gluing according to AWPA C28 for waterborne preservatives. After dressing and end-cutting each member to final size and shape, apply a field-treatment preservative to comply with AWPA M4 to surfaces cut to a depth of more than 1/16 inch (1.6 mm).
6. Adhesive: Wet-use type complying with ASTM D 2559.
7. End Sealer: Manufacturer's standard, transparent, colorless wood sealer that is effective in retarding the transmission of moisture at cross-grain cuts and is compatible with indicated finish.
8. Penetrating Sealer: Manufacturer's standard, transparent, penetrating wood sealer that is compatible with indicated finish.
9. Finish: Natural, unstained wood **OR** Semitransparent stain applied after erection **OR** Semitransparent stain applied at factory, **as directed**, color as selected.

L. Wood Poles

1. Poles: Douglas fir **OR** Southern yellow pine, **as directed**, machine trimmed by turning, **as directed**, complying with ANSI O5.1 and with AWPA C4 for wood species used; and bored, roofed, and gained before treatment.
   a. Mounting Provisions: Embedded.
2. Preservative Treatment: Pressure treat poles with creosote **OR** pentachlorophenol **OR** ammoniacal copper arsenate, **as directed**, according to AWPA C1 and AWPA C4.
3. Luminaire Brackets: Comply with ANSI C136.13.

M. Prestressed Concrete Poles

1. Poles: Manufactured by centrifugal spin-casting process **OR** of cast concrete, **as directed**.
   a. Shape: Round, tapered **OR** Round, straight **OR** Square, tapered **OR** Square, straight, **as directed**.
   b. Mounting Provisions: Steel butt flange for bolted mounting to foundation or breakaway support **OR** Embedded, **as directed**.
   c. Finishing: Capped at top and plugged at bottom. Seat each steel reinforcing strand with epoxy adhesive.
   d. Grounding: Continuous copper ground wire cast into pole. Terminate at top of pole and attach to 24-inch (610-mm) lightning rod, **as directed**.
2. Cure with wet steam and age for a minimum of 15 days before installation.
3. Fabricate poles with a hard, nonporous surface that is resistant to water, frost, and road and soil chemicals and that has a maximum water-absorption rate of 3 percent.

4. Cast aluminum nameplate into pole wall at approximately 5 feet (1.5 m) above ground line, listing name of manufacturer, Project identifier, overall height, and approximate weight.
5. Pole Brackets: Comply with ANSI C136.13.
6. Finish Color: Provided by color material complying with ASTM C 979, uniformly impregnated throughout the pole concrete. Color material shall provide a uniform, stable, permanent color and be as follows:
   a. Inert, and carbon free.
   b. Unaffected by environmental conditions and contaminants including, but not limited to, UV solar radiation, salts, and alkalis.
7. Finish Texture: Standard form **OR** Polished exposed aggregate **OR** Etched exposed aggregate, **as directed**.
   a. Exposed aggregate shall be of <**Insert aggregate type selected from manufacturers' lists**> type.

N. Pole Accessories
1. Duplex Receptacle: 120 V, 20 A in a weatherproof assembly complying with Division 16 Section "Wiring Devices" for ground-fault circuit-interrupter type.
   a. Surface mounted **OR** Recessed, **as directed**, 12 inches (300 mm) above finished grade.
   b. Nonmetallic polycarbonate plastic or reinforced fiberglass, weatherproof in use, cover, that when mounted results in NEMA 250, Type 3R **OR** Type 4X, **as directed**, enclosure.
   c. With cord opening.
   d. With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.
2. Minimum 1800-W transformer, protected by replaceable fuses, mounted behind access cover.
3. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.
4. Transformer Type Base: Same material and color as pole. Coordinate dimensions to suit pole's base flange and accept ballast(s) **OR** indicated accessories, **as directed**.
5. Decorative accessories, supplied by decorative pole manufacturer, include the following:
   a. Banner Arms: <**Insert material**>.
   b. Flag Holders: <**Insert material**>.
   c. Ladder Rests: <**Insert material**>.

O. Lowering System For Luminaires
1. Arrange system to lower luminaire **OR** luminaire assembly, **as directed**, to a servicing position within 36 inches (900 mm) of finished grade in winds up to 30 mph (49 km/h) and to provide for manual plug connection to electrical power in the lowered position for testing.
2. Coordinate with luminaire and pole manufacturers for assembly details, wind-load and vibration analysis, and compatibility of materials for electrolysis-free attachment and connection for luminaire mounting assembly, lowering device, lowering cable, and portable winch.
3. Structural and Mechanical Design: Use a minimum safety factor of 5.0 for static and dynamic loads of load-bearing components, including cable.
4. Luminaire Mounting and Disconnect Arrangement: Multiple ring **OR** carriage, **as directed**,-mounted luminaires, arranged for lowering and rising as a group.
   a. Electrical cable for normal operating power to luminaires manually disconnects inside pole base, using weatherproof multipin connector, and shall be arranged to move within the pole during lowering and rising of luminaire assembly.
      OR
      Electrical cable for normal operating power to luminaires automatically disconnects at a weatherproof multipin connector within the pole-top lowering head at the beginning of the lowering cycle and reconnects when luminaire or luminaire assembly is raised to the operating position.
5. Lowering Device: Weatherproof, cast-aluminum housing and multiple mechanical latches. Moving parts of latching assembly shall be located in the portion of the unit that is lowered to the servicing position. Positive latching in the operating position shall be indicated to the operator at the base of the pole by a clear visual signal, or by other means acceptable to the Owner or authorities having jurisdiction.

6. Lowering Cable: Zinc-electroplated- or stainless-steel aircraft cable.
7. Portable Winch: Manual **OR** 120-V electric, **as directed**, type. One required.
   a. Winch Power Connection: Cord and plug.
   b. Winch Raise-Lower Control: Remote-control station with 15 feet (5 m) of cable.
8. Winch Transformer: Portable, totally enclosed, encapsulated, single-phase, dry type. Primary rated at lighting-circuit voltage; secondary rated at 120 V. Permanent, primary and secondary, twist-locking plug connectors on pigtails shall match pole-base power outlet and winch plug.

1.3 EXECUTION

A. Luminaire Installation
1. Install lamps in each luminaire.
2. Fasten luminaire to indicated structural supports.
   a. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
3. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation, **as directed**.

B. Pole Installation
1. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
2. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
   a. Fire Hydrants and Storm Drainage Piping: 60 inches (1520 mm).
   b. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3 m).
   c. Trees: 15 feet (5 m) from tree trunk.
3. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-place Concrete".
4. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
   a. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
   b. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
   c. Install base covers unless otherwise indicated.
   d. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
5. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
   a. Dig holes large enough to permit use of tampers in the full depth of hole.
   b. Backfill in 6-inch (150-mm) layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.
6. Embedded Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
   a. Make holes 6 inches (150 mm) in diameter larger than pole diameter.
   b. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi (20 MPa) at 28 days, and finish in a dome above finished grade.
   c. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.
   d. Cure concrete a minimum of 72 hours before performing work on pole.
7. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- (150-mm-) wide, unpaved gap between the pole or pole foundation and the edge of adjacent

concrete slab. Fill unpaved ring with pea gravel to a level 1 inch (25 mm) below top of concrete slab.

8. Raise and set poles using web fabric slings (not chain or cable).

C. Bollard Luminaire Installation

1. Align units for optimum directional alignment of light distribution.
2. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-place Concrete".

D. Installation Of Individual Ground-Mounting Luminaires

1. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-place Concrete".

E. Corrosion Prevention

1. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
2. Steel Conduits: Comply with Division 26 Section "Raceway And Boxes For Electrical Systems". In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

F. Grounding

1. Ground metal poles and support structures according to Division 26 Section "Grounding And Bonding For Electrical Systems".
   a. Install grounding electrode for each pole unless otherwise indicated.
   b. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
2. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding And Bonding For Electrical Systems".
   a. Install grounding electrode for each pole.
   b. Install grounding conductor and conductor protector.
   c. Ground metallic components of pole accessories and foundations.

G. Field Quality Control

1. Inspect each installed fixture for damage. Replace damaged fixtures and components.
2. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
   a. Verify operation of photoelectric controls.
3. Illumination Tests:
   a. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
      1) IESNA LM-5, "Photometric Measurements of Area and Sports Lighting Installations."
      2) IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
      3) IESNA LM-52, "Photometric Measurements of Roadway Sign Installations."
      4) IESNA LM-64, "Photometric Measurements of Parking Areas."
      5) IESNA LM-72, "Directional Positioning of Photometric Data."
4. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

H. Demonstration

1. Train the Owner's maintenance personnel to adjust, operate, and maintain luminaire lowering devices.

END OF SECTION 02 84 16 00b

SECTION 02 84 33 00 - OVERHEAD ELECTRICAL DISTRIBUTION

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for overhead electrical distribution. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
    a. Conductors, connectors, and splices.
    b. Poles and crossarms.
    c. Hardware and accessories.
    d. Surge arresters.
    e. Cutouts, switches, and fuses.
    f. Pole-mounted distribution transformers.
    g. Primary metering equipment.

C. Definitions
1. BIL: Basic impulse level, stated in kilovolts.
2. RUS: Department of Agriculture, Rural Utilities Service.
3. Sag: The distance measured vertically from a conductor to the straight line joining its two points of support, measured at the midpoint of the span, unless otherwise indicated.
    a. Final Sag: The sag of a conductor under specified conditions of loading and temperature applied after it has been subjected, for an appreciable period, to the loading prescribed for the loading district in which it is situated, or equivalent loading, and the loading removed. Final sag includes the effect of inelastic deformation (creep).
    b. Initial Unloaded Sag: The sag of a conductor before the application of an external load.
4. Secondary: Conductors and components for circuits operating at the utilization voltage of 600 V or less.
5. Service: Set of insulated conductors extending from a pole to the metering point or service entrance connection at the location of utilization of electricity.

D. Submittals
1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Qualification Data: For qualified manufacturer **OR** testing agency, **as directed**.
3. Material Certificates: For the following items, from manufacturers:
    a. Wood poles.
    b. Concrete poles.
    c. Wood crossarms.
4. Listing Documentation: Indicate that products comply with RUS listing requirements specified in "Quality Assurance" Article.
    a. Time-Current Coordination Curves: Illustrate optimum coordination of protective devices involved in the Work of this Section.
    b. Source quality-control test reports.
5. Field quality-control reports.
6. Operation and Maintenance Data: For switches **OR** transformers, **as directed**, to include in emergency, operation, and maintenance manuals.
7. Survey records for locations of pole, anchors, and other features for inclusion in Project Record Documents.

E. Quality Assurance
1. Concrete Pole Manufacturer Qualifications: Certified by PCI as a qualified manufacturer of concrete utility poles of type and size indicated for this Project.
2. Inspection Agency Qualifications for Pole and Crossarm Inspection: An independent agency, acceptable to authorities having jurisdiction, qualified to conduct inspections indicated.
3. Testing Agency Qualifications: Member company of NETA or an NRTL.
4. Testing Agency's Field Supervisor: Currently certified by NETA or an NRTL.
5. Treatment Technician Qualifications for Field Treatment of Wood Poles and Crossarms: Certified by authorities having jurisdiction over environmental protection at the location of Project for field application of chemicals required.
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
7. Overhead-Line Components, Devices, and Accessories: Currently listed in RUS Informational Publication 202-1 without restriction for the intended application.
8. Comply with IEEE C2 **OR** CPUC General Order 95, **as directed**, except where stricter requirements are indicated or where local requirements that are stricter apply.
9. Strength of Line and Line Components Selected by Contractor: Provide grades of construction and strength required by IEEE C2 for conditions encountered at Project site for heavy **OR** medium **OR** light, **as directed**, line loading unless otherwise indicated.

F. Delivery, Storage, And Handling
1. Wood Pole Storage and Handling: Comply with ATIS O5.1. Do not use pointed handling tools capable of producing indentations greater than 1 inch (25 mm).

G. Project Conditions
1. Interruption of Existing Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   a. Notify Owner no fewer than two days in advance of proposed interruption of service.
   b. Do not proceed with interruption of service without Owner's written permission.

H. Coordination
1. Coordinate with utility supplying electricity to lines specified in this Section, and make final connections **OR** arrangements for final connections by utility, **as directed**.
2. Coordinate with those responsible for voice **OR** data **OR** video, **as directed**, systems that will have cables supported by poles installed according to this Section.

1.2 PRODUCTS

A. Conductors, Connectors, And Splices
1. Conductor Type AAC: Bare **OR** Bare and covered, **as directed**, all-aluminum, Alloy 1350-H19, complying with ASTM B 230/B 230M and ASTM B 231/B 231M.
   OR
   Conductor Type AAAC: Bare **OR** Bare and covered, **as directed**, all-aluminum-alloy, Alloy 6201-T81, complying with ASTM B 398/B 398M and ASTM B 399/B 399M.
   OR
   Conductor Type ACSR: Bare **OR** Bare and covered, **as directed**, aluminum conductor, steel reinforced, complying with ASTM B 232/B 232M.
   OR
   Conductor Type CU: Bare **OR** Bare and covered, **as directed**, hard-drawn copper, complying with ASTM B 1 and ASTM B 8.
2. Conductor Covering: UV resistant, complying with ICEA-S-70-547. HDPE **OR** XLP, **as directed**, 150 mils (3.81 mm) thick.

3. Self-Supported, Multiconductor, Insulated Medium-Voltage Wiring: Factory-assembled, messenger-supported type, listed under UL 1072 as sunlight-resistant Type MV cable for cable tray use.
   a. Conductors: Aluminum, Alloy 1350, complying with ASTM B 230/B 230M and ASTM B 231/B 231M **OR** Hard-drawn copper, complying with ASTM B 1 and ASTM B 8, **as directed**; stranded for No. 2 AWG and larger.
   b. Conductor Insulation: XLP, complying with NEMA WC 70/ICEA S-95-658 **OR** EPR, complying with NEMA WC 70/ICEA S-95-658, **as directed**.
   c. Insulation Level: 100 **OR** 133, **as directed**, percent of rated circuit line-to-line voltage.
   d. Conductor Shield: Extruded, nonconducting, thermoset material, complying with NEMA WC 70/ICEA S-95-658; 18-mil (0.046-mm) minimum thickness.
   e. Insulation Shield: Include the following two components:
      1) Nonmetallic conducting, material complying with NEMA WC 70/ICEA S-95-658 and UL 1072, extruded over, and free stripping from the insulation.
      2) Metallic Tape Shield: Bare copper, 5-mil (0.127-mm) minimum thickness, helically applied with a 15 percent minimum overlap.
   f. Conductor Jacket: Extruded, chlorosulfonated-polyethylene-based material, complying with NEMA WC 70/ICEA S-95-658.
   g. Messenger: Copper **OR** Composite copper and copper, **as directed**,-clad steel.
   h. Conductor Support Strap: Copper strap, wound around conductors and messenger the full length of the cable.
4. Secondary-Voltage Line Conductors: Aluminum conductor, steel **reinforced**, complying with ASTM B 232/B 232M **OR** Covered aluminum conductor, steel reinforced, complying with ICEA S-70-547, with HDPE or XLP covering, **as directed**, 60 mils (1.52 mm) thick.
   OR
   Secondary-Voltage Line Conductors: Bare hard-drawn copper, complying with ASTM B 1 and ASTM B 8 **OR** Covered hard-drawn copper, complying with ICEA S-70-547, with HDPE or XLP covering, **as directed**, 60 mils (1.52 mm) thick. Neutral-supported, secondary service-drop cable, **as directed**.
   OR
   Racked Secondary Conductors, 600 V and Less: Copper, insulated with XLP, complying with NEMA WC 70/ICEA S-95-658, **as directed**.
5. Neutral-Supported, Secondary Service-Drop Cable, 600 V and Less: Insulated conductors with bare neutral, complying with ICEA S-76-474, and using the following combination of materials:
   a. Conductors and Neutral: Copper with copper-clad-steel neutral **OR** Aluminum with bare Alloy 1350 aluminum neutral **OR** Aluminum with ACSR neutral, **as directed**.
   b. Insulation: XLP, complying with NEMA WC 70/ICEA S-95-658 **OR** High-modular-weight, low-density polyethylene **OR** Weather-resistant polyolefin, complying with ICEA S-70-547, **as directed**.
6. Connectors, Splices, and Conductor Securing and Protecting Components: Items include wire clamps, ties, conductor armor, fittings, connectors, and terminals. Listed for the specific applications and conductor types and combinations of materials used. Descriptions as follows for various applications:
   a. Copper to Copper: Copper alloy, complying with UL 486A-486B.
   b. Aluminum Composition to Aluminum Composition: Aluminum alloy, complying with UL 486A-486B.
   c. Copper to Aluminum Composition: Type suitable for this purpose, complying with UL 486A-486B.
   d. Connectors and Splices for Secondary Conductors: Listed and labeled for the conditions and materials involved in each application.
   e. Taps for Medium-Voltage Line Conductors: Hot-line clamps, screw type, with concealed threads and bare, hard-drawn copper stirrups. Listed for the combination of materials being connected.
   f. Splices under Tension: Compression type with strength exceeding the conductors spliced.

g. Splices and Terminations for Covered Conductors: As recommended by conductor manufacturer for conductor and covering combination and for specific materials and physical arrangement of each splice.
h. Splices and Terminations for Insulated Medium-Voltage Conductors: Comply with requirements in Division 26 Section "Medium-voltage Cables".

B. Wood Poles
1. Comply with ATIS O5.1 and RUS Bulletin 1728F-700, for wood poles pressure treated with creosote **OR** pentachlorophenol, **as directed**, **OR** ammoniacal copper arsenate, **OR** ammoniacal copper zinc arsenate **OR** chromated copper arsenate, **as directed**.
2. Wood Species: Douglas fir **OR** Lodgepole pine **OR** Western larch **OR** Southern yellow pine, **as directed**.
3. Pole Marking:
   a. Manufacturer's Mark: Comply with ATIS O5.1; locate 10 feet (3 m) from the pole butt for poles 50 feet (15 m) long or less.
   b. Pole Number: Machine-embossed aluminum, alphanumeric characters not less than 2-1/2 inches (65 mm) high, with aluminum nails.
4. Factory Operations: Machine trim poles by turning smooth, full length. Roof, gain, and bore poles before pressure treatment.

C. Concrete Poles
1. Description: Spuncast prestressed concrete, complying with requirements of ASTM C 1089.
   a. Comply with requirements of RUS Bulletin 1724E-216.
2. Design: Base design on calculation of strength required by IEEE C2 or indicated on Drawings, whichever is greater. Design shall be suitable for installation at a location where annual temperature range is between minus 4 deg F and plus 100 deg F (minus 20 deg C and plus 38 deg C). Include pole design for embedded attachments matching fittings, brackets, and other items installed in the field.
3. Shaft: Hollow, for poles at overhead-to-underground connections. Provide 3-1/2-inch- (89-mm-) minimum cable raceway capacity, with conduit elbow **OR** cable entry port, **as directed**, at base.
4. Water Absorption: Not more than 3 percent.
5. Surface: Smooth, hard, nonporous, and resistant to soil acids **OR** road salts **OR** frost and freezing damage, **as directed**.
6. Pole Marking:
   a. Manufacturer's Mark: Comply with ATIS O5.1; locate 10 feet (3 m) from the pole butt for poles 50 feet (15 m) long or less.
   b. Pole Number: Machine-embossed aluminum, alphanumeric characters not less than 2-1/2 inches (65 mm) high.

D. Crossarms
1. Description: Solid-wood distribution type, complying with RUS Bulletin 1728H-701 for specified construction grade **OR** Galvanized, steel angles, **as directed**, and complying with IEEE C2 for required climbing space and wire clearances.
2. Braces: Galvanized, flat, ferrous-metal units; 1/4 inch (6 mm) thick by 1-1/4 inches (30 mm) wide, minimum, with length to suit crossarm dimensions.

E. Guys And Anchors
1. Guy Strand Assemblies: Cable and attachment assemblies shall have uniform minimum breaking strength of the cable.
2. Cable: Seven strands. Zinc-coated steel, complying with ASTM A 475 **OR** Aluminum-clad steel, complying with ASTM B 416 **OR** Copper-clad steel, complying with ASTM B 228, **as directed**. Breaking strength shall be not less than 10,000 lb (45 kN).
3. Cable Termination:
   1) Thimble eye.
   OR

Hooks and guy strain plates, complying with IEEE C135.1.
2) Preformed galvanized-steel guy grips, matching material, galvanizing, and strength of the guy strand assembly.

4. Anchor and Anchor-Rod Assemblies: Hot-dip galvanized steel.
   a. Power-installed screw-type anchors.
      1) 15-inch (380-mm) screw; with rod 96 inches (2400 mm) long by 1-1/2 inches (38 mm) in diameter. Rated at 10,000 lb (45 kN) when installed.
      2) Guy anchors shall have strength and holding area as required for anchor load and soil conditions at location of that anchor.
5. Strain Insulators: Epoxy-bonded fiberglass of length to meet clearance requirements specified in "Guy Installation" Article.
6. Guy Markers: Round, of vinyl or PVC material, white **OR** yellow, **as directed**, color, 96 inches (2440 mm) long. Shatter resistant at temperatures below 0 deg F (minus 18 deg C).

F. Hardware And Accessories
1. Description: Ferrous-metal items include, but are not limited to, bolts, nuts, washers, crossarm gains and braces, insulator pins, anchor rods, anchors, eyebolts, staples, and transformer brackets.
   a. Comply with IEEE C135.1, IEEE C135.2, ANSI C135.4, ANSI C135.22, and RUS Informational Publication 202-1 listings with the exception that base material shall be malleable iron or ductile iron, and finish shall be hot-dip galvanized, **as directed**.
2. Insulator Brackets: Hot-dip galvanized steel, style as indicated, designed to hold vertical-post-type or pin-type insulators, with one **OR** two, **as directed**,-bolt attachment to pole.
3. Secondary Insulator Racks: Hot-dip galvanized steel, style as indicated, with smooth, rounded 12-gage struts designed to support two **OR** three **OR** four, **as directed**, spool insulators for attachment of secondary drop conductors. Spool spacing of 4 inches (100 mm) **OR** 8 inches (200 mm) **OR** 12 inches (300 mm), **as directed**.
4. Pole Riser Shields: Galvanized steel with boot **OR** backplate **OR** vent, **as directed**.
5. Padlocks: ASTM F 883.
   a. Class: PO1 **OR** PO2, **as directed**.
   b. Grade: 1 **OR** 2 **OR** 3 **OR** 4 **OR** 5 **OR** 6, **as directed**.
   c. Option: A **OR** B **OR** C **OR** D **OR** E **OR** F **OR** G, **as directed**.
6. Insulators: Units rated 6 kV and above shall be free from radio interference.
   a. Porcelain insulators shall be wet-process type, complying with the following:
      1) Pin: ANSI C29.5.
      2) Line Post: ANSI C29.7. Include mounting stud of length suitable for each mounting arrangement used.
      3) Suspension: ANSI C29.2.
      4) Guy Strain: ANSI C29.4.
      5) Secondary Spool: ANSI C29.3, Class 53-2.
   b. Polymer-composite, fiberglass-reinforced insulators shall comply with the following:
      1) Line Post: CEA LWIWG-02.
      2) Dead End/Suspension: CEA LWIWG-01.
      3) Guy Strain: Fiberglass reinforced, epoxy finished. Designed specifically for use in guy assemblies.
7. Grounding Materials: Comply with Division 26 Section "Grounding And Bonding For Electrical Systems", using materials listed by RUS for the intended purpose without restriction.
   a. Conductors: No. 4 AWG, minimum; bare, solid, annealed copper, complying with ASTM B 8 unless otherwise indicated.
   b. Ground Conductor Protectors: PVC or half-round wood molding, fir, pressure treated according to AWPA C25 **OR** cypress **OR** cedar, **as directed**.

G. Surge Arresters
1. Distribution-Class Surge Arresters: Porcelain **OR** Polymer, **as directed**,-enclosed, gapless, metal-oxide type with automatic-indicating type, ground-lead disconnection feature, **as directed**, complying with IEEE C62.11 and NEMA LA 1.

2. Intermediate-Class Surge Arresters: Porcelain **OR** Polymer, **as directed**,-enclosed, gapless, metal-oxide type, complying with IEEE C62.11 and NEMA LA 1.
   a. Voltage Rating: 3 **OR** 6 **OR** 9 **OR** 10 **OR** 12 **OR** 15 **OR** 27 **OR** 30 **OR** 36, **as directed**, kV, at the altitude of Project, unless otherwise indicated.

H. Cutouts, Switches, And Fuses
1. Description: Medium-voltage disconnect, protective, and bypass, **as directed**, units shall be rated for the line-to-line voltage of the systems in which installed, unless higher ratings are indicated. BIL ratings are 45 **OR** 60 **OR** 75 **OR** 95 **OR** 150 **OR** 200, **as directed**, kV.
   a. Momentary Current Rating of Switching Devices: 20 **OR** 40, **as directed**, kA, asymmetrical at nominal system operating voltage.
   b. Fuse Characteristics: Time-current characteristics for each set of fuses selected according to written recommendations of manufacturer of component protected by the fuses and coordinated with upstream and downstream protective devices. Prepare time-current coordination curves according to IEEE 242 that illustrate optimum coordination of devices in this Project.
   c. Interrupting Rating of Fuses: <**Insert value**> symmetrical A at nominal system operating voltage.
2. Fuse Cutouts: Open **OR** enclosed, **as directed**, type, rated 100 **OR** 200, **as directed**, A, continuous, complying with ANSI C37.42.
   a. Fuses: Enclosed link, Type K **OR** Type T, **as directed**, complying with ANSI C37.42.
   b. Fuse Current Rating: 150 percent of the transformer full-load current unless otherwise indicated.
   c. Switching Application: Include switch link instead of fuse.
   d. Switch Current Interrupting Rating: Transformer magnetizing current.
3. Fused Switches: Single-pole, manual units.
   a. Switch Rating: 400 **OR** 600, **as directed**,-A rms continuous and load-current interrupting.
   b. Fuses: Dropout-type power fuses.
4. Nonfused Switches: Single-pole, manual units, rated 100 **OR** 200 **OR** 400 **OR** 600, **as directed**,-A rms continuous.
5. Group-Operated, Load-Interrupter Switches: Fused **OR** Nonfused, **as directed**, three-pole, single-throw units, manually operated by handle through insulated mechanical linkage.
   a. High-pressure contact type, complying with ANSI C37.32.
   b. Factory assembled to suit specific configuration and mounting conditions for this Project.
   c. Operating Handle: Padlock equipped.
   d. Current Interrupting Rating: Equal to continuous current rating of switch.
   e. Fuses: Nondropout power type.
6. Group-Operated, Air-Break (Nonloadbreak) Switches: Three-pole, single-throw units, manually operated by handle through insulated mechanical linkage.
   a. Comply with ANSI C37.32.
   b. Factory assembled to suit specific configuration and mounting conditions for this Project.
   c. Operating Handle: Padlock equipped.
   d. Suitable for field conversion to load-interrupter switch by adding interrupter modules.

I. Distribution Transformers
1. Description: Single-phase, two-winding, single **OR** two, **as directed**,-bushing, liquid-filled, self-cooled, pole-mounting distribution type, suitable for external fuse and surge suppressor protection; complying with IEEE C 57.12.00, and tested according to IEEE C 57.12.90 and with the following additional requirements, **as directed**:
   a. Cooling Class: OA.
   b. Temperature Rise: 65 deg C.
   c. Insulating Liquid: Mineral oil, ASTM D 3487, Type II.
      OR
      Insulating Liquid: High molecular weight, mineral oil based, and UL listed as less-flammable type.

OR
Insulating Liquid: Biodegradable insulating and cooling liquid, UL listed as less flammable type.
d. Identification: Label the transformer as "non-PCB" and place manufacturer's name and type of fluid on the nameplate.
2. BIL: 95 **OR** 75 **OR** 60, **as directed**, kV.
3. Taps: Two, 2.5 percent above and below **OR** Four, 2.5 percent below, **as directed**, high-voltage and full-load rated. Tap changer shall have an external operating handle, **as directed**.
4. Mounting Brackets: Single **OR** Double, **as directed**, integral; suitable for pole mounting, individually or in cluster, or on crossarm.
5. Minimum Efficiency: Class 1, as defined by NEMA TP 1, based on test results that comply with requirements of NEMA TP 2.
6. Bushings: Creepage distance shall exceed nominal value standard for unit rating by at least 75 percent.
7. Hardware: Stainless steel.
8. Tank and Cover: Stainless steel, complying with ASTM A 167, Type 304 or 304L, with paint coating exterior finish system complying with IEEE C57.12.28, including manufacturer's standard color finish coat.
9. Show transformer kiloampere capacity using 2-1/2-inch (65-mm) numerals placed near the low-voltage bushings.

J. Primary Metering Equipment
1. Metering Transformers: Outdoor current and potential transformers, designed for crossarm mounting, complying with IEEE C57.13, and having the following features:
a. BIL: 45 **OR** 60 **OR** 75 **OR** 95 **OR** 150 **OR** 200, **as directed**, kV.
b. Secondary connection box arranged for conduit connection.
c. Potential-Transformer Voltage Rating: 2.4 **OR** 4.16 **OR** 7.2 **OR** 12.0 **OR** 12.47, **as directed**, kV to 120-V ac, 60 Hz.
d. Potential-Transformer Accuracy Class: Minimum 0.3 at 75-VA burden.
e. Voltage Rating: 2.4 **OR** 4.16 **OR** 7.2 **OR** 12.0 **OR** 12.47, **as directed**, kV.
f. Current Rating: <**Insert value**> to 5 A.
g. Accuracy Class: Minimum 0.2 at 50-VA burden.
2. Watt-Hour Meter: Outdoor solid-state unit, with demand register, **OR** arranged for pulse initiation, **as directed**, complying with ANSI C12.10, and including the following ratings and features:
a. Form: 8S **OR** 9S, **as directed**.
b. Element: 2 **OR** 2-1/2 **OR** 3, **as directed**.
c. Voltage: 120 V.
d. Current: 2-1/2 A.
e. Frequency: 60 Hz.
f. Kilowatt-Hour Register: Five-digit type.
g. Demand-Register Multiplier: A quantity in even hundreds, indicated on meter face.
h. Demand-Register Interval: 15 **OR** 30, **as directed**, minutes.
i. Mounting: On matching socket, complying with ANSI C12.7, and complete with automatic current short-circuiting device.
j. Meter Test Block: Matched to meter, and furnished and equipped with open knife switches designed to isolate each metering component for test.
k. Meter Cabinet: Galvanized steel; weatherproof enclosure with pole-mounting bracket and the following features:
1) Hinged Door: Arranged for padlocking in closed position.
2) Size: Adequate to house meter and other equipment indicated, but not less than 20 by 30 by 11 inches (510 by 760 by 280 mm) deep.

K. Source Quality Control
1. Factory Tests: Conduct routine tests of transformers **OR** medium-voltage switches **OR** metering equipment, **as directed**, according to referenced standards.

2. Testing Agency: Engage a qualified testing agency to inspect poles and crossarms before and after preservative treatment for compliance of wood poles and crossarms with requirements indicated. RUS quality mark "WQC" on each item is acceptable in place of inspection as evidence of compliance.
3. Poles and crossarms will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

1.3 EXECUTION

A. Right-Of-Way Clearance And Tree Trimming
1. Clear right of way according to Division 01 Section(s) "Temporary Tree And Plant Protection" AND Division 31 Section(s) "Site Clearing".
2. Clear right of way to maintain minimum clearances required by IEEE C2, unless Drawings indicate greater clearances or greater clearances are required by state or local codes or regulations. If no minimum requirements are mandated, maintain a minimum of 15 feet (4.5 m) on both sides horizontally and below medium-voltage conductors and 60 inches (1500 mm) on both sides horizontally and below secondary-voltage conductors. Remove overhanging branches.

B. General Installation Requirements
1. Install underground power and metering circuits and those circuits indicated to be in raceways according to Division 26 Section "Underground Ducts And Raceways For Electrical Systems" and Division 26 Section "Medium-voltage Cables", and make splices and terminations for those circuits according to the applicable Sections.
2. Engage the services of a licensed surveyor to verify dimensions by field measurement, to identify locations of poles, anchors, and other features, and to verify all clearances. The survey document shall also identify locations of connections to new and existing supply lines and to primary and secondary services. Notify the Owner of discrepancies and field conditions that are not indicated and that will affect installation.
3. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
4. Apply warning signs and equipment labels according to Division 26 Section "Identification For Electrical Systems".

C. Conductor Installation, General
1. Handle and string conductors to prevent cuts, gouges, scratches, kinks, flattening, or deformation. Remove damaged sections and splice conductors.
   a. String new conductors to "initial" sag values recommended by manufacturer for type and size of conductor except as otherwise indicated.
   b. Conductors Reinstalled or Resagged: String to "final" sag values recommended by manufacturer for type and size of conductor except as otherwise indicated.
2. Connections, Splices, and Terminations: Use kits listed for the specific type of connection and combination of materials in the connection or recommended for the specific use by manufacturer of material on which applied.
   a. Splice Location: Do not install within 10 feet (3 m) of a support.
   b. Line Conductors and Service Drops: Install so strength exceeds ultimate rated strength of conductor.
   c. Splices and Terminations of Covered Conductors: Comply with manufacturer's written instructions.
   d. Splices and Terminations of Insulated Conductors of Self-Supported, Medium-Voltage Cable: Comply with manufacturer's written instructions.

D. Medium-Voltage Line Conductor Installation
1. Application: Install bare conductors unless otherwise indicated.

2. Armor Rod: Install to protect conductors if line conductors are supported by insulators.
3. Flat Aluminum Armor Wire: Install to protect conductors if they are supported by, or attached to, galvanized or coated iron or steel clamps or fittings.
4. Support line conductors and taps as follows:
   a. Use wire ties for conductor attachment to pin and vertical post insulators unless otherwise indicated.
   b. Install wire ties tight against conductor and insulator, and turn ends back and flat against conductor, to eliminate exposed wire ends.
   c. Use wire clamps on horizontal post, dead end, and suspension insulators unless otherwise indicated.

E. Pole And Crossarm Installation
1. Pole Orientation: Align curve of curved wood poles with straight-line runs of three or more poles. Align gained surfaces perpendicular to runs.
2. Elevation of Line above Grade: Install poles with top at same elevation, unless grade changes dictate elevation change in poles, and according to the following:
   a. On level ground, set poles so tops of consecutive poles vary not more than 60 inches (1500 mm) in elevation.
   b. Shorten wood poles by cutting off the top and make cuts to shed water. Apply preservative to cuts.
3. Set poles according to the following:
   a. Make pole holes vertical, uniform in diameter, and large enough to permit effective use of tamping bars all around. Bore or excavate holes with an average diameter at grade less than twice the diameter of the pole at the same grade.
   b. Use minimum depths indicated, except at locations where hole is partly or entirely in rock and if hole is not vertical or has a diameter at grade more than two times the pole diameter at the same level; in these conditions, increase the depth of the hole by the following increments before setting the pole:
      1) Poles up to 35 Feet (10.6 m) Long: 24 inches (600 mm).
      2) Poles 36 to 60 Feet (11 to 18.3 m) Long: 30 inches (760 mm).
      3) Poles 61 to 75 Feet (18.6 to 22.9 m) Long: 36 inches (900 mm).
   c. For poles on slopes, indicated hole depth is from finished grade at lowest side of hole.
   d. Set poles in alignment and plumb except at dead ends, angles, and points of extra strain; rake poles against conductor strain 1 inch (25 mm) minimum, 2 inches (51 mm) maximum, (after conductors are installed at required tension) for each 10 feet (3 m) of pole length. Rake poles so they will not lean or bend in direction of strain when loaded.
   e. Backfill holes in 6-inch (150-mm) maximum lifts, and thoroughly tamp each layer before starting the next.
   f. Place surplus earth around pole in a conical shape, and tamp thoroughly to provide drainage away from pole.
   g. Set poles so alternate crossarm gains face in alternate directions, except at terminals and dead ends; place gains on last two poles on side facing terminal or dead end.
   h. Poles Set in Concrete Paved Areas: Install poles with minimum of 6-inch- (150-mm-) wide, unpaved gap between the pole and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch (25 mm) below top of concrete slab.
4. Field treat factory-treated poles and crossarms as follows:
   a. Poles Treated More Than One Year before Installation: Treat portion from 24 inches (600 mm) above ground line to butt.
   b. Field-Bored Holes and Field-Cut Gains and Pole Tops: Treat cut portions.
   c. Unused Holes: Treat and plug with treated-wood-dowel drive pins.
   d. Engage the services of a technician certified according to "Quality Assurance" Article to apply treatment. Comply with requirements in AWPA standards that govern original factory treatment for field-applied treatment and application of chemicals.
5. Crossarm Installation: Set line crossarms at right angle to line for straight runs and for angles 45 degrees and more. Bisect angles less than 45 degrees.
   a. Buck Arms: Install at corners and junction poles unless otherwise indicated.

b. Double Crossarms: Install at dead ends, corners, angles, and line crossings.
c. Equipment Arms: Locate below lines and set parallel or at right angles to them, whichever provides best climbing space.
d. Gains: Install factory-cut or metal-pole gains only. Do not cut gains in field without specific written approval.
6. Locate pole numbers to provide maximum visibility from the road or patrol route.

F. Guy Installation
1. Install guys to resist unbalanced loads, including those developed at angles, corners, and dead ends. Install two or more guys if a single guy will not provide adequate strength. Install separate guys if unbalanced loads are separated by 36 inches (900 mm) or more. Comply with IEEE C2.
a. Unless a thimble eye is used, at the pole end, install a minimum of two guy hooks and two guy strain plates.
b. At the anchor end, attach guy strand assembly with preformed grips.
2. Protect guy strands from damage. Replace damaged guy strands. Install guy insulators where required to comply with IEEE C2 clearance requirements.
3. Install guys with a lead-to-height ratio of 1 to 1 unless otherwise indicated. The minimum lead-to-height ratio shall be 1/2 to 1. When less than 1 to 1, increase guy strength by the ratio of the sine of the lead angle indicated to the sine of the lead angle provided.
4. Install screw-type guy anchors aligned in soil with guy. Set with anchor rod pointing at guy attachment on pole and rod projecting 6 to 9 inches (150 to 230 mm) from ground.
5. Install strain insulators to provide a minimum of 12 inches (300 mm) of clearance between the nearest energized surface and the strain insulator fitting farthest from the pole. When loaded to the tension indicated, fiberglass strain insulators shall be loaded to not more than two-thirds of manufacturer's published rating.
6. Guy Markers: Install at anchor end of guys to visually mark the guy wire at all accessible locations. Clamp to guy strand or anchor at top and bottom of marker.

G. Hardware And Accessories Installation
1. Install washers against wood and under nuts, including eyenuts and locknuts.
2. Install nuts and locknuts wrench-tight on threaded connections.

H. Insulator Installation
1. Medium-Voltage Line Application: Install pin **OR** post, **as directed**, type, except install suspension type at corners, angles, dead ends, and other locations where horizontal forces exceed rated values for pin or line-post-type units.
a. Install suspension insulators and hardware that have mechanical strength exceeding rated breaking strength of attached conductors.
b. Install horizontal line-post insulators for armless construction.
2. Post-Insulator Conductor Support: Where installed horizontally and for line angles more than 15 degrees, install clamp-top conductor clamps.
3. Install spool-type insulators for secondary lines mounted on clevis attachments or secondary racks.
4. Guy Strain Type: Install porcelain **OR** fiberglass-reinforced, **as directed**, units.

I. Surge Arresters
1. Install surge arresters to protect distribution **OR** metering equipment **OR** reclosers, **as directed**, group-operated, load-interrupter switches, **as directed**, aerial-to-underground transitions, **as directed**, and other items indicated.
a. Units Installed 6000 Feet (1800 m) or More above Sea Level: Use arresters specifically rated for this service.

J. Cutout, Switch, And Fuse Installation
1. Hook-Stick-Operated Switches: Install to maximize safe operating access.

2. Group-Operated, Load-Interrupter Switches and Air-Break Switches: Install operating handle 42 inches (1067 mm) above finished grade.
   a. Locking Provisions: Install padlock at hasp.

K. Metering Component Installation
   1. Current and Voltage Transformers: Install secondary conductors between transformers and cabinet in sleeves made of galvanized rigid steel **OR** intermediate metal **OR** PVC, **as directed**, conduit. Install to prevent collection of moisture in raceway and cabinet system.
   2. Meter Cabinet: Mount on pole, 72 inches (1825 mm) above finished grade to center of cabinet.
      a. Make conduit connections with raintight hubs.
      b. Install metering transformer secondary leads without splices. Train leads at sides and bottom of enclosure, and secure with wire ties.
      c. Install meter and meter test block within cabinet.
      d. Install identical phase sequence, and color-code for both potential and current leads.
      e. Identify leads using designations consistent with marking on transformer terminals.

L. Field Quality Control
   1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
   2. Perform tests and inspections.
   3. Tests and Inspections:
      a. Furnish instruments and equipment required for tests that comply with NETA Acceptance Testing Specification.
      b. Guy Anchors: Test one of each type and capacity installed, plus additional units specifically indicated for testing, **as directed**. Apply rated pull-out force in the same pull direction applied by the guy at the test location.
         1) Acceptable Test Results: Denoted by movement of less than 3/8 inch (10 mm) by the holding component of the anchor in the earth or other medium in which it is installed.
         2) Replace or reinstall, at the Owner 's option, all anchors of same type and capacity as anchor type that fails this test.
      c. Ground Resistance: Comply with Division 26 Section "Grounding And Bonding For Electrical Systems". Measure resistance of each separate grounding electrode, including pole grounds. Also measure resistance of separate grounding electrode systems before bonding together.
         1) Perform tests and obtain acceptable results before energizing any portion of overhead electrical distribution system.
         2) Results and Follow-up: If ground resistance for a single ground electrode or pole ground, tested individually, exceeds 25 ohms, add a ground electrode not less than 10 feet (3 m) away and interconnect with No. 2 AWG, minimum, bare conductor buried at least 12 inches (300 mm) below furnished grade.
      d. Aerial Conductor Sag and Tension: Observe procedures used by Contractor to verify that initial stringing sags and tensions comply with IEEE C2 and conductor manufacturer's product data and written recommendations.
      e. Self-Supported, Medium-Voltage Cable: After installation, while cable is isolated, and after terminations are installed and before connecting or energizing, apply dc voltage between each phase conductor and grounding connections of sheath or metallic shield. Comply with NEMA WC 70/ICEA S-95-658 for method, voltage, duration, pass-fail performance, and other test criteria. Perform other field inspections and tests recommended by manufacturer.
      f. Neutral-Supported, Secondary Service-Drop Cable: Test for insulation resistance while cable is isolated, before connecting or energizing. Minimum acceptable resistance is 100 megohms.
      g. Existing Surge Arresters: Disconnect and measure resistance between line and ground terminals with a megger test rated 600 V or more. Acceptable resistance values are 300 megohms and more.

h. New Surge Arresters, Cutouts, and Switches: Inspect after installation and connection to wiring. Verify that ratings and characteristics match approved submittals and comply with system requirements. Verify that installation complies with requirements and that clearances of units and connecting wiring comply with IEEE C2 requirements.
    1) Verify proper grounding of metallic equipment parts.
    2) Fuses and Disconnect Links: Verify that ratings and characteristics match submittals and comply with system requirements.
    3) Switches:
        a) Manually operate each cutout and switch at least three times, to verify proper operation.
        b) Verify correct contact alignment, blade penetration, travel stops, and arc interrupter operation.
    4) Group-Operated, Load-Interrupter Switches and Air-Break Switches:
        a) Perform mechanical operator tests according to manufacturer's written instructions.
        b) Test resistance to ground of parts to be energized. Acceptable value is 200,000 megohms.
        c) Perform contact-resistance test across all switch blade contacts. Refer to manufacturer's data for acceptable contact resistance.
    5) Verify that clearances of energized parts and connecting wires comply with IEEE C2 requirements.

i. Distribution Transformers: Inspect after installation and connection to wiring and verify that ratings and characteristics match approved submittals and comply with system requirements. Verify the integrity and good condition of unit.
    1) Inspect for physical damage, cracked insulators, leaks, tightness of connections, and overall mechanical and electrical integrity.
    2) Perform preenergizing inspections and tests recommended by manufacturer.
    3) Verify proper equipment grounding.
    4) Verify that clearances of terminals and connecting wires comply with IEEE C2.

j. Metering Transformers: Inspect after installation and connection to wires, and verify that ratings and characteristics match approved submittals and comply with system requirements. Verify the integrity and good condition of unit.
    1) Verify proper connections, tightness of bolted connections, and integrity of mounting provisions.
    2) Verify that required grounding and shorting connections provide good contact.
    3) Verify that clearances of terminals and connecting wires comply with IEEE C2.
    4) Perform electrical tests according to manufacturer's written instructions, including insulation-resistance tests, polarity tests, and turns-ratio and ratio-verification tests.

k. Meters: Inspect after installation and connection to wiring and verify that ratings and characteristics match approved submittals and comply with system requirements. Verify the integrity and good condition of unit.
    1) Verify tightness of electrical connections.
    2) Verify accuracy at 25, 50, 75, and 100 percent of full-rated load and verify all instrument multipliers according to manufacturer's written instructions.

4. Prepare test and inspection reports.

M. Adjusting
1. Distribution Transformers: Set voltage taps as directed by the Owner.

N. Cleaning
1. After completing equipment installation, inspect equipment. Remove spots, dirt, and debris. Repair damaged finish to match original finish. For distribution transformer, use tank touchup paint provided by manufacturer.
    a. Clean enclosures internally, on completion of installation, according to manufacturer's written instructions.

O. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain overhead electrical distribution.

END OF SECTION 02 84 33 00

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Task	Specification	Specification Description
02 86 00 00	02 41 13 13	Selective Demolition
02 86 00 00	02 61 00 00	Excavation And Handling Of Contaminated Material
02 86 00 00	02 61 13 00	Underground Storage Tank Removal
02 86 00 00	02 61 13 00a	Precision Testing Of Underground Fuel Oil Tanks
02 86 00 00	02 61 13 00b	Hydrostatic Pressure Testing Of Air Receiving Tanks
02 86 00 00	02 61 26 00	Disposal Of Hazardous Materials

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SECTION 02 87 13 33 - MOLD REMEDIATION

1.1 GENERAL

A. Description Of Work
   1. This specification covers the removal and disposal of mold. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. List of all personnel to be involved in the work with their training and certifications.
   2. List of all products and procedures proposed for use in performance of the work.
   3. Test reports.
   4. Certificates.

C. References
   1. U.S. EPA “Mold Remediation in Schools and Commercial Buildings”
   2. U.S. EPA “A Brief Guide to Mold, Moisture, and Your Home”

D. Quality Assurance
   1. Conform to all Federal, State, and Local regulations which govern the handling and disposal of mold materials.

1.2 PRODUCT - (Not Used)

1.3 EXECUTION

A. Environmental Assessment: The presence of mold, water damage, or musty odors shall be addressed immediately. In all instances, any source(s) of water must be stopped and the extent of water damaged determined. Water damaged materials shall be dried and repaired. Mold damaged materials shall be remediated in accordance with this document.
   1. Visual Inspection: A visual inspection is the most important initial step in identifying a possible contamination problem. The extent of any water damage and mold growth shall be visually assessed. This assessment is important in determining remedial strategies. Ventilation systems shall also be visually checked, particularly for damp filters but also for damp conditions elsewhere in the system and overall cleanliness. Ceiling tiles, gypsum wallboard (sheetrock), cardboard, paper, and other cellulosic surfaces shall be given careful attention during a visual inspection. The use of equipment such as a boroscope, to view spaces in ductwork or behind walls, or a moisture meter, to detect moisture in building materials, may be helpful in identifying hidden sources of fungal growth and the extent of water damage.
   2. Bulk/Surface Sampling
      a. Bulk or surface sampling is not required to undertake a remediation. Remediation of visually identified fungal contamination shall proceed without further evaluation.
      b. Bulk or surface samples may need to be collected to identify specific fungal contaminants as part of a medical evaluation if occupants are experiencing symptoms which may be related to fungal exposure or to identify the presence or absence of mold if a visual inspection is equivocal (e.g., discoloration, and staining).
      c. An individual trained in appropriate sampling methodology shall perform bulk or surface sampling. Bulk samples shall be collected from visibly moldy surfaces by scraping or cutting materials with a clean tool into a clean plastic bag. Surface samples shall be collected by wiping a measured area with a sterile swab or by stripping the suspect surface

with clear tape. Surface sampling is less destructive than bulk sampling. Other sampling methods may also be available. A laboratory specializing in mycology shall be consulted for specific sampling and delivery instructions.

3. Air Monitoring
    a. Air sampling for fungi shall not be part of a routine assessment. This is because decisions about appropriate remediation strategies can usually be made on the basis of a visual inspection. In addition, air-sampling methods for some fungi are prone to false negative results and therefore cannot be used to definitively rule out contamination.
    b. Air monitoring may be necessary if an individual(s) has been diagnosed with a disease that is or may be associated with a fungal exposure (e.g., pulmonary hemorrhage/hemosiderosis, and aspergillosis).
    c. Air monitoring may be necessary if there is evidence from a visual inspection or bulk sampling that ventilation systems may be contaminated. The purpose of such air monitoring is to assess the extent of contamination throughout a building. It is preferable to conduct sampling while ventilation systems are operating.
    d. Air monitoring may be necessary if the presence of mold is suspected (e.g., musty odors) but cannot be identified by a visual inspection or bulk sampling (e.g., mold growth behind walls). The purpose of such air monitoring is to determine the location and/or extent of contamination.
    e. If air monitoring is performed, for comparative purposes, outdoor air samples shall be collected concurrently at an air intake, if possible, and at a location representative of outdoor air. For additional information on air sampling, refer to the American Conference of Governmental Industrial Hygienists' document, "Bioaerosols: Assessment and Control."
    f. Personnel conducting the sampling shall be trained in proper air sampling methods for microbial contaminants. A laboratory specializing in mycology shall be consulted for specific sampling and shipping instructions.
4. Analysis of Environmental Samples
    a. Microscopic identification of the spores/colonies requires considerable expertise. These services are not routinely available from commercial laboratories. Documented quality control in the laboratories used for analysis of the bulk/surface and air samples is necessary. The American Industrial Hygiene Association (AIHA) offers accreditation to microbial laboratories (Environmental Microbiology Laboratory Accreditation Program (EMLAP)). Accredited laboratories must participate in quarterly proficiency testing (Environmental Microbiology Proficiency Analytical Testing Program (EMPAT)).
5. Evaluation of bulk/surface and air sampling data shall be performed by an experienced health professional. The presence of few or trace amounts of fungal spores in bulk/surface sampling shall be considered background. Amounts greater than this or the presence of fungal fragments (e.g., hyphae, and conidiophores) may suggest fungal colonization, growth, and/or accumulation at or near the sampled location. Air samples shall be evaluated by means of comparison (i.e., indoors to outdoors) and by fungal type (e.g., genera, and species). In general, the levels and types of fungi found should be similar indoors (in non-problem buildings) as compared to the outdoor air. Differences in the levels or types of fungi found in air samples may indicate that moisture sources and resultant fungal growth may be problematic.

B. Remediation
1. General
    a. **In all situations, the underlying cause of water accumulation must be rectified or fungal growth will recur.** Any initial water infiltration shall be stopped and cleaned immediately. An immediate response (within 24 to 48 hours) and thorough clean up, drying, and/or removal of water damaged materials will prevent or limit mold growth. If the source of water is elevated humidity, relative humidity shall be maintained at levels below 60% to inhibit mold growth. Emphasis shall be on ensuring proper repairs of the building infrastructure, so that water damage and moisture buildup does not recur.
    b. Five different levels of abatement are described below. The size of the area impacted by fungal contamination primarily determines the type of remediation. The sizing levels below

are based on professional judgment and practicality; currently there is not adequate data to relate the extent of contamination to frequency or severity of health effects. **The goal of remediation is to remove or clean contaminated materials in a way that prevents the emission of fungi and dust contaminated with fungi from leaving a work area and entering an occupied or non-abatement area, while protecting the health of workers performing the abatement.** The listed remediation methods were designed to achieve this goal, however, due to the general nature of these methods it is the responsibility of the people conducting remediation to ensure the methods enacted are adequate. The listed remediation methods are not meant to exclude other similarly effective methods. Any changes to the remediation methods listed in these guidelines, however, shall be carefully considered prior to implementation.

c. Non-porous (e.g., metals, glass, and hard plastics) and semi-porous (e.g., wood, and concrete) materials that are structurally sound and are visibly moldy can be cleaned and reused. Cleaning shall be done using a detergent solution. Porous materials such as ceiling tiles and insulation, and wallboards with more than a small area of contamination shall be removed and discarded. Porous materials (e.g., wallboard, and fabrics) that can be cleaned, can be reused, but should be discarded if possible. A professional restoration consultant shall be contacted when restoring porous materials with more than a small area of fungal contamination. All materials to be reused shall be dry and visibly free from mold. Routine inspections shall be conducted to confirm the effectiveness of remediation work.

d. The use of gaseous, vapor-phase, or aerosolized biocides for remedial purposes is **not** recommended. The use of biocides in this manner can pose health concerns for people in occupied spaces of the building and for people returning to the treated space if used improperly. Furthermore, the effectiveness of these treatments is unproven and does not address the possible health concerns from the presence of the remaining non-viable mold. For additional information on the use of biocides for remedial purposes, refer to the American Conference of Governmental Industrial Hygienists' document, "Bioaerosols: Assessment and Control."

2. ***Level I***: **Small Isolated Areas** (10 sq. ft or less) - e.g., ceiling tiles, small areas on walls

a. Remediation can be conducted by regular building maintenance staff. Such persons shall receive training on proper clean up methods, personal protection, and potential health hazards. This training can be performed as part of a program to comply with the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200).

b. Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.

c. The work area shall be unoccupied. Vacating people from spaces adjacent to the work area is not necessary but is recommended in the presence of infants (less than 12 months old), persons recovering from recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).

d. Containment of the work area is not necessary. Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.

e. Contaminated materials that cannot be cleaned shall be removed from the building in a sealed plastic bag. There are no special requirements for the disposal of moldy materials.

f. The work area and areas used by remedial workers for egress shall be cleaned with a damp cloth and/or mop and a detergent solution.

g. All areas shall be left dry and visibly free from contamination and debris.

3. ***Level II***: **Mid-Sized Isolated Areas** (10 - 30 sq. ft.) - e.g., individual wallboard panels.

a. Remediation can be conducted by regular building maintenance staff. Such persons shall receive training on proper clean up methods, personal protection, and potential health hazards. This training can be performed as part of a program to comply with the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200).

b. Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.

c. The work area shall be unoccupied. Vacating people from spaces adjacent to the work area is not necessary but is recommended in the presence of infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).
d. The work area shall be covered with a plastic sheet(s) and sealed with tape before remediation, to contain dust/debris.
e. Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.
f. Contaminated materials that cannot be cleaned shall be removed from the building in sealed plastic bags. There are no special requirements for the disposal of moldy materials.
g. The work area and areas used by remedial workers for egress shall be HEPA vacuumed (a vacuum equipped with a High-Efficiency Particulate Air filter) and cleaned with a damp cloth and/or mop and a detergent solution.
h. All areas shall be left dry and visibly free from contamination and debris.

4. ***Level III*: Large Isolated Areas** (30 - 100 square feet) - e.g., several wallboard panels.
   a. A health and safety professional with experience performing microbial investigations shall be consulted prior to remediation activities to provide oversight for the project.
   b. The following procedures *at a minimum* are recommended:
      1) Personnel trained in the handling of hazardous materials and equipped with respiratory protection, (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.
      2) The work area and areas directly adjacent shall be covered with a plastic sheet(s) and taped before remediation, to contain dust/debris.
      3) Seal ventilation ducts/grills in the work area and areas directly adjacent with plastic sheeting.
      4) The work area and areas directly adjacent shall be unoccupied. Further vacating of people from spaces near the work area is recommended in the presence of infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).
      5) Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.
      6) Contaminated materials that cannot be cleaned shall be removed from the building in sealed plastic bags. There are no special requirements for the disposal of moldy materials.
      7) The work area and surrounding areas shall be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution.
      8) All areas shall be left dry and visibly free from contamination and debris.
   c. If abatement procedures are expected to generate a lot of dust (e.g., abrasive cleaning of contaminated surfaces, demolition of plaster walls) or the visible concentration of the fungi is heavy (blanket coverage as opposed to patchy), then it is recommended that the remediation procedures for Level IV are followed.

5. ***Level IV*: Extensive Contamination** (greater than 100 contiguous square feet in an area)
   a. A health and safety professional with experience performing microbial investigations shall be consulted prior to remediation activities to provide oversight for the project. The following procedures are recommended:
      1) Personnel trained in the handling of hazardous materials equipped with:
         a) Full-face respirators with high efficiency particulate air (HEPA) cartridges
         b) Disposable protective clothing covering both head and shoes
         c) Gloves
      2) Containment of the affected area:

a) Complete isolation of work area from occupied spaces using plastic sheeting sealed with duct tape (including ventilation ducts/grills, fixtures, and any other openings)
b) The use of an exhaust fan with a HEPA filter to generate negative pressurization
c) Airlocks and decontamination room

3) Vacating people from spaces adjacent to the work area is not necessary but is recommended in the presence of infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).
4) Contaminated materials that cannot be cleaned shall be removed from the building in sealed plastic bags. The outside of the bags shall be cleaned with a damp cloth and a detergent solution or HEPA vacuumed in the decontamination chamber prior to their transport to uncontaminated areas of the building. There are no special requirements for the disposal of moldy materials.
5) The contained area and decontamination room shall be HEPA vacuumed and cleaned with a damp cloth and/or mop with a detergent solution and be visibly clean prior to the removal of isolation barriers.
6) Air monitoring shall be conducted prior to occupancy to determine if the area is fit to reoccupy.

6. ***Level V***: Remediation of HVAC Systems
a. A Small Isolated Area of Contamination (<10 square feet) in the HVAC System
1) Remediation can be conducted by regular building maintenance staff. Such persons shall receive training on proper clean up methods, personal protection, and potential health hazards. This training can be performed as part of a program to comply with the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200).
2) Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.
3) The HVAC system shall be shut down prior to any remedial activities.
4) The work area shall be covered with a plastic sheet(s) and sealed with tape before remediation, to contain dust/debris.
5) Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.
6) Growth supporting materials that are contaminated, such as the paper on the insulation of interior lined ducts and filters, shall be removed. Other contaminated materials that cannot be cleaned shall be removed in sealed plastic bags. There are no special requirements for the disposal of moldy materials.
7) The work area and areas immediately surrounding the work area shall be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution.
8) All areas shall be left dry and visibly free from contamination and debris.
9) A variety of biocides are recommended by HVAC manufacturers for use with HVAC components, such as, cooling coils and condensation pans. HVAC manufacturers shall be consulted for the products they recommend for use in their systems.

b. Areas of Contamination (>10 square feet) in the HVAC System: A health and safety professional with experience performing microbial investigations shall be consulted prior to remediation activities to provide oversight for remediation projects involving more than a small isolated area in an HVAC system. The following procedures are recommended:
1) Personnel trained in the handling of hazardous materials equipped with:
a) Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended.
b) Gloves and eye protection

c) Full-face respirators with HEPA cartridges and disposable protective clothing covering both head and shoes shall be worn if contamination is greater than 30 square feet.

2) The HVAC system shall be shut down prior to any remedial activities.

3) Containment of the affected area:

a) Complete isolation of work area from the other areas of the HVAC system using plastic sheeting sealed with duct tape.

b) The use of an exhaust fan with a HEPA filter to generate negative pressurization.

c) Airlocks and decontamination room if contamination is greater than 30 square feet.

4) Growth supporting materials that are contaminated, such as the paper on the insulation of interior lined ducts and filters, shall be removed. Other contaminated materials that cannot be cleaned should be removed in sealed plastic bags. When a decontamination chamber is present, the outside of the bags shall be cleaned with a damp cloth and a detergent solution or HEPA vacuumed prior to their transport to uncontaminated areas of the building. There are no special requirements for the disposal of moldy materials.

5) The contained area and decontamination room shall be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution prior to the removal of isolation barriers.

6) All areas shall be left dry and visibly free from contamination and debris.

7) Air monitoring shall be conducted prior to re-occupancy with the HVAC system in operation to determine if the area(s) served by the system are fit to reoccupy.

8) A variety of biocides are recommended by HVAC manufacturers for use with HVAC components, such as, cooling coils and condensation pans. HVAC manufacturers shall be consulted for the products they recommend for use in their systems.

7. Hazard Communication: When fungal growth requiring large-scale remediation is found, the building owner, management, and/or employer shall notify occupants in the affected area(s) of its presence. Notification shall include a description of the remedial measures to be taken and a timetable for completion. Group meetings held before and after remediation with full disclosure of plans and results can be an effective communication mechanism. Individuals with persistent health problems that appear to be related to bioaerosol exposure should see their physicians for a referral to practitioners who are trained in occupational/environmental medicine or related specialties and are knowledgeable about these types of exposures. Individuals seeking medical attention shall be provided with a copy of all inspection results and interpretation to give to their medical practitioners.

END OF SECTION 02 87 13 33

SECTION 02 87 16 13 - BIRD AND BIRD WASTE ABATEMENT

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for bird and bird waste abatement. Products shall be as follows or as directed by the the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary Of Work
   1. Work Included - Conventional Enclosure for Removal of Birds and Bird Waste
      a. Seal off penetrations on perimeter walls into the work area (critical barriers) and establish a decontamination facility for workers.
      b. Coordinate activities with the demolition and well capping activities.
   2. Work Included - Removal and disposal of birds and bird waste.
      a. Establish work area by installing construction barrier tape around removal area.
      b. Remove and properly dispose of bulk contamination debris.
      c. Mist bird waste and contaminated material with Biocide or the equivalent (i.e. Sanogene, Oxine, or Envirocon).
      d. Remove and properly dispose of contaminated waste material from all building components.
      e. Utilize low pressure washers or scrub brushes to clean all wall surfaces of bird waste.

C. Quality Criteria
   1. Qualifications for Performance of Work
      a. Contractor (or subcontractor engaged to perform the Work of this Section) shall:
         1) Be a licensed bird waste abatement contractor in accordance with the Statutes of the State in which the work is to be performed. Submit notarized documentation confirming current licensure.
         2) Have a record of not less than five years successful experience in bird waste removal or asbestos removal.
   2. Reference Standards
      a. Acknowledge, by the executing of the Contract, awareness and familiarity with the contents and requirements of the following regulations, codes, and standards, and assume responsibility for the performance of the Work in strict compliance therewith and for every instance of failure to comply therewith.
      b. Where conflict among requirements or with the Contract Documents exists, the more stringent requirements shall apply.
         1) USEPA Regional National Emissions Standards for Hazardous Air Pollutants (NESHAPS)
         2) U.S. Occupational and Safety and Health Administration (OSHA)
         3) U.S. EPA Office of Pesticide and Toxic Substances Guidance Document
         4) U.S. Department of Transportation, Hazardous Substances: Final Rule (49 CFR 171 and 172), Federal Register November 21, 1986 and corrected February 17, 1987.
         5) Statutes of the State in which the Work is to be Performed: Licensure for Asbestos Consultants and Contractors.
         6) All state, county, and city codes and ordinances as applicable. Make available for review at the site one copy of EPA, OSHA, and applicable State, County, and City Regulations governing the Work.
   3. Patent/Copyright Compliance: Contractor shall determine the applicability of any process patents that may be employed and shall be responsible for the payment of all fees, royalties and licenses that may be required for the use of any patented or licensed process. Contractor shall hold the Owner, Engineer and Testing Laboratory harmless for failure to obtain any licenses and to pay any applicable fees and royalties.

D. Product Handling
  1. Deliver all materials in the original packages, containers, or bundles bearing the name of the manufacturer and the brand name.
  2. Store all materials subject to damage off the ground, away from wet or damp surfaces, and under cover sufficient to prevent damage or contamination.
  3. Remove from the premises all damaged or deteriorating materials. Dispose of materials that become contaminated with waste in accordance with applicable regulatory standards.

E. Worksite Conditions
  1. Worker and Visitor Procedures: The Contractor is hereby advised that the birds and bird wastes have been determined to cause diseases by inhalation and Contractor shall provide workers and qualified visitors with respirators that, as a minimum, shall meet the requirements of current applicable OSHA regulations, and protective clothing during preparation of system of enclosures, prior to commencing, during actual removal, and until final clean-up is completed. Also all personnel assigned to work on this project shall attend a training/awareness class for the purpose of explaining the hazards of improperly handling these materials and proper control measures to take in order to protect themselves.

F. Personnel Protection
  1. General
    a. Provide respiratory protection in accordance with OSHA regulations 29 CFR 1910-134 and in accordance with the following paragraphs.
      1) Prior to commencement of work, all workers shall be instructed by the Contractor and shall be knowledgeable in the appropriate procedures of personnel protection and waste removal.
      2) Where respirators with disposable filters are used, provide sufficient filters for replacement as necessary by the workers, or as required by applicable regulations.
      3) Permit no visitors, except for governmental inspectors having jurisdiction, or as authorized by Engineer or the Owner, in the work areas after commencement of waste disturbance or removal. Provide authorized visitors with suitable respirators.
      4) Provide workers with sufficient sets of protective disposable clothing, consisting of full-body coveralls, head covers, gloves, and foot covers, of sizes to properly fit individual workers.
      5) Provide authorized visitors with a set of suitable protective disposable clothing, headgear, eye protection, and/or footwear of sizes to properly fit visitors whenever they are required to enter the work area, to a maximum of six sets per day.
      6) Provide, in addition to respirators and protective clothing provided for authorized visitors, protective clothing and respirators for use by Testing Laboratory's representative. Furnish protective clothing in as many sets as required for full-time monitoring by Testing Laboratory.
      7) Provide and post the decontamination and work procedures to be followed by workers.
  2. Respiratory Protection Program
    a. Maintain a respiratory protection program that contains all the elements of the OSHA regulations. Provide a copy to the Engineer for approval.
    b. Appoint a respiratory protection program administrator, who shall be responsible for the program, maintaining all documentation, instructing workers and providing fit tests. Respiratory protection administrator is to be qualified under OSHA requirements and to have attended and passed, as a minimum, OSHA training institute 2-week course on respiratory protection or NIOSH course "Occupational Respiratory Protection." Respiratory protection program administer is to be on-site daily during abatement activities. All written programs and directions are to be in English and/or the language of the abatement workers if they are not fluent in English.
    c. The Contractor is advised that the minimum respiratory requirements as called for in this section and on any drawings/sketches shall be applied unless reported measures indicate

that a lower form of respiratory protection is acceptable according to the appropriate OSHA regulations and the more strict sections of the specification.

3. Respiratory Protection Requirements
   a. Workers shall be provided with respiratory protection equipment. The respirators are to be sanitized and maintained in accordance with the manufacturer's specification. Appropriate respirator selection will be dependent upon the work to be performed and the level of exposure, as given below.
   b. For the clean-up, as a minimum, the use of full-faced air-purifying respirators is required for all preparation, removal and cleaning work.
   c. This specification requires that workers shall wear suitable respiratory protection at all times whenever a potential for exposure to bird and bird waste exists.

1.2 PRODUCTS

A. Materials

1. Polyethylene/Plastic sheeting shall be of the thicknesses specified, not less than 6 mil, in sizes to minimize the frequency of joints. Utilize reinforced plastic sheeting in specified thicknesses on floors.
2. Tape shall be glass fiber or other type capable of sealing joints of adjacent sheets of plastic and for attachment of plastic sheet to finished or unfinished surfaces of dissimilar materials under both dry and wet conditions.
3. Sodium Hypochlorite ("bleach")
4. Impermeable Containers shall be suitable to receive and retain contaminated materials until disposal at an approved site and shall be labeled in accordance with U.S. DOT 49 CFR 171 and 172, and containers shall be both air- and water-tight. Use a minimum of two types of impermeable containers: 1) six millimeter-thick (mil) plastic bags sized to fit within the drum; and 2) metal or fiber drums with tightly fitting lids.
5. Other Materials: Provide all other materials, such as lumber, nails, and hardware, that may be required to construct and dismantle the decontamination area and the barriers that isolate the work area(s).
6. Caulking shall be non-shrinking caulk to be used where insulated pipes continue through areas such as walls and ceilings. Contractor shall determine and submit proof that caulk proposed for use is compatible with the temperature conditions of the surfaces to which it is to be applied.
   a. Tools And Equipment
      1) Water Sprayer - utilize airless or other low pressure sprayer for amended water application.
      2) Air Purifying Equipment (for internal recirculation in the work area) shall be HEPA Filtration Systems or Electronic Precipitators. Ensure that no internal air movement system or purification equipment exhausts contaminated air from the work area(s) outside the work area.
      3) Diminished Air Pressure Equipment shall comply with ANSI 29.2-7, local exhaust ventilation.
      4) Scaffolding shall be as required to accomplish the specified work and shall meet all applicable safety regulations.
      5) Transportation - as required for loading, temporary storage, transit, and unloading of contaminated waste without exposure to persons or property.

1.3 EXECUTION

A. Procedures

1. All personnel assigned to perform the work shall attend a training/awareness class for the purpose of explaining the hazards of improperly handling the waste and the proper control measures to take in order to protect themselves. These work procedures shall be discussed with

each individual followed by the individual acknowledging receipt of this training by completing the pertinent information on a Hazardous Awareness Training Form

2. The majority of diseases related to bird waste is related to the inhalation of the airborne dust released by the waste. All personnel performing removal/decontamination waste shall therefore wear Powered Air Purifying Respirators (PAPR) equipped with combination Organic Vapor and High Efficiency Particulate Air (HEPA) filters while handling the waste.
3. Workers shall wear non-porous gloves and boots during all preparatory and removal operations.
4. When entering the building, the removal/decontamination personnel shall mist all surfaces having visible remnants of waste, using a diluted sodium hypochlorite ("bleach") and water solution. This solution shall be diluted at a ratio of 10 parts water to 1 part bleach for a 10 to 1 ration (10:1). The waste shall be continuously misted during occupancy in order to keep airborne dust emissions from the waste to a minimurn.
5. Remove all birds from the building and seal all openings into the building. The main purpose of this is to eliminate the availability for future bird access into the building. The openings may be temporarily sealed or closed up in many ways, including boarding up windows/doors, polyethylene sheeting, or other convenient and cost effective means. It is not the intention of this task to complete seal the building airtight.
6. Designate an area of the facility for the purpose of storing the waste prior to loading for transportation to the appropriate landfill. The area designated shall have easy access to the door which will be utilized as the waste load-out.

END OF SECTION 02 87 16 13

Task	Specification	Specification Description
02 89 00 00	01 22 16 00	No Specification Required
02 89 00 00	02 82 33 00a	Removal And Disposal Of Lead-Containing Paint
02 89 00 00	02 83 19 13	Lead Paint Related Abatement Procedures
02 89 00 00	02 83 19 13a	XRF Testing For Lead-Based Paint
02 89 00 00	02 83 19 13b	Lead Dust Wipe, Air And Tclp Sampling And Analysis
02 90 55 00	01 22 16 00	No Specification Required

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SECTION 03 01 30 71 - CONCRETE REHABILITATION

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for concrete rehabilitation. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes the following:
    a. Removal of deteriorated concrete and reinforcement and subsequent replacement and patching.
    b. Floor joint repair.
    c. Epoxy crack injection.
    d. Corrosion-inhibiting treatment.
    e. Polymer overlays.
    f. Polymer sealers.
    g. Steel structural reinforcement.
    h. Composite structural reinforcement.

C. Submittals

1. Product Data: For each type of product indicated. Include material descriptions, chemical composition, physical properties, test data, and mixing, preparation, and application instructions.
2. Formwork and Shoring Drawings: Prepared by or under the supervision of a qualified professional engineer detailing formwork and temporary shoring and supports. Include schedule and sequence for erection and removal relative to removal of deteriorated concrete and reinforcement and subsequent repair and reinforcement.
3. Samples: Cured Samples of overlay and patching materials.
4. Rehabilitation Program: For each phase of rehabilitation process, including protection of surrounding materials and Project site during operations. Describe in detail materials, methods, equipment, and sequence of operations to be used for each phase of the Work.
    a. If alternative materials and methods to those indicated are proposed for any phase of rehabilitation work, submit substitution request and provide a written description of proposed materials and methods, including evidence of successful use on other comparable projects, and a testing program to demonstrate their effectiveness for this Project.

D. Delivery, Storage, And Handling

1. Deliver materials to Project site in manufacturer's original and unopened containers, labeled with type and name of products and manufacturers.
2. Comply with manufacturer's written instructions for minimum and maximum temperature requirements and other conditions for storage.
3. Store cementitious materials off the ground, under cover, and in a dry location.
4. Store aggregates, covered and in a dry location, where grading and other required characteristics can be maintained and contamination avoided.

E. Project Conditions

1. Environmental Limitations for Epoxies: Do not apply when air and substrate temperatures are outside limits permitted by manufacturer. During hot weather, cool epoxy components before mixing, store mixed products in shade, and cool unused mixed products to retard setting. Do not apply to wet substrates unless approved by manufacturer.

a. Use only Class A epoxies when substrate temperatures are below or are expected to go below 40 deg F (5 deg C) within 8 hours.
b. Use only Class A or B epoxies when substrate temperatures are below or are expected to go below 60 deg F (16 deg C) within 8 hours.
c. Use only Class C epoxies when substrate temperatures are above and are expected to stay above 60 deg F (16 deg C) for 8 hours.

2. Cold-Weather Requirements for Cementitious Materials:
   a. Do not apply unless air temperature is above 40 deg F (5 deg C) and will remain so for at least 48 hours after completion of Work.
   OR
   Comply with the following procedures:
      1) When air temperature is below 40 deg F (5 deg C), heat patching material ingredients and existing concrete to produce temperatures between 40 and 90 deg F (5 and 32 deg C).
      2) When mean daily air temperature is between 25 and 40 deg F (minus 4 and plus 5 deg C), cover completed Work with weather-resistant insulating blankets for 48 hours after repair or provide enclosure and heat to maintain temperatures above 32 deg F (0 deg C) within the enclosure for 48 hours after repair.
      3) When mean daily air temperature is below 25 deg F (minus 4 deg C), provide enclosure and heat to maintain temperatures above 32 deg F (0 deg C) within the enclosure for 48 hours after repair.
3. Hot-Weather Requirements for Cementitious Materials: Protect repair work when temperature and humidity conditions produce excessive evaporation of water from patching materials. Provide artificial shade and wind breaks, and use cooled materials as required. Do not apply to substrates with temperatures of 90 deg F (32 deg C) and above.
4. Environmental Limitations for High-Molecular-Weight Methacrylate Sealers: Do not apply when concrete surface temperature is below 55 deg F (13 deg C) or above 75 deg F (24 deg C) **OR** 90 deg F (32 deg C), **as directed**. Apply only to dry substrates **OR** substrates that have been dry for at least 72 hours.

1.2 PRODUCTS

A. Bonding Agents
1. Epoxy-Modified, Cementitious Bonding and Anticorrosion Agent: Product that consists of water-insensitive epoxy adhesive, portland cement, and water-based solution of corrosion-inhibiting chemicals that forms a protective film on steel reinforcement.
2. Epoxy Bonding Agent: ASTM C 881/C 881M, Type II **OR** V, **as directed**.
   a. Thin Film Open Time: Not less than two **OR** six **OR** 24, **as directed**, hours.
3. Latex Bonding Agent: ASTM C 1059, Type I **OR** II **OR** II at exterior locations and where indicated, Type I at other locations, **as directed**.
4. Mortar Scrub-Coat: 1 part portland cement complying with ASTM C 150, Type I, II, or III and 1 part fine aggregate complying with ASTM C 144, except 100 percent passing a No. 16 (1.18-mm) sieve.

B. Patching Mortar
1. Patching Mortar, General:
   a. Overhead Patching Mortar: For overhead repairs, use patching mortar recommended by manufacturer for overhead use and as specified in this Article.
   b. Coarse Aggregate for Adding to Patching Mortar: Washed aggregate complying with ASTM C 33, Size No. 8, Class 5S. Add only as permitted by patching mortar manufacturer.
2. Job-Mixed Patching Mortar: 1 part portland cement complying with ASTM C 150, Type I, II, or III and 2-1/2 parts fine aggregate complying with ASTM C 144, except 100 percent passing a No. 16 (1.18-mm) sieve.

3. Cementitious Patching Mortar: Packaged, dry mix complying with ASTM C 928.
4. Polymer-Modified, Cementitious Patching Mortar: Packaged, dry mix complying with ASTM C 928, that contains a non-redispersible latex additive as either a dry powder or a separate liquid that is added during mixing.
5. Polymer-Modified, Silica-Fume-Enhanced, Cementitious Patching Mortar: Packaged, dry mix complying with ASTM C 928, that contains silica fume complying with ASTM C 1240 and a non-redispersible latex additive as either a dry powder or a separate liquid that is added during mixing.

C. Concrete
1. Concrete Materials and Admixtures: Comply with Division 03 Section "Cast-in-place Concrete".
2. Steel and Fiber Reinforcement and Reinforcement Accessories: Comply with Division 03 Section "Cast-in-place Concrete".
3. Form-Facing Materials: Comply with Division 03 Section "Cast-in-place Concrete".
4. Shotcrete: Comply with Division 03 Section "Shotcrete".
5. Preplaced Aggregate: Washed aggregate complying with ASTM C 33, Class 5S, with 95 to 100 percent passing a 1-1/2-inch (37.5-mm) sieve, 40 to 80 percent passing a 1-inch (25-mm) sieve, 20 to 45 percent passing a 3/4-inch (19-mm) sieve, 0 to 10 percent passing a 1/2-inch (12.5-mm) sieve, and 0 to 2 percent passing a 3/8-inch ((9.5-mm)) sieve **OR** 100 percent passing a 1-1/2-inch (37.5-mm) sieve, 95 to 100 percent passing a 1-inch (25-mm) sieve, 40 to 80 percent passing a 3/4-inch (19-mm) sieve, 0 to 15 percent passing a 1/2-inch (12.5-mm) sieve, and 0 to 2 percent passing a 3/8-inch (9.5-mm) sieve, **as directed**.
6. Fine Aggregate for Grout Used with Preplaced Aggregate: Fine aggregate complying with ASTM C 33, but with 100 percent passing a No. 8 (2.36-mm) sieve, 95 to 100 percent passing a No. 16 (1.18-mm) sieve, 55 to 80 percent passing a No. 30 (0.6-mm) sieve, 30 to 55 percent passing a No. 50 (0.3-mm) sieve, 10 to 30 percent passing a No. 100 (0.15-mm) sieve, 0 to 10 percent passing a No. 200 (0.075-mm) sieve, and having a fineness modulus of 1.30 to 2.10.
7. Grout Fluidifier for Grout Used with Preplaced Aggregate: ASTM C 937.
8. Portland Cement for Grout Used with Preplaced Aggregate: ASTM C 150.
9. Pozzolans for Grout Used with Preplaced Aggregate: ASTM C 618.

D. Miscellaneous Materials
1. Epoxy Joint Filler: 2-component, semirigid, 100 percent solids, epoxy resin with a Type A Shore durometer hardness of at least 80 per ASTM D 2240.
2. Polyurea Joint Filler: 2-component, semirigid, 100 percent solids, polyurea resin with a Type A Shore durometer hardness of at least 80 per ASTM D 2240.
3. Epoxy Crack Injection Adhesive: ASTM C 881/C 881M, Type I **OR** IV, **as directed**, Grade 1, except for gel time **OR** solvent free, **as directed**.
4. Capping Adhesive: Product manufactured for use with crack injection adhesive by same manufacturer.
5. Corrosion-Inhibiting Treatment Materials: Water-based solution of alkaline corrosion-inhibiting chemicals that penetrates concrete by diffusion and forms a protective film on steel reinforcement.
6. Polymer Overlay: Epoxy adhesive complying with ASTM C 881/C 881M, Type III.
7. Aggregate for Use with Polymer Overlay: Oven-dried, washed silica sand complying with ACI 503.3.
8. Polymer Sealer: Low-viscosity epoxy or high-molecular-weight methacrylate penetrating sealer recommended by manufacturer for application to exterior concrete traffic surfaces.
9. Methylmethacrylate Sealer/Brighteners: Clear low-viscosity sealer recommended by manufacturer for sealing exterior exposed-aggregate concrete, and formulated to bring out color of aggregates and give concrete a wet look.
10. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
    a. After fabricating, prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

b. For minimum protection to steel after preparation, apply one coat of lead- and chromate-free, modified-alkyd primer complying with MPI#76 and one coat of alkyd-gloss enamel complying with MPI#96.

c. After preparation, apply two-coat high-performance coating system consisting of organic zinc-rich primer, complying with SSPC-Paint 20 or SSPC-Paint 29 and topcoat of high-build, urethane or epoxy coating recommended by manufacturer for application over specified zinc-rich primer. Comply with coating manufacturer's written directions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

11. Bolts, Nuts, and Washers: Carbon steel; ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), for bolts; ASTM A 563 (ASTM A 563M), Grade A, for nuts; and ASTM F 436 (ASTM F 436M) for washers; hot-dip or mechanically zinc coated.

12. Postinstalled Anchors: Chemical or expansion anchors, made from stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Alloy Group A1 or A4) for bolts and nuts; ASTM A 666 or ASTM A 276, Type 304 or 316, for anchors, with capability to sustain, without failure, a load equal to four times the load imposed, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

13. Composite Structural Reinforcement: Manufacturer's system consisting of carbon **OR** glass, **as directed**,-fiber reinforcement in the form of preimpregnated sheets or tow sheet with field-applied saturant, and epoxy primers, fillers, adhesives, saturants, and topcoats, designed for use as external structural reinforcement for concrete.

E. Mixes

1. Mix products, in clean containers, according to manufacturer's written instructions.

a. Add clean silica sand and coarse aggregates to products only as recommended by manufacturer.

b. Do not add water, thinners, or additives unless recommended by manufacturer.

c. When practical, use manufacturer's premeasured packages to ensure that materials are mixed in proper proportions. When premeasured packages are not used, measure ingredients using graduated measuring containers; do not estimate quantities or use shovel or trowel as unit of measure.

d. Do not mix more materials than can be used within recommended open time. Discard materials that have begun to set.

2. Mortar Scrub-Coat: Mix with enough water to provide consistency of thick cream.

3. Dry-Pack Mortar: Mix with just enough liquid to form damp cohesive mixture that can be squeezed by hand into a ball but is not plastic.

4. Concrete: Comply with Division 03 Section "Cast-in-place Concrete".

5. Shotcrete: Comply with Division 03 Section "Shotcrete".

6. Grout for Use with Preplaced Aggregate: Proportion according to ASTM C 938. Add grout fluidifier to mixing water followed by cementitious materials and then fine aggregate.

1.3 EXECUTION

A. Examination

1. Notify the Owner seven days in advance of dates when areas of deteriorated or delaminated concrete and deteriorated reinforcing bars will be located.

2. Locate areas of deteriorated or delaminated concrete using hammer or chain drag sounding and mark boundaries. Mark areas for removal by simplifying and squaring off boundaries. At columns and walls make boundaries level and plumb, unless otherwise indicated.

3. Locate at least three reinforcing bars using a pachometer, and drill test holes to determine depth of cover. Calibrate pachometer, using depth of cover measurements, and verify depth of cover in removal areas using pachometer.

B. Preparation
1. Protect people, motor vehicles, equipment, surrounding construction, Project site, plants, and surrounding buildings from injury resulting from concrete rehabilitation work.
    a. Erect and maintain temporary protective covers over pedestrian walkways and at points of entrance and exit for people and vehicles, unless such areas are made inaccessible during the course of concrete rehabilitation work. Construct covers of tightly fitted, 3/4-inch (19-mm) exterior-grade plywood supported at 16 inches (405 mm) o.c. and covered with asphalt roll roofing.
    b. Protect adjacent equipment and surfaces by covering them with heavy polyethylene film and waterproof masking tape or a liquid strippable masking agent. If practical, remove items, store, and reinstall after potentially damaging operations are complete.
    c. Neutralize and collect alkaline and acid wastes according to requirements of authorities having jurisdiction, and dispose of by legal means off the Owner's property.
    d. Dispose of runoff from wet operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.
    e. Collect runoff from wet operations and dispose of by legal means off the Owner's property.
2. Shoring: Install temporary supports before beginning concrete removal.
3. Concrete Removal:
    a. Saw-cut perimeter of areas indicated for removal to a depth of at least 1/2 inch (13 mm). Make cuts perpendicular to concrete surfaces and no deeper than cover on reinforcement.
    b. Remove deteriorated and delaminated concrete by breaking up and dislodging from reinforcement.
    c. Remove additional concrete, if necessary, to provide a depth of removal of at least 1/2 inch (13 mm) over entire removal area.
    d. Where half or more of the perimeter of reinforcing bar is exposed, bond between reinforcing bar and surrounding concrete is broken, or reinforcing bar is corroded, remove concrete from entire perimeter of bar and to provide at least a 3/4-inch (19-mm) clearance around bar.
    e. Test areas where concrete has been removed by tapping with hammer, and remove additional concrete until unsound and disbonded concrete is completely removed.
    f. Provide fractured aggregate surfaces with a profile of at least 1/8 inch (3 mm) that are approximately perpendicular or parallel to original concrete surfaces. At columns and walls, make top and bottom surfaces level, unless otherwise directed.
    g. Thoroughly clean removal areas of loose concrete, dust, and debris.
4. Reinforcing Bar Preparation: Remove loose and flaking rust from reinforcing bars by high-pressure water cleaning **OR** abrasive blast cleaning **OR** needle scaling **OR** wire brushing, **as directed**, until only tightly bonded light rust remains.
    a. Where section loss of reinforcing bar is more than 25 percent, or 20 percent in 2 or more adjacent bars, cut bars and remove and replace. Remove additional concrete as necessary to provide at least 3/4-inch (19-mm) clearance at existing and replacement bars. Splice replacement bars to existing bars according to ACI 318 (ACI 318M), by lapping, welding, or using mechanical couplings.
5. Preparation of Floor Joints for Repair: Saw-cut joints full width to edges and depth of spalls, but not less than 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**, deep. Clean out debris and loose concrete; vacuum or blow clear with compressed air.
6. Surface Preparation for Corrosion-Inhibiting Treatment: Clean concrete by low-pressure water cleaning **OR** detergent scrubbing **OR** sand blasting, **as directed**, to remove dirt, oils, films, and other materials detrimental to treatment application. Allow surface to dry before applying corrosion-inhibiting treatment.
7. Surface Preparation for Overlays: Remove delaminated material and deteriorated concrete surface material. Roughen surface of concrete by sand blasting **OR** shot blasting **OR** scarifying **OR** needle scaling **OR** high-pressure water jetting **OR** scabbling **OR** flame blasting **OR** milling, **as directed**, to produce a surface profile matching CSP 3 **OR** 4 **OR** 5 **OR** 6 **OR** 7 **OR** 8 **OR** 9, **as directed**, per ICRI 03732. Sweep and vacuum roughened surface to remove debris followed by low-pressure water cleaning.

8. Surface Preparation for Sealers: Clean concrete by shot blasting **OR** low-pressure water cleaning **OR** detergent scrubbing, **as directed**, to remove dirt, oils, films, and other materials detrimental to sealer application.
9. Surface Preparation for Sealers: Acid etch surface of concrete to produce a surface profile matching CSP 1 per ICRI 03732. Prepare surface for acid etching by detergent scrubbing to remove oils and films that may prevent acid penetration.
   a. Remove excess acid solution, reaction products, and debris by squeegeeing or vacuuming.
   b. Scrub surface with an alkaline detergent, rinse, and squeegee or vacuum.
   c. Check acidity of surface with pH test paper and continue rinsing until pH is acceptable.
   d. When pH is acceptable and surface is clean, vacuum dry.
10. Surface Preparation for Composite Structural Reinforcement: Remove delaminated material and deteriorated concrete surface material. Clean concrete where reinforcement and epoxy patching mortar is to be applied by low-pressure water cleaning **OR** detergent scrubbing, **as directed**, to remove dirt, oils, films, and other materials detrimental to epoxy application. Roughen surface of concrete by sand blasting.

C. Application
1. General: Comply with manufacturer's written instructions and recommendations for application of products, including surface preparation.
2. Epoxy-Modified, Cementitious Bonding and Anticorrosion Agent: Apply to reinforcing bars and concrete by stiff brush or hopper spray according to manufacturer's written instructions. Apply to reinforcing bars in two coats, allowing first coat to dry two to three hours before applying second coat. Allow to dry before placing patching mortar or concrete.
3. Epoxy Bonding Agent: Apply to reinforcing bars and concrete by brush, roller, or spray according to manufacturer's written instructions, leaving no pinholes or other uncoated areas. Apply to reinforcing bars in at least two coats, allowing first coat to dry before applying second coat. Apply patching mortar or concrete while epoxy is still tacky. If epoxy dries, recoat before placing patching mortar or concrete.
4. Latex Bonding Agent, Type II: Mix with portland cement and scrub into concrete surface according to manufacturer's written instructions. Apply patching mortar or concrete while bonding agent is still wet. If bonding agent dries, recoat before placing patching mortar or concrete.
5. Latex Bonding Agent, Type I: Apply to concrete by brush roller or spray. Allow to dry before placing patching mortar or concrete.
6. Mortar Scrub-Coat: Dampen repair area and surrounding concrete 6 inches (150 mm) beyond repair area. Remove standing water and apply scrub-coat with a brush, scrubbing it into surface and thoroughly coating repair area. If scrub-coat dries, recoat before applying patching mortar or concrete.
7. Patching Mortar: Unless otherwise recommended by manufacturer, apply as follows:
   a. Wet substrate thoroughly and then remove standing water. Scrub a slurry of neat patching mortar mixed with latex bonding agent into substrate, filling pores and voids.
   b. Place patching mortar by troweling toward edges of patch to force intimate contact with edge surfaces. For large patches, fill edges first and then work toward center, always troweling toward edges of patch. At fully exposed reinforcing bars, force patching mortar to fill space behind bars by compacting with trowel from sides of bars.
   c. For vertical patching, place material in lifts of not more than 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, nor less than 1/8 inch (3 mm) **OR** 1/4 inch (6 mm), **as directed**. Do not feather edge.
   d. For overhead patching, place material in lifts of not more than 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, nor less than 1/8 inch (3 mm) **OR** 1/4 inch (6 mm), **as directed**. Do not feather edge.
   e. After each lift is placed, consolidate material and screed surface.
   f. Where multiple lifts are used, score surface of lifts to provide a rough surface for application of subsequent lifts. Allow each lift to reach final set before placing subsequent lifts.

g. Allow surfaces of lifts that are to remain exposed to become firm and then finish to a smooth **OR** rough, **as directed**, surface with a wood or sponge float **OR** broom or burlap drag, **as directed**.
h. Wet-cure cementitious patching materials, including polymer-modified, cementitious patching materials, for not less than seven days by water-fog spray or water-saturated absorptive cover.

8. Dry-Pack Mortar: Use for deep cavities and where indicated. Unless otherwise recommended by manufacturer, apply as follows:
   a. Provide forms where necessary to confine patch to required shape.
   b. Wet substrate and forms thoroughly and then remove standing water.
   c. Place dry-pack mortar into cavity by hand, and compact into place with a hardwood drive stick and mallet or hammer. Do not place more material at a time than can be properly compacted. Continue placing and compacting until patch is approximately level with surrounding surface.
   d. After cavity is filled and patch is compacted, trowel surface to match profile and finish of surrounding concrete. A thin coat of patching mortar may be troweled into the surface of patch to help obtain required finish.
   e. Wet-cure patch for not less than seven days by water-fog spray or water-saturated absorptive cover.
9. Concrete: Place according to Division 03 Section "Cast-in-place Concrete" and as follows:
   a. Apply epoxy-modified, cementitious bonding and anticorrosion agent **OR** epoxy bonding agent, **as directed**, to reinforcement and concrete substrate.
   b. Apply latex bonding agent **OR** Type I, latex bonding agent **OR** mortar scrub-coat, **as directed**, to concrete substrate.
   c. Use vibrators to consolidate concrete as it is placed.
   d. At unformed surfaces, screed concrete to produce a surface that when finished with patching mortar will match required profile and surrounding concrete.
   e. Where indicated place concrete by form and pump method.
      1) Design and construct forms to resist pumping pressure in addition to weight of wet concrete. Seal joints and seams in forms and junctions of forms with existing concrete.
      2) Pump concrete into place, releasing air from forms as concrete is introduced. When formed space is full, close air vents and pressurize to 14 psi (96 kPa).
   f. Wet-cure concrete for not less than seven days by leaving forms in place or keeping surfaces continuously wet by water-fog spray or water-saturated absorptive cover.
   g. Fill placement cavities with dry-pack mortar and repair voids with patching mortar. Finish to match surrounding concrete.
10. Shotcrete: Place according to Division 03 Section "Shotcrete" and as follows:
    a. Apply epoxy-modified, cementitious bonding and anticorrosion agent **OR** epoxy bonding agent, **as directed**, to reinforcement and concrete substrate.
    b. Apply latex bonding agent **OR** Type I, latex bonding agent **OR** mortar scrub-coat, **as directed**, to concrete substrate.
    c. Screed and finish shotcrete to produce a surface matching required profile and surrounding concrete.
11. Grouted Preplaced Aggregate Concrete: Use for column and wall repairs **OR** where indicated, **as directed**. Place as follows:
    a. Design and construct forms to resist pumping pressure in addition to weight of wet grout. Seal joints and seams in forms and junctions of forms with existing concrete.
    b. Apply epoxy-modified, cementitious bonding and anticorrosion agent **OR** epoxy bonding agent, **as directed**, to reinforcement and concrete substrate.
    c. Place aggregate in forms, consolidating aggregate as it is placed. Pack aggregate into upper areas of forms to achieve intimate contact with concrete surfaces.
    d. Fill forms with water to thoroughly dampen aggregate and substrates. Drain water from forms before placing grout.

e. Pump grout into place at bottom of preplaced aggregate, forcing grout upward. Release air from forms at top as grout is introduced. When formed space is full and grout flows from air vents, close vents and pressurize to 14 psi (96 kPa).
f. Wet-cure concrete for not less than seven days by leaving forms in place or keeping surfaces continuously wet by water-fog spray or water-saturated absorptive cover.
g. Repair voids with patching mortar and finish to match surrounding concrete.

12. Joint Filler: Install in nonmoving floor joints where indicated.
a. Install filler to a depth of at least 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**. Use fine silica sand no more than 1/4 inch (6 mm) deep to close base of joint. Do not use sealant backer rods or compressible fillers below joint filler.
b. Install filler so that when cured, it is flush at top surface of adjacent concrete. If necessary, overfill joint and remove excess when filler has cured.

13. Epoxy Crack Injection: Comply with manufacturer's written instructions and the following:
a. Clean areas to receive capping adhesive of oil, dirt, and other substances that would interfere with bond, and clean cracks with oil-free compressed air or low-pressure water to remove loose particles.
b. Place injection ports as recommended by epoxy manufacturer, spacing no farther apart than thickness of member being injected. Seal injection ports in place with capping adhesive.
c. Seal cracks at exposed surfaces with a ribbon of capping adhesive at least 1/4 inch (6 mm) thick by 1 inch (25 mm) wider than crack.
d. Inject cracks wider than 0.003 inch (0.075 mm) to a depth of 8 inches (200 mm) or to a width of less than 0.003 inch (0.075 mm), whichever is less.
e. Inject epoxy adhesive, beginning at widest part of crack and working toward narrower parts. Inject adhesive into ports to refusal, capping adjacent ports when they extrude epoxy. Cap injected ports and inject through adjacent ports until crack is filled.
f. After epoxy adhesive has set, remove injection ports and grind surfaces smooth.

14. Corrosion-Inhibiting Treatment: Apply by brush, roller, or airless spray in two coats at manufacturer's recommended application rate. Remove film of excess treatment by high-pressure washing before patching treated concrete or applying a sealer or overlay.

15. Polymer Overlay: Apply according to ACI 503.3.
a. Apply to traffic-bearing surfaces, including parking areas and walks.

16. Polymer Sealer: Apply by brush, roller, or airless spray at manufacturer's recommended application rate.
a. Apply to traffic-bearing surfaces, including parking areas and walks.

17. Methylmethacrylate Sealer/Brighteners: Apply by brush, roller, or airless spray at manufacturer's recommended application rate.
a. Apply to exterior concrete surfaces that are exposed to view, excluding traffic-bearing surfaces.

18. Composite Structural Reinforcement Using Preimpregnated Fiber Sheet: Unless otherwise recommended by manufacturer, apply as follows:
a. Patch surface defects with epoxy mortar and allow to set before beginning reinforcement application.
b. Apply epoxy adhesive to a thickness of 1/16 inch (1.6 mm) to prepared concrete surfaces in areas where composite structural reinforcement will be applied.
c. Clean preimpregnated fiber sheet with acetone or other suitable solvent, and apply epoxy adhesive to a thickness of 1/16 inch (1.6 mm).
d. Apply adhesive-coated fiber sheet to adhesive-coated concrete within open time of epoxy adhesive, and roll with a hard rubber roller until fiber sheet is fully embedded in adhesive, air pockets are removed, and adhesive is forced out from beneath fiber sheet at edges.
e. Apply additional layers as indicated using same procedure.

19. Composite Structural Reinforcement Using Fiber Tow Sheet and Saturant: Unless otherwise recommended by manufacturer, apply as follows:
a. Apply epoxy primer using brush or short nap roller to prepared concrete surfaces in areas where composite structural reinforcement will be applied.

b. After primer has set, patch surface defects with epoxy filler and allow to set before beginning reinforcement application.
c. Apply epoxy saturant to fiber tow sheet or primed and patched surface with 3/8-inch- (10-mm-) nap roller. Apply fiber tow sheet to primed and patched surface while saturant is still wet, using pressure roller to remove air pockets. Remove paper backing from fiber tow sheet and apply additional epoxy as needed to fully saturate tow sheet.
d. Apply additional layers as indicated, fully saturating each with epoxy.
e. After saturant has cured, apply protective topcoat by brush, roller or spray.

D. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to sample materials and perform tests as follows:
a. Patching Mortar, Packaged Mixes: <**Insert number**> randomly selected samples tested according to ASTM C 928.
b. Patching Mortar, Field Mixed: <**Insert number**> randomly selected samples tested for compressive strength according to ASTM C 109/C 109M.
c. Concrete: As specified in Division 03 Section "Cast-in-place Concrete".
d. Shotcrete: As specified in Division 03 Section "Shotcrete".
e. Grouted Preplaced Aggregate: Tested for compressive strength of grout according to ASTM C 942.
1) Testing Frequency: One sample for each 25 cu. yd. (19 cu. m) of grout or fraction thereof, but not less than one sample for each day's work.
f. Joint Filler: Core drilled samples to verify proper installation.
1) Testing Frequency: One sample for each 100 feet (30 m) of joint filled.
2) Where samples are taken, fill holes with joint filler.
g. Epoxy Crack Injection: Core drilled samples to verify proper installation.
1) Testing Frequency: 3 samples from mockup and 1 sample for each 100 feet (30 m) of crack injected.
2) Where samples are taken, fill holes with epoxy mortar.

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SECTION 03 01 30 71a - SELF-ADHERING SHEET WATERPROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for self-adhering sheet waterproofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
    a. Modified bituminous sheet waterproofing.
    b. Modified bituminous sheet waterproofing, fabric reinforced.
    c. Modified bituminous deck paving sheet waterproofing.
    d. Modified bituminous composite panel waterproofing.
    e. Adhesive-coated HDPE sheet waterproofing.
    f. Molded-sheet drainage panels.
    g. Insulation.
    h. Plaza deck pavers and paver pedestals.

C. Submittals
1. Product Data: Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.
2. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
3. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for waterproofing.
4. Special warranties.
5. LEED Submittals:
    a. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.
    b. Shop Drawings: Show locations and extent of waterproofing and details of substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
        1) Include setting drawings showing layout, sizes, sections, profiles, and joint details of pedestal-supported concrete pavers.
    c. Samples: For each exposed product and for each color and texture specified, including the following products:
        1) 8-by-8-inch (200-by-200-mm) square of waterproofing and flashing sheet.
        2) 8-by-8-inch (200-by-200-mm) square of insulation.
        3) 4-by-4-inch (100-by-100-mm) square of drainage panel.
        4) Plaza-deck paver, 4-by-4-inch (100-by-100-mm) square **OR** full sized, **as directed**, in each color and texture required.
        5) Paver pedestal assembly.

D. Quality Assurance
1. Installer Qualifications: A firm that is approved or licensed by **OR** acceptable to, **as directed**, waterproofing manufacturer for installation of waterproofing required for this Project.
2. Preinstallation Conference: Conduct conference at Project site.

a. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.

E. Delivery, Storage, And Handling
1. Deliver liquid materials to Project site in original packages with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.
2. Store liquid materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by waterproofing manufacturer.
3. Remove and replace liquid materials that cannot be applied within their stated shelf life.
4. Store rolls according to manufacturer's written instructions.
5. Protect stored materials from direct sunlight.

F. Project Conditions
1. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.

G. Warranty
1. Special Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to replace waterproofing material that does not comply with requirements or that fails to remain watertight within specified warranty period.
   a. Warranty Period: Three **OR** Five, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Modified Bituminous Sheet Waterproofing
1. Modified Bituminous Sheet: Not less than 60-mil- (1.5-mm-) thick, self-adhering sheet consisting of 56 mils (1.4 mm) of rubberized asphalt laminated to a 4-mil- (0.10-mm-) thick, polyethylene film with release liner on adhesive side and formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction.
   a. Physical Properties:
      1) Tensile Strength: 250 psi (1.7 MPa) minimum; ASTM D 412, Die C, modified.
      2) Ultimate Elongation: 300 percent minimum; ASTM D 412, Die C, modified.
      3) Low-Temperature Flexibility: Pass at minus 20 deg F (minus 29 deg C); ASTM D 1970.
      4) Crack Cycling: Unaffected after 100 cycles of 1/8-inch (3-mm) movement; ASTM C 836.
      5) Puncture Resistance: 40 lbf (180 N) minimum; ASTM E 154.
      6) Hydrostatic-Head Resistance: 150 feet (45 m) minimum; ASTM D 5385.
      7) Water Absorption: 0.15 percent weight-gain maximum after 48-hour immersion at 70 deg F (21 deg C); ASTM D 570.
      8) Vapor Permeance: 0.05 perms (2.9 ng/Pa x s x sq. m); ASTM E 96, Water Method.
2. Modified Bituminous Sheet, Fabric Reinforced: 60-mil- (1.5-mm-) thick, self-adhering sheet consisting of rubberized-asphalt membrane embedded in spun-bonded polyester or fiberglass nonwoven fabric reinforcement laminated to a 0.50-mil- (0.01-mm-) thick polyester film with release liner on adhesive side.
   a. Physical Properties:
      1) Pliability: No cracks when bent 180 degrees over a 1-inch (25-mm) mandrel at minus 25 deg F (minus 32 deg C); ASTM D 146.
      2) Hydrostatic-Head Resistance: 150 feet (45 m) minimum.
      3) Vapor Permeance: 0.05 perms (2.9 ng/Pa x s x sq. m); ASTM E 96, Water Method.

B. Modified Bituminous Deck Paving Sheet Waterproofing

1. Modified Bituminous Deck Paving Sheet: Provide one of the products described below, **as directed**:
   a. 65-mil- (1.6-mm-) thick, self-adhering sheets consisting of 53 to 56 mils (1.3 to 1.4 mm) of rubberized asphalt laminated to a heat-resisting, 9- to 12-mil- (0.2- to 0.3-mm-) thick, woven polypropylene geotextile reinforcement with release liner on adhesive side.
   b. 70-mil- (1.8-mm-) thick, self-adhering sheets consisting of rubberized asphalt embedded in inert fabric reinforcement laminated to a reflective geotextile protective topping with release liner on adhesive side.
   c. 60-mil- (1.5-mm-) thick, self-adhering sheets consisting of rubberized asphalt embedded in nonwoven **OR** woven, **as directed**, fiberglass fabric reinforcement laminated to a 0.50-mil- (0.01-mm-) thick polyester mat with release liner on adhesive side.
   d. Physical Properties:
      1) Tensile Strength, Membrane: 50 lbf/in (8.75 kN/m) minimum; ASTM D 882.
      2) Pliability: Unaffected when bent 180 degrees over a 1/4-inch (6.4-mm) mandrel at minus 15 deg F (minus 26 deg C); ASTM D 146.
      3) Puncture Resistance, Mesh: 200 lbf (890 N) minimum; ASTM E 154.

C. Modified Bituminous Composite Panel Waterproofing

1. Modified Bituminous Composite Panel: 90-mil- (2.2-mm-) thick, multilaminated panel consisting of a protection course bonded to an asphalt saturated carrier sheet bonded to a rubberized asphalt waterproofing self-adhering membrane with release liner.

D. Adhesive-Coated HDPE Sheet Waterproofing

1. Adhesive-Coated HDPE Sheet for Vertical Applications: 32-mil- (0.8-mm-) thick, uniform, flexible sheets consisting of 16-mil- (0.4-mm-) thick, HDPE sheet coated with a pressure-sensitive rubber adhesive, a protective adhesive coating, and a release liner with the following physical properties:
   a. Tensile Strength, Film: 4000 psi (27.6 MPa) minimum; ASTM D 412.
   b. Low-Temperature Flexibility: Pass at minus 10 deg F (minus 23 deg C); ASTM D 1970.
   c. Peel Adhesion to Concrete: 5 lbf/in. (875 N/m); ASTM D 903, modified.
   d. Lap Adhesion: 2.5 lbf/in. (440 N/m); ASTM D 1876, modified.
   e. Hydrostatic-Head Resistance: 231 feet (70 m); ASTM D 5385, modified.
   f. Vapor Permeance: 0.01 perms (0.6 ng/Pa x s x sq. m); ASTM E 96, Water Method.
   g. Water Absorption: 0.5 percent; ASTM D 570.
2. Adhesive-Coated HDPE Sheet for Horizontal Applications: 46-mil- (1.2-mm-) thick, uniform, flexible sheets consisting of 30-mil- (0.76-mm-) thick, HDPE sheet coated with a pressure-sensitive rubber adhesive, a protective adhesive coating, a detackifying surface treatment, an uncoated self-adhering side lap strip, and a release liner with the following physical properties:
   a. Tensile Strength, Film: 4000 psi (27.6 MPa) minimum; ASTM D 412.
   b. Low-Temperature Flexibility: Pass at minus 10 deg F (minus 23 deg C); ASTM D 1970.
   c. Peel Adhesion to Concrete: 5 lbf/in. (875 N/m); ASTM D 903, modified.
   d. Lap Adhesion: 2.5 lbf/in. (440 N/m); ASTM D 1876, modified.
   e. Hydrostatic-Head Resistance: 231 feet (70 m); ASTM D 5385, modified.
   f. Vapor Permeance: 0.01 perms (0.6 ng/Pa x s x sq. m); ASTM E 96, Water Method.
   g. Water Absorption: 0.5 percent; ASTM D 570.

E. Auxiliary Materials

1. General: Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.
   a. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.
2. Primer: Liquid waterborne **OR** solvent-borne, **as directed**, primer recommended for substrate by manufacturer of sheet waterproofing material.
3. Surface Conditioner: Liquid, waterborne surface conditioner recommended for substrate by manufacturer of sheet waterproofing material.

4. Liquid Membrane: Elastomeric, two-component liquid, cold fluid applied, trowel grade or low viscosity.
5. Substrate Patching Membrane: Low-viscosity, two-component, asphalt-modified coating.
6. Sheet Strips: Self-adhering, rubberized-asphalt sheet strips of same material and thickness as sheet waterproofing.
7. Mastic, Adhesives, and Tape: Liquid mastic and adhesives, and adhesive tapes recommended by waterproofing manufacturer.
   a. Detail Tape: Two-sided, pressure-sensitive, self-adhering reinforced tape, 4-1/2 inches (114 mm) wide, with a tack-free protective adhesive coating on one side and release film on self-adhering side.
   b. Detail Strips: 62.5-mil- (1.58-mm-) thick, felt-reinforced self-adhesive strip, 9 inches (229 mm) wide, with release film on adhesive side.
8. Metal Termination Bars: Aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick, predrilled at 9-inch (229-mm) centers.
9. Protection Course: ASTM D 6506, semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners and as follows:
   a. Thickness: 1/8 inch (3 mm), nominal, for vertical applications; 1/4 inch (6 mm), nominal, elsewhere.
   b. Adhesive: Rubber-based solvent type recommended by waterproofing manufacturer for type of protection course.
10. Protection Course: Fan folded, with a core of extruded-polystyrene board insulation faced one side or both sides with plastic film, nominal thickness 1/4 inch (6 mm), with compressive strength of not less than 8 psi (55 kPa) per ASTM D 1621, and maximum water absorption by volume of 0.6 percent per ASTM C 272.
11. Protection Course: Unfaced, fan-folded, extruded-polystyrene board insulation, nominal thickness 1/4 inch (6 mm) with compressive strength of not less than 8 psi (55 kPa) per ASTM D 1621.
12. Protection Course: Extruded-polystyrene board insulation, unfaced, ASTM C 578, Type X, 1/2 inch (13 mm) thick.
13. Protection Course: Molded-polystyrene board insulation, ASTM C 578, Type I, 0.90-lb/cu. ft. (15-kg/cu. m) minimum density, 1-inch (25-mm) minimum thickness.

F. Molded-Sheet Drainage Panels
1. Molded-Sheet Drainage Panel: Comply with Division 33 Section "Subdrainage".
2. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21-mm) sieve laminated to one side with or without a polymeric film bonded to the other side of a studded, nonbiodegradable, molded-plastic-sheet drainage core, with a vertical flow rate of 9 to 15 gpm per ft. (112 to 188 L/min. per m).
3. Woven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a woven-geotextile facing with an apparent opening size not exceeding No. 40 (0.425-mm) sieve laminated to one side with or without a polymeric film bonded to the other side of a studded, nonbiodegradable, molded-plastic-sheet drainage core, with a horizontal flow rate not less than 2.8 gpm per ft. (35 L/min. per m).

G. Insulation
1. Board Insulation: Extruded-polystyrene board insulation complying with ASTM C 578, square or shiplap edged.
   a. Type IV, 25-psi (173-kPa) minimum compressive strength.
   b. Type VI, 40-psi (276-kPa) minimum compressive strength.
   c. Type VII, 60-psi (414-kPa) minimum compressive strength.
   d. Type V, 100-psi (690-kPa) minimum compressive strength.
2. Unfaced Wall Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type IV, 25-psi (173-kPa) or Type VI, 40-psi (276-kPa) minimum compressive

strength; unfaced; fabricated with shiplap or channel edges and with 1 side having grooved drainage channels.

3. Geotextile-Faced Wall Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type IV, 25-psi (173-kPa) or Type VI, 40-psi (276-kPa) minimum compressive strength; fabricated with tongue-and-groove edges and with 1 side having grooved drainage channels faced with nonwoven geotextile filter fabric.
4. Unfaced Plaza Deck Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type VI, 40-psi (276-kPa) **OR** Type VII, 60-psi (414-kPa), **as directed**, minimum compressive strength; unfaced; fabricated with shiplapped or channel edges and with 1 side having ribbed drainage channels.
5. Geotextile-Faced Plaza Deck Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type VII, 60-psi (414-kPa) minimum compressive strength; fabricated with tongue-and-groove edges and with 1 side having grooved drainage channels faced with manufacturer's standard, nonwoven geotextile filter fabric.

H. Plaza Deck Pavers

1. Plaza Deck Pavers: Brick **OR** Concrete **OR** Asphalt-Block, **as directed**, pavers specified in Division 32 Section "Unit Paving".
2. Plaza Deck Pavers: Granite **OR** Limestone **OR** Marble **OR** Quartz-Based Stone **OR** Slate, **as directed**, pavers specified in Division 09 Section "Stone Flooring".
3. Plaza Deck Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, manufactured for use as plaza deck pavers; minimum compressive strength 7500 psi (52 mpa) **or** 6500 psi (45 mpa), **as directed**, ASTM C 140; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C 67.
   a. Thickness: 1-5/8 inches (41 mm) **OR** 1-3/4 inches (45 mm) **OR** 2 inches (51 mm) **OR** 2-3/8 inches (60 mm), **as directed**.
   b. Face Size: 8-7/8 inches (225 mm) square **OR** 9 inches (229 mm) square **OR** 9 by 18 inches (229 by 457 mm) **OR** 12 inches (305 mm) square **OR** 12 by 24 inches (305 by 610 mm) **OR** 18 inches (457 mm) square **OR** 24 inches (610 mm) square **OR** As indicated, **as directed**.
   c. Color: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
4. Setting Bed: Provide aggregate **OR** mortar **OR** bituminous, **as directed**, setting-bed materials specified in Division 32 Section "Unit Paving".
5. Paver Pedestals: Paver manufacturer's standard SBR rubber, HDPE, or polyurethane paver support assembly, including fixed-height **OR** adjustable or stackable, **as directed**, pedestals, shims, and spacer tabs for joint spacing of 1/8 inch (3 mm) **OR** 3/16 inch (5 mm) **OR** 1/8 to 3/16 inch (3 to 5 mm), **as directed**.
   a. Concrete Fill: ACI 301, compressive strength of 5000 psi (34 MPa) at 28 days and air content of 6 percent.

1.3 EXECUTION

A. Surface Preparation

1. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.
2. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
3. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
4. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids.
5. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D 4258.

a. Install sheet strips and center over treated construction and contraction joints and cracks exceeding a width of 1/16 inch (1.6 mm) or 1/8 inch (3 mm) for modified bituminous deck paving waterproofing.

6. Bridge and cover isolation joints, expansion joints, and discontinuous deck-to-wall and deck-to-deck joints with overlapping sheet strips.
   a. Invert and loosely lay first sheet strip over center of joint. Firmly adhere second sheet strip to first and overlap to substrate.
7. Corners: Prepare, prime, and treat inside and outside corners according to ASTM D 6135.
   a. Install membrane strips centered over vertical inside corners. Install 3/4-inch (19-mm) fillets of liquid membrane on horizontal inside corners and as follows:
      1) At footing-to-wall intersections, extend liquid membrane each direction from corner or install membrane strip centered over corner.
      2) At plaza deck-to-wall intersections, extend liquid membrane or sheet strips onto deck waterproofing and to finished height of sheet flashing.
8. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions according to ASTM D 6135.

B. Modified Bituminous Sheet Waterproofing Application

1. Install modified bituminous sheets according to waterproofing manufacturer's written instructions and according to recommendations in ASTM D 6135.
2. Apply primer to substrates at required rate and allow to dry. Limit priming to areas that will be covered by sheet waterproofing in same day. Reprime areas exposed for more than 24 hours.
3. Apply and firmly adhere sheets over area to receive waterproofing. Accurately align sheets and maintain uniform 2-1/2-inch- (64-mm-) minimum lap widths and end laps. Overlap and seal seams and stagger end laps to ensure watertight installation.
   a. When ambient and substrate temperatures range between 25 and 40 deg F (minus 4 and plus 5 deg C), install self-adhering, modified bituminous sheets produced for low-temperature application. Do not use low-temperature sheets if ambient or substrate temperature is higher than 60 deg F (16 deg C).
4. Two-Ply Application: Install sheets to form a membrane with lap widths not less than 50 percent of sheet widths to provide a minimum of 2 thicknesses of sheet membrane over areas to receive waterproofing.
5. Horizontal Application: Apply sheets from low point to high point of decks to ensure that side laps shed water.
6. Apply continuous sheets over sheet strips bridging substrate cracks, construction, and contraction joints.
7. Seal exposed edges of sheets at terminations not concealed by metal counterflashings or ending in reglets with mastic.
8. Install sheet waterproofing and auxiliary materials to tie into adjacent waterproofing.
9. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending 6 inches (150 mm) beyond repaired areas in all directions.
10. Install protection course with butted joints over waterproofing membrane immediately.
    a. Molded-sheet drainage panels **OR** Insulation drainage panels **OR** Board insulation, **as directed**, may be used in place of a separate protection course to vertical applications when approved by waterproofing manufacturer and installed immediately.
11. Correct deficiencies in or remove sheet waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

C. Modified Bituminous Deck Paving Sheet Waterproofing Application

1. Install modified bituminous deck paving sheets according to waterproofing manufacturer's written instructions.
2. Apply primer to substrates at required rate and allow to dry. Limit priming to areas that will be covered by sheet waterproofing in same day. Reprime areas exposed for more than 24 hours.

3. Apply and firmly adhere sheets over areas to receive waterproofing. Accurately align sheets and maintain uniform 2-1/2-inch- (64-mm-) minimum lap widths and 6-inch (150-mm) end laps. Overlap and seal seams and stagger end laps to ensure watertight installation.
4. Apply sheet waterproofing from low point to high point of decks to ensure that side laps shed water.
5. Apply continuous sheets over sheet strips bridging substrate cracks, construction, and contraction joints.
6. Seal edges of sheet waterproofing terminations with mastic.
7. Install sheet waterproofing and auxiliary materials to tie into adjacent waterproofing.
8. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending 6 inches (150 mm) beyond repaired areas in all directions.
9. Correct deficiencies in or remove sheet waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

D. Modified Bituminous Composite Panel Waterproofing Application
1. Install modified bituminous composite panels according to waterproofing manufacturer's written instructions.
2. Apply primer to substrate at required rate and allow to dry. Limit priming to areas that will be covered by waterproofing in same day. Reprime areas exposed for more than 24 hours.
3. Install and firmly adhere composite panels over area to receive waterproofing. Accurately align and butt vertical and horizontal joints.
4. Seal vertical and horizontal butt joints and exposed top, side, and bottom edges at composite panel waterproofing terminations with detail strips.
5. Correct deficiencies in or remove composite panel waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair detail strips.

E. Adhesive-Coated HDPE Sheet Waterproofing Application
1. Install adhesive-coated HDPE sheets according to manufacturer's written instructions.
2. Place and secure molded-sheet drainage panels over substrate. Lap edges and ends of geotextile to maintain continuity.
3. Vertical Applications: Install adhesive-coated HDPE sheet with HDPE face against substrate. Accurately align sheets and maintain uniform 3-inch- (75-mm-) minimum lap widths and end laps. Overlap and seal seams and stagger and tape end laps to ensure watertight installation. Mechanically fasten to substrate.
    a. Securely fasten top termination of membrane with continuous metal termination bar anchored into substrate and cover with detailing tape.
4. Horizontal Applications: Install adhesive-coated HDPE sheet with HDPE face against substrate. Accurately align sheets and maintain uniform 3-inch- (75-mm-) minimum lap widths and end laps. Overlap and seal seams. Overlap, stagger, and seal end laps with detail tape to ensure watertight installation.
5. Corners: Seal lapped terminations and cut edges of sheet waterproofing at inside and outside corners with detail tape.
6. Seal penetrations through sheet waterproofing to provide watertight seal with detail tape patches or wraps and a liquid-membrane troweling.
7. Install sheet waterproofing and auxiliary materials to produce a continuous watertight tie into adjacent waterproofing.
8. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Tape perimeter of damaged or nonconforming area extending 6 inches (150 mm) beyond repaired areas in all directions. Apply a patch of sheet waterproofing and firmly secure with detail tape.
9. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

F. Molded-Sheet Drainage Panel Installation
1. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate, according to manufacturer's written instructions. Use adhesives or mechanical

fasteners that do not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.

a. For vertical applications, install board insulation **OR** protection course, **as directed**, before installing drainage panels.

G. Insulation Installation

1. Install one or more layers of board insulation to achieve required thickness and insulation drainage panels over waterproofed surfaces. Cut and fit to within 3/4 inch (19 mm) of projections and penetrations.
2. On vertical surfaces, set insulation units in adhesive or tape applied according to manufacturer's written instructions.
3. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

H. Plaza Deck Paver Installation

1. Setting Bed: Install setting bed in locations and of thickness indicated to comply with requirements in Division 32 Section(s) "Unit Paving" OR Division 09 Section(s) "Stone Flooring", **as directed**.
2. Install concrete pavers in locations indicated according to manufacturer's written instructions.
3. Accurately install fixed **OR** adjustable, **as directed**,-height paver pedestals and accessories in locations and to elevations required. Adjust for final level and slope with shims.
   a. Fill paver pedestal with concrete mix, strike smooth with top of pedestal, and cure according to ACI 301.
4. Loosely lay pavers on pedestals, maintaining a uniform open joint width. Tightly seat pavers against spacers to eliminate lateral movement or drift of paving assembly. Align joint patterns parallel in each direction.
   a. Lay out pavers to avoid less-than-half-width pavers at perimeter or other terminations.
5. Install pavers to not vary more than 1/16 inch (1.6 mm) in elevation between adjacent pavers or more than 1/16 inch (1.6 mm) from surface plane elevation of individual paver.
6. Maintain tolerances of paving installation within 1/4 inch in 10 feet (1:48) of surface plane in any direction.

I. Field Quality Control

1. Flood Testing: Flood test each deck area for leaks, according to recommendations in ASTM D 5957, after completing waterproofing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.
   a. Flood to an average depth of 2-1/2 inches (64 mm) with a minimum depth of 1 inch (25 mm) and not exceeding a depth of 4 inches (100 mm). Maintain 2 inches (51 mm) of clearance from top of sheet flashings.
   b. Flood each area for 24 **OR** 48 **OR** 72, **as directed**, hours.
   c. After flood testing, repair leaks, repeat flood tests, and make further repairs until waterproofing installation is watertight.
2. Engage an independent testing agency to observe flood testing and examine underside of decks and terminations for evidence of leaks during flood testing.

J. Protection And Cleaning

1. Do not permit foot or vehicular traffic on unprotected membrane.
2. Protect waterproofing from damage and wear during remainder of construction period.
3. Protect installed board insulation **OR** insulation drainage panels, **as directed**, from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation will be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
4. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 03 01 30 71a

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Task	Specification	Specification Description
03 01 30 71	01 22 16 00	No Specification Required

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SECTION 03 05 13 00 - CAST-IN-PLACE CONCRETE

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for cast-in-place concrete. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
a. Footings.
b. Foundation walls.
c. Slabs-on-grade.
d. Suspended slabs.
e. Concrete toppings.
f. Building frame members.
g. Building walls.

C. Definitions
1. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

D. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
1) Include statement indicating costs for each product having recycled content.
b. Design Mixtures for Credit ID 1.1: For each concrete mixture containing fly ash as a replacement for portland cement or other portland cement replacements and for equivalent concrete mixtures that do not contain portland cement replacements.
3. Design Mixtures: For each concrete mixture.
4. Shop Drawings: For steel reinforcement and formwork. Material test reports **OR** certificates, **as directed**.

E. Quality Assurance
1. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
a. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
2. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, **as directed**, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
3. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
a. ACI 301, "Specification for Structural Concrete," Sections 1 through 5 **OR** Sections 1 through 5 and Section 7, "Lightweight Concrete", **as directed**.
b. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
4. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

5. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement, **as directed**.
2. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

1.2 PRODUCTS

A. Form-Facing Materials
1. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
2. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
3. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
4. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.
5. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.
6. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch (19 by 19 mm), minimum.
7. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
8. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
   a. Formulate form-release agent with rust inhibitor for steel form-facing materials.
9. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
   a. Furnish units that will leave no corrodible metal closer than 1 inch (25 mm) to the plane of exposed concrete surface.
   b. Furnish ties that, when removed, will leave holes no larger than 1 inch (25 mm) in diameter in concrete surface.
   c. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

B. Steel Reinforcement
1. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 **OR** 60, **as directed**, percent.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
3. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
4. Galvanized Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, ASTM A 767/A 767M, Class I **OR** II, **as directed**, zinc coated after fabrication and bending.
5. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, ASTM A 775/A 775M **OR** ASTM A 934/A 934M, **as directed**, epoxy coated, with less than 2 percent damaged coating in each 12-inch (300-mm) bar length.
6. Stainless-Steel Reinforcing Bars: ASTM A 955/A 955M, Grade 60 (Grade 420), Type 304 **OR** 316L, **as directed**, deformed.

7. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, assembled with clips.
8. Plain-Steel Wire: ASTM A 82, as drawn **OR** galvanized, **as directed**.
9. Deformed-Steel Wire: ASTM A 496.
10. Epoxy-Coated Wire: ASTM A 884/A 884M, Class A, Type 1 coated, as-drawn, plain-steel-wire **OR** deformed-steel wire, **as directed**, with less than 2 percent damaged coating in each 12-inch (300-mm) wire length.
11. Plain-Steel Welded Wire Reinforcement: ASTM A 1064, plain, fabricated from as-drawn steel wire into flat sheets.
12. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.
13. Galvanized-Steel Welded Wire Reinforcement: ASTM A 1064, plain, fabricated from galvanized steel wire into flat sheets.
14. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A coated, Type 1, plain **OR** deformed, **as directed**, steel.

C. Reinforcement Accessories
1. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars, cut bars true to length with ends square and free of burrs.
2. Epoxy-Coated Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars, ASTM A 775/A 775M epoxy coated.
3. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 775M.
4. Zinc Repair Material: ASTM A 780, zinc-based solder, paint containing zinc dust, or sprayed zinc.
5. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
   a. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
   b. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
   c. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

D. Concrete Materials
1. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
   a. Portland Cement: ASTM C 150, Type I **OR** II **OR** I/II **OR** III **OR** V, **as directed**, gray **OR** white, **as directed**. Supplement with the following:
      1) Fly Ash: ASTM C 618, Class C **OR** F, **as directed**.
      2) Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
   b. Blended Hydraulic Cement: ASTM C 595, Type IS, portland blast-furnace slag **OR** IP, portland-pozzolan **OR** I (PM), pozzolan-modified portland **OR** I (SM), slag-modified Portland, **as directed**, cement.
2. Silica Fume: ASTM C 1240, amorphous silica.
3. Normal-Weight Aggregates: ASTM C 33, graded, 1-1/2-inch (38-mm) **OR** 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum coarse-aggregate size.
   a. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
4. Lightweight Aggregate: ASTM C 330, 1-inch (25-mm) **OR** 3/4-inch (19-mm) **OR** 1/2-inch (13-mm) **OR** 3/8-inch (10-mm), **as directed**, nominal maximum aggregate size.
5. Water: ASTM C 94/C 94M and potable, **as directed**.

E. Admixtures
1. Air-Entraining Admixture: ASTM C 260.

2. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
   a. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
   b. Retarding Admixture: ASTM C 494/C 494M, Type B.
   c. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
   d. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
   e. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
   f. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
3. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C 494/C 494M, Type C.
4. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.
5. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, **as directed**, nonfading, and resistant to lime and other alkalis.
   a. Color: As indicated by manufacturer's designation **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.

F. Fiber Reinforcement
1. Carbon-Steel Fiber: ASTM A 820, deformed, minimum of 1.5 inches (38 mm) **OR** 2 inches (50 mm) **OR** 2.4 inches (60 mm), **as directed**, long, and aspect ratio of 35 to 40 **OR** 45 to 50 **OR** 60 to 65, **as directed**.
   a. Fiber: Type 1, cold-drawn wire **OR** 2, cut sheet, **as directed**.
2. Synthetic Micro-Fiber: Monofilament or fibrillated polypropylene micro-fibers engineered and designed for use in concrete, complying with ASTM C 1116/ C 1116M , Type III, 1/2 to 1-1/2 inches (13 to 38 mm) **OR** 1 to 2-1/4 inches (25 to 57 mm)long.
3. Synthetic Macro-Fiber: Polyolefin macro-fibers engineered and designed for use in concrete, complying with ASTM C 1116/C 1116M, Type III, 1 to 2-1/4 inches (25 to 57 mm) long.

G. Waterstops
1. Flexible Rubber Waterstops: CE CRD-C 513, with factory-installed metal eyelets, **as directed**, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
   a. Profile: Flat, dumbbell with center bulb **OR** Flat, dumbbell without center bulb **OR** Ribbed with center bulb **OR** Ribbed without center bulb **OR** As indicated, **as directed**.
   b. Dimensions: 4 inches by 3/16 inch thick (100 mm by 4.75 mm thick) **OR** 6 inches by 3/8 inch thick (150 mm by 10 mm thick) **OR** 9 inches by 3/8 inch thick (225 mm by 10 mm thick), **as directed**; nontapered.
2. Chemically Resistant Flexible Waterstops: Thermoplastic elastomer rubber waterstops with factory-installed metal eyelets, **as directed**, for embedding in concrete to prevent passage of fluids through joints; resistant to oils, solvents, and chemicals. Factory fabricate corners, intersections, and directional changes.
   a. Profile: Flat, dumbbell with center bulb **OR** Flat, dumbbell without center bulb **OR** Ribbed with center bulb **OR** Ribbed without center bulb **OR** As indicated, **as directed**.
   b. Dimensions: 4 inches by 3/16 inch thick (100 mm by 4.75 mm thick) **OR** 6 inches by 3/16 inch thick (150 mm by 4.75 mm thick) **OR** 6 inches by 3/8 inch thick (150 mm by 10 mm thick) **OR** 9 inches by 3/16 inch thick (225 mm by 4.75 mm thick) **OR** 9 inches by 3/8 inch thick (225 mm by 10 mm thick), **as directed**; nontapered.
3. Flexible PVC Waterstops: CE CRD-C 572, with factory-installed metal eyelets, **as directed**, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

a. Profile: Flat, dumbbell with center bulb **OR** Flat, dumbbell without center bulb **OR** Ribbed with center bulb **OR** Ribbed without center bulb **OR** As indicated, **as directed**.
b. Dimensions: 4 inches by 3/16 inch thick (100 mm by 4.75 mm thick) **OR** 6 inches by 3/8 inch thick (150 mm by 10 mm thick) **OR** 9 inches by 3/8 inch thick (225 mm by 10 mm thick), **as directed**; nontapered.
4. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch (19 by 25 mm).
5. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch (10 by 19 mm).

H. Vapor Retarders
1. Plastic Vapor Retarder:
a. ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.
b. ASTM E 1745, Class B. Include manufacturer's recommended adhesive or pressure-sensitive tape.
c. ASTM E 1745, Class C, or polyethylene sheet, ASTM D 4397, not less than 10 mils (0.25 mm) thick, **as directed**. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.
2. Bituminous Vapor Retarder: 110-mil- (2.8-mm-) thick, semiflexible, 7-ply sheet membrane consisting of reinforced core and carrier sheet with fortified asphalt layers, protective weathercoating, and removable plastic release liner. Furnish manufacturer's accessories including bonding asphalt, pointing mastics, and self-adhering joint tape.
a. Water-Vapor Permeance: 0.00 grains/h x sq. ft. x inches Hg (0.00 ng/Pa x s x sq. m); ASTM E 154.
b. Tensile Strength: 140 lbf/in. (24.5 kN/m); ASTM E 154.
c. Puncture Resistance: 90 lbf (400N); ASTM E 154.
3. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.
4. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 448, Size 10, with 100 percent passing a 3/8-inch (9.5-mm) sieve, 10 to 30 percent passing a No. 100 (0.15-mm) sieve, and at least 5 percent passing No. 200 (0.075-mm) sieve; complying with deleterious substance limits of ASTM C 33 for fine aggregates.

I. Floor And Slab Treatments
1. Slip-Resistive Emery Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive, crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials with 100 percent passing 3/8-inch (9.5-mm) **OR** No. 4 (4.75-mm) **OR** No. 8 (2.36-mm), **as directed**, sieve.
2. Slip-Resistive Aluminum Granule Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of not less than 95 percent fused aluminum-oxide granules.
3. Emery Dry-Shake Floor Hardener: Pigmented **OR** Unpigmented, **as directed**, factory-packaged, dry combination of portland cement, graded emery aggregate, and plasticizing admixture; with emery aggregate consisting of no less than 60 percent of total aggregate content.
a. Color: As indicated by manufacturer's designation **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.
4. Metallic Dry-Shake Floor Hardener: Pigmented **OR** Unpigmented, **as directed**, factory-packaged, dry combination of portland cement, graded metallic aggregate, rust inhibitors, and plasticizing admixture; with metallic aggregate consisting of no less than 65 percent of total aggregate content.

a. Color: As indicated by manufacturer's designation **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.

5. Unpigmented Mineral Dry-Shake Floor Hardener: Factory-packaged dry combination of portland cement, graded quartz aggregate, and plasticizing admixture.
6. Pigmented Mineral Dry-Shake Floor Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.
   a. Color: As indicated by manufacturer's designation **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.
7. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; colorless; that penetrates, hardens, and densifies concrete surfaces.

J. Liquid Floor Treatments
1. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.
2. Penetrating Liquid Floor Treatments for Polished Concrete Finish: Clear, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and is suitable for polished concrete surfaces.

K. Curing Materials
1. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
2. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.
3. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
4. Water: Potable.
5. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
6. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering, **as directed**.
7. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 18 to 25 percent solids, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering, **as directed**.
8. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
9. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

L. Related Materials
1. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber **OR** ASTM D 1752, cork or self-expanding cork, **as directed**.
2. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 **OR** aromatic polyurea with a Type A shore durometer hardness range of 90 to 95, **as directed**, per ASTM D 2240.
3. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
4. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
   a. Types I and II, non-load bearing **OR** IV and V, load bearing, **as directed**, for bonding hardened or freshly mixed concrete to hardened concrete.
5. Reglets: Fabricate reglets of not less than 0.0217-inch- (0.55-mm-) thick, galvanized steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

6. Dovetail Anchor Slots: Hot-dip galvanized steel sheet, not less than 0.0336 inch (0.85 mm) thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

M. Repair Materials
1. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3.2 mm) and that can be feathered at edges to match adjacent floor elevations.
    a. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
    b. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
    c. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by underlayment manufacturer.
    d. Compressive Strength: Not less than 4100 psi (29 MPa) at 28 days when tested according to ASTM C 109/C 109M.
2. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3.2 mm) and that can be feathered at edges to match adjacent floor elevations.
    a. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
    b. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
    c. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by topping manufacturer.
    d. Compressive Strength: Not less than 5000 psi (34.5 MPa) at 28 days when tested according to ASTM C 109/C 109M.

N. Concrete Mixtures, General
1. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
    a. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
2. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent **OR** Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows, **as directed**
    a. Fly Ash: 25 percent.
    b. Combined Fly Ash and Pozzolan: 25 percent.
    c. Ground Granulated Blast-Furnace Slag: 50 percent.
    d. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
    e. Silica Fume: 10 percent.
    f. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
    g. Combined Fly Ash or Pozzolans, Ground Granulated Blast-Furnace Slag, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
3. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 **OR** 0.15 **OR** 0.30 **OR** 1.00, **as directed**, percent by weight of cement.
4. Admixtures: Use admixtures according to manufacturer's written instructions.
    a. Use water-reducing **OR** high-range water-reducing **OR** plasticizing, **as directed**, admixture in concrete, as required, for placement and workability.
    b. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

c. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

d. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

5. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

O. Concrete Mixtures For Building Elements

1. Footings: Proportion normal-weight concrete mixture as follows:
   a. Minimum Compressive Strength: 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**, at 28 days.
   b. Maximum Water-Cementitious Materials Ratio: 0.50 **OR** 0.45 **OR** 0.40, **as directed**.
   c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm) **OR** 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, **as directed**, plus or minus 1 inch (25 mm).
   d. Air Content:
      1) 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
      2) 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum aggregate size.
2. Foundation Walls: Proportion normal-weight concrete mixture as follows:
   a. Minimum Compressive Strength: 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**, at 28 days.
   b. Maximum Water-Cementitious Materials Ratio: 0.50 **OR** 0.45 **OR** 0.40, **as directed**.
   c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm) **OR** 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, **as directed**, plus or minus 1 inch (25 mm).
   d. Air Content:
      1) 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
      2) 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum aggregate size.
3. Slabs-on-Grade: Proportion normal-weight concrete mixture as follows:
   a. Minimum Compressive Strength: 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**, at 28 days.
   b. Minimum Cementitious Materials Content: 470 lb/cu. yd. (279 kg/cu. m) **OR** 520 lb/cu. yd. (309 kg/cu. m) **OR** 540 lb/cu. yd. (320 kg/cu. m), **as directed**.
   c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm), **as directed**, plus or minus 1 inch (25 mm).
   d. Air Content
      1) 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
      2) 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum aggregate size.
      3) Do not allow air content of troweled finished floors to exceed 3 percent.
   e. Steel-Fiber Reinforcement: Add to concrete mixture, according to manufacturer's written instructions, at a rate of 50 lb/cu. yd. (29.7 kg/cu. m).
   f. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd. (0.60 kg/cu. m) **OR** 1.5 lb/cu. yd. (0.90 kg/cu. m), **as directed**.
4. Suspended Slabs: Proportion normal-weight concrete mixture as follows:
   a. Minimum Compressive Strength: 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**, at 28 days.

b. Minimum Cementitious Materials Content: 470 lb/cu. yd. (279 kg/cu. m) **OR** 520 lb/cu. yd. (309 kg/cu. m) **OR** 540 lb/cu. yd. (320 kg/cu. m), **as directed**.
c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm), **as directed**, plus or minus 1 inch (25 mm).
d. Air Content:
   1) 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
   2) 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum aggregate size.
   3) Do not allow air content of troweled finished floors to exceed 3 percent.
e. Steel-Fiber Reinforcement: Add to concrete mixture, according to manufacturer's written instructions, at a rate of 50 lb/cu. yd. (29.7 kg/cu. m).
f. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd. (0.60 kg/cu. m) **OR** 1.5 lb/cu. yd. (0.90 kg/cu. m), **as directed**.

5. Suspended Slabs: Proportion structural lightweight concrete mixture as follows:
   a. Minimum Compressive Strength: 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**, at 28 days.
   b. Calculated Equilibrium Unit Weight: 115 lb/cu. ft. (1842 kg/cu. m) **OR** 110 lb/cu. ft. (1762 kg/cu. m) **OR** 105 lb/cu. ft. (1682 kg/cu. m), **as directed**, plus or minus 3 lb/cu. ft. (48.1 kg/cu. m) as determined by ASTM C 567.
   c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm), **as directed**, plus or minus 1 inch (25 mm).
   d. Air Content:
      1) 6 percent, plus or minus 2 percent at point of delivery for nominal maximum aggregate size greater than 3/8 inch (10 mm).
      2) 7 percent, plus or minus 2 percent at point of delivery for nominal maximum aggregate size 3/8 inch (10 mm) or less.
      3) Do not allow air content of troweled finished floors to exceed 3 percent.
   e. Steel-Fiber Reinforcement: Add to concrete mixture, according to manufacturer's written instructions, at a rate of 50 lb/cu. yd. (29.7 kg/cu. m).
   f. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd. (0.60 kg/cu. m) **OR** 1.5 lb/cu. yd. (0.90 kg/cu. m), **as directed**.
6. Concrete Toppings: Proportion normal-weight concrete mixture as follows:
   a. Minimum Compressive Strength: 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**, at 28 days.
   b. Minimum Cementitious Materials Content: 470 lb/cu. yd. (279 kg/cu. m) **OR** 520 lb/cu. yd. (309 kg/cu. m) **OR** 540 lb/cu. yd. (320 kg/cu. m), **as directed**.
   c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm), **as directed**, plus or minus 1 inch (25 mm).
   d. Air Content:
      1) 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
      2) 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum aggregate size.
      3) Do not allow air content of troweled finished toppings to exceed 3 percent.
   e. Steel-Fiber Reinforcement: Add to concrete mixture, according to manufacturer's written instructions, at a rate of 50 lb/cu. yd. (29.7 kg/cu. m).
   f. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd. (0.60 kg/cu. m) **OR** 1.5 lb/cu. yd. (0.90 kg/cu. m), **as directed**.
7. Building Frame Members: Proportion normal-weight concrete mixture as follows:
   a. Minimum Compressive Strength: 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**, at 28 days.
   b. Maximum Water-Cementitious Materials Ratio: 0.50 **OR** 0.45 **OR** 0.40, **as directed**.

c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm) **OR** 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, **as directed**, plus or minus 1 inch (25 mm).
d. Air Content:
1) 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
2) 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum aggregate size.

8. Building Walls: Proportion normal-weight concrete mixture as follows:
a. Minimum Compressive Strength: 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**, at 28 days.
b. Maximum Water-Cementitious Materials Ratio: 0.50 **OR** 0.45 **OR** 0.40, **as directed**.
c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm) **OR** 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, **as directed**, plus or minus 1 inch (25 mm).
d. Air Content:
1) 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
2) 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum aggregate size.

P. Fabricating Reinforcement
1. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

Q. Concrete Mixing
1. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116, **as directed**, and furnish batch ticket information.
a. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.
2. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.
a. For mixer capacity of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
b. For mixer capacity larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).
c. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

1.3 EXECUTION

A. Formwork
1. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
2. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
3. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
a. Class A, 1/8 inch (3.2 mm) for smooth-formed finished surfaces.

b. Class B, 1/4 inch (6 mm) **OR** Class C, 1/2 inch (13 mm) **OR** Class D, 1 inch (25 mm), **as directed**, for rough-formed finished surfaces.

4. Construct forms tight enough to prevent loss of concrete mortar.
5. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
   a. Install keyways, reglets, recesses, and the like, for easy removal.
   b. Do not use rust-stained steel form-facing material.
6. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
7. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
8. Chamfer **OR** Do not chamfer, **as directed**, exterior corners and edges of permanently exposed concrete.
9. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
10. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
11. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
12. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

B. Embedded Items
1. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   a. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
   b. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
   c. Install dovetail anchor slots in concrete structures as indicated.

C. Removing And Reusing Forms
1. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
   a. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of, **as directed**, its 28-day design compressive strength.
   b. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
2. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
3. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by the Owner.

D. Shores And Reshores

1. Comply with ACI 318 (ACI 318M) and ACI 301 for design, installation, and removal of shoring and reshoring.
   a. Do not remove shoring or reshoring until measurement of slab tolerances is complete.
2. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.
3. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

E. Vapor Retarders
1. Plastic Vapor Retarders: Place, protect, and repair vapor retarders according to ASTM E 1643 and manufacturer's written instructions.
   a. Lap joints 6 inches (150 mm) and seal with manufacturer's recommended tape.
2. Bituminous Vapor Retarders: Place, protect, and repair vapor retarders according to manufacturer's written instructions.
3. Granular Course: Cover vapor retarder with granular fill **OR** fine-graded granular material, **as directed**, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch (0 mm) or minus 3/4 inch (19 mm).
   a. Place and compact a 1/2-inch- (13-mm-) thick layer of fine-graded granular material over granular fill.

F. Steel Reinforcement
1. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
   a. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
2. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
3. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
   a. Weld reinforcing bars according to AWS D1.4, where indicated.
4. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
5. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.
6. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.
7. Zinc-Coated Reinforcement: Repair cut and damaged zinc coatings with zinc repair material according to ASTM A 780. Use galvanized steel wire ties to fasten zinc-coated steel reinforcement.

G. Joints
1. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
2. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by the Owner.
   a. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
   b. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
   c. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
   d. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.

e. Space vertical joints in walls, **as directed**. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
f. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
g. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

3. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
   a. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch (3.2 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
   b. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3.2-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
4. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
   a. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
   b. Terminate full-width joint-filler strips not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished concrete surface where joint sealants, specified in Division 07 Section "Joint Sealants", are indicated.
   c. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

H. Waterstops
1. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.
2. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

I. Concrete Placement
1. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
2. Do not add water to concrete during delivery, at Project site, or during placement unless approved by the Owner.
3. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
   a. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
4. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
   a. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
   b. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
   c. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6

inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

5. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
   a. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
   b. Maintain reinforcement in position on chairs during concrete placement.
   c. Screed slab surfaces with a straightedge and strike off to correct elevations.
   d. Slope surfaces uniformly to drains where required.
   e. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
6. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
   a. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
   b. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
   c. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
7. Hot-Weather Placement: Comply with ACI 301 and as follows:
   a. Maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
   b. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

J. Finishing Formed Surfaces
1. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
   a. Apply to concrete surfaces not exposed to public view.
2. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
   a. Apply to concrete surfaces exposed to public view, **OR** to receive a rubbed finish, **OR** to be covered with a coating or covering material applied directly to concrete, **as directed**.
3. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:
   a. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
   b. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.

c. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

4. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

K. Finishing Floors And Slabs

1. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
2. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch (6 mm) in 1 direction.
   a. Apply scratch finish to surfaces indicated and to receive concrete floor toppings **OR** to receive mortar setting beds for bonded cementitious floor finishes, **as directed**.
3. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
   a. Apply float finish to surfaces indicated **OR** to receive trowel finish **OR** to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo, **as directed**.
4. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
   a. Apply a trowel finish to surfaces indicated **OR** exposed to view **OR** to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system, **as directed**.
   b. Finish surfaces to the following tolerances, according to ASTM E 1155 (ASTM E 1155M), for a randomly trafficked floor surface:
      1) Specified overall values of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and of levelness, F(L) 15.
      2) Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade.
      3) Specified overall values of flatness, F(F) 30; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 15; for suspended slabs.
      4) Specified overall values of flatness, F(F) 45; and of levelness, F(L) 35; with minimum local values of flatness, F(F) 30; and of levelness, F(L) 24.
   c. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-foot- (3.05-m-) long straightedge resting on 2 high spots and placed anywhere on the surface does not exceed 1/4 inch (6 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/8 inch (3.2 mm), **as directed**.
5. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated **OR** where ceramic or quarry tile is to be installed by either thickset or thin-set method, **as directed**. While concrete is still plastic, slightly scarify surface with a fine broom.
   a. Comply with flatness and levelness tolerances for trowel finished floor surfaces.
6. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
   a. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with the Owner before application.

7. Slip-Resistive Finish: Before final floating, apply slip-resistive aggregate **OR** aluminum granule, **as directed**, finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:
    a. Uniformly spread 25 lb/100 sq. ft. (12 kg/10 sq. m) of dampened slip-resistive aggregate **OR** aluminum granules, **as directed**, over surface in 1 or 2 applications. Tamp aggregate flush with surface, but do not force below surface.
    b. After broadcasting and tamping, apply float finish.
    c. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive aggregate **OR** aluminum granules, **as directed**.
8. Dry-Shake Floor Hardener Finish: After initial floating, apply dry-shake floor hardener to surfaces according to manufacturer's written instructions and as follows:
    a. Uniformly apply dry-shake floor hardener at a rate of 100 lb/100 sq. ft. (49 kg/10 sq. m), **as directed**, unless greater amount is recommended by manufacturer.
    b. Uniformly distribute approximately two-thirds of dry-shake floor hardener over surface by hand or with mechanical spreader, and embed by power floating. Follow power floating with a second dry-shake floor hardener application, uniformly distributing remainder of material, and embed by power floating.
    c. After final floating, apply a trowel finish. Cure concrete with curing compound recommended by dry-shake floor hardener manufacturer and apply immediately after final finishing.

L. Miscellaneous Concrete Items
1. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
2. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
3. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.
4. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.

M. Concrete Protecting And Curing
1. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
2. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
3. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
4. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
5. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
    a. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
        1) Water.
        2) Continuous water-fog spray.

3) Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.

b. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

1) Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
2) Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
3) Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.

c. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

1) After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.

d. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

N. Liquid Floor Treatments

1. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.
   a. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
   b. Do not apply to concrete that is less than three **OR** seven **OR** 14 **OR** 28, **as directed**, days' old.
   c. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.
2. Polished Concrete Floor Treatment: Apply polished concrete finish system to cured and prepared slabs to match.
   a. Machine grind floor surfaces to receive polished finishes level and smooth and to depth required to reveal aggregate to match.
   b. Apply penetrating liquid floor treatment for polished concrete in polishing sequence and according to manufacturer's written instructions, allowing recommended drying time between successive coats.
   c. Continue polishing with progressively finer grit diamond polishing pads to gloss level to match approved mockup.
   d. Control and dispose of waste products produced by grinding and polishing operations.
   e. Neutralize and clean polished floor surfaces.
3. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

O. Joint Filling

1. Prepare, clean, and install joint filler according to manufacturer's written instructions.
   a. Defer joint filling until concrete has aged at least one **OR** six, **as directed**, month(s). Do not fill joints until construction traffic has permanently ceased.

2. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
3. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches (50 mm) deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

P. Concrete Surface Repairs
1. Defective Concrete: Repair and patch defective areas when approved by the Owner. Remove and replace concrete that cannot be repaired and patched to the Owner's approval.
2. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 (1.18-mm) sieve, using only enough water for handling and placing.
3. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
   a. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch (13 mm) in any dimension in solid concrete, but not less than 1 inch (25 mm) in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
   b. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
   c. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by the Owner.
4. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
   a. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
   b. After concrete has cured at least 14 days, correct high areas by grinding.
   c. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
   d. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
   e. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch (6 mm) to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
   f. Repair defective areas, except random cracks and single holes 1 inch (25 mm) or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch (19-mm) clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
   g. Repair random cracks and single holes 1 inch (25 mm) or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt,

and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

5. Perform structural repairs of concrete, subject to the Owner's approval, using epoxy adhesive and patching mortar.
6. Repair materials and installation not specified above may be used, subject to the Owner's approval.

Q. Field Quality Control
1. Testing and Inspecting: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
2. Inspections:
   a. Steel reinforcement placement.
   b. Steel reinforcement welding.
   c. Headed bolts and studs.
   d. Verification of use of required design mixture.
   e. Concrete placement, including conveying and depositing.
   f. Curing procedures and maintenance of curing temperature.
   g. Verification of concrete strength before removal of shores and forms from beams and slabs.
3. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
   a. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. (76 cu. m) or fraction thereof of each concrete mixture placed each day.
      1) When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
   b. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
   c. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173/C 173M, volumetric method, for structural lightweight concrete, **as directed**; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
   d. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each composite sample.
   e. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
   f. Compression Test Specimens: ASTM C 31/C 31M.
      1) Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
      2) Cast and field cure two sets of two standard cylinder specimens for each composite sample.
   g. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
      1) Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
      2) A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
   h. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
   i. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength

and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).

j. Test results shall be reported in writing to the Owner, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

k. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by the Owner but will not be used as sole basis for approval or rejection of concrete.

l. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by the Owner. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by the Owner.

m. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

n. Correct deficiencies in the Work that test reports and inspections indicate dos not comply with the Contract Documents.

4. Measure floor and slab flatness and levelness according to ASTM E 1155 (ASTM E 1155M) within 24 **OR** 48, **as directed**, hours of finishing.

R. Protection Of Liquid Floor Treatments

1. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION 03 05 13 00

Task	Specification	Specification Description
03 11 13 00	01 22 16 00	No Specification Required
03 11 13 00	03 05 13 00	Cast-In-Place Concrete

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SECTION 03 11 16 13 - RUSTICATED CONCRETE FINISHES

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of rusticated concrete finishes. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals

1. Product Data: For each type of product indicated.
2. Sample: A sample of finish expected shall be erected on site. Completed work shall approximate the sample. Work determined by the contracting officer not to be similar shall be removed and replaced without further expense to the Owner.

1.2 PRODUCTS

A. Overlaid Plywood: DOC PS 1, B-B High Density Overlaid Concrete Form, Class I.

B. Plywood: DOC PS 1, B-B (Concrete Form) Plywood, Class I, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection mark.

C. Chamfer Strips: Clear white pine with surface against concrete to be planed, metal, PVC, or rubber.

D. Form Liners: Provide commercially available molds and form-facing materials of metal, plastic, mood, or another material that is nonreactive with concrete and dimensionally stable to produce repetitive concrete surfaces.

1.3 EXECUTION

A. Form Construction: Forms shall be constructed to provide required sizes, shapes, lines, and dimensions and to provide continuous, straight, smooth exposed surfaces. Forms shall be fabricated for easy removal without hammering or prying against concrete surfaces. The number of joints shall be minimized. Joints shall be made watertight to prevent leakage of cement paste. Provisions shall be made for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, inserts, and other features required in the work.

B. Form Coatings: Forms shall be oiled with form-coating compounds that will not bond with, stain, nor adversely effect concrete surfaces, and will not impair subsequent treatments of concrete surfaces.

C. Finish: Fins and other projections shall be completely removed and smoothed. A smooth rubbed finish shall be provided not less than one day after form removal.

END OF SECTION 03 11 16 13

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SECTION 03 11 16 13a - CAST-IN-PLACE ARCHITECTURAL CONCRETE

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for cast-in-place architectural concrete. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section specifies cast-in-place architectural concrete including form facings, reinforcement accessories, concrete materials, concrete mixture design, placement procedures, and finishes.

C. Definitions
1. Cast-in-Place Architectural Concrete: Formed concrete that is exposed to view on surfaces of completed structure or building and that requires special concrete materials, formwork, placement, or finishes to obtain specified architectural appearance.
2. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.
3. Design Reference Sample: Sample designated by the Owner in the Contract Documents that reflects acceptable surface quality and appearance of cast-in-place architectural concrete.
4. Reveal: Projection of coarse aggregate from matrix or mortar after completion of exposure operations.

D. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
      1) Include statement indicating costs for each product having recycled content.
   b. Design Mixtures for Credit ID 1.1: For each concrete mixture containing fly ash as a replacement for portland cement or other portland cement replacements and for equivalent concrete mixtures that do not contain portland cement replacements.
3. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
   a. Indicate amounts of mixing water to be withheld for later addition at Project site.
4. Formwork Shop Drawings: Show formwork construction including form-facing joints, rustications, construction and contraction joints, form joint-sealant details, form tie locations and patterns, inserts and embedments, cutouts, cleanout panels, and other items that visually affect cast-in-place architectural concrete.
5. Placement Schedule: Submit concrete placement schedule before start of placement operations. Include locations of all joints including construction joints.
6. Samples: For each of the following materials:
   a. Form-facing panel.
   b. Form ties.
   c. Form liners.
   d. Coarse- and fine-aggregate gradations.
   e. Chamfers and rustications.
7. Material test reports **OR** certificates, **as directed**.

E. Quality Assurance
1. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
   a. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
2. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
   a. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
   b. Personnel performing laboratory tests shall be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
3. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
   a. ACI 301, "Specification for Structural Concrete," Sections 1 through 5 **OR** Sections 1 through 5 and Section 6, "Architectural Concrete", **as directed**.
   b. ACI 303.1, "Specification for Cast-in-Place Architectural Concrete."
4. Field Sample Panels: After approval of verification sample and before casting architectural concrete, produce field sample panels to demonstrate the approved range of selections made under sample submittals. Produce a minimum of 3 sets of full-scale panels, cast vertically, approximately 48 by 48 by 6 inches (1200 by 1200 by 150 mm) minimum, to demonstrate the expected range of finish, color, and texture variations.
5. Preinstallation Conference: Conduct conference at Project site.

1.2 PRODUCTS

A. Form-Facing Materials
1. General: Comply with Division 03 Section "Cast-in-place Concrete" for formwork and other form-facing material requirements.
2. Form-Facing Panels for As-Cast **OR** Exposed-Aggregate, **as directed**, Finishes: Steel, glass-fiber-reinforced plastic, or other approved nonabsorptive panel materials that will provide continuous, true, and smooth architectural concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
3. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will provide surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
4. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.
5. Form Liners: Units of face design, texture, arrangement, and configuration indicated **OR** to match design reference sample, **as directed**. Furnish with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent surface treatments of concrete.
6. Rustication Strips: Metal, rigid plastic, or dressed wood with sides beveled and back kerfed; nonstaining; in longest practicable lengths.
7. Chamfer Strips: Metal, rigid plastic, elastomeric rubber, or dressed wood, 3/4 by 3/4 inch (19 by 19 mm), minimum; nonstaining; in longest practicable lengths.
8. Form Joint Tape: Compressible foam tape; pressure sensitive; AAMA 800, "Specification 810.1, Expanded Cellular Glazing Tape"; minimum 1/4 inch (6 mm) thick.
9. Form Joint Sealant: Elastomeric sealant complying with ASTM C 920, Type M or S, Grade NS, that adheres to form joint substrates.
10. Sealer: Penetrating, clear, polyurethane wood form sealer formulated to reduce absorption of bleed water and prevent migration of set-retarding chemicals from wood.

11. Form-Release Agent: Commercially formulated colorless form-release agent that will not bond with, stain, or adversely affect architectural concrete surfaces and will not impair subsequent treatments of those surfaces.
    a. Formulate form-release agent with rust inhibitor for steel form-facing materials.
12. Surface Retarder: Chemical liquid set retarder, for application on form-facing materials, capable of temporarily delaying final hardening of newly placed concrete surface to depth of reveal specified.
13. Form Ties: Factory-fabricated, glass-fiber-reinforced plastic **OR** internally disconnecting **OR** removable, **as directed**, ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
    a. Furnish ties with tapered tie cone spreaders, **as directed**, that, when removed, will leave holes 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 1-1/4 inches (32 mm) **OR** 1-1/2 inches (38 mm), **as directed**, in diameter on concrete surface.
    b. Furnish internally disconnecting ties that will leave no metal closer than 1-1/2 inches (38 mm), after exposing aggregate, **as directed**, from the architectural concrete surface.
    c. Furnish glass-fiber-reinforced plastic ties, not less than 1/2 inch (13 mm) in diameter, of color to match the Owner's sample **OR** selected by the Owner from manufacturer's full range, **as directed**.
    d. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

B. Steel Reinforcement And Accessories
1. General: Comply with Division 03 Section "Cast-in-place Concrete" for steel reinforcement and other requirements for reinforcement accessories.
2. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 **OR** 60, **as directed**, percent.
3. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire fabric in place; manufacture according to CRSI's "Manual of Standard Practice."
    a. Where legs of wire bar supports contact forms, use gray, all-plastic **OR** CRSI Class 1, gray, plastic-protected **OR** CRSI Class 2, stainless-steel, **as directed**, bar supports.

C. Concrete Materials
1. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
    a. Portland Cement: ASTM C 150, Type I **OR** II **OR** I/II **OR** III, **as directed**, gray **OR** white, **as directed**. Supplement with the following:, **as directed**
        1) Fly Ash: ASTM C 618, Class C **OR** F, **as directed**.
        2) Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
        3) Silica Fume: ASTM C 1240, amorphous silica.
    b. Blended Hydraulic Cement: ASTM C 595, Type IS, portland blast-furnace slag **OR** IP, portland-pozzolan **OR** (PM), pozzolan-modified Portland **OR** I (SM), slag-modified Portland, **as directed**, cement.
2. Normal-Weight Aggregates: ASTM C 33, Class 5S **OR** 5M **OR** 1N, **as directed**, coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials, **as directed**.
    a. Maximum Coarse Aggregate Size: 1 inch (25 mm) **OR** 3/4 inch (19 mm) **OR** 1/2 inch (13 mm) **OR** 3/8 inch (10 mm), **as directed**.
    b. Gradation: Uniformly **OR** Gap, **as directed**, graded.
3. Normal-Weight Fine Aggregate: ASTM C 33 **OR** ASTM C 144, **as directed**, manufactured or natural sand, from same source for entire Project.
4. Water: Potable, complying with ASTM C 94/C 94M except free of wash water from mixer washout operations.

D. Admixtures
1. Air-Entraining Admixture: ASTM C 260.
2. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
a. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
b. Retarding Admixture: ASTM C 494/C 494M, Type B.
c. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
d. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
e. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
f. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
3. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, **as directed**, nonfading, and resistant to lime and other alkalis.
a. Color: As indicated by manufacturer's designation **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.

E. Curing Materials
1. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.
2. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
3. Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
a. For integrally colored concrete, curing compound shall be pigmented type, **as directed**, approved by color pigment manufacturer.
b. For concrete indicated to be sealed, curing compound shall be compatible with sealer.

F. Repair Materials
1. Bonding Agent: ASTM C 1059, Type II, nonredispersible, acrylic emulsion or styrene butadiene.
2. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements.
a. Types I and II, non-load bearing **OR** IV and V, load bearing, **as directed**, for bonding hardened or freshly mixed concrete to hardened concrete.

G. Concrete Mixtures, General
1. Prepare design mixtures for each type and strength of cast-in-place architectural concrete proportioned on basis of laboratory trial mixture or field test data, or both, according to ACI 301.
a. Use a qualified independent testing agency for preparing and reporting proposed design mixtures based on laboratory trial mixtures.
2. Proportion concrete mixtures as follows:
a. Compressive Strength (28 Days): 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**.
b. Maximum Water-Cementitious Materials Ratio: 0.46.
c. Slump Limit: 3 inches (75 mm) **OR** 4 inches (100 mm) **OR** 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, **as directed**, plus or minus 1 inch (25 mm).
d. Air Content:
1) 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
2) 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum aggregate size.
3. Cementitious Materials: For cast-in-place architectural concrete exposed to deicers, limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements. Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica

fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent, **as directed**.

4. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 **OR** 0.15 **OR** 0.30 **OR** 1.00, **as directed**, percent by weight of cement.
5. Admixtures: Use admixtures according to manufacturer's written instructions.
6. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

H. Concrete Mixing

1. Ready-Mixed or Site-Mixed Architectural Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and furnish batch ticket information.
   a. Clean equipment used to mix and deliver cast-in-place architectural concrete to prevent contamination from other concrete.
   b. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

1.3 EXECUTION

A. Formwork

1. General: Comply with Division 03 Section "Cast-in-place Concrete" for formwork, embedded items, and shoring and reshoring.
2. Limit deflection of form-facing panels to not exceed ACI 303.1 requirements.
3. In addition to ACI 303.1 limits on form-facing panel deflection, limit cast-in-place architectural concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
   a. Class A, 1/8 inch (3.2 mm) **OR** B, 1/4 inch (6 mm) **OR** C, 1/2 inch (13 mm), **as directed**.
4. Fabricate forms to result in cast-in-place architectural concrete that complies with ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
   a. In addition to ACI 117, comply with the following tolerances: <**Insert tolerances.**>
5. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-in-place surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood rustications, keyways, reglets, recesses, and the like, for easy removal.
   a. Seal form joints and penetrations at form ties with form joint tape or form joint sealant to prevent cement paste leakage.
   b. Do not use rust-stained steel form-facing material.
6. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
7. Chamfer **OR** Do not chamfer, **as directed**, exterior corners and edges of cast-in-place architectural concrete.
8. Coat contact surfaces of wood rustications and chamfer strips with sealer before placing reinforcement, anchoring devices, and embedded items.
9. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
10. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
11. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
12. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.
13. Coat contact surfaces of forms with surface retarder, according to manufacturer's written instructions, before placing reinforcement.
14. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and attach securely to prevent deflection and maintain stability of liners during concreting.

Prevent form liners from sagging and stretching in hot weather. Seal joints of form liners and form liner accessories to prevent mortar leaks. Coat form liner with form-release agent.

B. Reinforcement And Inserts
1. General: Comply with Division 03 Section "Cast-in-place Concrete" for fabricating and installing steel reinforcement. Securely fasten steel reinforcement and wire ties against shifting during concrete placement.
2. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

C. Removing And Reusing Forms
1. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
   a. Schedule form removal to maintain surface appearance that matches approved field sample panels.
   b. Cut off and grind glass-fiber-reinforced plastic form ties flush with surface of concrete.
2. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved 28-day design compressive strength **OR** at least 70 percent of 28-day design compressive strength, **as directed**. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
3. Clean and repair surfaces of forms to be reused in the Work. Do not use split, frayed, delaminated, or otherwise damaged form-facing material. Apply new form-release agent.
4. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for cast-in-place architectural concrete surfaces.

D. Joints
1. Construction Joints: Install construction joints true to line with faces perpendicular to surface plane of cast-in-place architectural concrete so strength and appearance of concrete are not impaired, at locations indicated or as approved by the Owner.
   a. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated.
   b. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete, **as directed**. Align construction joint within rustications attached to form-facing material.
   c. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
   d. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
   e. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
   f. Use bonding agent **OR** epoxy-bonding adhesive, **as directed**, at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
2. Contraction Joints: Form weakened-plane contraction joints true to line with faces perpendicular to surface plane of cast-in-place architectural concrete so strength and appearance of concrete are not impaired, at locations indicated or as approved by the Owner.

E. Concrete Placement
1. Before placing concrete, verify that installation of formwork, form-release agent, reinforcement, and embedded items is complete and that required inspections have been performed.
2. Do not add water to concrete during delivery, at Project site, or during placement unless approved by the Owner.
3. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

a. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

4. Deposit concrete continuously between construction joints. Deposit concrete to avoid segregation.
   a. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
   b. Consolidate placed concrete with mechanical vibrating equipment according to ACI 303.1.
   c. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. Do not permit vibrators to contact forms.
5. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
   a. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
   b. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
   c. Do not use calcium chloride, salt, or other materials containing antifreeze agents.
   d. Do not use chemical accelerators unless otherwise specified and approved in design mixtures.
6. Hot-Weather Placement: Comply with ACI 301 and as follows:
   a. Maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
   b. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

F. Finishes, General
1. Architectural Concrete Finish: Match the Owner's design reference sample, identified and described as indicated, to satisfaction of the Owner.
2. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces.
   a. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.
3. Maintain uniformity of special finishes over construction joints, unless otherwise indicated.

G. As-Cast Formed Finishes
1. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections exceeding specified limits on formed-surface irregularities.
2. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Remove fins and other projections exceeding specified limits on formed-surface irregularities. Repair **OR** Do not repair, **as directed**, and patch tie holes and defects.
3. Rubbed Finish: Apply the following to smooth-form-finished as-cast concrete where indicated:
   a. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
   b. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland

cement in amounts determined by trial patches so color of dry grout will match surrounding concrete. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.

c. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match surrounding concrete. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

4. Form-Liner Finish: Produce a textured surface free of pockets, streaks, and honeycombs, and of uniform appearance, color, and texture.

H. Exposed-Aggregate Finishes

1. Scrubbed Finish: After concrete has achieved a compressive strength of from 1000 to 1500 psi (6.9 to 10.3 MPa), apply scrubbed finish. Wet concrete surfaces thoroughly and scrub with stiff fiber or wire brushes, using water freely, until top mortar surface is removed and aggregate is uniformly exposed. Rinse scrubbed surfaces with clean water. Maintain continuity of finish on each surface or area of Work. Remove only enough concrete mortar from surfaces to match design reference sample.

2. High-Pressure Water-Jet Finish: Perform high-pressure water jetting on concrete that has achieved a minimum compressive strength of 4500 psi (31 MPa). Coordinate with formwork removal to ensure that surfaces to be high-pressure water-jet finished are treated at same age for uniform results.

   a. Surface Continuity: Perform high-pressure water-jet finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work. Maintain required patterns or variances in reveal projection to match design reference sample.

3. Abrasive-Blast Finish: Perform abrasive blasting after compressive strength of concrete exceeds 2000 psi (13.8 MPa). Coordinate with formwork removal to ensure that surfaces to be abrasive blasted are treated at same age for uniform results.

   a. Surface Continuity: Perform abrasive-blast finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work. Maintain required patterns or variances in depths of blast to match design reference sample.

   b. Abrasive Blasting: Abrasive blast corners and edges of patterns carefully, using backup boards, to maintain uniform corner or edge line. Determine type of nozzle, nozzle pressure, and blasting techniques required to match design reference sample.

   c. Depth of Cut: Use an abrasive grit of proper type and gradation to expose aggregate and surrounding matrix surfaces to match design reference sample, as follows:

      1) Brush: Remove cement matrix to dull surface sheen and expose face of fine aggregate; with no significant reveal.

      2) Light: Expose fine aggregate with occasional exposure of coarse aggregate and uniform color; with maximum reveal of 1/16 inch (1.5 mm).

      3) Medium: Generally expose coarse aggregate; with slight reveal, a maximum of 1/4 inch (6 mm).

      4) Heavy: Expose and reveal coarse aggregate to a maximum projection of one-third its diameter; with reveal range of 1/4 to 1/2 inch (6 to 13 mm).

4. Bushhammer Finish: Allow concrete to cure at least 14 days before starting bushhammer surface finish operations.

   a. Surface Continuity: Perform bushhammer finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work. Maintain required patterns or variances of cut as shown on Drawings or to match design reference sample or mockup.

   b. Surface Cut: Maintain required depth of cut and general aggregate exposure. Use power tool with hammer attachments for large, flat surfaces, and use hand hammers for small areas, at corners and edges, and for restricted locations where power tools cannot reach.

   c. Remove impressions of formwork and form facings with exception of tie holes.

I. Concrete Protecting And Curing
1. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with ACI 301 for hot-weather protection during curing.
2. Begin curing cast-in-place architectural concrete immediately after removing forms from **OR** applying as-cast formed finishes to, **as directed**, concrete. Cure according to ACI 308.1, by one or a combination of the following methods that will not mottle, discolor, or stain concrete:
   a. Moisture Curing: Keep exposed surfaces of cast-in-place architectural concrete continuously moist for not less than seven days with the following materials:
      1) Water.
      2) Continuous water-fog spray.
      3) Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.
   b. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period; use cover material and waterproof tape.
   c. Curing Compound: Mist concrete surfaces with water. Apply curing compound uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

J. Field Quality Control
1. General: Comply with Division 03 Section "Cast-in-place Concrete" for field quality-control requirements.

K. Repairs, Protection, And Cleaning
1. Repair and cure damaged finished surfaces of cast-in-place architectural concrete when approved by the Owner. Match repairs to color, texture, and uniformity of surrounding surfaces and to repairs on approved mockups.
   a. Remove and replace cast-in-place architectural concrete that cannot be repaired and cured to the Owner's approval.
2. Protect corners, edges, and surfaces of cast-in-place architectural concrete from damage; use guards and barricades.
3. Protect cast-in-place architectural concrete from staining, laitance, and contamination during remainder of construction period.
4. Clean cast-in-place architectural concrete surfaces after finish treatment to remove stains, markings, dust, and debris.
5. Wash and rinse surfaces according to concrete finish applicator's written recommendations. Protect other Work from staining or damage due to cleaning operations.
   a. Do not use cleaning materials or processes that could change the appearance of cast-in-place architectural concrete finishes.

END OF SECTION 03 11 16 13a

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Task	Specification	Specification Description
03 11 16 13	03 05 13 00	Cast-In-Place Concrete
03 11 23 00	01 22 16 00	No Specification Required
03 11 23 00	03 05 13 00	Cast-In-Place Concrete
03 15 13 13	03 05 13 00	Cast-In-Place Concrete
03 15 13 16	03 05 13 00	Cast-In-Place Concrete
03 15 16 00	03 05 13 00	Cast-In-Place Concrete
03 15 19 00	05 50 00 00	Metal Fabrications
03 21 11 00	03 05 13 00	Cast-In-Place Concrete
03 21 16 00	03 05 13 00	Cast-In-Place Concrete
03 22 11 00	03 05 13 00	Cast-In-Place Concrete
03 22 13 00	03 05 13 00	Cast-In-Place Concrete
03 22 16 00	03 05 13 00	Cast-In-Place Concrete

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SECTION 03 30 53 00 - MISCELLANEOUS CAST-IN-PLACE CONCRETE

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for miscellaneous cast-in-place concrete. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section includes cast-in-place concrete, including reinforcement, concrete materials, mixture design, placement procedures, and finishes.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittal:
      a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
      b. Design Mixtures for Credit ID 1.1: For each concrete mixture containing fly ash as a replacement for portland cement or other portland cement replacements. For each design mixture submitted, include an equivalent concrete mixture that does not contain portland cement replacements, to determine amount of portland cement replaced.
   3. Other Action Submittal:
      a. Design Mixtures: For each concrete mixture.

D. Quality Assurance
   1. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
   2. Comply with the following sections of ACI 301 (ACI 301M), unless modified by requirements in the Contract Documents:
      a. "General Requirements."
      b. "Formwork and Formwork Accessories."
      c. "Reinforcement and Reinforcement Supports."
      d. "Concrete Mixtures."
      e. "Handling, Placing, and Constructing."
      f. "Lightweight Concrete."
   3. Comply with ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

1.2 PRODUCTS

A. Formwork
   1. Furnish formwork and formwork accessories according to ACI 301 (ACI 301M).

B. Steel Reinforcement
   1. Recycled Content: Provide steel reinforcement with an average recycled content of steel products so that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
   2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
   3. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.

4. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel wire into flat sheets.
5. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

C. Concrete Materials
1. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout Project:
   a. Portland Cement: ASTM C 150, Type I **OR** Type II **OR** Type I/II **OR** Type III **OR** Type V, **as directed**. Supplement with the following, **as directed**:
      1) Fly Ash: ASTM C 618, Class C or F.
      2) Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
   b. Blended Hydraulic Cement: ASTM C 595, Type IS, portland blast-furnace slag **OR** Type IP, portland-pozzolan **OR** Type I (PM), pozzolan-modified portland **OR** Type I (SM), slag-modified Portland, **as directed**, cement.
2. Normal-Weight Aggregate: ASTM C 33, graded, 1-1/2-inch (38-mm) nominal maximum aggregate size.
3. Lightweight Aggregate: ASTM C 330, 1-inch (25-mm) nominal maximum aggregate size.
4. Water: ASTM C 94/C 94M.
5. Synthetic Fiber: Monofilament or fibrillated polypropylene fibers engineered and designed for use in concrete, complying with ASTM C 1116/C 1116M, Type III, 1/2 to 1-1/2 inches (13 to 38 mm) long.

D. Admixtures
1. Air-Entraining Admixture: ASTM C 260.
2. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
   a. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
   b. Retarding Admixture: ASTM C 494/C 494M, Type B.
   c. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
   d. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
   e. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
   f. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

E. Related Materials
1. Vapor Retarder: Plastic sheet, ASTM E 1745, Class A or B.
   OR
   Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils (0.25 mm) thick; or plastic sheet, ASTM E 1745, Class C.
2. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork.

F. Curing Materials
1. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.
2. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth or cotton mats.
3. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
4. Water: Potable.
5. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
6. Clear, Waterborne **OR** Solvent-Borne, **as directed**, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

G. Concrete Mixtures
1. Comply with ACI 301 (ACI 301M) requirements for concrete mixtures.

2. Normal-Weight Concrete: Prepare design mixes, proportioned according to ACI 301 (ACI 301M), as follows:
   a. Minimum Compressive Strength: 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**, at 28 days.
   b. Maximum Water-Cementitious Materials Ratio: 0.50 **OR** 0.45, **as directed**.
   c. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
   d. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm) **OR** 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, **as directed**, plus or minus 1 inch (25 mm).
   e. Air Content: Maintain within range permitted by ACI 301 (ACI 301M). Do not allow air content of trowel-finished floor slabs to exceed 3 percent.
3. Structural Lightweight Concrete Mix: ASTM C 330, proportioned to produce concrete with a minimum compressive strength of 3000 psi (20.7 MPa) at 28 days and a calculated equilibrium unit weight of 110 lb/cu. ft. (1762 kg/cu. m) plus or minus 3 lb/cu. ft. (48.1 kg/cu. m), as determined by ASTM C 567. Concrete slump at point of placement shall be the minimum necessary for efficient mixing, placing, and finishing.
   a. Limit slump to 5 inches (125 mm) for troweled slabs and 4 inches (100 mm) for other slabs.
4. Synthetic Fiber: Uniformly disperse in concrete mix at manufacturer's recommended rate but not less than a rate of 1.0 lb/cu. yd. (0.60 kg/cu. m) **OR** 1.5 lb/cu. yd. (0.90 kg/cu. m), **as directed**.

H. Concrete Mixing
1. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116, **as directed**, and furnish batch ticket information.
   a. When air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.
2. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.
   a. For mixer capacity of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
   b. For mixer capacity larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).
   c. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mix type, mix time, quantity, and amount of water added. Record approximate location of final deposit in structure.

1.3 EXECUTION

A. Formwork
1. Design, construct, erect, brace, and maintain formwork according to ACI 301 (ACI 301M).

B. Embedded Items
1. Place and secure anchorage devices and other embedded items required for adjoining work attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

C. Vapor Retarders
1. Install, protect, and repair vapor retarders according to ASTM E 1643; place sheets in position with longest dimension parallel with direction of pour.
   a. Lap joints 6 inches (150 mm) and seal with manufacturer's recommended adhesive or joint tape.

D. Steel Reinforcement
1. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
    a. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

E. Joints
1. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
2. Construction Joints: Locate and install so strength and appearance of concrete are not impaired, at locations indicated or as approved by the Owner.
3. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness, as follows:
    a. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with groover tool to a radius of 1/8 inch (3.2 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.
    b. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3.2-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
4. Isolation Joints: Install joint-filler strips at junctions with slabs-on-grade and vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
    a. Extend joint fillers full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.

F. Concrete Placement
1. Comply with ACI 301 (ACI 301M) for placing concrete.
2. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301 (ACI 301M).
   OR
   Do not add water to concrete during delivery, at Project site, or during placement.
3. Consolidate concrete with mechanical vibrating equipment.

G. Finishing Formed Surfaces
1. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defective areas repaired and patched. Remove fins and other projections exceeding 1/2 inch (13 mm).
    a. Apply to concrete surfaces not exposed to public view, **as directed**.
2. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Remove fins and other projections exceeding 1/8 inch (3 mm).
    a. Apply to concrete surfaces exposed to public view, **OR** to receive a rubbed finish, **OR** to be covered with a coating or covering material applied directly to concrete, **as directed**.
3. Rubbed Finish: Apply the following rubbed finish, defined in ACI 301 (ACI 301M), to smooth-formed finished as-cast concrete where indicated:
    a. Smooth-rubbed finish.
    b. Grout-cleaned finish.
    c. Cork-floated finish.
4. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

H. Finishing Unformed Surfaces

1. General: Comply with ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
2. Screed surfaces with a straightedge and strike off. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane before excess moisture or bleedwater appears on surface.
   a. Do not further disturb surfaces before starting finishing operations.
3. Scratch Finish: Apply scratch finish to surfaces indicated and surfaces to receive concrete floor topping or mortar setting beds for ceramic or quarry tile, portland cement terrazzo, and other bonded cementitious floor finishes, unless otherwise indicated.
4. Float Finish: Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, fluid-applied or direct-to-deck-applied membrane roofing, or sand-bed terrazzo.
5. Trowel Finish: Apply a hard trowel finish to surfaces indicated and to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system.
6. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set methods. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.
7. Nonslip Broom Finish: Apply a nonslip broom finish to surfaces indicated and to exterior concrete platforms, steps, and ramps. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.

I. Concrete Protecting And Curing
1. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with ACI 301 (ACI 301M) for hot-weather protection during curing.
2. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
3. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
4. Curing Methods: Cure formed and unformed concrete for at least seven days by one or a combination of the following methods:
   a. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
      1) Water.
      2) Continuous water-fog spray.
      3) Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.
   b. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
   c. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
   d. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

J. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Tests: Perform according to ACI 301 (ACI 301M).
a. Testing Frequency: One composite sample shall be obtained for each day's pour of each concrete mix exceeding 5 cu. yd. (4 cu. m) but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.
OR
Testing Frequency: One composite sample shall be obtained for each 100 cu. yd. (76 cu. m) or fraction thereof of each concrete mix placed each day.

K. Repairs
1. Remove and replace concrete that does not comply with requirements in this Section.

END OF SECTION 03 30 53 00

Task	Specification	Specification Description
03 30 53 00	03 05 13 00	Cast-In-Place Concrete

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SECTION 03 31 13 00 - CEMENT CONCRETE PAVEMENT

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for cement concrete pavement. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Driveways.
      b. Roadways.
      c. Parking lots.
      d. Curbs and gutters.
      e. Walks.

C. Definitions
   1. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

D. Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittals:
      a. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
      b. Design Mixtures for Credit ID 1.1: For each concrete mixture containing fly ash as a replacement for portland cement or other portland cement replacements. For each design mixture submitted, include an equivalent concrete mixture that does not contain portland cement replacements, to determine amount of portland cement replaced.
   3. Shop Drawings: Indicate pavement markings, lane separations, and defined parking spaces. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.
   4. Samples: For each type of product or exposed finish, prepared as Samples of size indicated below:
      a. Exposed Aggregate: 10-lb (4.5-kg) Sample of each mix.
      b. Wheel Stops: 6 inches (150 mm) long showing cross section; with fasteners.
      c. Preformed Traffic-Calming Devices: 6 inches (150 mm) long showing cross section; with fasteners.
   5. Other Action Submittals:
      a. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
   6. Qualification Data: For qualified Installer of detectable warnings, ready-mix concrete manufacturer and testing agency.
   7. Material Certificates: For the following, from manufacturer:
      a. Cementitious materials.
      b. Steel reinforcement and reinforcement accessories.
      c. Fiber reinforcement.
      d. Admixtures.
      e. Curing compounds.
      f. Applied finish materials.

g. Bonding agent or epoxy adhesive.
h. Joint fillers.
8. Material Test Reports: For each of the following:
a. Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.
9. Field quality-control reports.

E. Quality Assurance
1. Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer of stamped concrete paving systems.
2. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
a. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").
3. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
a. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
4. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.
5. ACI Publications: Comply with ACI 301 (ACI 301M) unless otherwise indicated.
6. Preinstallation Conference: Conduct conference at Project site.

F. Project Conditions
1. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
2. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F (4.4 deg C) for oil-based materials **OR** 55 deg F (12.8 deg C) for water-based materials, **as directed**, and not exceeding 95 deg F (35 deg C).

1.2 PRODUCTS

A. Forms
1. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
a. Use flexible or uniformly curved forms for curves with a radius of 100 feet (30.5 m) or less. Do not use notched and bent forms.
2. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

B. Steel Reinforcement
1. Recycled Content: Provide steel reinforcement with an average recycled content of steel so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
2. Plain-Steel Welded Wire Reinforcement: ASTM A 1064/A 1064M, fabricated from as-drawn steel **OR** galvanized-steel, **as directed**, wire into flat sheets.
3. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.
4. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A, plain steel.
5. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420); deformed.
6. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A 615/A 615M, Grade 60 (Grade 420) deformed bars.

7. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 (Grade 420) deformed bars.
8. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60 (Grade 420), deformed bars; assembled with clips.
9. Plain-Steel Wire: ASTM A 82/A 82M, as drawn **OR** galvanized, **as directed**.
10. Deformed-Steel Wire: ASTM A 496/A 496M.
11. Epoxy-Coated-Steel Wire: ASTM A 884/A 884M, Class A coated, plain **OR** deformed, **as directed**.
12. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A 767/A 767M, Class I coating, **as directed**. Cut bars true to length with ends square and free of burrs.
13. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars.
14. Tie Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
    OR
    Hook Bolts: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.
15. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:
    a. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
    b. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
16. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.
17. Zinc Repair Material: ASTM A 780.

C. Concrete Materials
1. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:
    a. Portland Cement: ASTM C 150, gray **OR** white, **as directed**, portland cement Type **I OR** Type **II OR** Type **I/II OR** Type **III OR** Type **V**, **as directed**. Supplement with the following, **as directed**:
        1) Fly Ash: ASTM C 618, Class C or Class F.
        2) Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
    b. Blended Hydraulic Cement: ASTM C 595, Type IS, portland blast-furnace slag **OR** Type IP, portland-pozzolan, **as directed**, cement.
2. Normal-Weight Aggregates: ASTM C 33, Class 4S **OR** Class 4M **OR** Class 1N, **as directed**, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials, **as directed**.
    a. Maximum Coarse-Aggregate Size: 1-1/2 inches (38 mm) **OR** 1 inch (25 mm) **OR** 3/4 inch (19 mm), **as directed**, nominal.
    b. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
3. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:
    a. Aggregate Sizes: 3/4 to 1 inch (19 to 25 mm) **OR** 1/2 to 3/4 inch (13 to 19 mm) **OR** 3/8 to 5/8 inch (10 to 16 mm), **as directed**, nominal.
    b. Aggregate Source, Shape, and Color: A**s required to meet Project requirements**.
4. Water: Potable and complying with ASTM C 94/C 94M.
5. Air-Entraining Admixture: ASTM C 260.

6. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
   a. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
   b. Retarding Admixture: ASTM C 494/C 494M, Type B.
   c. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
   d. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
   e. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
   f. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
7. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, **as directed**, nonfading, and resistant to lime and other alkalis.

D. Fiber Reinforcement
1. Synthetic Fiber: Monofilament or fibrillated polypropylene fibers engineered and designed for use in concrete paving, complying with ASTM C 1116/C 1116M, Type III, 1/2 to 1-1/2 inches (13 to 38 mm) long.

E. Curing Materials
1. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry or cotton mats.
2. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
3. Water: Potable.
4. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
5. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
6. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

F. Related Materials
1. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.
2. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.
3. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
4. Epoxy Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:
   a. Types I and II, non-load bearing **OR** Types IV and V, load bearing, **as directed**, for bonding hardened or freshly mixed concrete to hardened concrete.
5. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch (3 to 6 mm).
6. Pigmented Mineral Dry-Shake Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.
7. Rock Salt: Sodium chloride crystals, kiln dried, coarse gradation with 100 percent passing 3/8-inch (9.5-mm) sieve and 85 percent retained on a No. 8 (2.36-mm) sieve.

G. Detectable Warning Materials

1. Detectable Warning Stamp: Semirigid polyurethane mats with formed underside capable of imprinting detectable warning pattern on plastic concrete; perforated with a vent hole at each dome.
   a. Size of Stamp: One piece matching detectable warning area shown on Drawings **OR** 24 by 24 inches (610 by 610 mm) **OR** 24 by 36 inches (610 by 914 mm) **OR** 24 by 48 inches (610 by 1220 mm) **OR** 26 by 26 inches (660 by 660 mm) **OR** 26 by 36 inches (660 by 914 mm), **as directed**.
2. Liquid Release Agent: Manufacturer's standard, clear, evaporating formulation designed to facilitate release of stamp mats.

H. Pavement Markings
1. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, Type N **OR** Type F **OR** Type S, **as directed**; colors complying with FS TT-P-1952.
   a. Color: White **OR** Yellow **OR** Blue **OR** As indicated, **as directed**.
2. Pavement-Marking Paint: MPI #32 Alkyd Traffic Marking Paint.
   a. Color: White **OR** Yellow **OR** Blue **OR** As indicated, **as directed**.
3. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than three **OR** 45, **as directed**, minutes.
   a. Color: White **OR** Yellow **OR** Blue **OR** As indicated, **as directed**.
4. Pavement-Marking Paint: MPI #97 Latex Traffic Marking Paint.
   a. Color: White **OR** Yellow **OR** Blue **OR** As indicated, **as directed**.
5. Glass Beads: AASHTO M 247, Type 1 **OR** FS TT-B-1325, Type 1A, **as directed**.

I. Wheel Stops
1. Wheel Stops: Precast, air-entrained concrete, 2500-psi (17.2-MPa) minimum compressive strength, 4-1/2 inches (115 mm) high by 9 inches (225 mm) wide by 72 inches (1820 mm) long. Provide chamfered corners and drainage slots on underside and holes for anchoring to substrate.
   a. Dowels: Galvanized steel, 3/4 inch (19 mm) in diameter, 10-inch (254-mm) minimum length.
2. Wheel Stops: Solid, integrally colored, 96 percent recycled HDPE, or commingled postconsumer and postindustrial recycled rubber or plastic; UV stabilized; 4 inches (100 mm) high by 6 inches (150 mm) wide by 72 inches (1820 mm) long. Provide chamfered corners and drainage slots on underside and holes for anchoring to substrate.
   a. Color: Black **OR** Yellow **OR** Gray **OR** Green **OR** Blue, **as directed**.
   b. Dowels: Galvanized steel, 3/4 inch (19 mm) in diameter, 10-inch (254-mm) minimum length.
   c. Adhesive: As recommended by wheel stop manufacturer for application to concrete pavement.

J. Preformed Traffic-Calming Devices
1. Speed Bumps **OR** Humps **OR** Cushions, **as directed**: Solid, integrally colored, 100 percent postconsumer or commingled postconsumer and postindustrial recycled rubber or plastic; UV stabilized. Provide holes for anchoring to substrate.
   a. Bump Size: Modular 2 inches (50 mm) high by 10 inches (254 mm) wide by 72 inches (1800 mm) long, with overall length as dimensioned on Drawings.
   b. Hump **OR** Cushion, **as directed**, Size: Modular assemblies 3 inches (75 mm) high by 12 feet (3.7 m) in overall width **OR** 4 inches (100 mm) high by 14 feet (4.3 m) in overall width, **as directed**, with overall length as dimensioned on Drawings.
   c. Color: Black **OR** Yellow, **as directed**.
   d. Mounting Hardware: Galvanized-steel lag screw, shield, and washers; 1/2-inch (13-mm) diameter, 8-inch (200-mm) minimum length **OR** hardware as standard with device manufacturer for use with concrete paving, **as directed**.
   e. Adhesive: As recommended by device manufacturer.

K. Concrete Mixtures
1. Prepare design mixtures, proportioned according to ACI 301 (ACI 301M), for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
   a. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
   b. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that meet or exceed requirements.
2. Proportion mixtures to provide normal-weight concrete with the following properties:
   a. Compressive Strength (28 Days): 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**.
   b. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45 **OR** 0.50, **as directed**.
   c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm) **OR** 8 inches (200 mm), **as directed**, plus or minus 1 inch (25 mm).
3. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
   a. Air Content: 5-1/2 **OR** 4-1/2 **OR** 2-1/2, **as directed**, percent plus or minus 1.5 percent for 1-1/2-inch (38-mm) nominal maximum aggregate size.
   b. Air Content: 6 **OR** 4-1/2 **OR** 3, **as diredcted**, percent plus or minus 1.5 percent for 1-inch (25-mm) nominal maximum aggregate size.
   c. Air Content: 6 **OR** 5 **OR** 3-1/2, **as directed**, percent plus or minus 1.5 percent for 3/4-inch (19-mm) nominal maximum aggregate size.
4. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 **OR** 0.30, **as directed**, percent by weight of cement.
5. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
   a. Use water-reducing admixture **OR** high-range, water-reducing admixture **OR** high-range, water-reducing and retarding admixture **OR** plasticizing and retarding admixture, **as directed**, in concrete as required for placement and workability.
   b. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
6. Cementitious Materials: Limit percentage by weight of cementitious materials other than portland cement according to ACI 301 (ACI 301M) requirements for concrete exposed to deicing chemicals **OR** as follows, **as directed**:
   a. Fly Ash or Pozzolan: 25 percent.
   b. Ground Granulated Blast-Furnace Slag: 50 percent.
   c. Combined Fly Ash or Pozzolan, and Ground Granulated Blast-Furnace Slag: 50 percent, with fly ash or pozzolan not exceeding 25 percent.
7. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd. (0.60 kg/cu. m) **OR** 1.5 lb/cu. yd. (0.90 kg/cu. m), **as directed**.
8. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

L. Concrete Mixing
1. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M, **as directed**. Furnish batch certificates for each batch discharged and used in the Work.
   a. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.
2. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.
   a. For concrete batches of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.

b. For concrete batches larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).
c. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

1.3 EXECUTION

A. Examination
1. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
2. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
   a. Completely proof-roll subbase in one direction and repeat in perpendicular direction, **as directed**. Limit vehicle speed to 3 mph (5 km/h).
   b. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).
   c. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch (13 mm) according to requirements in Division 31 Section "Earth Moving".
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Remove loose material from compacted subbase surface immediately before placing concrete.

C. Edge Forms And Screed Construction
1. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
2. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

D. Steel Reinforcement
1. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
2. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
3. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
4. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
5. Zinc-Coated Reinforcement: Use galvanized-steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.
6. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M.
7. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch (50-mm) overlap of adjacent mats.

E. Joints
1. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
   a. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

2. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
   a. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
   b. Provide tie bars at sides of paving strips where indicated.
   c. Butt Joints: Use bonding agent **OR** epoxy bonding adhesive, **as directed**, at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
   d. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
   e. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
3. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
   a. Locate expansion joints at intervals of 50 feet (15.25 m) unless otherwise indicated.
   b. Extend joint fillers full width and depth of joint.
   c. Terminate joint filler not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished surface if joint sealant is indicated.
   d. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
   e. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
   f. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
4. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent concrete paving:
   a. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch (6-mm) **OR** 3/8-inch (10-mm), **as directed**, radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces, **as directed**.
      1) Tolerance: Ensure that grooved joints are within 3 inches (75 mm) either way from centers of dowels.
   b. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
      1) Tolerance: Ensure that sawed joints are within 3 inches (75 mm) either way from centers of dowels.
   c. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
   d. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch (6-mm) **OR** 3/8-inch (10-mm), **as directed**, radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces, **as directed**.

F. Concrete Placement
1. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
2. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

3. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
4. Comply with ACI 301 (ACI 301M) requirements for measuring, mixing, transporting, and placing concrete.
5. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.
6. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
7. Consolidate concrete according to ACI 301 (ACI 301M) by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
   a. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.
8. Screed paving surface with a straightedge and strike off.
9. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
10. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.
11. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.
    a. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.
12. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
    a. When air temperature has fallen to or is expected to fall below 40 deg F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
    b. Do not use frozen materials or materials containing ice or snow.
    c. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.
13. Hot-Weather Placement: Comply with ACI 301 (ACI 301M) and as follows when hot-weather conditions exist:
    a. Cool ingredients before mixing to maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
    b. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
    c. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

G. Float Finishing
1. General: Do not add water to concrete surfaces during finishing operations.
2. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
   a. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.

b. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
c. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch (1.6 to 3 mm) deep with a stiff-bristled broom, perpendicular to line of traffic.

H. Special Finishes
1. Monolithic Exposed-Aggregate Finish: Expose coarse aggregate in paving surface as follows:
a. Immediately after float finishing, spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
b. Cover paving surface with plastic sheeting, sealing laps with tape, and remove when ready to continue finishing operations.
c. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
d. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.
2. Seeded Exposed-Aggregate Finish: Immediately after initial floating, spread a single layer of aggregate uniformly on paving surface. Tamp aggregate into plastic concrete and float finish to entirely embed aggregate with mortar cover of 1/16 inch (1.6 mm).
a. Spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
b. Cover paving surface with plastic sheeting, sealing laps with tape, and remove sheeting when ready to continue finishing operations.
c. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
d. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.
3. Slip-Resistive Aggregate Finish: Before final floating, spread slip-resistive aggregate finish on paving surface according to manufacturer's written instructions and as follows:
a. Uniformly spread 25 lb/100 sq. ft. (12 kg/10 sq. m) **OR** 40 lb/100 sq. ft. (19.5 kg/10 sq. m) **OR** 60 lb/100 sq. ft. (29 kg/10 sq. m), **as directed**, of dampened, slip-resistive aggregate over paving surface in two applications. Tamp aggregate flush with surface using a steel trowel, but do not force below surface.
b. Uniformly distribute approximately two-thirds of slip-resistive aggregate over paving surface with mechanical spreader, allow to absorb moisture, and embed by power floating. Follow power floating with a second slip-resistive aggregate application, uniformly distributing remainder of material at right angles to first application to ensure uniform coverage, and embed by power floating.
c. Cure concrete with curing compound recommended by slip-resistive aggregate manufacturer. Apply curing compound immediately after final finishing.
d. After curing, lightly work surface with a steel wire brush or abrasive stone and water to expose nonslip aggregate.
4. Rock-Salt Finish: After initial floating **OR** troweling **OR** brooming, **as directed**, uniformly spread rock salt over paving surface at the rate of 5 lb/100 sq. ft. (0.2 kg/10 sq. m).
a. Embed rock salt into plastic concrete with roller or magnesium float.
b. Cover paving surface with 1-mil- (0.025-mm-) thick polyethylene sheet and remove sheet when concrete has hardened and seven-day curing period has elapsed.
c. After seven-day curing period, saturate concrete with water and broom-sweep surface to dissolve remaining rock salt, thereby leaving pits and holes.
5. Pigmented Mineral Dry-Shake Hardener Finish: After initial floating, apply dry-shake materials to paving surface according to manufacturer's written instructions and as follows:

a. Uniformly spread dry-shake hardener at a rate of 100 lb/100 sq. ft. (49 kg/10 sq. m), unless greater amount is recommended by manufacturer to match paving color required.
b. Uniformly distribute approximately two-thirds of dry-shake hardener over the concrete surface with mechanical spreader; allow hardener to absorb moisture and embed it by power floating. Follow power floating with a second application of pigmented mineral dry-shake hardener, uniformly distributing remainder of material at right angles to first application to ensure uniform color, and embed hardener by final power floating.
c. After final power floating, apply a hand-trowel finish followed by a broom finish.
d. Cure concrete with curing compound recommended by dry-shake hardener manufacturer. Apply curing compound immediately after final finishing.

I. Detectable Warnings
1. Blockouts: Form blockouts in concrete for installation of detectable paving units specified in Division 32 Section "Unit Paving".
a. Tolerance for Opening Size: Plus 1/4 inch (6 mm), no minus.
2. Stamped Detectable Warnings: Install stamped detectable warnings as part of a continuous concrete paving placement and according to stamp-mat manufacturer's written instructions.
a. Before using stamp mats, verify that the vent holes are unobstructed.
b. Apply liquid release agent to the concrete surface and the stamp mat.
c. Stamping: While initially finished concrete is plastic **OR** After application and final floating of pigmented mineral dry-shake hardener, **as directed**, accurately align and place stamp mats in sequence. Uniformly load, gently vibrate, and press mats into concrete to produce imprint pattern on concrete surface. Load and tamp mats directly perpendicular to the stamp-mat surface to prevent distortion in shape of domes. Press and tamp until mortar begins to come through all of the vent holes. Gently remove stamp mats.
d. Trimming: After 24 hours, cut off the tips of mortar formed by the vent holes.
e. Remove residual release agent according to manufacturer's written instructions, but no fewer than three days after stamping concrete. High-pressure-wash surface and joint patterns, taking care not to damage stamped concrete. Control, collect, and legally dispose of runoff.

J. Concrete Protection And Curing
1. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
2. Comply with ACI 306.1 for cold-weather protection.
3. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.
4. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
5. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
a. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
1) Water.
2) Continuous water-fog spray.
3) Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.
b. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm) and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period using cover material and waterproof tape.
c. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas that have been subjected to

heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

K. Paving Tolerances
1. Comply with tolerances in ACI 117 and as follows:
a. Elevation: 3/4 inch (19 mm).
b. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
c. Surface: Gap below 10-foot- (3-m-) long, unleveled straightedge not to exceed 1/2 inch (13 mm).
d. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches (13 mm per 300 mm) of tie bar.
e. Lateral Alignment and Spacing of Dowels: 1 inch (25 mm).
f. Vertical Alignment of Dowels: 1/4 inch (6 mm).
g. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches (6 mm per 300 mm) of dowel.
h. Joint Spacing: 3 inches (75 mm).
i. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
j. Joint Width: Plus 1/8 inch (3 mm), no minus.

L. Pavement Marking
1. Do not apply pavement-marking paint until layout, colors, and placement have been verified with the Owner.
2. Allow concrete paving to cure for a minimum of 28 days and be dry before starting pavement marking.
3. Sweep and clean surface to eliminate loose material and dust.
4. Apply paint with mechanical equipment to produce markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils (0.4 mm).
a. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to concrete surface. Mask an extended area beyond edges of each stencil to prevent paint application beyond stencil. Apply paint so that it cannot run beneath stencil.
b. Broadcast glass beads uniformly into wet markings at a rate of 6 lb/gal. (0.72 kg/L).

M. Wheel Stops
1. Install wheel stops in bed of adhesive applied as recommended by manufacturer.
2. Securely attach wheel stops to paving with not less than two steel **OR** galvanized-steel, **as directed**, dowels located at one-quarter to one-third points. Install dowels in drilled holes in the paving and bond dowels to wheel stop. Recess head of dowel beneath top of wheel stop.

N. Preformed Traffic-Calming Devices
1. Install preformed speed bumps **OR** humps **OR** cushions, **as directed**, in bed of adhesive applied as recommended by manufacturer for heavy traffic.
2. Securely attach preformed speed bumps **OR** humps **OR** cushions, **as directed**, to paving with hardware spaced as recommended by manufacturer for heavy traffic. Recess head of hardware beneath top surface.

O. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
a. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. (76 cu. m) **OR** 5000 sq. ft. (465 sq. m), **as directed**, or fraction thereof of each concrete mixture placed each day.

1) When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

b. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.

c. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

d. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when it is 80 deg F (27 deg C) and above, and one test for each composite sample.

e. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.

f. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.

1) A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

3. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).

4. Test results shall be reported in writing to the Owner, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

5. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by the Owner but will not be used as sole basis for approval or rejection of concrete.

6. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by the Owner.

7. Concrete paving will be considered defective if it does not pass tests and inspections.

8. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

9. Prepare test and inspection reports.

P. Repairs And Protection

1. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by the Owner.

2. Drill test cores, where directed by the Owner, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

3. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

4. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Final Completion inspections.

END OF SECTION 03 31 13 00

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SECTION 03 31 13 00a - ROLLER COMPACTED CONCRETE PAVEMENT

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of roller compacted concrete pavement. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Cementitious Materials:
1. Portland cement shall conform to ASTM C 150, Type I. Low alkali is to be used with aggregates when directed. In lieu of low-alkali cement, the Contractor may use a combination of Portland cement that does not meet the low-alkali requirement with a suitable pozzolan or ground granulated blast-furnace slag (GGBFS) provided the following requirement is met. The expansion of the proposed combination shall be equal to or less than the expansion of a low-alkali cement meeting the requirements of ASTM C 150 when tested in conformance with ASTM C 441. These two tests shall be performed concurrently at an independent certified laboratory at the Contractor's expense. the Owner reserves the right to confirm the test results and to adjust the percentage of pozzolan or GGBFS in the combination to suit other requirements at no additional cost to the Owner. Portland cement shall be furnished in bulk.
2. Pozzolan shall conform to ASTM C 618, and, in addition, limits in Table 2A, Uniformity Requirements (for air content) shall apply to all fly ash. Table 1A, Supplementary Optional Chemical Requirement for Maximum Alkalies, shall apply when it is to be used with aggregates listed to require low-alkali cement. Pozzolan shall be furnished in bulk.
3. The temperature of the cementitious materials as delivered to the site shall not exceed 150 degrees F.

B. Admixtures: All chemical admixtures furnished as liquids shall be in a solution of suitable viscosity and dilution for field use as determined by the Owner.
1. Water-Reducing Admixture (WRA) shall meet the requirements of ASTM C 494, Type D.
2. Air-entraining admixture shall conform to ASTM C 260.

C. Water for washing aggregates and for mixing and curing concrete shall be free from injurious amounts of oil, acid, salt, alkali, organic matter, or other deleterious substances and shall comply with COE CRD-C 400.

D. Aggregates
1. Composition: Fine aggregate shall consist of natural sand, manufactured sand, or a combination of natural and manufactured sands. Coarse aggregate shall consist of gravel, crushed gravel, crushed stone, air-cooled blast-furnace slag, or a combination thereof.
OR
All concrete mixtures will be proportioned by the Owner except that proportions for the slipformed facing concrete mixture will be selected by the Contractor. RCC shall be composed of cementitious materials, water, fine and coarse aggregates, and possibly admixtures. The cementitious material shall be portland cement, or portland cement in combination with pozzolan. An admixture when approved or directed will be a water-reducing/retarding admixture. Air-entraining admixture will be used in the bedding concrete and other conventional concrete.

1.3 EXECUTION

A. Concrete Mixing Plant: A continuous mixing plant(s) shall be capable of producing RCC of the same quality and uniformity as would be produced in a conventional redi-mix batch plant and shall be capable of producing a uniform continuous product (at both maximum and minimum production rates) that is mixed so that complete intermingling of all ingredients occurs without balling, segregation, and wet or dry portions.

B. Trucks: Truck mixers or agitators used for transporting central-mixed conventional concrete shall conform to the applicable requirements of ASTM C 94. Truck mixers shall not be used to transport concrete with larger than 37.5 mm (1-1/2-inch) nominal maximum size aggregate (NMSA) or 2 inch slump, or less. Nonagitating trucks may be used for transporting conventional central-mixed concrete over a smooth road when the hauling time is less than 15 minutes and the slump is less than 3 inches. Bodies of nonagitating trucks shall be smooth, water-tight, metal containers specifically designed to transport concrete, shaped with rounded corners to minimize segregation.

C. Belt Conveyors: Belt conveyors shall be designed and operated to assure a uniform flow of concrete from mixer or delivery truck to final place of deposit without segregation of ingredients or loss of mortar and shall be provided with positive means for preventing segregation of the concrete or loss of mortar at transfer points and the point of placing. The NMSA required in mixture proportions furnished by the Owner will not be changed to accommodate the belt width.

D. Spreading and Remixing Equipment: The primary spreading procedure shall be accomplished by dozer. Graders or other equipment not specified may be used to facilitate the RCC spreading process only when approved. For open, unrestricted areas, the dozer shall be a minimum size and weight equivalent to a Caterpillar D-6. For restricted placement areas, such as placement of RCC near the dam crest or next to abutments, the dozer shall have as a minimum a size and weight equivalent to a Caterpillar D-4. There shall be a minimum of one operating dozer for each 200 cubic yards of RCC placed each hour. The dozers shall be equipped with well-maintained grousers. A front-end loader with operator shall be available to assist with deposition and spreading of RCC as needed in confined areas. The equipment shall be maintained in good operating condition. The equipment shall not leak or drip oil, grease, or other visible contaminants onto the RCC surface. All equipment used for spreading and remixing that leaves the surface of the structure for maintenance or repairs or, for any other reason, must be cleaned of all contaminants by an approved method before returning to the structure surface. Under no conditions shall a dozer or other tracked vehicle be operated on other than fresh uncompacted RCC except to facilitate startup operations for each lift and by approved procedures.

E. Compaction Equipment:
   1. Self-propelled vibratory rollers shall be used for primary rolling and shall be double-drum. They shall transmit a dynamic impact to the surface through a smooth steel drum by means of revolving weights, eccentric shafts, or other equivalent methods. The compactor shall have a minimum gross mass of 20,000 pounds and shall produce a minimum dynamic force of 350 pounds per linear inch of drum width. The operating frequency shall be variable in the approximate range of 1,700 to 3,000 cycles per minute. The amplitude shall be adjustable between 0.015 and 0.04 inches. The roller shall be capable of full compaction in both forward and reverse directions. The roller shall be operated at speeds not exceeding 2.2 ft/s. Within the range of the operating capability of the equipment, the Owner may direct or approve variations to the frequency, amplitude, and speed of operation which result in the specified density at the fastest production rate.
   2. Small vibratory rollers shall be used to compact the RCC where the larger vibratory rollers specified above cannot maneuver. The rollers shall compact the RCC to the required density and shall be so demonstrated during construction of the test section. Small vibratory rollers cannot compact the RCC to the same density and thickness as the primary rollers. When small rollers are used, total lift thickness of the RCC layer or lift shall be reduced to not over 6 inches

uncompacted thickness to permit adequate compaction. Rollers shall have independent speed and vibration controls and shall be capable of a wide range of speed adjustments.

3. The tampers shall compact the RCC to the required density and shall be so demonstrated during construction of the test section. Tampers cannot compact the RCC to the same density and thickness as the primary rollers. When tampers are used, thickness of each RCC layer that is to be compacted shall be reduced to not more than 6 inches uncompacted thickness to assure adequate compaction.

F. Placing During Rain: RCC shall not be placed during rainfall of 0.1 inch/hr or more. During periods of lesser rainfall, placement of RCC may continue if, in the opinion of the Owner, no damage to the RCC is occurring. Work shall commence only after excess free surface water and contaminated paste or RCC have been removed. The surface shall have gained sufficient strength (no less than 4 hours after the RCC placement was suspended) to prevent rutting, pumping, intermixing of rainwater with the RCC, or other damage to the RCC. When the RCC surface has been contaminated or damaged in any manner, the RCC surface shall be washed to break up and remove laitance and/or mud-like coatings from the surface. Any undercut coarse aggregate shall be removed. All waste shall be removed and disposed of in an approved manner.

G. Hot-Weather Placement: In hot-weather placement the temperature of the RCC shall be controlled so that it does not exceed 75.0 degrees F when placed. Placement shall be suspended as soon as the RCC temperature exceeds 75 degrees F. Measures that can be taken to prevent temperatures exceeding75 degrees F include, but are not limited to; 1.) chilling mixing water, 2.) sprinkling aggregate stockpiles, 3.) use of a canopy to shade the RCC placement areas, 4.) placing during nighttime and early morning hours, or 5.) restricting placements to cloudy days. Use of any of these systems shall not be reason for extension of completion dates specified in these specifications. In addition, to prevent potential damage to the RCC due to hot-weather related placement conditions, all RCC operation shall be suspended between June 15 and October 31, unless directed otherwise.

END OF SECTION 03 31 13 00a

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SECTION 03 31 13 00b - PORTLAND CEMENT CONCRETE OVERLAYS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of Portland cement concrete overlays. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Coarse Aggregate:
1. Composition: Coarse aggregate shall consist of gravel, crushed gravel, crushed stone, a combination thereof, or crushed blast-furnace slag.
2. Particle Shape: Particles of the coarse aggregate shall be generally spherical or cubical in shape. The quantity of flat and elongated particles in any size group shall not exceed 20 percent by weight as determined by ASTM D 3398.
3. Gradation: The maximum size of coarse aggregate shall be the lesser of 1/4 of the pavement thickness or 2 inches nominal size. Gradation limits are specified in ASTM C 136.
4. Deleterious Substances: The amount of deleterious substances in the coarse aggregate shall not exceed the limits, defined in ASTM C 117 and C 123.

B. Fine Aggregate shall consist of natural sand, manufactured sand, or a combination of natural and manufactured sand and shall be composed of clean, hard, durable particles. Particles of the fine aggregate shall be generally spherical or cubical in shape. Gradation limits are specified in ASTM C 136.

C. Portland Cement shall be Type I in compliance with ASTM C 150.

D. Air-Entraining Admixture shall be in compliance with ASTM C 260. Concrete mixtures shall have air content by volume of concrete of 4 to 7 percent based on measurements made immediately after discharge from the mixer.

E. Concrete Mixture shall have a nominal slump of 2 inches with a maximum of 3 inches and a 28-day flexural strength of not less than 650 psi.

F. Joint and Crack Sealing Materials: Joint filler, joint sealant, and crack sealant shall comply with the following:
1. Expansion Joint Fillers shall comply with ASTM D 1751 or D 1752 or shall be resin impregnated fiberboard in compliance with the physical requirements of ASTM D 1752.
2. Type I Sealant shall comply with Fed. Spec. SS-S-200, except that sealant may be furnished as a ready-mixed liquid.
3. Type II Sealant shall comply with Fed. Spec. SS-S-1401.
4. Type V Sealant shall comply with COE CRD-C-527 and may be either a single- or multiple-component material.

G. Epoxy-Resin Materials: Materials used in epoxy-resin grout, mortar, and concrete shall comply with the following:
1. Epoxy-Resin Grout shall be a two-compound material formulated to comply with ASTM C 881.

2. Epoxy-Resin Concrete shall be composed of epoxy-resin binder and uniformly graded aggregate in compliance with ASTM C 144. The maximum size of aggregate shall be 3/8 or 1/2 inch.

H. Dowels shall be plain steel bars complying with ASTM A 499.

1.3 EXECUTION

A. Preparation of Existing Surface: The Contractor shall raise and reset all structures such as manhole frames, valve boxes, drainage structures, etc. to meet the required grade. Bonding course shall be applied to the area prepared to receive overlay and shall be of epoxy-resin grout and Portland cement mortar.

B. Concrete Placement: Concrete shall be placed within 45 minutes from the time all ingredients are charged into the mixing drum.

C. Vibration: In the final phases of placing, surface vibrating equipment shall be used, and the duration of vibration shall not exceed 20 seconds.

D. Joints shall be saw cut and in alignment with underlying existing joints.

E. Finishing:
1. Transverse Finishing: Immediately after placement, concrete shall be accurately struck off and screeded to such elevation that when consolidated and finished, the surface of the pavement will be free from porous places and will be at the required grade. The finishing machine shall make at least two trips over each area of pavement to compact the concrete and produce a surface of uniform texture, true to grade.
2. Longitudinal Floating: After completion of the transverse finishing, the longitudinal mechanical float shall be operated to smooth and finish the pavement to grade.
3. Hand Finishing shall be with an approved strike and tamping template and a longitudinal float.
4. Straightedge Finishing: After the longitudinal floating is completed but while the concrete is still plastic, minor irregularities and score marks in the pavement surface shall be eliminated by means of long-handled wood floats and straightedges. The final finish shall be made with the straightedges, which shall be used to float the entire pavement surface.
5. Burlap Drag Finishing: When most of the water glaze or sheen has disappeared and before the concrete becomes nonplastic, drag the surface of the pavement in the direction of the concrete placement with a multiple-ply burlap drag.
6. Edging: After other finishing has been completed, the edges of slabs along the forms and at the joints shall be carefully finished with an edging tool to form a smooth rounded surface of the required radius.

F. Concrete Curing and Protection:
1. Concrete Curing Methods shall consist of mat method, impervious sheeting method, or liquid membrane curing method.
2. Concrete Protection: Protect repaired areas against damage prior to final acceptance. Traffic shall be excluded from repaired areas.

END OF SECTION 03 31 13 00b

SECTION 03 31 13 00c - STEEL REINFORCED PORTLAND CEMENT CONCRETE OVERLAYS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of steel reinforced Portland cement concrete overlays. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Coarse Aggregate:
1. Composition: Coarse aggregate shall consist of gravel, crushed gravel, crushed stone, a combination thereof, or crushed blast-furnace slag.
2. Particle Shape: Particles of the coarse aggregate shall be generally spherical or cubical in shape. The quantity of flat and elongated particles in any size group shall not exceed 20 percent by weight as determined by ASTM D 3398.
3. Gradation: The maximum size of coarse aggregate shall be the lesser of 1/4 of the pavement thickness or 2 inches nominal size. Gradation limits are specified in ASTM C 136.
4. Deleterious Substances: The amount of deleterious substances in the coarse aggregate shall not exceed the limits, defined in ASTM C 117 and C 123.

B. Fine Aggregate shall consist of natural sand, manufactured sand, or a combination of natural and manufactured sand and shall be composed of clean, hard, durable particles. Particles of the fine aggregate shall be generally spherical or cubical in shape. Gradation limits are specified in ASTM C 136.

C. Portland Cement shall be Type I in compliance with ASTM C 150.

D. Air-Entraining Admixture shall be in compliance with ASTM C 260. Concrete mixtures shall have air content by volume of concrete of 4 to 7 percent based on measurements made immediately after discharge from the mixer.

E. Concrete Mixture shall have a nominal slump of 2 inches with a maximum of 3 inches and a 28-day flexural strength of not less than 650 psi.

F. Joint and Crack Sealing Materials: Joint filler, joint sealant, and crack sealant shall comply with the following:
1. Expansion Joint Fillers shall comply with ASTM D 1751 or D 1752 or shall be resin impregnated fiberboard in compliance with the physical requirements of ASTM D 1752.
2. Type I Sealant shall comply with Fed. Spec. SS-S-200, except that sealant may be furnished as a ready-mixed liquid.
3. Type II Sealant shall comply with Fed. Spec. SS-S-1401.
4. Type V Sealant shall comply with COE CRD-C-527 and may be either a single- or multiple-component material.

G. Epoxy-Resin Materials: Materials used in epoxy-resin grout, mortar, and concrete shall comply with the following:

1. Epoxy-Resin Grout shall be a two-compound material formulated to comply with ASTM C 881.
2. Epoxy-Resin Concrete shall be composed of epoxy-resin binder and uniformly graded aggregate in compliance with ASTM C 144. The maximum size of aggregate shall be 3/8 or 1/2 inch.

H. Steel Reinforcement: All reinforcement shall be free from loose flaky rust, loose scale, oil, grease, mud, or other coatings that might reduce bond. Bar mats shall comply with ASTM A 184. Welded steel wire fabric shall comply with ASTM A 1064. Tie bars shall be deformed bars in compliance with ASTM A 615, A 616, or A 617. Dowels shall be plain steel bars complying with ASTM A 499.

1.3 EXECUTION

A. Preparation of Existing Surface: The Contractor shall raise and reset all structures such as manhole frames, valve boxes, drainage structures, etc. to meet the required grade. Bonding course shall be applied to the area prepared to receive overlay and shall be of epoxy-resin grout and Portland cement mortar.

B. Reinforcement Steel shall be installed by the strike-off method wherein the concrete is deposited on the subgrade and struck to the indicated elevation of the steel. The reinforcement shall be laid upon the prestruck surface.

C. Concrete Placement: Concrete shall be placed within 45 minutes from the time all ingredients are charged into the mixing drum.

D. Vibration: In the final phases of placing, surface vibrating equipment shall be used, and the duration of vibration shall not exceed 20 seconds.

E. Joints shall be saw cut and in alignment with underlying existing joints.

F. Finishing:
1. Transverse Finishing: Immediately after placement, concrete shall be accurately struck off and screeded to such elevation that when consolidated and finished, the surface of the pavement will be free from porous places and will be at the required grade. The finishing machine shall make at least two trips over each area of pavement to compact the concrete and produce a surface of uniform texture, true to grade.
2. Longitudinal Floating: After completion of the transverse finishing, the longitudinal mechanical float shall be operated to smooth and finish the pavement to grade.
3. Hand Finishing shall be with an approved strike and tamping template and a longitudinal float.
4. Straightedge Finishing: After the longitudinal floating is completed but while the concrete is still plastic, minor irregularities and score marks in the pavement surface shall be eliminated by means of long-handled wood floats and straightedges. The final finish shall be made with the straightedges, which shall be used to float the entire pavement surface.
5. Burlap Drag Finishing: When most of the water glaze or sheen has disappeared and before the concrete becomes nonplastic, drag the surface of the pavement in the direction of the concrete placement with a multiple-ply burlap drag.
6. Edging: After other finishing has been completed, the edges of slabs along the forms and at the joints shall be carefully finished with an edging tool to form a smooth rounded surface of the required radius.

G. Concrete Curing and Protection:
1. Concrete Curing Methods shall consist of mat method, impervious sheeting method, or liquid membrane curing method.
2. Concrete Protection: Protect repaired areas against damage prior to final acceptance. Traffic shall be excluded from repaired areas.

END OF SECTION 03 31 13 00c

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SECTION 03 31 13 00d - FIBER REINFORCED PORTLAND CEMENT CONCRETE OVERLAYS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of fiber reinforced Portland cement concrete overlays. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Coarse Aggregate:
1. Composition: Coarse aggregate shall consist of gravel, crushed gravel, crushed stone, a combination thereof, or crushed blast-furnace slag.
2. Particle Shape: Particles of the coarse aggregate shall be generally spherical or cubical in shape. The quantity of flat and elongated particles in any size group shall not exceed 20 percent by weight as determined by ASTM D 3398.
3. Gradation: The maximum size of coarse aggregate shall be the lesser of 1/4 of the pavement thickness or 2 inches nominal size. Gradation limits are specified in ASTM C 136.
4. Deleterious Substances: The amount of deleterious substances in the coarse aggregate shall not exceed the limits, defined in ASTM C 117 and C 123.

B. Fine Aggregate shall consist of natural sand, manufactured sand, or a combination of natural and manufactured sand and shall be composed of clean, hard, durable particles. Particles of the fine aggregate shall be generally spherical or cubical in shape. Gradation limits are specified in ASTM C 136.

C. Portland Cement shall be Type I in compliance with ASTM C 150.

D. Air-Entraining Admixture shall be in compliance with ASTM C 260. Concrete mixtures shall have air content by volume of concrete of 4 to 7 percent based on measurements made immediately after discharge from the mixer.

E. Concrete Mixture shall have a nominal slump of 2 inches with a maximum of 3 inches and a 28-day flexural strength of not less than 650 psi.

F. Joint and Crack Sealing Materials: Joint filler, joint sealant, and crack sealant shall comply with the following:
1. Expansion Joint Fillers shall comply with ASTM D 1751 or D 1752 or shall be resin impregnated fiberboard in compliance with the physical requirements of ASTM D 1752.
2. Type I Sealant shall comply with Fed. Spec. SS-S-200, except that sealant may be furnished as a ready-mixed liquid.
3. Type II Sealant shall comply with Fed. Spec. SS-S-1401.
4. Type V Sealant shall comply with COE CRD-C-527 and may be either a single- or multiple-component material.

G. Epoxy-Resin Materials: Materials used in epoxy-resin grout, mortar, and concrete shall comply with the following:

1. Epoxy-Resin Grout shall be a two-compound material formulated to comply with ASTM C 881.
2. Epoxy-Resin Concrete shall be composed of epoxy-resin binder and uniformly graded aggregate in compliance with ASTM C 144. The maximum size of aggregate shall be 3/8 or 1/2 inch.

H. Steel Fibers: The fibers shall be made from low carbon steel. The following sizes of steel are acceptable:
1. 0.010-inch x 0.022-inch flat steel fiber,
2. 0.010-inch x 0.50-inch round steel fiber,
3. 0.016-inch x 1.0-inch round steel fiber,
4. 0.016-inch x 0.75-inch round steel fiber with 0.010-inch x 0.020-inch flat section along the length of the fiber
5. 2.5-inch x 0.025-inch round steel fibers.

1.3 EXECUTION

A. Preparation of Existing Surface: The Contractor shall raise and reset all structures such as manhole frames, valve boxes, drainage structures, etc. to meet the required grade. Bonding course shall be applied to the area prepared to receive overlay and shall be of epoxy-resin grout and Portland cement mortar.

B. Reinforcement Steel shall be installed by the strike-off method wherein the concrete is deposited on the subgrade and struck to the indicated elevation of the steel. The reinforcement shall be laid upon the prestruck surface.

C. Concrete Placement: Concrete shall be placed within 45 minutes from the time all ingredients are charged into the mixing drum.

D. Vibration: In the final phases of placing, surface vibrating equipment shall be used, and the duration of vibration shall not exceed 20 seconds.

E. Joints shall be saw cut and in alignment with underlying existing joints.

F. Finishing:
1. Transverse Finishing: Immediately after placement, concrete shall be accurately struck off and screeded to such elevation that when consolidated and finished, the surface of the pavement will be free from porous places and will be at the required grade. The finishing machine shall make at least two trips over each area of pavement to compact the concrete and produce a surface of uniform texture, true to grade.
2. Longitudinal Floating: After completion of the transverse finishing, the longitudinal mechanical float shall be operated to smooth and finish the pavement to grade.
3. Hand Finishing shall be with an approved strike and tamping template and a longitudinal float.
4. Straightedge Finishing: After the longitudinal floating is completed but while the concrete is still plastic, minor irregularities and score marks in the pavement surface shall be eliminated by means of long-handled wood floats and straightedges. The final finish shall be made with the straightedges, which shall be used to float the entire pavement surface.
5. Broom Finishing: Burlap drag finishing will not be allowed as this brings the steel fibers to the surface. Finishing shall be accomplished using a stiff broom.
6. Edging: After other finishing has been completed, the edges of slabs along the forms and at the joints shall be carefully finished with an edging tool to form a smooth rounded surface of the required radius.

G. Concrete Curing and Protection:
1. Concrete Curing Methods shall consist of mat method, impervious sheeting method, or liquid membrane curing method.

2. Concrete Protection: Protect repaired areas against damage prior to final acceptance. Traffic shall be excluded from repaired areas.

END OF SECTION 03 31 13 00d

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Task	Specification	Specification Description
03 31 13 00	03 05 13 00	Cast-In-Place Concrete
03 35 13 00	03 05 13 00	Cast-In-Place Concrete
03 35 16 00	03 05 13 00	Cast-In-Place Concrete
03 35 19 00	03 05 13 00	Cast-In-Place Concrete

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SECTION 03 35 23 00 - EXPOSED AGGREGATE SURFACE CONCRETE WALLS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of exposed aggregate surface concrete walls. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Submit product data and manufacturer's application instruction.
2. Shop drawings shall be submitted for approval.

1.2 PRODUCTS

A. Concrete Materials and Mixing
1. Portland Cement: ASTM C 150, Type 1 or 1A.
   a. Shrinkage-Compensating Cement: Portland cement containing a stable expansive chemical compound such as calcium sulfoaluminate.
   b. Aggregate: ASTM C 33; aggregate for exposed aggregate concrete shall match existing, if appropriate.
   c. Admixtures: Submit manufacturer's literature for all admixtures proposed for the work.
   d. Curing Compounds: ASTM C 309, Type 1.
   e. Epoxy Bonding Agent: Sika or approved equal.

B. Concrete Formwork, Reinforcement, and Accessories
1. Formwork: Plywood form and liners shall be minimum grade B-B High Density Concrete Form Overlay, Class I, complying with ANSI A199.1.
2. Reinforcement:
   a. Reinforcement Bars: ASTM A 615, Grade 40 or Grade 60.
   b. Welded Wire Fabric: ASTM A 1064. Where welded wire fabric is needed, use No. 6 gauge wire at 6-inch spacing in each direction.
   c. Accessories for proper installation of reinforcement shall comply with CRSI "Manual of Standard Practice for Reinforced Concrete Construction."
   d. Reinforcement fabrication shall comply with ACI 318 and ACI 315.

C. Curing and Climatic Conditions
1. Comply with ACI 306 and ACI 305 for protecting and curing concrete in cold and hot weather.
2. Immediately after finishing, begin curing flatwork by covering with constantly saturated moisture retaining fabrics, impervious sheeting, or membrane curing compounds.
3. Apply membrane curing compounds as required.

1.3 EXECUTION

A. Preparation when attaching to existing surfaces:
1. Remove all defective material by chipping and cutting to sound concrete in order to secure a solid foundation.
2. Square cut or undercut the edges to a minimum depth of one inch to form key.
3. Cut concrete out from behind exposed reinforcing bars and rods.
4. All exposed reinforcing shall be cleaned of rust and primed.

B. Installation
1. Formwork requirements:
a. Formwork shall comply with ACI 347. Joints in forms shall be horizontal or vertical.
b. Use plywood, fiberglass, or metal forms.
2. Reinforcement shall be repaired when rusted through. Rods at least l2 inches long shall be wired to the failed rods. In closing gaps, rods shall lap existing rods by at least 12 inches or 30 diameters, whichever is greater.
3. Mixing and transporting concrete: Ready-mixed concrete shall be mixed and delivered to the project in compliance with ASTM C 94. Job-mixed concrete shall comply with the requirements of ACI 318.
4. Mixing epoxy-resin patching mortar: Mix thoroughly with a power mixer at low speeds (150 - 400 rpm) until material attains uniform color and consistency (minimum time of two to three minutes at 70 F).

END OF SECTION 03 35 23 00

Task	Specification	Specification Description
03 35 23 00	03 05 13 00	Cast-In-Place Concrete
03 35 26 00	03 05 13 00	Cast-In-Place Concrete
03 35 29 00	03 05 13 00	Cast-In-Place Concrete
03 35 33 00	03 05 13 00	Cast-In-Place Concrete
03 35 63 00	03 05 13 00	Cast-In-Place Concrete
03 35 66 00	03 05 13 00	Cast-In-Place Concrete
03 35 83 00	03 05 13 00	Cast-In-Place Concrete

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SECTION 03 37 13 00 - SHOTCRETE

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for shotcrete. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes shotcrete applied by dry-mix or wet-mix process.

C. Definitions

1. Shotcrete: Mortar or concrete pneumatically projected onto a surface at high velocity.
2. Dry-Mix Shotcrete: Shotcrete with most of the water added at nozzle.
3. Wet-Mix Shotcrete: Shotcrete with ingredients, including mixing water, mixed before introduction into delivery hose.

D. Submittals

1. Product Data: For manufactured materials and products including reinforcement and forming accessories, shotcrete materials, admixtures, and curing compounds.
2. LEED Submittal:
   a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
      1) Include statement indicating costs for each product having recycled content.
3. Shop Drawings: For details of fabricating, bending, and placing reinforcement. Include support and anchor details, number and location of splices, and special reinforcement required for openings through shotcrete structures.
4. Samples: Approximately 24 by 24 by 2 inches (600 by 600 by 50 mm), to illustrate quality of finishes, colors, and textures of exposed surfaces of shotcrete.
5. Design Mixes: For each shotcrete mix.
6. Material Test Reports: For shotcrete materials.
7. Material Certificates: For each material item, signed by manufacturers.
8. Field quality-control test reports.

E. Quality Assurance

1. Installer Qualifications: A qualified installer employing nozzle operators for the Project, each of whom attains mean core grades not exceeding 2.5, according to ACI 506.2, on preconstruction tests **OR** is ACI Shotcrete Nozzleman certified in Dry-Mix Process for Vertical Position **OR** is ACI Shotcrete Nozzleman certified in Dry-Mix Process for Vertical and Overhead Positions **OR** is ACI Shotcrete Nozzleman certified in Wet-Mix Process for Vertical Position **OR** is ACI Shotcrete Nozzleman certified in Wet-Mix Process for Vertical and Overhead Positions as appropriate to the required shotcrete work**, as directed**.
2. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, and acceptable to authorities having jurisdiction, **as directed**.
3. Comply with provisions of the following, unless more stringent requirements are indicated:
   a. ACI 301, "Specifications for Structural Concrete."
   b. ACI 506.2, "Specification for Shotcrete."
4. Preinstallation Conference: Conduct conference at Project site.
5. Shotcrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design shotcrete mixtures.

F. Project Conditions
1. Cold-Weather Shotcreting: Protect shotcrete work from physical damage or reduced strength caused by frost, freezing, or low temperatures according to ACI 306.1 and as follows:
   a. Discontinue shotcreting when ambient temperature is 40 deg F (4.4 deg C) and falling. Uniformly heat water and aggregates before mixing to obtain a shotcrete shooting temperature of not less than 50 deg F (10 deg C) and not more than 90 deg F (32 deg C).
   b. Do not use frozen materials or materials containing ice or snow.
   c. Do not place shotcrete on frozen surfaces or surfaces containing frozen materials.
   d. Do not use calcium chloride, salt, or other materials containing antifreeze agents.
2. Hot-Weather Shotcreting: Mix, place, and protect shotcrete according to ACI 305R when hot-weather conditions and high temperatures would seriously impair quality and strength of shotcrete, and as follows:
   a. Cool ingredients before mixing to maintain shotcrete temperature at time of placement below 100 deg F (38 deg C) for dry mix or 90 deg F (32 deg C) for wet mix.
   b. Reduce temperature of reinforcing steel and receiving surfaces below 100 deg F (38 deg C) before shotcreting.

1.2 PRODUCTS

A. Form Materials
1. Forms: Form-facing panels that will provide continuous, straight, smooth, concrete surfaces. Furnish panels in largest practicable sizes to minimize number of joints.

B. Reinforcing Materials
1. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 **OR** 60, **as directed** percent.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
3. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
4. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II, zinc coated, hot-dip galvanized after fabrication and bending, as follows:
   a. Steel Reinforcement: ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed.
5. Plain-Steel Wire: ASTM A 82, as drawn **OR** galvanized, **as directed**.
6. Plain-Steel-Welded Wire Fabric: ASTM A 1064, fabricated from as-drawn **OR** galvanized, **as directed**, steel wire into flat sheets.
7. Deformed-Steel-Welded Wire Fabric: ASTM A 497, flat sheet.
8. Supports: Bolsters, chairs, spacers, ties, and other devices for spacing, supporting, and fastening reinforcing steel in place according to CRSI's "Manual of Standard Practice" and as follows:
   a. For uncoated reinforcement, use all-plastic **OR** CRSI Class 1, plastic-protected **OR** CRSI Class 2, stainless-steel, **as directed**, bar supports.
   b. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire **OR** all-plastic, **as directed**, bar supports.
   c. Retain paragraph and subparagraph below if devices are required to anchor, support, or space steel reinforcement.
9. Reinforcing Anchors: ASTM A 36/A 36M, unheaded rods or ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), hex-head bolts; carbon steel; and carbon-steel nuts.
   a. Finish: Plain, uncoated **OR** Hot-dip zinc coating, ASTM A 153/A 153M, Class C, **as directed**.

C. Shotcrete Materials
1. Portland Cement: ASTM C 150, Type I **OR** III, **as directed**. Use only one brand and type of cement for Project.

a. Fly Ash: ASTM C 618, Class C or F.
b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

2. Blended Hydraulic Cement: ASTM C 595, Type IS **OR** IP **OR** I(PM) **OR** I(SM), **as directed**.
3. Silica Fume: ASTM C 1240, amorphous silica.
4. Normal-Weight Aggregates: ASTM C 33, from a single source, and as follows:
   a. Aggregate Gradation: ACI 506R, Gradation No. 1 with 100 percent passing 3/8-inch (10-mm) **OR** 2 with 100 percent passing 1/2-inch (13-mm), **as directed**, sieve.
   b. Coarse-Aggregate Class: 3S **OR** 3M **OR** 1N, **as directed**.
5. Lightweight Aggregates: ASTM C 330.
   a. Aggregate Gradation: ACI 506R, Gradation No. 1 with 100 percent passing 3/8-inch (10-mm) **OR** 2 with 100 percent passing 1/2-inch (13-mm), **as directed** sieve.
6. Coloring Agent: ASTM C 979, synthetic mineral-oxide pigments or colored, water-reducing admixtures, free of carbon black; color stable, nonfading, and resistant to lime and other alkalis.
   a. Color: As indicated by manufacturer's designation **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.
7. Water: Potable, complying with ASTM C 94/C 94M, free from deleterious materials that may affect color stability, setting, or strength of shotcrete.
8. Carbon-Steel Fiber: ASTM C 1116, Type 1, carbon-steel fiber and ASTM A 820, Type 1, cold-drawn wire **OR** cut sheet, **as directed**, not less than 1 inch (25 mm) long.
9. Synthetic Fiber: Fibrillated polypropylene fibers engineered and designed for use in shotcrete, complying with ASTM C 1116, Type III, not less than 3/4 inch (19 mm) long.
10. Ground Wire: High-strength steel wire, 0.8 to 1 mm in diameter.
11. Joint Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

D. Chemical Admixtures
1. General: ASTM C 1141, Class A or B, but limited to the following admixture materials. Provide admixtures for shotcrete that contains not more than 0.1 percent chloride ions. Certify compatibility of admixtures with each other and with other cementitious materials.
   a. Air-Entraining Admixture: ASTM C 260.
   b. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
   c. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
   d. Water-Reducing and Accelerating Admixture: ASTM C 494/C 494M, Type E.
   e. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
   f. Accelerating Admixture: ASTM C 494/C 494M, Type C.

E. Curing Materials
1. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry.
2. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
3. Water: Potable.
4. Clear, Waterborne **OR** Solvent-Borne, **as directed**, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

F. Shotcrete Mixtures, General
1. Prepare design mixes for each type and strength of shotcrete.
   a. Limit use of fly ash **OR** ground granulated blast-furnace slag **OR** silica fume, **as directed**, to not exceed, in combination, 25 percent of portland cement by weight.
2. Limit water-soluble chloride ions to maximum percentage by weight of cement or cementitious materials permitted by ACI 301.
3. Admixtures: When included in shotcrete design mixes, use admixtures and retarding admixtures according to manufacturer's written instructions.
4. Carbon-Steel Fiber: Uniformly disperse in shotcrete mix, according to manufacturer's written instructions, at a rate of 50 lb/cu. yd. (30 kg/cu. m) **OR** 100 lb/cu. yd. (60 kg/cu. m), **as directed**.
5. Synthetic Fiber: Uniformly disperse in shotcrete mix, according to manufacturer's written instructions, at a rate of 1.5 lb/cu. yd. (0.90 kg/cu. m) **OR** 5 lb/cu. yd. (3 kg/cu. m), **as directed**.

6. Design-Mix Adjustments: Subject to compliance with requirements, shotcrete design-mix adjustments may be proposed when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

G. Shotcrete Mixtures
1. Proportion dry mixtures by field test data methods and wet mixtures according to ACI 211.1 and ACI 301, using materials to be used on Project, to provide shotcrete with the following properties:
a. Compressive Strength (28 Days): 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa), **as directed**.
b. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight, wet-mix shotcrete having an air content before pumping of 7 **OR** 8, **as directed**, percent with a tolerance of plus or minus 1-1/2 percent.

H. Shotcrete Equipment
1. Mixing Equipment: Capable of thoroughly mixing shotcrete materials in sufficient quantities to maintain continuous placement.
2. Dry-Mix Delivery Equipment: Capable of discharging aggregate-cement mixture into delivery hose under close control and maintaining continuous stream of uniformly mixed materials at required velocity to discharge nozzle. Equip discharge nozzle with manually operated water-injection system for directing even distribution of water to aggregate-cement mixture.
a. Provide uniform, steady supply of clean, compressed air to maintain constant nozzle velocity while simultaneously operating blow pipe for cleaning away rebound.
b. Provide water supply with uniform pressure at discharge nozzle to ensure uniform mixing with aggregate-cement mix. Provide water pump to system if line water pressure is inadequate.
3. Wet-Mix Delivery Equipment: Capable of discharging aggregate-cement-water mixture accurately, uniformly, and continuously.

I. Batching And Mixing
1. Dry-Mix Process: Measure mix proportions by weight batching according to ASTM C 94/C 94M or by volume batching complying with ASTM C 685/C 685M requirements.
a. In volume batching, adjust fine-aggregate volume for bulking. Test fine-aggregate moisture content at least once daily to determine extent of bulking.
b. Prepackaged shotcrete materials may be used at Contractor's option. Predampen prepackaged shotcrete materials and mix before use.
2. Wet-Mix Process: Measure, batch, mix, and deliver shotcrete according to ASTM C 94/C 94M and ASTM C 1116, **as directed**, and furnish batch ticket information.
a. Comply with ASTM C 685/C 685M when shotcrete ingredients are delivered dry and proportioned and mixed on-site.

1.3 EXECUTION

A. Preparation
1. Concrete or Masonry: Before applying shotcrete, remove unsound or loose materials and contaminants that may inhibit shotcrete bonding. Chip or scarify areas to be repaired to extent necessary to provide sound substrate. Cut edges square and 1/2 inch (13 mm) deep at perimeter of work, tapering remaining shoulder at 1:1 slope into cavity to eliminate square shoulders. Dampen surfaces before shotcreting.
a. Abrasive blast or hydroblast existing surfaces that do not require chipping to remove paint, oil, grease, or other contaminants and to provide roughened surface for proper shotcrete bonding.
2. Earth: Compact and trim to line and grade before placing shotcrete. Do not place shotcrete on frozen surfaces. Dampen surfaces before shotcreting.

3. Rock: Clean rock surfaces of loose materials, mud, and other foreign matter that might weaken shotcrete bonding.
4. Steel: Clean steel surfaces by abrasive blasting according to SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

B. Forms
1. General: Design, erect, support, brace, and maintain forms, according to ACI 301, to support shotcrete and construction loads and to facilitate shotcreting. Construct forms so shotcrete members and structures are secured to prevent excessive vibration or deflection during shotcreting.
   a. Fabricate forms to be readily removable without impact, shock, or damage to shotcrete surfaces and adjacent materials.
   b. Construct forms to required sizes, shapes, lines, and dimensions using ground wires and depth gages to obtain accurate alignment, location, and grades in finished structures. Construct forms to prevent mortar leakage but permit escape of air and rebound during shotcreting. Provide for openings, offsets, blocking, screeds, anchorages, inserts, and other features required in the Work.
2. Form openings, chases, recesses, bulkheads, keyways, and screeds in formwork. Determine sizes and locations from trades providing such items. Accurately place and securely support items built into forms.

C. Steel Reinforcement
1. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
2. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that weaken shotcrete bonding.
3. Securely embed reinforcing anchors into existing substrates, located as required.
4. Accurately position, support, and rigidly secure reinforcement against displacement by formwork, construction, or shotcreting. Locate and support reinforcement by metal chairs, runners, bolsters, spacers, and hangers, as required.
5. Place reinforcement to obtain minimum coverage for shotcrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during shotcreting. Set wire ties with ends directed into shotcrete, not toward exposed shotcrete surfaces.
6. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

D. Joints
1. Construction Joints: Locate and install construction joints tapered to a 1:1 slope where joint is not subject to compression loads and square where joint is perpendicular to main reinforcement. Continue reinforcement through construction joints, unless otherwise indicated.
2. Contraction Joints: Construct contraction joints in shotcrete using saw cuts 1/8-inch- (3-mm-) wide-by-1/3 slab depth or joint-filler strips 1/4-inch- (6-mm-) wide-by-1/3 shotcrete depth, unless otherwise indicated.
   a. After shotcrete has cured, remove strip inserts and clean groove of loose debris.
   b. Space joints at 15 feet (4.5 m) o.c. **OR** centers indicated, **as directed**, horizontally and vertically.
   c. Tool edges round on each side of strip inserts if floated or troweled finishes are required.

E. Alignment Control
1. Ground Wires: Install ground wires to establish thickness and planes of shotcrete surfaces. Install ground wires at corners and offsets not established by forms. Pull ground wires taut and position adjustment devices to permit additional tightening.

F. Embedded Items

1. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by shotcrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

G. Application
1. Apply temporary protective coverings and protect adjacent surfaces against deposit of rebound and overspray or impact from nozzle stream.
2. Moisten wood forms immediately before placing shotcrete where form coatings are not used.
3. Apply shotcrete according to ACI 506.2.
4. Apply dry-mix shotcrete materials within 45 minutes after predampening and wet-mix shotcrete materials within 90 minutes after batching.
5. Deposit shotcrete continuously in multiple passes, to required thickness, without cold joints and laminations developing. Place shotcrete with nozzle held perpendicular to receiving surface. Begin shotcreting in corners and recesses.
6. Remove and dispose of rebound and overspray materials during shotcreting to maintain clean surfaces and to prevent rebound entrapment.
7. Maintain reinforcement in position during shotcreting. Place shotcrete to completely encase reinforcement and other embedded items. Maintain steel reinforcement free of overspray and prevent buildup against front face during shotcreting.
8. Do not place subsequent lifts until previous lift of shotcrete is capable of supporting new shotcrete.
9. Do not permit shotcrete to sag, slough, or dislodge.
10. Remove hardened overspray, rebound, and laitance from shotcrete surfaces to receive additional layers of shotcrete; dampen surfaces before shotcreting.
11. Do not disturb shotcrete surfaces before beginning finishing operations.
12. Remove ground wires or other alignment control devices after shotcrete placement.
13. Shotcrete Core Grade: Apply shotcrete to achieve mean core grades not exceeding 2.5 according to ACI 506.2, with no single core grade exceeding 3.0.
14. Installation Tolerances: Place shotcrete without exceeding installation tolerances permitted by ACI 117R, increased by a factor of 2.

H. Surface Finishes
1. General: Finish shotcrete according to descriptions in ACI 506R for the following finishes:
2. Natural Finish:
   a. Gun Finish: Natural undisturbed finish.
   b. Rod Finish: Rough-textured finish obtained by cutting or screeding exposed face of shotcrete to plane by rod or straightedge after initial set, and wood-float finished **OR** and steel-trowel finished**as directed**.
   c. Broom Finish: Rough-textured finish obtained by screeding exposed face of shotcrete to required plane by rod, cutting screed, or trowel, and brooming after initial set.
3. Flash-Coat Finish: After screeding and rodding surface, apply up to 1/4-inch (6-mm) coat of shotcrete using ACI 506R, Gradation No. 1, fine-screened sand modified with maximum aggregate size not exceeding No. 4 (4.75-mm) sieve to provide a finely textured finish.
4. Flash-Coat and Final Finish: After screeding and rodding surface, apply up to 1/4-inch (6-mm) coat of shotcrete using ACI 506R, Gradation No. 1, fine-screened sand modified with maximum aggregate size not exceeding No. 4 (4.75-mm) sieve and apply wood-float **OR** rubber-float **OR** brush-float **OR** steel-trowel, **as directed**, finish.
5. Finish-Coat Finish: After screeding and rodding surface, apply shotcrete finish coat, 1/4 to 1 inch (6 to 25 mm) thick, using ACI 506R, Gradation No. 1, fine-screened sand modified with maximum aggregate size not exceeding No. 4 (4.75-mm) sieve to provide a finish of uniform texture and appearance.
6. Finish-Coat and Final Finish: After screeding and rodding surface, apply shotcrete finish coat, 1/4 to 1 inch (6 to 25 mm) thick, using ACI 506R, Gradation No. 1, fine-screened sand modified with

maximum aggregate size not exceeding No. 4 (4.75-mm) sieve and apply wood-float **OR** rubber-float **OR** brush-float **OR** steel-trowel, **as directed**, finish.

I. Curing
1. Protect freshly placed shotcrete from premature drying and excessive cold or hot temperatures.
2. Start initial curing as soon as free water has disappeared from shotcrete surface after placing and finishing.
3. Curing Exposed Surfaces: Cure shotcrete by one of the following methods:
    a. Moisture Curing: Keep surfaces continuously moist for at least seven days with water, continuous water-fog spray, water-saturated absorptive covers, or moisture-retaining covers. Lap and seal sides and ends of covers.
    b. Curing Compound: Apply curing compound uniformly in continuous operation by power spray according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
        1) Apply curing compound to natural- or gun-finished shotcrete at rate of 1 gal./100 sq. ft. (1 L/2.5 sq. m).
4. Curing Formed Surfaces: Cure formed shotcrete surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

J. Form Removal
1. Forms not supporting weight of shotcrete may be removed after curing at not less than 50 deg F (10 deg C) for 24 consecutive hours after gunning, provided shotcrete is hard enough not to be damaged by form-removal operations and provided curing and protecting operations are maintained.
    a. Leave forms supporting weight of shotcrete in place until shotcrete has attained design compressive strength. Determine compressive strength of in-place shotcrete by testing representative field-cured specimens of shotcrete.
    b. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
2. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing materials are unacceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.

K. Field Quality Control
1. Engage a qualified independent testing agency to sample materials, visually grade cores, perform tests, and submit reports during shotcreting.
2. Air Content: ASTM C 173/C 173M, volumetric method or ASTM C 231, pressure method; 1 test for each compressive-strength test for each mix of air-entrained, wet-mix shotcrete measured before pumping.
3. Shotcrete Temperature: ASTM C 1064/C 1064M; 1 test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and 1 test for each set of compressive-strength specimens.
4. Test Panels: Make a test panel, reinforced as in structure, for each shotcrete mix and for each workday or for every 50 cu. yd. (38 cu. m) of shotcrete placed; whichever is less. Produce test panels with dimensions of 24 by 24 inches (600 by 600 mm) minimum and of average thickness of shotcrete, but not less than 4-1/2 inches (115 mm). From each test panel, testing agency will obtain six test specimens: one set of three specimens unreinforced and one set of three specimens reinforced.
    a. Test each set of unreinforced specimens for compressive strength according to ASTM C 1140 and construction testing requirements in ACI 506.2.
    b. Visually inspect each set of reinforced shotcrete cores taken from test panels and determine mean core grades according to ACI 506.2.

5. In-Place Shotcrete: Take a set of 3 unreinforced cores for each mix and for each workday or for every 50 cu. yd. (38 cu. m) of shotcrete placed; whichever is less. Test cores for compressive strength according to ACI 506.2 and ASTM C 42. Do not cut steel reinforcement.
6. Strength of shotcrete will be considered satisfactory when mean compressive strength of each set of 3 unreinforced cores equals or exceeds 85 percent of specified compressive strength, with no individual core less than 75 percent of specified compressive strength.
   a. Mean compressive strength of each set of 3 unreinforced cubes shall equal or exceed design compressive strength with no individual cube less than 88 percent of specified compressive strength.

L. Repairs
1. Remove and replace shotcrete that is delaminated or exhibits laminations, voids, or sand/rock pockets exceeding limits for specified core grade of shotcrete.
   a. Remove unsound or loose materials and contaminants that may inhibit bond of shotcrete repairs. Chip or scarify areas to be repaired to extent necessary to provide sound substrate. Cut edges square and 1/2 inch (13 mm) deep at perimeter of work, tapering remaining shoulder at 1:1 slope into cavity to eliminate square shoulders. Dampen surfaces and apply new shotcrete.
2. Repair core holes from in-place testing according to repair provisions in ACI 301 and match adjacent finish, texture, and color.

M. Cleaning
1. Remove and dispose of rebound and overspray materials from final shotcrete surfaces and areas not intended for shotcrete placement.

END OF SECTION 03 37 13 00

SECTION 03 37 13 00a - GLASS FIBER REINFORCED CONCRETE

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for glass-fiber-reinforced precast concrete panels. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes glass-fiber-reinforced concrete (GFRC) panels consisting of GFRC panel frames, anchors, and connection hardware.
a. GFRC panels include wall units, window wall units, mullions, column covers, fascia units, cornices, and soffits.

C. Definitions
1. Design Reference Sample: Sample of approved GFRC color, finish, and texture; preapproved by the Owner.

D. Performance Requirements
1. Structural Performance: Provide GFRC panels, including panel frames, anchors, and connections, capable of withstanding the following design loads as well as the effects of thermal- and moisture-induced volume changes, according to load factors and combinations established in PCI MNL 128, "Recommended Practice for Glass Fiber Reinforced Concrete Panels."
a. Design Loads: As required to meet Project requirements.
b. Deflection Limits: Design panel frames to withstand design loads without lateral deflections greater than 1/240 of wall span.
c. Thermal Movements: Provide for thermal movements resulting from annual ambient temperature changes of 100 deg F (56 deg C).
d. Design panel frames and connections to accommodate deflections and other building movements.
e. Design panel frames to transfer window loads to building structure.

E. Submittals
1. Product Data: For each type of product indicated. Include GFRC design mixes.
2. Shop Drawings: Show fabrication and installation details for GFRC panels including the following:
a. Structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
b. Panel elevations, sections, and dimensions.
c. Thickness of facing mix, GFRC backing, and bonding pads for typical panels.
d. Finishes.
e. Joint and connection details.
f. Erection details.
g. Panel frame details for typical panels including sizes, spacings, thickness, and yield strength of various members.
h. Location and details of connection hardware attached to structure.
i. Size, location, and details of flex, gravity, and seismic anchors for typical panels.
j. Other items sprayed into panels.
k. Erection sequence for special conditions.
l. Relationship to adjacent materials.
m. Description of loose, cast-in, and field hardware.

3. Samples: Representative of finished exposed face of GFRC showing the full range of colors and textures specified, 12 by 12 inches (305 by 305 mm) and of actual thickness.
4. Qualification Data: For qualified GFRC manufacturer, including proof of current Precast/Prestressed Concrete Institute (PCI) or Architectural Precast Association (APA) Plant Certification.
5. Welding certificates.
6. Steel Sheet Certification: For steel sheet used in cold-formed steel panel framing.
7. Mill Certificates: For structural-steel shapes and hollow structural sections used in panel framing.
8. Source Quality-Control Program: For GFRC manufacturer.
9. Source Quality-Control Test Reports: For GFRC, inserts, and anchors.

F. Quality Assurance

1. Manufacturer Qualifications: A qualified manufacturer that participates in PCI's Plant Certification Program and is designated a PCI-Certified Plant for Group G - Glass Fiber Reinforced Concrete or that participates in APA's Plant Certification Program and is certified for GFRC production.
   a. Manufacturer's responsibility includes fabricating and installing GFRC panels and providing professional engineering services needed to assume engineering responsibility for GFRC panels.
   b. Engineering responsibility includes preparation of Shop Drawings and comprehensive engineering analysis, based on GFRC production test values, by a qualified professional engineer experienced in GFRC design.
2. Steel Sheet Certifications: Obtain mill certificates signed by manufacturers of steel sheet, or test reports from a qualified testing agency, indicating that steel sheet used in cold-formed metal panel framing complies with requirements including uncoated steel thickness, yield strength, tensile strength, total elongation, chemical requirements, and galvanized-coating thickness.
3. Mill Certificates: Obtain certified mill test reports from manufacturer of structural-steel shapes and hollow structural sections used in panel framing indicating compliance of these products with requirements.
4. Source Limitations: Obtain GFRC panels from single source from single manufacturer.
5. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," and AWS D1.3, "Structural Welding Code - Sheet Steel."
6. PCI Manuals: Comply with requirements and recommendations in the following PCI manuals unless more stringent requirements are indicated:
   a. PCI MNL 128, "Recommended Practice for Glass Fiber Reinforced Concrete Panels."
   b. PCI MNL 130, "Manual for Quality Control for Plants and Production of Glass Fiber Reinforced Concrete Products."
7. AISC Specifications: Comply with AISC's "Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design" **OR** "Load and Resistance Factor Design Specification for Structural Steel Buildings" **OR** "Specification for the Design of Steel Hollow Structural Sections," **as directed**, if using structural-steel shapes or hollow structural sections for panel frames.
8. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling

1. Handle and transport GFRC panels to avoid damage.
   a. Place nonstaining resilient spacers between panels.
   b. Support panels on nonstaining material during shipment.
   c. Protect panels from dirt and damage during handling and transport.
2. Store GFRC panels to protect from contact with soil, staining, and physical damage.
   a. Store panels with nonstaining resilient supports in same positions as when transported.
   b. Store panels on firm, level, and smooth surfaces.
   c. Place stored panels so identification marks are clearly visible.

1.2 PRODUCTS

A. Mold Materials
1. Molds: Rigid, dimensionally stable, nonabsorptive material, warp and buckle free, that will provide continuous and true GFRC surfaces; nonreactive with GFRC and capable of producing required finish surfaces.
a. Mold-Release Agent: Commercially produced liquid-release agent that will not bond with, stain, or adversely affect GFRC surfaces and will not impair subsequent surface or joint treatments of GFRC.
2. Form Liners: Units of face design, texture, arrangement, and configuration indicated **OR** to match GFRC design reference sample, **as directed**. Provide solid backing and form supports to ensure that form liners remain in place during GFRC application. Use with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect GFRC surfaces and will not impair subsequent surface or joint treatments of GFRC.
3. Surface Retarder: Chemical liquid set retarder capable of temporarily delaying hardening of newly placed GFRC face mix to depth of reveal specified.

B. GFRC Materials
1. Portland Cement: ASTM C 150; Type I, II, or III.
a. For surfaces exposed to view in finished structure, use gray **OR** white, **as directed**, of same type, brand, and source throughout GFRC production.
b. Metakaolin: ASTM C 618, Class N.
2. Glass Fibers: Alkali resistant, with a minimum zirconia content of 16 percent, 1 to 2 inches (25 to 50 mm) long, specifically produced for use in GFRC, and complying with PCI MNL 130.
3. Sand: Washed and dried silica, complying with composition requirements in ASTM C 144; passing No. 20 (0.85-mm) sieve with a maximum of 2 percent passing No. 100 (0.15-mm) sieve.
4. Facing Aggregate: ASTM C 33, except for gradation, and PCI MNL 130, 1/4-inch (6-mm) maximum size.
a. Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining; to match sample.
5. Coloring Admixture: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures, temperature stable, nonfading, and alkali resistant.
6. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of GFRC and complying with chemical limits of PCI MNL 130.
7. Polymer-Curing Admixture: Acrylic thermoplastic copolymer dispersion complying with PCI MNL 130.
8. Air-Entraining Admixture: ASTM C 260, containing not more than 0.1 percent chloride ions.
9. Chemical Admixtures: ASTM C 494/C 494M, containing not more than 0.1 percent chloride ions.

C. Anchors, Connectors, And Miscellaneous Materials
1. Stainless-Steel Plates: ASTM A 240/A 240M or ASTM A 666, Type 304.
2. Carbon-Steel Shapes and Plates: ASTM A 36/A 36M. Finish steel shapes and plates less than 3/16 inch (4.76 mm) thick as follows:
a. Finish: Zinc coated by hot-dip process according to ASTM A 123/A 123M, after fabrication, or ASTM A 153/A 153M, as applicable **OR** electrodeposition according to ASTM B 633, SC 3, **as directed**.
OR
Finish: Shop primed with MPI#79 **OR** SSPC-Paint 25, **as directed**, on surfaces prepared to comply with SSPC-SP 2, "Hand Tool Cleaning," or better.
3. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.
4. Carbon-Steel Bars: ASTM A 108, AISI Grade 1018. Finish steel bars less than 3/16 inch (4.76 mm) thick as follows:
a. Finish: Zinc coated by hot-dip process according to ASTM A 123/A 123M, after fabrication, or ASTM A 153/A 153M, as applicable **OR** electrodeposition according to ASTM B 633, SC 3, **as directed**.

b. Finish: Shop primed with MPI#79 **OR** SSPC-Paint 25, **as directed**, on surfaces prepared to comply with SSPC-SP 2, "Hand Tool Cleaning," or better.

5. Malleable-Iron Castings: ASTM A 47/ A 47M, Grade 32510 (Grade 22010).
6. Carbon-Steel Castings: ASTM A 27/A 27M, Grade 60-30 (Grade 415-205).
7. Bolts: ASTM A 307 or ASTM A 325 (ASTM F 568M or ASTM A 325M).
   a. Finish: Zinc coated by hot-dip process according to ASTM A 123/A 123M, after fabrication, and ASTM A 153/A 153M, as applicable **OR** electrodeposition according to ASTM B 633, SC 3, **as directed**.
8. Reglets: PVC extrusions **OR** Stainless steel, ASTM A 240/A 240M, Type 304, 0.016 inch (0.40 mm) thick, **as directed**.

D. Panel Frame Materials

1. Cold-Formed Steel Framing: Manufacturer's standard C-shaped steel studs, complying with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members," minimum uncoated steel thickness of 0.053 inch (1.34 mm) of web depth indicated, with stiffened flanges, U-shaped steel track, and of the following steel sheet:
   a. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, structural-steel sheet, G60 (Z180) **OR** G90 (Z275), **as directed**, zinc coating, of grade required by structural performance of framing.
   b. Painted, Nonmetallic-Coated Steel Sheet: ASTM A 1011/A 1011M, hot rolled; or ASTM A 1008/A 1008M, cold rolled; nonmetallic coated according to ASTM A 1003/A 1003M; of grade required by structural performance of framing.
2. Hollow Structural Sections: Steel tubing, ASTM A 500, Grade B, or ASTM A 513. Finish hollow structural sections with wall thickness less than 3/16 inch (4.76 mm) as follows:
   a. Organic Zinc-Rich Primer: SSPC-Paint 20 on surfaces prepared to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   b. Primer: MPI#79 **OR** SSPC-Paint 25, **as directed**, on surfaces prepared to comply with SSPC-SP 2, "Hand Tool Cleaning," or better.
3. Steel Channels and Angles: ASTM A 36/A 36M, finished as follows:
   a. Organic Zinc-Rich Primer: SSPC-Paint 20 on surfaces prepared to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   b. Primer: MPI#79 **OR** SSPC-Paint 25, **as directed**, on surfaces prepared to comply with SSPC-SP 2, "Hand Tool Cleaning," or better.

E. GFRC Mixes

1. Backing Mix: Proportion backing mix of portland cement, glass fibers, sand, and admixtures to comply with design requirements. Provide nominal glass-fiber content of not less than 5 percent by weight of total mix.
2. Face Mix: Proportion face mix of portland cement, sand, facing aggregates, and admixtures to comply with design requirements.
3. Mist Coat: Portland cement, sand slurry, and admixtures; of same proportions as backing mix without glass fibers.
4. Polymer-Curing Admixture: 6 to 7 percent by weight of polymer-curing admixture solids to dry portland cement.
5. Air Content: 8 to 10 percent; ASTM C 185.
6. Coloring Admixture: Not to exceed 10 percent of cement weight.

F. Panel Frame Fabrication

1. Fabricate panel frames and accessories plumb, square, true to line, and with components securely fastened, according to Shop Drawings and requirements in this Section.
   a. Fabricate panel frames using jigs or templates.
   b. Cut cold-formed metal framing members by sawing or shearing; do not torch cut.
   c. Fasten cold-formed metal framing members by welding. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

d. Fasten framing members of hollow structural sections, steel channels, or steel angles by welding. Comply with AWS D1.1/D1.1M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
e. Weld flex, gravity, and seismic anchors to panel frames.

2. Reinforce, stiffen, and brace framing assemblies, if necessary, to withstand handling, delivery, and erection stresses. Lift fabricated assemblies in a manner that prevents damage or significant distortion.
3. Galvanizing Repair: Touch up accessible damaged galvanized surfaces according to ASTM A 780.
4. Painting Repair: Touch up accessible damaged painted surfaces using same primer.

G. Mold Fabrication

1. Construct molds that will result in finished GFRC complying with profiles, dimensions, and tolerances indicated, without damaging GFRC during stripping. Construct molds to prevent water leakage and loss of cement paste.
   a. Coat contact surfaces of molds with form-release agent.
   b. Coat contact surfaces of molds with surface retarder.
2. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and supports to maintain stability of liners during GFRC application. Coat form liner with form-release agent.
3. Locate, place, and secure flashing reglets accurately.

H. GFRC Fabrication

1. Proportioning and Mixing: For backing mix, meter sand/cement slurry and glass fibers to spray head at rates to achieve design mix proportions and glass-fiber content according to PCI MNL 130 procedures.
2. Spray Application: Comply with general procedures as follows:
   a. Spray mist coat over molds to a nominal thickness of 1/8 inch (3 mm) on planar surfaces.
   b. Spray or place face mix in thickness indicated on Shop Drawings.
   c. Proceed with spraying backing mix before face mix **OR** mist coat, **as directed**, has set, using procedures that produce a uniform thickness and even distribution of glass fibers and matrix.
   d. Consolidate backing mix by rolling or other technique to achieve complete encapsulation of glass fibers and compaction.
   e. Measure thickness with a pin gage or other acceptable method at least once for each 5 sq. ft. (0.5 sq. m) of panel surface. Take not less than six measurements per panel.
3. Hand form and consolidate intricate details, incorporate formers or infill materials, and over spray before material reaches initial set to ensure complete bonding.
4. Attach panel frame to GFRC before initial set of GFRC backing, maintaining a minimum clearance of 1/2 inch (13 mm) from GFRC backing, and without anchors protruding into GFRC backing.
5. Build up homogeneous GFRC bonding pads over anchor feet, maintaining a minimum thickness of 1/2 inch (13 mm) over tops of anchor feet, before initial set of GFRC backing.
6. Inserts and Embedments: Build up homogeneous GFRC bosses or bonding pads over inserts and embedments to provide sufficient anchorage and embedment to comply with design requirements.
7. Curing: Employ initial curing method that will ensure sufficient strength for removing units from mold. Comply with PCI MNL 130 procedures.
8. Panel Identification: Mark each GFRC panel to correspond with identification mark on Shop Drawings. Mark each panel with its casting date.

I. Fabrication Tolerances

1. Manufacturing Tolerances: Manufacture GFRC panels so each finished unit complies with PCI MNL 130 for dimension, position, and tolerances.
   OR

Manufacturing Tolerances: Manufacture GFRC panels so each finished unit complies with the following dimensional tolerances. For dimensional tolerances not listed below, comply with PCI MNL 130.

a. Overall Height and Width of Units, Measured at the Face Adjacent to Mold: As follows:
   1) 10 feet (3 m) or less, plus or minus 1/8 inch (3 mm).
   2) More than 10 feet (3 m), plus or minus 1/8 inch per 10 feet (3 mm per 3 m); 1/4 inch (6 mm) maximum.
b. Edge Return Thickness: Plus 1/2 inch (13 mm), minus 0 inch (0 mm).
c. Architectural Facing Thickness: Plus 1/8 inch (3 mm), minus 0 inch (0 mm).
d. Backing Thickness: Plus 1/4 inch (6 mm), minus 0 inch (0 mm).
e. Panel Depth from Face of Skin to Back of Panel Frame or Integral Rib: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
f. Angular Variation of Plane of Side Mold: Plus or minus 1/32 inch per 3 inches (0.8 mm per 75 mm) of depth or plus or minus 1/16 inch (1.5 mm) total, whichever is greater.
g. Variation from Square or Designated Skew (Difference in Length of Two Diagonal Measurements): Plus or minus 1/8 inch per 72 inches (3 mm per 1800 mm) or plus or minus 1/4 inch (6 mm) total, whichever is greater.
h. Local Smoothness: 1/4 inch per 10 feet (6 mm per 3 m).
i. Bowing: Not to exceed L/240 unless unit meets erection tolerances using connection adjustments.
j. Length and Width of Block Outs and Openings within One Unit: Plus or minus 1/4 inch (6 mm).
k. Location of Window Opening within Panel: Plus or minus 1/4 inch (6 mm).
l. Maximum Permissible Warpage of One Corner out of the Plane of the Other Three: 1/16 inch per 12 inches (1.5 mm per 305 mm) of distance from nearest adjacent corner.

2. Position Tolerances: Measured from datum line locations, as indicated on Shop Drawings.
   a. Panel Frame and Track: Plus or minus 1/4 inch (6 mm).
   b. Flashing Reglets at Edge of Panel: Plus or minus 1/4 inch (6 mm).
   c. Inserts: Plus or minus 1/2 inch (13 mm).
   d. Special Handling Devices: Plus or minus 3 inches (75 mm).
   e. Location of Bearing Devices: Plus or minus 1/4 inch (6 mm).
   f. Blockouts: Plus or minus 3/8 inch (10 mm).
3. Panel Frame Tolerances: As follows:
   a. Vertical and Horizontal Alignment: 1/4 inch per 10 feet (6 mm per 3 m).
   b. Spacing of Framing Member: Plus or minus 3/8 inch (10 mm).
   c. Squareness of Frame: Difference in length of diagonals of 3/8 inch (10 mm).
   d. Overall Size of Frame: Plus or minus 3/8 inch (10 mm).

J. Finishes
1. Finish exposed-face surfaces of GFRC as follows to match approved design reference sample. Panel faces shall be free of joint marks, grain, or other obvious defects.
   a. Design Reference Sample: <Insert description and identify manufacturer and code number of sample>.
   b. As-Cast-Surface Finish: Provide free of sand streaks, honeycombs, and excessive air voids, with uniform color and texture.
   c. Textured-Surface Finish: Impart by form liners to provide surfaces free of sand streaks, honeycombs, and excessive air voids, with uniform color and texture.
   d. Retarded Finish: Use chemical-retarding agents applied to concrete forms and washing and brushing procedures to expose aggregate and surrounding matrix surfaces after form removal.
   e. Sand- or Abrasive-Blast Finish: Use abrasive grit, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces.
   f. Acid-Etched Finish: Use acid and hot-water solution equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces.

K. Source Quality Control
1. Quality-Control Testing: Establish and maintain a quality-control program for manufacturing GFRC panels according to PCI MNL 130.
   a. Test materials and inspect production techniques.
   b. Quality-control program shall monitor glass-fiber content, spray rate, unit weight, product physical properties, anchor pull-off and shear strength, and curing period and conditions.
   c. Prepare test specimens and test according to ASTM C 1228, PCI MNL 130, and PCI MNL 128 procedures.
   d. Test GFRC inserts and anchors according to ASTM C 1230 to validate design values.
   e. Produce test boards at a rate not less than one per work shift per operator for each spray machine and for each mix design.
      1) For each test board, determine glass-fiber content according to ASTM C 1229, and flexural yield and ultimate strength according to ASTM C 947.

1.3 EXECUTION

A. Examination
1. Examine structure and conditions for compliance with requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance of the Work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Erection
1. Install clips, hangers, and other accessories required for connecting GFRC panels to supporting members and backup materials.
2. Lift GFRC panels and install without damage.
3. Install GFRC panels level, plumb, square, and in alignment. Provide temporary supports and bracing as required to maintain position, stability, and alignment of panels until permanent connections are completed.
   a. Maintain horizontal and vertical joint alignment and uniform joint width.
   b. Remove projecting hoisting devices.
4. Connect GFRC panels in position by bolting or welding, or both, as indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as possible after connecting is completed.
5. Welding: Comply with applicable AWS D1.1/D1.1M and AWS D1.3 requirements for welding, appearance, quality of welds, and methods used in correcting welding work.
   a. Protect GFRC panels from damage by field welding or cutting operations, and provide noncombustible shields as required.
6. At bolted connections, use lock washers or other acceptable means to prevent loosening of nuts.

C. Erection Tolerances
1. Erect GFRC panels to comply with the following noncumulative tolerances:
   a. Plan Location from Building Grid Datum: Plus or minus 1/2 inch (13 mm).
   b. Top Elevation from Nominal Top Elevation: As follows:
      1) Exposed Individual Panel: Plus or minus 1/4 inch (6 mm).
      2) Nonexposed Individual Panel: Plus or minus 1/2 inch (13 mm).
      3) Exposed Panel Relative to Adjacent Panel: 1/4 inch (6 mm).
      4) Nonexposed Panel Relative to Adjacent Panel: 1/2 inch (13 mm).
   c. Support Elevation from Nominal Elevation: As follows:
      1) Maximum Low: 1/2 inch (13 mm).
      2) Maximum High: 1/4 inch (6 mm).
   d. Maximum Plumb Variation over the Lesser of Height of Structure or 100 Feet (30 m): 1 inch (25 mm).
   e. Plumb in Any 10 Feet (3 m) of Element Height: 1/4 inch (6 mm).
   f. Maximum Jog in Alignment of Matching Edges: 1/4 inch (6 mm).
   g. Maximum Jog in Alignment of Matching Faces: 1/4 inch (6 mm).

h. Face Width of Joint: As follows (governs over joint taper):
   1) Panel Dimension 20 Feet (6 m) or Less: Plus or minus 1/4 inch (6 mm).
   2) Panel Dimension More Than 20 Feet (6 m): Plus or minus 5/16 inch (8 mm).
i. Maximum Joint Taper: 3/8 inch (10 mm).
j. Joint Taper in 10 Feet (3 m): 1/4 inch (6 mm).
k. Differential Bowing, as Erected, between Adjacent Members of Same Design: 1/4 inch (6 mm).

D. Repairs
1. Repairs will be permitted provided structural adequacy of GFRC panel and appearance are not impaired, as approved by the Owner.
2. Mix patching materials and repair GFRC so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces.
3. Prepare and repair accessible damaged galvanized coatings with galvanizing repair paint according to ASTM A 780.
4. Wire brush, clean, and paint accessible weld areas on prime-painted components with same type of shop primer.
5. Remove and replace damaged GFRC panels when repairs do not comply with requirements.

E. Cleaning And Protection
1. Perform cleaning procedures, if necessary, according to GFRC manufacturer's written instructions. Clean soiled GFRC surfaces with detergent and water, using soft fiber brushes and sponges, and rinse with clean water. Prevent damage to GFRC surfaces and staining of adjacent materials.

END OF SECTION 03 37 13 00a

Task	Specification	Specification Description
03 37 16 00	03 05 13 00	Cast-In-Place Concrete
03 37 16 00	03 11 16 13a	Cast-In-Place Architectural Concrete
03 39 13 00	03 11 16 13a	Cast-In-Place Architectural Concrete
03 39 23 23	03 05 13 00	Cast-In-Place Concrete

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SECTION 03 41 16 00 - PRECAST LIGHWEIGHT ROOF SLABS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of precast lightweight roof deck concrete channels, concrete planks, and gypsum planks. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCTS

A. Channel Slabs: Slabs shall be composed of Portland cement and lightweight aggregate with minimum compressive strength 3,750 psi. Legs shall be reinforced with deformed bars; web shall have welded wire fabric reinforcement. Channels shall support a 30 psf live load plus a 20 psf superimposed dead load.

B. Concrete Planks: Planks shall be composed of Portland cement and lightweight aggregate with a minimum compressive strength of 3,750 psi. Planks shall be reinforced with welded wire fabric. Planks shall support a 30 psf live load plus a 20 psf superimposed dead load.

C. Gypsum Planks shall conform to ASTM C 956, factory-laminated to 2-inch thickness, 2-foot wide panels. Planks shall be continuously supported along sides.

D. Subpurlins shall be bulb-ties, ASTM A 440.

E. Grout shall be lightweight concrete or gypsum concrete.

1.3 EXECUTION

A. Concrete Channels and Planks shall be securely attached to support steel or concrete by metal clips or other approved attachments; minimum support bearing shall be 4 inches. Open joints between channels or planks shall be filled with lightweight concrete grout. Planks with tongue and groove edges may not require grouting.

B. Gypsum Planks shall be snugly fit between bulb-tee subpurlins. Subpurlins shall be tack-welded or screw-attached to supporting steel or weld bar cast in supporting concrete. Joints at bulb-tees shall be grouted with gypsum grout.

END OF SECTION 03 41 16 00

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SECTION 03 41 23 00 - PLANT-PRECAST STRUCTURAL CONCRETE

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for plant-precast structural concrete. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Precast structural concrete.
      b. Precast structural concrete with thin-brick or stone facings.
      c. Precast structural concrete with commercial architectural finish.

C. Definition
   1. Design Reference Sample: Sample of approved precast structural concrete color, finish, and texture, preapproved by the Owner.

D. Performance Requirements
   1. Delegated Design: Design precast structural concrete, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
   2. Structural Performance: Precast structural concrete units and connections shall withstand design loads indicated within limits and under conditions indicated.
      a. Fire-Resistance Rating: Select material and minimum thicknesses to provide indicated fire rating.

E. Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittals:
      a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
         1) Include statement indicating costs for each product having recycled content.
      b. Design Mixtures for Credit ID 1.1: For each concrete mixture containing fly ash as a replacement for portland cement or other portland cement replacements and for equivalent concrete mixtures that do not contain portland cement replacements.
   3. Design Mixtures: For each precast concrete mixture. Include compressive strength and water-absorption tests.
   4. Shop Drawings: Include member locations, plans, elevations, dimensions, shapes and sections, openings, support conditions, and types of reinforcement, including special reinforcement. Detail fabrication and installation of precast structural concrete units.
   5. Delegated-Design Submittal: For precast structural concrete indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   6. Qualification Data: For Installer **OR** fabricator **OR** testing agency, **as directed**.
   7. Welding certificates.
   8. Material Certificates.
   9. Material Test Reports.
   10. Source quality-control reports.
   11. Field quality-control and special inspection, **as directed**, reports.

F. Quality Assurance
1. Fabricator Qualifications: A firm that assumes responsibility for engineering precast structural concrete units to comply with performance requirements. Responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
   a. Participates in PCI's Plant Certification program and is designated a PCI-certified plant as follows:
      1) Group C, Category C1 - Precast Concrete Products (no prestressed reinforcement) **OR** Category C2 - Prestressed Hollowcore and Repetitively Produced Products **OR** Category C3 - Prestressed Straight Strand Structural Members **OR** Category C4 - Prestressed Deflected Strand Structural Members, **as directed**.
      2) Group CA, Category C1A - Precast Concrete Products (no prestressed reinforcement) **OR** Category C2A - Prestressed Hollowcore and Repetitively Produced Products **OR** Category C3A - Prestressed Straight-Strand Structural Members **OR** Category C4A - Prestressed Deflected-Strand Structural Members, **as directed**.
2. Design Standards: Comply with ACI 318 (ACI 318M) and design recommendations in PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete," applicable to types of precast structural concrete units indicated.
3. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Structural Precast Concrete Products."
4. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D.1.1M, "Structural Welding Code - Steel."
   b. AWS D1.4, "Structural Welding Code - Reinforcing Steel."
5. Fire-Resistance Calculations: Where indicated, provide precast structural concrete units whose fire resistance meets the prescriptive requirements of authorities having jurisdiction or has been calculated according to ACI 216.1/TMS 0216.1, "Standard Method for Determining Fire Resistance of Concrete and Masonry Construction Assemblies," **OR** PCI MNL 124, "Design for Fire Resistance of Precast Prestressed Concrete," **as directed**, and is acceptable to authorities having jurisdiction.
6. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Support units during shipment on nonstaining shock-absorbing material in same position as during storage.
2. Store units with adequate bracing and protect units to prevent contact with soil, to prevent staining, and to prevent cracking, distortion, warping or other physical damage.
   a. Store units with dunnage across full width of each bearing point unless otherwise indicated.
   b. Place adequate dunnage of even thickness between each unit.
   c. Place stored units so identification marks are clearly visible, and units can be inspected.
3. Handle and transport units in a position consistent with their shape and design in order to avoid excessive stresses that would cause cracking or damage.
4. Lift and support units only at designated points shown on Shop Drawings.

H. Coordination
1. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction before starting that Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.

1.2 PRODUCTS

A. Mold Materials

1. Molds: Rigid, dimensionally stable, non-absorptive material, warp and buckle free, that will provide continuous and true precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and suitable for producing required finishes.
   a. Mold-Release Agent: Commercially produced liquid-release agent that will not bond with, stain or adversely affect precast concrete surfaces and will not impair subsequent surface or joint treatments of precast concrete.
2. Form Liners: Units of face design, texture, arrangement, and configuration indicated **OR** to match those used for precast concrete design reference sample, **as directed**. Furnish with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect precast concrete surfaces and will not impair subsequent surface or joint treatments of precast concrete.
3. Surface Retarder: Chemical set retarder, capable of temporarily delaying final hardening of newly placed concrete mixture to depth of reveal specified.

B. Reinforcing Materials
1. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 **OR** 60, **as directed**, percent.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
3. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
4. Galvanized Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized, and chromate wash treated after fabrication and bending, **as directed**.
5. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, ASTM A 775/A 775M **OR** ASTM A 934/A 934M, **as directed**, epoxy coated, with less than 2 percent damaged coating in each 12-inch (300-mm) bar length.
6. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, assembled with clips.
7. Plain-Steel Welded Wire Reinforcement: ASTM A 1064, fabricated from as-drawn steel **OR** galvanized-steel, **as directed**, wire into flat sheets.
8. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.
9. Epoxy-Coated-Steel Wire: ASTM A 884/A 884M, Class A coated, plain **OR** deformed, **as directed**, flat sheet, Type 1 bendable **OR** Type 2 nonbendable, **as directed**, coating.
10. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 116.

C. Prestressing Tendons
1. Pretensioning Strand: ASTM A 416/A 416M, Grade 250 (Grade 1720) or Grade 270 (Grade 1860), uncoated, 7-wire **OR** ASTM A 886/A 886M, Grade 270 (Grade 1860), indented, 7-wire, **as directed**, low-relaxation strand.
2. Unbonded Post-Tensioning Strand: ASTM A 416/A 416M, Grade 270 (Grade 1860), uncoated, 7-wire, low-relaxation strand.
   a. Coat unbonded post-tensioning strand with post-tensioning coating complying with ACI 423.6 and sheath with polypropylene tendon sheathing complying with ACI 423.6. Include anchorage devices and coupler assemblies.
3. Post-Tensioning Bars: ASTM A 722, uncoated high-strength steel bar.

D. Concrete Materials
1. Portland Cement: ASTM C 150, Type I or Type III, gray, unless otherwise indicated.
   a. For surfaces exposed to view in finished structure, mix gray with white cement, of same type, brand, and mill source.
2. Supplementary Cementitious Materials:
   a. Fly Ash: ASTM C 618, Class C or F, with maximum loss on ignition of 3 percent.
   b. Metakaolin Admixture: ASTM C 618, Class N.

c. Silica Fume Admixture: ASTM C 1240, with optional chemical and physical requirement.
d. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

3. Normal-Weight Aggregates: Except as modified by PCI MNL 116, ASTM C 33, with coarse aggregates complying with Class 5S **OR** Class 5M **OR** Class 4S **OR** Class 4M, **as directed**. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.
   a. Face-Mixture-Coarse Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining; to match selected finish sample.
      1) Gradation: Uniformly graded **OR** Gap graded **OR** To match design reference sample, **as directed**.
   b. Face-Mixture-Fine Aggregates: Selected, natural or manufactured sand of same material as coarse aggregate unless otherwise approved by the Owner.
4. Lightweight Aggregates: Except as modified by PCI MNL 116, ASTM C 330, with absorption less than 11 percent.
5. Coloring Admixture: ASTM C 979, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable, and nonfading.
6. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 116.
7. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
8. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.
   a. Water-Reducing Admixtures: ASTM C 494/C 494M, Type A.
   b. Retarding Admixture: ASTM C 494/C 494M, Type B.
   c. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
   d. Water-Reducing and Accelerating Admixture: ASTM C 494/C 494M, Type E.
   e. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
   f. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
   g. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M.
9. Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

E. Steel Connection Materials
1. Carbon-Steel Shapes and Plates: ASTM A 36/A 36M.
2. Carbon-Steel-Headed Studs: ASTM A 108, AISI 1018 through AISI 1020, cold finished, AWS D1.1/D1.1M, Type A or B, with arc shields and with minimum mechanical properties of PCI MNL 116.
3. Carbon-Steel Plate: ASTM A 283/A 283M.
4. Malleable-Iron Castings: ASTM A 47/A 47M.
5. Carbon-Steel Castings: ASTM A 27/A 27M, Grade 60-30 (Grade 415-205).
6. High-Strength, Low-Alloy Structural Steel: ASTM A 572/A 572M.
7. Carbon-Steel Structural Tubing: ASTM A 500, Grade B.
8. Wrought Carbon-Steel Bars: ASTM A 675/A 675M, Grade 65 (Grade 450).
9. Deformed-Steel Wire or Bar Anchors: ASTM A 496 or ASTM A 706/A 706M.
10. Carbon-Steel Bolts and Studs: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); carbon-steel, hex-head bolts and studs; carbon-steel nuts, ASTM A 563 (ASTM A 563M); and flat, unhardened steel washers, ASTM F 844.
11. High-Strength Bolts and Nuts: ASTM A 325 (ASTM A 325M) or ASTM A 490 (ASTM A 490M), Type 1, heavy hex steel structural bolts; heavy hex carbon-steel nuts, ASTM A 563 (ASTM A 563M); and hardened carbon-steel washers, ASTM F 436 (ASTM F 436M).
    a. Do not zinc coat ASTM A 490 (ASTM A 490M) bolts.
12. Zinc-Coated Finish: For exterior steel items, steel in exterior walls, **as directed**, and items indicated for galvanizing, apply zinc coating by hot-dip process according to ASTM A 123/A 123M

or ASTM A 153/A 153M **OR** electrodeposition according to ASTM B 633, SC 3, Types 1 and 2, **as directed**.

a. For steel shapes, plates, and tubing to be galvanized, limit silicon content of steel to less than 0.03 percent or to between 0.15 and 0.25 percent or limit sum of silicon and 2.5 times phosphorous content to 0.09 percent.

b. Galvanizing Repair Paint: High-zinc-dust-content paint with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035B or SSPC-Paint 20.

13. Shop-Primed Finish: Prepare surfaces of nongalvanized-steel items, except those surfaces to be embedded in concrete, according to requirements in SSPC-SP 3, and shop apply lead- and chromate-free, rust-inhibitive primer, complying with performance requirements in MPI 79 **OR** SSPC-Paint 25, **as directed**, according to SSPC-PA 1.
14. Welding Electrodes: Comply with AWS standards.
15. Precast Accessories: Provide clips, hangers, plastic or steel shims, and other accessories required to install precast structural concrete units.

F. Stainless-Steel Connection Materials

1. Stainless-Steel Plate: ASTM A 666, Type 304, of grade suitable for application.
2. Stainless-Steel Bolts and Studs: ASTM F 593, Alloy 304 or 316, hex-head bolts and studs; stainless-steel nuts; and flat, stainless-steel washers. Lubricate threaded parts of stainless-steel bolts with an antiseize thread lubricant during assembly.
3. Stainless-Steel-Headed Studs: ASTM A 276, with minimum mechanical properties of PCI MNL 116.

G. Bearing Pads

1. Provide one of the following bearing pads for precast structural concrete units as recommended by precast fabricator for application, **as directed**:

a. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, 50 to 70 Shore, Type A durometer hardness, ASTM D 2240; minimum tensile strength 2250 psi (15.5 MPa), ASTM D 412.

b. Random-Oriented, Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer. 70 to 90 Shore, Type A durometer hardness, ASTM D 2240; capable of supporting a compressive stress of 3000 psi (20.7 MPa) with no cracking, splitting, or delaminating in the internal portions of pad. Test 1 specimen for every 200 pads used in Project.

c. Cotton-Duck-Fabric-Reinforced Elastomeric Pads: Preformed, horizontally layered cotton-duck fabric bonded to an elastomer; 80 to 100 Shore, Type A durometer hardness, ASTM D 2240; complying with AASHTO's "AASHTO Load and Resistance Factor Design (LRFD) Bridge Specifications," Division II, Section 18.10.2; or with MIL-C-882E.

d. Frictionless Pads: Tetrafluoroethylene, glass-fiber reinforced, bonded to stainless- or mild-steel plate, of type required for in-service stress.

e. High-Density Plastic: Multimonomer, nonleaching, plastic strip.

H. Grout Materials

1. Sand-Cement Grout: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 144 or ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
2. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, Grade A for drypack and Grades B and C for flowable grout and of consistency suitable for application within a 30-minute working time.
3. Epoxy-Resin Grout: Two-component, mineral-filled epoxy resin; ASTM C 881/C 881M, of type, grade, and class to suit requirements.

I. Thin-Brick Units And Accessories

1. Thin-Brick Units: ASTM C 216, Type FBX or ASTM C 1088, Grade Exterior, Type TBX, not less than 1/2 inch (13 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick with a tolerance of plus or minus 1/16 inch (1.6 mm), and as follows:
   a. Face Color and Texture: Match the Owner's samples **OR** Medium brown, wire cut **OR** Full-range red, sand molded **OR** Gray, velour, **as directed**.
   b. Face Size:
      1) 2-1/4 inches (57 mm) high by 8 inches (203 mm) long.
      2) 2-1/4 inches (57 mm) high by 7-1/2 to 7-5/8 inches (190 to 194 mm) long.
      3) 2-3/4 to 2-13/16 inches (70 to 71 mm) high by 7-1/2 to 7-5/8 inches (190 to 194 mm) long.
      4) 3-1/2 to 3-5/8 inches (89 to 92 mm) high by 7-1/2 to 7-5/8 inches (190 to 194 mm) long.
      5) 3-1/2 to 3-5/8 inches (89 to 92 mm) high by 11-1/2 to 11-5/8 inches (292 to 295 mm) long.
   c. Where indicated to "match existing," provide thin brick matching color, texture, and face size of existing adjacent brick work.
   d. Face Size:
      1) 57 mm high by 190 mm long.
      2) 70 mm high by 190 mm long.
      3) 90 mm high by 190 mm long.
      4) 90 mm high by 290 mm long.
   e. Special Shapes: Include corners, edge corners, and end edge corners.
   f. Initial Rate of Absorption: Less than 30 g/30 sq. in. (30 g/194 sq. cm) per minute; ASTM C 67.
   g. Efflorescence: Tested according to ASTM C 67 and rated "not effloresced."
   h. Surface Coating: Thin brick with colors or textures applied as coatings shall withstand 50 cycles of freezing and thawing; ASTM C 67 with no observable difference in applied finish when viewed from 10 feet (3 m).
   i. Back Surface Texture: Scored, combed, wire roughened, ribbed, keybacked, or dovetailed.
2. Sand-Cement Mortar: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 144. Mix at ratio of 1 part cement to 4 parts sand, by volume, with minimum water required for placement.
3. Latex-Portland Cement Pointing Grout: ANSI A118.6 and as follows:
   a. Dry-grout mixture, factory prepared, of portland cement, graded aggregate, and dry, redispersible, ethylene-vinyl-acetate additive for mixing with water; uniformly colored.
   b. Commercial portland cement grout, factory prepared, with liquid styrene-butadiene rubber or acrylic-resin latex additive; uniformly colored.
   c. Colors: As indicated by manufacturer's designations **OR** Match the Owner's samples **OR** As selected by the Owner from manufacturer's full range, **as directed**.

J. Stone Materials And Accessories
1. Stone facing for precast structural concrete is specified in Division 04 Section "Exterior Stone Cladding".
2. Anchors: Stainless steel, ASTM A 666, Type 304, of temper and diameter required to support loads without exceeding allowable design stresses.
   a. Fit each anchor leg with neoprene grommet collar of width at least twice the diameter and of length at least five times the diameter of anchor.
3. Sealant Filler: ASTM C 920, low-modulus, multicomponent, nonsag urethane sealant complying with requirements in Division 07 Section "Joint Sealants" and that is nonstaining to stone substrate.
4. Epoxy Filler: ASTM C 881/C 881M, 100 percent solids, sand-filled nonshrinking, nonstaining of type, class, and grade to suit application.
   a. Elastomeric Anchor Sleeve: 1/2 inch (13 mm) long; 60 Shore, Type A durometer hardness; ASTM D 2240.

5. Bond Breaker: Preformed, compressible, resilient, nonstaining, nonwaxing, closed-cell polyethylene foam pad, nonabsorbent to liquid and gas, 1/8 inch (3.2 mm) thick **OR** Polyethylene sheet, ASTM D 4397, 6 to 10 mils (0.15 to 0.25 mm) thick, **as directed**.

K. Insulated Flat Wall Panel Accessories
1. Molded-Polystyrene Board Insulation: ASTM C 578, Type I, 0.90 lb/cu. ft. (15 kg/cu. m) **OR** Type VIII, 1.15 lb/cu. ft. (18 kg/cu. m) **OR** Type II, 1.35 lb/cu. ft. (22 kg/cu. m), **as directed**; square **OR** ship-lap, **as directed**, edges; with R-value and thickness as directed by the Owner.
2. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.60 lb/cu. ft. (26 kg/cu. m) **OR** Type X, 1.30 lb/cu. ft. (21 kg/cu. m) **OR** Type VI, 1.80 lb/cu. ft. (29 kg/cu. m), **as directed**; square **OR** ship-lap, **as directed**, edges; with R-value and thickness as directed by the Owner.
3. Polyisocyanurate Board Insulation: ASTM C 591, Type I, 1.8 lb/cu. ft. (29 kg/cu. m) **OR** Type IV, 2 lb/cu. ft. (32 kg/cu. m) **OR** Type II, 2.5 lb/cu. ft. (40 kg/cu. m), **as directed**, unfaced, with R-value and thickness as directed by the Owner.
4. Wythe Connectors: Glass-fiber connectors **OR** Vinyl-ester polymer connectors **OR** Polypropylene pin connectors **OR** Stainless-steel pin connectors **OR** Bent galvanized reinforcing bars **OR** Galvanized welded wire trusses **OR** Galvanized bent wire connectors **OR** Cylindrical metal sleeve anchors, **as directed**, manufactured to connect wythes of precast concrete panels.

L. Concrete Mixtures
1. Prepare design mixtures for each type of precast concrete required.
   a. Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
   b. Limit use of fly ash to 25 percent replacement of portland cement by weight and granulated blast-furnace slag to 40 percent of portland cement by weight; metakaolin and silica fume to 10 percent of portland cement by weight.
2. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at precast structural concrete fabricator's option.
3. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 318 (ACI 318M) or PCI MNL 116 when tested according to ASTM C 1218/C 1218M.
4. Normal-Weight Concrete Mixtures: Proportion face mixtures **OR** face and backup mixtures **OR** full-depth mixture, **as directed,** by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:
   a. Compressive Strength (28 Days): 5000 psi (34.5 MPa).
   b. Maximum Water-Cementitious Materials Ratio: 0.45.
5. Water Absorption: 6 percent by weight or 14 percent by volume, tested according to PCI MNL 116.
6. Lightweight Concrete Backup Mixtures: Proportion mixtures by either laboratory trial batch or field test data methods according to ACI 211.2, with materials to be used on Project, to provide lightweight concrete with the following properties:
   a. Compressive Strength (28 Days): 5000 psi (34.5 MPa).
   b. Unit Weight: Calculated equilibrium unit weight of 115 lb/cu. ft. (1842 kg/cu. m), plus or minus 3 lb/cu. ft. (48 kg/cu. m), according to ASTM C 567.
7. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 116.
8. When included in design mixtures, add other admixtures to concrete mixtures according to manufacturer's written instructions.
9. Concrete Mix Adjustments: Concrete mix design adjustments may be proposed if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

M. Mold Fabrication
1. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes and for prestressing and

detensioning operations. Coat contact surfaces of molds with release agent before reinforcement is placed. Avoid contamination of reinforcement and prestressing tendons by release agent.

a. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and supports to maintain stability of liners during concrete placement. Coat form liner with form-release agent.

2. Maintain molds to provide completed precast structural concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.
   a. Form joints are not permitted on faces exposed to view in the finished work.
   b. Edge and Corner Treatment: Uniformly chamfered **OR** radiused, **as directed**.

N. Thin-Brick Facings
1. Place form-liner templates accurately to provide grid for thin-brick facings. Provide solid backing and supports to maintain stability of liners while placing thin bricks and during concrete placement.
2. Securely place thin-brick units face down into form-liner pockets and place concrete backing mixture.
3. Completely fill joint cavities between thin-brick units with sand-cement mortar, and place precast concrete backing mixture while sand-cement mortar is still fluid enough to ensure bond.
4. Mix and install pointing grout according to ANSI A108.10. Completely fill joint cavities between thin-brick units with pointing grout, and compress into place without spreading pointing grout onto faces of thin-brick units. Remove excess pointing grout immediately to prevent staining of brick.
   a. Tool joints to a slightly concave shape **OR** grapevine shape **OR** V-shape, **as directed**, when pointing grout is thumbprint hard.
5. Clean faces and joints of brick facing.

O. Stone Facings
1. Clean stone surfaces before placing in molds to remove soil, stains, and foreign materials. Use cleaning methods and materials recommended by stone supplier.
2. Accurately position stone facings to comply with requirements and in locations indicated on Shop Drawings. Install anchors, supports, and other attachments indicated or necessary to secure stone in place. Keep concrete reinforcement a minimum of 3/4 inch (19 mm) from the back surface of stone. Use continuous spacers to obtain uniform joints of widths indicated and with edges and faces aligned according to established relationships and indicated tolerances.
   a. Stone to Precast Anchorages: Provide anchors in numbers, types and locations required to satisfy specified performance criteria, but not less than 2 anchors per stone unit of less than 2 sq. ft. (0.19 sq. m) in area and 4 anchors per unit of less than 12 sq. ft. (1.1 sq. m) in area; for units larger than 12 sq. ft. (1.1 sq. m) in area, provide anchors spaced not more than 24 inches (600 mm) o.c. horizontally and vertically. Locate anchors a minimum of 6 inches (150 mm) from stone edge.
3. Fill anchor holes with sealant filler and install anchors **OR** epoxy filler and install anchors with elastomeric anchor sleeve at back surface of stone, **as directed**.
   a. Install polyethylene sheet to prevent bond between back of stone facing and concrete substrate and to ensure no passage of precast matrix to stone surface.
   b. Install 1/8-inch (3-mm) polyethylene-foam bond breaker to prevent bond between back of stone facing and concrete substrate and to ensure no passage of precast matrix to stone surface. Maintain minimum projection requirements of stone anchors into concrete substrate.

P. Fabrication
1. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.

a. Weld-headed studs and deformed bar anchors used for anchorage according to AWS D1.1/D1.1M and AWS C5.4, "Recommended Practices for Stud Welding."
2. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing precast structural concrete units to supporting and adjacent construction.
3. Cast-in reglets, slots, holes, and other accessories in precast structural concrete units as indicated on the Contract Drawings.
4. Cast-in openings larger than 10 inches (250 mm) in any dimension. Do not drill or cut openings or prestressing strand without the Owner's approval.
5. Reinforcement: Comply with recommendations in PCI MNL 116 for fabricating, placing, and supporting reinforcement.
   a. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete. When damage to epoxy-coated reinforcement exceeds limits specified, repair with patching material compatible with coating material and epoxy coat bar ends after cutting.
   b. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.
   c. Place reinforcement to maintain at least 3/4-inch (19-mm) minimum coverage. Increase cover requirements according to ACI 318 (ACI 318M) when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
   d. Place reinforcing steel and prestressing strand to maintain at least 3/4-inch (19-mm) minimum concrete cover. Increase cover requirements for reinforcing steel to 1-1/2 inches (38 mm) when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
   e. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh spacing and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.
6. Reinforce precast structural concrete units to resist handling, transportation, and erection stresses.
7. Prestress tendons for precast structural concrete units by either pretensioning or post-tensioning methods. Comply with PCI MNL 116.
   a. Delay detensioning or post-tensioning of precast, prestressed structural concrete units until concrete has reached its indicated minimum design release compressive strength as established by test cylinders cured under same conditions as concrete.
   b. Detension pretensioned tendons either by gradually releasing tensioning jacks or by heat cutting tendons, using a sequence and pattern to prevent shock or unbalanced loading.
   c. If concrete has been heat cured, detension while concrete is still warm and moist to avoid dimensional changes that may cause cracking or undesirable stresses.
   d. Protect strand ends and anchorages with bituminous, zinc-rich, or epoxy paint to avoid corrosion and possible rust spots.
   e. Protect strand ends and anchorages with a minimum of 1-inch- (25-mm-) thick, nonmetallic, nonshrink, grout mortar and sack rub surface. Coat or spray the inside surfaces of pocket with bonding agent before installing grout.
8. Comply with requirements in PCI MNL 116 and in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.
9. Place face mixture to a minimum thickness after consolidation of the greater of 1 inch (25 mm) or 1.5 times the maximum aggregate size, but not less than the minimum reinforcing cover specified.
10. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast concrete units.
    a. Place backup concrete mixture to ensure bond with face-mixture concrete.

11. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air on surfaces. Use equipment and procedures complying with PCI MNL 116.
    a. Place self-consolidating concrete without vibration according to PCI TR-6, "Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants."
12. Comply with ACI 306.1 procedures for cold-weather concrete placement.
13. Comply with PCI MNL 116 procedures for hot-weather concrete placement.
14. Identify pickup points of precast structural concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast structural concrete unit on a surface that will not show in finished structure.
15. Cure concrete, according to requirements in PCI MNL 116, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.
16. Discard and replace precast structural concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 116 and meet the Owner's approval.

Q. Casting Insulated Wall Panels
1. Cast and screed wythe supported by mold.
2. Place insulation boards abutting edges and ends of adjacent boards. Insert wythe connectors through insulation, and consolidate concrete around connectors according to connector manufacturer's written instructions.
3. Cast and screed top wythe to meet required finish.

R. Fabrication Tolerances
1. Fabricate precast structural concrete units straight and true to size and shape with exposed edges and corners precise and true so each finished unit complies with PCI MNL 116 product dimension tolerances.
2. Brick-Faced Precast Structural Concrete Units: Restrict the following misalignments to 2 percent of number of bricks in a unit:
    a. Alignment of Mortar Joints:
        1) Jog in Alignment: 1/8 inch (3 mm).
        2) Alignment with Panel Centerline: Plus or minus 1/8 inch (3 mm).
    b. Variation in Width of Exposed Mortar Joints: Plus or minus 1/8 inch (3 mm).
    c. Tipping of Individual Bricks from the Panel Plane of Exposed Brick Surface: Plus 1/16 inch (1.6 mm); minus 1/4 inch (6 mm) less than or equal to depth of form-liner joint.
    d. Exposed Brick Surface Parallel to Primary Control Surface of Panel: Plus 1/4 inch (6 mm); minus 1/8 inch (3 mm).
    e. Individual Brick Step in Face from Panel Plane of Exposed Brick Surface: Plus 1/16 inch (1.6 mm); minus 1/4 inch (6 mm) less than or equal to depth of form-liner joint.
3. Stone Veneer-Faced Precast Structural Concrete Units:
    a. Variation in Cross-Sectional Dimensions: For thickness of walls from dimensions indicated: Plus or minus 1/4 inch (6 mm).
    b. Variation in Joint Width: 1/8 inch in 36 inches (3 mm in 900 mm) or a quarter of nominal joint width, whichever is less.
    c. Variation in Plane between Adjacent Stone Units (Lipping): 1/16-inch (1.6-mm) difference between planes of adjacent units.

S. Commercial Finishes
1. Commercial Grade: Remove fins and large protrusions and fill large holes. Rub or grind ragged edges. Faces must have true, well-defined surfaces. Air holes, water marks, and color variations are permitted. Limit form joint offsets to 3/16 inch (5 mm).

2. Standard Grade: Normal plant-run finish produced in molds that impart a smooth finish to concrete. Surface holes smaller than 1/2 inch (13 mm) caused by air bubbles, normal color variations, form joint marks, and minor chips and spalls are permitted. Fill air holes greater than 1/4 inch (6 mm) in width that occur more than once per 2 sq. in (1300 sq. mm). Major or unsightly imperfections, honeycombs, or structural defects are not permitted. Limit joint offsets to 1/8 inch (3 mm).
3. Grade B Finish: Fill air pockets and holes larger than 1/4 inch (6 mm) in diameter with sand-cement paste matching color of adjacent surfaces. Fill air holes greater than 1/8 inch (3 mm) in width that occur more than once per 2 sq. in. (1300 sq. mm). Grind smooth form offsets or fins larger than 1/8 inch (3 mm). Repair surface blemishes due to holes or dents in molds. Discoloration at form joints is permitted.
4. Grade A Finish: Fill surface blemishes with the exception of air holes 1/16 inch (1.6 mm) in width or smaller, and form marks where the surface deviation is less than 1/16 inch (1.6 mm). Float apply a neat cement-paste coating to exposed surfaces. Rub dried paste coat with burlap to remove loose particles. Discoloration at form joints is permitted. Grind smooth all form joints.
5. Screed or float finish unformed surfaces. Strike off and consolidate concrete with vibrating screeds to a uniform finish. Hand screed at projections. Normal color variations, minor indentations, minor chips, and spalls are permitted. Major imperfections, honeycombing, or defects are not permitted.
6. Smooth, steel trowel finish unformed surfaces. Consolidate concrete, bring to proper level with straightedge, float, and trowel to a smooth, uniform finish.
7. Apply roughened surface finish according to ACI 318 (ACI 318M) to precast concrete units that will receive concrete topping after installation.

T. Commercial Architectural Finishes
1. Manufacture member faces free of joint marks, grain, and other obvious defects with corners, including false joints, uniform, straight, and sharp. Finish exposed-face surfaces of precast concrete units to match approved design reference sample **OR** sample panels, **as directed**, and as follows:
   a. PCI's "Architectural Precast Concrete - Color and Texture Selection Guide," of plate numbers indicated.
   b. Smooth-Surface Finish: Provide surfaces free of excessive air voids, sand streaks, and honeycombs, with uniform color and texture.
   c. Textured-Surface Finish: Impart by form liners or inserts to provide surfaces free of pockets, streaks, and honeycombs, with uniform color and texture.
   d. Bushhammer Finish: Use power or hand tools to remove matrix and fracture coarse aggregates.
   e. Exposed-Aggregate Finish: Use chemical-retarding agents applied to concrete molds and washing and brushing procedures to expose aggregate and surrounding matrix surfaces after form removal.
   f. Abrasive-Blast Finish: Use abrasive grit, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces.
   g. Acid-Etched Finish: Use acid and hot-water solution, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces. Protect hardware, connections, and insulation from acid attach.
   h. Honed Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
   i. Polished Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
   j. Sand-Embedment Finish: Use selected stones placed in a sand bed in bottom of mold, with sand removed after curing.

U. Source Quality Control
1. Testing: Test and inspect precast structural concrete according to PCI MNL 116 requirements.
   a. Test and inspect self-consolidating concrete according to PCI TR-6.

2. Strength of precast structural concrete units will be considered deficient if units fail to comply with ACI 318 (ACI 318M) requirements for concrete strength.
3. If there is evidence that strength of precast concrete units may be deficient or may not comply with ACI 318 (ACI 318M) requirements, employ a qualified testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C 42/C 42M.
   a. A minimum of three representative cores will be taken from units of suspect strength, from locations directed by the Owner.
   b. Cores will be tested in an air-dry condition or, if units will be wet under service conditions, test cores after immersion in water in a wet condition.
   c. Strength of concrete for each series of 3 cores will be considered satisfactory if average compressive strength is equal to at least 85 percent of 28-day design compressive strength and no single core is less than 75 percent of 28-day design compressive strength.
   d. Test results will be made in writing on same day that tests are performed, with copies to the Owner, Contractor, and precast concrete fabricator. Test reports will include the following:
      1) Project identification name and number.
      2) Date when tests were performed.
      3) Name of precast concrete fabricator.
      4) Name of concrete testing agency.
      5) Identification letter, name, and type of precast concrete unit(s) represented by core tests; design compressive strength; type of break; compressive strength at breaks, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.
4. Patching: If core test results are satisfactory and precast structural concrete units comply with requirements, clean and dampen core holes and solidly fill with same precast concrete mixture that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.
5. Defective Units: Discard and replace precast structural concrete units that do not comply with requirements, including strength, manufacturing tolerances, and color and texture range. Chipped, spalled, or cracked units may be repaired, subject to the Owner's approval. the Owner reserves the right to reject precast units that do not match approved samples and sample panels.

1.3 EXECUTION

A. Installation
1. Install clips, hangers, bearing pads, and other accessories required for connecting precast structural concrete units to supporting members and backup materials.
2. Erect precast structural concrete level, plumb, and square within specified allowable tolerances. Provide temporary structural framing, supports, and bracing as required to maintain position, stability, and alignment of units until permanent connection.
   a. Install temporary steel or plastic spacing shims or bearing pads as precast structural concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.
   b. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
   c. Remove projecting lifting devices and grout fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.
   d. For hollow-core slab voids used as electrical raceways or mechanical ducts, align voids between units and tape butt joint at end of slabs.
3. Connect precast structural concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.
   a. Do not permit connections to disrupt continuity of roof flashing.
4. Field cutting of precast units is not permitted without approval of the the Owner.

5. Fasteners: Do not use drilled or powder-actuated fasteners for attaching accessory items to precast, prestressed concrete units.
6. Welding: Comply with applicable AWS D1.1/D1.1M and AWS D1.4 for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.
    a. Protect precast structural concrete units and bearing pads from damage by field welding or cutting operations, and provide noncombustible shields as required.
    b. Clean weld-affected steel surfaces with chipping hammer followed by brushing, and apply a minimum 4.0-mil- (0.1-mm-) thick coat of galvanized repair paint to galvanized surfaces according to ASTM A 780.
    c. Clean weld-affected steel surfaces with chipping hammer followed by brushing, and reprime damaged painted surfaces.
    d. Remove, reweld, or repair incomplete and defective welds.
7. At bolted connections, use lock washers, tack welding, or other approved means to prevent loosening of nuts after final adjustment.
    a. Where slotted connections are used, verify bolt position and tightness. For sliding connections, properly secure bolt but allow bolt to move within connection slot. For friction connections, apply specified bolt torque and check 25 percent of bolts at random by calibrated torque wrench.
8. Grouting: Grout connections and joints and open spaces at keyways, connections, and joints where required or indicated on Shop Drawings. Retain grout in place until hard enough to support itself. Pack spaces with stiff grout material, tamping until voids are completely filled.
    a. Place grout to finish smooth, level, and plumb with adjacent concrete surfaces.
    b. Fill joints completely without seepage to other surfaces.
    c. Trowel top of grout joints on roofs smooth and uniform. Finish transitions between different surface levels not steeper than 1 to 12.
    d. Place grout end cap or dam in voids at ends of hollow-core slabs.
    e. Promptly remove grout material from exposed surfaces before it affects finishes or hardens.
    f. Keep grouted joints damp for not less than 24 hours after initial set.

B. Erection Tolerances
1. Erect precast structural concrete units level, plumb, square, true, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135.
2. Minimize variations between adjacent slab members by jacking, loading, or other method recommended by fabricator and approved by the Owner.

C. Field Quality Control
1. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
    a. Erection of precast structural concrete members.
2. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
3. Field welds will be visually inspected and nondestructive tested according to ASTM E 165 or ASTM E 709. High-strength bolted connections will be subject to inspections.
4. Testing agency will report test results promptly and in writing to Contractor and the Owner.
5. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.
6. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
7. Prepare test and inspection reports.

D. Repairs
1. Repair precast structural concrete units if permitted by the Owner.
    a. Repairs may be permitted if structural adequacy, serviceability, durability, and appearance of units has not been impaired.

2. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet (6 m).
3. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A 780.
4. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.
5. Remove and replace damaged precast structural concrete units that cannot be repaired or when repairs do not comply with requirements as determined by the Owner.

E. Cleaning
1. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.
2. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.
    a. Perform cleaning procedures, if necessary, according to precast concrete fabricator's written recommendations. Clean soiled precast concrete surfaces with detergent and water, using stiff fiber brushes and sponges, and rinse with clean water. Protect other work from staining or damage due to cleaning operations.
    b. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION 03 41 23 00

SECTION 03 41 26 00 - UNBONDED POST-TENSIONED CONCRETE

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for unbonded post-tensioned concrete. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes the following:
   a. Furnishing post-tensioning reinforcement and accessories including non-encapsulated and encapsulated prestressing tendons, pocket formers, support bars, bar chairs, and slab bolsters.
   b. Installing post-tensioning tendons.
   c. Performing post-tensioning operations including stressing and finishing tendons.
   d. Recording tendon elongations and gage pressures.
   e. Finishing tendon ends and patching stressing pockets.

C. Definitions

1. Strand Tail: Excess strand length extending past the anchorage device.
2. Stressing Blockout: Opening created in the slab to allow access to stressing-end anchorages.
3. Stressing Pocket: Void formed by pocket former at stressing-end anchorage to provide required cover over wedges and strand tail.
4. Wedge Cavity: Cone-shaped hole in anchorage device designed to hold the wedges that anchor the strand.

D. Performance Requirements

1. Structural Performance: Design cast-in-place, post-tensioned concrete reinforcement as indicated in this Section. Show final effective forces, tendon profiles, and nonprestressed reinforcement on design Shop Drawings.
2. Employ professional Engineer, registered in <**Insert State**>, and acceptable to the Owner, to perform design. Sign and seal design Shop Drawings and design calculations submitted to the Owner for review. Prepare and seal drawings and calculations for submittal to authorities having jurisdiction. Comply with design intent, criteria, and requirements of the Contract Documents.
3. Design structure to withstand loads according to governing codes, within limits and under conditions indicated.
4. Average Precompression:
   a. Minimum Average Slab Precompression: 125 psi (0.86 MPa) **OR** 200 psi (1.4 MPa), **as directed**.
   b. Maximum Average Slab Precompression: 300 psi (2.1 MPa) **OR** 500 psi (3.4 MPa), **as directed**.
   c. Minimum Average Precompression in T-, L-, and Rectangular-Beam Cross Sections: 200 psi (1.4 MPa).
   d. Minimum Precompression in Slab Section Not Included in T- or L-Beam Section: 100 psi (0.7 MPa).
   e. Maximum Precompression in Transfer Girders: 1000 psi (6.9 MPa). Specify stage-stressing sequence to avoid overstress.
5. Comply with ACI 318 (ACI 318M) limits on stresses at transfer of prestress and under service load.
6. Comply with ACI 318 (ACI 318M) requirements for minimum bonded reinforcement.
7. Comply with ACI 318 (ACI 318M) requirements for concrete cover over reinforcement.

8. Design members such that thickness and concrete cover over reinforcement comply with fire-resistance requirements of authorities having jurisdiction.
9. Design members such that thickness and concrete cover over reinforcement comply with the following fire-resistance requirements:
    a. Slabs: Two hours.
    b. Beam: Two hours.
10. Deflection Limits Including Creep and Shrinkage Effects:
    a. Total Dead Load: L/600.
    b. Total Dead Plus Live Load: L/360.
11. Slab Design:
    a. Minimum Slab Thickness: 5-1/2 inches (140 mm).
        1) Minimum Thickness if Conduit Is Embedded: 6 inches (150 mm).
        2) Maximum Span/Depth Ratio: 45.
    b. Locate closure strips at midspan and adjust tendon forces and profiles accordingly. Calculate moments in spans with closure strips assuming a continuous slab. Provide only nonprestressed reinforcement within closure strips. Design reinforcement in closure strip to carry ultimate moment at midspan.

E. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
    a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
        1) Include statement indicating costs for each product having recycled content.
3. Shop Drawings: Installation drawings including plans, elevations, sections, details, and notes prepared by or under the supervision of a registered professional engineer detailing tendon layout and installation procedures.
4. Product Certificates:
5. Qualification Data: For Installer, manufacturer, and testing agency.
6. Mill Test Reports: For prestressing strand.
7. Field quality-control test reports.
8. Calibration Certificates: For jacks and gages.
9. Stressing Records: Filled out by testing agency during stressing operation with the following information recorded:
    a. Name of Project.
    b. Date of approved installation drawings used for installation and stressing.
    c. Floor number and concrete placement area.
    d. Date of stressing operation.
    e. Weather conditions including temperature and rainfall.
    f. Name and signature of inspector.
    g. Name of individual in charge of stressing operation.
    h. Serial or identification numbers of jack and gage.
    i. Date of jack-and-gage calibration certificates.
    j. Gage pressure to achieve required stressing force per supplied calibration chart.
    k. Tendon identification mark.
    l. Calculated tendon elongation.
    m. Actual tendon elongation.
    n. Actual gage pressure.

F. Quality Assurance
1. Installer Qualifications: A qualified installer whose full-time Project superintendent has successfully completed PTI's Level 1 - Field Fundamentals course or has equivalent verifiable experience and knowledge acceptable to the Owner.

a. Superintendent must have received training from post-tensioning supplier in the operation of stressing equipment to be used on Project.

2. Manufacturer Qualifications: Fabricating plant certified by PTI.
3. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated, as documented according to ASTM E 548.
   a. Testing Agency Inspector: Personnel performing field inspections and measuring elongations shall have successfully completed PTI's Level 1 - Field Fundamentals course or shall have equivalent qualifications acceptable to the Owner.
4. ACI Publications: Comply with ACI 423.6, "Specification for Unbonded Single Strand Tendons," unless otherwise indicated in the Contract Documents.
5. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
   1. Deliver, store, and handle post-tensioning materials according to PTI's "Field Procedures Manual for Unbonded Single Strand Tendons."

H. Coordination
   1. Attachments and Penetrations:
      a. Attach permanent fixtures such as curtain-wall systems, handrails, fire-protection equipment, lights, and security devices to the slab using embedded anchors. Drilled anchors are not allowed unless authorized in writing by the Owner.
      b. Power-driven fasteners are not allowed unless authorized in writing by the Owner.
      c. Core drilling for sleeves or other penetrations is not allowed unless authorized in writing by the Owner.
      d. Protect penetrations within 18 inches (460 mm) of an anchorage with ASTM A 53/A 53M, Schedule 40 steel pipe.

1.2 PRODUCTS

A. Prestressing Tendons
   1. Prestressing Strand: ASTM A 416/A 416M, Grade 270 (Grade 1860), uncoated, 7-wire, low-relaxation, 0.5-inch- (12.7-mm-) **OR** 0.6-inch- (15.2-mm-), **as directed**, diameter strand.
   2. Post-Tensioning Coating: Compound with friction-reducing, moisture-displacing, and corrosion-inhibiting properties specified in ACI 423.6; chemically stable and nonreactive with prestressing steel, nonprestressed reinforcement, sheathing material, and concrete.
      a. Minimum Coating Weight: 2.5 lb (1.14 kg) for 0.5-inch- (12.7-mm-) diameter strand **OR** 3 lb (1.36 kg) for 0.6-inch- (15.2-mm-) diameter strand, **as directed**, per 100 feet (30 m) of strand.
      b. Completely fill annular space between strand and sheathing over entire tendon length with post-tensioning coating.
   3. Tendon Sheathing: Comply with ACI 423.6.
      a. Minimum Thickness: 0.050 inch (1.25 mm) for polyethylene or polypropylene with a minimum density of 0.034 lb/cu. in. (0.9 g/cu. cm).
      b. Continuous over the entire length of tendon to provide watertight encapsulation of strand and between anchorages to prevent intrusion of cement paste or loss of coating for a non-encapsulated system.
   4. Anchorage Device and Coupler Assembly: Assembly of strand, wedges, and anchorage device or coupler complying with static and fatigue testing requirements in ACI 423.6 and capable of developing 95 percent of actual breaking strength of strand.
      a. Anchorage Bearing Stresses: Comply with ACI 423.6 for stresses at transfer load and service load.
      b. Fixed-End Anchorage Device Assemblies: Plant fabricated with wedges seated at a load of not less than 80 percent and not more than 85 percent of breaking strength of strand.
   5. Encapsulation System: Watertight encapsulation of prestressing strand consisting of the following:

a. Wedge-Cavity Caps: Attached to anchorages with a positive mechanical connection and completely filled with post-tensioning coating.
   1) Caps for Fixed and Stressing-End Anchorages Devices: Designed to provide watertight encapsulation of wedge cavity. Sized to allow required extension of strand past the wedges.
      a) Attach cap for fixed-end anchorage device in fabricating plant.
   2) Caps at Intermediate Anchorages: Open to allow passage of strand.
b. Sleeves: Attached to anchorage device with positive mechanical connection; overlapped a minimum of 4 inches (100 mm) with sheathing and completely filled with post-tensioning coating.

B. Nonprestressed Steel Bars
1. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 **OR** 60, **as directed**, percent.
2. Support Bars, Reinforcing Bars, Hairpins: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed. Minimum support bar size is 1/2 inch (13 mm).
3. Low-Alloy-Steel Support Bars, Reinforcing Bars, Hairpins: ASTM A 706/A 706M, deformed.
4. Galvanized Support Bars, Reinforcing Bars, Hairpins: ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, ASTM A 767/A 767M, Class I **OR** II, **as directed**, zinc coated after fabrication and bending.
   a. Zinc Repair Material: ASTM A 780, zinc-based solder, paint containing zinc dust, or sprayed zinc.
5. Epoxy-Coated Support Bars, Reinforcing Bars, Hairpins: ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, ASTM A 775/A 775M epoxy coated with less than 2 percent damaged coating in each 12-inch (300-mm) bar length.
   a. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on bars and complying with ASTM A 775/A 755M. Repair damaged areas according to ASTM D 3963/D 3963M.
6. Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening tendons and tendon support bars in place. Manufacture bar supports, according to CRSI's "Manual of Standard Practice," from steel wire, plastic, or precast concrete of greater compressive strength than concrete, and as follows:
   a. For uncoated bars, use all-plastic **OR** CRSI Class 1 plastic-protected **OR** CRSI Class 2 stainless-steel, **as directed**, bar supports.
   b. For epoxy-coated bars, use CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire **OR** all-plastic, **as directed**, bar supports.
   c. For zinc-coated bars, use galvanized wire or dielectric-polymer-coated wire **OR** all-plastic, **as directed**, bar supports.

C. Accessories
1. Pocket Formers: Capable of completely sealing wedge cavity; sized to provide the required cover over the anchorage and allow access for cutting strand tail.
2. Anchorage Fasteners: Stainless-steel **OR** Galvanized steel **OR** Uncoated steel, **as directed**, nails, wires, and screws used to attach anchorage devices to formwork.
3. Sheathing Repair Tape: Elastic, self-adhesive, moistureproof tape with minimum width of 2 inches (50 mm), in contrasting color to tendon sheathing; nonreactive with sheathing, coating, or prestressing steel.

D. Patching Material
1. Patching Material: One component, polymer-modified, premixed patching material containing selected silica aggregates and portland cement, suitable for vertical and overhead application. Do not use material containing chlorides or other chemicals known to be deleterious to prestressing steel or material that is reactive with prestressing steel, anchorage device material, or concrete.

1.3 EXECUTION

A. Formwork
1. Provide formwork for post-tensioned elements as specified in Division 03 Section "Cast-in-place Concrete". Design formwork to support load redistribution that may occur during stressing operation. Ensure that formwork does not restrain elastic shortening, camber, or deflection resulting from application of prestressing force.
2. Do not remove forms supporting post-tensioned elements until tendons have been fully stressed and elongations have been approved by the Owner, unless authorized in writing by the Owner.
3. Do not place concrete in supported floors until tendons on supporting floors have been stressed and elongations have been approved by the Owner, unless authorized in writing by the Owner.

B. Nonprestressed Steel Reinforcement Placement
1. Placement of nonprestressed steel reinforcement is specified in Division 03 Section "Cast-in-place Concrete". Coordinate placement of nonprestressed steel reinforcement with installation of post-tensioning tendons.

C. Tendon Installation
1. Install tendons according to approved installation drawings and procedures stated in PTI's "Field Procedures Manual for Unbonded Single Strand Tendons."
2. Tendon Supports: Provide continuous slab bolsters or bars supported on individual high chairs spaced at a maximum of 42 inches (1070 mm) o.c. to ensure tendons remain in their designated positions during construction operations and concrete placement.
   a. Support tendons as required to provide profiles shown on installation drawings. Position supports at high and low points and at intervals not exceeding 48 inches (1220 mm). Ensure that tendon profiles between high and low points are smooth parabolic curves.
   b. Attach tendons to supporting chairs and reinforcement without damaging tendon sheathing.
   c. Support slab tendons independent of beam reinforcement.
3. Maintain tendon profile within maximum allowable deviations from design profile as follows:
   a. 1/4 inch (6.3 mm) for member depth less than or equal to 8 inches (200 mm).
   b. 3/8 inch (10 mm) for member depth greater than 8 inches (200 mm) and less than or equal to 24 inches (610 mm).
   c. 1/2 inch (13 mm) for member depth greater than 24 inches (610 mm).
4. Maintain minimum radius of curvature of 480-strand diameters for lateral deviations to avoid openings, ducts, and embedded items. Maintain a minimum of 2 inches (50 mm) of separation between tendons at locations of curvature.
5. Limit tendon bundles to five tendons. Do not twist or entwine tendons within a bundle. Maintain a minimum distance of 12 inches (300 mm) between center of adjacent bundles.
6. If tendon locations conflict with nonprestressed reinforcement or embedded items, tendon placement governs unless changes are authorized in writing by the Owner. Obtain the Owner's approval before relocating tendons or tendon anchorages that interfere with one another.
7. Deviations in horizontal spacing and location of slab tendons are permitted when required to avoid openings and inserts.
8. Installation of Anchorage Devices:
   a. Place anchorage devices at locations shown on approved installation drawings.
   b. Do not switch fixed and stressing-end anchorage locations unless authorized in writing by the Owner.
   c. Attach pocket formers, intermediate anchorage devices, and stressing-end anchorage devices securely to bulkhead forms. Install stressing-end and intermediate anchorage devices perpendicular to tendon axis.
   d. Install tendons straight, without vertical or horizontal curvature, for a minimum of 12 inches (300 mm) behind stressing-end and intermediate anchorages.
   e. Embed intermediate anchorage devices at construction joints in first concrete placed at joint.

f. Minimum splice length in reinforcing bars at anchorages is 24 inches (600 mm). Stagger splices a minimum of 60 inches (1500 mm).
g. Place fixed-end anchorage devices in formwork at locations shown on installation drawings. Support anchorages firmly to avoid movement during concrete placement.
h. Remove loose caps on fixed-end anchorages, refill with post-tensioning coating, and re-attach caps to achieve a watertight enclosure.

9. Maintain minimum concrete cover as follows:
   a. From Exterior Edge of Concrete to Wedge Cavity: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**.
   b. From Exterior Edge of Concrete to Strand Tail: 3/4 inch (19 mm).
   c. From Exterior Edge of Concrete to Wedge-Cavity Cap: 1 inch (25 mm).
   d. Top, Bottom, and Edge Cover for Anchorage Devices: 3/4 inch (19 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
10. Maintain minimum clearance of 6 inches (150 mm) between tendons and openings.
11. Prior to concrete placement, mark tendon locations on formwork with spray paint.
12. Do not install sleeves within 36 inches (914 mm) of anchorages after tendon layout has been inspected unless authorized in writing by the Owner.
13. Do not install conduit, pipe, or embeds requiring movement of tendons after tendon layout has been inspected unless authorized in writing by the Owner.
14. Do not use couplers unless location has been approved by the Owner.

D. Sheathing Inspection And Repair
1. Inspect sheathing for damage after installing tendons. Repair damaged areas by restoring post-tensioning coating and repairing or replacing tendon sheathing.
   a. Ensure that sheathing is watertight and there are no air voids.
   b. Follow tape repair procedures in PTI's "Field Procedures Manual for Unbonded Single Strand Tendons."
2. Maximum length of exposed strand behind anchorages is as follows:
   a. Fixed End: 12 inches (300 mm).
   b. Intermediate and Stressing End: 0 inches (0 mm) **OR** 1 inch (25 mm), **as directed**.
      1) Cover exposed strand with sheathing repair tape to prevent contact with concrete.
3. Immediately remove and replace tendons that have damaged strand.

E. Concrete Placement
1. Do not place concrete until placement of tendons and nonprestressed steel reinforcement has been inspected by special inspector **OR** testing agency, **as directed**.
2. Provide the Owner and special inspector **OR** testing agency, **as directed**, a minimum of 48 hours' notice before concrete placement.
3. Place concrete as specified in Division 03 Section "Cast-in-place Concrete". Ensure compaction of concrete around anchorages.
4. Ensure that position of tendon and nonprestressed steel reinforcement does not change during concrete placement. Reposition tendons and nonprestressed steel reinforcement moved during concrete placement.
5. Ensure that method of concrete placement does not damage tendon sheathing. Do not support pump lines, chutes, or other concrete placing equipment on tendons.

F. Tendon Stressing
1. Calibrate stressing jacks and gages at start of job and at least every six months thereafter. Keep copies of calibration certificates for each jack-and-gage pair on Project site and available for inspection. Exercise care in handling stressing equipment to ensure that proper calibration is maintained.
2. Stress tendons only under supervision of qualified post-tensioning superintendent.
3. Do not begin stressing operations until concrete strength has reached 3000 psi (20.7 MPa) as indicated by compression tests of field-cured cylinders.
4. Complete stressing within 96 hours of concrete placement.

5. If concrete has not reached required strength, obtain the Owner's approval to partially stress tendons and delay final stressing until concrete has reached required strength.
6. Stage stress transfer girders **OR** foundation mats, **as directed**, according to schedule shown on the Contract Drawings.
7. If detensioning and restressing of tendon is required, discard wedges used in original stressing and provide new wedges.
8. Mark and measure elongations according to PTI's "Field Procedures Manual for Unbonded Single Strand Tendons." Measure elongations to closest 1/8 inch (3.2 mm).
9. Submit stressing records within one day of completion of stressing. If discrepancies between measured and calculated elongations exceed plus or minus 7 percent, resolve these discrepancies to satisfaction of the Owner.
10. Prestressing will be considered acceptable if gage pressures shown on stressing record correspond to required stressing force and calculated and measured elongations agree within 7 percent.
11. If measured elongations deviate from calculated elongations by more than 7 percent, additional testing, restressing, strengthening, or replacement of affected elements may be required.

G. Tendon Finishing
1. Do not cut strand tails or cover anchorages until stressing records have been reviewed and approved by the Owner.
2. Cut strand tails as soon as possible after approval of elongations.
3. Cut strand tail between 1/2 and 3/4 inch (13 and 19 mm) from wedges. Do not damage tendon or concrete during removal of strand tail. Acceptable methods of cutting strand tail include the following:
   a. Oxyacetylene flame.
   b. Abrasive wheel.
   c. Hydraulic shears.
   d. Plasma cutting.
4. Install caps and sleeves on intermediate anchorages within one day of stressing.
5. Cut strand tails and install caps on stressing-end anchorages within one day of the Owner's acceptance of elongations.
6. Patch stressing pockets within one day of cutting strand tail. Clean inside surface of pocket to remove laitance or post-tensioning coating before installing patch material. Finish patch material flush with adjacent concrete.

H. Field Quality Control
1. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports. Cooperate with testing agency to facilitate the execution of its duties.
   a. Before concrete placement, special inspector **OR** testing agency, **as directed**, will inspect the following for compliance with post-tensioning installation drawings and the Contract Documents:
      1) Location and number of tendons.
      2) Tendon profiles and cover.
      3) Installation of backup bars, hairpins, and other nonprestressed reinforcement shown on post-tensioning installation drawings.
      4) Installation of pocket formers and anchorage devices.
      5) Repair of damaged sheathing.
      6) Connections between sheathing and anchorage devices.
   b. Special inspector **OR** Testing agency, **as directed**, will record tendon elongations during stressing.
   c. Special inspector **OR** Testing agency, **as directed**, will immediately report deviations from the Contract Documents to the Owner.

I. Protection

1. Do not expose tendons to electric ground currents, welding sparks, or temperatures that would degrade component.
2. Protect exposed components within one workday of their exposure during installation.
3. Prevent water from entering tendons during installation and stressing.
4. Provide weather protection to stressing-end anchorages if strand tails are not cut within 10 days of stressing the tendons.

J. Repairs
   1. Submit repair procedure to the Owner for evaluation and approval.
   2. Do not proceed with repairs requiring removal of concrete unless authorized in writing by the Owner.

END OF SECTION 03 41 26 00

Task	Specification	Specification Description
03 48 29 00	03 41 23 00	Plant-Precast Structural Concrete
03 48 46 00	03 41 23 00	Plant-Precast Structural Concrete
03 48 49 00	03 41 23 00	Plant-Precast Structural Concrete

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SECTION 03 51 13 00 - CEMENTITIOUS WOOD-FIBER DECK

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for cementitious wood-fiber deck. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Monolithic cementitious wood-fiber units.
   b. Composite cementitious wood-fiber units.
   c. Insulated composite cementitious wood-fiber units.
   d. Subpurlin tees.

C. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Show fabrication and installation details for cementitious wood-fiber deck. Include details at supports, reinforcement at openings, and attachment to other work.
3. Samples: Show texture, finish, and edge and end configurations of monolithic **OR** composite **OR** insulated composite, **as directed,** cementitious wood-fiber units, 12 inches (305 mm) **OR** 24 inches (610 mm), **as directed,** long by width of unit.
   a. Include unit with galvanized steel edge channel.

D. Quality Assurance
1. Fire-Test-Response Characteristics: Provide cementitious wood-fiber units that comply with the following requirements:
   a. Fire-response testing performed by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction and that performs testing and follow-up services.
   b. Surface-Burning Characteristics: Maximum flame-spread and smoke-developed indices of 25 and 50, respectively, as determined by testing identical products per ASTM E 84.
   c. Fire-resistance-rated assemblies indicated by design designations from UL's "Fire Resistance Directory," ITS's "Directory of Listed Products," or the listings of another testing and inspecting agency are identical in materials and construction to those tested per ASTM E 119.
   d. Products are identified with appropriate markings of applicable testing and inspecting agency.

E. Delivery, Storage, And Handling
1. Protect cementitious wood-fiber units from moisture.
2. Store units on elevated platforms at the Project site in a dry, well-ventilated, covered space and stack according to manufacturer's written recommendations.
3. Handle units to prevent chipping, breaking, cracking, staining, soiling, warping, or other physical damage. Discard damaged units at time of installation.

1.2 PRODUCTS

A. Materials
1. Cementitious Wood-Fiber Units, General: Manufacturer's standard factory-cast structural units complying with the following requirements:

a. Composition: Chemically processed long wood fibers mixed with Portland cement, ASTM C 150, Type III or magnesium oxysulfate hydraulic cement, pressure bonded to produce units of thicknesses and sizes indicated:
b. Properties: As follows, determined according to test method indicated:
    1) Noise Reduction Coefficient: NRC 0.55 **OR** 0.60 **OR** 0.65 **OR** 0.70 **OR** 0.75 **OR** 0.80, **as directed**; ASTM C 423.
    2) Light Reflectance: 60 percent; ASTM E 1349.
c. Finish: Manufacturer's standard natural or prime-painted finish.

2. Oriented-Strand-Board Sheathing: APA-rated sheathing, Exposure 1 complying with DOC PS 2.
3. Polyisocyanurate-Foam Insulation: 2 lb/cu. ft. (32 kg/cu. m) nominal density, 35 lbf/sq. in. (240 kPa) compressive strength per ASTM D 1621.
4. Extruded-Polystyrene Insulation: ASTM C 578, Type IV.
5. Expanded-Polystyrene Insulation: ASTM C 578, Type I.

B. Monolithic Cementitious Wood-Fiber Units
1. Tile: Manufacturer's standard rabbet-edged, cementitious wood-fiber units.
2. Plank: Manufacturer's standard tongue-and-groove-edged, cementitious wood-fiber units.
3. Channel-Reinforced Plank: Manufacturer's standard tongue-and-groove-edged, cementitious wood-fiber planks with factory-installed, cold-formed, 0.0598-inch- (1.52-mm-) thick, galvanized steel channel set in grooved edge.
4. Concealed-Tee Plank: Manufacturer's standard cementitious wood-fiber units, with edges kerfed, back rabbeted, and beveled.

C. Composite Cementitious Wood-Fiber Units
1. Composite Tile: Manufacturer's standard factory-laminated composite deck units consisting of a rabbet-edged, cementitious wood-fiber tile base and top layer of oriented-strand-board sheathing, 7/16 inch (11 mm) thick.
2. Composite Plank: Manufacturer's standard factory-laminated composite deck units consisting of a standard tongue-and-groove-edged, cementitious wood-fiber plank base and top layer of oriented-strand-board sheathing, 7/16 inch (11 mm) thick.
3. Composite Channel-Reinforced Plank: Manufacturer's standard factory-laminated composite deck units consisting of a standard tongue-and-groove-edged, cementitious wood-fiber plank base with factory-installed, cold-formed, 0.0598-inch- (1.52-mm-) thick, galvanized steel channel set in grooved edge, and top layer of oriented-strand-board sheathing, 7/16 inch (11 mm) thick.

D. Insulated Composite Cementitious Wood-Fiber Units
1. Insulated Composite Tile: Manufacturer's standard factory-laminated composite deck units consisting of a rabbet-edged, cementitious wood-fiber tile base, insulation, and top layer; and as follows:
    a. Insulation: Polyisocyanurate **OR** Extruded polystyrene **OR** Expanded polystyrene, **as directed**.
    b. Top Layer: Manufacturer's standard asphalt-free, glass-fiber-reinforced, black felt facing **OR** 7/16-inch- (11-mm-) thick, oriented-strand board, **as directed**.
2. Insulated Composite Plank: Manufacturer's standard factory-laminated composite deck units consisting of a standard tongue-and-groove-edged, cementitious wood-fiber plank base, insulation, and top layer; and as follows:
    a. Insulation: Polyisocyanurate **OR** Extruded polystyrene **OR** Expanded polystyrene, **as directed**.
    b. Top Layer: Manufacturer's standard asphalt-free, glass-fiber-reinforced, black felt facing **OR** 7/16-inch- (11-mm-) thick, oriented-strand-board, **as directed**.
3. Insulated Composite Channel-Reinforced Plank: Manufacturer's standard factory-laminated composite deck units consisting of a standard tongue-and-groove-edged, cementitious wood-fiber plank base with factory-installed, cold-formed, 0.0598-inch- (1.52-mm-) thick, galvanized steel channel set in grooved edge, insulation, and top layer; and as follows:

a. Insulation: Polyisocyanurate **OR** Extruded polystyrene **OR** Expanded polystyrene, **as directed**.
b. Top Layer: Manufacturer's standard asphalt-free, glass-fiber-reinforced, black felt facing **OR** 7/16-inch- (11-mm-) thick, oriented-strand board, **as directed**.

E. Subpurlins
1. Bulb-Tee Subpurlins: Hot-rolled steel bulb tees complying with ASTM A 499 of length required to span three support spacings; shop painted with metal primer.

F. Accessories
1. Gypsum Concrete Grout: Factory-packaged, gypsum concrete grout formulation recommended by cementitious wood-fiber unit manufacturer with a minimum compressive strength of 500 psi (3.45 MPa).
2. Anchor Clips: Manufacturer's standard formed anchor clips of 0.0478-inch- (1.21-mm-) thick minimum, galvanized steel sheet, of type and configuration required for deck system indicated.
3. Screws: Manufacturer's recommended corrosion-resistant screw fasteners and washers, self-drilling, self-tapping, of length required for deck and structural framing indicated.
4. Nails: Manufacturer's recommended corrosion-resistant nails of size and length required for deck and structural framing indicated.
5. Adhesive: Manufacturer's recommended construction adhesive complying with APA AFG-01.
6. Filler Strips: Insulation strips, same as used in manufacture of insulated composite cementitious wood-fiber units.
7. Polyethylene Film: 0.004 inch (0.10 mm) thick, complying with ASTM D 4397.

1.3 EXECUTION

A. Installation
1. Comply with manufacturer's written instructions for installing cementitious wood-fiber deck.
   a. Install fastenings according to manufacturer's written instructions, unless otherwise indicated **OR** as indicated, **as directed**.
2. Deck Interruptions: Provide barrier seals or blocking at overhangs to form wind seals and at partitions and walls to form sound seals, unless otherwise indicated.

B. Form-Deck Installation
1. Tile and Subpurlin Form Deck: Space subpurlin members as indicated. Attach subpurlins to each support with 3/4-inch- (19-mm-) long minimum, fillet welds on both sides of flanges at ends of members and on alternate sides at intermediate structural supports.
   a. Lay tile with rabbeted edges supported on subpurlins, and shim or block in place to prevent dislocation during placing of fill.
   b. Lay tile with square-cut ends concealed and supported on cross subpurlins **OR** over supporting purlins or beams, **as directed**.
   c. Lay tile with tongue-and-groove ends exposed in pattern indicated.
   d. Fill void with gypsum concrete grout where edge joints meet subpurlins. Strike grout flush with top of tile and feather uneven top surfaces to a plane.
   e. Provide shoring of sufficient strength to withstand weight of cast-in-place fill and construction traffic. Design, install, and remove shoring according to Division 03 Section "Cast-in-place Concrete".
2. Plank Form Deck: Install planks progressively with long dimension perpendicular to supports and with end joints in alternate rows, staggered and centered over supports, unless otherwise indicated. Tightly nest tongue-and-groove edges and tightly butt end joints.
   a. Cut panels to provide starter units.
   b. Continuously support plank edges and ends at perimeter of building and at openings in deck.

c. Provide shoring of sufficient strength to withstand weight of cast-in-place fill and construction traffic. Design, install, and remove shoring according to Division 03 Section "Cast-in-place Concrete".
d. Cover exposed edges and ends of form planks with polyethylene film before pouring cast-in-place fill to prevent paste or mixing water from penetrating deck and seeping through to bottom face. Remove exposed film after cast-in-place fill has set.

3. Concealed-Tee Plank Deck: Install planks progressively with long dimension perpendicular to supports and with end joints in alternate rows, staggered and centered over supports, unless otherwise indicated. Install flange of bulb tee into kerfed edge and tightly butt adjoining plank to engage other flange. Tightly nest tongue-and-groove **OR** butt square, **as directed,** end joints.
   a. Cut panels to provide starter units.
   b. Continuously support plank edges and ends at perimeter of building and at openings in deck.
   c. Fill void with gypsum concrete grout where edge joints meet subpurlins. Strike grout flush with top of plank and feather uneven top surfaces to a plane.
   d. Provide shoring of sufficient strength to withstand weight of cast-in-place fill and construction traffic. Design, install, and remove shoring according to Division 03 Section "Cast-in-place Concrete".

C. Roof Deck Installation

1. Tile and Subpurlin Roof Deck: Space subpurlin members as indicated. Attach subpurlins to each support with 3/4-inch- (19-mm-) long minimum, fillet welds on both sides of flanges at ends of members and on alternate sides at intermediate structural supports.
   a. Lay tile with rabbeted edges supported on subpurlins.
   b. Lay tile with square-cut ends concealed and supported on cross subpurlins **OR** over supporting purlins or beams, **as directed**.
   c. Lay tile with tongue-and-groove ends exposed in pattern indicated.
   d. Fill void with gypsum concrete grout where edge joints meet subpurlins. Strike grout flush with top of tile and feather uneven top surfaces to a plane.
   e. Fill void with gypsum concrete grout where edge joints meet subpurlins. Strike grout flush with top surface of cementitious wood-fiber base. Fill remainder of joint with filler strips of insulation.
2. Plank Roof Deck: Install planks progressively with long dimension perpendicular to supports and with end joints in alternate rows, staggered and centered over supports, unless otherwise indicated. Tightly nest tongue-and-groove edges and tightly butt end joints.
   a. Cut panels to provide starter units.
   b. Continuously support plank edges and ends at perimeter of building and at openings in deck.
   c. Mechanically fasten planks to supports and perimeter members.
   d. Adhesively and mechanically fasten planks to supports and perimeter members. Apply adhesive to tongue-and-groove edges.
3. Concealed-Tee Plank Roof Deck: Install planks progressively with long dimension perpendicular to supports and with end joints in alternate rows, staggered and centered over supports, unless otherwise indicated. Install flange of bulb tee into kerfed edge and tightly butt adjoining plank to engage other flange. Tightly nest tongue-and-groove **OR** butt square, **as directed,** end joints.
   a. Cut panels to provide starter units.
   b. Continuously support plank edges and ends at perimeter of building and at openings in deck.
   c. Mechanically fasten planks to supports and perimeter members.
   d. Adhesively and mechanically fasten planks to supports and perimeter members. Apply adhesive to tongue-and-groove edges.
   e. Fill void with gypsum concrete grout where edge joints meet subpurlins. Strike grout flush with top of plank and feather uneven top surfaces to a plane.

D. Cleaning And Protection

1. Protect top surfaces of deck from damage caused by construction operations.
2. Protect exposed bottom surfaces of deck from soiling and damage during handling and construction.
3. Clean exposed bottom surfaces of completed deck and touch up minor damage to surfaces as approved.
4. Provide final protection and maintain conditions in a manner acceptable to manufacturer and Installer that ensures that cementitious wood-fiber deck is without damage or deterioration at time of Final Completion.
5. Remove and replace deteriorated and damaged deck units.

END OF SECTION 03 51 13 00

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SECTION 03 51 16 00 - GYPSUM PLANK DECKING

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for gypsum plank decking for interstitial decks **OR** fire rated interstitial decks, **as directed**, and roof decks. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. Fire Tests: Fire tests, data and certifications substantiating that Gypsum Plank Decking complies with fire rating requirements.
   2. Shop Drawings: Show typical plank layouts, perimeter and framed opening supports and details of construction, installation, fastenings and grouting.
   3. Manufacturer's Literature and Data: Each item specified.
   4. Load tables for sub-purlins.

C. Quality Control
   1. Work performed by experienced, qualified installers approved by manufacturer of gypsum plank.
   2. Gypsum materials products of one manufacturer.

D. Delivery And Storage
   1. Deliver materials in original packages, containers, or bundles bearing brand name and name of manufacturer.
   2. Store materials in a manner that prevents damage before use. When stored under tarpaulins, provide ventilation to prevent moisture accumulation under tarpaulin.
   3. Store gypsum planks flat and off ground. Handle and stack in a manner to prevent damage to face, ends, and edges and keep dry until used.
   4. Store gypsum concrete off ground and keep dry until used.

1.2 PRODUCTS

A. Materials
   1. Structural Steel Tee Sub-purlins:
      a. Open web truss-tees, hot-rolled bulb-tees or folded sheet metal tees as required by design loads, spans and fire ratings.
      b. Flanges: Provide 5/8-inch (16 mm) minimum bearing for gypsum planks.
      c. Galvanize or factory coat sub-purlins with manufacturer's standard primer.
      d. Open web truss-tees: Fabricate from cold-formed steel wire conforming to ASTM A82.
      e. Hot-rolled bulb-tees: Rail-shaped, fabricated from hot-rolled steel conforming to ASTM A36/A36M or ASTM A499.
      f. Folded sheet metal tees: Fabricate from sheet steel conforming to ASTM A653 and ASTM A568/A568M.
   2. Cross-Tees:
      a. Cold-Formed, Fabrication from sheet steel conforming to ASTM A653/A653M or ASTM A568/A568M.
      b. Size: 1-1/4-inches (30 mm) by 1/2-inch (13 mm) by 0.023-inch (0.6 mm) thick by 24-inches (600 mm) long.
      c. Tees shall be galvanized or factory coated with manufacturer's standard primer.
   3. Gypsum Deck Plank:
      a. Fabricated of gypsum board: ASTM C442.

b. Nominal Size: 2-inches (50 mm) **OR** 2-5/8-inches (65 mm), **as directed**, thick by 24-inches (600 mm) wide by main purlin span. Where possible, length should span two main purlin spans.
c. Factory laminate from two 1-inch (25 mm) thick gypsum panels with top panel edge set back along sub-purlin edge not more than 1/2-inch (13 mm).
d. Offset edges encased in water-resistant paper.

4. Gypsum Deck Panels: ASTM C36, Type "X", 5/8-inch (16 mm) thick by 24-inches (600 mm) wide by main purlin span.
5. Grout: Gypsum Concrete: ASTM C317, Class A, 500 psi (3.5 MPa) minimum compressive strength.
6. Miscellaneous Materials: Adhesives, mastics, cements, tapes and primers shall be as recommended by the gypsum plank manufacturer and shall be compatible with the material to which they are to be bonded.

B. Deck System
1. Interstitial deck: Provide two-hour fire rating as tested by gypsum plank manufacturer under ASTM E119.
2. Roof Deck: Provide one hour **OR** 1-1/2 hour, **as directed**, fire rating per tested assembly by Underwriters' Laboratory Inc. or other testing.

1.3 EXECUTION

A. Installation
1. Weld per AWS D1.1.
2. Sub-purlins:
   a. Space at approximately 24-5/8-inches (650 mm) on center to provide minimum 5/8 inch (16 mm) continuous bearing for gypsum plank or deck.
   b. Install framing of openings.
   c. Touch up welds with same type of rust-inhibitive paint used for primer.
   d. Interstitial Decks: Use 3/4-inch (19 mm) fillet welds on both sides of sub-purlins at math purlin.
   e. Roof Decks: Use minimum 1/2-inch (13 mm) fillet welds on alternate sides of sub-purlins, both sides at end joints to main purlins.
   f. For fire rated roof decks weld per fire test assembly.
3. For Two Hour fire rated interstitial decks **OR** fire-rated roof decks, **as directed**.
   a. Place gypsum deck panels on bottom flanges of sub-purlins with 5/8-inch (16 mm) minimum continuous bearing.
   b. Place gypsum deck plank over gypsum deck panels, with off-set edges "up" to form a "T" receptacle for gypsum grout.
   c. Cut to fit around openings shown.
   d. Install plank to conform to fire test assembly.
4. Gypsum Deck Plank for Roof Decks:
   a. Place plank on lower flanges of sub-purlins or other framing with ends and edges supported.
   b. Stagger joints in adjacent courses.
   c. Support end joints with cross-tees not supported by framing.
   d. Cut plank to fit at ends and framed openings.
5. Provide continuous 5/8-inch (16 mm) minimum bearing for plank support at deck perimeter, plank ends and openings exceeding 8-inches (200 mm).
6. Grout:
   a. Mix gypsum concrete thoroughly using a minimum amount of water to form a thick, pourable consistency.
   b. Fill edge joints to slight excess with single pour at sub-purlins.
      1) Grout end joints on single span system against steel framing.

2) After initial set, strike of excess to form smooth, flush joint.
3) Form cant strips and curbs where shown.

c. Fill joints at roof ridges, hips and valleys.

7. Patching:
   a. Fill with grout and smooth any surface damage to gypsum plank.
   b. Remove and replace cracked, broken, and plank damaged beyond repair.
8. Cleaning and Protection:
   a. Upon completion of gypsum plank decking, remove, debris and sweep surface clean. Leave ready for subsequent work.
   b. Protect finished deck from weather and subsequent construction operations.
   c. Provide hardboard or plywood temporary protection over decking subject to repetitive impact or wheeled loads.

END OF SECTION 03 51 16 00

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SECTION 03 51 16 00a - GYPSUM CONCRETE DECKS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of gypsum concrete decks. Products shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCTS

A. Gypsum Concrete: ASTM C 317, Class A.

B. Formboards:
   1. Gypsum Board: ASTM C 318.
   2. Mineral Fiber Board: ASTM C612.
   3. Glass Fiber Board: Lightweight, rigid, composed of pressed glass fibers.

C. Bulb Tees: ASTM A 499, Grade 50.

D. Reinforcing Mesh:
   1. Welded Wire Fabric: ASTM A 1064, galvanized, 12 x 48-W0.5 x W0.5.
   2. Woven Wire Fabric: ASTM A 82, galvanized, 19 gauge wire, 2-inch hexagonal mesh.

1.3 EXECUTION

A. Support System: Sub-purlins shall be spaced to support formboards and rigidly attached to main supports. Formboards shall fit snugly at sub-purlins and at wall, curbs, and openings.

B. Reinforcement: Lay wire fabric continuously over sub-purlins. Do not lap side of reinforcement.

C. Gypsum Concrete: Gypsum concrete shall be placed continuously without interruption until entire panel or section is complete. Immediately after placement, screed, level, and trowel smooth.

END OF SECTION 03 51 16 00a

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Task	Specification	Specification Description
03 51 16 00	03 41 16 00	Precast Lighweight Roof Slabs

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SECTION 03 53 14 00 - CONCRETE FLOOR TOPPING

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for concrete floor topping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Emery-aggregate concrete floor topping.
      b. Iron-aggregate concrete floor topping.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. Product Test Reports.
   3. Field quality-control test reports.

D. Quality Assurance
   1. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
   2. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
   1. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage, mixing with other components, and application.
   2. Store materials to comply with manufacturer's written instructions to prevent deterioration from moisture or other detrimental effects.

F. Project Conditions
   1. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature and moisture content, ambient temperature and humidity, ventilation, and other conditions affecting concrete floor topping performance.
      a. Place concrete floor topping only when ambient temperature and temperature of base slabs are between 50 and 86 deg F (10 and 30 deg C).
   2. Close areas to traffic during topping application and, after application, for time period recommended in writing by manufacturer.

1.2 PRODUCTS

A. Concrete Floor Toppings
   1. Emery-Aggregate Concrete Floor Topping: Factory-prepared and dry-packaged mixture of graded, crushed emery aggregate containing not less than 50 percent aluminum oxide, not less than 24 percent ferric oxide, and not more than 8 percent silica; portland cement or blended hydraulic cement; plasticizers; and other admixtures to which only water needs to be added at Project site.
      a. Compressive Strength (28 Days): 10,000 psi (69 MPa); ASTM C 109/C 109M.
   2. Iron-Aggregate Concrete Floor Topping: Factory-prepared and dry-packaged mixture of graded iron aggregate, portland cement, plasticizers, and other admixtures to which only water needs to be added at Project site.

a. Compressive Strength (28 Days): 12,000 psi (83 MPa); ASTM C 109/C 109M.

B. Curing Materials
1. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.
2. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.
3. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
4. Water: Potable.
5. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 25 percent solids content, minimum.

C. Related Materials
1. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A Shore durometer hardness of 80 **OR** aromatic polyurea with a Type A Shore durometer hardness range of 90 to 95, **as directed**, per ASTM D 2240.
2. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.
3. Portland Cement: ASTM C 150, Type I or II.
4. Sand: ASTM C 404, fine aggregate passing No. 16 (1.18-mm) sieve.
5. Water: Potable.
6. Acrylic-Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
7. Epoxy Adhesive: ASTM C 881/C 881M, Type V, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements.

D. Mixing
1. Bonding Slurry: Mix portland cement with water to a thick paint consistency.
OR
Bonding Slurry: Mix 1 part portland cement and 1-1/2 **OR** 2 **OR** 2-1/2, **as directed**, parts sand with water and an acrylic-bonding agent according to manufacturer's written instructions, **as directed**, to a thick paint consistency.
2. Floor Topping: Mix concrete floor topping materials and water in appropriate drum-type batch machine mixer or truck mixer according to manufacturer's written instructions.

1.3 EXECUTION

A. Examination
1. Examine substrates, with Installer present, for conditions affecting performance of concrete floor topping.
2. Verify that base concrete slabs comply with scratch finish requirements specified in Division 03 Section "Cast-in-place Concrete".
3. Verify that base slabs are visibly dry and free of moisture. Test for capillary moisture by the plastic sheet method according to ASTM D 4263.
4. Proceed with application only after unsatisfactory conditions have been corrected.

B. Preparation
1. Existing Concrete: Remove existing surface treatments and deteriorated and unsound concrete. Mechanically abrade base slabs to produce a heavily scarified surface profile with an amplitude of 1/4 inch (6 mm.)
a. Prepare and clean existing base slabs according to concrete floor topping manufacturer's written instructions. Fill voids, cracks, and cavities in base slabs.
b. Mechanically remove contaminants from existing concrete that might impair bond of floor topping.

c. Saw cut contraction and construction joints in existing concrete to a depth of 1/2 inch (13 mm) and fill with semirigid joint filler.

d. To both sides of joint edges and at perimeter of existing base slab mechanically remove a 4-inch- (100-mm-) wide and 0- to 1-inch (0- to 25-mm-) deep, tapered wedge of concrete and retexture surface **OR** install concrete nails in manufacturer's recommended staggered pattern, **as directed**.

2. Install joint-filler strips where topping abuts vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
   a. Extend joint-filler strips full width and depth of joint, terminating flush with topping surface, unless otherwise indicated.
   b. Terminate full-width, joint-filler strips 1/2 inch (13 mm) below topping surface where joint sealants, specified in Division 07 Section "Joint Sealants", are indicated.
   c. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

C. Floor Topping Application

1. Start floor topping application in presence of manufacturer's technical representative.
2. Monolithic Floor Topping: After textured-float finish is applied to fresh concrete of base slabs specified in Division 03 Section "Cast-in-place Concrete", place concrete floor topping while concrete is still plastic.
3. Deferred Floor Topping: Within 72 hours of placing base slabs, mix and scrub bonding slurry into dampened concrete to a thickness of 1/16 to 1/8 inch (1.6 to 3 mm), without puddling. Place floor topping while slurry is still tacky.
4. Existing Concrete: Apply epoxy-bonding adhesive, mixed according to manufacturer's written instructions, and scrub into dry base slabs to a thickness of 1/16 to 1/8 inch (1.6 to 3 mm), without puddling. Place floor topping while adhesive is still tacky.
5. Place concrete floor topping continuously in a single layer, tamping and consolidating to achieve tight contact with bonding surface. Do not permit cold joints or seams to develop within pour strip.
   a. Screed surface with a straightedge and strike off to correct elevations.
   b. Slope surfaces uniformly where indicated.
   c. Begin initial floating using bull floats to form a uniform and open-textured surface plane free of humps or hollows.
6. Finishing: Consolidate surface with power-driven floats as soon as concrete floor topping can support equipment and operator. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until concrete floor topping surface has a uniform, smooth, granular texture.
   1) Hard Trowel Finish: After floating surface, apply first trowel finish and consolidate concrete floor topping by power-driven trowel without allowing blisters to develop. Continue troweling passes and restraighten until surface is smooth and uniform in texture.
   2) Finish surfaces to specified overall values of flatness, F(F) 25; and levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and levelness, F(L) 15, and measure **OR** notify independent testing agency to permit measurement, **as directed**, within 24 hours according to ASTM E 1155 (ASTM E 1155M) for a randomly trafficked floor surface.
   3) Finish and measure surface so gap at any point between surface and an unleveled freestanding 10-foot- (3-m-) long straightedge, resting on 2 high spots and placed anywhere on the surface, does not exceed 1/4 inch (6 mm).
7. Construction Joints: Construct joints true to line with faces perpendicular to surface plane of concrete floor topping, at locations indicated or as approved by the Owner.
   a. Coat face of construction joint with epoxy adhesive at locations where concrete floor topping is placed against hardened or partially hardened concrete floor topping.
8. Contraction Joints: Form weakened-plane contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3-mm-) wide joints into concrete

floor topping when cutting action will not tear, abrade, or otherwise damage surface and before random contraction cracks develop.

a. Form joints in concrete floor topping over contraction joints in base slabs, unless otherwise indicated.
b. Construct contraction joints for a combined depth equal to topping thickness and not less than one-fourth of base-slab thickness.
c. Construct contraction joints for a depth equal to one-half of concrete floor topping thickness, but not less than 1/2 inch (13 mm) deep.

D. Protecting And Curing

1. General: Protect freshly placed concrete floor topping from premature drying and excessive cold or hot temperatures.
2. Evaporation Retarder: Apply evaporation retarder to concrete floor topping surfaces in hot, dry, or windy conditions before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying floor topping, but before float finishing.
3. Begin curing immediately after finishing concrete floor topping. Cure by one or a combination of the following methods, according to concrete floor topping manufacturer's written instructions:
   a. Moisture Curing: Keep surfaces continuously moist for not less than 7 days with water **OR** continuous water-fog spray **OR** absorptive cover, water saturated and kept continuously wet. Cover topping surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers, **as directed**.
   b. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
   c. Curing Compound: Apply uniformly in two coats in continuous operations by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

E. Joint Filling

1. Prepare and clean contraction joints and install semirigid joint filler, according to manufacturer's written instructions, once topping has fully cured.
2. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
3. Install semirigid joint filler full depth of contraction joints. Overfill joint and trim semirigid joint filler flush with top of joint after hardening.

F. Repairs

1. Defective Topping: Repair and patch defective concrete floor topping areas, including areas that have not bonded to concrete substrate.

G. Field Quality Control

1. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
2. Testing Services: Testing and inspecting of completed applications of concrete floor toppings shall take place in successive stages, in areas of extent and using methods as follows:
   a. Sample Sets: At point of placement, a set of 3 molded-cube samples shall be taken from the topping mix for the first 1000 sq. ft. (93 sq. m), plus 1 set of samples for each subsequent 5000 sq. ft. (464 sq. m) of topping, or fraction thereof, but not less than 6 samples for each day's placement. Samples shall be tested according to ASTM C 109/C 109M for compliance with compressive-strength requirements.

b. Concrete floor topping shall be tested for delamination by dragging a steel chain over the surface.
c. Concrete floor topping shall be tested for compliance with surface flatness and levelness tolerances.

3. Remove and replace applications of concrete floor topping where test results indicate that it does not comply with specified requirements.
4. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION 03 53 14 00

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Task	Specification	Specification Description
03 53 19 00	03 53 14 00	Concrete Floor Topping

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SECTION 03 54 16 00 - CEMENT-BASED UNDERLAYMENT

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for hydraulic cement-based underlayment. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section includes hydraulic-cement-based, polymer-modified, self-leveling underlayment for application below interior floor coverings.

C. Action Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittals:
      a. Product Data for Credit IEQ 4.2: For priming and sealing coatings, documentation including printed statement of VOC content.
   3. Shop Drawings: Include plans indicating substrates, locations, and average depths of underlayment based on survey of substrate conditions.

D. Informational Submittals
   1. Qualification Data: For qualified Installer.
   2. Product Certificates: Signed by manufacturers of underlayment and floor-covering systems certifying that products are compatible.
   3. Minutes of preinstallation conference.

E. Quality Assurance
   1. Installer Qualifications: Installer who is approved by manufacturer for application of underlayment products required for this Project.
   2. Product Compatibility: Manufacturers of underlayment and floor-covering systems certify in writing that products are compatible.
   3. Fire-Resistance Ratings: Where indicated, provide hydraulic-cement underlayment systems identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
      a. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
   4. Sound Transmission Characteristics: Where indicated, provide hydraulic-cement underlayment systems identical to those of assemblies tested for STC and IIC ratings per ASTM E 90 and ASTM E 492 by a qualified testing agency.

F. Delivery, Storage, And Handling
   1. Store materials to comply with manufacturer's written instructions to prevent deterioration from moisture or other detrimental effects.

G. Project Conditions
   1. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ventilation, ambient temperature and humidity, and other conditions affecting underlayment performance.
      a. Place hydraulic-cement-based underlayments only when ambient temperature and temperature of substrates are between 50 and 80 deg F (10 and 27 deg C).

1.2 PRODUCTS

A. Hydraulic-Cement-Based Underlayments
1. Underlayment: Hydraulic-cement-based, polymer-modified, self-leveling product that can be applied in minimum uniform thicknesses of 1/4 inch (6 mm) and that can be feathered at edges to match adjacent floor elevations.
   a. Cement Binder: ASTM C 150, portland cement, or hydraulic or blended hydraulic cement as defined by ASTM C 219.
   b. Compressive Strength: Not less than 4100 psi (28 MPa) at 28 days when tested according to ASTM C 109/C 109M.
   c. Underlayment Additive: Resilient-emulsion product of underlayment manufacturer formulated for use with underlayment when applied to substrate and conditions indicated.
2. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3 to 6 mm); or coarse sand as recommended by underlayment manufacturer.
   a. Provide aggregate when recommended in writing by underlayment manufacturer for underlayment thickness required.
3. Water: Potable and at a temperature of not more than 70 deg F (21 deg C).
4. Reinforcement: For underlayment applied to wood substrates, provide galvanized metal lath or other corrosion-resistant reinforcement recommended in writing by underlayment manufacturer.
5. Primer: Product of underlayment manufacturer recommended in writing for substrate, conditions, and application indicated.
6. Corrosion-Resistant Coating: Recommended in writing by underlayment manufacturer for metal substrates.

B. Accessories
1. Sound Mat
2. Sound Reduction Board

1.3 EXECUTION

A. Examination
1. Examine substrates, with Installer present, for conditions affecting performance.
   a. Proceed with application only after unsatisfactory conditions have been corrected.

B. Preparation
1. General: Prepare and clean substrate according to manufacturer's written instructions.
   a. Treat nonmoving substrate cracks according to manufacturer's written instructions to prevent cracks from telegraphing (reflecting) through underlayment.
   b. Fill substrate voids to prevent underlayment from leaking.
2. Concrete Substrates: Mechanically remove, according to manufacturer's written instructions, laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants that might impair underlayment bond.
   a. Moisture Testing: Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates do not exceed a maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/100 sq. m) in 24 hours.
3. Wood Substrates: Mechanically fasten loose boards and panels to eliminate substrate movement and squeaks. Sand to remove coatings that might impair underlayment bond and remove sanding dust.
   a. Install underlayment reinforcement recommended in writing by manufacturer.
4. Metal Substrates: Mechanically remove, according to manufacturer's written instructions, rust, foreign matter, and other contaminants that might impair underlayment bond. Apply corrosion-resistant coating compatible with underlayment if recommended in writing by underlayment manufacturer.

5. Nonporous Substrates: For ceramic tile, quarry tile, and terrazzo substrates, remove waxes, sealants, and other contaminants that might impair underlayment bond, and prepare surfaces according to manufacturer's written instructions.
6. Adhesion Tests: After substrate preparation, test substrate for adhesion with underlayment according to manufacturer's written instructions.
7. Sound Control Mat and Board: Install sound control materials according to manufacturer's written instructions.
   a. Do not install mechanical fasteners that penetrate through the sound control materials.

C. Application
1. General: Mix and apply underlayment components according to manufacturer's written instructions.
   a. Close areas to traffic during underlayment application and for time period after application recommended in writing by manufacturer.
   b. Coordinate application of components to provide optimum underlayment-to-substrate and intercoat adhesion.
   c. At substrate expansion, isolation, and other moving joints, allow joint of same width to continue through underlayment.
2. Apply primer over prepared substrate at manufacturer's recommended spreading rate.
3. Apply underlayment to produce uniform, level surface.
   a. Apply a final layer without aggregate to product surface.
   b. Feather edges to match adjacent floor elevations.
4. Cure underlayment according to manufacturer's written instructions. Prevent contamination during application and curing processes.
5. Do not install floor coverings over underlayment until after time period recommended in writing by underlayment manufacturer.
6. Remove and replace underlayment areas that evidence lack of bond with substrate, including areas that emit a "hollow" sound when tapped.

D. Protection
1. Protect underlayment from concentrated and rolling loads for remainder of construction period.

END OF SECTION 03 54 16 00

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Task	Specification	Specification Description
03 61 16 00	01 22 16 00	No Specification Required
03 62 13 00	03 41 23 00	Plant-Precast Structural Concrete
03 62 16 00	03 41 23 00	Plant-Precast Structural Concrete
03 64 23 00	03 41 23 00	Plant-Precast Structural Concrete
03 64 26 00	01 22 16 00	No Specification Required

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SECTION 04 01 20 91 - CLAY MASONRY RESTORATION AND CLEANING

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for clay masonry restoration and cleaning. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section includes maintenance of unit masonry consisting of brick and terra cotta clay masonry restoration and cleaning as follows:
    a. Unused anchor removal.
    b. Repairing unit masonry, including replacing units.
    c. Painting steel uncovered during the work.
    d. Reanchoring veneers.
    e. Repointing joints.
    f. Preliminary cleaning, including removing plant growth.
    g. Cleaning exposed unit masonry surfaces.
2. Owner-Furnished Material: Salvaged brick (if salvaged brick is available from the Owner for reuse).

C. Definitions

1. Very Low-Pressure Spray: Under 100 psi (690 kPa).
2. Low-Pressure Spray: 100 to 400 psi (690 to 2750 kPa); 4 to 6 gpm (0.25 to 0.4 L/s).
3. Medium-Pressure Spray: 400 to 800 psi (2750 to 5510 kPa); 4 to 6 gpm (0.25 to 0.4 L/s).
4. High-Pressure Spray: 800 to 1200 psi (5510 to 8250 kPa); 4 to 6 gpm (0.25 to 0.4 L/s).
5. Saturation Coefficient: Ratio of the weight of water absorbed during immersion in cold water to weight absorbed during immersion in boiling water; used as an indication of resistance of masonry units to freezing and thawing.

D. Preconstruction Testing

1. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on masonry units as follows.
    a. Existing Brick and Terra Cotta: Test each type of existing masonry unit indicated for replacement, according to testing methods in ASTM C 67 for compressive strength, 24-hour cold-water absorption, 5-hour boil absorption, saturation coefficient, and initial rate of absorption (suction). Carefully remove five existing units from locations designated by the Owner. Take testing samples from these units.
    b. Existing Mortar: Test according to ASTM C 295, modified as agreed by testing service and the Owner for Project requirements, to determine proportional composition of original ingredients, sizes and colors of aggregates, and approximate strength. Use X-ray diffraction, infrared spectroscopy, and differential thermal analysis as necessary to supplement microscopical methods. Carefully remove existing mortar from within joints at five locations designated by the Owner or testing service.
    c. Temporary Patch: as directed by the Owner, provide temporary materials at locations from which existing samples were taken.
    d. Replacement Brick and Terra Cotta: Test each proposed type of replacement masonry unit, according to sampling and testing methods in ASTM C 67 for compressive strength, 24-hour cold-water absorption, 5-hour boil absorption, saturation coefficient, and initial rate of absorption (suction).

E. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings: For the following:
   a. Full-size patterns with complete dimensions for new terra cotta units, specially molded brick shapes, and brick arches and their jointing, showing relation of existing to new units.
   b. Setting number of each new terra cotta unit and its location on the structure in annotated plans and elevations.
   c. Provisions for expansion joints or other sealant joints.
   d. Provisions for flashing, lighting fixtures, conduits, and weep holes as required.
   e. Replacement and repair anchors. Include details of anchors within individual masonry units, with locations of anchors and dimensions of holes and recesses in units required for anchors.
3. Samples: For each exposed product and for each color and texture specified.
4. Preconstruction Test Reports.

F. Quality Assurance
1. Restoration Specialist Qualifications: Engage an experienced, preapproved masonry restoration and cleaning firm to perform work of this Section. Firm shall have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance. Experience installing standard unit masonry is not sufficient experience for masonry restoration work.
   a. At Contractor's option, work may be divided between two specialist firms: one for cleaning work and one for repair work.
   b. Field Supervision: Restoration specialist firms shall maintain experienced full-time supervisors on Project site during times that clay masonry restoration and cleaning work is in progress. Supervisors shall not be changed during Project except for causes beyond the control of restoration specialist firm.
   c. Restoration Worker Qualifications: Persons who are experienced and specialize in restoration work of types they will be performing. When masonry units are being patched, assign at least one worker among those performing patching work who is trained and certified by manufacturer of patching compound to apply its products.
2. Terra Cotta Manufacturer Qualifications: A firm regularly engaged in manufacturing custom architectural terra cotta units for building restoration purposes, of same type and of similar size, complexity, and tolerances as those required for the Work.
3. Mockups: Prepare mockups of restoration and cleaning to demonstrate aesthetic effects and set quality standards for materials and execution and for fabrication and installation.
   a. Masonry Repair: Prepare sample areas for each type of masonry material indicated to have repair work performed. If not otherwise indicated, size each mockup not smaller than 2 adjacent whole units or approximately 48 inches (1200 mm) in least dimension. Erect sample areas in existing walls unless otherwise indicated, to demonstrate quality of materials, workmanship, and blending with existing work. Include the following as a minimum:
      1) Replacement:
         a) Four brick units replaced.
         b) Four terra cotta units replaced.
      2) Reanchoring Veneers: Install three masonry repair anchors in mockup wall assembly of each anchor type required.
      3) Patching: Three small holes at least 1 inch (25 mm) in diameter **OR** as directed, **as directed**, for each type of masonry material indicated to be patched, so as to leave no evidence of repair.
      4) Widening Joints: Widen a joint in 2 separate locations, each approximately 12 inches (300 mm) long **OR** as directed, **as directed**.
   b. Repointing: Rake out joints in 2 separate areas, each approximately 36 inches (900 mm) high by 48 inches (1200 mm) wide **OR** as indicated, **as directed**, for each type of repointing required and repoint one of the areas.

c. Cleaning: Clean an area approximately 25 sq. ft. (2.3 sq. m) **OR** as indicated, **as directed**, for each type of masonry and surface condition.
4. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver masonry units to Project site strapped together in suitable packs or pallets or in heavy-duty cartons.
2. Deliver each piece of terra cotta with code mark or setting number on unexposed face, corresponding to Shop Drawings, using nonstaining paint.
3. Deliver other materials to Project site in manufacturer's original and unopened containers, labeled with manufacturer's name and type of products.
4. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
5. Store hydrated lime in manufacturer's original and unopened containers. Discard lime if containers have been damaged or have been opened for more than two days.
6. Store lime putty covered with water in sealed containers.
7. Store sand where grading and other required characteristics can be maintained and contamination avoided.

H. Project Conditions
1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit masonry restoration and cleaning work to be performed according to manufacturers' written instructions and specified requirements.
2. Repair masonry units and repoint mortar joints only when air temperature is between 40 and 90 deg F (4 and 32 deg C) and is predicted to remain so for at least 7 days after completion of the Work unless otherwise indicated.
3. Cold-Weather Requirements: Comply with the following procedures for masonry repair and mortar-joint pointing unless otherwise indicated:
   a. When air temperature is below 40 deg F (4 deg C), heat mortar ingredients, masonry repair materials, and existing masonry walls to produce temperatures between 40 and 120 deg F (4 and 49 deg C).
   b. When mean daily air temperature is below 40 deg F (4 deg C), provide enclosure and heat to maintain temperatures above 32 deg F (0 deg C) within the enclosure for 7 days after repair and pointing.
   c. Hot-Weather Requirements: Protect masonry repair and mortar-joint pointing when temperature and humidity conditions produce excessive evaporation of water from mortar and repair materials. Provide artificial shade and wind breaks and use cooled materials as required to minimize evaporation. Do not apply mortar to substrates with temperatures of 90 deg F (32 deg C) and above unless otherwise indicated.
4. For manufactured repair materials, perform work within the environmental limits set by each manufacturer.
5. Clean masonry surfaces only when air temperature is 40 deg F (4 deg C) and above and is predicted to remain so for at least 7 days after completion of cleaning.

1.2 PRODUCTS

A. Masonry Materials
1. Face Brick: Provide face brick, including specially molded, ground, cut, or sawed shapes where required to complete masonry restoration work.
   a. Provide units with physical properties, colors, color variation within units, surface texture, size, and shape to match existing brickwork.
      1) Physical Properties per ASTM C 67:
      2) For existing brickwork that exhibits a range of colors or color variation within units, provide brick that proportionally matches that range and variation rather than brick that matches an individual color within that range.

b. Special Shapes:
1) Provide specially molded, 100 percent solid shapes for applications where core holes or "frogs" could be exposed to view or weather when in final position and where shapes produced by sawing would result in sawed surfaces being exposed to view.
2) Provide specially ground units, shaped to match patterns, for arches and where indicated.
3) Mechanical chopping or breaking brick, or bonding pieces of brick together by adhesive, are not acceptable procedures for fabricating special shapes.

c. Tolerances as Fabricated: Comply with tolerance requirements in ASTM C 216, Type FBX **OR** Comply with tolerance requirements in ASTM C 216, Type FBS, **as directed**.

2. Building Brick: Provide building brick complying with ASTM C 62, of same vertical dimension as face brick, for masonry work concealed from view.
a. Grade SW where in contact with earth.
b. Grade SW, MW, or NW for concealed backup.

3. Salvaged Brick: Obtain salvaged brick from the Owner from location shown on Drawings. Clean off residual mortar.

4. Glazed Terra Cotta: Provide new terra cotta units to match existing terra cotta units in body composition, physical properties, color, gloss, surface texture, thickness, profile, dimensions, and composition of surface glaze.
a. Physical Properties: Provide units with tested physical properties within 10 percent of those determined from preconstruction testing of selected existing units.
1) Physical Properties per ASTM C 67:
b. Tolerances as Fabricated: Comply with tolerance requirements in ASTM C 212, Type FTX.

5. Brownstone Terra Cotta: Provide new, unglazed, brownstone terra cotta units to match existing terra cotta units in body composition, physical properties, colors, color variation within units, surface texture, unit profile, and dimensions.
a. Physical Properties: Provide units with tested physical properties within 10 percent of those determined from preconstruction testing of selected existing units.
b. Physical Properties per ASTM C 67:
c. Tolerances as Fabricated: Comply with tolerance requirements in ASTM C 212, Type FTX.
d. For existing terra cotta that exhibits a range of colors or color variation within units, provide terra cotta that proportionally matches that range and variation rather than terra cotta that matches an individual color within that range.

B. Mortar Materials
1. Portland Cement: ASTM C 150, Type I or Type II, white or gray or both where required for color matching of exposed mortar.
a. Provide cement containing not more than 0.60 percent total alkali when tested according to ASTM C 114.
2. Hydrated Lime: ASTM C 207, Type S.
3. Factory-Prepared Lime Putty: ASTM C 1489.
4. Quicklime: ASTM C 5, pulverized lime.
5. Mortar Sand: ASTM C 144 unless otherwise indicated.
a. Color: Provide natural sand or ground marble, granite, or other sound stone of color necessary to produce required mortar color.
b. For pointing mortar, provide sand with rounded edges.
c. Match size, texture, and gradation of existing mortar sand as closely as possible. Blend several sands if necessary to achieve suitable match.
6. Mortar Pigments: Natural and synthetic iron oxides, compounded for mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortars.
7. Water: Potable.

C. Manufactured Repair Materials
1. Masonry Patching Compound: Factory-mixed cementitious product that is custom manufactured for patching masonry.
a. Use formulation that is vapor- and water permeable (equal to or more than the masonry unit), exhibits low shrinkage, has lower modulus of elasticity than the masonry units being repaired, and develops high bond strength to all types of masonry.
b. Use formulation having working qualities and retardation control to permit forming and sculpturing where necessary.
c. Formulate patching compound used for patching brick and terra cotta in colors and textures to match each masonry unit being patched.
2. Terra Cotta Glaze Replacement: A high-solids, nonyellowing, fade-resistant, waterborne polyurethane or epoxy coating intended for exterior use as terra cotta glaze replacement. Product shall be custom mixed by manufacturer to match color and gloss of existing terra cotta glaze.

D. Paint Removers
1. Alkaline Paste Paint Remover: Manufacturer's standard alkaline paste formulation for removing paint coatings from masonry.
2. Covered or Skin-Forming Alkaline Paint Remover: Manufacturer's standard covered or skin-forming alkaline formulation for removing paint coatings from masonry.
3. Solvent-Type Paint Remover: Manufacturer's standard water-rinsable, solvent-type gel formulation for removing paint coatings from masonry.
4. Low-Odor, Solvent-Type Paint Remover: Manufacturer's standard low-odor, water-rinsable solvent-type gel formulation, containing no methanol or methylene chloride, for removing paint coatings from masonry.

E. Cleaning Materials
1. Water: Potable.
2. Hot Water: Water heated to a temperature of 140 to 160 deg F (60 to 71 deg C).
3. Job-Mixed Detergent Solution: Solution prepared by mixing 2 cups (0.5 L) of tetrasodium polyphosphate, 1/2 cup (125 mL) of laundry detergent, and 20 quarts (20 L) of hot water for every 5 gal. (20 L) of solution required.
4. Job-Mixed Mold, Mildew, and Algae Remover: Solution prepared by mixing 2 cups (0.5 L) of tetrasodium polyphosphate, 5 quarts (5 L) of 5 percent sodium hypochlorite (bleach), and 15 quarts (15 L) of hot water for every 5 gal. (20 L) of solution required.
5. Nonacidic Gel Cleaner: Manufacturer's standard gel formulation, with pH between 6 and 9, that contains detergents with chelating agents and is specifically formulated for cleaning masonry surfaces.
6. Nonacidic Liquid Cleaner: Manufacturer's standard mildly alkaline liquid cleaner formulated for removing mold, mildew, and other organic soiling from ordinary building materials, including polished stone, brick, aluminum, plastics, and wood.
7. Mild Acidic Cleaner: Manufacturer's standard mildly acidic cleaner containing no muriatic (hydrochloric), hydrofluoric, or sulfuric acid; or ammonium bifluoride or chlorine bleaches.
8. Acidic Cleaner: Manufacturer's standard acidic masonry cleaner composed of hydrofluoric acid or ammonium bifluoride blended with other acids, detergents, wetting agents, and inhibitors.
9. Two-Part Chemical Cleaner: Manufacturer's standard system consisting of potassium or sodium hydroxide based, alkaline prewash cleaner and acidic afterwash cleaner that does not contain hydrofluoric acid.

F. Accessory Materials
1. Liquid Strippable Masking Agent: Manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, and polished stone surfaces from damaging effects of acidic and alkaline masonry cleaners.
2. Terra Cotta Anchors: Type and size indicated or, if not indicated, to match existing anchors in size and type. Fabricate anchors from Type 304 **OR** Type 316, **as directed**, stainless steel.

3. Masonry Repair Anchors, Expansion Type: Mechanical fasteners designed for masonry veneer stabilization consisting of 1/4-inch- (6-mm-) diameter, Type 304 **OR** Type 316, **as directed**, stainless-steel rod with brass expanding shells at each end and water-shedding washer in the middle. Expanding shells shall be designed to provide positive mechanical anchorage to veneer on one end and backup masonry on the other.
4. Masonry Repair Anchors, Spiral Type: Type 304 **OR** Type 316, **as directed**, stainless-steel spiral rods designed to anchor to backing and veneer. Anchors are flexible in plane of veneer but rigid perpendicular to it.
    a. Provide adhesive-installed anchors complete with manufacturer's standard epoxy adhesive and injection tubes, or other devices required for installation.
    b. Provide driven-in anchors designed to be installed in drilled holes and relying on screw effect rather than adhesive to secure them to backup and veneer.
5. Masonry Repair Anchors, Rod/Screen Tube Type: Stainless-steel screen tube with or without Type 304 **OR** Type 316, **as directed**, stainless-steel rod, adhesive installed by injection with manufacturer's standard epoxy adhesive, complete with other devices required for installation.
6. Sealant Materials:
    a. Provide manufacturer's standard chemically curing, elastomeric sealant(s) of base polymer and characteristics indicated below that comply with applicable requirements in Division 07 Section "Joint Sealants".
        1) Single-component, nonsag urethane sealant.
    b. Colors: Provide colors of exposed sealants to match colors of masonry adjoining installed sealant unless otherwise indicated.
    c. Ground-Mortar Aggregate: Custom crushed and ground pointing mortar sand or existing mortar retrieved from joints. Grind to a particle size that matches the adjacent mortar aggregate and color. Remove all fines passing the 100 sieve.
7. Joint-Sealant Backing:
    a. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin) or Type B (bicellular material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
    b. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where acceptable.
8. Setting Buttons: Resilient plastic buttons, nonstaining to masonry, sized to suit joint thicknesses and bed depths of masonry units without intruding into required depths of pointing materials.
9. Masking Tape: Nonstaining, nonabsorbent material, compatible with pointing mortar, joint primers, sealants, and surfaces adjacent to joints; that will easily come off entirely, including adhesive.
10. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with MPI #79, Alkyd Anticorrosive Metal Primer or SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating.
    a. Use coating requiring no better than SSPC-SP 2, "Hand Tool Cleaning" **OR** SSPC-SP 3, "Power Tool Cleaning" **OR** SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning", **as directed**, surface preparation according to manufacturer's literature or certified statement.
    b. Use coating with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
11. Miscellaneous Products: Select materials and methods of use based on the following, subject to approval of a mockup:
    a. Previous effectiveness in performing the work involved.
    b. Little possibility of damaging exposed surfaces.
    c. Consistency of each application.
    d. Uniformity of the resulting overall appearance.
    e. Do not use products or tools that could do the following:
        1) Remove, alter, or in any way harm the present condition or future preservation of existing surfaces, including surrounding surfaces not in contract.

2) Leave a residue on surfaces.

G. Mortar Mixes
1. Preparing Lime Putty: Slake quicklime and prepare lime putty according to appendix to ASTM C 5 and manufacturer's written instructions.
2. Measurement and Mixing: Measure cementitious materials and sand in a dry condition by volume or equivalent weight. Do not measure by shovel; use known measure. Mix materials in a clean, mechanical batch mixer.
    a. Mixing Pointing Mortar: Thoroughly mix cementitious materials and sand together before adding any water. Then mix again adding only enough water to produce a damp, unworkable mix that will retain its form when pressed into a ball. Maintain mortar in this dampened condition for 15 to 30 minutes. Add remaining water in small portions until mortar reaches desired consistency. Use mortar within one hour of final mixing; do not retemper or use partially hardened material.
3. Colored Mortar: Produce mortar of color required by using specified ingredients. Do not alter specified proportions without the Owner's approval.
    a. Mortar Pigments: Where mortar pigments are indicated, do not exceed a pigment-to-cement ratio of 1:10 by weight.
4. Do not use admixtures in mortar unless otherwise indicated.
5. Mortar Proportions: Mix mortar materials in the following proportions:
    a. Pointing Mortar for Brick: 1 part portland cement, 2 parts lime, and 6 parts sand **OR** 1 part portland cement, 6 parts lime, and 12 parts sand, **as directed**.
        1) Add mortar pigments to produce mortar colors required.
    b. Pointing Mortar for Terra Cotta: 1 part white portland cement, 1 part lime, and 6 parts sand.
        1) Add mortar pigments to produce mortar colors required.
    c. Rebuilding (Setting) Mortar: Same as pointing mortar except mortar pigments are not required, **as directed**.
    d. Rebuilding (Setting) Mortar: 1 part portland cement, 2 parts lime, and 6 parts sand **OR** 1 part portland cement, 6 parts lime, and 12 parts sand, **as directed**.
    e. Rebuilding (Setting) Mortar: Comply with ASTM C 270, Proportion Specification, Type N unless otherwise indicated; with cementitious material limited to portland cement and lime.

H. Chemical Cleaning Solutions
1. Dilute chemical cleaners with water to produce solutions not exceeding concentration recommended by chemical-cleaner manufacturer.
2. Acidic Cleaner Solution for Brick and Brownstone Terra Cotta: Dilute with water to produce hydrofluoric acid content of 3 percent or less, but not greater than that recommended by chemical-cleaner manufacturer.
3. Acidic Cleaner Solution for Glazed Terra Cotta: Dilute with water to concentration demonstrated by testing that does not etch or otherwise damage terra cotta surface, but not greater than that recommended by chemical-cleaner manufacturer.

1.3 EXECUTION

A. Protection
1. Protect persons, motor vehicles, surrounding surfaces of building being restored, building site, plants, and surrounding buildings from harm resulting from masonry restoration work.
    a. Erect temporary protective covers over walkways and at points of pedestrian and vehicular entrance and exit that must remain in service during course of restoration and cleaning work.
2. Comply with chemical-cleaner manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent chemical-cleaning solutions from coming into contact with people, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

a. Cover adjacent surfaces with materials that are proven to resist chemical cleaners used unless chemical cleaners being used will not damage adjacent surfaces. Use materials that contain only waterproof, UV-resistant adhesives. Apply masking agents to comply with manufacturer's written instructions. Do not apply liquid masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
b. Keep wall wet below area being cleaned to prevent streaking from runoff.
c. Do not clean masonry during winds of sufficient force to spread cleaning solutions to unprotected surfaces.
d. Neutralize and collect alkaline and acid wastes for disposal off the Owner's property.
e. Dispose of runoff from cleaning operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

3. Prevent mortar from staining face of surrounding masonry and other surfaces.
a. Cover sills, ledges, and projections to protect from mortar droppings.
b. Keep wall area wet below rebuilding and pointing work to discourage mortar from adhering.
c. Immediately remove mortar in contact with exposed masonry and other surfaces.
d. Clean mortar splatters from scaffolding at end of each day.

4. Remove gutters and downspouts adjacent to masonry and store where indicated during masonry restoration and cleaning. Reinstall when masonry restoration and cleaning are complete.
a. Provide temporary rain drainage during work as indicated to direct water away from building.

B. Unused Anchor Removal

1. Remove masonry anchors, brackets, wood nailers, and other extraneous items no longer in use unless identified as historically significant or indicated to remain.
a. Remove items carefully to avoid spalling or cracking masonry.
b. Where directed, if an item cannot be removed without damaging surrounding masonry, do the following:
1) Cut or grind off item approximately 3/4 inch (20 mm) beneath surface and core drill a recess of same depth in surrounding masonry as close around item as practical.
2) Immediately paint exposed end of item with two coats of antirust coating, following coating manufacturer's written instructions and without exceeding manufacturer's recommended dry film thickness per coat. Keep paint off sides of recess.
c. Patch the hole where each item was removed unless directed to remove and replace the masonry unit.

C. Brick Removal And Replacement

1. At locations indicated, remove bricks that are damaged, spalled, or deteriorated or are to be reused. Carefully demolish or remove entire units from joint to joint, without damaging surrounding masonry, in a manner that permits replacement with full-size units.
a. When removing single bricks, remove material from center of brick and work toward outside edges.

2. Support and protect remaining masonry that surrounds removal area. Maintain flashing, reinforcement, lintels, and adjoining construction in an undamaged condition.

3. Notify the Owner of unforeseen detrimental conditions including voids, cracks, bulges, and loose units in existing masonry backup, rotted wood, rusted metal, and other deteriorated items.

4. Remove in an undamaged condition as many whole bricks as possible.
a. Remove mortar, loose particles, and soil from brick by cleaning with hand chisels, brushes, and water.
b. Remove sealants by cutting close to brick with utility knife and cleaning with solvents.
c. Store brick for reuse. Store off ground, on skids, and protected from weather.
d. Deliver cleaned brick not required for reuse to the Owner unless otherwise indicated.

5. Clean bricks surrounding removal areas by removing mortar, dust, and loose particles in preparation for replacement.

6. Replace removed damaged brick with other removed brick and salvaged brick in good quality, where possible, or with new brick matching existing brick, including size. Do not use broken units unless they can be cut to usable size.
7. Install replacement brick into bonding and coursing pattern of existing brick. If cutting is required, use a motor-driven saw designed to cut masonry with clean, sharp, unchipped edges.
   a. Maintain joint width for replacement units to match existing joints.
   b. Use setting buttons or shims to set units accurately spaced with uniform joints.
8. Lay replacement brick with completely filled bed, head, and collar joints. Butter ends with sufficient mortar to fill head joints and shove into place. Wet both replacement and surrounding bricks that have ASTM C 67 initial rates of absorption (suction) of more than 30 g/30 sq. in. per min. (30 g/194 sq. cm per min.). Use wetting methods that ensure that units are nearly saturated but surface is dry when laid.
   a. Tool exposed mortar joints in repaired areas to match joints of surrounding existing brickwork.
   b. Rake out mortar used for laying brick before mortar sets and point new mortar joints in repaired area to comply with requirements for repointing existing masonry, and at same time as repointing of surrounding area.
   c. When mortar is sufficiently hard to support units, remove shims and other devices interfering with pointing of joints.

D. Terra Cotta Removal And Replacement
1. At locations indicated, remove terra cotta units that are damaged, spalled, or deteriorated. Carefully demolish or remove entire units from joint to joint, without damaging surrounding masonry, in a manner that permits replacement with full-size units.
2. Support and protect remaining masonry that was supported by removed units. Maintain flashing, reinforcement, lintels, and adjoining construction in an undamaged condition.
3. Notify the Owner of unforeseen detrimental conditions including voids, cracks, bulges, and loose units in existing masonry backup, rotted wood, rusted metal, and other deteriorated items.
4. Clean masonry surrounding removal areas by removing mortar, dust, and loose particles in preparation for replacement.
5. Install replacement units into bonding and coursing pattern of existing units.
   a. Do not cut or grind glazed terra cotta.
   b. If minor cutting of replacement brownstone terra cotta is required, use a motor-driven grinder or saw designed to cut masonry with clean, sharp, unchipped edges. Do not cut or grind more than 1/8 inch (3 mm) along any edge.
   c. Use setting buttons or shims to set units accurately spaced with uniform joints.
6. Set replacement units in a full bed of mortar. Replace existing anchors with new anchors of size and type indicated.
   a. Embed anchors in mortar and fill voids behind units with mortar.
   b. Tool exposed mortar joints in repaired areas to match joints of surrounding existing terra cotta.
   c. Rake out mortar used for laying terra cotta before mortar sets and point new mortar joints in repaired area to comply with requirements for repointing existing masonry, and at same time as repointing of surrounding area.
   d. When mortar is sufficiently hard to support units, remove shims and other devices interfering with pointing of joints.

E. Reanchoring Veneers
1. Install masonry repair anchors in horizontal mortar joints and according to manufacturer's written instructions. Install at not more than 16 inches (400 mm) o.c. vertically and 32 inches (800 mm) o.c. horizontally unless otherwise indicated. Install at locations to avoid penetrating flashing.
2. Recess anchors at least 5/8 inch (16 mm) from surface of mortar joint and fill recess with pointing mortar.

F. Painting Steel Uncovered During The Work

1. Inspect steel exposed during masonry removal. Where the Owner determines that it is structural, or for other reasons cannot be totally removed, prepare and paint it as follows:
   a. Remove paint, rust, and other contaminants according to SSPC-SP 2, "Hand Tool Cleaning" **OR** SSPC-SP 3, "Power Tool Cleaning" **OR** SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning", **as directed**, as applicable to meet paint manufacturer's recommended preparation.
   b. Immediately paint exposed steel with two coats of antirust coating, following coating manufacturer's written instructions and without exceeding manufacturer's recommended rate of application (dry film thickness per coat).
2. If on inspection and rust removal, the cross section of a steel member is found to be reduced from rust by more than 1/16 inch (1.6 mm), notify the Owner before proceeding.

G. Masonry Unit Patching
1. Patch the following masonry units unless another type of replacement or repair is indicated:
   a. Units indicated to be patched.
   b. Units with holes.
   c. Units with chipped edges or corners.
   d. Units with small areas of deep deterioration.
2. Remove and replace existing patches unless otherwise indicated or approved by the Owner.
3. Patching Bricks:
   a. Remove loose material from masonry surface. Carefully remove additional material so patch will not have feathered edges but will have square or slightly undercut edges on area to be patched and will be at least 1/4 inch (6 mm) thick, but not less than recommended by patching compound manufacturer.
   b. Mask adjacent mortar joint or rake out for repointing if patch will extend to edge of masonry unit.
   c. Mix patching compound in individual batches to match each unit being patched. Combine one or more colors of patching compound, as needed, to produce exact match.
   d. Rinse surface to be patched and leave damp, but without standing water.
   e. Brush-coat surfaces with slurry coat of patching compound according to manufacturer's written instructions.
   f. Place patching compound in layers as recommended by patching compound manufacturer, but not less than 1/4 inch (6 mm) or more than 2 inches (50 mm) thick. Roughen surface of each layer to provide a key for next layer.
   g. Trowel, scrape, or carve surface of patch to match texture and surrounding surface plane or contour of the masonry unit. Shape and finish surface before or after curing, as determined by testing, to best match existing masonry unit.
   h. Keep each layer damp for 72 hours or until patching compound has set.
4. Patching Terra Cotta:
   a. Remove deteriorated material as determined by sounding gently with a small hammer. Carefully remove additional material so patch will not have feathered edges but will have square or slightly undercut edges on area to be patched and will be at least 1/4 inch (6 mm) thick, but not less than recommended by patching compound manufacturer.
   b. Where mortar joints adjacent to patch are open, fill back of joints with pointing mortar and allow to cure before patching terra cotta. Leave space for pointing joints according to "Repointing Masonry" Article.
   c. Mask adjacent mortar joint or rake out for repointing if patch will extend to edge of unit.
   d. Rinse surface to be patched and leave damp, but without standing water.
   e. Brush-coat surfaces with slurry coat of patching compound according to manufacturer's written instructions.
   f. Place patching compound in layers as recommended by patching compound manufacturer, but not less than 1/4 inch (6 mm) or more than 2 inches (50 mm) thick. Roughen surface of each layer to provide a key for next layer.
   g. Do not apply patching compound over mortar joints. If patching compound bridges mortar joints, cut out joints after patching compound hardens.

h. Trowel, scrape, or carve surface of patch to match texture, details, and surrounding surface plane or contour of terra cotta. Shape and finish surface before or after curing, as determined by testing to best match existing terra cotta.
i. Keep each layer damp for 72 hours or until patching compound has set.
j. After final layer of patching compound has cured, apply glaze replacement according to manufacturer's written instructions. Apply two or more coats, as needed, to match glaze of adjacent terra cotta units.

H. Widening Joints
1. Do not widen a joint, except where indicated or approved by the Owner.
2. Location Guideline: Where an existing masonry unit abuts another or the joint is less than 1/8 inch (3 mm), widen the joint for length indicated and to depth required for repointing after obtaining the Owner 's approval.
3. Carefully perform widening by cutting, grinding, routing, or filing procedures demonstrated in an approved mockup.
4. Widen joint to width equal to or less than predominant width of other joints on building. Make sides of widened joint uniform and parallel. Ensure that edges of units along widened joint are in alignment with joint edges at unaltered joints.

I. Cleaning Masonry, General
1. Proceed with cleaning in an orderly manner; work from bottom to top **OR** top to bottom, **as directed**, of each scaffold width and from one end of each elevation to the other. Ensure that dirty residues and rinse water will not wash over cleaned, dry surfaces.
2. Use only those cleaning methods indicated for each masonry material and location.
a. Do not use wire brushes or brushes that are not resistant to chemical cleaner being used. Do not use plastic-bristle brushes if natural-fiber brushes will resist chemical cleaner being used.
b. Use spray equipment that provides controlled application at volume and pressure indicated, measured at spray tip. Adjust pressure and volume to ensure that cleaning methods do not damage masonry.
1) Equip units with pressure gages.
c. For chemical-cleaner spray application, use low-pressure tank or chemical pump suitable for chemical cleaner indicated, equipped with cone-shaped spray tip.
d. For water-spray application, use fan-shaped spray tip that disperses water at an angle of 25 to 50 degrees.
e. For high-pressure water-spray application, use fan-shaped spray tip that disperses water at an angle of at least 40 degrees.
f. For heated water-spray application, use equipment capable of maintaining temperature between 140 and 160 deg F (60 and 71 deg C) at flow rates indicated.
g. For steam application, use steam generator capable of delivering live steam at nozzle.
3. Perform each cleaning method indicated in a manner that results in uniform coverage of all surfaces, including corners, moldings, and interstices, and that produces an even effect without streaking or damaging masonry surfaces.
4. Water Application Methods:
a. Water-Soak Application: Soak masonry surfaces by applying water continuously and uniformly to limited area for time indicated. Apply water at low pressures and low volumes in multiple fine sprays using perforated hoses or multiple spray nozzles. Erect a protective enclosure constructed of polyethylene sheeting to cover area being sprayed.
b. Water-Spray Applications: Unless otherwise indicated, hold spray nozzle at least 6 inches (150 mm) from surface of masonry and apply water in horizontal back and forth sweeping motion, overlapping previous strokes to produce uniform coverage.
5. Steam Cleaning: Apply steam to masonry surfaces at the very low pressures indicated for each type of masonry material. Hold nozzle at least 6 inches (150 mm) from surface of masonry and apply steam in horizontal back and forth sweeping motion, overlapping previous strokes to produce uniform coverage.

6. Chemical-Cleaner Application Methods: Apply chemical cleaners to masonry surfaces to comply with chemical-cleaner manufacturer's written instructions; use brush or spray application. Do not spray apply at pressures exceeding 50 psi (345 kPa). Do not allow chemicals to remain on surface for periods longer than those indicated or recommended by manufacturer.
7. Rinse off chemical residue and soil by working upward from bottom to top of each treated area at each stage or scaffold setting. Periodically during each rinse, test pH of rinse water running off of cleaned area to determine that chemical cleaner is completely removed.
    a. Apply neutralizing agent and repeat rinse if necessary to produce tested pH of between 6.7 and 7.5.
8. After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.

J. Preliminary Cleaning
1. Removing Plant Growth: Completely remove visible plant, moss, and shrub growth from masonry surfaces. Carefully remove plants, creepers, and vegetation by cutting at roots and allowing to dry as long as possible before removal. Remove loose soil and debris from open masonry joints to whatever depth they occur.
2. Preliminary Cleaning: Before beginning general cleaning, remove extraneous substances that are resistant to cleaning methods being used. Extraneous substances include paint, calking, asphalt, and tar.
    a. Carefully remove heavy accumulations of material from surface of masonry with a sharp chisel. Do not scratch or chip masonry surface.
    b. Remove paint and calking with alkaline paint remover.
        1) Comply with requirements in "Paint Removal" Article.
        2) Repeat application up to two times if needed.
    c. Remove asphalt and tar with solvent-type paint remover.
        1) Comply with requirements in "Paint Removal" Article.
        2) Apply paint remover only to asphalt and tar by brush without prewetting.
        3) Allow paint remover to remain on surface for 10 to 30 minutes.
        4) Repeat application if needed.

K. Paint Removal
1. Paint Removal with Alkaline Paste Paint Remover:
    a. Remove loose and peeling paint using low **OR** medium **OR** high, **as directed**,-pressure spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
    b. Apply paint remover to dry, painted masonry with brushes.
    c. Allow paint remover to remain on surface for period recommended by manufacturer.
    d. Rinse with cold **OR** hot, **as directed**, water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and paint residue.
    e. Repeat process if necessary to remove all paint.
    f. Apply acidic cleaner or manufacturer's recommended afterwash to masonry, while surface is still wet, using low-pressure spray equipment or soft-fiber brush. Let cleaner or afterwash remain on surface as a neutralizing agent for period recommended by chemical cleaner or afterwash manufacturer.
    g. Rinse with cold water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and soil.
2. Paint Removal with Covered or Skin-Forming Alkaline Paint Remover:
    a. Remove loose and peeling paint using low **OR** medium **OR** high, **as directed**,-pressure spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
    b. Apply paint remover to dry, painted masonry with trowel, spatula, or as recommended by manufacturer.
    c. Apply cover, if required by manufacturer, per manufacturer's written instructions.
    d. Allow paint remover to remain on surface for period recommended by manufacturer or as determined in test panels.
    e. Scrape off paint and remover and collect for disposal.

f. Rinse with cold **OR** hot, **as directed**, water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and paint residue.
g. Use alkaline paste paint remover, according to "Paint Removal with Alkaline Paste Paint Remover" Paragraph, if necessary to remove remaining paint.
h. Apply acidic cleaner or manufacturer's recommended afterwash to masonry, while surface is still wet, using low-pressure spray equipment or soft-fiber brush. Let cleaner or afterwash remain on surface as a neutralizing agent for period recommended by chemical-cleaner or afterwash manufacturer.
i. Rinse with cold water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and soil.

3. Paint Removal with Solvent-Type Paint Remover:
   a. Remove loose and peeling paint using low **OR** medium **OR** high, **as directed**,-pressure spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
   b. Apply thick coating of paint remover to painted masonry with natural-fiber cleaning brush, deep-nap roller, or large paint brush.
   c. Allow paint remover to remain on surface for period recommended by manufacturer. Agitate periodically with stiff-fiber brush.
   d. Rinse with cold **OR** hot, **as directed**, water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and paint residue.

L. Cleaning Brickwork
1. Cold-Water Soak:
   a. Apply cold water by intermittent spraying to keep surface moist.
   b. Use perforated hoses or other means that will apply a fine water mist to entire surface being cleaned.
   c. Apply water in cycles with at least 30 minutes between cycles.
   d. Continue spraying until surface encrustation has softened sufficiently to permit its removal by water wash, as indicated by cleaning tests.
   e. Continue spraying for 72 hours.
   f. Remove soil and softened surface encrustation from masonry with cold water applied by low-pressure spray.
2. Cold-Water Wash: Use cold water applied by low **OR** medium **OR** high, **as directed**,-pressure spray.
3. Hot-Water Wash: Use hot water applied by low **OR** medium **OR** high, **as directed**,-pressure spray.
4. Steam Cleaning: Apply steam at very low pressures not exceeding 30 psi (207 kPa) **OR** 80 psi (550 kPa), **as directed**. Remove dirt softened by steam with wood scrapers, stiff-nylon or -fiber brushes, or cold-water wash, as indicated by cleaning tests.
5. Detergent Cleaning:
   a. Wet masonry with cold **OR** hot, **as directed**, water applied by low-pressure spray.
   b. Scrub masonry with detergent solution using medium-soft brushes until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from mortar joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that masonry surface remains wet.
   c. Rinse with cold **OR** hot, **as directed**, water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove detergent solution and soil.
   d. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.
6. Mold, Mildew, and Algae Removal:
   a. Wet masonry with cold **OR** hot, **as directed**, water applied by low-pressure spray.
   b. Apply mold, mildew, and algae remover by brush or low-pressure spray.
   c. Scrub masonry with medium-soft brushes until mold, mildew, and algae are thoroughly dislodged and can be removed by rinsing. Use small brushes for mortar joints and crevices. Dip brush in mold, mildew, and algae remover often to ensure that adequate fresh cleaner is used and that masonry surface remains wet.

d. Rinse with cold **OR** hot, **as directed**, water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove mold, mildew, and algae remover and soil.
e. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.

7. Nonacidic Gel Chemical Cleaning:
   a. Wet masonry with cold **OR** hot, **as directed**, water applied by low-pressure spray.
   b. Apply nonacidic gel cleaner in 1/8-inch (3-mm) thickness by brush, working into joints and crevices. Apply quickly and do not brush out excessively so area will be uniformly covered with fresh cleaner and dwell time will be uniform throughout area being cleaned.
   c. Let cleaner remain on surface for period indicated below:
      1) As recommended by chemical-cleaner manufacturer.
      2) As established by mockup.
   d. Remove bulk of nonacidic gel cleaner by squeegeeing into containers for disposal.
   e. Rinse with cold **OR** hot, **as directed**, water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and soil.
   f. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.
8. Nonacidic Liquid Chemical Cleaning:
   a. Wet masonry with cold **OR** hot, **as directed**, water applied by low-pressure spray.
   b. Apply cleaner to masonry in two applications, **as directed**, by brush or low-pressure spray. Let cleaner remain on surface for period indicated below:
      1) As recommended by chemical-cleaner manufacturer.
      2) As established by mockup.
      3) Two to three minutes.
   c. Rinse with cold **OR** hot, **as directed**, water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and soil.
   d. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.
9. Mild Acidic **OR** Acidic, **as directed**, Chemical Cleaning:
   a. Wet masonry with cold water applied by low-pressure spray.
   b. Apply cleaner to masonry in two applications, **as directed**, by brush or low-pressure spray. Let cleaner remain on surface for period indicated below:
      1) As recommended by chemical-cleaner manufacturer.
      2) As established by mockup.
      3) Two to three minutes.
   c. Rinse with cold water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and soil.
   d. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use a steam cleaning.

M. Cleaning Brownstone Terra Cotta
1. Cold-Water Soak:
   a. Apply cold water by intermittent spraying to keep surface moist.
   b. Use perforated hoses or other means that will apply a fine water mist to entire surface being cleaned.
   c. Apply water in cycles with at least 30 minutes between cycles.
   d. Continue spraying until surface encrustation has softened sufficiently to permit its removal by water wash, as indicated by cleaning tests.
   e. Continue spraying for 72 hours.
   f. Remove soil and softened surface encrustation from masonry with cold water applied by low-pressure spray.

2. Cold-Water Wash: Use cold water applied by low **OR** medium **OR** high, **as directed**,-pressure spray.
3. Hot-Water Wash: Use hot water applied by low **OR** medium **OR** high, **as directed**,-pressure spray.
4. Steam Cleaning: Apply steam at very low pressures not exceeding 30 psi (207 kPa) **OR** 80 psi (550 kPa), **as directed**. Remove dirt softened by steam with wood scrapers, stiff-nylon or -fiber brushes, or cold-water wash, as indicated by cleaning tests.
5. Detergent Cleaning:
   a. Wet masonry with cold **OR** hot, **as directed**, water applied by low-pressure spray.
   b. Scrub masonry with detergent solution using medium-soft brushes until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from mortar joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that masonry surface remains wet.
   c. Rinse with cold **OR** hot, **as directed**, water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove detergent solution and soil.
   d. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.
6. Mold, Mildew, and Algae Removal:
   a. Wet masonry with cold **OR** hot, **as directed**, water applied by low-pressure spray.
   b. Apply mold, mildew, and algae remover by brush or low-pressure spray.
   c. Scrub masonry with medium-soft brushes until mold, mildew, and algae are thoroughly dislodged and can be removed by rinsing. Use small brushes for mortar joints and crevices. Dip brush in mold, mildew, and algae remover often to ensure that adequate fresh cleaner is used and that masonry surface remains wet.
   d. Rinse with cold **OR** hot, **as directed**, water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove mold, mildew, and algae remover and soil.
   e. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.
7. Nonacidic Gel Chemical Cleaning:
   a. Wet masonry with cold **OR** hot, **as directed**, water applied by low-pressure spray.
   b. Apply nonacidic gel cleaner in 1/8-inch (3-mm) thickness by brush, working into joints and crevices. Apply quickly and do not brush out excessively so area will be uniformly covered with fresh cleaner and dwell time will be uniform throughout area being cleaned.
   c. Let cleaner remain on surface for period indicated below:
      1) As recommended by chemical-cleaner manufacturer.
      2) As established by mockup.
   d. Remove bulk of nonacidic gel cleaner by squeegeeing into containers for disposal.
   e. Rinse with cold **OR** hot, **as directed**, water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and soil.
   f. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.
8. Nonacidic Liquid Chemical Cleaning:
   a. Wet masonry with cold **OR** hot, **as directed**, water applied by low-pressure spray.
   b. Apply cleaner to masonry in two applications, **as directed**, by brush or low-pressure spray. Let cleaner remain on surface for period indicated below:
      1) As recommended by chemical-cleaner manufacturer.
      2) As established by mockup.
      3) Two to three minutes.
   c. Rinse with cold **OR** hot, **as directed**, water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and soil.
   d. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.
9. Mild Acidic **OR** Acidic, **as directed**, Chemical Cleaning:
   a. Wet masonry with cold water applied by low-pressure spray.

b. Apply cleaner to masonry in two applications, **as directed**, by brush or low-pressure spray. Let cleaner remain on surface for period indicated below:
   1) As recommended by chemical-cleaner manufacturer.
   2) As established by mockup.
   3) Two to three minutes.
c. Rinse with cold water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and soil.
d. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use a steam cleaning.

N. Cleaning Glazed Terra Cotta
1. Hot-Water Wash: Use hot water applied by low **OR** medium **OR** high, **as directed**,-pressure spray.
2. Steam Cleaning: Apply steam at very low pressures not exceeding 30 psi (207 kPa) **OR** 80 psi (550 kPa), **as directed**. Remove dirt softened by steam with wood scrapers, stiff-nylon or -fiber brushes, or cold-water wash, as indicated by cleaning tests.
3. Nonacidic Gel Chemical Cleaning:
   a. Wet terra cotta with cold **OR** hot, **as directed**, water applied by low-pressure spray.
   b. Apply nonacidic gel cleaner in 1/8-inch (3-mm) thickness by brush, working into joints and crevices. Apply quickly and do not brush out excessively so area will be uniformly covered with fresh cleaner and dwell time will be uniform throughout area being cleaned.
   c. Let cleaner remain on surface for period indicated below:
      1) As recommended by chemical-cleaner manufacturer.
      2) As established by mockup.
   d. Remove bulk of nonacidic gel cleaner by squeegeeing into containers for disposal.
   e. Rinse with cold **OR** hot, **as directed**, water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and soil.
   f. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.
4. Nonacidic Liquid Chemical Cleaning:
   a. Wet terra cotta with cold **OR** hot, **as directed**, water applied by low-pressure spray.
   b. Apply cleaner to terra cotta in two applications, **as directed**. Let cleaner remain on surface for period indicated below:
      1) As recommended by chemical-cleaner manufacturer.
      2) As established by mockup.
      3) Two to three minutes.
   c. Rinse with cold **OR** hot, **as directed**, water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and soil.
   d. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.
5. Mild Acidic Chemical Cleaning:
   a. Wet terra cotta with cold water applied by low-pressure spray.
   b. Apply cleaner to terra cotta in two applications, **as directed**. Let cleaner remain on surface for period indicated below:
      1) As recommended by chemical-cleaner manufacturer.
      2) As established by mockup.
      3) Two to three minutes.
   c. Rinse with cold water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and soil.
   d. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.

6. Two-Part Chemical Cleaning:
   a. Wet terra cotta with cold **OR** hot, **as directed**, water applied by low-pressure spray.
   b. Apply alkaline prewash cleaner to terra cotta by brush or roller. Let cleaner remain on surface for period recommended by chemical-cleaner manufacturer unless otherwise indicated.
   c. Rinse with cold **OR** hot, **as directed**, water applied by medium-pressure spray to remove chemicals and soil.
   d. Apply acidic afterwash cleaner to terra cotta in two applications, **as directed**, while surface is still wet, using low-pressure spray equipment, deep-nap roller or soft-fiber brush. Let neutralizer remain on surface for period recommended by manufacturer unless otherwise indicated.
   e. Rinse with cold water applied by medium-pressure spray to remove chemicals and soil.
   f. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.

O. Repointing Masonry
1. Rake out and repoint joints to the following extent:
   a. All joints in areas indicated.
   b. Joints where mortar is missing or where they contain holes.
   c. Cracked joints where cracks can be penetrated at least 1/4 inch (6 mm) by a knife blade 0.027 inch (0.7 mm) thick.
   d. Cracked joints where cracks are 1/16 inch (1.6 mm) **OR** 1/8 inch (3 mm), **as directed**, or more in width and of any depth.
   e. Joints where they sound hollow when tapped by metal object.
   f. Joints where they are worn back 1/4 inch (6 mm) or more from surface.
   g. Joints where they are deteriorated to point that mortar can be easily removed by hand, without tools.
   h. Joints where they have been filled with substances other than mortar.
   i. Joints indicated as sealant-filled joints.
2. Do not rake out and repoint joints where not required.
3. Rake out joints as follows, according to procedures demonstrated in approved mockup:
   a. Remove mortar from joints to depth of joint width plus 1/8 inch (3 mm) **OR** 2 times joint width **OR** 2-1/2 times joint width, **as directed**,, but not less than 1/2 inch (13 mm) or not less than that required to expose sound, unweathered mortar.
   b. Remove mortar from masonry surfaces within raked-out joints to provide reveals with square backs and to expose masonry for contact with pointing mortar. Brush, vacuum, or flush joints to remove dirt and loose debris.
   c. Do not spall edges of masonry units or widen joints. Replace or patch damaged masonry units as directed by the Owner.
      1) Cut out mortar by hand with chisel and resilient mallet. Do not use power-operated grinders without the Owner's written approval based on approved quality-control program.
      2) Cut out center of mortar bed joints using angle grinders with diamond-impregnated metal blades. Remove remaining mortar by hand with chisel and resilient mallet. Strictly adhere to approved quality-control program.
4. Notify the Owner of unforeseen detrimental conditions including voids in mortar joints, cracks, loose masonry units, rotted wood, rusted metal, and other deteriorated items.
5. Pointing with Mortar:
   a. Rinse joint surfaces with water to remove dust and mortar particles. Time rinsing application so, at time of pointing, joint surfaces are damp but free of standing water. If rinse water dries, dampen joint surfaces before pointing.
   b. Apply pointing mortar first to areas where existing mortar was removed to depths greater than surrounding areas. Apply in layers not greater than 3/8 inch (9 mm) until a uniform depth is formed. Fully compact each layer thoroughly and allow it to become thumbprint hard before applying next layer.

c. After low areas have been filled to same depth as remaining joints, point all joints by placing mortar in layers not greater than 3/8 inch (9 mm). Fully compact each layer and allow to become thumbprint hard before applying next layer. Where existing masonry units have worn or rounded edges, slightly recess finished mortar surface below face of masonry to avoid widened joint faces. Take care not to spread mortar beyond joint edges onto exposed masonry surfaces or to featheredge the mortar.
d. When mortar is thumbprint hard, tool joints to match original appearance of joints as demonstrated in approved mockup. Remove excess mortar from edge of joint by brushing.
e. Cure mortar by maintaining in thoroughly damp condition for at least 72 consecutive hours including weekends and holidays.
    1) Acceptable curing methods include covering with wet burlap and plastic sheeting, periodic hand misting, and periodic mist spraying using system of pipes, mist heads, and timers.
    2) Adjust curing methods to ensure that pointing mortar is damp throughout its depth without eroding surface mortar.
f. Hairline cracking within the mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.

6. Pointing with Sealant:
    a. After raking out, keep joints dry and free of mortar and debris.
    b. Clean and prepare joint surfaces according to Division 07 Section "Joint Sealants". Prime joint surfaces unless sealant manufacturer recommends against priming. Do not allow primer to spill or migrate onto adjoining surfaces.
    c. Fill sealant joints with specified joint sealant according to Division 07 Section "Joint Sealants" and the following:
        1) Install cylindrical sealant backing beneath the sealant, except where space is insufficient. There, install bond-breaker tape.
        2) Install sealant using only proven installation techniques that will ensure that sealant will be deposited in a uniform, continuous ribbon, without gaps or air pockets, and with complete wetting of the joint bond surfaces equally on both sides. Fill joint flush with surrounding masonry and matching the contour of adjoining mortar joints.
        3) Install sealant as recommended by sealant manufacturer but within the following general limitations, measured at the center (thin) section of the bead:
            a) Fill joints to a depth equal to joint width, but not more than 1/2 inch (13 mm) deep or less than 1/4 inch (6 mm) deep.
        4) Immediately after first tooling, apply ground-mortar aggregate to sealant, gently pushing aggregate into the surface of sealant. Retool sealant to form smooth, uniform beads, slightly concave. Remove excess sealant and aggregate from surfaces adjacent to joint.
        5) Do not allow sealant to overflow or spill onto adjoining surfaces, or to migrate into the voids of adjoining surfaces, particularly rough textures. Remove excess and spillage of sealant promptly as the work progresses. Clean adjoining surfaces by the means necessary to eliminate evidence of spillage, without damage to adjoining surfaces or finishes, as demonstrated in an approved mockup.
    d. Cure sealant according to Division 07 Section "Joint Sealants".
7. Where repointing work precedes cleaning of existing masonry, allow mortar to harden at least 30 days before beginning cleaning work.

P. Final Cleaning
1. After mortar has fully hardened, thoroughly clean exposed masonry surfaces of excess mortar and foreign matter; use wood scrapers, stiff-nylon or -fiber brushes, and clean water, spray applied at low pressure.
    a. Do not use metal scrapers or brushes.
    b. Do not use acidic or alkaline cleaners.
2. Wash adjacent woodwork and other nonmasonry surfaces. Use detergent and soft brushes or cloths.

3. Clean mortar and debris from roof; remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.
4. Sweep and rake adjacent pavement and grounds to remove mortar and debris. Where necessary, pressure wash pavement surfaces to remove mortar, dust, dirt, and stains.

Q. Field Quality Control
1. Inspectors: Engage qualified independent inspectors to perform inspections and prepare test reports. Allow inspectors use of lift devices and scaffolding, as needed, to perform inspections.
2. the Owner's Project Representatives: the Owner will assign Project representatives to help carry out the Owner's responsibilities at the site, including observing progress and quality of portion of the Work completed. Allow the Owner's Project representatives use of lift devices and scaffolding, as needed, to observe progress and quality of portion of the Work completed.
3. Notify inspectors and the Owner's Project representatives in advance of times when lift devices and scaffolding will be relocated. Do not relocate lift devices and scaffolding until inspectors and the Owner's Project representatives have had reasonable opportunity to make inspections and observations of work areas at lift device or scaffold location.

END OF SECTION 04 01 20 91

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Task	Specification	Specification Description
04 01 20 91	01 22 16 00	No Specification Required
04 01 20 91	03 01 30 71	Concrete Rehabilitation
04 01 20 91	01 54 23 00a	Unit Masonry Assemblies
04 01 50 52	04 01 20 91	Clay Masonry Restoration And Cleaning
04 05 13 26	01 54 23 00a	Unit Masonry Assemblies
04 05 16 26	01 54 23 00a	Unit Masonry Assemblies
04 05 19 13	01 54 23 00a	Unit Masonry Assemblies
04 05 19 16	01 54 23 00a	Unit Masonry Assemblies
04 05 23 13	01 54 23 00a	Unit Masonry Assemblies

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SECTION 04 05 23 16 - SHEET METAL FLASHING AND TRIM

1.1 GENERAL

A. Description Of Work:

1. This specification covers the furnishing and installation of materials for sheet metal flashing and trim. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   - a. Manufactured Products:
     - 1) Manufactured through-wall flashing and counterflashing.
     - 2) Manufactured reglets and counterflashing.
   - b. Formed Products:
     - 1) Formed roof drainage sheet metal fabrications.
     - 2) Formed low-slope roof sheet metal fabrications.
     - 3) Formed steep-slope roof sheet metal fabrications.
     - 4) Formed wall sheet metal fabrications.
     - 5) Formed equipment support flashing.
     - 6) Formed overhead-piping safety pans.

C. Performance Requirements

1. General: Sheet metal flashing and trim assemblies as indicated shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
2. Fabricate and install roof edge flashing and copings capable of resisting the following forces according to recommendations in FMG Loss Prevention Data Sheet 1-49:
   - a. Wind Zone 1: For velocity pressures of 10 to 20 lbf/sq. ft. (0.48 to 0.96 kPa): 40-lbf/sq. ft. (1.92-kPa) perimeter uplift force, 60-lbf/sq. ft. (2.87-kPa) corner uplift force, and 20-lbf/sq. ft. (0.96-kPa) outward force.
   - b. Wind Zone 1: For velocity pressures of 21 to 30 lbf/sq. ft. (1.00 to 1.44 kPa): 60-lbf/sq. ft. (2.87-kPa) perimeter uplift force, 90-lbf/sq. ft. (4.31-kPa) corner uplift force, and 30-lbf/sq. ft. (1.44-kPa) outward force.
   - c. Wind Zone 2: For velocity pressures of 31 to 45 lbf/sq. ft. (1.48 to 2.15 kPa): 90-lbf/sq. ft. (4.31-kPa) perimeter uplift force, 120-lbf/sq. ft. (5.74-kPa) corner uplift force, and 45-lbf/sq. ft. (2.15-kPa) outward force.
   - d. Wind Zone 3: For velocity pressures of 46 to 104 lbf/sq. ft. (2.20 to 4.98 kPa): 208-lbf/sq. ft. (9.96-kPa) perimeter uplift force, 312-lbf/sq. ft. (14.94-kPa) corner uplift force, and 104-lbf/sq. ft. (4.98-kPa) outward force.
3. Thermal Movements: Provide sheet metal flashing and trim that allows for thermal movements from ambient and surface temperature changes.
   - a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

D. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings: Show installation layouts of sheet metal flashing and trim, including plans, elevations, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work.

a. Include details for forming, joining, supporting, and securing sheet metal flashing and trim, including pattern of seams, termination points, fixed points, expansion joints, expansion-joint covers, edge conditions, special conditions, and connections to adjoining work.
3. Samples: For each exposed product and for each finish specified.
4. Maintenance data.
5. Warranty: Sample of special warranty.

E. Quality Assurance
1. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.
2. Copper Sheet Metal Standard: Comply with CDA's "Copper in Architecture Handbook." Conform to dimensions and profiles shown unless more stringent requirements are indicated.
3. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
a. Build mockup of typical roof eave, including built-in gutter, fascia, fascia trim, and apron flashing, approximately 10 feet (3.0 m) long, including supporting construction cleats, seams, attachments, underlayment, and accessories.
4. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
2. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to the extent necessary for the period of sheet metal flashing and trim installation.

G. Warranty
1. Special Warranty on Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within 20 **OR** 10, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Sheet Metals
1. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.
2. Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 or H01 temper.
a. Non-Patinated Exposed Finish: Mill.
b. Non-Patinated, Exposed, Lacquered Finish: Finish designations for copper alloys comply with the system defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."
1) Brushed Satin (Lacquered): M32-06x (Mechanical Finish: directionally textured, medium satin; with clear organic coating); coating of "Incralac," waterborne **OR** solvent-borne, **as directed**, methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats per manufacturer's written instructions to a total thickness of 1 mil (0.025 mm).
2) Mirror Polished (Lacquered): M22-06x (Mechanical Finish: buffed, specular; with clear organic coating); coating of "Incralac," waterborne **OR** solvent-borne, **as directed**, air-drying, methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats per manufacturer's written instructions to a total thickness of 1 mil (0.025 mm).
c. Pre-Patinated Copper-Sheet Finish: Dark brown **OR** Verdigris, **as directed**, pre-patinated according to ASTM B 882.

3. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required.
   a. As-Milled Finish: Mill **OR** One-side bright mill **OR** Standard one-side bright **OR** Standard two-side bright, **as directed**, finish.
   b. Alclad Finish: Metallurgically bonded surfacing to both sides, forming a composite aluminum sheet with reflective luster.
   c. Surface: Smooth, flat **OR** Embossed, **as directed**.
   d. Factory Prime Coating: Where painting after installation is indicated, pretreat with white or light-colored, factory-applied, baked-on epoxy primer coat; minimum dry film thickness of 0.2 mil (0.005 mm).
   e. Clear Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
   f. Color Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
      1) Color: Champagne **OR** Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black, **as directed**.
      2) Color Range: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
   g. Exposed Coil-Coated Finishes:
      1) Two-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat.
      2) Three-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
      3) Four-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat and clear coats.
      4) Mica Fluoropolymer: AAMA 620. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat.
      5) Metallic Fluoropolymer: AAMA 620. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
      6) FEVE Fluoropolymer: AAMA 620. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat.
      7) Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
      8) Plastisol: Epoxy primer and vinyl plastisol topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 3.8 mils (0.97 mm) for topcoat.
   h. Color: As selected from manufacturer's full range.
   i. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).
4. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304, dead soft, fully annealed.
   a. Finish: 2D (dull, cold rolled) **OR** 2B (bright, cold rolled) **OR** 3 (coarse, polished directional satin) **OR** 4 (polished directional satin), **as directed**.
   b. Surface: Smooth, flat **OR** Embossed, **as directed**.
5. Zinc-Tin Alloy-Coated Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, dead-soft, fully annealed stainless-steel sheet of minimum uncoated thickness indicated; coated on both sides with a zinc-tin alloy (50 percent zinc, 50 percent tin), with factory-applied gray preweathering.
6. Zinc-Tin Alloy-Coated Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 temper, of minimum uncoated weight (thickness) indicated; coated on both sides with a zinc-tin alloy (50 percent zinc, 50 percent tin).
7. Metallic-Coated Steel Sheet: Restricted flatness steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40 (Class AZM150 coating designation, Grade 275); structural quality.
c. Surface: Smooth, flat **OR** Embossed, **as directed**, and mill phosphatized for field painting **OR** and with manufacturer's standard clear acrylic coating on both sides, **as directed**.
d. Exposed Coil-Coated Finish:
    1) Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat.
    2) Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
    3) Four-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat and clear coats.
    4) Mica Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat.
    5) Metallic Fluoropolymer: AAMA 621. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
    6) FEVE Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat.
    7) Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
    8) Plastisol: Epoxy primer and vinyl plastisol topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 3.8 mils (0.97 mm) for topcoat.
e. Color: As selected from manufacturer's full range.
f. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

8. Zinc Sheet: Zinc, 99 percent pure, alloyed with a maximum of 1 percent copper and titanium; with manufacturer's standard factory-applied, flexible, protective back coating.
    a. Finish: Bright rolled **OR** Preweathered gray **OR** Preweathered black, **as directed**.

B. Underlayment Materials
1. Polyethylene Sheet: 6-mil- (0.15-mm-) thick polyethylene sheet complying with ASTM D 4397.
2. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
3. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
    a. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F (116 deg C).
    b. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F (29 deg C).
4. Slip Sheet: Building paper, 3-lb/100 sq. ft. (0.16-kg/sq. m) minimum, rosin sized.

C. Miscellaneous Materials
1. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
2. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
    a. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.

1) Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating.
2) Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
3) Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.

b. Fasteners for Copper **OR** Zinc-Tin Alloy-Coated Copper, **as directed**, Sheet: Copper, hardware bronze or Series 300 stainless steel.
c. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
d. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
e. Fasteners for Zinc-Tin Alloy-Coated Stainless-Steel Sheet: Series 300 stainless steel.
f. Fasteners for Zinc-Coated (Galvanized) **OR** Aluminum-Zinc Alloy-Coated, **as directed**, Steel Sheet: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329 or Series 300 stainless steel.
g. Fasteners for Zinc Sheet: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329 or Series 300 stainless steel.

3. Solder:
   a. For Copper: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.
   b. For Stainless Steel: ASTM B 32, Grade Sn60, with an acid flux of type recommended by stainless-steel sheet manufacturer.
   c. For Zinc-Tin Alloy-Coated Stainless Steel **OR** Copper, **as directed**: ASTM B 32, 100 percent tin.
   d. For Zinc-Coated (Galvanized) Steel: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead.
   e. For Zinc: ASTM B 32, 40 percent tin and 60 percent lead with low antimony, as recommended by manufacturer.
4. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
5. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane **OR** polysulfide **OR** silicone, **as directed**, polymer sealant; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
6. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
7. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.
8. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.
9. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

D. Manufactured Sheet Metal Flashing And Trim
1. Through-Wall Ribbed Sheet Metal Flashing: Manufacture through-wall sheet metal flashing for embedment in masonry with ribs at 3-inch (75-mm) intervals along length of flashing to provide an integral mortar bond. Manufacture through-wall flashing with snaplock receiver on exterior face to receive counterflashing **OR** interlocking counterflashing on exterior face, of same metal as reglet, **as directed**.
   a. Copper: 10 oz. (0.34 mm thick) minimum for fully concealed flashing; 16 oz. (0.55 mm thick) elsewhere.
   b. Stainless Steel: 0.016 inch (0.40 mm) thick.
2. Reglets: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and -welded corners and junctions **OR** with interlocking counterflashing on exterior face, of same metal as reglet, **as directed**.
   a. Material: Stainless steel, 0.019 inch (0.48 mm) thick **OR** Copper, 16 oz./sq. ft. (0.55 mm thick) **OR** Aluminum, 0.024 inch (0.61 mm) thick **OR** Galvanized steel, 0.022 inch (0.56 mm) thick, **as directed**.

b. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
c. Stucco Type: Provide with upturned fastening flange and extension leg of length to match thickness of applied finish materials.
d. Concrete Type: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
e. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
f. Accessories:
   1) Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
   2) Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.
g. Finish: Mill **OR** With manufacturer's standard color coating, **as directed**.

E. Fabrication, General
1. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.
   a. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
   b. Obtain field measurements for accurate fit before shop fabrication.
   c. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
   d. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.
2. Fabrication Tolerances:
   a. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.
   OR
   Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."
3. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant.
4. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with butyl sealant concealed within joints.
5. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
6. Fabricate cleats and attachment devices of sizes as recommended by SMACNA's "Architectural Sheet Metal Manual" and by FMG Loss Prevention Data Sheet 1-49, **as directed**, for application, but not less than thickness of metal being secured.
7. Seams:
   a. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
   OR
   Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.
8. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength.

9. Do not use graphite pencils to mark metal surfaces.

F. Roof Drainage Sheet Metal Fabrications
1. Hanging Gutters: Fabricate to cross section indicated, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum 96-inch- (2400-mm-) long sections. Furnish flat-stock gutter spacers and gutter brackets fabricated from same metal as gutters, of size recommended by SMACNA but not less than twice the gutter thickness. Fabricate expansion joints, expansion-joint covers, gutter bead reinforcing bars, and gutter accessories from same metal as gutters.
    a. Gutter Style: SMACNA designation A **OR** B **OR** C **OR** D **OR** E **OR** F **OR** G **OR** H **OR** I **OR** J **OR** K **OR** L, **as directed**.
    b. Expansion Joints: Lap type **OR** Butt type **OR** Butt type with cover plate **OR** Built in, **as directed**.
    c. Accessories: Continuous removable leaf screen with sheet metal frame and hardware cloth screen **OR** Wire ball downspout strainer **OR** Valley baffles, **as directed**.
    d. Gutters with Girth up to 15 Inches (380 mm): Fabricate from the following materials:
        1) Copper: 16 oz./sq. ft. (0.55 mm thick).
        2) Aluminum: 0.032 inch (0.81 mm) thick.
        3) Stainless Steel: 0.016 inch (0.40 mm) thick.
        4) Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
        5) Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
        6) Galvanized Steel: 0.022 inch (0.56 mm) thick.
        7) Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
        8) Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
    e. Gutters with Girth 16 to 20 Inches (410 to 510 mm): Fabricate from the following materials:
        1) Copper: 16 oz./sq. ft. (0.55 mm thick).
        2) Aluminum: 0.040 inch (1.02 mm) thick.
        3) Stainless Steel: 0.019 inch (0.48 mm) thick.
        4) Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
        5) Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
        6) Galvanized Steel: 0.028 inch (0.71 mm) thick.
        7) Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
        8) Zinc: 0.039 inch (1.00 mm) **OR** 0.048 inch (1.25 mm), **as directed**, thick.
    f. Gutters with Girth 21 to 25 Inches (530 to 640 mm): Fabricate from the following materials:
        1) Copper: 20 oz./sq. ft. (0.68 mm thick).
        2) Aluminum: 0.050 inch (1.27 mm) thick.
        3) Stainless Steel: 0.025 inch (0.64 mm) thick.
        4) Zinc-Tin Alloy-Coated Stainless Steel: 0.024 inch (0.61 mm) thick.
        5) Zinc-Tin Alloy-Coated Copper: 20 oz./sq. ft. (0.68 mm thick).
        6) Galvanized Steel: 0.034 inch (0.86 mm) thick.
        7) Aluminum-Zinc Alloy-Coated Steel: 0.034 inch (0.86 mm) thick.
        8) Zinc: 0.048 inch (1.25 mm) **OR** 0.059 inch (1.50 mm), **as directed**, thick.
    g. Gutters with Girth 26 to 30 Inches (660 to 760 mm): Fabricate from the following materials:
        1) Copper: 24 oz./sq. ft. (0.82 mm thick).
        2) Aluminum: 0.063 inch (1.60 mm) thick.
        3) Stainless Steel: 0.031 inch (0.79 mm) thick.
        4) Zinc-Tin Alloy-Coated Copper: 24 oz./sq. ft. (0.82 mm thick).
        5) Galvanized Steel: 0.040 inch (1.02 mm) thick.
        6) Aluminum-Zinc Alloy-Coated Steel: 0.040 inch (1.02 mm) thick.
    h. Gutters with Girth 31 to 35 Inches (790 to 890 mm): Fabricate from the following materials:
        1) Copper: 24 oz./sq. ft. (0.82 mm thick).
        2) Stainless Steel: 0.038 inch (0.95 mm) thick.
        3) Zinc-Tin Alloy-Coated Copper: 25 oz./sq. ft. (0.87 mm thick).
        4) Galvanized Steel: 0.052 inch (1.32 mm) thick.
        5) Aluminum-Zinc Alloy-Coated Steel: 0.052 inch (1.32 mm) thick.

2. Built-in Gutters: Fabricate to cross section indicated, with riveted and soldered joints, complete with end pieces, outlet tubes, and other special accessories as required. Fabricate in minimum 96-inch- (2400-mm-) long sections. Fabricate expansion joints and accessories from same metal as gutters unless otherwise indicated.
   a. Fabricate gutters with built-in expansion joints and gutter-end expansion joints at walls.
   b. Accessories: Continuous removable leaf screen with sheet metal frame and hardware cloth screen **OR** Bronze wire ball downspout strainer **OR** Wire ball downspout strainer, **as directed**.
   c. Fabricate from the following materials:
      1) Copper: 16 oz./sq. ft. (0.55 mm thick).
      2) Stainless Steel: 0.016 inch (0.40 mm) thick.
      3) Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
      4) Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
      5) Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
3. Downspouts: Fabricate round **OR** rectangular **OR** open-face, **as directed**, downspouts complete with mitered elbows. Furnish with metal hangers, from same material as downspouts, and anchors.
   a. Fabricated Hanger Style: SMACNA figure designation 1-35A **OR** 1-35B **OR** 1-35C **OR** 1-35D **OR** 1-35E **OR** 1-35F **OR** 1-35G **OR** 1-35H **OR** 1-35I **OR** 1-35J, **as directed**.
   b. Manufactured Hanger Style: SMACNA figure designation 1-34A **OR** 1-34B **OR** 1-34C **OR** 1-34D **OR** 1-34E, **as directed**.
   c. Hanger Style: <**Insert description**>.
   d. Fabricate from the following materials:
      1) Copper: 16 oz./sq. ft. (0.55 mm thick).
      2) Aluminum: 0.024 inch (0.61 mm) thick.
      3) Stainless Steel: 0.016 inch (0.40 mm) thick.
      4) Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
      5) Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
      6) Galvanized Steel: 0.022 inch (0.56 mm) thick.
      7) Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
      8) Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
4. Parapet Scuppers: Fabricate scuppers of dimensions required with closure flange trim to exterior, 4-inch- (100-mm-) wide wall flanges to interior, and base extending 4 inches (100 mm) beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scupper. Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Aluminum: 0.032 inch (0.81 mm) thick.
   c. Stainless Steel: 0.019 inch (0.48 mm) thick.
   d. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
   e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
   f. Galvanized Steel: 0.028 inch (0.71 mm) thick.
   g. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
   h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
5. Conductor Heads: Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shape indicated complete with outlet tubes, exterior flange trim, and built-in overflows. Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Aluminum: 0.032 inch (0.81 mm) thick.
   c. Stainless Steel: 0.016 inch (0.40 mm) thick.
   d. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
   e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
   f. Galvanized Steel: 0.028 inch (0.71 mm) thick.
   g. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
   h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
6. Splash Pans: Fabricate from the following materials:

a. Copper: 16 oz./sq. ft. (0.55 mm thick).
b. Aluminum: 0.040 inch (1.02 mm) thick.
c. Stainless Steel: 0.019 inch (0.48 mm) thick.
d. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
f. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.

G. Low-Slope Roof Sheet Metal Fabrications
1. Roof-Edge Flashing (Gravel Stop) and Fascia Cap: Fabricate in minimum 96-inch- (2400-mm-) long, but not exceeding 10-foot- (3-m-) long, sections. Furnish with 6-inch- (150-mm-) wide, joint cover plates.
a. Joint Style: Lap, 4 inches (100 mm) wide **OR** Butt, with 12-inch- (300-mm-) wide, concealed backup plate **OR** Butt, with 6-inch- (150-mm-) wide, exposed cover plates **OR** Butt, with 12-inch- (300-mm-) wide, concealed backup plate and 6-inch- (150-mm-) wide, exposed cover plates, **as directed**.
b. Fabricate with scuppers spaced 10 feet (3 m) apart, of dimensions required with 4-inch- (100-mm-) wide flanges and base extending 4 inches (100 mm) beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scupper.
c. Fabricate from the following materials:
1) Copper: 20 oz./sq. ft. (0.68 mm thick).
2) Aluminum: 0.050 inch (1.27 mm) thick.
3) Stainless Steel: 0.019 inch (0.48 mm) thick.
4) Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
5) Zinc-Tin Alloy-Coated Copper: 20 oz./sq. ft. (0.68 mm thick).
6) Galvanized Steel: 0.028 inch (0.71 mm) thick.
7) Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
8) Zinc: 0.048 inch (1.25 mm) **OR** 0.059 inch (1.50 mm), **as directed**, thick.
2. Copings: Fabricate in minimum 96-inch- (2400-mm-) long, but not exceeding 10-foot- (3-m-) long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and drill elongated holes for fasteners on interior leg. Miter corners, seal, and solder or weld watertight.
a. Coping Profile: SMACNA figure designation 3-4A **OR** 3-4B **OR** 3-4C **OR** 3-4D **OR** 3-4E **OR** 3-4F **OR** 3-4G, **as directed**.
b. Joint Style: Butt, with 12-inch- (300-mm-) wide, concealed backup plate **OR** Butt, with 6-inch- (150-mm-) wide, exposed cover plates **OR** Butt, with 12-inch- (300-mm-) wide, concealed backup plate and 6-inch- (150-mm-) wide, exposed cover plates, **as directed**.
c. Fabricate from the following materials:
1) Copper: 24 oz./sq. ft. (0.82 mm thick).
2) Aluminum: 0.050 inch (1.27 mm) thick.
3) Stainless Steel: 0.025 inch (0.64 mm) thick.
4) Zinc-Tin Alloy-Coated Stainless Steel: 0.024 inch (0.61 mm) thick.
5) Zinc-Tin Alloy-Coated Copper: 24 oz./sq. ft. (0.82 mm thick).
6) Galvanized Steel: 0.040 inch (1.02 mm) thick.
7) Aluminum-Zinc Alloy-Coated Steel: 0.040 inch (1.02 mm) thick.
8) Zinc: 0.048 inch (1.25 mm) **OR** 0.059 inch (1.50 mm), **as directed**, thick.
3. Roof and Roof to Wall Transition **OR** Roof to Roof Edge Flashing (Gravel Stop) Transition **OR** Roof to Roof Edge Flashing (Gravel Stop) and Fascia Cap Transition, **as directed,** Expansion-Joint Cover: Fabricate from the following materials:
a. Copper: 16 oz./sq. ft. (0.55 mm thick).
b. Aluminum: 0.050 inch (1.27 mm) thick.
c. Stainless Steel: 0.025 inch (0.64 mm) thick.
d. Zinc-Tin Alloy-Coated Stainless Steel: 0.024 inch (0.61 mm) thick.
e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick)>.
f. Galvanized Steel: 0.034 inch (0.86 mm) thick.
g. Aluminum-Zinc Alloy-Coated Steel: 0.034 inch (0.86 mm) thick.
h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.

4. Base Flashing: Fabricate from the following materials:
   a. Copper: 20 oz./sq. ft. (0.68 mm thick)>.
   b. Aluminum: 0.040 inch (1.02 mm) thick.
   c. Stainless Steel: 0.019 inch (0.48 mm) thick.
   d. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
   e. Zinc-Tin Alloy-Coated Copper: 20 oz./sq. ft. (0.68 mm thick)>.
   f. Galvanized Steel: 0.028 inch (0.71 mm) thick.
   g. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
   h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
5. Counterflashing: Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Aluminum: 0.032 inch (0.81 mm) thick.
   c. Stainless Steel: 0.019 inch (0.48 mm) thick.
   d. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
   e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick)>.
   f. Galvanized Steel: 0.022 inch (0.56 mm) thick.
   g. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
   h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
6. Flashing Receivers: Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Aluminum: 0.032 inch (0.81 mm) thick.
   c. Stainless Steel: 0.016 inch (0.40 mm) thick.
   d. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
   e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
   f. Galvanized Steel: 0.022 inch (0.56 mm) thick.
   g. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
   h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
7. Roof-Penetration Flashing: Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Stainless Steel: 0.019 inch (0.48 mm) thick.
   c. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
   d. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
   e. Galvanized Steel: 0.028 inch (0.71 mm) thick.
   f. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
   g. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
8. Roof-Drain Flashing: Fabricate from the following materials:
   a. Copper: 12 oz./sq. ft. (0.41 mm thick).
   b. Stainless Steel: 0.016 inch (0.40 mm) thick.
   c. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.

H. Steep-Slope Roof Sheet Metal Fabrications
1. Apron, Step, Cricket, and Backer Flashing: Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Aluminum: 0.032 inch (0.81 mm) thick.
   c. Stainless Steel: 0.016 inch (0.40 mm) thick.
   d. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
   e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
   f. Galvanized Steel: 0.022 inch (0.56 mm) thick.
   g. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
   h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
2. Valley Flashing: Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Stainless Steel: 0.019 inch (0.48 mm) thick.
   c. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
   d. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).

e. Galvanized Steel: 0.028 inch (0.71 mm) thick.
f. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
g. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.

3. Drip Edges: Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Aluminum: 0.032 inch (0.81 mm) thick.
   c. Stainless Steel: 0.016 inch (0.40 mm) thick.
   d. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
   e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
   f. Galvanized Steel: 0.022 inch (0.56 mm) thick.
   g. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
   h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
4. Eave, Rake, Ridge, and Hip Flashing: Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Aluminum: 0.032 inch (0.81 mm) thick.
   c. Stainless Steel: 0.016 inch (0.40 mm) thick.
   d. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
   e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
   f. Galvanized Steel: 0.022 inch (0.56 mm) thick.
   g. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
   h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
5. Counterflashing: Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Aluminum: 0.032 inch (0.81 mm) thick.
   c. Stainless Steel: 0.019 inch (0.48 mm) thick.
   d. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
   e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
   f. Galvanized Steel: 0.022 inch (0.56 mm) thick.
   g. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
   h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
6. Flashing Receivers: Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Aluminum: 0.032 inch (0.81 mm) thick.
   c. Stainless Steel: 0.016 inch (0.40 mm) thick.
   d. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
   e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
   f. Galvanized Steel: 0.022 inch (0.56 mm) thick.
   g. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
   h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
7. Roof-Penetration Flashing: Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Stainless Steel: 0.019 inch (0.48 mm) thick.
   c. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
   d. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick)>.
   e. Galvanized Steel: 0.028 inch (0.71 mm) thick.
   f. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
   g. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.

I. Wall Sheet Metal Fabrications
1. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch- (2400-mm-) long, but not exceeding 12-foot- (3.6-m-) long, sections, under copings, at shelf angles, and where indicated. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches (150 mm) beyond each side of wall openings. Form with 2-inch- (50-mm-) high, end dams where flashing is discontinuous. Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Stainless Steel: 0.016 inch (0.40 mm) thick.

c. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
d. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
e. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.

2. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches (100 mm) beyond wall openings. Form head and sill flashing with 2-inch- (50-mm-) high, end dams. Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Aluminum: 0.032 inch (0.81 mm) thick.
   c. Stainless Steel: 0.016 inch (0.40 mm) thick.
   d. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
   e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
   f. Galvanized Steel: 0.022 inch (0.56 mm) thick.
   g. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
   h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
3. Wall Expansion-Joint Cover: Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Aluminum: 0.040 inch (1.02 mm) thick.
   c. Stainless Steel: 0.019 inch (0.48 mm) thick.
   d. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
   e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
   f. Galvanized Steel: 0.028 inch (0.71 mm) thick.
   g. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
   h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.

J. Miscellaneous Sheet Metal Fabrications
1. Equipment Support Flashing: Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Stainless Steel: 0.019 inch (0.48 mm) thick.
   c. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
   d. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
   e. Galvanized Steel: 0.028 inch (0.71 mm) thick.
   f. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
2. Overhead-Piping Safety Pans: Fabricate from the following materials:
   a. Copper: 24 oz./sq. ft. (0.82 mm thick).
   b. Stainless Steel: 0.025 inch (0.64 mm) thick.
   c. Zinc-Tin Alloy-Coated Stainless Steel: 0.024 inch (0.61 mm) thick.
   d. Zinc-Tin Alloy-Coated Copper: 24 oz./sq. ft. (0.82 mm thick).
   e. Galvanized Steel: 0.040 inch (1.02 mm) thick.
   f. Aluminum-Zinc Alloy-Coated Steel: 0.040 inch (1.02 mm) thick.

1.3 EXECUTION

A. Underlayment Installation
1. General: Install underlayment as indicated on Drawings.
2. Polyethylene Sheet: Install polyethylene sheet with adhesive for anchorage to minimize use of mechanical fasteners under sheet metal flashing and trim. Apply in shingle fashion to shed water, with lapped and taped joints of not less than 2 inches (50 mm).
3. Felt Underlayment: Install felt underlayment with adhesive for temporary anchorage to minimize use of mechanical fasteners under sheet metal flashing and trim. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm).
4. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free. Apply primer if required by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply in shingle fashion to shed water, with end laps of not

less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps with roller. Cover underlayment within 14 days.

B. Installation, General
1. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
   a. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
   b. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
   c. Space cleats not more than 12 inches (300 mm) apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
   d. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
   e. Install sealant tape where indicated.
   f. Torch cutting of sheet metal flashing and trim is not permitted.
   g. Do not use graphite pencils to mark metal surfaces.
2. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by SMACNA.
   a. Coat back side of uncoated aluminum and stainless-steel sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.
   b. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene sheet.
3. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.
4. Fastener Sizes: Use fasteners of sizes that will penetrate wood sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws **OR** metal decking not less than recommended by fastener manufacturer to achieve maximum pull-out resistance, **as directed**.
5. Seal joints as shown and as required for watertight construction.
   a. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F (4 deg C).
   b. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants".
6. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches (38 mm), except reduce pre-tinning where pre-tinned surface would show in completed Work.
   a. Do not solder metallic-coated steel and aluminum sheet.
   b. Pre-tinning is not required for zinc-tin alloy-coated stainless steel and zinc-tin alloy-coated copper.
   c. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

d. Stainless-Steel Soldering: Tin edges of uncoated sheets using solder recommended for stainless steel and acid flux. Promptly remove acid flux residue from metal after tinning and soldering. Comply with solder manufacturer's recommended methods for cleaning and neutralization.
e. Copper Soldering: Tin edges of uncoated copper sheets using solder for copper.
7. Rivets: Rivet joints in uncoated aluminum **OR** zinc, **as directed**, where indicated and where necessary for strength.

C. Roof Drainage System Installation
1. General: Install sheet metal roof drainage items to produce complete roof drainage system according to SMACNA recommendations and as indicated. Coordinate installation of roof perimeter flashing with installation of roof drainage system.
2. Hanging Gutters: Join sections with riveted and soldered joints or with lapped joints sealed with sealant. Provide for thermal expansion. Attach gutters at eave or fascia to firmly anchored gutter brackets **OR** straps **OR** twisted straps, **as directed**, spaced not more than 36 inches (900 mm) apart. Provide end closures and seal watertight with sealant. Slope to downspouts.
a. Fasten gutter spacers to front and back of gutter.
b. Loosely lock straps to front gutter bead and anchor to roof deck.
c. Anchor and loosely lock back edge of gutter to continuous cleat **OR** eave or apron flashing, **as directed**.
d. Anchor back of gutter that extends onto roof deck with cleats spaced not more than 24 inches (600 mm) apart.
e. Anchor gutter with spikes and ferrules spaced not more than 24 inches (600 mm) **OR** 30 inches (750 mm), **as directed**, apart.
f. Install gutter with expansion joints at locations indicated, but not exceeding, 50 feet (15.24 m) apart. Install expansion-joint caps.
g. Install continuous gutter screens on gutters with noncorrosive fasteners, removable **OR** hinged to swing open, **as directed**, for cleaning gutters.
3. Built-in Gutters: Join sections with riveted and soldered or lapped joints sealed with sealant. Provide for thermal expansion. Slope to downspouts. Provide end closures and seal watertight with sealant.
a. Install felt underlayment layer in built-in gutter trough and extend to drip edge at eaves and under felt underlayment on roof sheathing. Lap sides a minimum of 2 inches (50 mm) over underlying course. Lap ends a minimum of 4 inches (100 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with roofing nails. Install slip sheet over felt underlayment.
b. Anchor and loosely lock back edge of gutter to continuous cleat **OR** eave or apron flashing, **as directed**.
c. Anchor back of gutter that extends onto roof deck with cleats spaced not more than 24 inches (600 mm) apart.
d. Install gutter with expansion joints at locations indicated, but not exceeding, 50 feet (15.24 m) apart. Install expansion-joint caps.
4. Downspouts: Join sections with 1-1/2-inch (38-mm) telescoping joints.
a. Provide hangers with fasteners designed to hold downspouts securely to walls. Locate hangers at top and bottom and at approximately 60 inches (1500 mm) o.c. in between.
b. Provide elbows at base of downspout to direct water away from building.
c. Connect downspouts to underground drainage system indicated.
5. Splash Pans: Install where downspouts discharge on low-slope roofs. Set in asphalt roofing cement **OR** elastomeric sealant, **as directed**, compatible with roofing membrane.
6. Parapet Scuppers: Install scuppers where indicated through parapet. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
a. Anchor scupper closure trim flange to exterior wall and solder or seal with elastomeric sealant to scupper.
b. Loosely lock front edge of scupper with conductor head.

c. Solder or seal with elastomeric sealant exterior wall scupper flanges into back of conductor head.

7. Conductor Heads: Anchor securely to wall with elevation of conductor head rim 1 inch (25 mm) below scupper **OR** gutter, **as directed**, discharge.
8. Expansion-Joint Covers: Install expansion-joint covers at locations and of configuration indicated. Lap joints a minimum of 4 inches (100 mm) in direction of water flow.

D. Roof Flashing Installation

1. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
2. Roof Edge Flashing:
   a. Anchor to resist uplift and outward forces according to recommendations in SMACNA's "Architectural Sheet Metal Manual" and as indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch (75-mm) centers.
   OR
   Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at 24-inch (600-mm) **OR** 16-inch (400-mm), **as directed**, centers.
3. Copings: Anchor to resist uplift and outward forces according to recommendations in SMACNA's "Architectural Sheet Metal Manual" and as indicated.
   a. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at 24-inch (600-mm) **OR** 16-inch (400-mm), **as directed**, centers.
   b. Anchor interior leg of coping with washers and screw fasteners through slotted holes at 24-inch (600-mm) centers.
4. Copings: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated.
   a. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at 24-inch (600-mm) **OR** 16-inch (400-mm), **as directed**, centers.
   b. Anchor interior leg of coping with screw fasteners and washers at 24-inch (600-mm) **OR** 20-inch (500-mm), **as directed**, centers.
5. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending a minimum of 4 inches (100 mm) over base flashing. Install stainless-steel draw band and tighten.
6. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches (100 mm) over base flashing. Lap counterflashing joints a minimum of 4 inches (100 mm) and bed with sealant. Secure in a waterproof manner by means of snap-in installation and sealant or lead wedges and sealant **OR** interlocking folded seam or blind rivets and sealant **OR** anchor and washer at 36-inch (900-mm) centers, **as directed**.
7. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric **OR** butyl, **as directed**, sealant and clamp flashing to pipes that penetrate roof.

E. Wall Flashing Installation

1. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to SMACNA recommendations and as indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.
2. Through-Wall Flashing: Installation of through-wall flashing is specified in Division 04 Section(s) "Unit Masonry" OR "Stone Masonry", **as directed**.
3. Reglets: Installation of reglets is specified in Division 03 Section(s) "Cast-in-place Concrete" OR Division 04 Section(s) "Unit Masonry", **as directed**.

4. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches (100 mm) beyond wall openings.

F. Miscellaneous Flashing Installation
1. Overhead-Piping Safety Pans: Suspend pans independent from structure above as indicated on Drawings. Pipe and install drain line to plumbing waste or drainage system.
2. Equipment Support Flashing: Coordinate installation of equipment support flashing with installation of roofing and equipment. Weld or seal flashing with elastomeric sealant to equipment support member.

G. Erection Tolerances
1. Installation Tolerances:
a. Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.
OR
Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

H. Cleaning And Protection
1. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
2. Clean and neutralize flux materials. Clean off excess solder.
3. Clean off excess sealants.
4. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of installation, remove unused materials and clean finished surfaces. Maintain in a clean condition during construction.
5. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 04 05 23 16

Task	Specification	Specification Description
04 05 23 16	01 22 16 00	No Specification Required
04 21 13 00	01 54 23 00a	Unit Masonry Assemblies
04 21 26 00	01 54 23 00a	Unit Masonry Assemblies
04 22 23 13	01 54 23 00a	Unit Masonry Assemblies
04 22 23 23	01 54 23 00a	Unit Masonry Assemblies
04 22 23 26	01 54 23 00a	Unit Masonry Assemblies
04 22 23 29	01 54 23 00a	Unit Masonry Assemblies
04 22 23 31	01 54 23 00a	Unit Masonry Assemblies

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SECTION 04 23 13 00 - GLASS UNIT MASONRY ASSEMBLIES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for glass unit masonry assemblies. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes
      a. Glass block set in mortar.
      b. Glass block set in silicone sealant.
      c. Glass block set in glass-block grid systems.

C. Performance Requirements
   1. Structural Performance: Provide glass-block grid systems capable of withstanding the effects of gravity loads and the loads and stresses within limits and under conditions indicated.

D. Action Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittals:
      a. Product Data for Credit IEQ 4.1: For sealants used inside the weatherproofing system, documentation including printed statement of VOC content.
      b. Laboratory Test Reports for Credit IEQ 4: For sealants used inside the weatherproofing system, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
   3. Shop Drawings: Show fabrication and installation details for glass unit masonry, including vertical and horizontal coursing, anchors, reinforcement, and expansion strips and glass-block grid systems.
   4. Provide Samples for each form, pattern, and color of glass block and color of joint material and glass-block grid material indicated or selected by the Owner.
   5. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, documentation including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

E. Informational Submittals
   1. Qualification Data: For qualified professional engineer.

F. Quality Assurance
   1. Fire-Rated Glass Unit Masonry Assemblies: Assemblies listed by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 **OR** IBC Standard 715, **as directed**.
      a. Test Pressure: Test at atmospheric pressure **OR** After 10 minutes into the test, neutral pressure level in furnace shall be located so that at least two-thirds of test specimen is above the neutral pressure plane, **as directed**.

G. Delivery, Storage, And Handling
   1. Store glass block in unopened cartons on elevated platforms, under cover, and in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

2. Store glass-block grid materials in unopened cartons in an enclosed, dry location.
3. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
4. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
5. Store accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

H. Project Conditions
1. Environmental Limitations for Sealants: Do not install sealants when ambient and substrate temperatures are outside limits permitted by sealant manufacturer or below 40 deg F (5 deg C) or when joint substrates are wet.
2. Weather Limitations: Proceed with installation of glass unit masonry assemblies only when ambient and material temperatures are 40 deg F (5 deg C) or higher.
   a. Maintain temperature in installation areas at 40 deg F (5 deg C) or above for 48 hours after installing.

I. Sequencing And Scheduling
1. Sequence and coordinate completion of glass unit masonry assemblies so sealants can be installed immediately after mortar has attained final set.

1.2 PRODUCTS

A. Glass Block
1. Hollow Glass Block: Hollow units made from transparent glass, with manufacturer's standard edge coating.
   a. Glass Color: As selected from manufacturer's full range.
   b. Pattern:
      1) Smooth, undistorted inner and outer faces.
      2) Wavy, light-diffusive design on inner faces, and smooth outer faces.
      3) Fluted, light-diffusive design, horizontal on one inner face, vertical on other; and smooth outer faces.
      4) Linear prismatic design, horizontal on one inner face, vertical on other; and smooth outer faces.
      5) Prismatic pyramid, light-diffusive design on inner faces, and smooth outer faces.
      6) As indicated by manufacturer's designation.
      7) Manufacturer's standard decorative pattern to match sample.
      8) As selected from manufacturer's full range.
      9) Custom decorative pattern to match design.
   c. Edge-Coating Color: As selected from manufacturer's full range.
   d. Sizes: Manufacturer's standard sizes corresponding to nominal sizes indicated on Drawings.
   e. Thick-Faced Units: Units with faces at least 3/4 inch (19 mm) thick.
2. Solid Glass Block: Colorless, transparent, solid glass blocks with smooth **OR** stippled, **as directed**, faces and manufacturer's standard edge coating.
   a. Square-Block Size: 5-3/4 inches (146 mm) **OR** 7-3/4 inches (197 mm) **OR** 11-3/4 inches (299 mm) **as directed**, square by 1-1/2 inches (38 mm) **OR** 3 inches (76 mm) thick, actual size, **as directed**.
   b. Rectangular-Block Size: 3 by 7-3/4 inches (76 by 197 mm) **OR** 5-3/4 by 7-3/4 inches (146 by 197 mm), **as directed by** 1-1/2 inches (38 mm) **OR** 3 inches (76 mm) thick, actual size, **as directed**.
3. Glass Paver Block: Transparent, colorless, pressed glass units, with a smooth top surface and a decorative, light-diffusing, patterned bottom surface; **6 inches (152 mm) square by 1 inch (25 mm) OR 4-3/4 inches (120 mm) square by 1-9/16 inches (40 mm) OR 6-5/16 inches (160 mm) square by 1-3/16 inches (30 mm) OR 7-1/2 inches (190 mm) square by 1-1-15/16**

inches (50 mm) OR 7-1/2 inches (190 mm) square by 2-3/4 inches (70 mm) OR 7-7/8 inches (200 mm) square by 7/8 inch (22 mm) OR 7-7/8 inches (200 mm) square by 1-15/16 inches (50 mm) OR 4-5/8 inches (117 mm) in diameter by 2-3/8 inches (60 mm) thick, actual size, **as directed.**

a.

B. Glass-Block Grid Systems

1. General: Aluminum extrusions complying with ASTM B 221 (ASTM B 221M), Alloy 6063-T6 or Alloy 6463-T6, forming a grid system and frame designed for application indicated.
2. Window and Wall System: Aluminum T-bar grid with tubular frame and vinyl glass-block boots.
   a. Finish: As selected from manufacturer's full range.
   b. Glass-Block Size: 7-3/4 inches (197 mm) square by 3-1/8 inches (79 mm) thick.
   c. Provide self-flashing, **as directed**, aluminum exterior frame covers with vinyl thermal break.
   d. Provide extruded-aluminum frame receivers (corner starters) at heads, jambs, and sills.
   e. Provide extruded-aluminum mullions where indicated.
   f. Provide aluminum trim and closures as indicated.
3. Skylight System: Aluminum T-bar grid with tubular frame; vinyl thermal break; extruded-aluminum, curb-mounting frame and counterflashing; and vinyl glass-block boots.
   a. Finish: As selected from manufacturer's full range.
   b. Glass-Block Size: 7-3/4 inches (197 mm) square by 3-1/8 inches (79 mm) thick.
4. Floor System: Aluminum tubular grid and frame with glass-block boots made from UV- and oil-resistant EPDM.
   a. Finish: Class II, clear-anodized finish; complying with AAMA 611.
   b. Glass-Paver-Block Size: 6 inches (152 mm) square by 1 inch (25 mm) thick.
5. Sealant: Product recommended by glass-block grid system manufacturer.
   a. Provide sealants for use inside the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Mortar Materials

1. Portland Cement: ASTM C 150, Type I or Type II, natural color or white cement as required to produce mortar color indicated.
   a. Where joints are indicated to be raked out and pointed, gray cement may be used for setting mortar.
2. Hydrated Lime: ASTM C 207, Type S.
3. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207, Type S.
4. Masonry Cement: ASTM C 91.
5. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar.
6. Colored Cement Product: Packaged blend made from portland cement and lime **OR** masonry cement, **as directed**, and mortar pigments, all complying with specified requirements, and containing no other ingredients.
   a. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
   b. Pigments shall not exceed 10 percent of portland cement **OR** 5 percent of masonry cement, **as directed**, by weight.
7. Aggregate: ASTM C 144, with 100 percent passing No. 8 (2.36-mm) sieve.
   a. For pointing mortar and joints narrower than 1/4 inch (6 mm), use aggregate graded with 100 percent passing No. 16 (1.18-mm) sieve.
   b. White Aggregates: Natural white sand or crushed white stone.
   c. Colored Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
8. Water-Repellent Admixture: Manufacturer's standard dry mixture of stearates, water-reducing agents, and fine aggregates intended to reduce capillarity in mortar.

9. Water-Repellent Admixture: Liquid polymeric water-repellent mortar admixture that does not reduce flexural bond strength of mortar.
10. Water: Potable.

D. Glass Unit Masonry Accessories
1. Panel Reinforcement: Ladder-type units, butt welded, not lapped and welded; complying with ASTM A 951 in straight lengths of not less than 10 feet (3 m), and as follows:
    a. Interior Walls: Hot-dip galvanized, carbon-steel wire.
    b. Exterior Walls: Hot-dip galvanized, carbon-steel **OR** Stainless-steel, **as directed**, wire.
    c. Wire Size: W1.7 or 0.148-inch (3.8-mm) diameter.
    d. Width: 2 inches (50 mm) **OR** 1-5/8 inches (40 mm), **as directed**.
    e. Spacing of Cross Rods: Not more than 16 inches (407 mm) apart.
2. Panel Anchors: Glass-block manufacturer's standard perforated steel strips, 0.0359 inch (0.9 mm) by 1-3/4 inches (44 mm) wide by 24 inches (600 mm) long, hot-dip galvanized after fabrication to comply with ASTM A 153/A 153M.
3. Mortarless Installation System: System of aluminum or plastic perimeter framing, anchors, and spacers designed for installing glass block with sealant-filled joints.
4. Fasteners, General: Unless otherwise indicated, provide Type 304 or Type 316 stainless-steel fasteners at exterior walls and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, at interior walls. Select fasteners for type, grade, and class required.
5. Carbon-Steel Bolts: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6) with hex nuts, ASTM A 563 (ASTM A 563M), if applicable.
6. Stainless-Steel Bolts: ASTM F 593 (ASTM F 738M), Alloy Group 1 or 2 (A1 or A4) with hex nuts, ASTM F 594 (ASTM F 836M), if applicable.
7. Postinstalled Anchors: Provide powder-actuated fasteners **OR** metal expansion sleeve anchors **OR** metal impact expansion anchors, **as directed**, of type and size necessary for installation indicated, as recommended by manufacturer, unless otherwise indicated.
8. Asphalt Emulsion: Cold-applied asphalt emulsion complying with ASTM D 1187 or ASTM D 1227.
9. Mineral-Fiber Expansion Strips: Mineral-fiber strips, complying with requirements of fire-rated assembly listing and glass-block manufacturer.
    a. Use for fire-rated assemblies.
10. Plastic-Foam Expansion Strips: Polyethylene foam complying with requirements of glass-block manufacturer; 3/8 inch (9 mm) thick by 4 inches (100 mm) **OR** 3-1/2 inches (89 mm) **OR** 2-1/2 inches (63 mm) wide, **as directed.**
    a. Use plastic-foam expansion strips for non-fire-rated assemblies **OR** fire-rated and non-fire-rated assemblies, **as directed**.
11. Sealants: Manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated below that comply with applicable requirements in Division 07 Section "Joint Sealants".
    a. Single-component, neutral-curing **OR** acid-curing, **as directed**, silicone sealant.
    b. Single-component, nonsag urethane sealant.
    c. Multicomponent, nonsag polysulfide sealant.
    d. Provide sealants for use inside the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    e. Sealant Accessories: Provide sealant accessories, including primers, bond-breaker tape, and cylindrical sealant backing, that comply with applicable requirements in Division 07 Section "Joint Sealants".

E. Mortar Mixes
1. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, or antifreeze compounds, unless otherwise indicated.
    a. Do not use calcium chloride in mortar.
    b. For mortar in exterior panels, use water-repellent admixture according to admixture manufacturer's written instructions.

c. For pointing mortar in exterior panels, use water-repellent admixture according to admixture manufacturer's written instructions.
d. Limit cementitious materials in mortar to portland cement and lime.

2. Mortar for Glass Unit Masonry Assemblies: Provide mortar, mixed according to glass-block manufacturer's listing with testing and inspecting agency, for fire-resistance rating indicated.
OR
Mortar for Glass Unit Masonry Assemblies: Comply with ASTM C 270, Proportion Specification for Type S mortar.
   a. Combine and thoroughly mix cementitious materials, water, and aggregates in a mechanical batch mixer, unless otherwise indicated. Mix mortar to produce a stiff but workable consistency that is drier than mortar for brick or concrete masonry. Discard mortar when it has reached initial set.
3. Pigmented Mortar: Use colored cement product **OR** Select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products, **as directed**.
   a. Pigments shall not exceed 10 percent of portland cement by weight.
   b. Pigments shall not exceed 5 percent of masonry cement by weight.
   c. Mix to match sample.
4. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
   a. Mix to match sample.

1.3 EXECUTION

A. Examination
1. Examine sills, jambs, and heads surrounding glass unit masonry assemblies for compliance with requirements for installation tolerances and other conditions affecting performance.
   a. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installing Glass Block With Mortar
1. Apply a heavy coat of asphalt emulsion to sill and adhere expansion strips to jambs and heads with asphalt emulsion. Allow asphalt emulsion to dry before placing mortar. Trim expansion strips to width required to fit glass block and to full lengths of heads and jambs.
2. Set glass block with completely filled bed and head joints, with no furrowing, accurately spaced and coordinated with other construction. Maintain 1/4-inch (6-mm) **OR** 3/8-inch (10-mm), **as directed**, exposed joint widths, unless otherwise indicated.
3. Install panel reinforcement in horizontal joints at spacing indicated and continuously from end to end of panels; comply with the following requirements:
   a. Vertical Spacing of Panel Reinforcement for Exterior Panels: Every other course but not more than 16 inches (407 mm) o.c., starting with first course above sill **OR** As indicated on Drawings, **as directed**.
   b. Vertical Spacing of Panel Reinforcement for Interior Panels: Not more than 16 inches (407 mm) o.c. **OR** As indicated on Drawings, **as directed**.
   c. Do not bridge expansion joints with panel reinforcement.
   d. Place panel reinforcement in joints immediately above and below all openings within glass unit masonry assemblies.
   e. Lap panel reinforcement not less than 6 inches (150 mm) if more than 1 length is necessary.
   f. Embed panel reinforcement in mortar bed by placing lower half of mortar bed first, pressing panel reinforcement into place and covering with upper half of mortar bed.
4. Install panel anchors at locations indicated and in same horizontal joints where panel reinforcement occurs. Extend panel anchors at least 12 inches (300 mm) into joints, and bend within expansion joints at edges of panels and across the head. Attach panel anchors as follows:
   a. For in-place unit masonry assemblies and concrete, attach panel anchors with 1/4-inch- (6-mm-) diameter bolt-size, postinstalled anchors, 2 per panel anchor.

b. For new unit masonry assemblies, embed other ends of panel anchors, after bending portions crossing expansion joint, in horizontal mortar joints closest in elevation to joints in glass unit masonry assemblies containing panel anchors.
c. For steel members, attach panel anchors with 1/4-inch- (6-mm-) diameter through bolts and nuts or bolts in tapped holes in steel members.

5. Use rubber mallet to tap units into position. Do not use steel tools, and do not allow units to come into contact with metal accessories and frames.
6. Use plastic spacers **OR** temporary wedges, **as directed**, in mortar joints to produce uniform joint widths and to prevent mortar from being squeezed out of joints.
   a. If temporary wedges are used, remove them after mortar has set and fill voids with mortar.
7. Keep expansion joints free of mortar.
8. Rake out joints indicated to be pointed to a uniform depth sufficient to accommodate pointing material, but not less than joint width.
   a. If temporary wedges are used, remove them before raking out and pointing joints.
   b. Point joints at exterior face **OR** both faces, **as directed**, of exterior panels with mortar.
   c. Point joints at exterior face **OR** both faces, **as directed**, of exterior panels with sealant.
   d. Point joints at both faces of exterior and interior panels with sealant.
9. Point joints with mortar by filling raked joints and voids. Place and compact pointing mortar in layers not more than 3/8 inch (10 mm) thick. Compact each layer thoroughly and allow to become thumbprint hard before applying next layer.
   a. Tool exposed joints slightly concave when pointing mortar is thumbprint hard. Use a smooth plastic jointer larger than joint width.
10. Point joints by filling with sealant to comply with requirements in Division 07 Section "Joint Sealants".
11. Clean glass unit masonry assemblies as work progresses. Remove mortar fins and smears immediately, using a clean, wet sponge or a scrub brush with stiff fiber bristles. Do not use harsh cleaners, acids, abrasives, steel wool, or wire brushes when removing mortar or cleaning glass unit masonry assemblies.
12. Install sealant at jambs, heads, mullions and other locations indicated. Prepare joints, including installation of primer and bond-breaker tape or cylindrical sealant backing, and apply elastomeric sealants to comply with requirements in Division 07 Section "Joint Sealants".
13. Construction Tolerances: Set glass block to comply with the following tolerances:
   a. Variation from Plumb: For lines and surfaces of vertical elements and arris, do not exceed 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch in 40 feet (12 mm in 12 m) or more.
   b. Variation from Level: For bed joints, and other conspicuous lines, do not exceed 1/8 inch in 10 feet (3 mm in 3 m) , 1/4 inch in 20 feet (6 mm in 6 m) or 1/2 inch in 40 feet (12 mm in 12 m) or more.
   c. Variation of Location in Plan: For location of elements in plan do not vary from that indicated by more than plus or minus 1/4 inch (6 mm).
   d. Variation in Mortar-Joint Thickness: Do not vary from joint thickness indicated by more than plus or minus 1/16 inch (1.5 mm).
   e. For faces of adjacent exposed units, do not vary from flush alignment by more than 1/16 inch (1.5 mm).

C. Installing Glass Block With Sealant
1. General: Install mortarless glass-block systems according to manufacturer's written instructions.
   a. Fasten frames and anchors or clips securely to surrounding construction.
   b. Shim starting track as needed to make it level.
   c. Adhere glass block to starting track and spacers with silicone sealant.
2. After glass blocks are installed, apply sealant to completely fill channel around each glass block, and tool flush with exterior surface. Remove excess sealant and smears.

D. Glass-Block Grid System Installation
1. General: Install glass-block grid systems according to manufacturer's written instructions.

2. Window and Wall System Installation: Assemble grid system, apply continuous sealant bead to back of window Z-bar, place in position, adjust as needed to make grid level and plumb, and fasten to substrate.
   a. Insert glass blocks into vinyl glass-block boots and carefully insert into grid from exterior side. Install blocks firmly against T-bars without deforming boots.
   b. Apply sealant to completely fill channel around each glass block, and tool flush with exterior surface. Remove excess sealant and smears.
3. Skylight System Installation: Assemble grid system, apply continuous sealant bead to top of supporting curb, place in position, adjust as needed to bring grid true to line, and fasten to substrate.
   a. Insert glass blocks into vinyl glass-block boots and carefully insert into grid from exterior side. Install blocks firmly against T-bars without deforming boots.
   b. Apply sealant to completely fill channel around each glass block, and tool flush with exterior surface. Remove excess sealant and smears.
4. Floor System Installation: Assemble grid system in position, adjusting supports as needed to level grid as system is assembled, and fasten to substrate.
   a. Insert glass blocks into glass-block boots and install in grid. Install blocks flush with adjoining floor surfaces and aluminum grid.
   b. Apply sealant to completely fill channel around each glass block and joints of aluminum grid. Tool sealant flush with exterior surface and remove excess sealant and smears.

E. Cleaning
1. On surfaces adjacent to glass unit masonry assemblies, remove mortar, sealants, and other residue resulting from glass-block installation, in a manner approved by manufacturers of materials involved.
2. Remove excess sealants with commercial solvents of type recommended by sealant manufacturer. Exercise care not to damage sealant in joints.
3. Perform final cleaning of glass unit masonry assemblies when surface is not exposed to direct sunlight. Start at top of panel using generous amounts of clean water. Remove water with clean, dry, soft cloths; change cloths frequently to eliminate dried mortar particles and aggregate.

END OF SECTION 04 23 13 00

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Task	Specification	Specification Description
04 23 13 00	01 54 23 00a	Unit Masonry Assemblies

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SECTION 04 41 00 00 - DIMENSION STONE CLADDING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for dimension stone cladding. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following types of dimension stone:
   a. Panels set with individual anchors.
   b. Panels mechanically anchored on prefabricated steel trusses.
   c. Panels mechanically anchored on prefabricated steel strongback frames.
   d. Panels mechanically anchored on prefabricated steel stud frames.
   e. Panels mechanically anchored (field installed) on a metal-grid system.
   f. Panels set in architectural precast concrete.
   g. Panels glazed into aluminum curtain-wall framing system.
   h. Trim units, including bands, copings, sills, jambs and soffits.
   i. Units with carving or inscriptions.

C. Definitions
1. Definitions contained in ASTM C 119 apply to this Section.
2. Dimension Stone Cladding System: An exterior wall covering system consisting of dimension stone panels and trim together with anchors, backup structure, secondary weather barrier (sheathing), mortar, adhesives, fasteners, and sealants used to secure the stone to building structure and to produce a weather-resistant covering.
   a. Backup structure includes prefabricated steel trusses **OR** prefabricated steel strongback frames **OR** prefabricated steel stud frames **OR** metal-grid system **OR** miscellaneous steel framing required to secure stone to building structure, **as directed**.

D. Performance Requirements
1. General: Design stone anchors and anchoring systems according to ASTM C 1242.
2. Structural Performance: Provide dimension stone cladding system capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
   a. Wind Loads: Determine loads based on the following minimum design wind pressures:
      1) Uniform pressure of 20 lbf/sq. ft. (957 Pa) **OR** 30 lbf/sq. ft. (1436 Pa), **as directed**, acting inward or outward.
   b. Equipment Loads: Allow for loads due to window cleaning and maintenance equipment.
3. Seismic Performance: Provide dimension stone cladding system capable of withstanding the effects of earthquake motions determined according to ASCE 7.
4. Safety Factors for Stone: Design dimension stone cladding system to withstand loads indicated without exceeding allowable working stress of stone determined by dividing stone's average ultimate strength, as established by testing, by the following safety factors:
   a. Safety Factor for Granite: 3, **as directed**.
   b. Safety Factor for Oolitic Limestone: 8, **as directed**.
   c. Safety Factor for Dolomitic Limestone: 6, **as directed**.
   d. Safety Factor for Marble: 5, **as directed**.
   e. Safety Factor for Quartz-Based Stone: 6, **as directed**.
   f. Safety Factor for Serpentine: 6, **as directed**.
   g. Safety Factor for Slate: 5, **as directed**.
   h. Safety Factor for Travertine: 8, **as directed**.

i. Safety Factor for Concentrated Stresses: 4 for granite and 10 for stone varieties other than granite.

E. Submittals
1. Product Data: For each variety of stone, stone accessory, and other manufactured products indicated.
2. Shop Drawings: Show fabrication and installation details for dimension stone cladding system, including dimensions and profiles of stone units.
   a. Show locations and details of joints both within dimension stone cladding system and between dimension stone cladding system and other construction.
   b. Show locations and details of anchors and backup structure.
   c. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
3. Stone Samples: Sets for each color, grade, finish, and variety of stone required; not less than 12 inches (300 mm) square.
4. Colored Pointing Mortar Samples: For each color required.
5. Sealant Samples for Verification: For each type and color of joint sealant required.
6. Material Test Reports: From a qualified independent testing agency, as follows:
   a. Stone Test Reports: For each stone variety proposed for use on Project, provide test data indicating compliance with required physical properties, other than abrasion resistance, according to referenced ASTM standards. Base reports on testing done within previous five **OR** three, **as directed**, years.
7. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.

F. Quality Assurance
1. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated.
2. Source Limitations for Stone: Obtain each variety of stone, regardless of finish, from a single quarry.
3. Preconstruction Stone Testing: Engage a qualified independent testing agency to perform preconstruction testing indicated below.
   a. Furnish test specimens that are representative of materials proposed for incorporation into the Work.
   b. Physical Property Tests: For each stone variety proposed for use on Project, tested for compliance with physical property requirements, other than abrasion resistance, according to referenced ASTM standards.
   c. Flexural Strength Tests: For each combination of stone variety, thickness, orientation of cut, and finish, proposed for use on Project, tested according to ASTM C 880, in both wet and dry conditions.
   d. Anchorage Tests: For each combination of stone variety, orientation of cut, finish, and anchor type proposed for use on Project, tested according to ASTM C 1354.
4. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   a. Build mockups of typical exterior wall with dimension stone cladding, approximately 72 inches (1800 mm) long by 48 inches (1200 mm) high **OR** 15 feet (4.5 m) long by 10 feet (3 m) high, **as directed**.

G. Delivery, Storage, And Handling
1. Store and handle stone and related materials to prevent deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, and other causes.
   a. Lift stone with wide-belt slings; do not use wire rope or ropes that might cause staining. Move stone, if required, using dollies with cushioned wood supports.

b. Store stone on wood skids or pallets with nonstaining, waterproof covers. Arrange to distribute weight evenly and to prevent damage to stone. Ventilate under covers to prevent condensation.

2. Mark stone units, on surface that will be concealed after installation, with designations used on Shop Drawings to identify individual stone units. Orient markings on vertical panels so that they are right side up when units are installed.
3. Deliver sealants to Project site in original unopened containers labeled with manufacturer's name, product name and designation, color, expiration period, pot life, curing time, and mixing instructions for multicomponent materials.
4. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
5. Store aggregates in locations where grading and other required characteristics can be maintained and where contamination can be avoided.

H. Project Conditions

1. Environmental Limitations for Mortar: Do not use frozen materials or materials mixed or coated with ice or frost. Remove and replace dimension stone cladding damaged by frost or freezing conditions. Comply with cold- and hot-weather construction and protection requirements for masonry contained in ACI 530.1/ASCE 6/TMS 602.
2. Environmental Limitations for Sealants: Do not install sealants when ambient and substrate temperatures are outside limits permitted by sealant manufacturer or below 40 deg F (5 deg C) or when joint substrates are wet.

1.2 PRODUCTS

A. Granite

1. Granite: Comply with ASTM C 615.
2. Finish: Polished **OR** Honed **OR** Thermal **OR** As indicated **OR** Match sample, **as directed**.
3. Match samples for color, finish, and other stone characteristics relating to aesthetic effects.

B. Limestone

1. Limestone: Comply with ASTM C 568.
   a. Classification: I Low-Density **OR** II Medium-Density **OR** II Medium-Density, except change requirements per ASTM C 568 for absorption by weight, density, compressive strength, and modulus of rupture to, respectively, 5 percent maximum, 150 lb/cu. ft. (2400 kg/cu. m) minimum, 8000 psi (55 MPa), and 800 psi (5.5 MPa) minimum **OR** III High-Density, **as directed**.
   b. Description: Dolomitic **OR** Oolitic **OR** Shell, **as directed**, limestone.
2. Indiana Oolitic Limestone Grade and Color: Select, buff **OR** Select, gray **OR** Standard, buff **OR** Standard, gray **OR** Rustic, buff **OR** Rustic, gray **OR** Variegated, **as directed**, according to grade and color classification established by ILI.
3. Finish: Smooth **OR** Sand rubbed **OR** Machine tooled, 4 bats per 1 inch (25 mm) **OR** Machine tooled, 6 bats per 1 inch (25 mm) **OR** Machine tooled, 8 bats per 1 inch (25 mm) **OR** As indicated **OR** Match sample, **as directed**.
4. Match samples for color, finish, and other stone characteristics relating to aesthetic effects.

C. Marble

1. Marble: Comply with ASTM C 503, Classification I Calcite **OR** II Dolomite, **as directed**.
2. Finish: Polished **OR** Honed **OR** As indicated **OR** Match sample, **as directed**.
3. Match samples for color, finish, and other stone characteristics relating to aesthetic effects.

D. Quartz-Based Stone

1. Quartz-Based Stone: Comply with ASTM C 616, Classification I Sandstone **OR** II Quartzitic Sandstone **OR** III Quartzite, **as directed**.

2. Finish: Sand rubbed **OR** Natural cleft **OR** Thermal **OR** As indicated **OR** Match sample, **as directed**.
3. Match samples for color, finish, and other stone characteristics relating to aesthetic effects.

E. Serpentine
1. Serpentine: Comply with ASTM C 1526, Classification I Exterior **OR** II Interior, **as directed**.
2. Finish: Polished **OR** Honed **OR** As indicated **OR** Match sample, **as directed**.
3. Match samples for color, finish, and other stone characteristics relating to aesthetic effects.

F. Slate
1. Slate: Comply with ASTM C 629, Classification I Exterior **OR** II Interior, **as directed**, with a fine, even grain and unfading color, **as directed**, from clear, sound stock.
2. Finish: Honed **OR** Sand rubbed **OR** Natural cleft **OR** As indicated **OR** Match sample, **as directed**.
3. Match samples for color, finish, and other stone characteristics relating to aesthetic effects.

G. Travertine
1. Travertine: Comply with ASTM C 1527, Classification I Exterior **OR** II Interior, **as directed**.
2. Finish: Polished **OR** Honed **OR** As indicated **OR** Match sample, **as directed**.
3. Match samples for color, finish, and other stone characteristics relating to aesthetic effects.
4. Mortar Materials
5. Portland Cement: ASTM C 150, Type I or Type II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
   a. Low-Alkali Cement: Portland cement for use with limestone shall contain not more than 0.60 percent total alkali when tested according to ASTM C 114.
6. Hydrated Lime: ASTM C 207.
7. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207.
8. Colored Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III; hydrated lime complying with ASTM C 207; and mortar pigments. Use a mix of formulation required to produce color indicated or, if not indicated, as selected from manufacturer's standard formulations. Pigments shall not exceed 10 percent of portland cement by weight.
9. Aggregate: ASTM C 144; except for joints narrower than 1/4 inch (6 mm) and pointing mortar, use aggregate graded with 100 percent passing No. 16 (1.18-mm) sieve.
   a. White Aggregates: Natural white sand or ground white stone.
   b. Colored Aggregates: Natural-colored sand or ground marble, granite, or other durable stone; of color necessary to produce required mortar color.
10. Mortar Pigments: Natural and synthetic iron oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in mortar and containing no carbon black.
11. Water: Potable.

H. Anchors And Fasteners
1. Fabricate anchors, including shelf angles, **as directed**, from stainless steel, ASTM A 666, Type 304 **OR** 316, **as directed**. Fabricate dowels and pins from stainless steel, ASTM A 276, Type 304 **OR** 316, **as directed**.
2. Fabricate shelf angles for limestone from hot-dip galvanized steel, ASTM A 36/A 36M for materials and ASTM A 123/A 123M for galvanizing.
3. Cast-in-Place Concrete Inserts: Steel, cast iron, or malleable iron adjustable inserts, with bolts, nuts, washers, and shims; all hot-dip galvanized or mechanically zinc coated, with capability to sustain, without failure, a load equal to 4 times the loads imposed as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
4. Postinstalled Anchor Bolts for Concrete and Masonry: Chemical anchors **OR** torque-controlled expansion anchors **OR** undercut anchors, **as directed**, made from stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and

ASTM F 836M, Alloy Group A1 or A4) for bolts and nuts; ASTM A 666 or ASTM A 276, Type 304 or 316, for anchors, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

5. Threaded Fasteners: Heavy hexagon structural bolts, heavy hexagon nuts, and hardened washers.
   a. For stainless steel, use stainless-steel bolts, nuts, and washers; ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Alloy Group A1 or A4).
   b. For galvanized steel shelf angles and backup structure, use carbon steel bolts, nuts, and washers; ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), for bolts; ASTM A 563 (ASTM A 563M), Grade A, for nuts; and ASTM F 436 (ASTM F 436M) for washers; all hot-dip or mechanically zinc coated.
6. Weld Plates for Installation in Concrete: Comply with Division 05 Section "Metal Fabrications".

I. Framing For Backup Structure
1. Steel Trusses **OR** Strongback Frames **OR** Miscellaneous Steel Framing, **as directed**: For framing members in contact with stone fabricate from same material and finish specified for anchors. For framing members not in contact with stone, comply with requirements indicated below:
   a. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M, minimum thickness of 3/16 inch (5 mm).
   b. Steel Tubing: ASTM A 500 (cold formed), or ASTM A 513, Type 5 (mandrel drawn), minimum thickness of 3/16 inch (5 mm).
   c. Slotted Channel Framing: Cold-formed metal channels with continuous slot complying with MFMA-3, made from galvanized steel complying with ASTM A 653/A 653M, structural steel, Grade 33 (Grade 230), with G90 (Z275) coating, and not less than 0.108-inch (2.74-mm) nominal thickness **OR** steel sheet complying with ASTM A 1008/A 1008M, structural steel, Grade 33 (Grade 230), not less than 0.105-inch (2.66-mm) nominal thickness, hot-dip galvanized after fabrication to comply with ASTM A 123/A 123M, **as directed**.
2. Prefabricated Steel Stud Frames: Galvanized steel wall framing complying with Division 05 Section "Cold-formed Metal Framing".
   a. Secondary Weather Barrier (Sheathing): Galvanized steel sheet complying with ASTM A 653/A 653M, commercial steel, coating designation G90 (Z275).
3. Metal-Grid Systems: Provide manufacturer's standard integrated system that combines metal struts, fittings, fasteners, and stone anchors and that is engineered expressly for mechanically installing dimension stone cladding and that complies with the following requirements:
   a. Struts: Cold-formed metal channels with continuous slot complying with MFMA-3, of size and shape required for application indicated, made from galvanized steel complying with ASTM A 653/A 653M, with G90 (Z275) coating, and not less than 0.108-inch (2.74-mm) nominal thickness **OR** steel sheet complying with ASTM A 1008/A 1008M, not less than 0.105-inch (2.66-mm) nominal thickness, hot-dip galvanized after fabrication to comply with ASTM A 123/A 123M, **as directed**.
   b. Fittings and Fasteners: System manufacturer's standard components of design, size, and material required to securely attach struts to building structure, by method indicated or selected, and stone anchors to struts, as well as to prevent galvanic corrosion. Fabricate components in contact with stone from same material specified for anchors.
   c. Stone Anchors: Shapes and sizes standard with system manufacturer, complying with "Anchors and Fasteners" Article.

J. Stone Accessories
1. Setting Shims: Strips of resilient plastic or vulcanized neoprene, Type A Shore durometer hardness of 50 to 70, nonstaining to stone, of thickness needed to prevent point loading of stone on anchors and of depths to suit anchors without intruding into required depths of pointing materials.

2. Setting Buttons: Resilient plastic buttons, nonstaining to stone, sized to suit joint thicknesses and bed depths of stone units without intruding into required depths of pointing materials.
3. Concealed Sheet Metal Flashing: Fabricate from zinc-tin alloy-coated, **as directed**, stainless steel in thicknesses indicated, but not less than 0.0156 inch (0.4 mm) thick. Comply with requirements specified in Division 07 Section "Sheet Metal Flashing And Trim".
4. Cementitious Dampproofing for Limestone: Provide cementitious formulations that are recommended by ILI and that are nonstaining to stone, compatible with joint sealants, and noncorrosive to anchors and attachments.
5. Weep and Vent Tubes: Medium-density polyethylene tubing, 1/4-inch (6-mm) OD **OR** Rectangular, cellular, polypropylene or clear butyrate extrusion, 3/8 by 1-1/2 inches (9 by 38 mm), **as directed**, and of length required to extend from exterior face of stone to cavity behind.
6. Plastic Weep Hole/Vents: One-piece, flexible extrusion manufactured from UV-resistant polypropylene copolymer, designed to weep moisture in masonry cavity to exterior, in color selected from manufacturer's standard.
7. Wicking Material: Absorbent rope, made from cotton or UV-resistant synthetic fiber, 1/4 to 3/8 inch (6 to 10 mm) in diameter, in length required to produce 2-inch (50-mm) exposure on exterior and 18 inches (450 mm) in cavity between wythes.
8. Sealants for Joints in Dimension Stone Cladding: Manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated below that comply with applicable requirements in Division 07 Section "Joint Sealants" and do not stain stone.
    a. Multicomponent **OR** Single-component, **as directed**, nonsag, polysulfide sealant.
    b. Multicomponent **OR** Single-component, **as directed**, nonsag, urethane sealant.
    c. Single-component, neutral-curing silicone sealant.
    d. Colors: Provide colors of exposed sealants to comply with the following requirement:
        1) Match color of sample **OR** Match color of stone **OR** Provide color as indicated by manufacturer's designations **OR** Provide color as selected from manufacturer's full range, **as directed**.
9. Sealant for Filling Kerfs: Same sealant used for joints in dimension stone **OR** Manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated below that comply with applicable requirements in Division 07 Section "Joint Sealants" and that do not stain stone, **as directed**.
    a. Single-component, nonsag, urethane sealant; Class 25, Use T (traffic), and Use M (masonry).
    b. Single-component, nonsag, neutral-curing, medium to high modulus, silicone sealant; Class 25, Use NT (nontraffic), and Use M (masonry).

K. Stone Fabrication
1. General: Fabricate stone units in sizes and shapes required to comply with requirements indicated, including details on Drawings and Shop Drawings.
    a. For granite, comply with recommendations in NBGQA's "Specifications for Architectural Granite."
    b. For limestone, comply with recommendations in ILI's "Indiana Limestone Handbook."
    c. For marble, comply with recommendations in MIA's "Dimensional Stone--Design Manual IV."
2. Control depth of stone and back check to maintain minimum clearance of 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed,** between backs of stone units and surfaces or projections of structural members, fireproofing (if any), backup walls, and other work behind stone.
3. Dress joints (bed and vertical) straight and at right angle to face, unless otherwise indicated. Shape beds to fit supports.
4. Cut and drill sinkages and holes in stone for anchors, fasteners, supports, and lifting devices as indicated or needed to set stone securely in place.
5. Finish exposed faces and edges of stone, except sawed reveals, to comply with requirements indicated for finish and to match approved samples and mockups.
6. Cut stone to produce uniform joints 3/8 inch (10 mm) **OR** 1/2 inch (13 mm), **as directed,** wide and in locations indicated.

7. Contiguous Work: Provide chases, reveals, reglets, openings, and similar features as required to accommodate contiguous work.
8. Fabricate molded work, including washes and drips, to produce stone shapes with a uniform profile throughout entire unit length, with precisely formed arris slightly eased to prevent snipping, and with matching profile at joints between units.

L. Fabrication Of Backup Structure
1. Fabrication of Steel Trusses **OR** Strongback Frames **OR** Miscellaneous Steel Framing, **as directed**: Fabricate in shop to comply with AISC's "Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design," to accommodate construction tolerances specified, and as indicated on Shop Drawings.
   a. Weld shop connections to comply with applicable provisions of AWS D1.1/D1.1M.
   b. Fabricate joints to exclude water or to permit its escape to building exterior, at locations where water could accumulate because of condensation or other causes.
   c. Hot-dip galvanize backup structure after fabrication to comply with ASTM A 123/A 123M.
2. Fabrication of Prefabricated Steel Stud Frames: Fabricate and assemble by welding to comply with requirements in Division 05 Section "Cold-formed Metal Framing".
   a. Weld secondary weather barrier (sheathing) to outside face of steel stud frames. Use continuous welds at all four edges of sheets to provide continuous weather seal.
   b. For assemblies made from galvanized steel, clean welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

M. Shop-Painted Steel Finishes
1. General: Paint uncoated steel backup structure before delivering to Project site to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel."
2. Surface Preparation: After completing fabrication of steel items, prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Apply two-coat high-performance coating system consisting of organic zinc-rich primer, complying with SSPC-Paint 20 or SSPC-Paint 29 and topcoat of high-build urethane or epoxy coating recommended by manufacturer for application over specified zinc-rich primer.

N. Mortar Mixes
1. General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures needed to produce mortar of uniform quality and with optimum performance characteristics.
   a. Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated. Do not use calcium chloride.
   b. Combine and thoroughly mix cementitious materials, water, and aggregates in a mechanical batch mixer, unless otherwise indicated. Discard mortar when it has reached initial set.
2. Portland Cement-Lime Setting Mortar: Comply with ASTM C 270, Proportion Specification, for types of mortar indicated below:
   a. Set granite with Type S mortar.
   b. Set limestone with Type N mortar.
   c. Set marble with Type S mortar.
   d. Set quartz-based stone with Type S **OR** N, **as directed**, mortar.
   e. Set serpentine with Type S mortar.
   f. Set slate with Type S mortar.
   g. Set travertine with Type N mortar.
   h. Backparge travertine with Type O mortar.
3. Pointing Mortar: Comply with ASTM C 270, Proportion Specification, for types of mortar indicated. Provide pointing mortar mixed to match sample and complying with the following:

a. Pigmented Pointing Mortar: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1:10, by weight.
b. Packaged Portland Cement-Lime Mix Mortar: Use portland cement-lime mix of selected color.
c. Colored-Aggregate Pointing Mortar: Produce color required by combining colored aggregates with portland cement of selected color.
d. Point granite with Type S **OR** N, **as directed**, mortar.
e. Point limestone with Type N **OR** O, **as directed**, mortar.
f. Point marble with Type N **OR** O, **as directed**, mortar.
g. Point quartz-based stone with Type N **OR** O, **as directed**, mortar.
h. Point serpentine with Type N **OR** O, **as directed**, mortar.
i. Point slate with Type N mortar.
j. Point travertine with Type N **OR** O, **as directed**, mortar.

1.3 EXECUTION

A. Installing Backup Structure
1. Installing Steel Trusses **OR** Strongback Frames **OR** Miscellaneous Steel Framing, **as directed**: Comply with AISC's "Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design," and install to accommodate construction tolerances specified and as indicated on Shop Drawings.
a. Maintain erection tolerances of backup structure within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
b. For prefabricated units to which stone has been installed before erection, maintain tolerances of stone faces and edges as specified in "Installation Tolerances" Article.
2. Installing Prefabricated Steel Stud Frames: Install by welding to steel weld-plates anchored in concrete **OR** by welding to structural-steel frame **OR** by bolting to structural-steel frame, **as directed**, to comply with requirements in Division 05 Section "Cold-formed Metal Framing".
a. Install prefabricated steel stud frames level, plumb, and true to line with no variation in plane or alignment exceeding 1/16 inch (1.5 mm) and no variation in position exceeding 1/8 inch (3 mm).
b. For prefabricated frames to which stone has been installed before erection, maintain tolerances of stone faces and edges as specified in "Installation Tolerances" Article.
3. Installing Metal-Grid Systems: Comply with manufacturer's written instructions to provide integrated system that combines metal struts, fittings, fasteners, and stone anchors.
a. Fasten struts by bolting to inserts in concrete or steel angle clips bolted to steel framing.
b. Fasten stone supports and anchors by bolting to struts.
c. Shim and adjust struts and stone supports and anchors to provide grid that is level, plumb, and true to line with no variation in plane or alignment exceeding 1/16 inch (1.5 mm) and no variation in position exceeding 1/8 inch (3 mm).

B. Setting Dimension Stone Cladding, General
1. Before setting stone clean surfaces that are dirty or stained by removing soil, stains, and foreign materials. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.
2. Coat limestone with dampproofing to extent indicated below:
a. Stone at Grade: Beds, joints, and back surfaces to at least 12 inches (300 mm) above finish-grade elevations.
b. Stone Extending below Grade: Beds, joints, back surfaces, and face surfaces below grade.
c. Allow cementitious dampproofing formulations to cure before setting dampproofed stone. Do not damage or remove dampproofing while handling and setting stone.
3. Parge back side of travertine panels with mortar not less than 3/8 inch (10 mm) thick.

4. Execute dimension stone cladding installation by skilled mechanics and employ skilled stone fitters at Project site to do necessary field cutting as stone is set.
   a. Use power saws with diamond blades to cut stone. Produce lines cut straight and true, with edges eased slightly to prevent snipping.
5. Contiguous Work: Provide reveals, reglets, and openings as required to accommodate contiguous work.
6. Set stone to comply with requirements indicated on Drawings and Shop Drawings. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure dimension stone cladding in place. Shim and adjust anchors, supports, and accessories to set stone accurately in locations indicated with uniform joints of widths indicated and with edges and faces aligned according to established relationships and indicated tolerances.
7. Provide expansion, control, and pressure-relieving joints of widths and at locations indicated.
   a. Sealing expansion and other joints is specified in Division 07 Section "Joint Sealants".
   b. Keep expansion joints free of mortar and other rigid materials.
8. Install concealed flashing at continuous shelf angles, lintels, ledges, and similar obstructions to downward flow of water to divert water to building exterior.
9. Keep cavities open where unfilled space is indicated between back of stone units and backup wall; do not fill cavities with mortar or grout.
   a. Place weep holes in joints where moisture may accumulate, including base of cavity walls, above shelf angles, and flashing. Locate weep holes at intervals not exceeding 24 inches (600 mm). Use weep and vent tubes **OR** plastic weep hole/vents **OR** wicking material, **as directed**.
   b. Place vents in cavity walls at tops of cavities, below shelf angles and flashing, and at intervals not exceeding 20 feet (6 m) vertically. Locate vents in joints at intervals not exceeding 60 inches (1500 mm) horizontally. Use weep and vent tubes **OR** plastic weep hole/vents, **as directed**.

C. Setting Mechanically Anchored Dimension Stone Cladding
1. Attach anchors securely to stone and to backup surfaces. Comply with recommendations in ASTM C 1242.
2. Provide compressible filler in ends of dowel holes and bottoms of kerfs to prevent end bearing of dowels and anchor tabs on stone. Fill remainder of anchor holes and kerfs with sealant indicated for filling kerfs.
3. Set stone supported on clips or continuous angles on resilient setting shims. Use material of thickness required to maintain uniform joint widths and to prevent point loading of stone on anchors. Hold shims back from face of stone a distance at least equal to width of joint.

D. Setting Dimension Stone Cladding With Mortar
1. Set stone in full bed of mortar with head joints filled, unless otherwise indicated.
   a. Use setting buttons of adequate size, in sufficient quantity, and of thickness required to maintain uniform joint width and to prevent mortar from extruding. Hold buttons back from face of stone a distance at least equal to width of joint, but not less than depth of pointing materials.
   b. Do not set heavy units or projecting courses until mortar in courses below has hardened enough to resist being squeezed out of joint.
   c. Support and brace projecting stones until wall above is in place and mortar has set.
   d. Provide compressible filler in ends of dowel holes and bottoms of kerfs to prevent end bearing of dowels and anchor tabs on stone. Fill remainder of anchor holes and kerfs with mortar.
2. Embed ends of sills in mortar; leave remainder of joint open until final pointing.
3. Rake out joints for pointing with mortar to depths of not less than 1/2 inch (12 mm). Rake joints to uniform depths with square bottoms and clean sides.
4. Prepare stone-joint surfaces for pointing with mortar by removing dust and mortar particles. Where setting mortar was removed to depths greater than surrounding areas, apply first layer of pointing mortar in layers not more than 3/8 inch (10 mm) until a uniform depth is formed.

5. Point stone joints by placing pointing mortar in layers not more than 3/8 inch (10 mm). Compact each layer thoroughly and allow to become thumbprint hard before applying next layer.
6. Tool joints with a round jointer having a diameter 1/8 inch (3 mm) larger than width of joint, when pointing mortar is thumbprint hard.
7. Rake out mortar from sealant-pointed joints to depths of not less than 1/2 inch (12 mm) nor less than that required for sealant and sealant backing. Rake joints to uniform depths with square bottoms and clean sides.
8. Set the following dimension stone cladding with unfilled head joints for installing joint sealants:
   a. Cornices.
   b. Copings.
   c. Belt and other projecting courses.

E. Joint-Sealant Installation
1. Prepare joints and apply sealants of type and at locations indicated to comply with applicable requirements in Division 07 Section "Joint Sealants".

F. Installation Tolerances
1. Variation from Plumb: For vertical lines and surfaces of walls, do not exceed 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (10 mm in 6 m), or 1/2 inch in 40 feet (12 mm in 12 m) or more. For external corners, corners and jambs within 20 feet (6 m) of an entrance, expansion joints, and other conspicuous lines, do not exceed 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 3/8 inch in 40 feet (10 mm in 12 m) or more.
2. Variation from Level: For lintels, sills, water tables, parapets, horizontal bands, horizontal grooves, and other conspicuous lines, do not exceed 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 3/8 inch (10 mm) maximum.
3. Variation of Linear Building Line: For positions shown in plan and related portions of walls and partitions, do not exceed 1/4 inch in 20 feet (6 mm in 6 m) or 1/2 inch in 40 feet (12 mm in 12 m) or more.
4. Variation in Cross-Sectional Dimensions: For thickness of walls from dimensions indicated, do not exceed plus or minus 1/4 inch (6 mm).
5. Variation in Joint Width: Do not vary from average joint width more than plus or minus 1/8 inch (3 mm) or a quarter of nominal joint width, whichever is less. For joints within 60 inches (1500 mm) of each other, do not vary more than 1/8 inch (3 mm) or a quarter of nominal joint width, whichever is less from one to the other.
6. Variation in Plane between Adjacent Stone Units (Lipping): Do not exceed 1/16-inch (1.5-mm) difference between planes of adjacent units.

G. Adjusting And Cleaning
1. Remove and replace broken, chipped, stained, or otherwise damaged stone, defective joints, and dimension stone cladding that does not match approved samples and mockups. Damaged stone may be repaired if the Owner approves methods and results.
2. Replace in a manner that results in dimension stone cladding's matching approved samples and mockups, complying with other requirements, and showing no evidence of replacement.
3. In-Progress Cleaning: Clean dimension stone cladding as work progresses. Remove mortar fins and smears before tooling joints. Remove excess sealant and smears as sealant is installed.
4. Final Cleaning: Clean dimension stone cladding no fewer than six days after completion of pointing and sealing, using clean water and stiff-bristle fiber brushes. Do not use wire brushes, acid-type cleaning agents, cleaning agents containing caustic compounds or abrasives, or other materials or methods that could damage stone.

END OF SECTION 04 41 00 00

SECTION 04 41 00 00a - INTERIOR STONE FACING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for interior stone facing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following interior applications of dimension stone:
   a. Wall paneling.
   b. Wainscot paneling.
   c. Column facing.
   d. Window stools.
   e. Base.
   f. Trim.
   g. Benches.

C. Performance Requirements
1. General: Design stone anchors and anchoring systems according to ASTM C 1242.
2. Seismic Performance: Provide interior stone facing system capable of withstanding the effects of earthquake motions determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

D. Submittals
1. Product Data: For each variety of stone, installation materials, and other manufactured products.
2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   a. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
3. Samples:
   a. For Each Stone Type: Include two **OR** three **OR** four **OR** five, **as directed**, or more Samples in each set and show the full range of variations in appearance characteristics expected in completed Work.
   b. For each color of grout and pointing mortar required.
4. LEED Submittal:
   a. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
5. Sealant Compatibility Test Report: From sealant manufacturer, complying with requirements in Division 07 Section "Joint Sealants" and indicating that sealants will not stain or damage stone.
6. Maintenance data.

E. Quality Assurance
1. Installer Qualifications: An installer who employs experienced stone setters who are skilled in installing interior stone facing similar in material, design, and extent to that indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.
   a. Installer's responsibilities include fabricating and installing interior stone facing, including anchoring system, and providing professional engineering services needed to assume engineering responsibility.
   b. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

2. Source Limitations for Stone: Obtain each variety of stone, regardless of finish, from a single quarry, whether specified in this Section or in another Section, with resources to provide materials of consistent quality in appearance and physical properties.

F. Delivery, Storage, And Handling
1. Lift stone with wide-belt slings; do not use wire rope or ropes that might cause staining. Move stone, if required, using dollies with cushioned wood supports.
2. Store stone on wood A-frames or pallets with nonstaining separators and nonstaining, waterproof covers. Ventilate under covers to prevent condensation.
3. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

1.2 PRODUCTS

A. Granite
1. Granite: Comply with ASTM C 615.
2. Description: Uniform, fine-grained **OR** medium-grained, **as directed**, white **OR** pink **OR** gray **OR** black, **as directed**, stone with **OR** without, **as directed**, veining.
3. Cut: Vein **OR** Fleuri, **as directed**, cut.
    a. Orientation of Veining: Horizontal **OR** Vertical **OR** As indicated, **as directed**.
4. Cut stone from one block or contiguous, matched blocks in which natural markings occur.
5. Finish: polished **OR** Honed **OR** Thermal **OR** As indicated **OR** Match sample, **as directed**.

B. Limestone
1. Limestone: Comply with ASTM C 568.
    a. Classification: I Low-Density **OR** II Medium-Density **OR** III High-Density, **as directed**.
    b. Description: Dolomitic **OR** Oolitic **OR** Shell, **as directed**, limestone.
2. Cut: Vein **OR** Fleuri, **as directed**, cut.
    a. Orientation of Veining: Horizontal **OR** Vertical **OR** As indicated, **as directed**.
3. Cut stone from one block or contiguous, matched blocks in which natural markings occur.
4. Finish: Smooth **OR** Sand rubbed **OR** Machine tooled, 4 bats per 1 inch (25 mm) **OR** Machine tooled, 6 bats per 1 inch (25 mm) **OR** Machine tooled, 8 bats per 1 inch (25 mm) **OR** As indicated **OR** Match sample, **as directed**.

C. Marble
1. Marble: Comply with ASTM C 503.
2. Description: Uniform, fine- to medium-grained, white stone with only slight veining.
3. Cut: Vein **OR** Fleuri, **as directed**, cut.
    a. Orientation of Veining: Horizontal **OR** Vertical **OR** As indicated, **as directed**.
4. Cut stone from one block or contiguous, matched blocks in which natural markings occur.
5. Finish: Polished **OR** Honed **OR** As indicated **OR** Match sample, **as directed**.

D. Quartz-Based Stone
1. Quartz-Based Stone: Comply with ASTM C 616, Classification I Sandstone **OR** II Quartzitic Sandstone **OR** III Quartzite, **as directed**.
2. Finish: Sand rubbed **OR** Natural cleft **OR** Thermal **OR** As indicated **OR** Match sample, **as directed**.

E. Serpentine
1. Serpentine: Comply with ASTM C 1526, Classification I Exterior **OR** II Interior, **as directed**.
2. Cut stone from one block or contiguous, matched blocks in which natural markings occur.
3. Finish: Polished **OR** Honed **OR** As indicated **OR** Match sample, **as directed**.

F. Slate

1. Slate: Comply with ASTM C 629, Classification I Exterior **OR** II Interior, **as directed**, with a fine, even grain and unfading color, from clear, sound stock.
    a. Color: Black **OR** Blue-black **OR** Gray **OR** Blue-gray **OR** Green **OR** Purple **OR** Mottled purple and green **OR** Red, **as directed**.
2. Finish: Honed **OR** Sand rubbed **OR** Natural cleft **OR** As indicated **OR** Match sample, **as directed**.

G. Travertine
1. Travertine: Comply with ASTM C 1527, Classification I Exterior **OR** II Interior, **as directed**.
2. Cut: Vein **OR** Fleuri, **as directed**, cut.
    a. Orientation of Veining: Horizontal **OR** Vertical **OR** As indicated, **as directed**.
3. Cut stone from one block or contiguous, matched blocks in which natural markings occur.
4. Filling: Fill pores on faces of stone with cementitious filler of color selected **OR** matching sample, **as directed**.
5. Finish: Polished **OR** Honed **OR** As indicated **OR** Match sample, **as directed**.

H. Setting Materials
1. Molding Plaster: ASTM C 59/C 59M.
2. Portland Cement: ASTM C 150, Type I or II.
    a. Low-Alkali Cement: Not more than 0.60 percent total alkali when tested according to ASTM C 114.
3. Hydrated Lime: ASTM C 207, Type S.
4. Aggregate: ASTM C 144.
5. Water: Potable.
6. Adhesives, General: Use only adhesives formulated for stone and ceramic tile and recommended by their manufacturer for the application indicated.
7. Organic Adhesive: ANSI A136.1, Type I, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
8. Water-Cleanable Epoxy Adhesive: ANSI A118.3, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. Stone Adhesive: 2-part, epoxy-resin or polyester-resin stone adhesive with an initial set time of not more than 2 hours at 70 deg F (21 deg C), and with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    a. Color: Clear **OR** Match stone, **as directed**.

I. Grout
1. Grout Colors: Match stone **OR** As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
2. Sand-Portland Cement Grout: ANSI A108.10, composed of white or gray cement and white or colored aggregate as required to produce required color.
3. Standard Sanded Cement Grout: ANSI A118.6.
4. Standard Unsanded Cement Grout: ANSI A118.6.
5. Polymer-Modified Tile Grout: ANSI A118.7.
    a. Polymer Type: Ethylene vinyl acetate, in dry, redispersible form, prepackaged with other dry ingredients.
    b. Polymer Type: Acrylic resin or styrene-butadiene rubber in liquid-latex form for addition to prepackaged dry-grout mix.
    c. Polymer Type: Either ethylene vinyl acetate, in dry, redispersible form, prepackaged with other dry ingredients, or acrylic resin or styrene-butadiene rubber in liquid-latex form for addition to prepackaged dry-grout mix.
    d. Grout Type: Sanded **OR** Unsanded, **as directed**.
6. Water-Cleanable Epoxy Grout: ANSI A118.3, chemical-resistant, water-cleanable, tile-setting and -grouting epoxy.

J. Pointing Mortar Materials

1. Portland Cement: ASTM C 150, Type I or II. Provide natural color or white cement as required to produce mortar color indicated.
   a. Low-Alkali Cement: Not more than 0.60 percent total alkali when tested according to ASTM C 114.
2. Hydrated Lime: ASTM C 207, Type S.
3. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or III, and hydrated lime complying with ASTM C 207, Type S.
4. Colored Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III; hydrated lime complying with ASTM C 207, Type S; and mortar pigments. Use a mix of formulation required to produce color indicated or, if not indicated, as selected from manufacturer's standard formulations. Pigments shall not exceed 10 percent of portland cement by weight.
5. Aggregate: ASTM C 144, except with 100 percent passing No. 16 (1.18-mm) sieve.
   a. White Aggregates: Natural white sand or ground white stone.
   b. Colored Aggregates: Natural-colored sand or ground marble, granite, or other durable stone; of color necessary to produce required mortar color.
6. Mortar Pigments: Natural and synthetic iron oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in mortar and containing no carbon black.
7. Water: Potable.

K. Sealants
1. Joint Sealants: Manufacturer's standard sealants of characteristics indicated below that comply with applicable requirements in Division 07 Section "Joint Sealants" and will not stain the stone they are applied to.
   a. Single-component, mildew-resistant, neutral-curing **OR** acid-curing, **as directed**, silicone sealant.
   b. Single-component, nonsag urethane sealant.
   c. Latex Sealant.
   d. VOC Content: 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   e. Colors: Provide colors of exposed sealants to match colors of grout in stone adjoining sealed joints, unless otherwise indicated.
2. Sealant for Filling Kerfs: Same sealant used for joints in dimension stone **OR** Manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated below that comply with applicable requirements in Division 07 Section "Joint Sealants" and that do not stain stone, **as directed**.
   a. Single-component, nonsag, urethane sealant; Class 25, Use T (traffic), and Use M (masonry).
   b. Single-component, nonsag, neutral-curing, medium to high modulus, silicone sealant; Class 25, Use NT (nontraffic), and Use M (masonry).
   c. VOC Content: 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

L. Stone Anchors And Attachments
1. Fabricate anchors from stainless steel, ASTM A 240/A 240M, Type 304.
   a. Fasteners for Stainless-Steel Anchors: Annealed stainless-steel bolts, nuts, and washers; ASTM F 593 (ASTM F 738M) for bolts and ASTM F 594 (ASTM F 836M) for nuts, Alloy Group 1 (A1).
2. Fabricate dowels from stainless steel, ASTM A 276, Type 304.
3. Fabricate anchors from extruded aluminum, ASTM B 221 (ASTM B 221M), alloy and temper as required to support loads imposed without exceeding allowable design stresses, but not less than strength and durability properties of Alloy 6063-T6.
   a. Fasteners for Extruded-Aluminum Anchors: Annealed stainless-steel bolts, nuts, and washers; ASTM F 593 (ASTM F 738M) for bolts and ASTM F 594 (ASTM F 836M) for nuts, Alloy Group 1 (A1).

4. Anchor Support Grids: Roll-formed steel channels, of size and shape required for application indicated, formed from galvanized steel sheet not less than 0.108 inch (2.8 mm) thick and complying with ASTM A 653/A 653M, G90 (Z275).
   a. Fittings and Fasteners: System manufacturer's standard components of design, size, and material required to securely attach grids to building structure and stone anchors to grids. Fabricate components in contact with stone from same material specified for anchors.
5. Wire Tiebacks: No. 9 AWG copper or copper-alloy or 0.120-inch- (3.0-mm-) diameter, stainless-steel wire.
6. Dovetail Slots: Furnish dovetail slots with filler strips of slot size required to receive anchors provided, fabricated from 0.0336-inch- (0.85-mm-) thick, galvanized steel sheet complying with ASTM A 653/A 653M, G90 (Z275).
7. Direct-Mount Anchoring Systems: Stainless-steel or aluminum stone anchors designed to be applied directly to wall surfaces or to metal grids. System is secured to wall framing, furring, or sheet-metal reinforcing strips built into wall with stainless-steel self-drilling screws. Anchors fit into kerfs or holes in edges of interior stone facing panels and do not need setting spots.

M. Stone Accessories
1. Temporary Setting Shims: Rigid plastic shims, nonstaining to stone, sized to suit joint thickness.
2. Setting Shims for Direct-Mount Anchoring Systems: Strips of resilient plastic or neoprene, nonstaining to stone, of thickness needed to prevent point loading of stone on anchors and of depths to suit anchors without intruding into required depths of pointing materials.
3. Cleaner: Stone cleaner specifically formulated for stone types, finishes, and applications indicated, as recommended by stone producer. Do not use cleaning compounds containing acids, caustics, harsh fillers, or abrasives.
4. Stone Sealer: Colorless, stain-resistant sealer that does not affect color or physical properties of stone surfaces, as recommended by stone producer for application indicated.

N. Stone Fabrication, General
1. Select stone for intended use to prevent fabricated units from containing cracks, seams, and starts that could impair structural integrity or function.
   a. Repairs that are characteristic of the varieties specified are acceptable provided they do not impair structural integrity or function and are not aesthetically unpleasing, as judged by the Owner.
2. Fabricate interior stone facing in sizes and shapes required to comply with requirements indicated, including details on Drawings and Shop Drawings.
   a. For granite, comply with recommendations in NBGQA's "Specifications for Architectural Granite."
   b. For marble, comply with recommendations in MIA's "Dimension Stone--Design Manual."
   c. For limestone, comply with recommendations in ILI's "Indiana Limestone Handbook."
3. Cut stone to produce pieces of thickness, size, and shape indicated and to comply with fabrication and construction tolerances recommended by applicable stone association.
   a. Where items are installed with adhesive or where edges of stone is visible in the finished work, make items uniform in thickness and of identical thickness for each type of item; gage back of stone if necessary.
   b. Clean sawed backs of stones to remove rust stains and iron particles.
   c. Dress joints straight and at right angle to face, unless otherwise indicated.
   d. Cut and drill sinkages and holes in stone for anchors, supports, and lifting devices as indicated or needed to set stone securely in place; shape beds to fit supports.
   e. Provide openings, reveals, and similar features as needed to accommodate adjacent work.
4. Fabricate molded work to produce stone shapes with a uniform profile throughout entire unit length and with precisely formed arris slightly eased to prevent snipping, and matched at joints between units.
   a. Produce moldings with machines having abrasive shaping wheels made to reverse contour of molding shape; do not sculpt moldings.
   b. Miter moldings at corners, unless otherwise indicated, with edges of miters slightly eased at outside corners.

5. Finish exposed faces and edges of stone to comply with requirements indicated for finish of each type of stone required and to match approved Samples.
6. Carefully inspect finished stone units at fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units.
   a. Grade and mark stone for overall uniform appearance when assembled in place. Natural variations in appearance are acceptable if installed stone units match range of colors and other appearance characteristics represented in approved Samples.

O. Stone Paneling And Column Facing
1. Arrange panels in shop or other suitable space in proposed orientation and sequence for examination by the Owner. Mark units with temporary sequence numbers to indicate position in proposed layout.
   a. Lay out one elevation at a time if approved by the Owner.
   b. Notify the Owner seven days in advance of date and time when layout will be available for viewing.
   c. Provide lighting of similar type and level as that of final installation for viewing layout, unless otherwise approved by the Owner.
   d. Rearrange panels as directed by the Owner until layout is approved.
   e. Do not trim nonmodular-size units to less than modular size until after the Owner's approval of layout, unless otherwise approved by the Owner.
   f. Mark backs of units and Shop Drawings with sequence numbers based on approved layout. Mark backs of units to indicate orientation of units in completed Work.
2. Nominal Thickness: 3/4 inch (20 mm) **OR** 7/8 inch (21 mm) **OR** 1 inch (25 mm) **OR** 1-1/4 inches (32 mm) **OR** 2 inches (50 mm), **as directed**, unless otherwise indicated.
3. Maintain minimum clearances of 3/4 inch (20 mm) **OR** 1 inch (25 mm), **as directed**, between backs of panels and structural members, fireproofing if any, backup walls, and other work behind stone. Do not back check stone less than 1 inch (25 mm) thick.
4. Joints: 1/16-inch- (1.5-mm-) wide grouted **OR** 1/8-inch- (3-mm-) wide grouted **OR** 1/8-inch- (3-mm-) wide, sealant-filled **OR** 1/4-inch- (6-mm-) wide, mortar-pointed **OR** 1/4-inch- (6-mm-) wide, sealant-filled **OR** 3/8-inch- (10-mm-) wide, mortar-pointed **OR** 3/8-inch- (10-mm-) wide, sealant-filled, **as directed**, joints.
5. Quirk-miter corners, unless otherwise indicated. Install anchorage in top and bottom bed joints of corner units.
6. Carve and cut inscriptions and decorative surfaces according to Shop Drawings. Use skilled stone carvers experienced in the successful performance of work similar to that indicated.
7. Abrasively etch inscriptions and decorative surfaces according to Shop Drawings.
8. Laser etch inscriptions and decorative surfaces according to Shop Drawings.
9. Pattern Arrangement: Fabricate and arrange panels with veining and other natural markings to comply with the following requirements:
   a. Arrange panels with veining horizontal.
   b. Arrange panels with veining vertical.
   c. Arrange panels with veining as indicated on Drawings.
   d. Arrange panels in blend pattern.
   e. Book match units, single-course height.
   f. Book match units, both vertically and horizontally.
   g. Book match units in each course. No matching is required between successive courses.
   h. Slip match units, single-course height.
   i. Slip match units, both vertically and horizontally.
   j. Slip match units in each course. No matching is required between successive courses.

P. Stone Window Stools, Base, And Trim
1. Window Stools:
   a. Nominal Thickness: 3/4 inch (20 mm) **OR** 7/8 inch (22 mm) **OR** 1-1/4 inches (32 mm), **as directed**, unless otherwise indicated.

b. Edge Detail: Straight, slightly eased at corners **OR** 3/8-inch (10-mm) bevel at top edge, bottom corner slightly eased **OR** 3/8-inch (10-mm) radius at top edge, bottom corner slightly eased **OR** 3/4-inch (20-mm) bullnose **OR** 1-1/2-inch (40-mm) laminated bullnose **OR** As indicated, **as directed**.
c. Ends: Extend stools beyond opening same distance as stool overhang and finish ends to match exposed edge.
d. Joints: 1/16-inch- (1.5-mm-) wide grouted joints **OR** 1/8-inch- (3-mm-) wide grouted joints **OR** 1/8-inch- (3-mm-) wide, sealant-filled joints **OR** Bonded joints, 1/32 inch (0.8 mm) or less in width, **as directed**.
e. Assemble window stools by bonding joints with stone adhesive. Mask areas adjacent to joints to prevent adhesive smears. Clamp units to temporary bracing to ensure that window stools are properly aligned and joints are minimum width.

2. Base:
a. Nominal Thickness: 3/4 inch (20 mm) **OR** 7/8 inch (22 mm) **OR** 1-1/4 inches (32 mm), **as directed**, unless otherwise indicated.
b. Top-Edge Detail: Straight, slightly eased at corner **OR** 3/8-inch (10-mm) bevel **OR** 3/4-inch (20-mm) radius **OR** 3/8-inch (10-mm) radius **OR** As indicated, **as directed**.
c. Ends: Butt ends into casings **OR** Butt ends into opening frames **OR** Return ends to depth of adjacent finish with edge detail same as top edge, **as directed**, unless otherwise indicated.
d. Joints: 1/16-inch- (1.5-mm-) wide grouted joints **OR** 1/8-inch- (3-mm-) wide grouted joints **OR** 1/8-inch- (3-mm-) wide, sealant-filled joints **OR** Bonded joints, 1/32 inch (0.8 mm) or less in width, **as directed**.
1) Locate joints at midpoints between adjacent paneling joints, unless otherwise indicated.

3. Flat Trim:
a. Nominal Thickness: 3/4 inch (20 mm) **OR** 7/8 inch (22 mm) **OR** 1-1/4 inches (32 mm) **OR** 1-1/2 inches (40 mm), **as directed**, unless otherwise indicated.
b. Edge Detail: Straight, slightly eased at corners **OR** 3/8-inch (10-mm) bevels **OR** 3/4-inch (20-mm) radii **OR** 3/8-inch (10-mm) radii **OR** As indicated, **as directed**.
c. Joints: 1/16-inch- (1.5-mm-) wide grouted joints **OR** 1/8-inch- (3-mm-) wide grouted joints **OR** 1/8-inch- (3-mm-) wide, sealant-filled joints **OR** Bonded joints, 1/32 inch (0.8 mm) or less in width, **as directed**.

4. Molded Trim:
a. Profile: Match profiles indicated on Drawings **OR** existing, **as directed**.
b. Joints: 1/16-inch- (1.5-mm-) wide grouted joints **OR** 1/8-inch- (3-mm-) wide grouted joints **OR** 1/8-inch- (3-mm-) wide, sealant-filled joints **OR** Bonded joints, 1/32 inch (0.8 mm) or less in width, **as directed**.

Q. Stone Benches
1. Tops:
a. Nominal Thickness: 3/4 inch (20 mm) **OR** 7/8 inch (22 mm) **OR** 1-1/4 inches (32 mm) **OR** 1-1/2 inches (40 mm) **OR** 2 inches (50 mm), **as directed**, unless otherwise indicated.
b. Edge Detail: Straight, slightly eased at corners **OR** 3/8-inch (10-mm) bevel at top edge, bottom corner slightly eased **OR** 3/8-inch (10-mm) radius at top edge, bottom corner slightly eased **OR** 3/8-inch (10-mm) bevel at top and bottom edges **OR** full bullnose **OR** As indicated, **as directed**.
c. Corner Detail: Match top edge **OR** Square, slightly eased **OR** As indicated, **as directed**.
d. Bottom Surface Finish: Smooth.
2. Pedestals:
a. Nominal Thickness: 4 inches (100 mm), unless otherwise indicated.
b. Edge Detail: Straight, slightly eased at corners **OR** 3/8-inch (10-mm) bevel at corners **OR** 3/8-inch (10-mm) radius at corners **OR** full bullnose **OR** As indicated, **as directed**.
3. Base: Stone facing applied to concrete **OR** masonry, **as directed**.
a. Nominal Stone Thickness: 3/4 inch (20 mm) **OR** 7/8 inch (22 mm) **OR** 1-1/4 inches (32 mm), **as directed**, unless otherwise indicated.

b. Joints: 1/16-inch- (1.5-mm-) wide grouted **OR** 1/8-inch- (3-mm-) wide grouted **OR** 1/4-inch- (6-mm-) wide, mortar-pointed **OR** 3/8-inch- (10-mm-) wide, mortar-pointed, **as directed**, joints.

R. Mixes
1. Spotting Plaster: Stiff mix of molding plaster and water.
2. Mortar: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures needed to produce mortar of uniform quality and with optimum performance characteristics.
   a. Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated. Do not use calcium chloride.
   b. Combine and thoroughly mix cementitious materials, water, and aggregates in a mechanical batch mixer, unless otherwise indicated. Discard mortar when it has reached initial set.
3. Setting Mortar: Comply with ASTM C 270, Proportion Specification.
   a. Type: N **OR** O, **as directed**.
   b. Mix Proportions: 1 part portland cement and 2-1/2 to 4 parts lime with aggregate ratio of 2-1/4 to 3 times volume of cement and lime.
4. Pointing Mortar: Comply with ASTM C 270, Proportion Specification, for types of mortar indicated. Provide pointing mortar mixed to match the Owner's sample and complying with the following:
   a. Pigmented Pointing Mortar: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1:10, by weight.
   b. Packaged Portland Cement-Lime Mix Mortar: Use portland cement-lime mix of selected color.
   c. Colored-Aggregate Pointing Mortar: Produce color required by combining colored aggregates with portland cement of selected color.
   d. Type: N **OR** O, **as directed**.
   e. Mix Proportions: 1 part portland cement and 2-1/2 to 4 parts lime with aggregate ratio of 2-1/4 to 3 times volume of cement and lime.
5. Grout: Comply with mixing requirements of referenced ANSI standards and with manufacturer's written instructions.

1.3 EXECUTION

A. Preparation
1. Clean dirty or stained stone surfaces by removing soil, stains, and foreign materials before setting. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

B. Setting Of Stone, General
1. Do necessary field cutting as stone is set. Use power saws with diamond blades to cut stone. Cut lines straight and true, with edges eased slightly to prevent snipping.
2. Contiguous Work: Provide reveals and openings as required to accommodate contiguous work.
3. Set stone to comply with requirements indicated on Drawings and Shop Drawings. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure stone in place. Shim and adjust anchors, supports, and accessories to set stone accurately in locations indicated, with edges and faces aligned according to established relationships and indicated tolerances.
4. Erect stone units level, plumb, and true with uniform joint widths. Use temporary shims to maintain joint width.

5. Provide expansion, control, and pressure-relieving joints of widths and at locations indicated.
   a. Sealing of expansion, control, and pressure-relieving joints is specified in Division 07 Section "Joint Sealants".
   b. Keep expansion, control, and pressure-relieving joints free of plaster, mortar, grout, and other rigid materials.

C. Construction Tolerances
1. Variation from Plumb: For vertical lines and surfaces, do not exceed 1/8 inch in 96 inches (3 mm in 2400 mm), 1/4 inch (6 mm) maximum.
2. Variation from Level: For lintels, sills, chair rails, horizontal bands, horizontal grooves, and other conspicuous lines, do not exceed 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), 3/8 inch (10 mm) maximum.
3. Variation of Linear Building Line: For position shown in plan and related portion of walls and partitions, do not exceed 1/8 inch in 96 inches (3 mm in 2400 mm), 1/4 inch in 20 feet (6 mm in 6 m), 3/8 inch (10 mm) maximum.
4. Variation in Cross-Sectional Dimensions: For thickness of walls from dimensions indicated, do not exceed plus or minus 1/8 inch (3 mm).
5. Variation in Joint Width: Do not vary joint thickness more than 1/16 inch (1.5 mm) or 1/4 of nominal joint width, whichever is less.
6. Variation in Plane between Adjacent Stone Units (Lipping): Do not exceed 1/32-inch (0.8-mm) difference between planes of adjacent units.

D. Installation Of Stone Paneling And Column Facing
1. Set units firmly against setting spots. Locate setting spots at anchors and spaced not more than 18 inches (450 mm) apart across back of unit, but provide no fewer than 1 setting spot per 2 sq. ft. (0.18 sq. m), unless otherwise indicated.
   a. Moisture Exposure: Use portland cement mortar for setting spots where stone is applied to inside face of exterior walls and at other locations where stone or cavity will be exposed to moisture.
2. Set units on direct-mount anchoring system with anchors securely attached to stone and to backup surfaces. Comply with recommendations in ASTM C 1242.
   a. Provide compressible filler in ends of dowel holes and bottoms of kerfs to prevent end bearing of dowels and anchor tabs on stone. Fill remainder of anchor holes and kerfs with sealant indicated for filling kerfs.
   b. Set stone supported on clips or continuous angles on resilient setting shims. Use material of thickness required to maintain uniform joint widths and to prevent point loading of stone on anchors. Hold shims back from face of stone a distance at least equal to width of joint.
3. Minimum Anchors: Provide anchors at a maximum of 24 inches (600 mm) o.c. around perimeter of interior stone facing panels with a minimum of 4 anchors per panel.
4. Minimum Anchors: Provide a minimum of 4 anchors per panel up to 12 sq. ft. (1.1 sq. m) in face area, plus a minimum of 2 additional anchors for each additional 8 sq. ft. (0.7 sq. m).
5. Grout **OR** Point, **as directed**, joints after setting.

E. Installation Of Stone Window Stools, Base, And Trim
1. Stone Window Stools: Set stone window stools on masonry in a full bed of mortar.
   OR
   Stone Window Stools: Set stone window stools on wood or metal framing or wood blocking in a full bed of organic **OR** water-cleanable epoxy, **as directed**, adhesive. Hold adhesive back from exposed edges of joints to allow for grouting **OR** pointing with sealant, **as directed**.
2. Where window stools are too long to be installed in one piece, assemble by bonding joints with stone adhesive as units are set. Mask areas adjacent to joints to prevent adhesive smears. Clamp units in place to ensure that window stools are properly aligned and joints are minimum width.
3. Where joints are indicated in window stools maintain alignment across joints. Use temporary shims as necessary to maintain joint width.

4. Stone Base and Trim at Walls with Stone Paneling: Set units by adhering to interior stone facing with water-cleanable epoxy adhesive. Hold adhesive back from exposed edges of joints to allow for grouting.
   OR
   Stone Base and Trim at Walls with Stone Paneling: Set units firmly against setting spots. Located setting spots at anchors and spaced not more than 18 inches (450 mm) apart, unless otherwise indicated. Provide no fewer than 2 anchors per piece for stone trim up to 48 inches (1200 mm) in length, plus 1 additional anchor for each additional 24 inches (600 mm) of length.
5. Stone Base and Trim at Walls without Stone Paneling: Adhere units to plywood backing with full spread of water-cleanable epoxy adhesive. Hold adhesive back from exposed edges of joints to allow for grouting.
   OR
   Stone Base and Trim at Walls without Stone Paneling: Adhere units to gypsum board with full spread of organic **OR** water-cleanable epoxy, **as directed**, adhesive. Hold adhesive back from exposed edges of joints to allow for grouting.
6. Assemble stone base and trim by bonding joints with stone adhesive as units are set. Mask areas adjacent to joints to prevent adhesive smears. Clamp units in place to ensure that surfaces are properly aligned and joints are minimum width.
7. Grout **OR** Point, **as directed**, joints after setting.

F. Installation Of Stone Benches
1. Stone Pedestals: Set pedestals on concrete subfloor **OR** stone flooring, **as directed**, in a full bed of mortar. Anchor pedestals with no fewer than two 1/4-inch (6-mm) **OR** 3/8-inch (10-mm), **as directed**, dowels, extending not les than 2 inches (50 mm) into pedestals and 2 inches (50 mm) **OR** 4 inches (100 mm), **as directed**, into floor construction. Solidly fill space around dowels with mortar.
   OR
   Stone Pedestals: Set pedestals on stone flooring in a full bed of water-cleanable epoxy adhesive. Anchor pedestals with no fewer than two 1/4-inch (6-mm) **OR** 3/8-inch (10-mm), **as directed**, dowels, extending not les than 2 inches (50 mm) into pedestals and 2 inches (50 mm) into floor construction. Solidly fill space around dowels with adhesive. Hold adhesive back from exposed edges to allow for grouting.
2. Stone Bench Tops: Set tops on pedestals **OR** concrete or masonry bases, **as directed**, in a full bed of mortar. Anchor tops with no fewer than two 1/4-inch (6-mm) **OR** 3/8-inch (10-mm), **as directed**, dowels, extending not les than 2 inches (50 mm) into pedestals **OR** bases, **as directed**, and half of thickness into the tops. Solidly fill space around dowels with mortar.
   OR
   Stone Bench Tops: Set stone bench tops on pedestals **OR** concrete or masonry bases, **as directed**, in a full bed of water-cleanable epoxy adhesive. Anchor tops with no fewer than two 1/4-inch (6-mm) **OR** 3/8-inch (10-mm), **as directed**, dowels, extending not less than 2 inches (50 mm) into pedestals **OR** bases, **as directed**, and half of thickness into the tops. Solidly fill space around dowels with adhesive. Hold adhesive back from exposed edges of joints to allow for grouting.
3. Stone Base: Apply stone facing to concrete or masonry bases by setting in a full spread of mortar **OR** water-cleanable epoxy adhesive, **as directed**.
   a. Provide no fewer than 2 anchors per piece for stone base up to 48 inches (1200 mm) in length, plus 1 additional anchor for each additional 24 inches (600 mm) of length.
   b. Hold adhesive back from exposed edges of joints to allow for grouting.

G. Grouting Joints
1. Grout stone to comply with ANSI A108.10.
   a. Use sanded grout mixture for joints wider than 1/8 inch (3 mm).
   b. Use unsanded grout mixture for joints 1/8 inch (3 mm) and narrower.
2. Remove temporary shims before grouting.
3. Tool joints uniformly and smoothly with plastic tool.

H. Pointing Joints With Mortar
1. Prepare stone-joint surfaces for pointing with mortar by removing temporary shims, dust, and mortar particles. Where setting spots occur at joints, rake out excess setting mortar or plaster to a depth of not less than 1/2 inch (13 mm).
2. Point stone joints by placing pointing mortar in layers not more than 3/8 inch (10 mm). Compact each layer thoroughly and allow to become thumbprint hard before applying next layer. Apply mortar first to areas where depths are greater than surrounding areas until a uniform depth is formed.
3. Tool joints when pointing mortar is thumbprint hard. Use a round jointer having a diameter 1/8 inch (3 mm) larger than width of joint.

I. Joint-Sealant Installation
1. Prepare joints and apply sealants of type and at locations indicated to comply with applicable requirements in Division 07 Section "Joint Sealants". Remove temporary shims before applying sealants.

J. Adjusting And Cleaning
1. In-Progress Cleaning: Clean interior stone facing as work progresses. Remove adhesive, grout, mortar, and sealant smears immediately.
2. Remove and replace interior stone facing of the following description:
   a. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved by the Owner.
   b. Defective stone facing.
   c. Defective joints, including misaligned joints.
   d. Interior stone facing and joints not matching approved Samples.
   e. Interior stone facing not complying with other requirements indicated.
3. Replace in a manner that results in interior stone facing's matching approved Samples, complying with other requirements, and showing no evidence of replacement.
4. Clean interior stone facing no fewer than six days after completion of grouting and pointing, using clean water and soft rags or stiff-bristle fiber brushes. Do not use wire brushes, acid-type cleaning agents, cleaning compounds with caustic or harsh fillers, or other materials or methods that could damage stone.
5. Sealer Application: Apply stone sealer to comply with stone producer's and sealer manufacturer's written instructions and recommendations.

K. Protection
1. Protect stone surfaces, edges, and corners from construction damage. Use securely fastened untreated wood, plywood, or heavy cardboard to prevent damage.
2. Before inspection for Final Completion, remove protective coverings and clean surfaces.

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SECTION 04 42 43 00 - STONE MASONRY

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for stone masonry. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section includes the following applications of stone masonry:
   a. Anchored or Adhered to concrete backup.
   b. Anchored or Adhered to unit masonry backup.
   c. Anchored or Adhered to wood framing and sheathing.
   d. Anchored or Adhered to cold-formed metal framing and sheathing.

C. Submittals

1. Product Data: For each type of product indicated.
   a. For stone varieties proposed for use on Project, include test data indicating compliance with physical properties specified or required by referenced ASTM standards.
2. Samples:
   a. For each stone type indicated.
   b. For each color of mortar required.

D. Delivery, Storage, And Handling

1. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
2. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
3. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.
4. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

E. Project Conditions

1. Protection of Stone Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed stone masonry when construction is not in progress.
   a. Extend cover a minimum of 24 inches (600 mm) down both sides and hold cover securely in place.
2. Stain Prevention: Immediately remove mortar and soil to prevent them from staining the face of stone masonry.
   a. Protect base of walls from rain-splashed mud and mortar splatter by coverings spread on the ground and over the wall surface.
   b. Protect sills, ledges, and projections from mortar droppings.
   c. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
   d. Turn scaffold boards near the wall on edge at end of each day to prevent rain from splashing mortar and dirt on completed stone masonry.
3. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace stone masonry damaged by

frost or freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

a. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.

4. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1.2 PRODUCTS

A. Granite

1. Granite: Comply with ASTM C 615.

B. Limestone

1. Limestone: Comply with ASTM C 568.

C. Quartz-Based Stone

1. Quartz-Based Stone: Comply with ASTM C 616, Classification I Sandstone **OR** II Quartzitic Sandstone **OR** III Quartzite, **as directed**.

D. Mortar Materials

1. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
   a. Low-Alkali Cement: Not more than 0.60 percent total alkali when tested according to ASTM C 114.
2. Hydrated Lime: ASTM C 207, Type S.
3. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or III, and hydrated lime complying with ASTM C 207.
4. Mortar Cement: ASTM C 1329.
5. Masonry Cement: ASTM C 91.
6. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in stone masonry mortar.
7. Colored Cement Product: Packaged blend made from portland cement and lime **OR** masonry cement **OR** mortar cement, **as directed**, and mortar pigments, all complying with specified requirements, and containing no other ingredients.
   a. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
8. Aggregate: ASTM C 144 and as follows:
   a. For pointing mortar, use aggregate graded with 100 percent passing No. 16 (1.18-mm) sieve.
   b. White Aggregates: Natural white sand or ground white stone.
   c. Colored Aggregates: Natural-colored sand or ground marble, granite, or other sound stone; of color necessary to produce required mortar color.
9. Latex Additive: Manufacturer's standard **OR** acrylic-resin **OR** styrene-butadiene-rubber, **as directed**, water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement mortar bed, and not containing a retarder.
10. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
11. Water: Potable.

E. Veneer Anchors

1. Materials:
    a. Hot-Dip Galvanized-Steel Wire: ASTM A 82, with ASTM A 153/A 153M, Class B-2.
    b. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304 **OR** Type 316, **as directed**.
    c. Hot-Dip Galvanized-Steel Sheet: ASTM A 1008/A 1008M, cold-rolled, carbon-steel sheet hot-dip galvanized after fabrication to comply with ASTM A 153/A 153M, Class B-2.
    d. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304 **OR** Type 316, **as directed**.
2. Size: Sufficient to extend at least halfway, but not less than 1-1/2 inches (38 mm), through stone masonry and with at least 5/8-inch (16-mm) cover on outside face.
3. Wire Veneer Anchors: Wire ties formed from W1.7 or 0.148-inch- (3.8-mm-) diameter, hot-dip galvanized **OR** stainless, **as directed**,-steel wire.
4. Corrugated-Metal Veneer Anchors: Not less than 0.030-inch- (0.76-mm-) thick by 7/8-inch- (22-mm-) wide hot-dip galvanized **OR** stainless, **as directed**,-steel sheet with corrugations having a wavelength of 0.3 to 0.5 inch (7.6 to 13 mm) and an amplitude of 0.06 to 0.10 inch (1.5 to 2.5 mm).
5. Adjustable, Screw-Attached Veneer Anchors: Units consisting of a wire tie section and a metal anchor section that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:
    a. Structural Performance Characteristics: Capable of withstanding a 100-lbf (445-N) load in both tension and compression without deforming or developing play in excess of 0.05 inch (1.3 mm).
    b. Anchor Section: Rib-stiffened, sheet metal plate with screw holes top and bottom, 2-3/4 inches (70 mm) wide by 3 inches (75 mm) high; with projecting tabs having slotted holes for inserting vertical legs of wire tie specially formed to fit veneer anchor section.
    c. Anchor Section: Sheet metal plate, 1-1/4 inches (32 mm) wide by 6 inches (150 mm) **OR** 9 inches (225 mm), **as directed**, long, with screw holes top and bottom and with raised rib-stiffened strap, 5/8 inch (16 mm) wide by 3-5/8 inches (92 mm) **OR** 5-1/2 inches (140 mm), **as directed**, long, stamped into center to provide a slot between strap and plate for inserting wire tie.
    d. Anchor Section: Gasketed sheet metal plate, 1-1/4 inches (32 mm) wide by 6 inches (150 mm) long, with screw holes top and bottom; top and bottom ends bent to form pronged legs of length to match thickness of insulation or sheathing; and raised rib-stiffened strap, 5/8 inch (16 mm) wide by 6 inches (150 mm) long, stamped into center to provide a slot between strap and plate for inserting wire tie. Provide anchor manufacturer's standard, self-adhering, modified bituminous gaskets manufactured to fit behind anchor plate and extend beyond pronged legs.
    e. Anchor Section: Zinc-alloy barrel section with flanged head with eye and corrosion-resistant, self-drilling screw. Eye designed to receive wire tie and to serve as head for drilling fastener into framing. Barrel length to suit sheathing thickness, allowing screw to seat directly against framing with flanged head covering hole in sheathing.
    f. Fabricate sheet metal anchor sections and other sheet metal parts from 0.067-inch- (1.7-mm-) thick, steel sheet, galvanized after fabrication **OR** 0.097-inch- (2.5-mm-) thick, steel sheet, galvanized after fabrication **OR** 0.078-inch- (2.0-mm-) thick, stainless-steel sheet **OR** 0.109-inch- (2.8-mm-) thick, stainless-steel sheet, **as directed**.
    g. Wire Ties: Triangular-, rectangular-, or T-shaped wire ties fabricated from 0.188-inch- (4.8-mm-) **OR** 0.25-inch- (6.4-mm-), **as directed,** diameter, hot-dip galvanized **OR** stainless, **as directed**,-steel wire.
6. Seismic Veneer Anchors: Units consisting of a metal anchor section and a connector section designed to engage a continuous wire embedded in stone masonry mortar joint.
    a. Structural Performance Characteristics: Capable of withstanding a 100-lbf (445-N) load in both tension and compression without deforming or developing play in excess of 0.05 inch (1.3 mm).
    b. Anchor Section: Rib-stiffened, sheet metal plate with screw holes top and bottom, 2-3/4 inches (70 mm) wide by 3 inches (75 mm) high; with projecting tabs having slotted holes for inserting vertical leg of connector section.

c. Connector Section: Rib-stiffened, sheet metal bent plate with down-turned leg designed to fit in anchor section slot and with integral tabs designed to engage continuous wire. Size connector to extend at least halfway through stone masonry but with at least 5/8-inch (16-mm) cover on outside face.

d. Anchor Section: Rib-stiffened, sheet metal plate with screw holes top and bottom, 2-3/4 inches (70 mm) wide by 3 inches (75 mm) high; with projecting tabs having slotted holes for inserting vertical legs of wire tie specially formed to fit anchor section. Size wire tie to extend at least 1-1/2 inches (38 mm) into stone masonry but with at least 5/8-inch (16-mm) cover on outside face.

e. Connector Section: Sheet metal clip welded to wire tie with integral tabs designed to engage continuous wire.

f. Anchor Section: Gasketed sheet metal plate, 1-1/4 inches (32 mm) wide by 6 inches (150 mm) long, with screw holes top and bottom; top and bottom ends bent to form pronged legs to bridge insulation or sheathing and contact studs; and raised rib-stiffened strap, 5/8 inch (16 mm) wide by 6 inches (150 mm) long, stamped into center to provide a slot between strap and plate for inserting wire tie. Provide anchor manufacturer's standard, self-adhering, modified bituminous gaskets manufactured to fit behind anchor plate and extend beyond pronged legs.

g. Connector Section: Triangular wire tie and rigid PVC extrusion with snap-in grooves for inserting continuous wire.

h. Fabricate sheet metal anchor sections and other sheet metal parts from 0.067-inch- (1.7-mm-) thick, steel sheet, galvanized after fabrication **OR** 0.097-inch- (2.5-mm-) thick, steel sheet, galvanized after fabrication **OR** 0.078-inch- (2.0-mm-) thick, stainless-steel sheet **OR** 0.109-inch- (2.8-mm-) thick, stainless-steel sheet, **as directed**.

i. Fabricate wire connector sections from 0.188-inch- (4.8-mm-) **OR** 0.25-inch- (6.4-mm-), **as directed,** diameter, hot-dip galvanized, carbon **OR** stainless, **as directed**,-steel wire.

j. Continuous Wire: 0.188-inch- (4.8-mm-) diameter, hot-dip galvanized **OR** stainless, **as directed**,-steel wire.

7. Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C 954 except manufactured with hex washer head and neoprene washer, No. 10 (4.8-mm diameter) by length required to penetrate steel stud flange with not less than 3 exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours per ASTM B 117.

8. Stainless-Steel Drill Screws for Steel Studs: Proprietary fastener consisting of carbon-steel drill point and 300 Series stainless-steel shank, complying with ASTM C 954 except manufactured with hex washer head and neoprene washer, No. 10 (4.8-mm diameter) by length required to penetrate steel stud flange with not less than three exposed threads.

9. Polymer-Coated, Steel Drill Screws for Wood Studs: Self-drilling, bugle-head or wafer-head wood screws recommended by veneer anchor manufacturer for fastening to wood studs; not less than No. 10 (4.8-mm diameter), 1-1/2 inches (38 mm) long, and with organic polymer coating with salt-spray resistance to red rust of more than 500 hours per ASTM B 117.

10. Polymer-Coated, Steel Tapping Screws for Concrete Masonry: Self-tapping screws with specially designed threads for tapping and wedging into masonry, with hex washer head and neoprene washer, 3/16-inch (4.8-mm) diameter by 1-1/2-inch (38-mm) length, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours per ASTM B 117.

F. Stone Trim Anchors

1. Stone Trim Anchors: Units fabricated with tabs or dowels designed to engage kerfs or holes in stone trim units and holes for fasteners or postinstalled anchor bolts for fastening to substrates or framing as indicated.

2. Materials: Fabricate anchors from stainless steel, ASTM A 240/A 240M, Type 304. Fabricate dowels from stainless steel, ASTM A 276, Type 304.

3. Fasteners for Stone Trim Anchors: Annealed stainless-steel bolts, nuts, and washers; ASTM F 593 (ASTM F 738M) for bolts and ASTM F 594 (ASTM F 836M) for nuts, Alloy Group 1 (A1).

4. Postinstalled Anchor Bolts for Fastening Stone Trim Anchors: Chemical anchors **OR** torque-controlled expansion anchors **OR** undercut anchors, **as directed**, made from stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Alloy Group A1 or A4) for bolts and nuts; ASTM A 666 or ASTM A 276, Type 304 or 316, for anchors.

G. Embedded Flashing Materials

1. Metal Flashing: Provide metal flashing, where flashing is exposed or partly exposed and where indicated, complying with SMACNA's "Architectural Sheet Metal Manual **OR** Division 07 Section "Sheet Metal Flashing And Trim", **as directed,** and as follows:
   a. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch (0.4 mm) thick.
   b. Copper: ASTM B 370, Temper H00 or H01, cold-rolled copper sheet, 10-oz./sq. ft. (3-kg/sq. m) weight or 0.0135 inch (0.34 mm) thick for fully concealed flashing; 16-oz./sq. ft. (5-kg/sq. m) weight or 0.0216 inch (0.55 mm) thick elsewhere.
   c. Fabricate continuous flashings in sections 96 inches (2400 mm) long minimum, but not exceeding 12 feet (3.6 m). Provide splice plates at joints of formed, smooth metal flashing.
   d. Fabricate through-wall metal flashing embedded in masonry from stainless steel **OR** copper, **as directed**, with ribs at 3-inch (75-mm) intervals along length of flashing to provide an integral mortar bond.
   e. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
   f. Fabricate through-wall flashing with drip edge where **OR** unless otherwise, **as directed**, indicated. Fabricate by extending flashing 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed, **as directed**.
   g. Fabricate through-wall flashing with sealant stop where **OR** unless otherwise, **as directed**, indicated. Fabricate by bending metal back on itself 3/4 inch (19 mm) at exterior face of wall and down into joint 3/8 inch (10 mm) to form a stop for retaining sealant backer rod.
   h. Fabricate metal drip edges and sealant stops for ribbed metal flashing from plain metal flashing of same metal as ribbed flashing and extending at least 3 inches (75 mm) into wall with hemmed inner edge to receive ribbed flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam will shed water.
   i. Metal Drip Edges: Fabricate from stainless steel. Extend at least 3 inches (75 mm) into wall and 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed, **as directed**.
   j. Metal Flashing Terminations: Fabricate from stainless steel. Extend at least 3 inches (75 mm) into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch (19 mm) and down into joint 3/8 inch (10 mm) to form a stop for retaining sealant backer rod.
   k. Metal Expansion-Joint Strips: Fabricate from stainless steel **OR** copper, **as directed**, to shapes indicated.
2. Flexible Flashing: For flashing not exposed to the exterior, use one of the following unless otherwise indicated:
   a. Copper-Laminated Flashing: 5-oz./sq. ft. (1.5-kg/sq. m) **OR** 7-oz./sq. ft. (2-kg/sq. m), **as directed**, copper sheet bonded with asphalt between 2 layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.
   b. Asphalt-Coated Copper Flashing: 5-oz./sq. ft. (1.5-kg/sq. m) **OR** 7-oz./sq. ft. (2-kg/sq. m), **as directed**, copper sheet coated with flexible asphalt. Use only where flashing is fully concealed in masonry.
   c. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.030 inch (0.8 mm) **OR** 0.040 inch (1.0 mm), **as directed**.
   d. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymer alloy as follows:
      1) Monolithic Sheet: Elastomeric thermoplastic flashing, 0.040 inch (1.0 mm) thick.

2) Self-Adhesive Sheet: Elastomeric thermoplastic flashing, 0.025 inch (0.6 mm) thick, with a 0.015-inch- (0.4-mm-) thick coating of rubberized-asphalt adhesive.

3) Self-Adhesive Sheet with Drip Edge: Elastomeric thermoplastic flashing, 0.025 inch (0.6 mm) thick, with a 0.015-inch- (0.4-mm-) thick coating of rubberized-asphalt adhesive. Where flashing extends to face of masonry, rubberized-asphalt coating is held back approximately 1-1/2 inches (38 mm) from edge.

a) Color: Gray **OR** White **OR** Tan/buff **OR** Black, **as directed**.

4) Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.

e. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D 4637, 0.040 inch (1.0 mm) thick.

3. Solder and Sealants for Sheet Metal Flashings

a. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.

b. Solder for Copper: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.

c. Elastomeric Sealant: ASTM C 920, chemically curing urethane **OR** polysulfide **OR** silicone, **as directed**, sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

4. Adhesives, Primers, and Seam Tapes for Flexible Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

H. Miscellaneous Masonry Accessories

1. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene **OR** urethane **OR** PVC, **as directed**.

2. Cementitious Dampproofing: Cementitious formulations that are recommended by ILI and that are nonstaining to stone, compatible with joint sealants, and noncorrosive to veneer anchors and attachments.

3. Asphalt Dampproofing: Cut-back asphalt complying with ASTM D 4479, Type I **OR** asphalt emulsion complying with ASTM D 1227, Type III or IV, **as directed**.

4. Weep Hole/Vent Products: Use one of the following unless otherwise indicated:

a. Wicking Material: Absorbent rope, made from cotton **OR** UV-resistant synthetic fiber, **as directed**, 1/4 to 3/8 inch (6 to 10 mm) in diameter, in length required to produce 2-inch (50-mm) exposure on exterior and 18 inches (450 mm) in cavity behind stone masonry. Use only for weep holes.

b. Round Plastic Tubing: Medium-density polyethylene, 3/8-inch (10-mm) OD by thickness of stone masonry.

c. Rectangular Plastic Tubing: Clear butyrate, 3/8 by 1-1/2 inches (10 by 38 mm) by thickness of stone masonry.

d. Mesh Weep Holes/Vents: Free-draining mesh; made from polyethylene strands, full width of head joint and 2 inches (50 mm) high by thickness of stone masonry; in color selected from manufacturer's standard.

e. Aluminum Weep Holes/Vents: One-piece, L-shaped units made from sheet aluminum, designed to fit into head joint and consisting of vertical channel with louvers stamped in web and with top flap to keep mortar out of head joint; painted to comply with Division 07, before installation, in color approved to match that of mortar.

f. Vinyl Weep Holes/Vents: One-piece, offset, T-shaped units made from flexible, injection-molded PVC, designed to fit into head joint and consisting of louvered vertical leg, flexible wings to seal against ends of stone units, and top flap to keep mortar out of head joint; in color approved to match that of mortar.

5. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

a. Provide one of the following configurations:

1) Strips, full-depth of cavity and 10 inches (250 mm) wide, with dovetail shaped notches 7 inches (175 mm) deep that prevent mesh from being clogged with mortar droppings.
2) Strips, not less than 3/4 inch (19 mm) **OR** 1-1/2 inches (38 mm), **as directed**, thick and 10 inches (250 mm) wide, with dimpled surface designed to catch mortar droppings and prevent weep holes from being clogged with mortar.
3) Sheets or strips full depth of cavity and installed to full height of cavity.
4) Sheets or strips not less than 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed,** thick and installed to full height of cavity with additional strips 4 inches (100 mm) high at weep holes and thick enough to fill entire depth of cavity and prevent weep holes from being clogged with mortar.

6. Expanded Metal Lath: 3.4 lb/sq. yd. (1.8 kg/sq. m), self-furring, diamond-mesh lath complying with ASTM C 847. Fabricate from structural-quality, zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, G60 (Z180).
7. Woven-Wire Lath: ASTM C 1032, fabricated into 1-1/2-inch (38-mm) hexagonal-shaped mesh with minimum 0.0510-inch- (1.3-mm-) diameter, galvanized-steel wire.
8. Welded-Wire Lath: ASTM C 933, fabricated into 2-by-2-inch (50-by-50-mm) mesh with minimum 0.0625-inch- (1.6-mm-) diameter, galvanized-steel wire.
9. Lath Attachment Devices: Material and type required by ASTM C 1063 for installations indicated.

I. Cavity-Wall Insulation

1. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV **OR** Type X, **as directed**, closed-cell product extruded with an integral skin.
2. Extruded-Polystyrene Board Insulation with Increased R-Value: ASTM C 578, Type IV, but with an aged thermal resistance (R-value) for 1-inch (25-mm) thickness of 5.6 deg F x h x sq. ft./Btu at 75 deg F (1.0 K x sq. m/W at 24 deg C) at 5 years; closed-cell product with a carbon-black filler and extruded with an integral skin.
3. Molded-Polystyrene Board Insulation: ASTM C 578, Type I.
4. Polyisocyanurate Board Insulation: ASTM C 1289, Type I (aluminum-foil faced), Class 2 (glass-fiber reinforced).
5. Adhesive: Type recommended by insulation board manufacturer for application indicated.

J. Masonry Cleaners

1. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar and grout stains, efflorescence, and other new construction stains from stone masonry surfaces without discoloring or damaging masonry surfaces; expressly approved for intended use by cleaner manufacturer and stone producer.

K. Mortar Mixes

1. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
   a. Do not use calcium chloride.
   b. Limit cementitious materials in mortar to portland cement **OR** mortar cement, **as directed**, and lime.
   c. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
   d. Mixing Pointing Mortar: Thoroughly mix cementitious and aggregate materials together before adding water. Then mix again, adding only enough water to produce a damp, unworkable mix that will retain its form when pressed into a ball. Maintain mortar in this dampened condition for one to two hours. Add remaining water in small portions until mortar reaches desired consistency. Use mortar within 30 minutes of final mixing; do not retemper or use partially hardened material.
2. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in the form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

3. Mortar for Stone Masonry: Comply with ASTM C 270, Proportion **OR** Property, **as directed**, Specification.
   a. Mortar for Setting Stone: Type S **OR** Type N, **as directed**.
   b. Mortar for Pointing Stone: Type N **OR** Type O, **as directed**.
4. Latex-Modified Portland Cement Setting Mortar: Proportion and mix portland cement, aggregate, and latex additive to comply with latex-additive manufacturer's written instructions.
5. Cement-Paste Bond Coat: Mix either neat cement and water or cement, sand, and water to a consistency similar to that of thick cream.
   a. For latex-modified portland cement setting-bed mortar, substitute latex admixture for part or all of water, according to latex-additive manufacturer's written instructions.
6. Mortar for Scratch Coat over Metal Lath: 1 part portland cement, 1/2 part lime, 5 parts loose damp sand, and enough water to produce a workable consistency.
7. Mortar for Scratch Coat over Unit Masonry: 1 part portland cement, 1 part lime, 7 parts loose damp sand, and enough water to produce a workable consistency.
8. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
   a. Pigments shall not exceed 10 percent of portland cement by weight.
   b. Pigments shall not exceed 5 percent of masonry cement **OR** mortar cement, **as directed**, by weight.
   c. Mix to match sample.
9. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
   a. Mix to match sample.

L. Fabrication
1. Fabricate stone to comply with sizes, shapes, and tolerances recommended by applicable stone association or, if none, by stone source, for faces, edges, beds, and backs.
   a. For granite, comply with recommendations in NBGQA's "Specifications for Architectural Granite."
   b. For limestone, comply with recommendations in ILI's "Indiana Limestone Handbook."
2. Cut **OR** Select, **as directed**, stone to produce pieces of thickness, size, and shape indicated, including details on Drawings. Dress joints (bed and vertical) straight and at right angle to face unless otherwise indicated.
3. Cut and drill sinkages and holes in stone for anchors and supports.
4. Carefully inspect stone at quarry or fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units before shipment.
   a. Clean sawed backs of stone to remove rust stains and iron particles.
5. Gage backs of stones for adhered veneer if more than 81 sq. in. (522 sq. cm) in area.
6. Thickness of Stone: Provide thickness indicated, but not less than the following:
   a. Thickness for anchored veneer: 4 inches (100 mm) plus or minus 1/4 inch (6 mm) **OR** 1/2 inch (13 mm), **as directed**. Thickness does not include projection of pitched faces.
   b. Thickness for adhered veneer: 1 inch (25 mm) plus or minus 1/8 inch (3 mm) **OR** 1/4 inch (6 mm), **as directed**.
7. Shape stone for type of masonry (pattern) as follows:
   a. Sawed-bed, range ashlar with uniform course heights and uniform lengths as indicated on Drawings.
   b. Sawed-bed, range ashlar with uniform course heights as indicated on Drawings and with random lengths.
   c. Sawed-bed, broken-range ashlar with uniform course heights as indicated on Drawings and with random lengths.
   d. Sawed **OR** Split, **as directed**,-bed, random-range ashlar with random course heights and random lengths (interrupted coursed).
   e. Coursed rubble.
   f. Uncoursed rubble (fieldstone).
   g. Polygonal or mosaic.

8. Finish exposed faces and edges of stone to comply with requirements indicated for finish and to match approved samples and mockups.
   a. Finish: Split face **OR** Rock face (pitched face) **OR** Natural cleft **OR** Mixed split face and seam face **OR** Mixed split face, seam face, and rock face (pitched face) **OR** Smooth **OR** Sand rubbed **OR** As indicated, **as directed**.
   b. Finish for Sills: Smooth **OR** Sand rubbed **OR** Split face with sand-rubbed washes **OR** Rock face (pitched face) with sand-rubbed washes **OR** Rock face (pitched face) with tooled (boasted) washes, **as directed**
   c. Finish for Lintels: Smooth **OR** Sand rubbed **OR** Split face **OR** Rock face (pitched face), **as directed**.
   d. Finish for Copings: Smooth **OR** Sand rubbed **OR** Split faces **OR** Rock face (pitched face), front and back; sand-rubbed top **OR** Rock face (pitched face), front and back; tooled (boasted) top, **as directed**.
      1) Finish exposed ends of copings same as front and back faces.

1.3 EXECUTION

A. Preparation
1. Accurately mark stud centerlines on face of weather-resistant sheathing paper before beginning stone installation.
2. Coat concrete and unit masonry backup with asphalt dampproofing.
3. Clean dirty or stained stone surfaces by removing soil, stains, and foreign materials before setting. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

B. Setting Of Stone Masonry, General
1. Perform necessary field cutting and trimming as stone is set.
   a. Use power saws to cut stone that is fabricated with saw-cut surfaces. Cut lines straight and true, with edges eased slightly to prevent snipping.
   b. Use hammer and chisel to split stone that is fabricated with split surfaces. Make edges straight and true, matching similar surfaces that were shop or quarry fabricated.
   c. Pitch face at field-split edges as needed to match stones that are not field split.
2. Sort stone before it is placed in wall to remove stone that does not comply with requirements relating to aesthetic effects, physical properties, or fabrication, or that is otherwise unsuitable for intended use.
3. Arrange stones in range ashlar pattern with course heights as indicated, uniform **OR** random, **as directed** lengths, and uniform joint widths, with offset between vertical joints as indicated.
4. Arrange stones in broken-range ashlar pattern with uniform course heights, random lengths, and uniform joint widths.
5. Arrange stones in three-course, random-range ashlar pattern with random course heights, random lengths (interrupted coursed), and uniform joint widths.
6. Arrange stones in coursed **OR** uncoursed, **as directed**, rubble pattern with joint widths within tolerances indicated. Insert small stones into spaces between larger stones as needed to produce joints as uniform in width as practical, **as directed**.
7. Arrange stones in polygonal (mosaic) pattern with uniform joint widths.
8. Arrange stones with color and size variations uniformly dispersed for an evenly blended appearance.
9. Set stone to comply with requirements indicated on Drawings. Install supports, fasteners, and other attachments indicated or necessary to secure stone masonry in place. Set stone accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.
10. Maintain uniform joint widths except for variations due to different stone sizes and where minor variations are required to maintain bond alignment if any. Lay walls with joints not less than 1/4 inch (6 mm) **OR** 3/8 inch (10 mm), **as directed**, at narrowest points or more than 3/8 inch (10

mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm) **OR** 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, at widest points.

11. Provide sealant joints of widths and at locations indicated.
    a. Keep sealant joints free of mortar and other rigid materials.
    b. Sealing joints is specified in Division 07 Section "Joint Sealants".
12. Install metal expansion strips in sealant joints at locations indicated. Build flanges of expansion strips into masonry by embedding in mortar between stone masonry and backup wythe. Lap each joint 4 inches (100 mm) in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
13. Install embedded flashing and weep holes, **as directed**, at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.
    a. At stud-framed walls, extend flashing through stone masonry, up the face of sheathing at least 8 inches (200 mm) **OR** 12 inches (300 mm) **OR** 16 inches (400 mm), **as directed**, and behind weather-resistant sheathing paper.
    b. At multiwythe masonry walls, including cavity walls, extend flashing through stone masonry, turned up a minimum of 4 inches (100 mm) **OR** 8 inches (200 mm) **OR** 12 inches (300 mm) **OR** 16 inches (400 mm), **as directed**, and extend into or through inner wythe to comply with requirements in Division 04 Section "Unit Masonry".
    c. At concrete backing, extend flashing through stone masonry, turned up a minimum of 4 inches (100 mm) **OR** 6 inches (150 mm) **OR** 8 inches (200 mm) **OR** 12 inches (300 mm), **as directed**, and insert in reglet. Reglets are specified Division 07 Section "Sheet Metal Flashing And Trim".
    d. At lintels and shelf angles, extend flashing full length of angles but not less than 6 inches (150 mm) into masonry at each end.
    e. At sills, extend flashing not less than 4 inches (100 mm) at ends.
    f. At ends of head and sill flashing turn up not less than 2 inches (50 mm) to form end dams.
    g. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches (38 mm) or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Division 07 Section "Joint Sealants" for application indicated.
    h. Install metal drip edges and sealant stops with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Division 07 Section "Joint Sealants" for application indicated.
    i. Extend sheet metal flashing 1/2 inch (13 mm) beyond face of masonry at exterior and turn flashing down to form a drip.
    j. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall and adhere flexible flashing to top of metal drip edge.
    k. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall and adhere flexible flashing to top of metal flashing termination.
    l. Cut flexible flashing flush with face of wall after masonry wall construction is completed.
14. Coat limestone with cementitious dampproofing as follows:
    a. Stone at Grade: Beds, joints, and back surfaces to at least 12 inches (300 mm) above finish-grade elevations.
    b. Stone Extending below Grade: Beds, joints, back surfaces, and face surfaces below grade.
    c. Allow cementitious dampproofing formulations to cure before setting dampproofed stone. Do not damage or remove dampproofing in the course of handling and setting stone.
15. Place weep holes and vents in joints where moisture may accumulate, including at base of cavity walls, above shelf angles, and at flashing.
    a. Use wicking material **OR** round plastic tubing **OR** rectangular plastic tubing **OR** mesh weep holes/vents **OR** aluminum weep holes/vents **OR** vinyl weep holes/vents **OR** open head joints, **as directed**, to form weep holes.

b. Use wicking material to form weep holes above flashing in stone sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
c. Space weep holes 16 inches (400 mm) **OR** 24 inches (600 mm), **as directed**, o.c.
d. Space weep holes formed from plastic tubing **OR** wicking material, **as directed**, 16 inches (400 mm) o.c.
e. Trim wicking material used in weep holes flush with outside face of wall after mortar has set.
f. Place pea gravel in cavities as soon as practical to a height of not less than 2 inches (50 mm) above top of flashing, to maintain drainage.
g. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

16. Install vents in vertical head joints at the top of each continuous cavity at spacing indicated. Use round plastic tubing **OR** rectangular plastic tubing **OR** mesh weep holes/vents **OR** aluminum weep holes/vents **OR** vinyl weep holes/vents **OR** open head joints, **as directed**, to form vents.
    a. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

C. Construction Tolerances
1. Variation from Plumb: For vertical lines and surfaces, do not exceed 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (10 mm in 6 m), or 1/2 inch in 40 feet (13 mm in 12 m) or more. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed 1/4 inch in 20 feet (6 mm in 6 m) or 1/2 inch in 40 feet (13 mm in 12 m) or more.
2. Variation from Level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines, do not exceed 1/4 inch in 20 feet (6 mm in 6 m) or 1/2 inch in 40 feet (13 mm in 12 m) or more.
3. Variation of Linear Building Line: For position shown in plan, do not exceed 1/2 inch in 20 feet (13 mm in 6 m) or 3/4 inch in 40 feet (19 mm in 12 m) or more.
4. For rough stone, measure variation from level, plumb, and position shown in plan as variation of the average plane of the face of each stone from level, plumb, or dimensioned plane.
5. Variation in Mortar-Joint Thickness: Do not vary from joint size range indicated.
6. Variation in Plane between Adjacent Stones for Rough Stone: Do not exceed one-half of tolerance specified for thickness of stone.

D. Installation Of Anchored Stone Masonry
1. Anchor stone masonry to concrete with corrugated-metal veneer anchors unless otherwise indicated. Secure anchors by inserting dovetailed ends into dovetail slots in concrete.
2. Anchor stone masonry to unit masonry with corrugated-metal **OR** individual wire, **as directed**, veneer anchors unless otherwise indicated. Embed anchors in unit masonry mortar joints or grouted cells for distance at least one-half of unit masonry thickness.
3. Anchor stone masonry to unit masonry with wire anchors unless otherwise indicated. Connect anchors to masonry joint reinforcement by inserting pintles into eyes of masonry joint reinforcement projecting from unit masonry.
4. Anchor stone masonry to unit masonry with wire anchors unless otherwise indicated. Connect anchors to masonry joint reinforcement with vertical rods inserted through anchors and through eyes of masonry joint reinforcement projecting from unit masonry.
5. Anchor stone masonry to unit masonry with adjustable, screw-attached **OR** seismic, **as directed**, veneer anchors unless otherwise indicated. Fasten anchors to unit masonry with two screws.
6. Anchor stone masonry to stud framing with adjustable, screw-attached **OR** seismic, **as directed**, veneer anchors unless otherwise indicated. Fasten anchors through sheathing to framing with two screws.
7. Anchor stone masonry to stud framing with screw-attached veneer anchors unless otherwise indicated.
8. Anchor stone masonry to wood stud framing with corrugated-metal veneer anchors unless otherwise indicated. Fasten anchors through sheathing to studs with corrosion-resistant roofing nails.

9. Anchor stone masonry to wood stud framing with wire anchors unless otherwise indicated. Fasten anchors through sheathing to wood studs with corrosion-resistant roofing nails.
10. Anchor stone masonry to metal stud framing with wire anchors unless otherwise indicated. Tie anchors to studs.
11. Embed veneer anchors in mortar joints of stone masonry at least halfway, but not less than 1-1/2 inches (38 mm), through stone masonry and with at least 5/8-inch (16-mm) cover on outside face.
    a. Install continuous wire reinforcement in horizontal joints and attach to seismic veneer anchors as stone is set.
12. Space anchors to provide not less than 1 anchor per 2 sq. ft. (0.2 sq. m) of wall area. Install additional anchors within 12 inches (300 mm) of openings, sealant joints, and perimeter at intervals not exceeding 12 inches (300 mm).
13. Space anchors not more than 16 inches (400 mm) o.c. vertically and 24 inches (600 mm) o.c. horizontally. Install additional anchors within 12 inches (300 mm) of openings, sealant joints, and perimeter at intervals not exceeding 12 inches (300 mm).
14. Anchor stone trim with stone trim anchors where indicated. Install anchors by fastening to substrate and inserting tabs and dowels into kerfs and holes in stone units. Provide compressible filler in ends of dowel holes and bottoms of kerfs to prevent end bearing of dowels and anchor tabs on stone. Fill remainder of anchor holes and kerfs with mortar.
15. Set stone in full bed of mortar with full head joints unless otherwise indicated. Build anchors into mortar joints as stone is set.
16. Fill collar joint **OR** space between back of stone masonry and weather-resistant sheathing paper, **as directed**, with mortar as stone is set.
17. Provide 1-inch (25-mm) **OR** 2-inch (50-mm), **as directed**, cavity between stone masonry and backup construction unless otherwise indicated. Keep cavity free of mortar droppings and debris.
    a. Place mortar spots in cavity at veneer anchors to maintain spacing.
    b. Slope beds toward cavity to minimize mortar protrusions into cavity.
    c. Do not attempt to trowel or remove mortar fins protruding into cavity.
18. Rake out joints for pointing with mortar to depth of not less than 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, before setting mortar has hardened. Rake joints to uniform depths with square bottoms and clean sides.

E. Installation Of Adhered Stone Masonry Veneer
1. Install flashing over sheathing and behind weather-resistant sheathing paper by fastening through sheathing into framing.
2. Install lath over weather-resistant sheathing paper by fastening through sheathing into framing to comply with ASTM C 1063.
3. Install lath over unit masonry and concrete to comply with ASTM C 1063.
4. Install scratch coat over metal lath 3/8 inch (10 mm) thick to comply with ASTM C 926.
5. Coat backs of stone units and face of scratch coat **OR** masonry backup, **as directed**, with cement-paste bond coat, then butter both surfaces with setting mortar. Use sufficient setting mortar so a slight excess will be forced out the edges of stone units as they are set. Tap units into place, completely filling space between units and scratch coat **OR** masonry backup, **as directed**.
6. Rake out joints for pointing with mortar to depth of not less than 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, before setting mortar has hardened. Rake joints to uniform depths with square bottoms and clean sides.

F. Pointing
1. Prepare stone-joint surfaces for pointing with mortar by removing dust and mortar particles. Where setting mortar was removed to depths greater than surrounding areas, apply pointing mortar in layers not more than 3/8 inch (10 mm) deep until a uniform depth is formed.
2. Point stone joints by placing and compacting pointing mortar in layers not more than 3/8 inch (10 mm) deep. Compact each layer thoroughly and allow to become thumbprint hard before applying next layer.

3. Tool joints, when pointing mortar is thumbprint hard, with a smooth jointing tool to produce the following joint profile:
   a. Joint Profile: Concave **OR** Smooth, flat face slightly below edges of stone **OR** Smooth, flat face recessed 1/4 inch (6 mm) below edges of stone (raked joint) **OR** Flush, with a 3/8-inch (10-mm) half-round raised bead in middle of joint **OR** As indicated, **as directed**.

G. Adjusting And Cleaning
1. Remove and replace stone masonry of the following description:
   a. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved.
   b. Defective joints.
   c. Stone masonry not matching approved samples and mockups.
   d. Stone masonry not complying with other requirements indicated.
2. Replace in a manner that results in stone masonry matching approved samples and mockups, complying with other requirements, and showing no evidence of replacement.
3. In-Progress Cleaning: Clean stone masonry as work progresses. Remove mortar fins and smears before tooling joints.
4. Final Cleaning: After mortar is thoroughly set and cured, clean stone masonry as follows:
   a. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
   b. Test cleaning methods on mockup; leave one-half of panel uncleaned for comparison purposes. Obtain approval of sample cleaning before cleaning stone masonry.
   c. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.
   d. Wet wall surfaces with water before applying cleaner; remove cleaner promptly by rinsing thoroughly with clear water.
   e. Clean stone masonry by bucket and brush hand-cleaning method described in BIA Technical Note No. 20 Revised II, using job-mixed detergent solution.
   f. Clean stone masonry with proprietary acidic cleaner applied according to manufacturer's written instructions.
   g. Clean limestone masonry to comply with recommendations in ILI's "Indiana Limestone Handbook."

H. Excess Materials And Waste
1. Disposal as Fill Material: Dispose of clean masonry waste, including mortar and excess or soil-contaminated sand, by crushing and mixing with fill material as fill is placed.
   a. Crush masonry waste to less than 4 inches (100 mm) in greatest dimension.
   b. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Division 31 Section "Earth Moving".
   c. Do not dispose of masonry waste as fill within 18 inches (450 mm) of finished grade.
2. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other waste, and legally dispose of off the Owner's property.

END OF SECTION 04 42 43 00

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Task	Specification	Specification Description
04 42 43 00	04 41 00 00	Dimension Stone Cladding
04 42 43 00	04 41 00 00a	Interior Stone Facing
04 43 16 00	01 22 16 00	No Specification Required
04 43 16 00	04 41 00 00	Dimension Stone Cladding
04 43 16 00	04 42 43 00	Stone Masonry
04 43 16 00	04 41 00 00a	Interior Stone Facing
04 51 00 00	01 54 23 00a	Unit Masonry Assemblies

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SECTION 04 72 00 00 - ARCHITECTURAL PRECAST CONCRETE

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for architectural precast concrete. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Architectural precast concrete cladding and load-bearing units.
      b. Insulated, architectural precast concrete units.
      c. Brick-faced, architectural precast concrete units.
      d. Stone-faced, architectural precast concrete units.

C. Definition
   1. Design Reference Sample: Sample of approved architectural precast concrete color, finish and texture, preapproved by the Owner.

D. Performance Requirements
   1. Structural Performance: Provide architectural precast concrete units and connections capable of withstanding the following design loads within limits and under conditions indicated:
      a. Loads: As indicated.

E. Submittals
   1. Product Data: For each type of product indicated.
   2. Design Mixtures: For each precast concrete mixture. Include compressive strength and water-absorption tests.
   3. Shop Drawings: Detail fabrication and installation of architectural precast concrete units. Indicate locations, plans, elevations, dimensions, shapes, and cross sections of each unit. Indicate joints, reveals, and extent and location of each surface finish. Indicate details at building corners.
      NOTE: The following paragraph is not required if Architect or Engineer assumes or is required by law to assume design responsibility.
      a. Comprehensive engineering analysis signed and sealed **OR** certified, **as directed**, by the qualified professional engineer responsible for its preparation. Show governing panel types, connections, and types of reinforcement, including special reinforcement. Indicate location, type, magnitude, and direction of loads imposed on the building structural frame from architectural precast concrete.
   4. Samples: For each type of finish indicated on exposed surfaces of architectural precast concrete units, in sets of 3, illustrating full range of finish, color, and texture variations expected; approximately 12 by 12 by 2 inches (300 by 300 by 50 mm).
   5. Welding certificates.
   6. Material Test Reports: For aggregates.
   7. Material Certificates: Signed by manufacturers:
   8. Field quality-control test and special inspection reports.

F. Quality Assurance
   1. Fabricator Qualifications: A firm that assumes responsibility for engineering architectural precast concrete units to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

a. Participates in PCI's plant certification program and is designated a PCI-certified plant for Group A, Category A1 - Architectural Cladding and Load Bearing Units or participates in APA's "Plant Certification Program for Production of Architectural Precast Concrete Products" and is designated an APA-certified plant.

2. Design Standards: Comply with ACI 318 (ACI 318M) and design recommendations of PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete," applicable to types of architectural precast concrete units indicated.
3. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 117, "Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products."
4. Welding: Qualify procedures and personnel according to AWS D1.1/D.1.1M, "Structural Welding Code - Steel"; and AWS D1.4, "Structural Welding Code - Reinforcing Steel."
5. Calculated Fire-Test-Response Characteristics: Where indicated, provide architectural precast concrete units whose fire resistance has been calculated according to ACI 216.1/TMS 0216.1, "Standard Method for Determining Fire Resistance of Concrete and Masonry Construction Assemblies," **OR** PCI MNL 124, "Design for Fire Resistance of Precast Prestressed Concrete," **as directed**, and is acceptable to authorities having jurisdiction.
6. Sample Panels: After sample approval and before fabricating architectural precast concrete units, produce a minimum of 2 sample panels approximately 16 sq. ft. (1.5 sq. m) in area for review by the Owner. Incorporate full-scale details of architectural features, finishes, textures, and transitions in sample panels.

G. Delivery, Storage, And Handling

1. Deliver architectural precast concrete units in such quantities and at such times to limit unloading units temporarily on the ground.
2. Support units during shipment on nonstaining shock-absorbing material.
3. Store units with adequate dunnage and bracing and protect units to prevent contact with soil, to prevent staining, and to prevent cracking, distortion, warping or other physical damage.
4. Place stored units so identification marks are clearly visible, and units can be inspected.
5. Handle and transport units in a position consistent with their shape and design in order to avoid excessive stresses which would cause cracking or damage.
6. Lift and support units only at designated points shown on Shop Drawings.

1.2 PRODUCTS

A. Mold Materials

1. Molds: Rigid, dimensionally stable, non-absorptive material, warp and buckle free, that will provide continuous and true precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and suitable for producing required finishes.
   a. Mold-Release Agent: Commercially produced liquid-release agent that will not bond with, stain or adversely affect precast concrete surfaces and will not impair subsequent surface or joint treatments of precast concrete.
2. Form Liners: Units of face design, texture, arrangement, and configuration indicated **OR** to match those used for precast concrete design reference sample, **as directed**. Furnish with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect precast concrete surfaces and will not impair subsequent surface or joint treatments of precast concrete.
3. Surface Retarder: Chemical set retarder, capable of temporarily delaying final hardening of newly placed concrete mixture to depth of reveal specified.

B. Reinforcing Materials

1. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
2. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

3. Galvanized Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized, and chromate wash treated after fabrication and bending, **as directed**.
4. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, ASTM A 775/A 775M or ASTM A 934/A 934M epoxy coated.
5. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, assembled with clips.
6. Plain-Steel Welded Wire Reinforcement: ASTM A 1064, fabricated from as-drawn **OR** galvanized, **as directed**, steel wire into flat sheets.
7. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.
8. Epoxy-Coated-Steel Wire: ASTM A 884/A 884M, Class A coated, plain **OR** deformed, **as directed**, flat sheet, Type 1 bendable **OR** 2 nonbendable, **as directed**, coating.
9. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 117.

C. Prestressing Tendons
1. Prestressing Strand: ASTM A 416/A 416M, Grade 270 (Grade 1860), uncoated, 7-wire, low-relaxation strand.
    a. Coat unbonded post-tensioning strand with corrosion inhibitor passing ASTM D 1743 and sheath with polypropylene tendon sheathing. Include anchorage devices and coupler assemblies.

D. Concrete Materials
1. Portland Cement: ASTM C 150, Type I or Type III, gray, unless otherwise indicated.
    a. For surfaces exposed to view in finished structure, mix gray with white cement, of same type, brand, and mill source.
2. Supplementary Cementitious Materials:
    a. Fly Ash: ASTM C 618, Class C or F, with maximum loss on ignition of 3 percent.
    b. Metakaolin Admixture: ASTM C 618, Class N.
    c. Silica Fume Admixture: ASTM C 1240, with optional chemical and physical requirement.
    d. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
3. Normal-Weight Aggregates: Except as modified by PCI MNL 117, ASTM C 33, with coarse aggregates complying with Class 5S. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.
    a. Face-Mixture-Coarse Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining; to match selected finish sample.
        1) Gradation: Uniformly graded **OR** Gap graded **OR** To match design reference sample, **as directed**.
    b. Face-Mixture-Fine Aggregates: Selected, natural or manufactured sand of same material as coarse aggregate, unless otherwise approved by the Owner.
4. Lightweight Aggregates: Except as modified by PCI MNL 117, ASTM C 330, with absorption less than 11 percent.
5. Coloring Admixture: ASTM C 979, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable, and nonfading.
6. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 117.
7. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
8. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.
    a. Water-Reducing Admixtures: ASTM C 494/C 494M, Type A.
    b. Retarding Admixture: ASTM C 494/C 494M, Type B.
    c. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.

d. Water-Reducing and Accelerating Admixture: ASTM C 494/C 494M, Type E.
e. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
f. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
g. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017 M.

E. Steel Connection Materials
1. Carbon-Steel Shapes and Plates: ASTM A 36/A 36M.
2. Carbon-Steel-Headed Studs: ASTM A 108, AISI 1018 through AISI 1020, cold finished, AWS D1.1/D1.1M, Type A or B, with arc shields and with minimum mechanical properties of PCI MNL 117, Table 3.2.3.
3. Carbon-Steel Plate: ASTM A 283/A 283M.
4. Malleable Iron Castings: ASTM A 47/A 47M.
5. Carbon-Steel Castings: ASTM A 27/A 27M, Grade 60-30 (Grade 415-205).
6. High-Strength, Low-Alloy Structural Steel: ASTM A 572/A 572M.
7. Carbon-Steel Structural Tubing: ASTM A 500, Grade B.
8. Wrought Carbon-Steel Bars: ASTM A 675/A 675M, Grade 65 (Grade 450).
9. Deformed-Steel Wire or Bar Anchors: ASTM A 496 or ASTM A 706/A 706M.
10. Carbon-Steel Bolts and Studs: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); carbon-steel, hex-head bolts and studs; carbon-steel nuts, ASTM A 563 (ASTM A 563M); and flat, unhardened steel washers, ASTM F 844.
11. High-Strength Bolts and Nuts: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts; heavy hex carbon-steel nuts, ASTM A 563 (ASTM A 563M); and hardened carbon-steel washers, ASTM F 436 (ASTM F 436M).
12. Zinc-Coated Finish: For exterior steel items, steel in exterior walls, and items indicated for galvanizing, apply zinc coating by hot-dip process according to ASTM A 123/A 123M or ASTM A 153/A 153M **OR** electrodeposition according to ASTM B 633, SC 3, Types 1 and 2, **as directed**.
    a. For steel shapes, plates, and tubing to be galvanized, limit silicon content of steel to less than 0.03 percent or to between 0.15 and 0.25 percent or limit sum of silicon and 2.5 times phosphorous content to 0.09 percent.
    b. Galvanizing Repair Paint: High-zinc-dust-content paint with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035A or SSPC-Paint 20.
13. Shop-Primed Finish: Prepare surfaces of nongalvanized steel items, except those surfaces to be embedded in concrete, according to requirements in SSPC-SP 3 and shop-apply lead- and chromate-free, rust-inhibitive primer, complying with performance requirements in MPI 79 **OR** SSPC-Paint 25, **as directed**, according to SSPC-PA 1.
14. Welding Electrodes: Comply with AWS standards.

F. Stainless-Steel Connection Materials
1. Stainless-Steel Plate: ASTM A 666, Type 304, of grade suitable for application.
2. Stainless-Steel Bolts and Studs: ASTM F 593, Alloy 304 or 316, hex-head bolts and studs; stainless-steel nuts; and flat, stainless-steel washers.
    a. Lubricate threaded parts of stainless-steel bolts with an antiseize thread lubricant during assembly.
3. Stainless-Steel-Headed Studs: ASTM A 276, with minimum mechanical properties of PCI MNL 117, Table 3.2.3.

G. Bearing Pads
1. Provide one of the following bearing pads for architectural precast concrete units as recommended by precast fabricator for application:
    a. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, Type A durometer hardness of 50 to 70, ASTM D 2240, minimum tensile strength 2250 psi (15.5 MPa), ASTM D 412.

b. Random-Oriented, Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer. Type A durometer hardness of 70 to 90, ASTM D 2240; capable of supporting a compressive stress of 3000 psi (20.7 MPa) with no cracking, splitting, or delaminating in the internal portions of pad. Test one specimen for every 200 pads used in Project.
c. Cotton-Duck-Fabric-Reinforced Elastomeric Pads: Preformed, horizontally layered cotton-duck fabric bonded to an elastomer; Type A durometer hardness of 80 to 100, ASTM D 2240; complying with AASHTO's "AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Division II, Section 18.10.2, or with MIL-C-882E.
d. Frictionless Pads: Tetrafluoroethylene (Teflon), glass-fiber reinforced, bonded to stainless or mild-steel plate, of type required for in-service stress.
e. High-Density Plastic: Multimonomer, nonleaching, plastic strip.

H. Accessories
1. Reglets: Specified in Division 07 Section "Sheet Metal Flashing And Trim".
OR
Reglets: PVC extrusions, **OR** Stainless steel, Type 302 or 304, **OR** Copper, **as directed**, felt or fiber filled, or with face opening of slots covered.
2. Precast Accessories: Provide clips, hangers, plastic or steel shims, and other accessories required to install architectural precast concrete units.

I. Grout Materials
1. Sand-Cement Grout: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 144 or ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
2. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, Grade A for drypack and Grades B and C for flowable grout and of consistency suitable for application within a 30-minute working time.
3. Epoxy-Resin Grout: Two-component, mineral-filled epoxy resin; ASTM C 881/C 881M, of type, grade, and class to suit requirements.

J. Thin Brick Units And Accessories
1. Thin Brick Units: ASTM C 216, Type FBX or ASTM C 1088, Grade Exterior, Type TBX, not less than 1/2 inch (13 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick with a tolerance of plus or minus 1/16 inch (1.6 mm), and as follows:
a. Face Size: 2-1/4 inches (57 mm) high by 8 inches (203 mm) long.
b. Face Size: 2-1/4 inches (57 mm) high by 7-1/2 to 7-5/8 inches (190 to 194 mm) long.
c. Face Size: 2-3/4 to 2-13/16 inches (70 to 71 mm) high by 7-1/2 to 7-5/8 inches (190 to 194 mm) long.
d. Face Size: 3-1/2 to 3-5/8 inches (89 to 92 mm) high by 7-1/2 to 7-5/8 inches (190 to 194 mm) long.
e. Face Size: 3-1/2 to 3-5/8 inches (89 to 92 mm) high by 11-1/2 to 11-5/8 inches (292 to 295 mm) long.
f. Where indicated to "match existing," provide thin brick matching color, texture, and face size of existing adjacent brick work.
g. Face Size: 57 mm high by 190 mm long.
h. Face Size: 70 mm high by 190 mm long.
i. Face Size: 90 mm high by 190 mm long.
j. Face Size: 90 mm high by 290 mm long.
k. Special Shapes: Include corners, edge corners, and end edge corners.
l. Initial Rate of Absorption: Less than 30 g/30 sq. in. (30 g/194 sq. cm) per minute; ASTM C 67.
m. Efflorescence: Tested according to ASTM C 67 and rated "not effloresced."

n. Surface Coating: Thin brick with colors or textures applied as coatings shall withstand 50 cycles of freezing and thawing; ASTM C 67 with no observable difference in applied finish when viewed from 10 feet (3 m).
o. Face Color and Texture: Match approved samples **OR** Medium brown, wire cut **OR** Full-range red, sand molded **OR** Gray, velour, **as directed**.
p. Back Surface Texture: Scored, combed, wire roughened, ribbed, keybacked, or dovetailed.
2. Sand-Cement Mortar: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 144. Mix at ratio of 1 part cement to 4 parts sand, by volume, with minimum water required for placement.
3. Latex-Portland Cement Pointing Grout: ANSI A118.6 and as follows:
   a. Dry-grout mixture, factory prepared, of portland cement, graded aggregate, and dry, redispersible, ethylene-vinyl-acetate additive for mixing with water; uniformly colored.
   b. Commercial portland cement grout, factory prepared, with liquid styrene-butadiene rubber or acrylic-resin latex additive; uniformly colored.
   c. Colors: As selected by the Owner from manufacturer's full range.

K. Stone Materials And Accessories
1. Stone facing for architectural precast concrete is specified in Division 04 Section "Exterior Stone Cladding".
2. Anchors: Stainless steel, ASTM A 666, Type 304, of temper and diameter required to support loads without exceeding allowable design stresses.
   a. Fit each anchor leg with neoprene grommet collar of width at least twice the diameter and of length at least five times the diameter of anchor.
3. Sealant Filler: ASTM C 920, low-modulus, multicomponent, nonsag urethane sealant complying with requirements in Division 07 Section "Joint Sealants" and that is nonstaining to stone substrate.
4. Epoxy Filler: ASTM C 881/C 881M, 100 percent solids, sand-filled nonshrinking, nonstaining of type, class, and grade to suit application.
   a. Elastomeric Anchor Sleeve: 1/2 inch (13 mm) long, Type A durometer hardness of 60, ASTM D 2240.
5. Bond Breaker: Preformed, compressible, resilient, nonstaining, nonwaxing, closed-cell polyethylene foam pad, nonabsorbent to liquid and gas, 1/8 inch (3.2 mm) thick **OR** Polyethylene sheet, ASTM D 4397, 6 to 10 mils (0.15 to 0.25 mm) thick, **as directed**.

L. Insulated Panel Accessories
1. Molded-Polystyrene Board Insulation: ASTM C 578, Type I, 0.90 lb/cu. ft. (15 kg/cu. m) **OR** VIII, 1.15 lb/cu. ft. (18 kg/cu. m) **OR** II, 1.35 lb/cu. ft. (22 kg/cu. m), **as directed**; square **OR** ship-lap, **as directed**, edges; with R-value and thickness as required to meet Project requirements.
2. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.60 lb/cu. ft. (26 kg/cu. m) **OR** X, 1.30 lb/cu. ft. (21 kg/cu. m) **OR** VI, 1.80 lb/cu. ft. (29 kg/cu. m), **as directed**; square **OR** ship-lap, **as directed**, edges; with R-value and thickness as required to meet Project requirements.
3. Polyisocyanurate Board Insulation: ASTM C 591, Type I, 1.8 lb/cu. ft. (29 kg/cu. m) **OR** IV, 2 lb/cu. ft. (32 kg/cu. m) **OR** II, 2.5 lb/cu. ft. (40 kg/cu. m), **as directed**, unfaced, with R-value and thickness as required to meet Project requirements.
4. Wythe Connectors: Glass-fiber and vinyl-ester polymer connectors **OR** Polypropylene pin connectors **OR** Stainless-steel pin connectors **OR** Bent galvanized reinforcing bars or galvanized welded wire trusses **OR** Cylindrical metal sleeve anchors, **as directed**, manufactured to connect wythes of precast concrete panels.

M. Concrete Mixtures
1. Prepare design mixtures for each type of precast concrete required.
   a. Limit use of fly ash and silica fume to 20 percent of portland cement by weight; limit metakaolin and silica fume to 10 percent of portland cement by weight.

2. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at architectural precast concrete fabricator's option.
3. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 318 (ACI 318M) or PCI MNL 117 when tested according to ASTM C 1218/C 1218M.
4. Normal-Weight Concrete Mixtures: Proportion mixtures by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:
   a. Compressive Strength (28 Days): 5000 psi (34.5 MPa) minimum.
   b. Maximum Water-Cementitious Materials Ratio: 0.45.
5. Water Absorption: 6 percent by weight or 14 percent by volume, tested according to PCI MNL 117.
6. Lightweight Concrete Backup Mixtures: Proportion mixtures by either laboratory trial batch or field test data methods according to ACI 211.2, with materials to be used on Project, to provide lightweight concrete with the following properties:
   a. Compressive Strength (28 Days): 5000 psi (34.5 MPa).
   b. Unit Weight: Calculated equilibrium unit weight of 115 lb/cu. ft. (1842 kg/cu. m), plus or minus 3 lb/cu. ft. (48 kg/cu. m), according to ASTM C 567.
7. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 117.
8. When included in design mixtures, add other admixtures to concrete mixtures according to manufacturer's written instructions.

N. Mold Fabrication
1. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes and for prestressing and detensioning operations. Coat contact surfaces of molds with release agent before reinforcement is placed. Avoid contamination of reinforcement and prestressing tendons by release agent.
   a. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and supports to maintain stability of liners during concrete placement. Coat form liner with form-release agent.
2. Maintain molds to provide completed architectural precast concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.
   a. Form joints are not permitted on faces exposed to view in the finished work.
   b. Edge and Corner Treatment: Uniformly chamfered **OR** radiused, **as directed**.

O. Thin Brick Facings

NOTE: The following 2 paragraphs are not applicable if bonding back of thin brick directly to concrete instead of using mortar.
1. Place form liner templates accurately to provide grid for thin brick facings. Provide solid backing and supports to maintain stability of liners while placing thin bricks and during concrete placement.
2. Securely place thin brick units face down into form liner pockets and place concrete backing mixture.
3. Completely fill joint cavities between thin brick units with sand-cement mortar, and place precast concrete backing mixture while sand-cement mortar is still fluid enough to ensure bond.
4. Mix and install grout according to ANSI A108.10. Completely fill joint cavities between thin brick units with grout, and compress into place without spreading grout onto faces of thin brick units. Remove excess grout immediately to prevent staining of brick.
   a. Tool joints to a slightly concave **OR** grapevine **OR** V-, **as directed**,shape when pointing grout is thumbprint hard.
5. Clean faces and joints of brick facing.

P. Stone Facings
1. Accurately position stone facings to comply with requirements and in locations indicated on Shop Drawings. Install anchors, supports, and other attachments indicated or necessary to secure

stone in place. Keep concrete reinforcement a minimum of 3/4 inch (19 mm) from the back surface of stone. Use continuous spacers to obtain uniform joints of widths indicated and with edges and faces aligned according to established relationships and indicated tolerances.

a. Stone to Precast Anchorages: Provide anchors in numbers, types and locations required to satisfy specified performance criteria, but not less than 2 anchors per stone unit of less than 2 sq. ft. (0.19 sq. m) in area and 4 anchors per unit of less than 12 sq. ft. (1.1 sq. m) in area; for units larger than 12 sq. ft. (1.1 sq. m) in area, provide anchors spaced not more than 24 inches (600 mm) o.c. horizontally and vertically. Locate anchors a minimum of 6 inches (150 mm) from stone edge.

2. Fill anchor holes with sealant filler and install anchors **OR** epoxy filler and install anchors with elastomeric anchor sleeve at back surface of stone, **as directed**.

a. Install polyethylene sheet to prevent bond between back of stone facing and concrete substrate and to ensure no passage of precast matrix to stone surface.

OR

Install 1/8-inch (3-mm) polyethylene-foam bond breaker to prevent bond between back of stone facing and concrete substrate and to ensure no passage of precast matrix to stone surface. Maintain minimum projection requirements of stone anchors into concrete substrate.

Q. Fabrication

1. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.

a. Weld-headed studs and deformed bar anchors used for anchorage according to AWS D1.1/D1.1M and AWS C5.4, "Recommended Practices for Stud Welding."

2. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing architectural precast concrete units to supporting and adjacent construction.

3. Cast-in reglets, slots, holes, and other accessories in architectural precast concrete units as indicated on the Contract Drawings.

4. Cast-in openings larger than 10 inches (250 mm) in any dimension. Do not drill or cut openings or prestressing strand without the Owner's approval.

5. Reinforcement: Comply with recommendations in PCI MNL 117 for fabricating, placing, and supporting reinforcement.

a. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete. When damage to epoxy-coated reinforcing exceeds limits specified in ASTM A 775/A 775M, repair with patching material compatible with coating material and epoxy coat bar ends after cutting.

b. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.

c. Place reinforcement to maintain at least 3/4-inch (19-mm) minimum coverage. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.

d. Place reinforcing steel and prestressing strand to maintain at least 3/4-inch (19-mm) minimum concrete cover. Increase cover requirements for reinforcing steel to 1-1/2 inches (38 mm) when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.

e. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh spacing and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.

6. Reinforce architectural precast concrete units to resist handling, transportation, and erection stresses.
7. Prestress tendons for architectural precast concrete units by either pretensioning or post-tensioning methods. Comply with PCI MNL 117.
   a. Delay detensioning or post-tensioning of precast, prestressed architectural concrete units until concrete has reached its indicated minimum design release compressive strength as established by test cylinders cured under same conditions as concrete.
   b. Detension pretensioned tendons either by gradually releasing tensioning jacks or by heat-cutting tendons, using a sequence and pattern to prevent shock or unbalanced loading.
   c. If concrete has been heat cured, detension while concrete is still warm and moist to avoid dimensional changes that may cause cracking or undesirable stresses.
   d. Protect strand ends and anchorages with bituminous, zinc-rich, or epoxy paint to avoid corrosion and possible rust spots.
8. Comply with requirements in PCI MNL 117 and requirements in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.
9. Place face mixture to a minimum thickness after consolidation of the greater of 1 inch (25 mm) or 1.5 times the maximum aggregate size, but not less than the minimum reinforcing cover specified.
10. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast concrete units.
    a. Place backup concrete mixture to ensure bond with face-mixture concrete.
11. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air on surfaces. Use equipment and procedures complying with PCI MNL 117.
    a. Place self-consolidating concrete without vibration according to PCI TR-6, "Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants."
12. Comply with PCI MNL 117 for hot- and cold-weather concrete placement.
13. Identify pickup points of architectural precast concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each architectural precast concrete unit on a surface that will not show in finished structure.
14. Cure concrete, according to requirements in PCI MNL 117, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.
15. Discard and replace architectural precast concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 117 and the Owner's approval.

R. Insulated Panel Casting
   1. Cast and screed supported wythe over mold.
   2. Place insulation boards abutting edges and ends of adjacent boards. Insert wythe connectors through insulation, and consolidate concrete around connectors according to connector manufacturer's written instructions.
   3. Cast and screed top wythe to meet required finish.

S. Fabrication Tolerances
   1. Fabricate architectural precast concrete units straight and true to size and shape with exposed edges and corners precise and true so each finished panel complies with PCI MNL 117 product tolerances as well as position tolerances for cast-in items.
      OR
      Fabricate architectural precast concrete units straight and true to size and shape with exposed edges and corners precise and true so each finished panel complies with the following product tolerances:

a. Overall Height and Width of Units, Measured at the Face Exposed to View: As follows:
   1) 10 feet (3 m) or under, plus or minus 1/8 inch (3 mm).
   2) 10 to 20 feet (3 to 6 m), plus 1/8 inch (3 mm), minus 3/16 inch (5 mm).
   3) 20 to 40 feet (6 to 12 m), plus or minus 1/4 inch (6 mm).
   4) Each additional 10 feet (3 m), plus or minus 1/16 inch (1.5 mm).
b. Overall Height and Width of Units, Measured at the Face Not Exposed to View: As follows:
   1) 10 feet (3 m) or under, plus or minus 1/4 inch (6 mm).
   2) 10 to 20 feet (3 to 6 m), plus 1/4 inch (6 mm), minus 3/8 inch (10 mm).
   3) 20 to 40 feet (6 to 12 m), plus or minus 3/8 inch (10 mm).
   4) Each additional 10 feet (3 m), plus or minus 1/8 inch (3 mm).
c. Total Thickness or Flange Thickness: Plus 1/4 inch (6 mm), minus 1/8 inch (3 mm).
d. Rib Thickness: Plus or minus 1/8 inch (3 mm).
e. Rib to Edge of Flange: Plus or minus 1/8 inch (3 mm).
f. Distance between Ribs: Plus or minus 1/8 inch (3 mm).
g. Variation from Square or Designated Skew (Difference in Length of the Two Diagonal Measurements): Plus or minus 1/8 inch per 72 inches (3 mm per 1830 mm) or 1/2 inch (13 mm) total, whichever is greater.
h. Length and Width of Block-outs and Openings within One Unit: Plus or minus 1/4 inch (6 mm).
i. Location and Dimension of Block-outs Hidden from View and Used for HVAC and Utility Penetrations: Plus or minus 3/4 inch (19 mm).
j. Dimensions of Haunches: Plus or minus 1/4 inch (6 mm).
k. Haunch Bearing Surface Deviation from Specified Plane: Plus or minus 1/8 inch (3 mm).
l. Difference in Relative Position of Adjacent Haunch Bearing Surfaces from Specified Relative Position: Plus or minus 1/4 inch (6 mm).
m. Bowing: Plus or minus L/360, maximum 1 inch (25 mm).
n. Local Smoothness: 1/4 inch per 10 feet (6 mm per 3 m).
o. Warping: 1/16 inch per 12 inches (1.5 mm per 300 mm) of distance from nearest adjacent corner.
p. Tipping and Flushness of Plates: Plus or minus 1/4 inch (6 mm).
q. Dimensions of Architectural Features and Rustications: Plus or minus 1/8 inch (3 mm).

2. Position Tolerances: For cast-in items measured from datum line location, as indicated on Shop Drawings.
   a. Weld Plates: Plus or minus 1 inch (25 mm).
   b. Inserts: Plus or minus 1/2 inch (13 mm).
   c. Handling Devices: Plus or minus 3 inches (75 mm).
   d. Reinforcing Steel and Welded Wire Fabric: Plus or minus 1/4 inch (6 mm) where position has structural implications or affects concrete cover; otherwise, plus or minus 1/2 inch (13 mm).
   e. Reinforcing Steel Extending out of Member: Plus or minus 1/2 inch (13 mm) of plan dimensions.
   f. Tendons: Plus or minus 1/4 inch (6 mm), vertical; plus or minus 1 inch (25 mm), horizontal.
   g. Location of Rustication Joints: Plus or minus 1/8 inch (3 mm).
   h. Location of Opening within Panel: Plus or minus 1/4 inch (6 mm).
   i. Location of Flashing Reglets: Plus or minus 1/4 inch (6 mm).
   j. Location of Flashing Reglets at Edge of Panel: Plus or minus 1/8 inch (3 mm).
   k. Reglets for Glazing Gaskets: Plus or minus 1/8 inch (3 mm).
   l. Electrical Outlets, Hose Bibs: Plus or minus 1/2 inch (13 mm).
   m. Location of Bearing Surface from End of Member: Plus or minus 1/4 inch (6 mm).
   n. Allowable Rotation of Plate, Channel Inserts, and Electrical Boxes: 2-degree rotation or 1/4 inch (6 mm) maximum over the full dimension of unit.
   o. Position of Sleeve: Plus or minus 1/2 inch (13 mm).
   p. Location of Window Washer Track or Buttons: Plus or minus 1/8 inch (3 mm).

3. Brick-Faced Architectural Precast Concrete Units: Restrict the following misalignments to 2 percent of number of bricks in a unit.
   a. Alignment of Mortar Joints:
      1) Jog in Alignment: 1/8 inch (3 mm).
      2) Alignment with Panel Centerline: Plus or minus 1/8 inch (3 mm).
   b. Variation in Width of Exposed Mortar Joints: Plus or minus 1/8 inch (3 mm).
   c. Tipping of Individual Bricks from the Panel Plane of Exposed Brick Surface: Plus 1/16 inch (1.5 mm); minus 1/4 inch (6 mm) less than or equal to depth of form liner joint.
   d. Exposed Brick Surface Parallel to Primary Control Surface of Panel: Plus 1/4 inch (6 mm); minus 1/8 inch (3 mm).
   e. Individual Brick Step in Face from Panel Plane of Exposed Brick Surface: Plus 1/16 inch (1.5 mm); minus 1/4 inch (6 mm) less than or equal to depth of form liner joint.
4. Stone Veneer-Faced Architectural Precast Concrete Units (for smooth-finished stone):
   a. Variation in Cross-Sectional Dimensions: For thickness of walls from dimensions indicated: Plus or minus 1/4 inch (6 mm).
   b. Variation in Joint Width: 1/8 inch in 36 inches (3 mm in 900 mm) or a quarter of nominal joint width, whichever is less.
   c. Variation in Plane between Adjacent Stone Units (Lipping): 1/16 inch (1.5 mm) difference between planes of adjacent units.

T. Finishes
1. Panel faces shall be free of joint marks, grain, and other obvious defects. Corners, including false joints shall be uniform, straight, and sharp. Finish exposed-face surfaces of architectural precast concrete units to match approved design reference sample **OR** sample panels, **as directed**, and as follows:
   a. PCI's "Architectural Precast Concrete - Color and Texture Selection Guide," of plate numbers indicated.
   b. As-Cast Surface Finish: Provide surfaces free of pockets, sand streaks, and honeycombs.
   c. Textured-Surface Finish: Impart by form liners or inserts to provide surfaces free of pockets, streaks, and honeycombs, with uniform color and texture.
   d. Bushhammer Finish: Use power or hand tools to remove matrix and fracture coarse aggregates.
   e. Exposed-Aggregate Finish: Use chemical retarding agents applied to concrete forms and washing and brushing procedures to expose aggregate and surrounding matrix surfaces after form removal.
   f. Abrasive-Blast Finish: Use abrasive grit, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces.
   g. Acid-Etched Finish: Use acid and hot-water solution, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces. Protect hardware, connections, and insulation from acid attach.
   h. Honed Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
   i. Polished Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
   j. Sand-Embedment Finish: Use selected stones placed in a sand bed in bottom of mold, with sand removed after curing.
2. Finish exposed top **OR** bottom, **as directed**, and back, **as directed**, surfaces of architectural precast concrete units to match face-surface finish.
   OR
   Finish exposed top **OR** bottom, **as directed**, and back, **as directed**, surfaces of architectural precast concrete units by smooth, steel-trowel finish.
3. Finish unexposed surfaces of architectural precast concrete units by float finish.

U. Source Quality Control
1. Quality-Control Testing: Test and inspect precast concrete according to PCI MNL 117 requirements. If using self-consolidating concrete, also test and inspect according to PCI TR-6,

"Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants."

2. Strength of precast concrete units will be considered deficient if units fail to comply with ACI 318 (ACI 318M) requirements for concrete strength.
3. Testing: If there is evidence that strength of precast concrete units may be deficient or may not comply with ACI 318 (ACI 318M) requirements, precaster will employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C 42/C 42M.
   a. A minimum of three representative cores will be taken from units of suspect strength, from locations directed by the Owner.
   b. Cores will be tested in an air-dry condition.
   c. Strength of concrete for each series of 3 cores will be considered satisfactory if average compressive strength is equal to at least 85 percent of 28-day design compressive strength and no single core is less than 75 percent of 28-day design compressive strength.
   d. Test results will be made in writing on same day that tests are performed, with copies to the Owner, Contractor, and precast concrete fabricator. Test reports will include the following:
      1) Project identification name and number.
      2) Date when tests were performed.
      3) Name of precast concrete fabricator.
      4) Name of concrete testing agency.
      5) Identification letter, name, and type of precast concrete unit(s) represented by core tests; design compressive strength; type of break; compressive strength at breaks, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.
4. Patching: If core test results are satisfactory and precast concrete units comply with requirements, clean and dampen core holes and solidly fill with precast concrete mixture that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.

1.3 EXECUTION

A. Installation
1. Install clips, hangers, bearing pads, and other accessories required for connecting architectural precast concrete units to supporting members and backup materials.
2. Erect architectural precast concrete level, plumb, and square within specified allowable tolerances. Provide temporary supports and bracing as required to maintain position, stability, and alignment as units are being permanently connected.
   a. Install temporary steel or plastic spacing shims or bearing pads as precast concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.
   b. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
   c. Remove projecting lifting devices and grout fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.
   d. Unless otherwise indicated, maintain uniform joint widths of 3/4 inch (19 mm).
3. Connect architectural precast concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.
   a. Do not permit connections to disrupt continuity of roof flashing.
4. Welding: Comply with applicable AWS D1.1/D1.1M and AWS D1.4 for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.
   a. Protect architectural precast concrete units and bearing pads from damage by field welding or cutting operations, and provide noncombustible shields as required.
   b. Welds not specified shall be continuous fillet welds, using no less than the minimum fillet as specified by AWS.

c. Clean weld-affected metal surfaces with chipping hammer followed by brushing, and apply a minimum 4.0-mil- (0.1-mm-) thick coat of galvanized repair paint to galvanized surfaces according to ASTM A 780.
OR
Clean weld-affected metal surfaces with chipping hammer followed by brushing, and reprime damaged painted surfaces.
d. Remove, reweld, or repair incomplete and defective welds.

5. At bolted connections, use lock washers, tack welding, or other approved means to prevent loosening of nuts after final adjustment.
   a. Where slotted connections are used, verify bolt position and tightness. For sliding connections, properly secure bolt but allow bolt to move within connection slot. For friction connections, apply specified bolt torque and check 25 percent of bolts at random by calibrated torque wrench.
6. Grouting Connections: Grout connections where required or indicated. Retain grout in place until hard enough to support itself. Pack spaces with stiff grout material, tamping until voids are completely filled. Place grout to finish smooth, level, and plumb with adjacent concrete surfaces. Keep grouted joints damp for not less than 24 hours after initial set. Promptly remove grout material from exposed surfaces before it affects finishes or hardens.

B. Erection Tolerances
1. Erect architectural precast concrete units level, plumb, square, true, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 117, Appendix I.

C. Field Quality Control
1. Special Inspections: Engage a qualified special inspector to perform the following special inspections and prepare reports:
   a. Erection of precast concrete members.
2. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
3. Field welds will be subject to visual inspections and nondestructive testing according to ASTM E 165 or ASTM E 709. High-strength bolted connections will be subject to inspections.
4. Testing agency will report test results promptly and in writing to Contractor and the Owner.
5. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.
6. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

D. Repairs
1. Repair architectural precast concrete units if permitted by the Owner. the Owner reserves the right to reject repaired units that do not comply with requirements.
2. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet (6 m).
3. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A 780.
4. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.
5. Remove and replace damaged architectural precast concrete units when repairs do not comply with requirements.

E. Cleaning
1. Clean surfaces of precast concrete units exposed to view.
2. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.
3. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.

a. Perform cleaning procedures, if necessary, according to precast concrete fabricator's recommendations. Clean soiled precast concrete surfaces with detergent and water, using stiff fiber brushes and sponges, and rinse with clean water. Protect other work from staining or damage due to cleaning operations.

b. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION 04 72 00 00

Task	Specification	Specification Description
04 72 00 00	03 41 23 00	Plant-Precast Structural Concrete
04 72 00 00	01 54 23 00a	Unit Masonry Assemblies

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Task	Specification	Specification Description
05 05 19 00	01 22 16 00	No Specification Required
05 05 19 00	05 50 00 00	Metal Fabrications

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SECTION 05 05 21 00 - STRUCTURAL STEEL

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for structural steel. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Structural steel.
      b. Prefabricated building columns.
      c. Grout.

C. Definitions
   1. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."
   2. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.
   3. Heavy Sections: Rolled and built-up sections as follows:
      a. Shapes included in ASTM A 6/A 6M with flanges thicker than 1-1/2 inches (38 mm).
      b. Welded built-up members with plates thicker than 2 inches (50 mm).
      c. Column base plates thicker than 2 inches (50 mm).
   4. Protected Zone: Structural members or portions of structural members indicated as "Protected Zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.
   5. Demand Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the Seismic-Load-Resisting System and which are indicated as "Demand Critical" or "Seismic Critical" on Drawings.

D. Performance Requirements
   1. Connections: Provide details of connections **OR** simple shear connections, **as directed**, required by the Contract Documents to be selected or completed by structural-steel fabricator, including comprehensive engineering design by a qualified professional engineer, **as directed**, to withstand loads indicated and comply with other information and restrictions indicated.
      a. Select and complete connections using schematic details indicated and AISC 360.
      b. Use LRFD; data are given at factored-load level **OR** ASD; data are given at service-load level, **as directed**.
   2. Moment Connections: Type PR, partially **OR** FR, fully, **as directed**, restrained.
   3. Construction: Moment frame **OR** Braced frame **OR** Shear wall system **OR** Combined system of moment frame and braced frame **OR** Combined system of moment frame and shear walls **OR** Combined system of braced frame and shear walls **OR** Combined system of moment frame, braced frame, and shear walls, **as directed**.

E. Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittal:
      a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.

3. Shop Drawings: Show fabrication of structural-steel components.
    a. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
    b. Include embedment drawings.
    c. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
    d. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
    e. Identify members and connections of the seismic-load-resisting system.
    f. Indicate locations and dimensions of protected zones.
    g. Identify demand critical welds.
    h. For structural-steel connections indicated to comply with design loads, include structural design data signed and sealed by the qualified professional engineer responsible for their preparation, **as directed**.
4. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint whether prequalified **OR** qualified by testing, **as directed**, including the following:
    a. Power source (constant current or constant voltage).
    b. Electrode manufacturer and trade name, for demand critical welds.
5. Qualification Data: For qualified Installer **OR** fabricator **OR** professional engineer **OR** testing agency, **as directed**.
6. Welding certificates.
7. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
8. Mill test reports for structural steel, including chemical and physical properties.
9. Product Test Reports: For the following:
    a. Bolts, nuts, and washers including mechanical properties and chemical analysis.
    b. Direct-tension indicators.
    c. Tension-control, high-strength bolt-nut-washer assemblies.
    d. Shear stud connectors.
    e. Shop primers.
    f. Nonshrink grout.
10. Source quality-control reports.

F. Quality Assurance
1. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.
2. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category ACSE **OR** CSE, **as directed**.
3. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P1 **OR** P2 **OR** P3, **as directed**, or SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."
4. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
    a. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.
5. Comply with applicable provisions of the following specifications and documents:
    a. AISC 303.
    b. AISC 341 and AISC 341s1.
    c. AISC 360.
    d. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
6. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
    a. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
2. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
    a. Fasteners may be repackaged provided the Owner's testing and inspecting agency observes repackaging and seals containers.
    b. Clean and relubricate bolts and nuts that become dry or rusty before use.
    c. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

H. Coordination
1. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.
2. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.2 PRODUCTS

A. Structural-Steel Materials
1. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 **OR** 50, **as directed**, percent.
   OR
   Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than the following:
    a. W-Shapes: 60 percent.
    b. Channels, Angles, M **OR** S, **as directed**,-Shapes: 60 percent.
    c. Plate and Bar: 25 percent.
    d. Cold-Formed Hollow Structural Sections: 25 percent.
    e. Steel Pipe: 25 percent.
    f. All Other Steel Materials: 25 percent.
2. W-Shapes: ASTM A 992/A 992M **OR** ASTM A 572/A 572M, Grade 50 (345) **OR** ASTM A 529/A 529M, Grade 50 (345) **OR** ASTM A 913/A 913M, Grade 50 (345), **as directed**.
3. Channels, Angles, M **OR** S, **as directed**,-Shapes: ASTM A 36/A 36M **OR** ASTM A 572/A 572M, Grade 50 (345) **OR** ASTM A 529/A 529M, Grade 50 (345) **OR** ASTM A 913/A 913M, Grade 50 (345), **as directed**.
4. Plate and Bar: ASTM A 36/A 36M **OR** ASTM A 572/A 572M, Grade 50 (345) **OR** ASTM A 529/A 529M, Grade 50 (345), **as directed**.
5. Corrosion-Resisting Structural-Steel Shapes, Plates, and Bars: ASTM A 588/A 588M, Grade 50 (345).
6. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B **OR** C, **as directed**, structural tubing.
7. Corrosion-Resisting Cold-Formed Hollow Structural Sections: ASTM A 847/A 847M, structural tubing.
8. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.
    a. Weight Class: Standard **OR** Extra strong **OR** Double-extra strong, **as directed**.
    b. Finish: Black **OR** Galvanized **OR** Black except where indicated to be galvanized, **as directed**.

9. Steel Castings: ASTM A 216/A 216M, Grade WCB with supplementary requirement S11.
10. Steel Forgings: ASTM A 668/A 668M.
11. Welding Electrodes: Comply with AWS requirements.

B. Bolts, Connectors, And Anchors
1. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, (ASTM A 563M, Class 8S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers; all with plain finish.
   a. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type with plain finish.
2. High-Strength Bolts, Nuts, and Washers: ASTM A 490 (ASTM A 490M), Type 1, heavy-hex steel structural bolts or tension-control, bolt-nut-washer assemblies with splined ends, **as directed**; ASTM A 563, Grade DH, (ASTM A 563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers with plain finish.
   a. Direct-Tension Indicators: ASTM F 959, Type 490 (ASTM F 959M, Type 10.9), compressible-washer type with plain finish.
3. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH (ASTM A 563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers.
   a. Finish: Hot-dip zinc coating **OR** Mechanically deposited zinc coating, **as directed**.
   b. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type with mechanically deposited zinc coating **OR** mechanically deposited zinc coating, baked epoxy-coated, **as directed**, finish.
4. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex **OR** round, **as directed**, head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
   a. Finish: Plain **OR** Mechanically deposited zinc coating, **as directed**.
5. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.
6. Unheaded Anchor Rods: ASTM F 1554, Grade 36 **OR** ASTM F 1554, Grade 55, weldable **OR** ASTM A 354 **OR** ASTM A 449 **OR** ASTM A 572/A 572M, Grade 50 (345) **OR** ASTM A 36/A 36M, **as directed**.
   a. Configuration: Straight **OR** Hooked, **as directed**.
   b. Nuts: ASTM A 563 (ASTM A 563M) hex **OR** heavy-hex, **as directed**, carbon steel.
   c. Plate Washers: ASTM A 36/A 36M carbon steel.
   d. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
   e. Finish: Plain **OR** Hot-dip zinc coating, ASTM A 153/A 153M, Class C **OR** Mechanically deposited zinc coating, ASTM B 695, Class 50, **as directed**.
7. Headed Anchor Rods: ASTM F 1554, Grade 36 **OR** ASTM F 1554, Grade 55, weldable **OR** ASTM A 354 **OR** ASTM A 449, **as directed**, straight.
   a. Nuts: ASTM A 563 (ASTM A 563M) hex **OR** heavy-hex, **as directed**, carbon steel.
   b. Plate Washers: ASTM A 36/A 36M carbon steel.
   c. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
   d. Finish: Plain **OR** Hot-dip zinc coating, ASTM A 153/A 153M, Class C **OR** Mechanically deposited zinc coating, ASTM B 695, Class 50, **as directed**.
8. Threaded Rods: ASTM A 36/A 36M **OR** ASTM A 193/A 193M, Grade B7 **OR** ASTM A 354, Grade BD **OR** ASTM A 449 **OR** ASTM A 572/A 572M, Grade 50 (345), **as directed**.
   a. Nuts: ASTM A 563 (ASTM A 563M) hex **OR** heavy-hex, **as directed**, carbon steel.
   b. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened **OR** ASTM A 36/A 36M, **as directed**, carbon steel.
   c. Finish: Plain **OR** Hot-dip zinc coating, ASTM A 153/A 153M, Class C **OR** Mechanically deposited zinc coating, ASTM B 695, Class 50, **as directed**.
9. Clevises and Turnbuckles: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1035.
10. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1030.

11. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1018.
12. Structural Slide Bearings: Low-friction assemblies, of configuration indicated, that provide vertical transfer of loads and allow horizontal movement perpendicular to plane of expansion joint while resisting movement within plane of expansion joint.
    a. Mating Surfaces: PTFE and PTFE **OR** PTFE and mirror-finished stainless steel, **as directed**.
    b. Coefficient of Friction: Not more than 0.03 **OR** 0.04 **OR** 0.05 **OR** 0.06 **OR** 0.10 **OR** 0.12, **as directed**.
    c. Design Load: Not less than 2,000 psi (13.7 MPa) **OR** 5,000 psi (34 MPa) **OR** 6,000 psi (41 MPa), **as directed**.
    d. Total Movement Capability: 2 inches (50 mm).

C. Primer
1. Primer: Comply with Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
   OR
   Primer: SSPC-Paint 25, Type **I** **OR** Type **II**, **as directed**, zinc oxide, alkyd, linseed oil primer.
   OR
   Primer: SSPC-Paint 25 BCS, Type **I** **OR** Type **II**, **as directed**, zinc oxide, alkyd, linseed oil primer.
   OR
   Primer: SSPC-Paint 23, latex primer.
   OR
   Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat, **as directed**.
2. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20 **OR** ASTM A 780, **as directed**.

D. Grout
1. Metallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.
2. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

E. Fabrication
1. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.
    a. Camber structural-steel members where indicated.
    b. Fabricate beams with rolling camber up.
    c. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
    d. Mark and match-mark materials for field assembly.
    e. If shop priming is required, complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
2. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
    a. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.
3. Bolt Holes: Cut, drill, mechanically thermal cut, **as directed**, or punch standard bolt holes perpendicular to metal surfaces.
4. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
5. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning" **OR** SSPC-SP 2, "Hand Tool Cleaning" **OR** SSPC-SP 3, "Power Tool Cleaning", **as directed**.
6. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

7. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural steel. Straighten as required to provide uniform, square, and true members in completed wall framing.
8. Welded Door Frames: Build up welded door frames attached to structural steel. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk machine screws, uniformly spaced not more than 10 inches (250 mm) o.c. unless otherwise indicated.
9. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
   a. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning, **unless directed otherwise**.
   b. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
   c. Weld threaded nuts to framing and other specialty items indicated to receive other work.

F. Shop Connections
1. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
   a. Joint Type: Snug tightened **OR** Pretensioned **OR** Slip critical, **as directed**.
2. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M, **as directed**, for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
   a. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

G. Prefabricated Building Columns
1. Prefabricated building columns consisting of load-bearing structural-steel members protected by concrete fireproofing encased in an outer non-load-bearing steel shell.
2. Fire-Resistance Ratings: Provide prefabricated building column listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for ratings indicated, based on testing according to ASTM E 119.
   a. Fire-Resistance Rating: 4 hours **OR** 3 hours **OR** 2 hours **OR** As indicated, **as directed**.

H. Shop Priming
1. If shop priming is required, shop prime steel surfaces except the following:
   a. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
   b. Surfaces to be field welded.
   c. Surfaces to be high-strength bolted with slip-critical connections.
   d. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
   e. Galvanized surfaces.
2. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
   a. SSPC-SP 2, "Hand Tool Cleaning."
   b. SSPC-SP 3, "Power Tool Cleaning."
   c. SSPC-SP 7/NACE No. 4, "Brush-Off Blast Cleaning."
   d. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."
   e. SSPC-SP 14/NACE No. 8, "Industrial Blast Cleaning."
   f. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   g. SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning."
   h. SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning."
   i. SSPC-SP 8, "Pickling."
3. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5

mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

a. Stripe paint corners, crevices, bolts, welds, and sharp edges.

b. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

4. Painting: Prepare steel and apply a one-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils (0.038 mm).

I. Galvanizing

1. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.

a. Fill vent and drain holes that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.

b. Galvanize lintels, shelf angles, and welded door frames attached to structural-steel frame and located in exterior walls.

J. Source Quality Control

1. Testing Agency: Engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.

a. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

2. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3. Bolted Connections: Shop-bolted connections will be inspected **OR** tested and inspected, **as directed**, according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

4. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

a. Liquid Penetrant Inspection: ASTM E 165.

b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.

c. Ultrasonic Inspection: ASTM E 164.

d. Radiographic Inspection: ASTM E 94.

5. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

a. Bend tests will be performed if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.

b. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1/D1.1M.

1.3 EXECUTION

A. Examination

1. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

a. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation

1. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in

intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.
a. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

C. Erection
1. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
2. Base Bearing and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
a. Set plates for structural members on wedges, shims, or setting nuts as required.
b. Weld plate washers to top of baseplate.
c. Snug-tighten **OR** Pretension, **as directed**, anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
d. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts, **as directed**.
3. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
4. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
a. Level and plumb individual members of structure.
b. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
5. Splice members only where indicated.
6. Do not use thermal cutting during erection unless approved by the Owner. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.
7. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
8. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

D. Field Connections
1. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
a. Joint Type: Snug tightened **OR** Pretensioned **OR** Slip critical, **as directed**.
2. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M, **as directed**, for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
a. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
b. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.
c. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

E. Prefabricated Building Columns
1. Install prefabricated building columns to comply with AISC 360, manufacturer's written recommendations, and requirements of testing and inspecting agency that apply to the fire-resistance rating indicated.

F. Field Quality Control
1. Testing Agency: Engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.
2. Bolted Connections: Bolted connections will be inspected **OR** tested and inspected, **as directed**, according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
3. Welded Connections: Field welds will be visually inspected according to AWS D1.1/D1.1M.
   a. In addition to visual inspection, field welds will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
      1) Liquid Penetrant Inspection: ASTM E 165.
      2) Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
      3) Ultrasonic Inspection: ASTM E 164.
      4) Radiographic Inspection: ASTM E 94.
4. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
   a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
   b. Conduct tests on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1/D1.1M.
5. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

G. Repairs And Protection
1. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780.
2. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

   OR

   Touchup Painting: Cleaning and touchup painting are specified in Division 07.

END OF SECTION 05 05 21 00

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Task	Specification	Specification Description
05 05 23 00	01 22 16 00	No Specification Required
05 05 23 00	05 05 21 00	Structural Steel
05 05 23 00	05 50 00 00	Metal Fabrications

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SECTION 05 12 23 00 - COLD-FORMED METAL FRAMING

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for cold-formed metal framing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Exterior load-bearing wall framing.
      b. Interior load-bearing wall framing.
      c. Exterior non-load-bearing wall framing.
      d. Floor joist framing.
      e. Roof trusses.
      f. Roof rafter framing.
      g. Ceiling joist framing.

C. Performance Requirements
   1. Structural Performance: Provide cold-formed metal framing capable of withstanding design loads within limits and under conditions indicated.
      a. Design Loads: **As directed.**
      b. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
         1) Exterior Load-Bearing Wall Framing: Horizontal deflection of 1/240 **OR** 1/360 **OR** 1/600 **OR** 1/720, **as directed**, of the wall height.
         2) Interior Load-Bearing Wall Framing: Horizontal deflection of 1/240 **OR** 1/360, **as directed**, of the wall height under a horizontal load of 5 lbf/sq. ft. (239 Pa).
         3) Exterior Non-Load-Bearing Framing: Horizontal deflection of 1/240 **OR** 1/360 **OR** 1/600 **OR** 1/720, **as directed**, of the wall height.
         4) Floor Joist Framing: Vertical deflection of 1/480 for live loads and l/360 for total loads of the span.
         5) Roof Trusses: Vertical deflection of 1/240 **OR** 1/360, **as directed**, of the span.
         6) Scissor Roof Trusses: Horizontal deflection of 1-1/4 inches (32 mm) <Insert dimension> at reactions.
         7) Roof Rafter Framing: Horizontal deflection of 1/240 **OR** 1/360, **as directed**, of the horizontally projected span.
         8) Ceiling Joist Framing: Vertical deflection of 1/240 **OR** 1/360, **as directed**, of the span.
      c. Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F (67 deg C).
      d. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
         1) Upward and downward movement of 1/2 inch (13 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
   2. Cold-Formed Steel Framing, General: Design according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions."
      a. Headers: Design according to AISI's "Standard for Cold-Formed Steel Framing - Header Design."

b. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

c. Roof Trusses: Design according to AISI's "Standard for Cold-Formed Steel Framing - Truss Design."

D. Submittals

1. Product Data: For each type of product and accessory indicated.
2. LEED Submittal:
   a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
      1) Include statement indicating costs for each product having recycled content.
3. Shop Drawings: Show layout, spacings, sizes, thicknesses, and types of cold-formed metal framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
   a. For cold-formed metal framing indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
4. Welding certificates.
5. Qualification data.
6. Product test reports.
7. Research/evaluation reports.

E. Quality Assurance

1. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer.
2. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of cold-formed metal framing that are similar to those indicated for this Project in material, design, and extent.
3. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E 329 to conduct the testing indicated.
4. Product Tests: Mill certificates or data from a qualified independent testing agency**,** or in-house testing with calibrated test equipment, **as directed**, indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, ductility, and metallic-coating thickness.
5. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code--Steel," and AWS D1.3, "Structural Welding Code--Sheet Steel."
6. Fire-Test-Response Characteristics: Where indicated, provide cold-formed metal framing identical to that of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.
7. AISI Specifications and Standards: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" and its "Standard for Cold-Formed Steel Framing - General Provisions."
   a. Comply with AISI's "Standard for Cold-Formed Steel Framing - Truss Design."
   b. Comply with AISI's "Standard for Cold-Formed Steel Framing - Header Design."
8. Comply with AISI's "Standard for Cold-Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings" as applicable.
9. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling

1. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling.
2. Store cold-formed metal framing, protect with a waterproof covering, and ventilate to avoid condensation.

1.2 PRODUCTS

A. Materials
1. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
2. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:
   a. Grade: ST33H (ST230H) **OR** ST50H (ST340H) **OR** As required by structural performance, **as directed**.
   b. Coating: G60 (Z180), A60 (ZF180), AZ50 (AZ150), or GF30 (ZGF90) **OR** G90 (Z275) or equivalent, **as directed**.
3. Steel Sheet for Vertical Deflection **OR** Drift, **as directed**, Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:
   a. Grade: 50 (340), Class 1 or 2 **OR** As required by structural performance, **as directed**.
   b. Coating: G90 (Z275).

B. Load-Bearing Wall Framing
1. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges.
2. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges.
3. Steel Box or Back-to-Back Headers: Manufacturer's standard C-shapes used to form header beams, of web depths indicated, punched, with stiffened flanges.
4. Steel Double-L Headers: Manufacturer's standard L-shapes used to form header beams, of web depths indicated.

C. Exterior Non-Load-Bearing Wall Framing
1. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges.
2. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges.
3. Vertical Deflection Clips: Manufacturer's standard bypass **OR** head, **as directed**, clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
4. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal and lateral loads and transfer them to the primary structure.
5. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.
   a. Outer Track: Of web depth to allow free vertical movement of inner track, with flanges designed to support horizontal and lateral loads and transfer them to the primary structure.
   b. Inner Track: Of web depth indicated, and as follows:
6. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure.

D. Floor Joist Framing
1. Steel Joists: Manufacturer's standard C-shaped steel joists, of web depths indicated, unpunched, **OR** punched, **OR** punched, with enlarged service holes, **as directed**, with stiffened flanges, and as follows:
2. Steel Joist Track: Manufacturer's standard U-shaped steel joist track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

E. Roof Trusses
1. Roof Truss Members:

a. Manufacturer's standard-shape steel sections.
OR
Manufacturer's standard C-shaped steel sections, of web depths indicated, unpunched, with stiffened flanges.

F. Roof-Rafter Framing
1. Steel Rafters: Manufacturer's standard C-shaped steel sections, of web depths indicated, unpunched, with stiffened flanges.
2. Built-up Members: Built-up members of manufacturer's standard C-shaped steel section, with stiffened flanges, nested into a U-shaped steel section joist track, with unstiffened flanges; unpunched; of web depths indicated.

G. Ceiling Joist Framing
1. Steel Ceiling Joists: Manufacturer's standard C-shaped steel sections, of web depths indicated, unpunched, **OR** punched with enlarged service holes, **as directed**, with stiffened flanges, and as follows:

H. Framing Accessories
1. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.
2. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
   a. Supplementary framing.
   b. Bracing, bridging, and solid blocking.
   c. Web stiffeners.
   d. Anchor clips.
   e. End clips.
   f. Foundation clips.
   g. Gusset plates.
   h. Stud kickers, knee braces, and girts.
   i. Joist hangers and end closures.
   j. Hole reinforcing plates.
   k. Backer plates.

I. Anchors, Clips, And Fasteners
1. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.
2. Anchor Bolts: ASTM F 1554, Grade 36 **OR** 55, **as directed**, threaded carbon-steel hex-headed bolts **OR** headless, hooked bolts **OR** headless bolts, with encased end threaded, **as directed**, and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153/A 153M, Class C **OR** mechanically deposition according to ASTM B 695, Class 50, **as directed**.
3. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
4. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified independent testing agency.
5. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.
   a. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.
6. Welding Electrodes: Comply with AWS standards.

J. Miscellaneous Materials

1. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035 **OR** ASTM A 780, **as directed**.
2. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
3. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents, complying with ASTM C 1107, with fluid consistency and 30-minute working time.
4. Shims: Load bearing, high-density multimonomer plastic, nonleaching.
5. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch (6.4 mm) thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

K. Fabrication
1. Fabricate cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
   a. Fabricate framing assemblies using jigs or templates.
   b. Cut framing members by sawing or shearing; do not torch cut.
   c. Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
      1) Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
      2) Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by not less than three exposed screw threads.
   d. Fasten other materials to cold-formed metal framing by welding, bolting, or screw fastening, according to Shop Drawings.
2. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.
3. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:
   a. Spacing: Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
   b. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch (3 mm).

1.3 EXECUTION

A. Preparation
1. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.
2. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that are required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.
3. Install load bearing shims or grout between the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations to ensure a uniform bearing surface on supporting concrete or masonry construction.
4. Install sealer gaskets to isolate the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations.

B. Installation, General
1. Cold-formed metal framing may be shop or field fabricated for installation, or it may be field assembled.

2. Install cold-formed metal framing according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions" and to manufacturer's written instructions unless more stringent requirements are indicated.
3. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
    a. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch (1.6 mm).
4. Install cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened.
    a. Cut framing members by sawing or shearing; do not torch cut.
    b. Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
        1) Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
        2) Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.
5. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
6. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
7. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.
8. Install insulation, specified in Division 07 Section "Thermal Insulation", in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
9. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's standard punched openings.
10. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:
    a. Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

C. Load-Bearing Wall Installation
1. Install continuous top and bottom tracks sized to match studs. Align tracks accurately and securely anchor at corners and ends, and at spacings as follows:
    a. Anchor Spacing: 24 inches (610 mm) **OR** 32 inches (813 mm) **OR** To match stud spacing **OR** As shown on Shop Drawings, **as directed**.
2. Squarely seat studs against top and bottom tracks with gap not exceeding of 1/8 inch (3 mm) between the end of wall framing member and the web of track. Fasten both flanges of studs to top and bottom tracks. Space studs as follows:
    a. Stud Spacing:
        1) 12 inches (305 mm) **OR** 16 inches (406 mm) **OR** 19.2 inches (488 mm) **OR** 24 inches (610 mm) **OR** As indicated, **as directed**.
        2) 300 mm **OR** 400 mm **OR** 600 mm **OR** As indicated, **as directed**.
3. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar configurations.
4. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.
5. Align floor and roof framing over studs. Where framing cannot be aligned, continuously reinforce track to transfer loads.
6. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure as indicated.

7. Install headers over wall openings wider than stud spacing. Locate headers above openings as indicated. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.
   a. Frame wall openings with not less than a double stud at each jamb of frame as indicated on Shop Drawings. Fasten jamb members together to uniformly distribute loads.
   b. Install runner tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.
8. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.
   a. If type of supplementary support is not indicated, comply with stud manufacturer's written recommendations and industry standards in each case, considering weight or load resulting from item supported.
9. Install horizontal bridging in stud system, spaced 48 inches (1220 mm) **OR** as indicated **OR** as indicated on Shop Drawings, **as directed**. Fasten at each stud intersection.
   a. Bridging:
      1) Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs with a minimum of 2 screws into each flange of the clip angle for framing members up to 6 inches (150 mm) deep.
         OR
         Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
         OR
         Proprietary bridging bars installed according to manufacturer's written instructions.
10. Install steel sheet diagonal bracing straps to both stud flanges, terminate at and fasten to reinforced top and bottom tracks. Fasten clip-angle connectors to multiple studs at ends of bracing and anchor to structure.
11. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

D. Exterior Non-Load-Bearing Wall Installation
1. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.
2. Fasten both flanges of studs to bottom **OR** top and bottom, **as directed**, track, unless otherwise indicated. Space studs as follows:
   a. Stud Spacing:
      1) 12 inches (305 mm) **OR** 16 inches (406 mm) **OR** 19.2 inches (488 mm) **OR** 24 inches (610 mm) **OR** As indicated, **as directed**.
      2) 300 mm **OR** 400 mm **OR** 480 mm **OR** 600 mm **OR** As indicated, **as directed**.
3. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
4. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
   a. Install single-leg deflection tracks and anchor to building structure.
   b. Install double deep-leg deflection tracks and anchor outer track to building structure.
   c. Connect vertical deflection clips to bypassing **OR** infill, **as directed**, studs and anchor to building structure.
   d. Connect drift clips to cold formed metal framing and anchor to building structure.
5. Install horizontal bridging in wall studs, spaced in rows indicated on Shop Drawings but not more than 48 inches (1220 mm) apart. Fasten at each stud intersection.
   a. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches (305 mm) **OR** 18 inches (450 mm), **as directed**, of single deflection track. Install a combination of flat, taut, steel sheet straps of width and thickness indicated and stud or

stud-track solid blocking of width and thickness matching studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.

1) Install solid blocking at 96-inch (2440-mm) centers **OR** centers indicated **OR** centers indicated on Shop Drawings, **as directed**.

b. Bridging:

1) Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.

OR

Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.

OR

Proprietary bridging bars installed according to manufacturer's written instructions.

6. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, fasteners, and stud girts, to provide a complete and stable wall-framing system.

E. Joist Installation

1. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on Shop Drawings.
2. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.
   a. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm).
   b. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections as indicated on Shop Drawings.
3. Space joists not more than 2 inches (51 mm) from abutting walls, and as follows:
   a. Joist Spacing:
      1) 12 inches (305 mm) **OR** 16 inches (406 mm) **OR** 19.2 inches (488 mm) **OR** 24 inches (610 mm) **OR** As indicated, **as directed**.
      2) 300 mm **OR** 400 mm **OR** 480 mm **OR** 600 mm **OR** As indicated, **as directed**.
4. Frame openings with built-up joist headers consisting of joist and joist track, nesting joists, or another combination of connected joists if indicated.
5. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement, or as indicated **OR** as indicated on Shop Drawings, **as directed**.
   a. Install web stiffeners to transfer axial loads of walls above.
6. Install bridging at intervals indicated **OR** indicated on Shop Drawings, **as directed**. Fasten bridging at each joist intersection as follows:
   a. Bridging:
      1) Joist-track solid blocking of width and thickness indicated, secured to joist webs.

      OR

      Combination of flat, taut, steel sheet straps of width and thickness indicated and joist-track solid blocking of width and thickness indicated. Fasten flat straps to bottom flange of joists and secure solid blocking to joist webs.
7. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.
8. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

F. Truss Installation

1. Install, bridge, and brace trusses according to Shop Drawings and requirements in this Section.
2. Truss Spacing:
   a. 16 inches (406 mm) **OR** 19.2 inches (488 mm) **OR** 24 inches (610 mm) **OR** 32 inches (813 mm) **OR** 48 inches (1220 mm) **OR** As indicated, **as directed**.
   b. 400 mm **OR** 480 mm **OR** 600 mm **OR** 800 mm **OR** 1200 mm, **as directed**.

3. Do not alter, cut, or remove framing members or connections of trusses.
4. Erect trusses with plane of truss webs plumb and parallel to each other, align, and accurately position at spacings indicated.
5. Erect trusses without damaging framing members or connections.
6. Align webs of bottom chords and load-bearing studs or continuously reinforce track to transfer loads to structure. Anchor trusses securely at all bearing points.
7. Install continuous bridging and permanently brace trusses as indicated on Shop Drawings and designed according to LGSEA's Technical Note 551e, "Design Guide for Permanent Bracing of Cold-Formed Steel Trusses," **as directed**.

G. Field Quality Control
1. Testing: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
2. Field and shop welds will be subject to testing and inspecting.
3. Testing agency will report test results promptly and in writing to Contractor and the Owner.
4. Remove and replace work where test results indicate that it does not comply with specified requirements.
5. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

H. Repairs And Protection
1. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
2. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed metal framing is without damage or deterioration at time of Final Completion.

END OF SECTION 05 12 23 00

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Task	Specification	Specification Description
05 12 23 00	05 05 21 00	Structural Steel
05 12 23 00	05 50 00 00	Metal Fabrications
05 13 00 00	05 50 00 00	Metal Fabrications

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SECTION 05 14 13 00 - STRUCTURAL ALUMINUM

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for structural aluminum. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Performance Requirements
1. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-aluminum fabricator to withstand loads indicated and comply with other information and restrictions indicated.
   a. Select and complete connections using schematic details indicated and in accordance with minimum mechanical properties and applicable buckling formula constants published by The Aluminum Association's "Aluminum Construction Manual."

C. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Show fabrication of structural-aluminum components.
3. Welding certificates.
4. Mill test reports.
5. Source quality-control test reports.

D. Quality Assurance
1. Fabricator Qualifications: A qualified fabricator who has provided successful structural aluminum fabrication for a minimum of 5 years.
2. Welding: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code--Aluminum."
3. Comply with applicable provisions of The Aluminum Association's "Aluminum Construction Manual."
4. Preinstallation Conference: Conduct conference at Project site.

1.2 PRODUCTS

A. Structural-Aluminum Materials
1. W-Shapes, Channels, Angles, Plate and Bar, Cold-Formed Hollow Structural Sections, and Pipe: Structural shapes indicating minimum mechanical properties and applicable buckling formula constants are listed in Table 3.3.1, Section 3, of "Specifications for Aluminum Structures," Construction Manual Series Section 1, as published by The Aluminum Association. Applicable ASTM Designations include B209, B210, B211, B221, B241, B247, B308, and B429
2. Allowable Stresses:
   a. Building Type Structures: Basic allowable tensile stresses for buildings, structural supports for highway signs, luminaires, traffic signals and similar structures shall be the lesser of the minimum yield strength divided by a factor of safety of 1.65, or the minimum ultimate tensile strength divided by a factor of safety of 1.95. Other allowable stresses for buildings and similar structures shall be based upon the factors of safety shown in Table 3.3.3 of "Specifications for Aluminum Structures."
   b. Bridge Type Structures: Basic allowable tensile stresses for bridge type structures shall be the lesser of the minimum yield strength divided by a factor of safety of 1.85, or the minimum ultimate tensile strength divided by a factor of safety of 2.2. Other allowable

stresses for bridge and similar structures shall be based upon the factors of safety shown in Table 3.3.3 of "Specifications for Aluminum Structures."

3. Welding Electrodes: Comply with AWS requirements.

B. Bolts and Connectors

1. Rivets and Bolts:
   a. Aluminum alloys used for rivets and bolts shall be those listed in Tables 5.1.1b and 5.1.1c of "Specifications for Aluminum Structures."
   b. Nuts:
      1) For bolts 1/4" and smaller: Alloy 2024-T4. For improved corrosion resistance, apply 0.0002" minimum thickness anodic coating.
      2) For bolts larger than 1/4": 6061-T6 or 6262-T9.
      3) Flat Washers: Alclad 2024-T4.
      4) Spring Lock Washers: Alloy 7075-T6.
   c. Steel Bolts: Hot-dip galvanized, electro-galvanized, cadmium plated or aluminized steel bolts and Series 300 stainless steel bolts may be used instead of aluminum bolts. Plating thickness on steel shall be adequate to provide corrosion protection for the anticipated environ and service life.

C. Grout

1. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404, Size No. 2. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
2. Metallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.
3. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

D. Fabrication

1. Structural Aluminum: Fabricate and assemble in shop to greatest extent possible. Fabricate according to The Aluminum Association's "Aluminum Construction Manual."

E. Source Quality Control

1. Engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports. Comply with testing and inspection requirements of Part 1.3, Article "Field Quality Control."
2. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

1.3 EXECUTION

A. Erection

1. Examination: Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with erector present, for compliance with requirements.
   a. Proceed with installation only after unsatisfactory conditions have been corrected.
2. Set structural aluminum accurately in locations and to elevations indicated and according to The Aluminum Association's "Aluminum Construction Manual."
3. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.
   a. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.

b. Weld plate washers to top of base plate.
c. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate before packing with grout.
d. Promptly pack grout solidly between bearing surfaces and base or bearing plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

4. Maintain erection tolerances of structural aluminum within The Aluminum Association's "Aluminum Construction Manual."

B. Field Connections
1. Bolts: Shop install bolts according to The Aluminum Association's "Aluminum Construction Manual" for type of bolt and type of joint specified.
2. Weld Connections: Comply with AWS D1.2 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
   a. Comply with The Aluminum Association's "Aluminum Construction Manual" for bearing, adequacy of temporary connections, and alignment.

C. Field Quality Control
1. Testing Agency: Engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.
2. Bolted Connections: Shop-bolted connections shall be tested and inspected according to The Aluminum Association's "Aluminum Construction Manual."
3. Welded Connections: Field welds shall be visually inspected according to AWS D1.2.
   a. In addition to visual inspection, field welds shall be tested according to AWS D1.2.
4. Correct deficiencies in Work that test reports and inspections indicate are not in compliance with the Contract Documents.

END OF SECTION 05 14 13 00

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Task	Specification	Specification Description
05 14 13 00	01 22 16 00	No Specification Required

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SECTION 05 15 16 00 - ORNAMENTAL METAL

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for ornamental metal. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Decorative window security bars.
      b. Decorative mechanical grilles and frames.
      c. Decorative-metal-clad, hollow-metal doors and frames.
      d. Custom door pulls.
      e. Combination hall push-button stations.
      f. Metal reveals at wood paneling.
      g. Cast-metal rosettes at marble joints.

C. Submittals
   1. Product Data: For each type of product indicated, including finishing materials.
   2. LEED Submittals:
      a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
   3. Shop Drawings: Show fabrication and installation details for decorative metal.
      a. Include plans, elevations, component details, and attachments to other work.
      b. Indicate materials and profiles of each decorative metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.
   4. Patterns, Models, or Plaster Castings: Made from proposed patterns for each design of custom casting required.
   5. Samples: For each type of exposed finish required.
      a. Sections of linear shapes.
      b. Full-size Samples of castings and forgings.
         1) For custom castings, submit finished Samples showing ability to reproduce detail, cast-metal color, and quality of finish. Samples may be of similar previous work.
      c. Samples of welded and brazed joints showing quality of workmanship and color matching of materials.
   6. Qualification Data: For qualified fabricator **OR** organic-coating applicator **OR** anodic finisher **OR** powder-coating applicator, **as directed**.
   7. Mill Certificates: Signed by manufacturers of stainless-steel certifying that products furnished comply with requirements.
   8. Welding certificates.

D. Quality Assurance
   1. Fabricator Qualifications: A firm experienced in producing decorative metal similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
   2. Installer Qualifications: Fabricator of products.

3. Organic-Coating Applicator Qualifications: A firm experienced in successfully applying organic coatings, of type indicated, to aluminum extrusions and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.
4. Anodic Finisher Qualifications: A firm experienced in successfully applying anodic finishes of type indicated and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.
5. Powder-Coating Applicator Qualifications: A firm experienced in successfully applying powder coatings of type indicated and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.
6. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   c. AWS D1.3, "Structural Welding Code - Sheet Steel."
   d. AWS D1.6, "Structural Welding Code - Stainless Steel."
7. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
1. Store decorative metal in a well-ventilated area, away from uncured concrete and masonry, and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.
2. Deliver and store cast-metal products in wooden crates surrounded by sufficient packing material to ensure that products will not be cracked or otherwise damaged.

F. Project Conditions
1. Field Measurements: Verify actual locations of walls and other construction contiguous with decorative metal by field measurements before fabrication and indicate measurements on Shop Drawings.

G. Coordination
1. Coordinate installation of anchorages for decorative metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.2 PRODUCTS

A. Metals, General
1. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. Provide materials without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Aluminum
1. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.
   a. Extruded Bars and Shapes: ASTM B 221 (ASTM B 221M), Alloy 6063-T5/T52.
   b. Extruded Structural Pipe and Round Tubing: ASTM B 429/B 429M, Alloy 6063-T6.
   c. Drawn Seamless Tubing: ASTM B 210 (ASTM B 210M) or ASTM B 483/B 483M, Alloy 6063-T832.
   d. Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 3003-H14 **OR** Alloy 5005-H32 **OR** Alloy 6061-T6, **as directed**.
   e. Die and Hand Forgings: ASTM B 247 (ASTM B 247M), Alloy 6061-T6.
   f. Castings: ASTM B 26/B 26M, Alloy A356.0-T6.

C. Copper Alloys

1. Copper and Copper Alloys, General: Provide alloys indicated and temper to suit application and forming methods but with strength and stiffness not less than H01 (quarter-hard) for plate, sheet, strip, and bars and H55 (light-drawn) for tube and pipe.
2. Extruded Shapes, Bronze: ASTM B 455, Alloy UNS No. C38500 (architectural bronze).
3. Extruded Shapes, Brass: ASTM B 249/B 249M, Alloy UNS No. C36000 (free-cutting brass).
4. Extruded Shapes, Nickel Silver: ASTM B 249/B 249M, Alloy UNS No. C79600.
5. Seamless Pipe, Bronze: ASTM B 43, Alloy UNS No. C23000 (red brass, 85 percent copper).
6. Seamless Tube, Bronze: ASTM B 135 (ASTM B 135M), Alloy UNS No. C23000 (red brass, 85 percent copper).
7. Seamless Tube, Brass: ASTM B 135 (ASTM B 135M), Alloy UNS No. C26000 (cartridge brass, 70 percent copper).
8. Seamless Tube, Copper: ASTM B 75 (ASTM B 75M), Alloy UNS No. C12200 (phosphorous deoxidized, high residual phosphorous copper).
9. Castings, Bronze: ASTM B 62, Alloy UNS No. C83600 (85-5-5-5 or No. 1 composition commercial red brass) or ASTM B 584, Alloy UNS No. C86500 (No. 1 manganese bronze).
10. Castings, Brass: ASTM B 584, Alloy UNS No. C85200 (high-copper yellow brass).
11. Castings, Copper: ASTM B 824, with a minimum of 99.9 percent copper.
12. Castings, Nickel Silver: ASTM B 584, Alloy UNS No. C97300 (12 percent leaded nickel silver).
13. Plate, Sheet, Strip, and Bars; Bronze: ASTM B 36/B 36M, Alloy UNS No. C28000 (muntz metal, 60 percent copper).
14. Plate, Sheet, Strip, and Bars; Brass: ASTM B 36/B 36M, Alloy UNS No. C26000 (cartridge brass, 70 percent copper).
15. Plate, Sheet, Strip, and Bars; Copper: ASTM B 152/B 152M, Alloy UNS No. C11000 (electrolytic tough pitch copper) or UNS No. C12200 (phosphorous deoxidized, high-residual phosphorous copper).

D. Stainless Steel
1. Tubing: ASTM A 554, Grade MT 304 **OR** Grade MT 316 **OR** Grade MT 316L, **as directed**.
2. Pipe: ASTM A 312/A 312M, Grade TP 304 **OR** Grade TP 316 **OR** Grade TP 316L, **as directed**.
3. Castings: ASTM A 743/A 743M, Grade CF 8 or CF 20 **OR** Grade CF 8M or CF 3M, **as directed**.
4. Sheet, Strip, Plate, and Flat Bar: ASTM A 666, Type 304 **OR** Type 316 **OR** Type 316L, **as directed**.
5. Bars and Shapes: ASTM A 276, Type 304 **OR** Type 316 **OR** Type 316L, **as directed**.
6. Wire Rope and Fittings:
   a. Wire Rope: 1-by-19 **OR** 7-by-7 **OR** 7-by-19, **as directed**, wire rope made from wire complying with ASTM A 492, Type 316.
   b. Wire-Rope Fittings: Connectors of types indicated, fabricated from stainless steel, and with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.

E. Steel And Iron
1. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
2. Tubing: ASTM A 500 (cold formed) or ASTM A 513, Type 5 (mandrel drawn).
3. Bars: Hot-rolled, carbon steel complying with ASTM A 29/A 29M, Grade 1010.
4. Plates, Shapes, and Bars: ASTM A 36/A 36M.
5. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M unless otherwise indicated.
6. Steel Sheet, Cold Rolled: ASTM A 1008/A 1008M, either commercial steel or structural steel, exposed.

F. Titanium
1. Titanium Strip, Sheet, and Plate: ASTM B 265, Grade 1.
2. Titanium Bars: ASTM B 348, Grade 1.

G. Fasteners
1. Fastener Materials: Unless otherwise indicated, provide the following:
   a. Aluminum Items: Aluminum **OR** Type 304 stainless-steel **OR** Type 316 stainless-steel, **as directed**, fasteners.
   b. Copper-Alloy (Bronze) Items: Silicon bronze (Alloy 651 or Alloy 655) fasteners where concealed, muntz metal (Alloy 280) fasteners where exposed.
   c. Copper-Alloy (Brass) Items: Silicon bronze (Alloy 651 or Alloy 655) fasteners where concealed, brass (Alloy 260 or 360) fasteners where exposed.
   d. Stainless-Steel Items: Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners.
   e. Titanium Items: Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners.
   f. Uncoated-Steel Items: Plated steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating where concealed, Type 304 stainless-steel fasteners where exposed.
   g. Galvanized-Steel Items: Plated steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating.
   h. Dissimilar Metals: Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners.
2. Fasteners for Anchoring to Other Construction: Unless otherwise indicated, select fasteners of type, grade, and class required to produce connections suitable for anchoring indicated items to other types of construction indicated.
3. Provide concealed fasteners for interconnecting components and for attaching decorative metal items to other work unless otherwise indicated **OR** exposed fasteners are unavoidable, **as directed**.
   a. Provide Phillips **OR** tamper-resistant **OR** square or hex socket, **as directed**, flat-head machine screws for exposed fasteners unless otherwise indicated.
4. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
5. Post-Installed Anchors: Torque-controlled expansion type or chemical type.
   a. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5 unless otherwise indicated.
   b. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) **OR** Group 2 (A4), **as directed**, stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

H. Miscellaneous Materials
1. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
   a. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
2. Brazing Rods: For copper alloys, provide type and alloy as recommended by producer of metal to be brazed and as required for color match, strength, and compatibility in fabricated items.
3. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
4. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
5. Lacquer for Copper Alloys: Clear, acrylic lacquer specially developed for coating copper-alloy products.
6. Shop Primers: Provide primers that comply with Division 07 OR Division 09 Section(s) "High-performance Coatings", **as directed**.
7. Universal Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
   a. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
8. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

9. Shop Primer for Galvanized Steel: Cementitious galvanized metal primer complying with MPI#26 **OR** Vinyl wash primer complying with MPI#80 **OR** Water-based galvanized metal primer complying with MPI#134, **as directed**.
10. Intermediate Coats and Topcoats for Steel: Provide products that comply with Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
11. Epoxy Intermediate Coat for Steel: Complying with MPI#77 and compatible with primer and topcoat.
12. Polyurethane Topcoat for Steel: Complying with MPI#72 and compatible with undercoat.
13. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

I. Fabrication, General
1. Assemble items in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
2. Make up wire-rope assemblies in the shop to field-measured dimensions with fittings machine swaged. Minimize amount of turnbuckle take-up used for dimensional adjustment so maximum amount is available for tensioning wire ropes. Tag wire-rope assemblies and fittings to identify installation locations and orientations for coordinated installation.
3. Form decorative metal to required shapes and sizes, true to line and level with true curves and accurate angles and surfaces. Finish exposed surfaces to smooth, sharp, well-defined lines and arris.
4. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.
5. Form simple and compound curves in bars, pipe, tubing, and extruded shapes by bending members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces.
6. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
7. Mill joints to a tight, hairline fit. Cope or miter corner joints. Fabricate connections that will be exposed to weather in a manner to exclude water.
8. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.
9. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Cut, reinforce, drill, and tap as needed to receive finish hardware, screws, and similar items unless otherwise indicated.
10. Comply with AWS for recommended practices in shop welding and brazing. Weld and braze behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed joints of flux, and dress exposed and contact surfaces.
    a. Where welding and brazing cannot be concealed behind finished surfaces, finish joints to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 Welds: no evidence of a welded joint **OR** Type 2 Welds: completely sanded joint, some undercutting and pinholes okay **OR** Type 3 Welds: partially dressed weld with spatter removed **OR** Type 4 Welds: good quality, uniform undressed weld with minimal splatter, **as directed**.
11. Provide castings that are sound and free of warp, cracks, blowholes, or other defects that impair strength or appearance. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks.

J. Decorative Window Security Bars
1. General: Fabricate decorative window grilles to designs indicated from steel bars and shapes of sizes and profiles indicated. Form steel bars by bending, forging, coping, mitering, and welding.
2. Welding: Interconnect grille members with full-length, full-penetration welds unless otherwise indicated. Use welding method that is appropriate for metal and finish indicated and that

develops full strength of members joined. Finish exposed welds and surfaces smooth, flush, and blended to match adjoining surfaces.

3. Brackets, Fittings, and Anchors: Provide wall brackets, fittings, and anchors to connect decorative window grilles to other work unless otherwise indicated.
   a. Furnish inserts and other anchorage devices to connect decorative window grilles to concrete and masonry work. Coordinate anchorage devices with supporting structure.
   b. Fabricate anchorage devices that are capable of withstanding loads indicated.

K. Decorative Mechanical Grilles

1. Fabricate decorative grilles from perforated aluminum **OR** brass **OR** bronze **OR** stainless-steel **OR** steel, **as directed**, sheet or plate of thickness, size, and pattern indicated. Form perforations by punching, cutting, or drilling to produce openings of sizes and shapes indicated. Roll, press, and grind perforated metal to flatten and to remove burrs and deformations.
   a. Form perforations to match existing grilles.
      OR
      Drawings indicate perforated metal patterns required and are based on products of one manufacturer. Perforated metal patterns produced by other manufacturers may be considered, provided deviations are minor and do not change design concept as judged solely by the Owner.
2. Drill and countersink grilles for mounting screws at 2 inches (50 mm) from corners and at 10 inches (250 mm) or less o.c. Provide units with oval-head wood **OR** self-tapping machine, **as directed**, screws.
3. Fabricate grille frames from extruded aluminum **OR** brass **OR** bronze, **as directed**, of profiles, and to sizes and shapes indicated. Miter frame members at corners and connect with concealed splice plates welded **OR** brazed, **as directed**, to back of frames.
   a. Secure grilles in frames with 0.5-inch- (12-mm-) long welds **OR** brazing, **as directed**, along perimeter of grilles at 4 inches (100 mm) o.c.
   b. Provide frame profiles to match existing frames.
      OR
      Drawings indicate frame profiles required and are based on products of one manufacturer. Similar frame profiles produced by other manufacturers may be considered, provided deviations are minor and do not change design concept as judged solely by the Owner.
4. Drill and countersink frames for mounting screws at 4 inches (100 mm) from corners and at 16 inches (400 mm) or less o.c. Provide units with oval-head wood **OR** self-tapping machine, **as directed**, screws.

L. Decorative-Metal-Clad Doors And Frames

1. Laminate 0.0403-inch- (1.0-mm-) thick, muntz-metal **OR** 0.0403-inch- (1.0-mm-) thick, brass **OR** 0.0375-inch- (0.95-mm-) thick, stainless-steel **OR** 0.024-inch- (0.6-mm-) thick, titanium, **as directed**, sheets to outside face of hollow-metal doors and frames at locations and to comply with details indicated. Use adhesive recommended by metal fabricator that will fully bond metal to metal and that will prevent telegraphing and oil canning.
   a. Hollow-metal doors and frames are specified in Division 8 Section "Steel Doors and Frames."

M. Custom Door Pulls

1. Fabricate custom door pulls from brass **OR** bronze **OR** stainless-steel, **as directed**, bar stock of profile indicated, fabricated to shapes indicated. Form curves by bending to produce uniform curvature of radii indicated; maintain profile of member throughout entire bend without buckling, twisting, or otherwise deforming exposed surfaces. Where radii of bends are too small to avoid buckling, grind bars after bending to restore original profile. Drill and tap door pulls to receive through bolts for attachment to doors.
2. Fabricate backing plates for custom door pulls from 1/8-inch (3.2-mm) brass **OR** bronze **OR** stainless-steel, **as directed**, sheet. Cut to shape indicated and bevel edges at a 45-degree angle for one-half thickness of metal. Drill and countersink holes where indicated for screws and bolts.

3. Provide units with oval-head through bolts for mounting pulls and with oval-head wood screws for mounting backing plates.

N. Combination Hall Push-Button Stations
1. Fabricate units of brass **OR** bronze **OR** stainless steel, **as directed**, to comply with details indicated. Coordinate with requirements in Division 14 Section "Electric Traction Elevators" to provide integrated, closely fitted assemblies.
a. Fabricate faceplates from 1/8-inch- (3.2-mm-) thick sheet with edges beveled at a 45-degree angle for one-half thickness of metal.
b. Provide units with rectangular, split-bowl trash receptacle, designed for recess mounting in nominal 4-inch (100-mm) wall depth. Fabricate recessed cabinets, top rings, and split bowls of same metal as face of units; fabricate removable receptacles of drawn aluminum. Nominal dimensions of units are 10 by 10 by 3-1/2 inches (250 by 250 by 90 mm) in depth.
c. Provide units with emergency pictorial signs and text, complying with requirements of authorities having jurisdiction, indicating that in fire emergency, elevators should not be used and that stairways should be used instead. Engrave pictorial sign and text into front surface of faceplates to a depth of 1/16 inch (1.6 mm) with engraving painted red. Make signs 5 inches (125 mm) wide by 8 inches (200 mm) high.
d. Provide cutouts in faceplates of units for push buttons of elevator hall push-button station, card reader, **as directed**, and elevator key switches. Coordinate locations and sizes of cutouts so additional faceplate is not required and so faces of push buttons are flush with fronts of faceplates and key switches project beyond faceplate only by depth of bezel.

O. Metal Reveals
1. Fabricate metal reveals for wood paneling from 3/4-by-3/4-by-1/16-inch (19-by-19-by-3-mm) extruded-bronze **OR** 3/4-by-3/4-by-0.025-inch (19-by-19-by-0.6-mm) brake-formed, stainless-steel **OR** 3/4-by-3/4-by-0.015-inch (19-by-19-by-0.4-mm) brake-formed titanium, **as directed**, channels. Drill for mounting screws 6 inches (150 mm) from ends of channels and not more than 24 inches (600 mm) o.c. Locate mounting screws at same heights for all channels. Provide black-finished, **as directed**, hex-socket, wafer-head screws for mounting reveals.

P. Cast-Metal Rosettes
1. Fabricate cast-metal rosettes to design indicated from aluminum **OR** brass **OR** bronze **OR** nickel silver, **as directed**. Drill and tap castings for threaded mounting studs.
a. Provide custom castings to match design indicated.
b. Manufacturer's stock castings may be considered, provided deviations are minor and do not change design concept as judged solely by the Owner.
c. Drawings indicate cast-metal rosette designs required and are based on products of one manufacturer. Castings produced by other manufacturers may be considered, provided deviations are minor and do not change design concept as judged solely by the Owner.

Q. Finishes, General
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

R. Aluminum Finishes
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
3. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.

a. Color: Champagne **OR** Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from full range of industry colors and color densities, **as directed**.

4. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
5. Siliconized Polyester Finish: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
6. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

   OR

   High-Performance Organic Finish: Three **OR** Four, **as directed**,-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   b. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

S. Copper-Alloy Finishes
1. Finish designations for copper alloys comply with the system established for designating copper-alloy finish systems defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."
2. Buffed Finish: M21 (Mechanical Finish: buffed, smooth specular).
3. Hand-Rubbed Finish: M31-M34 (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed).
4. Medium-Satin Finish: M32 (Mechanical Finish: directionally textured, medium satin).
5. Fine-Matte Finish: M42 (Mechanical Finish: nondirectional finish, fine matte).
6. Buffed Finish, Lacquered: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear organic, air drying, as specified below):
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
7. Hand-Rubbed Finish, Lacquered: M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear organic, air drying, as specified below):
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
8. Medium-Satin Finish, Lacquered: M32-O6x (Mechanical Finish: directionally textured, medium satin; Coating: clear organic, air drying, as specified below):
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
9. Fine-Matte Finish, Lacquered: M42-O6x (Mechanical Finish: nondirectional finish, fine matte; Coating: clear organic, air drying, as specified below):

a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).

10. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide), with color matching the Owner's sample.
11. Patina Conversion Coating: M36-C12-C52 (Mechanical Finish: directionally textured, uniform; Chemical Finish: nonetched cleaned, degreased; Chemical Finish: conversion coating, ammonium sulfate), with color matching the Owner's sample.
12. Statuary Conversion Coating, Bright Relieved and Lacquered: M12-C55-M2x-O6x (Mechanical Finish: matte finish, as cast; Chemical Finish: conversion coating, sulfide; Mechanical Finish: buffed, as specified; Coating: clear, organic, air drying, as specified below), with color matching the Owner's sample:
    a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
13. Blackened, Bright Relieved, and Lacquered: M33-O60-M2x-O6x (Mechanical Finish: directionally textured, coarse satin; Coating: black, air drying; Mechanical Finish: buffed, as specified; Coating: clear, organic, air drying, as specified below), with blackening and buffing matching the Owner's sample:
    a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).

T. Stainless-Steel Finishes
1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
    a. Run grain of directional finishes with long dimension of each piece.
3. Bright, Cold-Rolled, Unpolished Finish: No. 2B.
4. Directional Satin Finish: No. 4.
5. Dull Satin Finish: No. 6.
6. Reflective, Directional Polish: No. 7.
7. Mirrorlike Reflective, Nondirectional Polish: No. 8.
8. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
9. Sputter-Coated Finish: Titanium nitride coating deposited by magnetic sputter-coating process over indicated mechanical finish.
10. Colored, Oxide-Film Finish: Clear, oxide interference film produced by degreasing and then immersing in a mixture of chromic and sulfuric acids.
    a. Product: Subject to compliance with requirements, provide INCO colored stainless-steel finish as developed and licensed by International Nickel Co., Ltd.
    b. Color: Match the Owner's sample **OR** As selected from finisher's full range, **as directed**.

U. Steel And Iron Finishes
1. Galvanizing: Hot-dip galvanize products made from rolled, pressed, and forged steel shapes, castings, plates, bars, and strips indicated to be galvanized to comply with ASTM A 123/A 123M.
    a. Hot-dip galvanize steel and iron hardware indicated to be galvanized to comply with ASTM A 153/A 153M.
    b. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
    c. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
2. Preparing Galvanized Items for Shop Priming: After galvanizing, thoroughly clean decorative metal of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.

3. Preparing Nongalvanized Items for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning" **OR** SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning" **OR** requirements indicated below, **as directed**:
   a. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   b. Interiors (SSPC Zone 1A): SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
4. Primer Application: Apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.
   a. Shop prime uncoated ferrous-metal surfaces with universal shop primer **OR** primers specified in Division 07, **as directed**, unless zinc-rich primer is **OR** primers specified in Division 09 Section "High-performance Coatings" are, **as directed**, indicated.
   b. Do not apply primer to galvanized surfaces.
5. Shop-Painted Finish: Comply with Division 09 Section(s) "Exterior Painting" OR "High-performance Coatings", **as directed**.
   a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
6. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.
   a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
7. Powder-Coat Finish: Prepare, treat, and coat nongalvanized ferrous metal to comply with resin manufacturer's written instructions and as follows:
   a. Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   b. Treat prepared metal with iron-phosphate pretreatment, rinse, and seal surfaces.
   c. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils (0.04 mm).
   d. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
8. Powder-Coat Finish: Prepare, treat, and coat galvanized metal to comply with resin manufacturer's written instructions and as follows:
   a. Prepare galvanized metal by thoroughly removing grease, dirt, oil, flux, and other foreign matter.
   b. Treat prepared metal with zinc-phosphate pretreatment, rinse, and seal surfaces.
   c. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils (0.04 mm).
   d. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

V. Titanium Finishes
1. General: Fabricate items from finished titanium stock, taking care not to damage finish during fabrication. Protect finish as needed during fabrication by applying a strippable, temporary protective covering.
2. Dull Matte Finish: Pickled and annealed.
3. Bright Matte Finish: Vacuum annealed.

1.3 EXECUTION

A. Examination
1. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative metal.

2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation, General
1. Provide anchorage devices and fasteners where needed to secure decorative metal to in-place construction.
2. Perform cutting, drilling, and fitting required to install decorative metal. Set products accurately in location, alignment, and elevation, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.
3. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, uniform reveals and spaces for sealants and joint fillers. Where cutting, welding, and grinding are required for proper shop fitting and jointing of decorative metal, restore finishes to eliminate evidence of such corrective work.
4. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.
5. Install concealed gaskets, joint fillers, insulation, and flashings as work progresses.
6. Restore protective coverings that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at same location.
   a. Retain protective coverings intact; remove coverings simultaneously from similarly finished items to preclude nonuniform oxidation and discoloration.
7. Field Welding: Comply with applicable AWS specification for procedures of manual shielded metal arc welding and requirements for welding and for finishing welded connections in "Fabrication, General" Article. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
8. Field Brazing: Comply with requirements for brazing and for finishing brazed connections in "Fabrication, General" Article. Braze connections that are not to be left as exposed joints but cannot be shop brazed because of shipping size limitations.
9. Corrosion Protection: Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

C. Installing Decorative Window Security Bars
1. Fasten security bar frames to concrete and masonry walls with cast-in-place or postinstalled anchors. Peen exposed threads of anchors to prevent removal of security bars.

D. Installing Decorative Mechanical Grilles
1. Mount decorative grilles at heights and in positions indicated, adjusting ductwork to be centered on grilles if any.
   a. Secure to framing and blocking with specified fasteners.
   b. On marble, brick, and other solid surfaces, secure with wood screws in lead plugs.

E. Installing Decorative-Metal-Clad, Hollow-Metal Doors And Frames
1. Install doors and frames to comply with requirements specified in Division 08 Section "Hollow Metal Doors And Frames".

F. Installing Custom Door Pulls
1. Install door pulls at heights and locations shown. Install with backing plates on both sides of doors. Fasten backing plates to doors with oval-head wood **OR** self-tapping metal, **as directed**, screws and secure pulls through doors and backing plates with oval-head machine screws.

G. Installing Combination Hall Push-Button Stations
1. Coordinate installation of combination hall push-button stations with installation of related elevator signal equipment components specified in Division 14 Section "Electric Traction Elevators". Secure units in place with faceplate overlapping surrounding wall finish and drawn into contact with surrounding wall finish at entire perimeter of faceplate.

H. Installing Metal Reveals At Wood Paneling
1. Install metal reveals between wood panels as paneling is installed. Secure to wood grounds with specified screws.

I. Installing Cast-Metal Rosettes At Marble Joints
1. Install cast-metal rosettes at intersections of marble joints where indicated. Install only after marble work is complete and joints are grouted. Secure to wall by drilling a 3/4-inch- (19-mm-) round hole at intersection of marble joints and by filling hole with molding plaster into which threaded stud is embedded. Angle drill and rotate so bottom of hole is larger than at surface.
   a. Secure rosettes in place with masking tape until plaster sets. After plaster has set, remove masking tape and adhesive residue.

J. Cleaning And Protection
1. Unless otherwise indicated, clean metals by washing thoroughly with clean water and soap, rinsing with clean water, and drying with soft cloths.
2. Clean copper alloys according to metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.
3. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   a. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

   OR

   Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
4. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.
5. Protect finishes of decorative metal from damage during construction period with temporary protective coverings approved by decorative metal fabricator. Remove protective covering at time of Final Completion.
6. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 05 15 16 00

Task	Specification	Specification Description
05 15 16 00	05 50 00 00	Metal Fabrications
05 15 19 00	05 15 16 00	Ornamental Metal

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SECTION 05 21 19 00 - STEEL JOISTS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for steel joists. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. K-series steel joists.
b. KCS-type K-series steel joists.
c. K-series steel joist substitutes.
d. Long-span steel joists.
e. Joist girders.
f. Joist accessories.

C. Definitions
1. SJI "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."
2. Special Joists: Steel joists or joist girders requiring modification by manufacturer to support nonuniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

D. Performance Requirements
1. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated.
2. Design special joists to withstand design loads with live load deflections no greater than the following:
a. Floor Joists: Vertical deflection of 1/360 **OR** 1/240, **as directed**, of the span.
b. Roof Joists: Vertical deflection of 1/360 **OR** 1/240, **as directed**, of the span.

E. Submittals
1. Product Data: For each type of joist, accessory, and product indicated.
2. LEED Submittal:
a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
1) Include statement indicating costs for each product having recycled content.
3. Shop Drawings: Show layout, designation, number, type, location, and spacings of joists. Include joining and anchorage details, bracing, bridging, joist accessories; splice and connection locations and details; and attachments to other construction.
4. Welding certificates.
5. Manufacturer Certificates
6. Mill Certificates: For bolts.
7. Field quality-control test and inspection reports.
8. Research/Evaluation Reports: For joists.

F. Quality Assurance
1. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables of SJI "Specifications."

a. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.
2. SJI Specifications: Comply with standard specifications in SJI's "Specifications" that are applicable to types of joists indicated.
3. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

G. Delivery, Storage, And Handling
1. Deliver, store, and handle joists as recommended in SJI's "Specifications."
2. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

H. Sequencing
1. Deliver steel bearing plates to be built into cast-in-place concrete and masonry construction.

1.2 PRODUCTS

A. Materials
1. Steel: Comply with SJI's "Specifications" for web and steel-angle chord members.
a. Recycled Content: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 **OR** 50 **OR** 60, **as directed**, percent.
2. Steel Bearing Plates: ASTM A 36/A 36M.
3. Carbon-Steel Bolts and Threaded Fasteners: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), carbon-steel, hex-head bolts and threaded fasteners; carbon-steel nuts; and flat, unhardened steel washers.
a. Finish: Plain, uncoated **OR** Hot-dip zinc coating, ASTM A 153/A 153M, Class C **OR** Mechanically deposited zinc coating, ASTM B 695, Class 50, **as directed**.
4. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts; ASTM A 563 (ASTM A 563M) heavy hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M) hardened carbon-steel washers.
a. Finish: Plain, uncoated **OR** Hot-dip zinc coating, ASTM A 153/A 153M, Class C **OR** Mechanically deposited zinc coating, ASTM B 695, Class 50, **as directed**.
5. Welding Electrodes: Comply with AWS standards.
6. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20 **OR** ASTM A 780, **as directed**.

B. Primers
1. Primer:
a. SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.
OR
Provide shop primer that complies with Division 07.

C. K-Series Steel Joists
1. Manufacture steel joists of type indicated according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.
a. Joist Type: K-series steel joists **OR** KCS-type K-series steel joists, **as directed**.
2. Steel Joist Substitutes: Manufacture according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle or -channel members.
3. Comply with AWS requirements and procedures for shop welding, appearance, quality of welds, and methods used in correcting welding work.
4. Provide holes in chord members for connecting and securing other construction to joists.

5. Top-Chord Extensions: Extend top chords of joists with SJI's Type S top-chord extensions where indicated, complying with SJI's "Specifications."
6. Extended Ends: Extend bearing ends of joists with SJI's Type R extended ends where indicated, complying with SJI's "Specifications."
7. Do not camber joists.
8. Camber joists according to SJI's "Specifications," **OR** as indicated, **as directed**.
9. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).

D. Long-Span Steel Joists
1. Manufacture steel joists according to "Standard Specifications for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members; of joist type and end and top-chord arrangements as follows **OR** as indicated, **as directed**.
   a. Joist Type: LH-series steel joists **OR** DLH-series steel joists, **as directed**.
   b. End Arrangement: Underslung **OR** Square, **as directed**.
   c. Top-Chord Arrangement: Parallel **OR** Pitched 1/8 inch per 12 inches (1:96), 1 way **OR** Pitched 1/8 inch per 12 inches (1:96), 2 ways, **as directed**.
2. Comply with AWS requirements and procedures for shop welding, appearance, quality of welds, and methods used in correcting welding work.
3. Provide holes in chord members for connecting and securing other construction to joists.
4. Camber long-span steel joists according to SJI's "Specifications" **OR** as indicated, **as directed**.
5. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).

E. Joist Girders
1. Manufacture joist girders according to "Standard Specifications for Joist Girders" in SJI's "Specifications," with steel-angle top- and bottom-chord members; with end and top-chord arrangements as follows **OR** as indicated, **as directed**.
   a. End Arrangement: Underslung **OR** Underslung with bottom-chord extensions **OR** Square, **as directed**.
   b. Top-Chord Arrangement: Parallel **OR** Pitched 1/8 inch per 12 inches (1:96), 1 way **OR** Pitched 1/8 inch per 12 inches (1:96), 2 ways, **as directed**.
2. Comply with AWS requirements and procedures for shop welding, appearance, quality of welds, and methods used in correcting welding work.
3. Provide holes in chord members for connecting and securing other construction to joist girders.
4. Camber joist girders according to SJI's "Specifications" **OR** as indicated, **as directed**.
5. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).

F. Joist Accessories
1. Bridging: Provide bridging anchors and number of rows of horizontal **OR** diagonal, **as directed**, bridging of material, size, and type required by SJI's "Specifications" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.
2. Bridging: Schematically indicated. Detail and fabricate according to SJI's "Specifications." Furnish additional erection bridging if required for stability.
3. Bridging: Fabricate as indicated and according to SJI's "Specifications." Furnish additional erection bridging if required for stability.
4. Fabricate steel bearing plates with integral anchorages of sizes and thicknesses indicated. Shop prime paint **OR** Hot-dip zinc coat according to ASTM A 123/A 123M, **as directed**.
5. Supply ceiling extensions, either extended bottom-chord elements or a separate extension unit of enough strength to support ceiling construction. Extend ends to within 1/2 inch (13 mm) of finished wall surface, unless otherwise indicated.
6. Supply miscellaneous accessories, including splice plates and bolts required by joist manufacturer to complete joist installation.

G. Cleaning And Shop Painting
1. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by hand-tool cleaning, SSPC-SP 2 **OR** power-tool cleaning, SSPC-SP 3, **as directed**.
2. Do not prime paint joists and accessories to receive sprayed fire-resistive materials, **as directed**.
3. Apply 1 coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil (0.025 mm) thick.
OR
Shop priming of joists and joist accessories is specified in Division 07.

1.3 EXECUTION

A. Installation
1. Do not install joists until supporting construction is in place and secured.
2. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written recommendations, and requirements in this Section.
a. Before installation, splice joists delivered to Project site in more than one piece.
b. Space, adjust, and align joists accurately in location before permanently fastening.
c. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
d. Delay rigidly connecting bottom-chord extensions to columns or supports until dead loads have been applied.
3. Field weld joists to supporting steel bearing plates and framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
4. Bolt joists to supporting steel framework using carbon-steel bolts.
OR
Bolt joists to supporting steel framework using high-strength structural bolts. Comply with RCSC's "Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts" for high-strength structural bolt installation and tightening requirements.
5. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

B. Field Quality Control
1. Testing Agency: Engage a qualified independent testing and inspecting agency to inspect field welds and bolted connections and to perform field tests and inspections and prepare test and inspection reports.
2. Field welds will be visually inspected according to AWS D1.1/D1.1M.
3. In addition to visual inspection, field welds will be tested according to AWS D1.1/D1.1M and the following procedures, as applicable:
a. Radiographic Testing: ASTM E 94.
b. Magnetic Particle Inspection: ASTM E 709.
c. Ultrasonic Testing: ASTM E 164.
d. Liquid Penetrant Inspection: ASTM E 165.
4. Bolted connections will be visually inspected.
5. High-strength, field-bolted connections will be tested and verified according to procedures in RCSC's "Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts."
6. Correct deficiencies in Work that test and inspection reports have indicated are not in compliance with specified requirements.
7. Additional testing will be performed to determine compliance of corrected Work with specified requirements.

C. Repairs And Protection

1. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
2. Touchup Painting:
   a. After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists, bearing plates, abutting structural steel, and accessories.
      1) Clean and prepare surfaces by hand-tool cleaning, SSPC-SP 2, or power-tool cleaning, SSPC-SP 3.
      2) Apply a compatible primer of same type as shop primer used on adjacent surfaces.
3. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that joists and accessories are without damage or deterioration at time of Final Completion.

END OF SECTION 05 21 19 00

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SECTION 05 31 13 00 - STEEL DECK

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for steel deck. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Roof deck.
b. Acoustical roof deck.
c. Cellular roof deck.
d. Acoustical cellular roof deck.
e. Composite floor deck.
f. Electrified cellular floor deck.
g. Noncomposite form deck.
h. Noncomposite vented form deck.

C. Submittals
1. Product Data: For each type of deck, accessory, and product indicated.
2. LEED Submittal:
a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
1) Include statement indicating costs for each product having recycled content.
3. Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.
4. Product Certificates.
5. Welding certificates.
6. Field quality-control test and inspection reports.
7. Research/Evaluation Reports: For steel deck.

D. Quality Assurance
1. Welding: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."
2. Fire-Test-Response Characteristics: Where indicated, provide steel deck units identical to those tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.
a. Fire-Resistance Ratings: Indicated by design designations of applicable testing and inspecting agency.
b. Steel deck units shall be identified with appropriate markings of applicable testing and inspecting agency.
3. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."
4. Electrical Raceway Units: Provide UL-labeled cellular floor-deck units complying with UL 209 and listed in UL's "Electrical Construction Equipment Directory" for use with standard header ducts and outlets for electrical distribution systems.
5. FMG Listing: Provide steel roof deck evaluated by FMG and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.

6. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

E. Delivery, Storage, And Handling
1. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
2. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.
   a. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

1.2 PRODUCTS

A. Roof Deck
   a. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 30, and with the following:
   b. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), Grade 33 (230) **OR** 40 (275) **OR** 80 (550), **as directed**, minimum, shop primed with manufacturer's standard baked-on, rust-inhibitive primer.
      1) Color: Manufacturer's standard **OR** Gray **OR** White **OR** Gray top surface with white underside, **as directed**.
   c. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230) **OR** 40 (275) **OR** 80 (550), **as directed**, G60 (Z180) **OR** G90 (Z275), **as directed**, zinc coating.
   d. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230) **OR** 40 (275) **OR** 80 (550), **as directed**, G60 (Z180) zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
      1) Color: Manufacturer's standard **OR** Gray **OR** White **OR** Gray top surface with white underside, **as directed**.
   e. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Structural Steel (SS), Grade 33 (230) minimum, AZ50 (AZ150) aluminum-zinc alloy coating.
   f. Deck Profile: As indicated **OR** Type NR, narrow rib **OR** Type IR, intermediate rib **OR** Type WR, wide rib **OR** Type 3DR, deep rib **OR** Long span, **as directed**.
   g. Cellular Deck Profile: As indicated **OR** Type WR, wide rib **OR** Type 3DR, deep rib **OR** Long span, **as directed**, with bottom plate.
   h. Profile Depth: As indicated **OR** 1-1/2 inches (38 mm) **OR** 2 inches (51 mm) **OR** 3 inches (76 mm) **OR** 4-1/2 inches (114 mm) **OR** 6 inches (152 mm) **OR** 7-1/2 inches (190 mm), **as directed**.
   i. Design Uncoated-Steel Thickness: As indicated **OR** 0.0295 inch (0.75 mm) **OR** 0.0358 inch (0.91 mm) **OR** 0.0474 inch (1.20 mm) **OR** 0.0598 inch (1.52 mm) **OR** 0.0747 inch (1.90 mm), **as directed**.
   j. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: As indicated **OR** 0.0358/0.0358 inch (0.91/0.91 mm) **OR** 0.0358/0.0474 inch (0.91/1.20 mm) **OR** 0.0474/0.0474 inch (1.20/1.20 mm) **OR** 0.0474/0.0598 inch (1.20/1.52 mm) **OR** 0.0598/0.0474 inch (1.52/1.20 mm) **OR** 0.0598/0.0598 inch (1.52/1.52 mm), **as directed**.
   k. Span Condition: As indicated **OR** Simple span **OR** Double span **OR** Triple span or more, **as directed**.
   l. Side Laps: Overlapped **OR** Interlocking seam, **as directed**.

B. Acoustical Roof Deck
1. Acoustical Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 30, and with the following:

a. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), Grade 33 (230) **OR** 40 (275) **OR** 80 (550), **as directed**, minimum, shop primed with manufacturer's standard baked-on, rust-inhibitive primer.
   1) Color: Manufacturer's standard **OR** Gray **OR** White **OR** Gray top surface with white underside, **as directed**.
b. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230) **OR** 40 (275) **OR** 80 (550), **as directed**, G60 (Z180) **OR** G90 (Z275), **as directed**, zinc coating.
c. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230) **OR** 40 (275) **OR** 80 (550), **as directed**, G60 (Z180) zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
   1) Color: Manufacturer's standard **OR** Gray **OR** White **OR** Gray top surface with white underside, **as directed**.
d. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Structural Steel (SS), Grade 33 (230) minimum, AZ50 (AZ150) aluminum-zinc alloy coating.
e. Deck Profile: As indicated **OR** Type WR, wide rib **OR** Type 3DR, deep rib **OR** Long span, **as directed**.
f. Cellular Deck Profile: As indicated **OR** Type WR, wide rib **OR** Type 3DR, deep rib **OR** Long span, **as directed**, with bottom plate.
g. Profile Depth: As indicated **OR** 1-1/2 inches (38 mm) **OR** 2 inches (51 mm) **OR** 3 inches (76 mm) **OR** 4-1/2 inches (114 mm) **OR** 6 inches (152 mm) **OR** 7-1/2 inches (190 mm), **as directed**.
h. Design Uncoated-Steel Thickness: As indicated **OR** 0.0295 inch (0.75 mm) **OR** 0.0358 inch (0.91 mm) **OR** 0.0474 inch (1.20 mm) **OR** 0.0598 inch (1.52 mm), **as directed**.
i. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: As indicated **OR** 0.0358/0.0358 inch (0.91/0.91 mm) **OR** 0.0358/0.0474 inch (0.91/1.20 mm) **OR** 0.0474/0.0358 inch (1.20/0.91 mm) **OR** 0.0474/0.0474 inch (1.20/1.20 mm) **OR** 0.0474/0.0598 inch (1.20/1.52 mm) **OR** 0.0598/0.0474 inch (1.52/1.20 mm) **OR** 0.0598/0.0598 inch (1.52/1.52 mm), **as directed**.
j. Span Condition: As indicated **OR** Simple span **OR** Double span **OR** Triple span or more, **as directed**.
k. Side Laps: Overlapped **OR** Interlocking seam**, as directed**.
l. Acoustical Perforations: Deck units with manufacturer's standard perforated vertical webs **OR** Cellular deck units with manufacturer's standard perforated flat-bottom plate welded to ribbed deck, **as directed**.
m. Sound-Absorbing Insulation: Manufacturer's standard premolded roll or strip of glass or mineral fiber.
   1) Factory install sound-absorbing insulation into cells of cellular deck.
   2) Installation of sound-absorbing insulation is specified in Division 07.
n. Acoustical Performance: NRC 0.65 **OR** 0.75 **OR** 0.80 **OR** 0.85 **OR** 0.90, **as directed**, tested according to ASTM C 423.

C. Composite Floor Deck
1. Composite Steel Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 30, with the minimum section properties indicated, and with the following:
   a. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), Grade 33 (230) **OR** 40 (275) **OR** 80 (550), **as directed**, minimum, with top surface phosphatized and unpainted and underside surface shop primed with manufacturers' standard gray **OR** white, **as directed**, baked-on, rust-inhibitive primer.
   b. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230), G30 (Z90) **OR** G60 (Z180) **OR** G90 (Z275), **as directed**, zinc coating.
   c. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230), G30 (Z90) **OR** G60 (Z180), **as directed**, zinc coating; with unpainted top surface and cleaned and pretreated bottom surface primed with manufacturer's standard gray **OR** white, **as directed**, baked-on, rust-inhibitive primer.

d. Profile Depth: 1-1/2 inches (38 mm) **OR** 2 inches (51 mm) **OR** 3 inches (76 mm) **OR** As indicated, **as directed**.
e. Design Uncoated-Steel Thickness: 0.0295 inch (0.75 mm) **OR** 0.0358 inch (0.91 mm) **OR** 0.0474 inch (1.20 mm) **OR** 0.0598 inch (1.52 mm), **as directed**.
f. Span Condition: As indicated **OR** Simple span **OR** Double span **OR** Triple span or more, a**s directed**.

D. Electrified Cellular Floor Deck
1. Electrified Cellular Floor Deck: Fabricate steel sheet cellular floor-deck panels, consisting of a ribbed top section welded to a lower flat-bottom sheet with interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck" in SDI Publication No. 30. Fabricate deck to the minimum section properties, width of panel, number and area of cells per panel indicated, and the following:
a. Cellular Deck Type: Composite **OR** Noncomposite, **as directed**.
b. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230), G60 (Z180) **OR** G90 (Z275), **as directed**, zinc coating.
c. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230), G60 (Z180) zinc coating; with underside surface cleaned, pretreated, and primed with manufacturer's standard gray **OR** white, **as directed**, baked-on, rust-inhibitive primer.
d. Profile Depth: 1-1/2 inches (38 mm) **OR** 2 inches (51 mm) **OR** 3 inches (76 mm) **OR** As indicated, **as directed**.
e. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: 0.0358/0.0358 inch (0.91/0.91 mm) **OR** 0.0358/0.0474 inch (0.91/1.20 mm) **OR** 0.0358/0.0598 inch (0.91/1.52 mm) **OR** 0.0474/0.0358 inch (1.20/0.91 mm) **OR** 0.0474/0.0474 inch (1.20/1.20 mm) **OR** 0.0474/0.0598 inch (1.20/1.52 mm) **OR** 0.0598/0.0474 inch (1.52/1.20 mm) **OR** 0.0598/0.0598 inch (1.52/1.52 mm), **as directed**.
f. Span Condition: As indicated **OR** Simple span **OR** Double span **OR** Triple span or more, **as directed**.
g. Factory punch holes, of size and arrangement indicated, into each deck cell at preset inserts and header duct locations.

E. Noncomposite Form Deck
1. Noncomposite Steel Form Deck: Fabricate ribbed-steel sheet noncomposite form-deck panels to comply with "SDI Specifications and Commentary for Noncomposite Steel Form Deck," in SDI Publication No. 30, with the minimum section properties indicated, and with the following:
a. Uncoated Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), Grade 33 (230) **OR** 40 (275) **OR** 80 (550), **as directed**, minimum.
b. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), Grade 33 (230) **OR** 40 (275) **OR** 80 (550), **as directed**, minimum, with underside **OR** top and underside, **as directed**, surface shop primed with manufacturer's standard baked-on, rust-inhibitive primer.
1) Color: Manufacturer's standard **OR** Gray **OR** White **OR** Gray top surface with white underside, **as directed**.
c. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230) **OR** 40 (275) **OR** 80 (550), **as directed**, G30 (Z90) **OR** G60 (Z180) **OR** G90 (Z275), **as directed**, zinc coating.
d. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230) **OR** 80 (550), **as directed**, G60 (Z180) zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
1) Color: Manufacturer's standard **OR** Gray **OR** White **OR** Gray top surface with white underside, **as directed**.
e. Profile Depth: 9/16 inch (14 mm) **OR** 15/16 inch (24 mm) **OR** 1-5/16 inches (33 mm) **OR** 1-1/2 inches (38 mm), **as directed**.

f. Design Uncoated-Steel Thickness: 0.0149 inch (0.38 mm) **OR** 0.0179 inch (0.45 mm) **OR** 0.0239 inch (0.61 mm) **OR** 0.0295 inch (0.75 mm) **OR** 0.0358 inch (0.91 mm) **OR** 0.0474 inch (1.20 mm) **OR** 0.0598 inch (1.52 mm), **as directed**.
g. Span Condition: As indicated **OR** Simple span **OR** Double span **OR** Triple span or more, **as directed**.
h. Side Laps: Overlapped **OR** Interlocking seam, **as directed**.

F. Noncomposite Vented Form Deck
1. Noncomposite Vented Steel Form Deck: Fabricate ribbed- and vented-steel sheet noncomposite form-deck panels to comply with "SDI Specifications and Commentary for Noncomposite Steel Form Deck," in SDI Publication No. 30, and with the following:
a. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230) **OR** 40 (275) **OR** 80 (550), **as directed**, G30 (Z90) **OR** G60 (Z180) **OR** G90 (Z275), **as directed**, zinc coating.
b. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230) **OR** 80 (550), **as directed**, G30 (Z90) **OR** G60 (Z180), **as directed**, zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
1) Color: Manufacturer's standard **OR** Gray **OR** White **OR** Gray top surface with white underside, **as directed**.
c. Profile Depth: 9/16 inch (14 mm) **OR** 15/16 inch (24 mm) **OR** 1-5/16 inches (33 mm) **OR** 1-1/2 inches (38 mm), a**s directed**.
d. Design Uncoated-Steel Thickness: 0.0149 inch (0.38 mm) **OR** 0.0179 inch (0.45 mm) **OR** 0.0239 inch (0.61 mm) **OR** 0.0295 inch (0.75 mm) **OR** 0.0358 inch (0.91 mm) **OR** 0.0474 inch (1.20 mm) **OR** 0.0598 inch (1.52 mm), **as directed**.
e. Span Condition: As indicated **OR** Simple span **OR** Double span **OR** Triple span or more, **as directed**.
f. Side Laps: Overlapped **OR** Interlocking seam, **as directed**.
g. Vent Slot Area: Manufacturer's standard vent slots providing 1-1/2 percent open area.

G. Accessories
1. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
2. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
3. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 (4.8-mm) minimum diameter.
4. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
5. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), not less than 0.0359-inch (0.91-mm) design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
6. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), of same material and finish as deck, and of thickness and profile indicated **OR** recommended by SDI Publication No. 30 for overhang and slab depth, **as directed**.
7. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.
8. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.
9. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0598 inch (1.52 mm) **OR** 0.0747 inch (1.90 mm), **as directed**, thick, with factory-punched hole of 3/8-inch (9.5-mm) minimum diameter.
10. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch (1.90 mm) thick, of same material and finish as deck, with 3-inch- (76-mm-) wide flanges and level **OR** sloped, **as directed**, recessed pans of 1-1/2-inch (38-mm) minimum depth. For drains, cut holes in the field.
11. Flat Sump Plate: Single-piece steel sheet, 0.0747 inch (1.90 mm) thick, of same material and finish as deck. For drains, cut holes in the field.

12. Galvanizing Repair Paint: ASTM A 780 **OR** SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight, **as directed**.
13. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

1.3 EXECUTION

A. Installation, General
1. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 30, manufacturer's written instructions, and requirements in this Section.
2. Install temporary shoring before placing deck panels, if required to meet deflection limitations.
3. Locate deck bundles to prevent overloading of supporting members.
4. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
    a. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.
5. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
6. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
7. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
8. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
9. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

B. Roof-Deck Installation
1. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches (38 mm) long, and as follows:
    a. Weld Diameter: 5/8 inch (16 mm) **OR** 3/4 inch (19 mm), **as directed**, nominal.
    b. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds 18 inches (450 mm) apart, maximum **OR** 12 inches (305 mm) apart in the field of roof and 6 inches (150 mm) apart in roof corners and perimeter, based on roof-area definitions in FMG Loss Prevention Data Sheet 1-28 **OR** as indicated, **as directed**.
    c. Weld Washers: Install weld washers at each weld location.
2. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or 18 inches (450 mm) **OR** 36 inches (910 mm), **as directed**, and as follows:
    a. Mechanically fasten with self-drilling, No. 10 (4.8-mm-) diameter or larger, carbon-steel screws.
    b. Mechanically clinch or button punch.
    c. Fasten with a minimum of 1-1/2-inch- (38-mm-) long welds.
3. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm), with end joints as follows:
    a. End Joints: Lapped 2 inches (51 mm) minimum **OR** Butted **OR** Lapped 2 inches (51 mm) minimum or butted at Contractor's option, **as directed**.
4. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and weld **OR** mechanically fasten, **as directed**, flanges to top of deck. Space welds **OR** mechanical fasteners, **as directed**, not more than 12 inches (305 mm) apart with at least one weld **OR** fastener, **as directed**, at each corner.
    a. Install reinforcing channels or zees in ribs to span between supports and weld **OR** mechanically fasten, **as directed**.

5. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld **OR** Mechanically fasten, **as directed**, to substrate to provide a complete deck installation.
   a. Weld cover plates at changes in direction of roof-deck panels, unless otherwise indicated.
6. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.
7. Sound-Absorbing Insulation: Installation into topside ribs of deck as specified in Division 07.

C. Floor-Deck Installation
1. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
   a. Weld Diameter: 5/8 inch (16 mm) **OR** 3/4 inch (19 mm), **as directed**, nominal.
   b. Weld Spacing: Weld edge ribs of panels at each support. Space additional welds an average of 12 inches (305 mm) apart, but not more than 18 inches (457 mm) apart.
   OR
   Weld Spacing: Space and locate welds as indicated.
   c. Weld Washers: Install weld washers at each weld location.
2. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of half of the span or 36 inches (910 mm), and as follows:
   a. Mechanically fasten with self-drilling, No. 10 (4.8-mm-) diameter or larger, carbon-steel screws.
   b. Mechanically clinch or button punch.
   c. Fasten with a minimum of 1-1/2-inch- (38-mm-) long welds.
3. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm), with end joints as follows:
   a. End Joints: Lapped **OR** Butted, **as directed**.
4. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations, unless otherwise indicated.
5. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.
6. Electrified Cellular Floor Deck: Install cellular floor system with deck assembled from all-cellular units **OR** alternating cellular units with noncellular composite units **OR** units indicated, **as directed**.
7. Install piercing hanger tabs at 14 inches (355 mm) apart in both directions, within 9 inches (228 mm) of walls at ends, and not more than 12 inches (305 mm) from walls at sides, unless otherwise indicated.

D. Field Quality Control
1. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
2. Field welds will be subject to inspection.
3. Testing agency will report inspection results promptly and in writing to Contractor and the Owner.
4. Remove and replace work that does not comply with specified requirements.
5. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

E. Repairs And Protection
1. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
2. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces **OR** top surface, **as directed**, of prime-painted deck immediately after installation, and apply repair paint.
   a. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.

3. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Final Completion.

END OF SECTION 05 31 13 00

Task	Specification	Specification Description
05 31 33 00	05 31 13 00	Steel Deck
05 36 00 00	05 31 13 00	Steel Deck
05 41 00 00	05 12 23 00	Cold-Formed Metal Framing
05 42 13 00	05 12 23 00	Cold-Formed Metal Framing
05 43 00 00	01 22 16 00	No Specification Required
05 43 00 00	05 12 23 00	Cold-Formed Metal Framing
05 43 00 00	05 50 00 00	Metal Fabrications

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SECTION 05 50 00 00 - METAL FABRICATIONS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for metal fabrications. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Steel framing and supports for ceiling-hung toilet compartments.
      b. Steel framing and supports for operable partitions.
      c. Steel framing and supports for overhead doors and grilles.
      d. Steel framing and supports for countertops.
      e. Steel framing and supports for mechanical and electrical equipment.
      f. Steel framing and supports for applications where framing and supports are not specified in other Sections.
      g. Steel framing and supports (outriggers) for window-washing equipment including mounting brackets and anchorages.
      OR
      Mounting brackets and anchorages for window-washing equipment.
      h. Elevator machine beams, hoist beams, and divider beams.
      i. Steel shapes for supporting elevator door sills.
      j. Steel girders for supporting wood frame construction.
      k. Steel pipe columns for supporting wood frame construction.
      l. Prefabricated building columns.
      m. Shelf angles.
      n. Metal ladders.
      o. Ladder safety cages.
      p. Alternating tread devices.
      q. Metal ships' ladders and pipe crossovers.
      r. Metal floor plate and supports.
      s. Structural-steel door frames.
      t. Miscellaneous steel trim including steel angle corner guards, steel edgings, and loading-dock edge angles.
      u. Metal bollards.
      v. Pipe **OR** Downspout, **as directed**, guards.
      w. Abrasive metal nosings, treads, and thresholds.
      x. Cast-iron wheel guards.
      y. Metal downspout boots.
      z. Loose bearing and leveling plates for applications where they are not specified in other Sections.
   2. Products furnished, but not installed, under this Section:
      a. Loose steel lintels.
      b. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
      c. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

C. Performance Requirements

1. Delegated Design: Design ladders and alternating tread devices, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Structural Performance of Aluminum Ladders: Aluminum ladders, including landings, shall withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.
3. Structural Performance of Alternating Tread Devices: Alternating tread devices shall withstand the effects of loads and stresses within limits and under conditions specified in ICC's International Building Code.
4. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
   a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

D. Submittals
1. Product Data: For the following:
   a. Nonslip aggregates and nonslip-aggregate surface finishes.
   b. Prefabricated building columns.
   c. Metal nosings and treads.
   d. Paint products.
   e. Grout.
2. LEED Submittals:
   a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: Indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content. Include statement indicating costs for each product having recycled content.
3. Shop Drawings: Show fabrication and installation details for metal fabrications.
   a. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
4. Samples: For each type and finish of extruded nosing and tread.
5. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
6. Qualification Data: For qualified professional engineer.
7. Mill Certificates: Signed by manufacturers of stainless-steel certifying that products furnished comply with requirements.
8. Welding certificates.
9. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

E. Quality Assurance
1. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   c. AWS D1.6, "Structural Welding Code - Stainless Steel."

F. Project Conditions
1. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

G. Coordination

1. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
2. Coordinate installation of anchorages and steel weld plates and angles for casting into concrete. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.2 PRODUCTS

A. Metals, General
1. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Ferrous Metals
1. Recycled Content of Steel Products: Provide products with average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
2. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
3. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 304 **OR** Type 316L, **as directed**.
4. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304 **OR** Type 316L, **as directed**.
5. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.
6. Rolled-Stainless-Steel Floor Plate: ASTM A 793.
7. Abrasive-Surface Floor Plate: Steel plate with abrasive granules rolled into surface or with abrasive material metallically bonded to steel.
8. Steel Tubing: ASTM A 500, cold-formed steel tubing.
9. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40) unless otherwise indicated.
10. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
    a. Size of Channels: 1-5/8 by 1-5/8 inches (41 by 41 mm) **OR** As indicated, **as directed**.
    b. Material: Galvanized steel, ASTM A 653/A 653M, commercial steel, Type B **OR** structural steel, Grade 33 (Grade 230), **as directed**, with G90 (Z275) coating; 0.108-inch (2.8-mm) (12 gage) **OR** 0.079-inch (2-mm) (14 gage) **OR** 0.064-inch (1.6-mm) (16 gage), **as directed**, nominal thickness.
    OR
    Material: Cold-rolled steel, ASTM A 1008/A 1008M, commercial steel, Type B **OR** structural steel, Grade 33 (Grade 230), **as directed**; 0.0966-inch (2.5-mm) (12 gage) **OR** 0.0677-inch (1.7-mm) (14 gage) **OR** 0.0528-inch (1.35-mm) (16 gage), **as directed**, minimum thickness; unfinished **OR** coated with rust-inhibitive, baked-on, acrylic enamel **OR** hot-dip galvanized after fabrication, **as directed**.
11. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

C. Nonferrous Metals
1. Aluminum Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 6061-T6.
2. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T6.
3. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T6.
4. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.
5. Bronze Plate, Sheet, Strip, and Bars: ASTM B 36/B 36M, Alloy UNS No. C28000 (muntz metal, 60 percent copper).
6. Bronze Extrusions: ASTM B 455, Alloy UNS No. C38500 (extruded architectural bronze).
7. Bronze Castings: ASTM B 584, Alloy UNS No. C83600 (leaded red brass) or No. C84400 (leaded semired brass).

8. Nickel Silver Extrusions: ASTM B 151/B 151M, Alloy UNS No. C74500.
9. Nickel Silver Castings: ASTM B 584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

D. Fasteners
1. General: Unless otherwise indicated, provide Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
   a. Provide stainless-steel fasteners for fastening aluminum.
   b. Provide stainless-steel fasteners for fastening stainless steel.
   c. Provide stainless-steel fasteners for fastening nickel silver.
   d. Provide bronze fasteners for fastening bronze.
2. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
3. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 325, Type 3 (ASTM A 325M, Type 3); with hex nuts, ASTM A 563, Grade C3 (ASTM A 563M, Class 8S3); and, where indicated, flat washers.
4. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593 (ASTM F 738M); with hex nuts, ASTM F 594 (ASTM F 836M); and, where indicated, flat washers; Alloy Group 1 (A1) **OR** Group 2 (A4), **as directed**.
5. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.
   a. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
6. Eyebolts: ASTM A 489.
7. Machine Screws: ASME B18.6.3 (ASME B18.6.7M).
8. Lag Screws: ASME B18.2.1 (ASME B18.2.3.8M).
9. Wood Screws: Flat head, ASME B18.6.1.
10. Plain Washers: Round, ASME B18.22.1 (ASME B18.22M).
11. Lock Washers: Helical, spring type, ASME B18.21.1 (ASME B18.21.2M).
12. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
13. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.
14. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.
   a. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
   b. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 1 (A1) **OR** Group 2 (A4), **as directed**, stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).
15. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches (41 by 22 mm) by length indicated with anchor straps or studs not less than 3 inches (75 mm) long at not more than 8 inches (200 mm) o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

E. Miscellaneous Materials
1. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

2. Shop Primers: Provide primers that comply with Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
3. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
   a. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
4. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
5. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
6. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
7. Nonshrink, Metallic Grout: Factory-packaged, ferrous-aggregate grout complying with ASTM C 1107, specifically recommended by manufacturer for heavy-duty loading applications.
8. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
9. Concrete: Comply with requirements in Division 03 Section "Cast-in-place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa).

F. Fabrication, General
1. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
2. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
3. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
4. Form exposed work with accurate angles and surfaces and straight edges.
5. Weld corners and seams continuously to comply with the following:
   a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   b. Obtain fusion without undercut or overlap.
   c. Remove welding flux immediately.
   d. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
6. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
7. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
8. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
9. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
   a. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches (3.2 by 38 mm), with a minimum 6-inch (150-mm) embedment and 2-inch (50-mm) hook, not less than 8 inches (200 mm) from ends and corners of units and 24 inches (600 mm) o.c., unless otherwise indicated.

G. Miscellaneous Framing And Supports
1. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

2. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
   a. Fabricate units from slotted channel framing where indicated.
   b. Furnish inserts for units installed after concrete is placed.
3. Fabricate supports for operable partitions from continuous steel beams of sizes indicated **OR** recommended by partition manufacturer, **as directed**, with attached bearing plates, anchors, and braces as indicated **OR** recommended by partition manufacturer, **as directed**. Drill or punch bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.
4. Fabricate steel girders for wood frame construction from continuous steel shapes of sizes indicated.
   a. Provide bearing plates welded to beams where indicated.
   b. Drill or punch girders and plates for field-bolted connections where indicated.
   c. Where wood nailers are attached to girders with bolts or lag screws, drill or punch holes at 24 inches (600 mm) o.c.
5. Fabricate steel pipe columns for supporting wood frame construction from steel pipe with steel baseplates and top plates as indicated. Drill or punch baseplates and top plates for anchor and connection bolts and weld to pipe with fillet welds all around. Make welds the same size as pipe wall thickness unless otherwise indicated.
   a. Unless otherwise indicated, fabricate from Schedule 40 steel pipe.
   b. Unless otherwise indicated, provide 1/2-inch (12.7-mm) baseplates with four 5/8-inch (16-mm) anchor bolts and 1/4-inch (6.4-mm) top plates.
6. Galvanize miscellaneous framing and supports where indicated.
   OR
   Prime miscellaneous framing and supports with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**, where indicated.

H. Prefabricated Building Columns
1. General: Provide prefabricated building columns consisting of load-bearing structural-steel members protected by concrete fireproofing encased in an outer non-load-bearing steel shell. Fabricate connections to comply with details shown or as needed to suit type of structure indicated.
2. Fire-Resistance Ratings: Provide prefabricated building columns listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for ratings indicated, based on testing according to ASTM E 119.
   a. Fire-Resistance Rating: 4 hours **OR** 3 hours **OR** 2 hours **OR** As indicated, **as directed**.

I. Shelf Angles
1. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch (19-mm) bolts, spaced not more than 6 inches (150 mm) from ends and 24 inches (600 mm) o.c., unless otherwise indicated.
   a. Provide mitered and welded units at corners.
   b. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches (50 mm) larger than expansion or control joint.
2. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.
3. Galvanize shelf angles located in exterior walls.
   OR
   Prime shelf angles located in exterior walls with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.
4. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

J. Metal Ladders

1. General:
   a. Comply with ANSI A14.3 unless otherwise indicated.
   b. For elevator pit ladders, comply with ASME A17.1.
2. Steel Ladders:
   a. Space siderails 16 inches (406 mm) **OR** 18 inches (457 mm), **as directed**, apart unless otherwise indicated.
   b. Space siderails of elevator pit ladders 12 inches (300 mm) apart.
   c. Siderails: Continuous, 3/8-by-2-1/2-inch (9.5-by-64-mm) **OR** 1/2-by-2-1/2-inch (12.7-by-64-mm), **as directed**, steel flat bars, with eased edges.
   d. Rungs: 3/4-inch- (19-mm-) diameter **OR** 3/4-inch- (19-mm-) square **OR** 1-inch- (25-mm-) diameter **OR** 1-inch- (25-mm-) square, **as directed**, steel bars.
   e. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
   f. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
   g. Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung.
   h. Provide platforms as indicated fabricated from welded or pressure-locked steel bar grating, supported by steel angles. Limit openings in gratings to no more than 1/2 inch (12 mm) **OR** 3/4 inch (19 mm), **as directed**, in least dimension.
   i. Support each ladder at top and bottom and not more than 60 inches (1500 mm) o.c. with welded or bolted steel brackets.
   j. Galvanize ladders **OR** exterior ladders, **as directed**, including brackets and fasteners.
      OR
      Prime ladders **OR** exterior ladders, **as directed**, including brackets and fasteners, with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.
3. Aluminum Ladders:
   a. Space siderails 16 inches (406 mm) **OR** 18 inches (457 mm), **as directed**, apart unless otherwise indicated.
   b. Siderails: Continuous extruded-aluminum channels or tubes, not less than 2-1/2 inches (64 mm) deep, 3/4 inch (19 mm) wide, and 1/8 inch (3.2 mm) thick.
   c. Rungs: Extruded-aluminum tubes, not less than 3/4 inch (19 mm) deep and not less than 1/8 inch (3.2 mm) thick, with ribbed tread surfaces.
   d. Fit rungs in centerline of siderails; fasten by welding or with stainless-steel fasteners or brackets and aluminum rivets.
   e. Provide platforms as indicated fabricated from pressure-locked aluminum bar grating or extruded-aluminum plank grating, supported by extruded-aluminum framing. Limit openings in gratings to no more than 1/2 inch (12 mm) **OR** 3/4 inch (19 mm), **as directed**, in least dimension.
   f. Support each ladder at top and bottom and not more than 60 inches (1500 mm) o.c. with welded or bolted aluminum brackets.
   g. Provide minimum 72-inch- (1830-mm-) high, hinged security door with padlock hasp at foot of ladder to prevent unauthorized ladder use.

K. Ladder Safety Cages
1. General:
   a. Fabricate ladder safety cages to comply with ANSI A14.3 **OR** OSHA regulations, **as directed**. Assemble by welding or with stainless-steel fasteners.
   b. Provide primary hoops at tops and bottoms of cages and spaced not more than 20 feet (6 m) o.c. Provide secondary intermediate hoops spaced not more than 48 inches (1200 mm) o.c. between primary hoops.
   c. Fasten assembled safety cage to ladder rails and adjacent construction by welding or with stainless-steel fasteners unless otherwise indicated.
2. Steel Ladder Safety Cages:
   a. Primary Hoops: 1/4-by-4-inch (6.4-by-100-mm) flat bar hoops.

b. Secondary Intermediate Hoops: 1/4-by-2-inch (6.4-by-50-mm) flat bar hoops.
c. Vertical Bars: 3/16-by-1-1/2-inch (4.8-by-38-mm) flat bars secured to each hoop.
d. Galvanize ladder safety cages, including brackets and fasteners.
OR
Prime ladder safety cages, including brackets and fasteners, with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.

3. Aluminum Ladder Safety Cages:
a. Primary Hoops: 1/4-by-4-inch (6.4-by-100-mm) flat bar hoops.
b. Secondary Intermediate Hoops: 1/4-by-2-inch (6.4-by-50-mm) flat bar hoops.
c. Vertical Bars: 1/4-by-2-inch (6.4-by-50-mm) flat bars secured to each hoop.

L. Alternating Tread Devices

1. Alternating Tread Devices: Fabricate alternating tread devices to comply with ICC's International Building Code. Fabricate of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.
a. Fabricate from steel **OR** stainless steel **OR** aluminum, **as directed**, and assemble by welding or with stainless-steel fasteners.
b. Comply with applicable railing requirements in Division 05 Section "Pipe And Tube Railings".

2. Galvanize steel **OR** exterior steel, **as directed**, alternating tread devices, including treads, railings, brackets, and fasteners.
OR
Prime steel **OR** exterior steel, **as directed**, alternating tread devices, including treads, railings, brackets, and fasteners, with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.

M. Metal Ships' Ladders And Pipe Crossovers

1. Provide metal ships' ladders and pipe crossovers where indicated. Fabricate of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.
a. Fabricate ships' ladders and pipe crossovers, including railings from steel **OR** stainless steel **OR** aluminum, **as directed**.
b. Fabricate treads **OR** treads and platforms, **as directed**, from welded or pressure-locked steel bar grating **OR** pressure-locked stainless-steel bar grating **OR** pressure-locked aluminum bar grating **OR** extruded-aluminum plank grating, **as directed**. Limit openings in gratings to no more than 1/2 inch (12 mm) **OR** 3/4 inch (19 mm), **as directed**, in least dimension.
c. Fabricate treads **OR** treads and platforms, **as directed**, from rolled-steel floor plate **OR** rolled-stainless-steel floor plate **OR** rolled-aluminum-alloy tread plate **OR** abrasive-surface floor plate, **as directed**.
d. Comply with applicable railing requirements in Division 5 Section "Pipe and Tube Railings."

2. Galvanize steel **OR** exterior steel, **as directed**, ships' ladders and pipe crossovers, including treads, railings, brackets, and fasteners.
OR
Prime steel **OR** exterior steel, **as directed**, ships' ladders and pipe crossovers, including treads, railings, brackets, and fasteners, with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.

N. Metal Floor Plate

1. Fabricate from rolled-steel floor **OR** rolled-stainless-steel floor **OR** rolled-aluminum-alloy tread **OR** abrasive-surface floor, **as directed**, plate of thickness indicated below:
a. Thickness: 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm) **OR** 5/16 inch (8 mm) **OR** 3/8 inch (9.5 mm) **OR** As indicated, **as directed**.

2. Provide grating sections where indicated fabricated from welded or pressure-locked steel bar grating **OR** pressure-locked stainless steel bar grating **OR** pressure-locked aluminum bar grating

OR extruded-aluminum plank grating, **as directed**. Limit openings in gratings to no more than 1/2 inch (12 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, in least dimension.

3. Provide steel **OR** stainless-steel **OR** aluminum, **as directed**, angle supports as indicated.
4. Include steel **OR** stainless-steel **OR** aluminum, **as directed**, angle stiffeners, and fixed and removable sections as indicated.
5. Provide flush steel **OR** stainless-steel **OR** aluminum, **as directed**, bar drop handles for lifting removable sections, one at each end of each section.

O. Structural-Steel Door Frames

1. Fabricate structural-steel door frames from steel shapes, plates, and bars of size and to dimensions indicated, fully welded together, with 5/8-by-1-1/2-inch (16-by-38-mm) steel channel stops, unless otherwise indicated. Plug-weld built-up members and continuously weld exposed joints. Secure removable stops to frame with countersunk machine screws, uniformly spaced at not more than 10 inches (250 mm) o.c. Reinforce frames and drill and tap as necessary to accept finish hardware.
   a. Provide with integrally welded steel strap anchors for securing door frames into adjoining concrete or masonry.
2. Extend bottom of frames to floor elevation indicated with steel angle clips welded to frames for anchoring frame to floor with expansion shields and bolts.
3. Galvanize steel **OR** exterior steel, **as directed**, frames.
   OR
   Prime steel **OR** exterior steel, **as directed**, frames with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.

P. Miscellaneous Steel Trim

1. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
2. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
   a. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.
3. Galvanize miscellaneous steel **OR** exterior miscellaneous steel, **as directed**, trim.
   OR
   Prime miscellaneous steel **OR** exterior miscellaneous steel, **as directed**, trim with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.

Q. Metal Bollards

1. Fabricate metal bollards from Schedule 40 steel pipe **OR** Schedule 80 steel pipe **OR** 1/4-inch (6.4-mm) wall-thickness rectangular steel tubing **OR** steel shapes, as indicated, **as directed**.
   a. Cap bollards with 1/4-inch- (6.4-mm-) thick steel plate (not required if bollards are concrete filled).
   b. Where bollards are indicated to receive controls for door operators, provide necessary cutouts for controls and holes for wire.
   c. Where bollards are indicated to receive light fixtures, provide necessary cutouts for fixtures and holes for wire.
2. Fabricate bollards with 3/8-inch- (9.5-mm-) thick steel baseplates for bolting to concrete slab (for mounting bollards on structural slab or on existing pavement). Drill baseplates at all four corners for 3/4-inch (19-mm) anchor bolts.
   a. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.
3. Fabricate sleeves for bollard anchorage from steel pipe or tubing with 1/4-inch- (6.4-mm-) thick steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches (200 mm) deep and 3/4 inch (19 mm) larger than OD of bollard.

4. Fabricate internal sleeves for removable bollards from Schedule 40 steel pipe or 1/4-inch (6.4-mm) wall-thickness steel tubing with an OD approximately 1/16 inch (1.5 mm) less than ID of bollards. Match drill sleeve and bollard for 3/4 inch (19 mm) steel machine bolt.
5. Prime bollards with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.

R. Pipe Or Downspout Guards
1. Fabricate pipe **OR** downspout, **as directed**, guards from 3/8-inch- (9.5-mm-) thick by 12-inch- (300-mm-) wide steel plate, bent to fit flat against the wall or column at both ends and to fit around pipe with 2-inch (50-mm) clearance between pipe and pipe guard. Drill each end for two 3/4-inch (19-mm) anchor bolts.
2. Galvanize pipe **OR** downspout, **as directed**, guards.
   OR
   Prime pipe **OR** downspout, **as directed**, guards with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.

S. Abrasive Metal Nosings, Treads And Thresholds
1. Cast-Metal Units: Cast iron **OR** aluminum **OR** bronze (leaded red or semired brass) **OR** nickel silver (leaded nickel bronze), **as directed**, with an integral-abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.
   a. Nosings: Cross-hatched units, 4 inches (100 mm) wide with 1/4-inch (6-mm) **OR** 1-inch (25-mm), **as directed**, lip, for casting into concrete steps.
      OR
      Nosings: Cross-hatched units, 1-1/2 by 1-1/2 inches (38 by 38 mm), for casting into concrete curbs.
   b. Treads: Cross-hatched units, full depth of tread with 3/4-by-3/4-inch (19-by-19-mm) nosing, for application over bent plate treads or existing stairs.
   c. Thresholds: Fluted-saddle-type units, 5 inches (125 mm) wide by 1/2 inch (12 mm) high, with tapered edges.
      OR
      Thresholds: Fluted-interlocking- (hook-strip-) type units, 5 inches (125 mm) wide by 5/8 inch (16 mm) high, with tapered edge.
      OR
      Thresholds: Plain-stepped- (stop-) type units, 5 inches (125 mm) wide by 1/2 inch (12 mm) high, with 1/2-inch (12-mm) step.
2. Extruded Units: Aluminum **OR** Bronze, **as directed**, with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in lengths necessary to accurately fit openings or conditions.
   a. Provide ribbed units, with abrasive filler strips projecting 1/16 inch (1.5 mm) above aluminum extrusion.
      OR
      Provide solid-abrasive-type units without ribs.
   b. Nosings: Square-back units, 1-7/8 inches (48 mm) **OR** 3 inches (75 mm) **OR** 4 inches (100 mm), **as directed**, wide, for casting into concrete steps.
      OR
      Nosings: Beveled-back units, 3 inches (75 mm) **OR** 4 inches (100 mm), **as directed**, wide with 1-3/8-inch (35-mm) lip, for surface mounting on existing stairs.
      OR
      Nosings: Two-piece units, 3 inches (75 mm) wide, with subchannel for casting into concrete steps.
   c. Treads: Square **OR** Beveled, **as directed**,-back units, full depth of tread with 1-3/8-inch (35-mm) lip, for application over existing stairs.
3. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.

4. Drill for mechanical anchors and countersink. Locate holes not more than 4 inches (100 mm) from ends and not more than 12 inches (300 mm) o.c., evenly spaced between ends, unless otherwise indicated. Provide closer spacing if recommended by manufacturer.
   a. Provide two rows of holes for units more than 5 inches (125 mm) wide, with two holes aligned at ends and intermediate holes staggered.
5. Apply bituminous paint to concealed surfaces of cast-metal units.
6. Apply clear lacquer to concealed surfaces of extruded units.

T. Cast-Iron Wheel Guards
1. Provide wheel guards made from cast iron, 3/4 inch (19 mm) thick, hollow-core construction, of size and shape indicated. Provide holes for countersunk anchor bolts and grouting.
2. Prime cast iron wheel guards with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.

U. Metal Downspout Boots
1. Provide downspout boots made from cast iron **OR** cast aluminum, **as directed**, in heights indicated with inlets of size and shape to suit downspouts. Provide units with flanges and holes for countersunk anchor bolts.
   a. Outlet: Vertical, to discharge into pipe **OR** Horizontal, to discharge into pipe **OR** At 35 degrees from horizontal, to discharge onto splash block or pavement, **as directed**.
2. Prime cast iron downspout boots with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.

V. Loose Bearing And Leveling Plates
1. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
2. Galvanize plates.
   OR
   Prime plates with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.

W. Loose Steel Lintels
1. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.
2. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span but not less than 8 inches (200 mm) unless otherwise indicated.
3. Galvanize loose steel lintels located in exterior walls.
4. Prime loose steel lintels located in exterior walls with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.

X. Steel Weld Plates And Angles
1. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

Y. Finishes, General
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Finish metal fabrications after assembly.
3. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

Z. Steel And Iron Finishes

1. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
   a. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
2. Shop prime iron and steel items not indicated to be galvanized, **as directed**, unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
   a. Shop prime with universal shop primer **OR** primers specified in Division 07, **as directed**, unless zinc-rich primer is **OR** primers specified in Division 09 Section "High-performance Coatings" are, **as directed**, indicated.
3. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning" **OR** SSPC-SP 3, "Power Tool Cleaning" **OR** requirements indicated below, **as directed**:
   a. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   b. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   c. Items Indicated to Receive Primers Specified in Division 9 Section "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   d. Other Items: SSPC-SP 3, "Power Tool Cleaning."
4. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
   a. Stripe paint corners, crevices, bolts, welds, and sharp edges.

AA. Aluminum Finishes
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. As-Fabricated Finish: AA-M10 (Mechanical Finish: as fabricated, unspecified).
3. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

1.3 EXECUTION

A. Installation, General
1. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
2. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
3. Field Welding: Comply with the following requirements:
   a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   b. Obtain fusion without undercut or overlap.
   c. Remove welding flux immediately.
   d. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
4. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
5. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

6. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
   a. Cast Aluminum: Heavy coat of bituminous paint.
   b. Extruded Aluminum: Two coats of clear lacquer.

B. Installing Miscellaneous Framing And Supports
   1. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
   2. Anchor supports for operable partitions securely to and rigidly brace from building structure.
   3. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
      a. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.
   4. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.
      a. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

C. Installing Prefabricated Building Columns
   1. Install prefabricated building columns to comply with AISC's "Specification for Structural Steel Buildings" and with requirements applicable to listing and labeling for fire-resistance rating indicated.

D. Installing Metal Bollards
   1. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.
      a. Do not fill removable bollards with concrete.
   2. Anchor bollards to existing construction with expansion anchors **OR** anchor bolts **OR** through bolts, **as directed**. Provide four 3/4-inch (19-mm) bolts at each bollard unless otherwise indicated.
      a. Embed anchor bolts at least 4 inches (100 mm) in concrete.
   3. Anchor bollards in concrete with pipe sleeves preset and anchored into concrete **OR** in formed or core-drilled holes not less than 8 inches (200 mm) deep and 3/4 inch (19 mm) larger than OD of bollard, **as directed**. Fill annular space around bollard solidly with nonshrink, nonmetallic grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch (3 mm) toward bollard.
   4. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches (75 mm) above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.
   5. Anchor internal sleeves for removable bollards in concrete by inserting into pipe sleeves preset into concrete **OR** formed or core-drilled holes not less than 8 inches (200 mm) deep and 3/4 inch (19 mm) larger than OD of sleeve, **as directed**. Fill annular space around internal sleeves solidly with nonshrink, nonmetallic grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch (3 mm) toward internal sleeve.
   6. Anchor internal sleeves for removable bollards in place with concrete footings. Center and align sleeves in holes 3 inches (75 mm) above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace sleeves in position until concrete has cured.
   7. Place removable bollards over internal sleeves and secure with 3/4-inch (19-mm) machine bolts and nuts. After tightening nuts, drill holes in bolts for inserting padlocks. the Owner will furnish padlocks.
   8. Fill bollards solidly with concrete, mounding top surface to shed water.
      a. Do not fill removable bollards with concrete.

E. Installing Pipe Guards

1. Provide pipe guards at exposed vertical pipes in parking garage where not protected by curbs or other barriers. Install by bolting to wall or column with expansion anchors. Provide four 3/4-inch (19-mm) bolts at each pipe guard. Mount pipe guards with top edge 26 inches (660 mm) above driving surface.

F. Installing Nosings, Treads, And Thresholds
1. Center nosings on tread widths unless otherwise indicated.
2. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.
3. Seal thresholds exposed to exterior with elastomeric sealant complying with Division 07 Section "Joint Sealants" to provide a watertight installation.

G. Installing Cast-Iron Wheel Guards
1. Anchor wheel guards to concrete or masonry construction to comply with manufacturer's written instructions. Fill cores solidly with concrete.

H. Installing Bearing And Leveling Plates
1. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
2. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
   a. Use nonshrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use nonshrink, nonmetallic grout in exposed locations unless otherwise indicated.
   b. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

I. Adjusting And Cleaning
1. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   a. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

   OR

   Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 07.
2. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 05 50 00 00

SECTION 05 51 13 00 - METAL STAIRS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for metal stairs. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Preassembled steel stairs with concrete-filled, precast concrete, epoxy-resin-filled, and abrasive-coating-finished formed-metal treads.
      b. Industrial-type stairs with steel floor plate and grating treads.
      c. Ornamental steel-framed stairs.
      d. Railings and Steel tube railings attached to metal stairs.
      e. Handrails and Steel tube handrails attached to walls adjacent to metal stairs.
      f. Railing gates at the level of exit discharge.

C. Performance Requirements
   1. Delegated Design: Design metal stairs, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
   2. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
      a. The following are based on the 2006 International Building Code (IBC):
         1) Uniform Load: 100 lbf/sq. ft. (4.79 kN/sq. m).
         2) Concentrated Load: 300 lbf (1.33 kN) applied on an area of 4 sq. in. (2580 sq. mm).
         3) Uniform and concentrated loads need not be assumed to act concurrently.
      b. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above, **as applicable**.
      c. Limit deflection of treads, platforms, and framing members to L/240 **OR** L/360, **as directed**, or 1/4 inch (6.4 mm), whichever is less. Preassembled steel stair manufacturers usually design stairs to L/240; retaining L/360 will decrease bounce and may be required to prevent cracking of plaster or gypsum board soffits. If brittle materials such as marble, granite, or ceramic tiles are used on treads and platforms, deflection limit should be reduced to L/720.
   3. Structural Performance of Railings: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated. The following loads are based on the 2006 IBC.
      a. Handrails and Top Rails of Guards:
         1) Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
         2) Concentrated load of 200 lbf (0.89 kN) applied in any direction.
         3) Uniform and concentrated loads need not be assumed to act concurrently.
      b. Infill of Guards:
         1) Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
         2) Infill load and other loads need not be assumed to act concurrently.
   4. Seismic Performance: Metal stairs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
      a. Component Importance Factor is 1.5.

D. Submittals
   1. Product Data: For metal stairs and the following:

a. Prefilled metal-pan stair treads.
b. Precast concrete treads.
c. Epoxy-resin-filled stair treads.
d. Nonslip aggregates and nonslip-aggregate finishes.
e. Abrasive nosings.
f. Metal floor plate treads.
g. Paint products.
h. Grout.

2. LEED Submittals:
   a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: Indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content. Include statement indicating costs for each product having recycled content.
3. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
4. Samples: For the following products, in manufacturer's standard sizes:
   a. Precast concrete treads.
   b. Epoxy-resin-filled stair treads.
   c. Stair treads with nonslip-aggregate surface finish.
   d. Metal floor plate treads.
   e. Grating treads.
   f. Abrasive nosings.
5. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
6. Qualification Data: For qualified professional engineer **OR** testing agency, **as directed**.
7. Welding certificates.
8. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.
9. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for stairs and railings.
   a. Test railings according ASTM E 894 and ASTM E 935.

E. Quality Assurance
1. Installer Qualifications: Fabricator of products.
2. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are indicated.
   a. Preassembled Stairs:
      1) Commercial class - typical enclosed stair (welds are required to be smooth).
      2) Service class - economy enclosed stair.
   b. Industrial-Type Stairs: Industrial class - typical for exposed locations in industrial facilities or for exterior stairs.
   c. Ornamental Stairs: Architectural class - ornamental stairs in exposed locations (joints are required to be concealed to maximum extent possible).
3. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
4. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. AWS D1.3, "Structural Welding Code - Sheet Steel."

F. Coordination
1. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
2. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items

with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
3. Coordinate locations of hanger rods and struts with other work so that they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.

1.2 PRODUCTS

A. Metals, General
1. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Ferrous Metals
1. Recycled Content of Steel Products: Provide products with average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
2. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
3. Steel Tubing: ASTM A 500 (cold formed) **OR** ASTM A 513, **as directed**.
4. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.
5. Abrasive-Surface Floor Plate: Steel plate with abrasive granules rolled into surface or with abrasive material metallically bonded to steel.
6. Steel Bars for Grating Treads: ASTM A 36/A 36M or steel strip, ASTM A 1011/A 1011M or ASTM A 1018/A 1018M.
7. Wire Rod for Grating Crossbars: ASTM A 510 (ASTM A 510M).
8. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.
9. Uncoated, Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, either commercial steel, Type B, or structural steel, Grade 25 (Grade 170), unless another grade is required by design loads; exposed.
10. Uncoated, Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, either commercial steel, Type B, or structural steel, Grade 30 (Grade 205), unless another grade is required by design loads.
11. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating, either commercial steel, Type B, or structural steel, Grade 33 (Grade 230), unless another grade is required by design loads.
12. Expanded-Metal, Carbon Steel: ASTM F 1267, Type I (expanded) **OR** Type II (expanded and flattened), **as directed**, Class 1 (uncoated).
    a. Style Designation: 3/4 number 13 **OR** 1-1/2 number 10, **as directed**.
13. Perforated Metal: Cold-rolled steel sheet, ASTM A 1008/A 1008M, or hot-rolled steel sheet, ASTM A 1011/A 1011M, commercial steel Type B, 0.060 inch (1.52 mm) thick, with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows **OR** with 1/8-by-1-inch (3.2-by-25.4-mm) round end slotted holes in staggered rows, **as directed**.
14. Perforated Metal: Galvanized-steel sheet, ASTM A 653/A 653M, G90 (Z275) coating, commercial steel Type B, 0.064 inch (1.63 mm) thick, with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows.
15. Woven-Wire Mesh: Intermediate-crimp, diamond **OR** square, **as directed**, pattern, 2-inch (50-mm) woven-wire mesh, made from 0.135-inch (3.5-mm) nominal diameter wire complying with ASTM A 510 (ASTM A 510M).

C. Nonferrous Metals
1. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T6.
2. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.
3. Bronze Extrusions: ASTM B 455, Alloy UNS No. C38500 (extruded architectural bronze).
4. Bronze Castings: ASTM B 584, Alloy UNS No. C83600 (leaded red brass) or No. C84400 (leaded semired brass).

5. Nickel Silver Castings: ASTM B 584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

D. Abrasive Nosings
1. Cast-Metal Units: Cast iron **OR** aluminum **OR** bronze **OR** nickel silver, **as directed**, with an integral abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.
   a. Configuration: Cross-hatched units, 3 inches (75 mm) **OR** 4 inches (100 mm), **as directed**, wide without lip.
   OR
   Configuration: Cross-hatched angle-shaped units, same depth as bar-grating treads and 1 to 1-1/2 inches (25 to 38 mm) wide.
2. Extruded Units: Aluminum **OR** Bronze, **as directed**, units with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in lengths necessary to accurately fit openings or conditions.
   a. Provide ribbed units, with abrasive filler strips projecting 1/16 inch (1.5 mm) above aluminum extrusion.
   OR
   Provide solid-abrasive-type units without ribs.
   b. Nosings: Square-back units, 1-7/8 inches (48 mm) **OR** 3 inches (75 mm) **OR** 4 inches (100 mm), **as directed**, wide, without lip.
   OR
   Nosings: Two-piece units, 3 inches (75 mm) wide, with subchannel for casting into concrete.
3. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.
4. Apply bituminous paint to concealed surfaces of cast-metal units set into concrete.
5. Apply clear lacquer to concealed surfaces of extruded units set into concrete.

E. Fasteners
1. General: Provide zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.
2. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
3. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
   a. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for exterior stairs **OR** stairs indicated to be galvanized **OR** stairs indicated to be shop primed with zinc-rich primer, **as directed**.
4. Machine Screws: ASME B18.6.3 (ASME B18.6.7M).
5. Lag Screws: ASME B18.2.1 (ASME B18.2.3.8M).
6. Plain Washers: Round, ASME B18.22.1 (ASME B18.22M).
7. Lock Washers: Helical, spring type, ASME B18.21.1 (ASME B18.21.2M).
8. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
   a. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
   b. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 1 (A1) **OR** Group 2 (A4), **as directed**, stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

F. Miscellaneous Materials

1. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
2. Shop Primers: Provide primers that comply with Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
3. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
   a. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
4. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
5. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
6. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
7. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
8. Concrete Materials and Properties: Comply with requirements in Division 3 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa) unless otherwise indicated.
9. Nonslip-Aggregate Concrete Finish: Factory-packaged abrasive aggregate made from fused, aluminum-oxide grits or crushed emery; rustproof and nonglazing; unaffected by freezing, moisture, or cleaning materials.
10. Welded Wire Fabric: ASTM A 1064/A 1064M, 6 by 6 inches (152 by 152 mm), W1.4 by W1.4, unless otherwise indicated.

G. Precast Concrete Treads
1. Concrete Materials and Properties: Comply with requirements in Division 03 Section "Cast-in-place Concrete" for normal-weight, ready-mixed concrete with a minimum 28-day compressive strength of 5000 psi (35 MPa) and a total air content of not less than 4 percent or more than 6 percent.
2. Reinforcing Wire Fabric: Galvanized, welded wire fabric, 2 by 2 inches (50 by 50 mm) by 0.062-inch- (1.6-mm-) diameter wire; comply with ASTM A 1064/A 1064M and ASTM A 82/A 82M, except for minimum wire size.

H. Fabrication, General
1. Provide complete stair assemblies, including metal framing, hangers, struts, railings, **as directed**, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
   a. Join components by welding unless otherwise indicated.
   b. Use connections that maintain structural value of joined pieces.
   c. Fabricate treads and platforms of exterior stairs so finished walking surfaces slope to drain.
2. Preassembled Stairs: Assemble stairs in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
3. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
4. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
5. Form exposed work with accurate angles and surfaces and straight edges.
6. Weld connections to comply with the following:
   a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   b. Obtain fusion without undercut or overlap.
   c. Remove welding flux immediately.
   d. Weld exposed corners and seams continuously unless otherwise indicated.

e. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds: no evidence of a welded joint **OR** Type 2 welds: completely sanded joint, some undercutting and pinholes okay **OR** Type 3 welds: partially dressed weld with spatter removed **OR** Type 4 welds: good quality, uniform undressed weld with minimal splatter, **as directed**.

7. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.
8. Fabricate joints that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

I. Steel-Framed Stairs

1. Stair Framing:
   a. Fabricate stringers of steel plates **OR** channels **OR** tubes, **as directed**.
      1) Provide closures for exposed ends of channel **OR** tube, **as directed**, stringers.
   b. Construct platforms of steel plate **OR** channel **OR** tube, **as directed**, headers and miscellaneous framing members as needed to comply with performance requirements **OR** indicated, **as directed**.
   c. Weld or bolt, **as directed**, stringers to headers; weld or bolt, **as directed**, framing members to stringers and headers. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.
   d. Where stairs are enclosed by gypsum board **OR** gypsum board shaft-wall, **as directed**, assemblies, provide hanger rods or struts to support landings from floor construction above or below. Locate hanger rods and struts where they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.
   e. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.
2. Metal-Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel sheet of thickness needed to comply with performance requirements but not less than 0.067 inch (1.7 mm) **OR** indicated, **as directed**.
   a. Steel Sheet: Uncoated cold **OR** hot, **as directed**,-rolled steel sheet unless otherwise indicated.
      OR
      Steel Sheet: Galvanized-steel sheet, where indicated.
   b. Directly weld metal pans to stringers; locate welds on top of subtreads where they will be concealed by concrete fill. Do not weld risers to stringers.
      OR
      Attach risers and subtreads to stringers with brackets made of steel angles or bars. Weld brackets to stringers and attach metal pans to brackets by welding, riveting, or bolting.
   c. Shape metal pans to include nosing integral with riser.
   d. Attach abrasive nosings to risers.
   e. At Contractor's option, provide stair assemblies with metal-pan subtreads filled with reinforced concrete during fabrication.
   f. Provide epoxy-resin-filled treads, reinforced with glass fibers, with slip-resistant, abrasive surface.
   g. Provide subplatforms of configuration indicated or, if not indicated, the same as subtreads. Weld subplatforms to platform framing.
      1) Smooth Soffit Construction: Construct subplatforms with flat metal under surfaces to produce smooth soffits.
3. Abrasive-Coating-Finished, Formed-Metal Stairs: Form risers, treads, and platforms to configurations shown from steel sheet of thickness needed to comply with performance requirements but not less than 0.097 inch (2.5 mm) **OR** indicated, **as directed**.
   a. Steel Sheet: Uncoated hot-rolled steel sheet unless otherwise indicated.
   b. Directly weld risers and treads to stringers; locate welds on underside of stairs.

c. Provide platforms of configuration indicated or, if not indicated, the same as treads. Weld platforms to platform framing.
d. Finish tread and platform surfaces with manufacturer's standard epoxy-bonded abrasive finish.

4. Metal Floor Plate Stairs: Form treads and platforms to configurations shown from rolled-steel **OR** abrasive-surface, **as directed**, floor plate of thickness needed to comply with performance requirements, but not less than 1/4 inch (6.4 mm) **OR** needed to comply with performance requirements, but not less than 3/16 inch (4.8 mm) **OR** needed to comply with performance requirements, but not less than 1/8 inch (3.2 mm) **OR** indicated, **as directed**.
   a. Form treads with integral nosing and back edge stiffener. Form risers of same material as treads.
      OR
      Form treads with integral nosing and back edge stiffener. Form risers from steel sheet not less than 0.097 inch (2.5 mm) thick, welded to tread nosings and stiffeners and to platforms.
      OR
      Form treads with integral nosing and back edge stiffener, and with open risers.
   b. Weld steel supporting brackets to stringers and weld treads to brackets.
   c. Fabricate platforms with integral nosings matching treads and weld to platform framing.
5. Metal Bar-Grating Stairs: Form treads and platforms to configurations shown from metal bar grating; fabricate to comply with NAAMM MBG 531, "Metal Bar Grating Manual."
   a. Fabricate treads and platforms from welded or pressure-locked steel grating with 1-1/4-by-3/16-inch (32-by-5-mm) bearing bars at 15/16 inch (24 mm) o.c. **OR** 1-by-3/16-inch (25-by-5-mm) bearing bars at 11/16 inch (17 mm) o.c. **OR** 1-by-1/8-inch (25-by-3-mm) bearing bars at 7/16 inch (11 mm) o.c., **as directed**, and crossbars at 4 inches (100 mm) o.c.
      OR
      Fabricate treads and platforms from welded or pressure-locked steel grating with openings in gratings no more than 5/16 inch (8 mm) **OR** 1/2 inch (12 mm) **OR** 3/4 inch (19 mm), **as directed**, in least dimension.
   b. Surface: Plain **OR** Serrated, **as directed**.
   c. Finish: Shop primed **OR** Painted **OR** Galvanized, **as directed**.
   d. Fabricate grating treads with rolled-steel floor plate **OR** cast abrasive, **as directed**, nosing and with steel angle or steel plate carrier at each end for stringer connections. Secure treads to stringers with bolts.
   e. Fabricate grating platforms with nosing matching that on grating treads. Provide toeplates at open-sided edges of grating platforms. Weld grating to platform framing.

J. Stair Railings
1. Comply with applicable requirements in Division 05 Section(s) "Pipe And Tube Railings" OR "Decorative Metal Railings", **as directed**.
   a. Fabricate newels of square steel tubing and provide newel caps of pressed steel **OR** gray-iron castings, **as directed**, as shown.
   b. Rails may be bent at corners, rail returns, and wall returns, instead of using prefabricated fittings.
   c. Connect posts to stair framing by direct welding unless otherwise indicated.
2. Steel Tube Railings: Fabricate railings to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of tube, post spacings, and anchorage, but not less than that needed to withstand indicated loads.
   a. Rails and Posts: 1-5/8-inch- (41-mm-) diameter **OR** 1-1/2-inch- (38-mm-) square, **as directed**, top and bottom rails and 1-1/2-inch- (38-mm-) square posts.
   b. Picket Infill: 1/2-inch- (13-mm-) square pickets spaced less than 4 inches (100 mm) clear.
   c. Expanded-Metal Infill: Expanded-metal panels edged with U-shaped channels made from steel sheet not less than 0.043 inch (1.1 mm) thick. Orient expanded metal with long dimension of diamonds parallel to top rail **OR** perpendicular to top rail **OR** vertical, **as directed**.

d. Perforated-Metal Infill: Perforated-metal panels edged with U-shaped channels made from metal sheet, of same metal as perforated metal and not less than 0.043 inch (1.1 mm) thick. Orient perforated metal with pattern parallel to top rail **OR** perpendicular to top rail **OR** horizontal **OR** vertical **OR** as indicated on Drawings, **as directed**.
e. Mesh Infill: Woven wire mesh crimped into 1-by-1/2-by-1/8-inch (25-by-13-by-3-mm) steel channel frames. Orient wire mesh with diamonds vertical **OR** wires perpendicular and parallel to top rail **OR** wires horizontal and vertical, **as directed**.
f. Intermediate Rails Infill: 1-5/8-inch- (41-mm-) diameter **OR** 1-1/2-inch- (38-mm-) square, **as directed**, intermediate rails spaced less than 12 inches (305 mm) **OR** 21 inches (533 mm), **as directed**, clear.
g. Gates: Form gates from steel tube of same size and shape as top rails, with infill to match guards. Provide with cam-type, self-closing **OR** spring, **as directed**, hinges for fastening to wall and overlapping stop with rubber bumper to prevent gate from opening in direction opposite egress.

3. Welded Connections: Fabricate railings with welded connections. Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
   a. Finish welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds: no evidence of a welded joint **OR** Type 2 welds: completely sanded joint, some undercutting and pinholes okay **OR** Type 3 welds: partially dressed weld with spatter removed **OR** Type 4 welds: good quality, uniform undressed weld with minimal splatter, **as directed**.
4. Form changes in direction of railings as follows:
   a. As detailed.
      OR
      By bending or by inserting prefabricated elbow fittings.
      OR
      By flush bends or by inserting prefabricated flush-elbow fittings.
      OR
      By radius bends of radius indicated or by inserting prefabricated elbow fittings of radius indicated.
      OR
      By inserting prefabricated elbow fittings **OR** flush-elbow fittings **OR** elbow fittings of radius indicated, **as directed**.
5. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
6. Close exposed ends of railing members with prefabricated end fittings.
7. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch (6 mm) or less.
8. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.
   a. Connect posts to stair framing by direct welding unless otherwise indicated.
   b. For galvanized railings, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous-metal components.
   c. For nongalvanized railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors embedded in exterior masonry and concrete construction.
9. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

K. Finishes

1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Finish metal stairs after assembly.
3. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
   a. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
   b. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
4. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning" **OR** SSPC-SP 3, "Power Tool Cleaning" **OR** minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed products, **as directed**:
   a. Exterior Stairs: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   b. Interior Stairs: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning" for stairs that are to receive zinc-rich primer or primer specified in Division 09 Section "High-performance Coatings".
      OR
      Interior Stairs: SSPC-SP 3, "Power Tool Cleaning."
5. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
   a. Stripe paint corners, crevices, bolts, welds, and sharp edges.

1.3 EXECUTION

A. Installation, General
1. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
2. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.
3. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.
4. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
5. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
6. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.
7. Place and finish concrete fill for treads and platforms to comply with Division 03 Section "Cast-in-place Concrete"
   a. Install abrasive nosings with anchors fully embedded in concrete. Center nosings on tread width.
8. Install precast concrete treads with adhesive supplied by manufacturer.

B. Installing Metal Stairs With Grouted Baseplates
1. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of baseplates.
2. Set steel stair baseplates on wedges, shims, or leveling nuts. After stairs have been positioned and aligned, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.

a. Use nonmetallic, nonshrink grout unless otherwise indicated.
b. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

C. Installing Railings
1. Adjust railing systems before anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated or, if not indicated, as required by design loads. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:
a. Anchor posts to steel by welding directly to steel supporting members.
b. Anchor handrail ends to concrete and masonry with steel round flanges welded to rail ends and anchored with postinstalled anchors and bolts.
2. Attach handrails to wall with wall brackets. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt **OR** with predrilled hole for exposed bolt anchorage, **as directed**. Provide bracket with 1-1/2-inch (38-mm) clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads. Secure wall brackets to building construction as required to comply with performance requirements **OR** as follows, **as directed**:
a. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
b. For hollow masonry anchorage, use toggle bolts.
c. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
d. For steel-framed partitions, use hanger or lag bolts set into fire-retardant-treated, **as directed**, wood backing between studs. Coordinate with stud installation to locate backing members.
OR
For steel-framed partitions, use self-tapping screws fastened to steel framing or to concealed steel reinforcements.
OR
For steel-framed partitions, use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

D. Adjusting And Cleaning
1. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
a. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.
OR
Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
2. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 05 51 13 00

SECTION 05 51 13 00a - FABRICATED SPIRAL STAIRS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for fabricated spiral stairs. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes fabricated spiral stairs with steel central-supporting columns and radiating treads.

C. Performance Requirements
1. Delegated Design: Design fabricated spiral stairs, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Structural Performance of Stairs: Fabricated spiral stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to SEI/ASCE 7:
   a. Uniform Load: 40 lbf/sq. ft. (1.92 kN/sq. m) **OR** 100 lbf/sq. ft. (4.79 kN/sq. m), **as directed**.
   b. Concentrated Load: 300 lbf (1.33 kN) applied on an area of 4 sq. in. (2580 sq. mm).
   c. Uniform and concentrated loads need not be assumed to act concurrently.
   d. Railing Loads: Stairs shall withstand stresses resulting from railing loads in addition to loads specified above.
3. Structural Performance of Railings: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to SEI/ASCE 7:
   a. Handrails:
      1) Uniform load of 20 lbf/ft. (0.29 kN/m) **OR** 50 lbf/ft. (0.73 kN/m), **as directed**, applied in any direction.
      2) Concentrated load of 200 lbf (0.89 kN) applied in any direction.
      3) Uniform and concentrated loads need not be assumed to act concurrently.
   b. Top Rails of Guards:
      1) Uniform load of 20 lbf/ft. (0.29 kN/m) applied in any direction **oR** 50 lbf/ft. (0.73 kN/m) applied in any direction **OR** 50 lbf/ft. (0.73 kN/m) applied horizontally and concurrently, with 100 lbf/ft. (1.46 kN/m) applied vertically downward, **as directed**.
      2) Concentrated load of 200 lbf (0.89 kN) applied in any direction.
      3) Uniform and concentrated loads need not be assumed to act concurrently.
   c. Infill of Guards:
      1) Concentrated load of 50 lbf (0.22 kN) **OR** 200 lbf (0.89 kN), **as directed,** applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
      2) Uniform load of 25 lbf/sq. ft. (1.2 kN/sq. m) applied horizontally.
      3) Infill load and other loads need not be assumed to act concurrently.
4. Seismic Performance: Fabricated spiral stairs shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
   a. Component Importance Factor is 1.5 **OR** 1.0, **as directed**.
5. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

D. Submittals
1. Product Data: For each type of product indicated.

2. LEED Submittal:
   a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
      1) Include statement indicating costs for each product having recycled content.
3. Shop Drawings.
4. Samples: For the following products, in manufacturer's standard sizes:
   a. Treads.
   b. Metal with painted finish.
   c. Railing members.
5. Delegated-Design Submittal: For fabricated spiral stairs indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
6. Welding certificates.

E. Quality Assurance
1. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   c. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.2 PRODUCTS

A. Materials
1. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
2. Brackets, Flanges, and Anchors: Same metal and finish as supported item unless otherwise indicated.
3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
4. Steel Bars for Grating Treads and Platforms: ASTM A 36/A 36M or ASTM A 1011/A 1011M.
5. Wire Rod for Grating Crossbars: ASTM A 510 (ASTM A 510M).
6. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or Grade D.
7. Steel Pipe Columns: ASTM A 53/A 53M, Schedule 40. Provide Schedule 80 for columns larger than NPS 4 (DN 100) and where required to support loads.
8. Steel Pipe Railings: ASTM A 53/A 53M, Schedule 40.
9. Steel Tubing: Either cold-formed steel tubing complying with ASTM A 500 or mandrel-drawn mechanical tubing complying with ASTM A 513, Type 5.
10. Iron Castings: Either gray iron complying with ASTM A 48/A 48M or malleable iron complying with ASTM A 47/A 47M unless otherwise indicated or required by structural loads.
11. Aluminum Sheet and Plate: ASTM B 209 (ASTM B 209M), Alloy 6061-T6.
12. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T6.
13. Aluminum Pipe and Structural Round Tubing: ASTM B 429, Alloy 6063-T6.
14. Extruded-Aluminum Tubing: ASTM B 221 (ASTM B 221M), Alloy 6063-T5/T52.
15. Aluminum Castings: ASTM B 26/B 26M, Alloy 319.0-F.
16. Extruded-Bronze Handrails: ASTM B 455, Alloy UNS No. C38500 (architectural bronze).
17. Seamless Bronze Tubing: ASTM B 135 (ASTM B 135M), Alloy UNS No. C23000 (red brass, 85 percent copper).
18. Seamless Brass Tubing: ASTM B 135 (ASTM B 135M), Alloy UNS No. C26000 (cartridge brass, 70 percent copper).
19. Stainless-Steel Tubing: ASTM A 554, Grade MT 304.

B. Miscellaneous Materials

1. Fasteners: For connecting stair components and for anchoring stairs to other construction, select fasteners of the type, grade, and class required to produce connections capable of withstanding design loadings.
   a. For aluminum, provide fasteners fabricated from Type 304 stainless steel.
   b. For steel and cast iron, use plated steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating.
2. Lacquer for Copper Alloys: Clear, air-drying, acrylic lacquer specially developed for coating copper-alloy products.
3. Shop Primers: Provide primers that comply with Division 09 Section(s) "Exterior Painting" OR "Interior Painting" **as directed**.
4. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with finish paint systems indicated.
5. Shop Primer for Galvanized Steel: Primer formulated for use over zinc-coated metal and compatible with finish paint systems indicated.
6. Shop Primer for Aluminum: Primer formulated for use over aluminum and compatible with finish paint systems indicated.
7. Wood for Stair Treads, Handrails, and Platforms: Unless directed otherwise, laminated red oak, sanded to 120-grit smoothness. Apply uniform coat of manufacturer's standard clear sealer.
8. Rubber Wearing Surfaces: Manufacturer's standard, 1/4-inch- (6-mm-) thick, molded-rubber covering in pattern and color indicated or, if not indicated, as selected by the Owner from manufacturer's standard colors and patterns.

C. Fabrication
1. Assemble spiral stairs in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
2. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
3. Form work true to line and level with accurate angles and surfaces.
4. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
5. Cut, reinforce, drill, and tap as needed to receive hardware, screws, and similar items.
6. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
   a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   b. Obtain fusion without undercut or overlap.
   c. Remove flux immediately.
   d. Provide Type 1 **OR** Type 2 **OR** Type 3, **as directed**, welds according to NOMMA Guideline 1, "Joint Finishes."
   e. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and, except for fillet welds, welded surface matches contours of adjoining surfaces.
7. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.
8. Fabricate center column from steel **OR** aluminum, **as directed**, pipe welded to baseplate for anchorage to floor structure. Brace column at upper floors by means of landings attached to column and floor structure unless otherwise indicated. Provide cap for column if top is exposed.
9. Provide cast-aluminum **OR** cast-iron, **as directed**, treads and platforms, **as directed**, with integral frames, legs, and hubs.
   a. Provide treads and platforms, **as directed**, with abrasive surfaces.
10. Provide steel-bar grating treads and platforms, **as directed**, with welded hubs and as follows:
    a. Radial grating treads.

OR
Abrasive **OR** Rolled-steel, floor-plate, **as directed**, nosings.
OR
Straight flanges and welded-on legs.
OR
Tapered flanges without legs.

11. Provide formed steel **OR** aluminum, **as directed**,-plate treads and platforms, **as directed**, welded to hubs or center column and as follows:
    a. Straight flanges and welded-on legs.
       OR
       Tapered flanges without legs.
       OR
       Pan treads without legs.
       OR
       One-piece treads and risers, without legs.
       OR
       Rolled-steel, floor-plate wearing surfaces.
       OR
       Aluminum-alloy, rolled tread-plate wearing surfaces.
       OR
       Smooth steel-plate wearing surfaces.
       OR
       Rubber wearing surfaces.
       OR
       Plywood subtread for covering with finish flooring specified in another Section.
12. Provide steel-framed treads and platforms, **as directed**, welded to hubs or center column and without legs; wearing surface as follows:
    a. Cast iron with integral abrasive.
       OR
       Smooth steel plate with integral abrasive.
       OR
       Wood.
       OR
       Plywood insert for covering with finish flooring specified in another Section.
13. Railings: Provide railing system indicated, uniformly bent to spiral shape, and continuing at top to form guardrail around floor opening.
    a. Space balusters less than 4 inches (102 mm), clear.
       OR
       Space balusters to provide one baluster per tread, but spaced less than 21 inches (533 mm), clear.
    b. Space intermediate rails less than 4 inches (101 mm) **OR** 21 inches (533 mm), **as directed,** clear.
    c. Locate bottom rail so that a 6-inch- (152-mm-) diameter sphere cannot pass between the stair and rail.
    d. Fabricate top rail from 1-1/4- to 2-inch- (32- to 51-mm-) OD steel pipe or round tubing.
       OR
       Fabricate top rail from steel of shape and size indicated.
       OR
       Fabricate top rail from 1-1/4- to 2-inch- (32- to 51-mm-) OD round aluminum **OR** bronze **OR** brass **OR** stainless-steel, **as directed**, tubing.
       OR
       Fabricate top rail from extruded bronze of shape and size indicated.
       OR
       Fabricate top rail from wood of shape and size indicated.

e. Fabricate balusters from 7/8-inch- (22-mm-) OD **OR** 1-inch- (25-mm-) OD **OR** 1-1/4-inch- (32-mm-) OD steel pipe or round tubing.
OR
Fabricate balusters from 1/2-inch- (13-mm-) OD **OR** 5/8-inch- (16-mm-) OD round steel bars **OR** tubing, **as directed**.
OR
Fabricate balusters from 1/2-inch- (13-mm-) **OR** 5/8-inch- (16-mm-) **OR** 3/4-inch- (19-mm-), **as directed**, square steel bars **OR** tubing, **as directed**.
OR
Fabricate balusters from 5/8-inch- (16-mm-) OD **OR** 3/4-inch- (19-mm-) OD, **as directed**, round aluminum tubing.

f. Fabricate intermediate rails from 7/8-inch- (22-mm-) OD **OR** 1-inch- (25-mm-) OD **OR** 1-1/4-inch- (32-mm-) OD, **as directed**, steel pipe or round tubing.
OR
Fabricate intermediate rails from steel pipe or round tubing same size as top rail.
OR
Fabricate intermediate rails from 5/8-inch- (16-mm-) OD **OR** 3/4-inch- (19-mm-) OD, **as directed**, round steel bars **OR** tubing, **as directed**.
OR
Fabricate intermediate rails from 5/8-inch- (16-mm-) OD **OR** 3/4-inch- (19-mm-) OD **OR** 1-inch- (25-mm-) OD **OR** 1-1/4-inch- (32-mm-) OD, **as directed**, round aluminum tubing.
OR
Fabricate intermediate rails from round aluminum tubing same size as top rail.

D. Steel And Iron Finishes
1. Galvanized Finish: Hot-dip galvanize stairs after fabrication to comply with ASTM A 123/A 123M.
2. Preparation for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.
3. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC's surface-preparation specifications and environmental exposure conditions of installed stairs:
   a. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   b. Interiors (SSPC Zone 1A): SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
4. Apply shop primer to prepared surfaces of handrails and railing components unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

E. Aluminum Finishes
1. Conversion-Coated and Factory-Primed Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid chromate-fluoride-phosphate conversion coating; Organic Coating: shop primer).
   a. Apply shop primer with a minimum dry film thickness of 1.5 mils (0.04 mm).
2. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
   a. Color and Gloss: As selected by the Owner from manufacturer's full range.

F. Stainless-Steel Finishes
1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish indicated, free of cross scratches.
   a. Run grain of directional finishes with long dimension of each piece.
   b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
   c. Directional Satin Finish: No. 4.
   d. Reflective, Directional Polish: No. 7.

e. Mirrorlike Reflective, Nondirectional Polish: No. 8.

G. Copper-Alloy Finishes
1. Finish designations for copper alloys comply with the system established for designating copper-alloy finish systems defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."
2. Buffed Finish: M21 (Mechanical Finish: buffed, smooth specular).
3. Buffed Finish, Lacquered: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear organic, air drying, as specified below).
4. Medium-Satin Finish, Lacquered: M32-O6x (Mechanical Finish: directionally textured, medium satin; Coating: clear organic, air drying, as specified below).
   a. Clear Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
5. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide).
   a. Color: Match the Owner's sample.

1.3 EXECUTION

A. Installation
1. Fastening to In-Place Construction: Provide anchorage devices and fasteners where needed for securing fabricated spiral stairs to in-place construction; include threaded fasteners for concrete and masonry inserts, through bolts, lag bolts, wood screws, and other connectors as required.
2. Assemble fabricated spiral stair components to comply with manufacturer's written instructions, with each component aligned and in correct relation to each other, securely anchored to the supporting column and adjacent structure.
3. Do not cut, alter, or drill stair components in the field that do not fit properly. Return components that do not fit to manufacturer for adjustment.
4. Install fabricated spiral stairs accurately in location, alignment, and elevation; level and plumb; and according to manufacturer's written instructions.
5. Install fabricated spiral stairs by welding to steel structure or to weld plates cast into concrete unless otherwise indicated.
6. Field Welding:
   a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   b. Obtain fusion without undercut or overlap.
   c. Remove welding flux immediately.
   d. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

B. Cleaning And Protection
1. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint and paint exposed areas with same material.
2. For galvanized surfaces, clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A 780.
   a. Paint repaired areas with same material used for shop painting.
3. Protect finished tread surfaces during construction by covering with 1/2-inch- (13-mm-) thick plywood secured with plastic strapping or another nonmarring fastening method.

END OF SECTION 05 51 13 00a

Task	Specification	Specification Description
05 51 13 00	05 50 00 00	Metal Fabrications
05 51 19 00	05 50 00 00	Metal Fabrications
05 51 19 00	05 51 13 00	Metal Stairs
05 51 19 00	05 51 13 00a	Fabricated Spiral Stairs
05 51 33 13	05 50 00 00	Metal Fabrications
05 51 33 13	05 52 13 00	Pipe And Tube Railings
05 51 33 16	05 50 00 00	Metal Fabrications
05 51 33 23	05 50 00 00	Metal Fabrications
05 51 33 23	05 52 13 00	Pipe And Tube Railings

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SECTION 05 52 13 00 - PIPE AND TUBE RAILINGS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for pipe and tube railings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Steel pipe and tube railings.
b. Aluminum pipe and tube railings.
c. Stainless-steel pipe and tube railings.

C. Performance Requirements
1. Delegated Design: Design railings, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
a. Steel: 72 percent of minimum yield strength.
b. Aluminum: The lesser of minimum yield strength divided by 1.65 or minimum ultimate tensile strength divided by 1.95.
c. Stainless Steel: 60 percent of minimum yield strength.
3. Structural Performance: Railings shall withstand the effects of gravity loads and loads and stresses within limits and under conditions indicated. Following loads are examples only and are based on the 2006 International Building Code (IBC).
a. Handrails and Top Rails of Guards:
1) Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
2) Concentrated load of 200 lbf (0.89 kN) applied in any direction.
3) Uniform and concentrated loads need not be assumed to act concurrently.
b. Infill of Guards:
1) Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
2) Infill load and other loads need not be assumed to act concurrently.
4. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
5. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

D. Submittals
1. Product Data: For the following:
a. Manufacturer's product lines of mechanically connected railings.
b. Railing brackets.
c. Grout, anchoring cement, and paint products.
2. LEED Submittals:
a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: Indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content. Include statement indicating costs for each product having recycled content.
3. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

4. Samples: For each type of exposed finish required.
    a. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
    b. Fittings and brackets.
    c. Assembled Sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need not be full height.
        1) Show method of finishing **OR** connecting, **as directed**, members at intersections.
5. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
6. Qualification Data: For qualified professional engineer **OR** testing agency, .
7. Mill Certificates: Signed by manufacturers of stainless-steel products certifying that products furnished comply with requirements.
8. Welding certificates.
9. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.
10. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

E. Quality Assurance
1. Source Limitations: Obtain each type of railing from single source from single manufacturer.
2. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
3. Welding Qualifications: Qualify procedures and personnel according to the following:
    a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
    b. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
    c. AWS D1.6, "Structural Welding Code - Stainless Steel."

F. Project Conditions
1. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

G. Coordination And Scheduling
1. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
2. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
3. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

1.2 PRODUCTS

A. Metals, General
1. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
2. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

B. Steel And Iron

1. Recycled Content of Steel Products: Provide products with average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
2. Tubing: ASTM A 500 (cold formed) or ASTM A 513.
3. Pipe: ASTM A 53/A 53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
   a. Provide galvanized finish for exterior installations and where indicated.
4. Plates, Shapes, and Bars: ASTM A 36/A 36M.
5. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.
6. Expanded Metal: ASTM F 1267, Type I (expanded) **OR** Type II (expanded and flattened), **as directed**, Class 1 (uncoated).
   a. Style Designation: 3/4 number 13 **OR** 1-1/2 number 10, **as directed**.
7. Perforated Metal: Cold-rolled steel sheet, ASTM A 1008/A 1008M, or hot-rolled steel sheet, ASTM A 1011/A 1011M, commercial steel Type B, 0.060 inch (1.52 mm) thick, with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows.
8. Perforated Metal: Galvanized-steel sheet, ASTM A 653/A 653M, G90 (Z275) coating, commercial steel Type B, 0.064 inch (1.63 mm) thick, with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows **OR** with 1/8-by-1-inch (3.2-by-25.4-mm) round end slotted holes in staggered rows, **as directed**.
9. Woven-Wire Mesh: Intermediate-crimp, diamond **OR** square, **as directed**, pattern, 2-inch (50-mm) woven-wire mesh, made from 0.135-inch (3.5-mm) nominal diameter wire complying with ASTM A 510 (ASTM A 510M).

C. Aluminum
1. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.
2. Extruded Bars and Tubing: ASTM B 221 (ASTM B 221M), Alloy 6063-T5/T52.
3. Extruded Structural Pipe and Round Tubing: ASTM B 429/B 429M, Alloy 6063-T6.
   a. Provide Standard Weight (Schedule 40) pipe, unless otherwise indicated.
4. Drawn Seamless Tubing: ASTM B 210 (ASTM B 210M), Alloy 6063-T832.
5. Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 6061-T6.
6. Die and Hand Forgings: ASTM B 247 (ASTM B 247M), Alloy 6061-T6.
7. Castings: ASTM B 26/B 26M, Alloy A356.0-T6.
8. Perforated Metal: Aluminum sheet, ASTM B 209 (ASTM B 209M), Alloy 6061-T6, 0.063 inch (1.60 mm) thick, with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows.
9. Woven-Wire Mesh: Intermediate-crimp, diamond **OR** square, **as directed**, pattern, 2-inch (50-mm) woven-wire mesh, made from 0.162-inch (4.1-mm) nominal diameter wire complying with ASTM B 211 (ASTM B 211M), Alloy 6061-T94.

D. Stainless Steel
1. Tubing: ASTM A 554, Grade MT 304 **OR** Grade MT 316L, **as directed**.
2. Pipe: ASTM A 312/A 312M, Grade TP 304 **OR** Grade TP 316L, **as directed**.
3. Castings: ASTM A 743/A 743M, Grade CF 8 or CF 20 **OR** Grade CF 8M or CF 3M, **as directed**.
4. Plate and Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304 **OR** Type 316L, **as directed**.
5. Expanded Metal: ASTM F 1267, Type I (expanded) **OR** Type II (expanded and flattened), **as directed**, Class 3 (corrosion-resistant steel), made from stainless-steel sheet, ASTM A 240/A 240M or ASTM A 666, Type 304 **OR** Type 316, **as directed**.
   a. Style Designation: 3/4 number 13 **OR** 1-1/2 number 10, **as directed**.
6. Perforated Metal: Stainless-steel sheet, ASTM A 240/A 240M or ASTM A 666, Type 304 **OR** Type 316L, **as directed**, 0.062 inch (1.59 mm) thick, with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows.
7. Woven-Wire Mesh: Intermediate-crimp, diamond **OR** square, **as directed**, pattern, 2-inch (50-mm) woven-wire mesh, made from 0.135-inch (3.5-mm) nominal diameter wire complying with ASTM A 580/A 580M, Type 304 **OR** Type 316, **as directed**.

E. Fasteners
1. General: Provide the following:
a. Ungalvanized-Steel Railings: Plated steel fasteners complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5 for zinc coating.
b. Hot-Dip Galvanized Railings: Type 304 stainless-steel or hot-dip zinc-coated steel fasteners complying with ASTM A 153/A 153M or ASTM F 2329 for zinc coating.
c. Aluminum Railings: Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners.
d. Stainless-Steel Railings: Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners.
2. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads, **as directed**.
3. Fasteners for Interconnecting Railing Components:
a. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.
OR
Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
b. Provide Phillips **OR** tamper-resistant **OR** square or hex socket, **as directed**, flat-head machine screws for exposed fasteners unless otherwise indicated.
4. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
a. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
b. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 1 (A1) **OR** Group 2 (A4), **as directed**, stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

F. Miscellaneous Materials
1. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
a. For aluminum and stainless-steel railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
2. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
3. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
4. Shop Primers: Provide primers that comply with Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
5. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
a. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
6. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
7. Shop Primer for Galvanized Steel: Cementitious galvanized metal primer complying with MPI#26 **OR** Vinyl wash primer complying with MPI#80 **OR** Water based galvanized metal primer complying with MPI#134, **as directed**.
8. Intermediate Coats and Topcoats: Provide products that comply with Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
9. Epoxy Intermediate Coat: Complying with MPI #77 and compatible with primer and topcoat.
10. Polyurethane Topcoat: Complying with MPI #72 and compatible with undercoat.

11. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
12. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
13. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
    a. Water-Resistant Product: At exterior locations and where indicated provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

G. Fabrication
1. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
2. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
3. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
4. Form work true to line and level with accurate angles and surfaces.
5. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
6. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
7. Connections: Fabricate railings with welded **OR** nonwelded, **as directed**, connections unless otherwise indicated.
8. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
    a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
    b. Obtain fusion without undercut or overlap.
    c. Remove flux immediately.
    d. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
9. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.
10. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
    a. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.
11. Form changes in direction as follows:
    a. As detailed.
       OR
       By bending or by inserting prefabricated elbow fittings.
       OR
       By flush bends or by inserting prefabricated flush-elbow fittings.
       OR
       By radius bends of radius indicated or by inserting prefabricated elbow fittings of radius indicated.
12. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
13. Close exposed ends of railing members with prefabricated end fittings.

14. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch (6 mm) or less.
15. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
    a. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers, or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.
16. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.
17. For railing posts set in concrete, provide steel **OR** stainless-steel, **as directed**, sleeves not less than 6 inches (150 mm) long with inside dimensions not less than 1/2 inch (13 mm) greater than outside dimensions of post, with metal plate forming bottom closure.
18. For removable railing posts, fabricate slip-fit sockets from steel **OR** stainless-steel, **as directed**, tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height. Provide socket covers designed and fabricated to resist being dislodged.
    a. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.
19. Expanded-Metal Infill Panels: Fabricate infill panels from expanded metal made from same metal as railings in which they are installed.
    a. Edge panels with U-shaped channels made from metal sheet, of same metal as expanded metal and not less than 0.043 inch (1.1 mm) thick.
    b. Orient expanded metal with long dimension of diamonds parallel to top rail **OR** perpendicular to top rail **OR** horizontal **OR** vertical, **as directed**.
20. Perforated-Metal Infill Panels: Fabricate infill panels from perforated metal made from steel **OR** galvanized steel **OR** aluminum **OR** stainless steel **OR** same metal as railings in which they are installed, **as directed**.
    a. Edge panels with U-shaped channels made from metal sheet, of same metal as perforated metal and not less than 0.043 inch (1.1 mm) thick.
    b. Orient perforated metal with pattern parallel to top rail **OR** perpendicular to top rail **OR** horizontal **OR** vertical **OR** as indicated on Drawings, **as directed**.
21. Woven-Wire Mesh Infill Panels: Fabricate infill panels from woven-wire mesh crimped into 1-by-1/2-by-1/8-inch (25-by-13-by-3-mm) metal channel frames. Make wire mesh and frames from same metal as railings in which they are installed.
    a. Orient wire mesh with diamonds vertical **OR** wires perpendicular and parallel to top rail **OR** wires horizontal and vertical, **as directed**.
22. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

H. Finishes, General
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
4. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

I. Steel And Iron Finishes
1. Galvanized Railings:

a. Hot-dip galvanize steel **OR** exterior steel, **as directed**, and iron railings, including hardware, after fabrication.
OR
Hot-dip galvanize indicated steel and iron railings, including hardware, after fabrication.
b. Comply with ASTM A 123/A 123M for hot-dip galvanized railings.
c. Comply with ASTM A 153/A 153M for hot-dip galvanized hardware.
d. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
e. Fill vent and drain holes that will be exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

2. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
3. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.
4. For nongalvanized steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors to be embedded in exterior concrete or masonry.
5. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning" **OR** SSPC-SP 3, "Power Tool Cleaning" **OR** requirements indicated below, **as directed**:
    a. Exterior Railings: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
    b. Railings Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
    c. Railings Indicated to Receive Primers Specified in Division 9 Section "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
    d. Other Railings: SSPC-SP 3, "Power Tool Cleaning."
6. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.
    a. Shop prime uncoated railings with universal shop primer **OR** primers specified in Division 07, **as directed**, unless zinc-rich primer is **OR** primers specified in Division 09 Section "High-performance Coatings" are, **as directed**, indicated.
    b. Do not apply primer to galvanized surfaces.
7. Shop-Painted Finish: Comply with Division 09 Section(s) "Exterior Painting" OR "High-performance Coatings", **as directed**.
    a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
8. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.
    a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

J. Aluminum Finishes
1. Mechanical Finish: AA-M12 (Mechanical Finish: nonspecular as fabricated).
2. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
3. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
    a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from full range of industry colors and color densities, **as directed**.
4. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

5. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

   OR

   High-Performance Organic Finish: Three **OR** Four, **as directed**,-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   b. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

K. Stainless-Steel Finishes
1. Remove tool and die marks and stretch lines, or blend into finish.
2. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
3. 180-Grit Polished Finish: Oil-ground, uniform, directionally textured finish.
4. 320-Grit Polished Finish: Oil-ground, uniform, fine, directionally textured finish.
5. Polished and Buffed Finish: Oil-ground, 180-grit finish followed by buffing.
6. Directional Satin Finish: No. 4.
7. Dull Satin Finish: No. 6.
8. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

1.3 EXECUTION

A. Examination
1. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

B. Installation, General
1. Fit exposed connections together to form tight, hairline joints.
2. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
   a. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
   b. Set posts plumb within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
   c. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet (5 mm in 3 m).
3. Corrosion Protection: Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
4. Adjust railings before anchoring to ensure matching alignment at abutting joints.
5. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

C. Railing Connections

1. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.
2. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.
3. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches (50 mm) beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches (150 mm) of post.

D. Anchoring Posts
1. Use metal sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.
2. Form or core-drill holes not less than 5 inches (125 mm) deep and 3/4 inch (20 mm) larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.
3. Cover anchorage joint with flange of same metal as post, welded to post after placing anchoring material **OR** attached to post with set screws, **as directed**.
OR
Leave anchorage joint exposed with 1/8-inch (3-mm) buildup, sloped away from post **OR** anchoring material flush with adjacent surface, **as directed**.
4. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
   a. For aluminum pipe railings, attach posts using fittings designed and engineered for this purpose.
   b. For stainless-steel pipe railings, weld flanges to post and bolt to supporting surfaces.
   c. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.
5. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

E. Attaching Railings
1. Anchor railing ends at walls with round flanges anchored to wall construction and welded to railing ends or connected to railing ends using nonwelded connections.
2. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends or connected to railing ends using nonwelded connections.
3. Attach railings to wall with wall brackets, except where end flanges are used. Provide brackets with 1-1/2-inch (38-mm) clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
   a. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt **OR** predrilled hole for exposed bolt anchorage, **as directed**.
   b. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
4. Secure wall brackets and railing end flanges to building construction as follows:
   a. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
   b. For hollow masonry anchorage, use toggle bolts.
   c. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
   d. For steel-framed partitions, use hanger or lag bolts set into fire-retardant-treated, **as directed**, wood backing between studs. Coordinate with stud installation to locate backing members.
   OR

For steel-framed partitions, use self-tapping screws fastened to steel framing or to concealed steel reinforcements.
OR
For steel-framed partitions, use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

F. Adjusting And Cleaning
1. Clean aluminum and stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.
2. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   a. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.
3. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
4. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

G. Protection
1. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Final Completion.

END OF SECTION 05 52 13 00

Task	Specification	Specification Description
05 52 13 00	05 50 00 00	Metal Fabrications

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SECTION 05 53 13 00 - GRATINGS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for gratings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Metal bar gratings.
      b. Expanded-metal gratings.
      c. Formed-metal plank gratings.
      d. Extruded-aluminum plank gratings.
      e. Glass-fiber-reinforced plastic gratings.
      f. Metal frames and supports for gratings.

C. Performance Requirements
   1. Delegated Design: Design gratings, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
   2. Structural Performance: Gratings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
      a. Loads in subparagraphs below are examples based on the 2006 International Building Code and ASCE/SEI 7. Adjust to local Project requirements.
         1) Floors (light manufacturing): Uniform load of 125 lbf/sq. ft. (6.00 kN/sq. m) or concentrated load of 2000 lbf (8.90 kN), whichever produces the greater stress.
         2) Floors (heavy manufacturing): Uniform load of 250 lbf/sq. ft. (11.97 kN/sq. m) or concentrated load of 3000 lbf (13.40 kN), whichever produces the greater stress.
         3) Walkways and Elevated Platforms Other Than Exits: Uniform load of 60 lbf/sq. ft. (2.87 kN/sq. m).
         4) Walkways and Elevated Platforms Used as Exits: Uniform load of 100 lbf/sq. ft. (4.79 kN/sq. m).
         5) Sidewalks and Vehicular Driveways, Subject to Trucking: Uniform load of 250 lbf/sq. ft. (11.97 kN/sq. m) or concentrated load of 8000 lbf (35.60 kN), whichever produces the greater stress.
         6) Limit deflection to L/240 **OR** L/360, **as directed**, or 1/4 inch (6.4 mm), whichever is less.
   3. Seismic Performance: Provide gratings capable of withstanding the effects of earthquake motions determined according to ASCE/SEI 7.

D. Submittals
   1. Product Data: For the following:
      a. Formed-metal plank gratings.
      b. Extruded-aluminum plank gratings.
      c. Glass-fiber-reinforced plastic gratings.
      d. Clips and anchorage devices for gratings.
      e. Paint products.
   2. LEED Submittals:
      a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: Indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content. Include statement indicating costs for each product having recycled content.
   3. Shop Drawings: Include plans, sections, details, and attachments to other work.

4. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
5. Qualification Data: For qualified professional engineer.
6. Mill Certificates: Signed by manufacturers of stainless-steel sheet certifying that products furnished comply with requirements.
7. Welding certificates.
8. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

E. Quality Assurance
1. Metal Bar Grating Standards: Comply with NAAMM MBG 531, "Metal Bar Grating Manual" and NAAMM MBG 532, "Heavy-Duty Metal Bar Grating Manual."
2. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   c. AWS D1.3, "Structural Welding Code - Sheet Steel."
   d. AWS D1.6, "Structural Welding Code - Stainless Steel."

F. Project Conditions
1. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

G. Coordination
1. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
2. Coordinate installation of anchorages for gratings, grating frames, and supports. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.2 PRODUCTS

A. Ferrous Metals
1. Recycled Content of Steel Products: Provide products with average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
2. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
3. Steel Bars for Bar Gratings: ASTM A 36/A 36M or steel strip, ASTM A 1011/A 1011M or ASTM A 1018/A 1018M.
4. Wire Rod for Bar Grating Crossbars: ASTM A 510 (ASTM A 510M).
5. Uncoated Steel Sheet: ASTM A 1011/A 1011M, structural steel, Grade 30 (Grade 205).
6. Galvanized-Steel Sheet: ASTM A 653/A 653M, structural quality, Grade 33 (Grade 230), with G90 (Z275) coating.
7. Expanded-Metal Carbon Steel: ASTM F 1267, Class 1.
8. Expanded-Metal Galvanized Steel: ASTM F 1267, Class 2, Grade A.
9. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304 **OR** Type 316, **as directed**.
10. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304 **OR** Type 316, **as directed**.
11. Expanded-Metal Stainless Steel: ASTM F 1267, Class 3, made from stainless-steel sheet, ASTM A 666, Type 304 **OR** Type 316, **as directed**.

B. Aluminum

1. Aluminum, General: Provide alloy and temper recommended by aluminum producer for type of use indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.
2. Extruded Bars and Shapes: ASTM B 221 (ASTM B 221M), alloys as follows:
   a. 6061-T6 or 6063-T6, for bearing bars of gratings and shapes.
   b. 6061-T1, for grating crossbars.
3. Aluminum Sheet: ASTM B 209 (ASTM B 209M), Alloy 5052-H32.

C. Fasteners
1. General: Unless otherwise indicated, provide Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
   a. Provide stainless-steel fasteners for fastening aluminum.
   b. Provide stainless steel fasteners for fastening stainless steel.
2. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
3. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts, and, where indicated, flat washers; ASTM F 593 (ASTM F 738M) for bolts and ASTM F 594 (ASTM F 836M) for nuts, Alloy Group 1 (A1) **OR** Group 2 (A4), **as directed**.
4. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
   a. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
5. Plain Washers: Round, ASME B18.22.1 (ASME B18.22M).
6. Lock Washers: Helical, spring type, ASME B18.21.1 (ASME B18.21.2M).
7. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
   a. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
   b. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 1 (A1) **OR** Group 2 (A4), **as directed**, stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

D. Miscellaneous Materials
1. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy that is welded.
2. Shop Primers: Provide primers that comply with Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
3. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
   a. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
4. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
5. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
6. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

E. Fabrication
1. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling

limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

2. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
3. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.
4. Fit exposed connections accurately together to form hairline joints.
5. Welding: Comply with AWS recommendations and the following:
   a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   b. Obtain fusion without undercut or overlap.
   c. Remove welding flux immediately.
6. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.
   a. Fabricate toeplates to fit grating units and weld to units in shop unless otherwise indicated. **OR**
      Fabricate toeplates for attaching in the field.
   b. Toeplate Height: 4 inches (100 mm) unless otherwise indicated.

F. Metal Bar Gratings
1. Welded Steel Grating:
   a. Bearing Bar Spacing: 7/16 or 1/2 inch (11 or 13 mm) **OR** 11/16 inch (17 mm) **OR** 15/16 inch (24 mm) **OR** 1-3/16 inches (30 mm) **OR** 1-3/8 inches (35 mm) **OR** 1-7/8 inches (48 mm) **OR** 2-3/8 inches (60 mm), **as directed**, o.c.
   b. Bearing Bar Depth: 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 1-1/4 inches (32 mm) **OR** 1-1/2 inches (38 mm) **OR** 1-3/4 inches (44 mm) **OR** 2 inches (51 mm) **OR** 2-1/4 inches (57 mm) **OR** 2-1/2 inches (64 mm) **OR** 3 inches (76 mm) **OR** 3-1/2 inches (89 mm) **OR** 4 inches (102 mm) **OR** 4-1/2 inches (114 mm) **OR** 5 inches (127 mm) **OR** As required to comply with structural performance requirements, **as directed**.
   c. Bearing Bar Thickness: 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm) **OR** 3/8 inch (9.5 mm) **OR** As required to comply with structural performance requirements, **as directed**.
   d. Crossbar Spacing: 2 inches (51 mm) **OR** 4 inches (102 mm), **as directed**, o.c.
   e. Grating Mark W-11-4 (1 x 3/16) STEEL: 1-by-3/16-inch (25-by-4.8-mm) bearing bars at 11/16 inch (18 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
   f. Grating Mark W-15-4 (1 x 1/8) STEEL: 1-by-1/8-inch (25-by-3.2-mm) bearing bars at 15/16 inch (24 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
   g. Grating Mark W-19-4 (1-1/4 x 3/16) STEEL: 1-1/4-by-3/16-inch (32-by-4.8-mm) bearing bars at 1-3/16 inches (30 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
   h. Grating Mark W-19-4 (1-1/2 x 3/16) STEEL: 1-1/2-by-3/16-inch (38-by-4.8-mm) bearing bars at 1-3/16 inches (30 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
   i. Grating Mark W-19-4 (2 x 1/4) STEEL: 2-by-1/4-inch (51-by-6.4-mm) bearing bars at 1-3/16 inches (30 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
   j. Grating Mark W-30-4 (5 x 3/8) STEEL: 5-by-3/8-inch (127-by-9.5-mm) bearing bars at 1-7/8 inches (60 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
   k. Grating Mark: As indicated.
   l. Traffic Surface: Plain **OR** Serrated **OR** Knurled **OR** Applied abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive **OR** As indicated, **as directed**.
   m. Steel Finish: Shop primed **OR** Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. (550 g/sq. m) of coated surface, **as directed**.
2. Pressure-Locked Steel Grating: Fabricated by pressing rectangular flush-top crossbars into slotted bearing bars or swaging crossbars between bearing bars.

a. Bearing Bar Spacing: 7/16 or 1/2 inch (11 or 13 mm) **OR** 11/16 inch (17 mm) **OR** 15/16 inch (24 mm) **OR** 1-3/16 inches (30 mm), **as directed**, o.c.
b. Bearing Bar Depth: 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 1-1/4 inches (32 mm) **OR** 1-1/2 inches (38 mm) **OR** 1-3/4 inches (44 mm) **OR** 2 inches (51 mm) **OR** 2-1/4 inches (57 mm) **OR** 2-1/2 inches (64 mm) **OR** As required to comply with structural performance requirements, **as directed**.
c. Bearing Bar Thickness: 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** As required to comply with structural performance requirements, **as directed**.
d. Crossbar Spacing: 2 inches (51 mm) **OR** 4 inches (102 mm), **as directed**, o.c.
e. Grating Mark P-11-4 (1 x 3/16) STEEL: 1-by-3/16-inch (25-by-4.8-mm) bearing bars at 11/16 inch (18 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
f. Grating Mark P-15-4 (1-1/4 x 1/8) STEEL: 1-1/4-by-1/8-inch (32-by-3.2-mm) bearing bars at 15/16 inch (24 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
g. Grating Mark P-19-4 (1-1/2 x 3/16) STEEL: 1-1/2-by-3/16-inch (38-by-4.8-mm) bearing bars at 1-3/16 inches (30 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
h. Grating Mark: As indicated.
i. Traffic Surface: Plain **OR** Serrated **OR** Knurled **OR** Applied abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive **OR** As indicated, **as directed**.
j. Steel Finish: Shop primed **OR** Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. (550 g/sq. m) of coated surface, **as directed**.

3. Riveted Steel Grating:
a. Bearing Bar Spacing: 3/4 inch (19 mm) **OR** 1-1/8 inches (29 mm) **OR** 2-5/16 inches (59 mm), **as directed**, clear.
b. Bearing Bar Depth: 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 1-1/4 inches (32 mm) **OR** 1-1/2 inches (38 mm) **OR** 1-3/4 inches (44 mm) **OR** 2 inches (51 mm) **OR** 2-1/4 inches (57 mm) **OR** 2-1/2 inches (64 mm) **OR** 3 inches (76 mm) **OR** 3-1/2 inches (89 mm) **OR** 4 inches (102 mm) **OR** 4-1/2 inches (114 mm) **OR** 5 inches (127 mm) **OR** As required to comply with structural performance requirements, **as directed**.
c. Bearing Bar Thickness: 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm) **OR** 3/8 inch (9.5 mm) **OR** As required to comply with structural performance requirements, **as directed**.
d. Rivet Spacing: 3-1/2 inches (89 mm) **OR** 5 inches (127 mm) **OR** 7 inches (178 mm), **as directed**, o.c. along bearing bar.
e. Grating Mark R-12-3-1/2 (1 x 1/8) STEEL: 1-by-1/8-inch (25-by-3.2-mm) bearing bars with 3/4-inch (19-mm) clear space between bearing bars, and rivets at 3-1/2 inches (89 mm) o.c. along bearing bar.
f. Grating Mark R-18-7 (1-1/2 x 3/16) STEEL: 1-1/2-by-3/16-inch (38-by-4.8-mm) bearing bars with 1-1/8-inch (29-mm) clear space between bearing bars, and rivets at 7 inches (178 mm) o.c. along bearing bar.
g. Grating Mark R-37-5 (4 x 1/4) STEEL: 4-by-1/4-inch (102-by-6.4-mm) bearing bars with 2-5/16-inch (59-mm) clear space between bearing bars, and rivets at 5 inches (127 mm) o.c. along bearing bar.
h. Grating Mark R-37-5 (5 x 3/8) STEEL: 5-by-3/8-inch (127-by-9.5-mm) bearing bars with 2-5/16-inch (59-mm) clear space between bearing bars, and rivets at 5 inches (127 mm) o.c. along bearing bar.
i. Grating Mark: As indicated.
j. Traffic Surface: Plain **OR** Serrated **OR** Knurled **OR** Applied abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive **OR** As indicated, **as directed**.
k. Steel Finish: Shop primed **OR** Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. (550 g/sq. m) of coated surface, **as directed**.

4. Pressure-Locked, Stainless-Steel Grating: Fabricated by pressing rectangular flush-top crossbars into slotted bearing bars or swaging crossbars between bearing bars, **as directed**.
a. Bearing Bar Spacing: 7/16 or 1/2 inch (11 or 13 mm) **OR** 11/16 inch (17 mm) **OR** 15/16 inch (24 mm) **OR** 1-3/16 inches (30 mm) **OR** 1-3/8 inches (35 mm) **OR** 1-7/8 inches (48 mm) **OR** 2-3/8 inches (60 mm), **as directed**, o.c.

b. Bearing Bar Depth: 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 1-1/4 inches (32 mm) **OR** 1-1/2 inches (38 mm) **OR** 1-3/4 inches (44 mm) **OR** 2 inches (51 mm) **OR** 2-1/4 inches (57 mm) **OR** 2-1/2 inches (64 mm) **OR** 3 inches (76 mm) **OR** 3-1/2 inches (89 mm) **OR** 4 inches (102 mm) **OR** 4-1/2 inches (114 mm) **OR** 5 inches (127 mm) **OR** As required to comply with structural performance requirements, **as directed**.
c. Bearing Bar Thickness: 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm) **OR** 3/8 inch (9.5 mm) **OR** As required to comply with structural performance requirements, **as directed**.
d. Crossbar Spacing: 2 inches (51 mm) **OR** 4 inches (102 mm), **as directed**, o.c.
e. Grating Mark P-11-4 (1 x 3/16) STAINLESS STEEL: 1-by-3/16-inch (25-by-4.8-mm) bearing bars at 11/16 inch (18 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
f. Grating Mark P-15-2 (1 x 1/8) STAINLESS STEEL: 1-by-1/8-inch (25-by-3.2-mm) bearing bars at 15/16 inch (24 mm) o.c., and crossbars at 2 inches (51 mm) o.c.
g. Grating Mark P-19-4 (1-1/2 x 3/16) STAINLESS STEEL: 1-1/2-by-3/16-inch (38-by-4.8-mm) bearing bars at 1-3/16 inches (30 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
h. Grating Mark P-30-4 (3 x 3/8) STAINLESS STEEL: 3-by-3/8-inch (76-by-9.5-mm) bearing bars at 1-7/8 inches (48 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
i. Grating Mark: As indicated.
j. Traffic Surface: Plain **OR** Serrated **OR** Knurled **OR** Applied abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive **OR** As indicated, **as directed**.
k. Finish: Mill finish **OR** Abrasive blasted **OR** Electropolished, **as directed**.

5. Pressure-Locked, Rectangular Bar Aluminum Grating: Fabricated by pressing rectangular flush-top crossbars into slotted bearing bars or swaging crossbars between bearing bars.
a. Bearing Bar Spacing: 7/16 or 1/2 inch (11 or 13 mm) **OR** 11/16 inch (17.5 mm) **OR** 15/16 inch (24 mm) **OR** 1-3/16 inches (30 mm), **as directed**, o.c.
b. Bearing Bar Depth: 1 inch (25 mm) **OR** 1-1/4 inches (32 mm) **OR** 1-1/2 inches (38 mm) **OR** 1-3/4 inches (44 mm) **OR** 2 inches (51 mm) **OR** 2-1/4 inches (57 mm) **OR** 2-1/2 inches (64 mm) **OR** As required to comply with structural performance requirements, **as directed**.
c. Bearing Bar Thickness: 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm) **OR** As required to comply with structural performance requirements, **as directed**.
d. Crossbar Spacing: 2 inches (51 mm) **OR** 4 inches (102 mm), **as directed**, o.c.
e. Grating Mark P-7-4 (1 x 1/8) ALUMINUM: 1-by-1/8-inch (25-by-3.2-mm) bearing bars at 7/16 inch (11 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
f. Grating Mark P-11-4 (1 x 3/16) ALUMINUM: 1-by-3/16-inch (25-by-4.8-mm) bearing bars at 11/16 inch (18 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
g. Grating Mark P-15-4 (1-1/2 x 3/16) ALUMINUM: 1-1/2-by-3/16-inch (38-by-4.8-mm) bearing bars at 15/16 inch (24 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
h. Grating Mark P-19-4 (2 x 3/16) ALUMINUM: 2-by-3/16-inch (51-by-4.8-mm) bearing bars at 1-3/16 inches (30 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
i. Grating Mark: As indicated.
j. Traffic Surface: Plain **OR** Applied abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive **OR** As indicated, **as directed**.
k. Aluminum Finish: Mill finish **OR** Class I, clear, anodized finish, **as directed**.

6. Pressure-Locked, Aluminum I-Bar Grating: Fabricated by swaging crossbars between bearing bars.
a. Bearing Bar Spacing: 7/16 or 1/2 inch (11 or 13 mm) **OR** 11/16 inch (17 mm) **OR** 15/16 inch (24 mm) **OR** 1-3/16 inches (30 mm), **as directed**, o.c.
b. Bearing Bar Depth: 1 inch (25 mm) **OR** 1-1/4 inches (32 mm) **OR** 1-1/2 inches (38 mm) **OR** 1-3/4 inches (44 mm) **OR** 2 inches (51 mm) **OR** 2-1/4 inches (57 mm) **OR** 2-1/2 inches (64 mm) **OR** As required to comply with structural performance requirements, **as directed**.
c. Bearing Bar Flange Width: 1/4 inch (6.4 mm).
d. Crossbar Spacing: 2 inches (51 mm) **OR** 4 inches (102 mm), **as directed**, o.c.
e. Grating Mark P-11-4 (1 I-Bar) ALUMINUM: 1-inch (25-mm) I-bar bearing bars at 11/16 inch (18 mm) o.c., and crossbars at 4 inches (102 mm) o.c.

f. Grating Mark P-15-2 (1 I-Bar) ALUMINUM: 1-inch (25-mm) I-bar bearing bars at 15/16 inch (24 mm) o.c., and crossbars at 2 inches (51 mm) o.c.
g. Grating Mark P-19-4 (1-1/2 I-Bar) ALUMINUM: 1-1/2-inch (38-mm) I-bar bearing bars at 1-3/16 inches (30 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
h. Grating Mark: As indicated.
i. Traffic Surface: Plain **OR** Grooved **OR** Applied abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive **OR** As indicated, **as directed**.
j. Aluminum Finish: Mill finish **OR** Class I, clear, anodized finish, **as directed**.

7. Removable Grating Sections: Fabricate with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated or, if not indicated, as recommended by manufacturer for attaching to supports.
a. Provide no fewer than four weld lugs for each heavy-duty grating section, with each lug shop welded to two bearing bars.
b. Provide no fewer than four saddle clips for each grating section composed of rectangular bearing bars 3/16 inch (4.8 mm) or less in thickness and spaced 15/16 inch (24 mm) or more o.c., with each clip designed and fabricated to fit over two bearing bars.
c. Provide no fewer than four weld lugs for each grating section composed of rectangular bearing bars 3/16 inch (4.8 mm) or less in thickness and spaced less than 15/16 inch (24 mm) o.c., with each lug shop welded to three or more bearing bars. Interrupt intermediate bearing bars as necessary for fasteners securing grating to supports.
d. Provide no fewer than four flange blocks for each section of aluminum I-bar grating, with block designed to fit over lower flange of I-shaped bearing bars.
e. Furnish threaded bolts with nuts and washers for securing grating to supports.
f. Furnish self-drilling fasteners with washers for securing grating to supports.
g. Furnish galvanized malleable-iron flange clamp with galvanized bolt for securing grating to supports. Furnish as a system designed to be installed from above grating by one person.

8. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.
a. Edge-band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.

9. Do not notch bearing bars at supports to maintain elevation.

G. Expanded-Metal Gratings
1. Provide expanded-metal gratings in material, finish, style, size, thickness, weight, and type indicated or, if not indicated, as recommended by manufacturer for indicated applications and as needed to support indicated loads.
a. Material: Steel **OR** Stainless steel **OR** Aluminum, **as directed**.
b. Steel Finish: Unfinished, oiled **OR** Shop primed **OR** Galvanized, **as directed**.
c. Stainless-Steel Finish: Mill finish, as fabricated.
d. Aluminum Finish: Mill finish, as fabricated.
e. Style Designation (for steel): 4.27 lb **OR** 3/4 number 9, **as directed**.
f. Style Designation (for stainless steel): 1-1/2 number 9 **OR** 3/4 number 9, **as directed**.
g. Size (for aluminum): 2 lb **OR** 3/4 0.188 **OR** 1-1/2 0.125, **as directed**.
h. Type: I, expanded **OR** II, expanded and flattened, **as directed**.

2. Fabricate cutouts in grating sections for penetrations of sizes and at locations indicated. Cut openings neatly and accurately to size. Edge-band openings with bars having a thickness not less than overall grating thickness at contact points.
3. Where gratings are pierced by pipes, ducts, and structural members, cut openings neatly and accurately to size and weld a strap collar not less than 1/8 inch (3 mm) thick to the cut ends. Divide panels into sections only to extent required for installation where grating platforms and runways are to be placed around previously installed pipe, ducts, and structural members.

H. Formed-Metal Plank Gratings
1. C-shaped channels rolled from heavy sheet metal of thickness indicated, and punched in serrated diamond shape to produce raised slip-resistant surface and drainage holes.

a. Channel Width: 4-3/4 inches (121 mm) **OR** 7 inches (178 mm) **OR** 9-1/2 inches (241 mm) **OR** 11-3/4 inches (298 mm) **OR** 18-3/4 inches (476 mm) **OR** 24 inches (610 mm) **OR** As indicated **OR** As required to comply with structural performance requirements, **as directed**.
b. Channel Depth: 1-1/2 inches (38 mm) **OR** 2 inches (51 mm) **OR** 2-1/2 inches (64 mm) **OR** 3 inches (76 mm) **OR** As indicated **OR** As required to comply with structural performance requirements, **as directed**.
c. Material: 0.074-inch- (1.9-mm-) thick steel sheet, shop primed **OR** 0.104-inch- (2.65-mm-) thick steel sheet, shop primed **OR** 0.079-inch- (2.0-mm-) thick, hot-dip galvanized-steel sheet **OR** 0.108-inch- (2.8-mm-) thick, hot-dip galvanized-steel sheet **OR** 0.074-inch- (1.9-mm-) thick steel sheet, hot-dip galvanized after fabrication **OR** 0.104-inch- (2.65-mm-) thick steel sheet, hot-dip galvanized after fabrication **OR** 0.062-inch- (1.6-mm-) thick, stainless-steel sheet **OR** 0.078-inch- (2.0-mm-) thick, stainless-steel sheet **OR** 0.080-inch- (2.0-mm-) thick aluminum sheet **OR** 0.100-inch- (2.5-mm-) thick aluminum sheet, **as directed**.

2. Fabricate cutouts in grating sections for penetrations of sizes and at locations indicated. Cut openings neatly and accurately to size. Edge-band openings with metal sheet or bars having a thickness not less than grating material.
3. Where gratings are pierced by pipes, ducts, and structural members, cut openings neatly and accurately to size and weld a strap collar not less than 1/8 inch (3 mm) thick to the cut ends. Divide panels into sections only to extent required for installation where grating platforms and runways are to be placed around previously installed pipe, ducts, and structural members.

I. Extruded-Aluminum Plank Gratings

1. Provide extruded-aluminum plank gratings in type, size, and finish indicated or, if not indicated, as recommended by manufacturer for indicated applications and as needed to support indicated loads.
   a. Type: Extruded-aluminum planks approximately 6 inches (152 mm) wide with multiple flanges approximately 1.2 inches (30 mm) o.c., acting as bearing bars connected by a web that serves as a walking surface. Top surface has raised ribs to increase slip resistance.
   b. Depth: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (51 mm) **OR** As required to comply with structural performance requirements, **as directed**.
   c. Perforations: None **OR** Rectangular, 19/32 by 3 inches (15 by 76 mm), with adjacent rows staggered **OR** 19/32 inch (15 mm) square, with adjacent rows aligned, **as directed**.
   d. Finish: Mill finish, as fabricated.
2. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.

J. Glass-Fiber-Reinforced Plastic Gratings

1. Molded Glass-Fiber-Reinforced Gratings: Bar gratings made by placing glass-fiber strands that have been saturated with thermosetting plastic resin in molds in alternating directions to form interlocking bars without voids and with a high resin content.
   a. Configuration: 1-1/2-inch- (38-mm-) square mesh, 1 inch (25 mm) thick **OR** 1-1/2-inch- (38-mm-) square mesh, 1-1/4 inches (32 mm) thick **OR** 1-1/2-inch- (38-mm-) square mesh, 1-1/2 inches (38 mm) thick **OR** 2-inch- (51-mm-) square mesh, 2 inches (51 mm) thick **OR** 1-1/2-inch- (38-mm-) square mesh, thickness as required to comply with structural performance requirements **OR** As required to comply with structural performance requirements, **as directed**.
   b. Weight: 2.5 lb/sq. ft. (12.2 kg/sq. m) **OR** 2.7 lb/sq. ft. (13.2 kg/sq. m) **OR** 3.2 lb/sq. ft. (15.6 kg/sq. m) **OR** 3.5 lb/sq. ft. (17.1 kg/sq. m) **OR** 3.7 lb/sq. ft. (18.1 kg/sq. m) **OR** 4.1 lb/sq. ft. (20.0 kg/sq. m) **OR** 5.0 lb/sq. ft. (24.4 kg/sq. m), **as directed**.
   c. Resin: Polyester **OR** Vinylester, **as directed**.
      1) Flame-Spread Index: 25 or less when tested according to ASTM E 84.
      2) U.S.D.A. Acceptance: Accepted for food-processing applications.
   d. Color: Beige **OR** Gray **OR** Green **OR** Orange **OR** Yellow **OR** Manufacturer's standard, **as directed**.
   e. Traffic Surface: Plain, meniscus **OR** Applied abrasive finish **OR** As indicated, **as directed**.

2. Pultruded Glass-Fiber-Reinforced Gratings: Bar gratings assembled from components made by simultaneously pulling glass fibers and extruding thermosetting plastic resin through a heated die under pressure to produce a product without voids and with a high glass-fiber content.
   a. Configuration: I4010; 1-inch (25-mm) I-bars spaced 1 inch (25 mm) o.c. (40 percent open) **OR** I6010; 1-inch (25-mm) I-bars spaced 1-1/2 inches (38 mm) o.c. (60 percent open) **OR** I4015; 1-1/2-inch (38-mm) I-bars spaced 1 inch (25 mm) o.c. (40 percent open) **OR** I6015; 1-1/2-inch (38-mm) I-bars spaced 1-1/2 inches (38 mm) o.c. (60 percent open) **OR** T3320; 2-inch (51-mm) T-bars spaced 1-1/2 inches (38 mm) o.c. (33 percent open) **OR** T5020; 2-inch (51-mm) T-bars spaced 2 inches (51 mm) o.c. (50 percent open) **OR** As required to comply with structural performance requirements, **as directed**.
   b. Weight: 2.35 lb/sq. ft. (11.5 kg/sq. m) **OR** 2.83 lb/sq. ft. (13.8 kg/sq. m) **OR** 3.10 lb/sq. ft. (15.1 kg/sq. m) **OR** 3.41 lb/sq. ft. (16.6 kg/sq. m) **OR** 4.10 lb/sq. ft. (20.0 kg/sq. m) **OR** 4.13 lb/sq. ft. (20.2 kg/sq. m), **as directed**.
   c. Resin Type: Polyester **OR** Vinylester, **as directed**.
      1) Flame-Spread Index: 25 or less when tested according to ASTM E 84.
      2) U.S.D.A. Acceptance: Accepted for food processing applications.
   d. Color: Beige **OR** Gray **OR** Green **OR** Orange **OR** Yellow **OR** Manufacturer's standard, **as directed**.
   e. Traffic Surface: Plain, grooved **OR** Applied abrasive finish **OR** As indicated, **as directed**.
3. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.

K. Grating Frames And Supports
1. Frames and Supports for Metal Gratings: Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.
   a. Unless otherwise indicated, fabricate from same basic metal as gratings.
   b. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors. Unless otherwise indicated, space anchors 24 inches (600 mm) o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches (32 mm) wide by 1/4 inch (6 mm) thick by 8 inches (200 mm) long.
2. Frames and Supports for Glass-Fiber-Reinforced Plastic Gratings: Fabricate from glass-fiber-reinforced plastic shapes of sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.
   a. Unless otherwise indicated, use shapes made from same resin as gratings.
   b. Equip units indicated to be cast into concrete or built into masonry with integral anchors.
3. Galvanize steel frames and supports in the following locations:
   a. Exterior.
   b. Interior, where indicated.

L. Aluminum Finishes
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

M. Steel Finishes
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Finish gratings, frames, and supports after assembly.
3. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

a. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
4. Shop prime gratings, frames and supports not indicated to be galvanized unless otherwise indicated.
   a. Shop prime with universal shop primer **OR** primers specified in Division 07, **as directed**, unless zinc-rich primer is **OR** primers specified in Division 09 Section "High-performance Coatings" are, **as directed**, indicated.
5. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning" **OR** SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning" **OR** requirements indicated below, **as directed**:
   a. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   b. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   c. Items Indicated to Receive Primers Specified in Division 9 Section "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   d. Other Items: SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
6. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1.3 EXECUTION

A. Installation, General
1. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
2. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
3. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.
4. Fit exposed connections accurately together to form hairline joints.
   a. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
5. Attach toeplates to gratings by welding at locations indicated.
6. Field Welding: Comply with the following requirements:
   a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   b. Obtain fusion without undercut or overlap.
   c. Remove welding flux immediately.
7. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

B. Installing Metal Bar Gratings
1. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.
2. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.
3. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

C. Installing Expanded-Metal Gratings
1. General: Comply with manufacturer's written instructions for installing gratings.
2. Place units with straight edge of bond up and with long direction of diamond-shaped openings parallel to direction of span.
3. Attach removable units to supporting members by bolting at 6-inch (150-mm) intervals.
4. Attach nonremovable units to supporting members by welding unless otherwise indicated. Space welds at 6-inch (150-mm) intervals.
5. Attach aluminum units to steel supporting members by bolting at 6-inch (150-mm) intervals.
6. Butt edges parallel to long direction of diamond-shaped openings and weld at every second bond point. Place individual grating sections so diamonds of one piece are aligned with those of adjacent sections.

D. Installing Metal Plank Gratings
1. General: Comply with manufacturer's written instructions for installing gratings. Use manufacturer's standard anchor clips and hold-down devices for bolted connections.
2. Attach removable units to supporting members by bolting at every point of contact.
3. Attach nonremovable units to supporting members by welding unless otherwise indicated. Comply with manufacturer's written instructions for size and spacing of welds.
4. Attach aluminum units to steel supporting members by bolting at side channels at every point of contact and by bolting intermediate planks at each end on alternate sides. Bolt adjacent planks together at midspan.

E. Installing Glass-Fiber-Reinforced Plastic Gratings
1. Comply with manufacturer's written instructions for installing gratings. Use manufacturer's standard stainless-steel anchor clips and hold-down devices for bolted connections.

F. Adjusting And Cleaning
1. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.
   a. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

   OR

   Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 07.
2. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 05 53 13 00

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Task	Specification	Specification Description
05 53 13 00	01 22 16 00	No Specification Required
05 53 13 00	05 50 00 00	Metal Fabrications
05 54 00 00	05 50 00 00	Metal Fabrications
05 55 13 00	05 50 00 00	Metal Fabrications
05 55 13 00	05 51 13 00	Metal Stairs
05 55 13 00	05 51 13 00a	Fabricated Spiral Stairs
05 55 16 00	05 50 00 00	Metal Fabrications
05 55 16 00	05 51 13 00	Metal Stairs
05 55 16 00	05 51 13 00a	Fabricated Spiral Stairs
05 56 00 00	05 50 00 00	Metal Fabrications

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SECTION 05 58 16 00 - ORNAMENTAL FORMED METAL

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for ornamental formed metal. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Beam wraps.
b. Closures and trim.
c. Column covers.
d. Decorative-metal-clad, hollow-metal doors and frames.
e. Elevator cab and entrance finishes.
f. Escalator enclosures.
g. Filler panels at demountable partitions and/or between dissimilar construction.
h. Heating-cooling unit enclosures.
i. Lighting coves.
j. Metal base.
k. Mullion cladding.
l. Pipe system covers.
m. Pockets for window treatment.
n. Window stools.
o. Exterior fins.
p. Exterior formed-metal-shaped panels.
q. Exterior sunshades.
r. Exterior trellises.
s. Exterior window covers.
t. Metal shapes as part of roof construction.

C. Performance Requirements
1. Delegated Design: Design exterior decorative formed metal items, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Structural Performance: Decorative formed metal items, including anchors and connections, shall withstand the effects of gravity loads and the following loads and stresses without exceeding the allowable design working stress of materials involved and without exhibiting permanent deformation in any components:
a. Wind Loads on Exterior Items: As indicated on Drawings **OR** 20 lbf/sq. ft. (957 Pa) **OR** 30 lbf/sq. ft. (1436 Pa) **OR** As required to meet local Project requirements.
b. Live Loads on Heating-Cooling Unit Enclosures: 100 lbf/sq. ft. (4.8 kN/sq. m) or a concentrated load of 300 lbf (1.3 kN) on an area of 4 sq. in. (26 sq. cm), whichever produces the greater stress.
3. Seismic Performance: Exterior decorative formed metal items, including anchors and connections, shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
a. Component Importance Factor is 1.0.
4. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

5. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

D. Submittals

1. Product Data: For each type of product indicated. Include finishing materials.
2. LEED Submittals:
   a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
   b. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: Show fabrication and installation details for decorative formed metal.
   a. Include plans, elevations, component details, and attachments to other work.
   b. Indicate materials and profiles of each decorative formed metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.
4. Samples: For each type of exposed finish required, prepared on 6-inch- (150-mm-) square Samples of metal of same thickness and material indicated for the Work.
5. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
6. Coordination Drawings: For decorative formed metal elements that house items specified in other Sections. Show dimensions of housed items, including locations of housing penetrations and attachments, and necessary clearances.
7. Qualification Data: For qualified Installer, fabricator, organic-coating applicator, anodic finisher, powder-coating applicator and professional engineer.
8. Mill Certificates: Signed by stainless-steel manufacturers certifying that products furnished comply with requirements.
9. Welding certificates.
10. Maintenance Data: For mirrorlike stainless-steel finish and statuary conversion coating copper-alloy finish to include in maintenance manuals.

E. Quality Assurance

1. Fabricator Qualifications: A firm experienced in producing decorative formed metal similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
2. Organic-Coating Applicator Qualifications: A firm experienced in successfully applying organic coatings of type indicated to metals of types indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.
3. Anodic Finisher Qualifications: A firm experienced in successfully applying anodic finishes of type indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.
4. Powder-Coating Applicator Qualifications: A firm experienced in successfully applying powder coatings of type indicated to metals of types indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.
5. Installer Qualifications: Fabricator of products.
6. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   c. AWS D1.3, "Structural Welding Code - Sheet Steel."
   d. AWS D1.6, "Structural Welding Code - Stainless Steel."

7. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Deliver decorative formed metal products wrapped in protective coverings and strapped together in suitable packs or in heavy-duty cartons. Remove protective coverings before they stain or bond to finished surfaces.
2. Store products on elevated platforms in a dry location.

G. Project Conditions
1. Field Measurements: Verify actual locations of walls, columns, beams, and other construction contiguous with decorative formed metal by field measurements before fabrication and indicate measurements on Shop Drawings.

H. Coordination
1. Coordinate installation of anchorages for decorative formed metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
2. Coordinate installation of decorative formed metal with adjacent construction to ensure that wall assemblies, flashings, trim, and joint sealants, are protected against damage from the effects of weather, age, corrosion, and other causes.

1.2 PRODUCTS

A. Sheet Metal
1. General: Provide sheet metal without pitting, seam marks, roller marks, stains, discolorations, or other imperfections where exposed to view on finished units.
2. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
3. Aluminum Sheet: Flat sheet complying with ASTM B 209 (ASTM B 209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than strength and durability properties of Alloy 5005-H32.
4. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating, either commercial steel or forming steel.
5. Steel Sheet: Uncoated, cold-rolled, ASTM A 1008/A 1008M, commercial steel, exposed or electrolytic zinc-coated, ASTM A 879/A 879M, with steel sheet substrate complying with ASTM A 1008/A 1008M, commercial steel, exposed.
6. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304 **OR** Type 316, **as directed**, stretcher-leveled standard of flatness.
7. Bronze Sheet: ASTM B 36/B 36M, Alloy UNS No. C28000 (muntz metal, 60 percent copper) or Alloy UNS No. C23000 (red brass, 85 percent copper).
8. Brass Sheet: ASTM B 36/B 36M, Alloy UNS No. C26000 (cartridge brass, 70 percent copper).
9. Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 temper.
10. Titanium Sheet: ASTM B 265, Grade 1.

B. Miscellaneous Materials
1. Gaskets: As required to seal joints in decorative formed metal and remain airtight **OR** weathertight, **as directed**; as recommended in writing by decorative formed metal manufacturer.
   a. ASTM D 1056, Type 1, Class A, grade as recommended by gasket manufacturer to obtain seal for application indicated.
   b. Closed-cell polyurethane foam, adhesive on two sides, release paper protected.
2. Sealants, Exterior: ASTM C 920; elastomeric silicone **OR** polyurethane **OR** polysulfide, **as directed**, sealant; of type, grade, class, and use classifications required to seal joints in

decorative formed metal and remain weathertight; and as recommended in writing by decorative formed metal manufacturer.

3. Sealants, Interior: Nonsag, paintable, nonstaining, latex sealant complying with ASTM C 834; of type and grade required to seal joints in decorative formed metal; and as recommended in writing by decorative formed metal manufacturer.
    a. Use sealant that has a VOC content of not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
4. Filler Metal and Electrodes: Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded or brazed and as necessary for strength, corrosion resistance, and compatibility in fabricated items.
    a. Use filler metals that will match the color of metal being joined and will not cause discoloration.
5. Fasteners: Fabricated from same basic metal and alloy as fastened metal unless otherwise indicated. Do not use metals that are incompatible with materials joined.
    a. Provide concealed fasteners for interconnecting decorative formed metal items and for attaching them to other work unless otherwise indicated **OR** exposed fasteners are unavoidable or are the standard fastening method, **as directed**.
    b. Provide Phillips **OR** tamper-resistant **OR** square or hex socket, **as directed**, flat-head machine screws for exposed fasteners unless otherwise indicated.
6. Structural Anchors: For applications indicated to comply with certain design loads, provide chemical or torque-controlled expansion anchors with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
7. Nonstructural Anchors: For applications not indicated to comply with design loads, provide powder-actuated fasteners **OR** metal expansion sleeve anchors **OR** metal-impact expansion anchors, **as directed**, of type, size, and material necessary for type of load and installation indicated, as recommended by manufacturer, unless otherwise indicated.
8. Anchor Materials:
    a. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
    b. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) **OR** Group 2 (A4), **as directed**, stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).
9. Sound-Deadening Materials:
    a. Insulation: Unfaced, mineral-fiber blanket insulation complying with ASTM C 665, Type I, and passing ASTM E 136 test.
    b. Mastic: Cold-applied asphalt emulsion complying with ASTM D 1187.
10. Backing Materials: Provided or recommended by decorative formed metal manufacturer.
11. Laminating Adhesive: Adhesive recommended by metal fabricator that will fully bond metal to metal and that will prevent telegraphing and oil canning and is compatible with substrate and noncombustible after curing.
    a. Contact Adhesive: VOC content of not more than 80 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    b. Metal-to-Metal Adhesive: VOC content of not more than 30 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    c. Multipurpose Construction Adhesive: VOC content of not more than 70 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    d. Special-Purpose Contact Adhesive: (Contact adhesive used to bond melamine-covered board, metal, unsupported vinyl, ultrahigh molecular weight polyethylene, and rubber or wood veneer, 1/16 inch thick or less, to any surface): 250 g/L.
12. Isolation Coating: Manufacturer's standard alkali-resistant coating **OR** bituminous paint **OR** epoxy coating, **as directed**.

C. Paints And Coatings
1. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
2. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
3. Lacquer for Copper Alloys: Clear, acrylic lacquer specially developed for coating copper-alloy products.
4. Shop Primers: Comply with Division 07 OR Division 09 Section(s) "High-performance Coatings", **as directed**.
5. Universal Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
   a. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
6. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
7. Shop Primer for Galvanized Steel: Cementitious galvanized metal primer complying with MPI#26 **OR** Vinyl wash primer complying with MPI#80 **OR** Water-based galvanized metal primer complying with MPI#134, **as directed**.
8. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

D. Fabrication, General
1. Shop Assembly: Preassemble decorative formed metal items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
2. Coordinate dimensions and attachment methods of decorative formed metal items with those of adjoining construction to produce integrated assemblies with closely fitting joints and with edges and surfaces aligned unless otherwise indicated.
3. Form metal to profiles indicated, in maximum lengths to minimize joints. Produce flat, flush surfaces without cracking or grain separation at bends. Fold back exposed edges of unsupported sheet metal to form a 1/2-inch- (12-mm-) wide hem on the concealed side, or ease edges to a radius of approximately 1/32 inch (1 mm) and support with concealed stiffeners.
4. Increase metal thickness or reinforce with concealed stiffeners, backing materials, or both, as needed to provide surface flatness equivalent to stretcher-leveled standard of flatness and sufficient strength for indicated use.
   a. Support joints with concealed stiffeners as needed to hold exposed faces of adjoining sheets in flush alignment.
5. Build in straps, plates, and brackets as needed to support and anchor fabricated items to adjoining construction. Reinforce decorative formed metal items as needed to attach and support other construction.
6. Provide support framing, mounting and attachment clips, splice sleeves, fasteners, and accessories needed to install decorative formed metal items.
7. Where welding or brazing is indicated, weld or braze joints and seams continuously. Grind, fill, and dress to produce smooth, flush, exposed surfaces in which joints are not visible after finishing is completed.
   a. Use welding and brazing procedures that will blend with and not cause discoloration of metal being joined.

E. Beam Wraps
1. Form beam wraps from metal of type and thickness indicated below. Fabricate to fit tightly to adjoining construction.
   a. Aluminum Sheet: 0.063 inch (1.60 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
      1) Finish: Baked enamel or powder coat **OR** Siliconized polyester **OR** High-performance organic coating **OR** Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
   b. Steel Sheet: 0.060 inch (1.52 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
      1) Finish: Factory primed **OR** Baked enamel **OR** Powder coat, **as directed**.

c. Stainless-Steel Sheet: 0.050 inch (1.27 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
1) Finish: No. 2B **OR** No. 4 **OR** No. 6 **OR** No. 7 **OR** No. 8, **as directed**.
2. Fabricate with calk stop angle to retain backer rod and sealant.

F. Closures And Trim
1. Form closures and trim from metal of type and thickness indicated below. Fabricate to fit tightly to adjoining construction, with weathertight joints at exterior installations.
a. Aluminum Sheet: 0.063 inch (1.60 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
1) Finish: Baked enamel or powder coat **OR** Siliconized polyester **OR** High-performance organic coating **OR** Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
b. Galvanized-Steel Sheet: 0.052 inch (1.32 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
1) Finish: Factory primed **OR** Baked enamel **OR** Siliconized polyester **OR** High-performance organic coating **OR** Powder coat, **as directed**.
c. Steel Sheet: 0.048 inch (1.21 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
1) Finish: Factory primed **OR** Baked enamel **OR** Powder coat, **as directed**.
d. Closures and trim may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view and not exposed to weather.
2. Conceal fasteners where possible; otherwise, locate where they are as inconspicuous as possible. Size fasteners to support closures and trim, with fasteners spaced to prevent buckling or waviness in finished surfaces.
3. Drill and tap holes needed for securing closures and trim to other surfaces.
4. Incorporate gaskets where indicated or needed for concealed, continuous seal at abutting surfaces.
5. Miter or cope trim members at corners and reinforce with bent metal splice plates to form tight joints.

G. Column Covers
1. Spackled-Seam Type: Form column covers from 0.125-inch (3.2-mm) aluminum, rolled to radii indicated. Taper edges of adjoining pieces of column covers, for taping and spackling, to 0.094-inch (2.4-mm) thickness in approximately 1 inch (25 mm) of width. Punch tapered edges for gypsum board screws at 1/2 inch (12 mm) o.c., and mill grooves in tapered edge to improve bond with joint compound.
a. Support Framing: At vertical joints, provide 1-1/2-by-3-5/8-inch (38-by-89-mm) steel channel support posts formed from 0.040-inch (1.0-mm) galvanized steel.
b. Joint Treatment Materials: Provide joint treatment compounds and reinforcing tape complying with requirements in Division 9 Section "Gypsum Board."
2. Snap-Together Type: Form column covers to shapes indicated from metal of type and minimum thickness indicated below. Return vertical edges and bend to form hook that will engage continuous mounting clips.
a. Aluminum Sheet: 0.063 inch (1.60 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
1) Finish: Baked enamel or powder coat **OR** Siliconized polyester **OR** High-performance organic coating **OR** Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
b. Steel Sheet: 0.060 inch (1.52 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
1) Finish: Factory primed **OR** Baked enamel **OR** Powder coat, **as directed**.
c. Stainless-Steel Sheet: 0.050 inch (1.27 mm) **OR** Thickness required to comply with performance requirements, **as directed**.

1) Finish: No. 2B **OR** No. 4 **OR** No. 6 **OR** No. 7 **OR** No. 8, **as directed**.

d. Bronze Sheet: 0.051 inch (1.29 mm) **OR** Thickness required to comply with performance requirements, **as directed**.

1) Finish: Buffed finish, lacquered **OR** Hand-rubbed finish, lacquered **OR** Statuary conversion coating over satin finish, **as directed**.

e. Brass Sheet: 0.051 inch (1.29 mm) **OR** Thickness required to comply with performance requirements, **as directed**.

1) Finish: Buffed **OR** Hand-rubbed, **as directed**, finish, lacquered.

f. Column covers may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.

g. Form returns at vertical joints to provide hairline V-joints.

OR

Form returns at vertical joints to provide 1/2-inch- (12-mm-) **OR** 3/4-inch- (18-mm-), **as directed**, wide reveal at joints. Provide snap-in metal filler strips at reveals that leave reveals 1/2 inch (12 mm) deep **OR** flush, **as directed**.

OR

Form returns at vertical joints to accommodate backer rod and sealant.

h. Fabricate column covers with hairline horizontal V-joints produced by forming returns on mating ends of column cover sections. Locate horizontal joints as indicated.

OR

Fabricate column covers without horizontal joints.

OR

Fabricate column covers with horizontal butt joints, tightly fitted and backed with a sleeve for field splicing with adhesive.

OR

Fabricate column covers with 1/2-inch- (12-mm-) wide, **as directed**, reveals at horizontal joints produced by forming returns on mating ends of column cover sections. Provide snap-in metal filler strips at reveals matching reveals at vertical joints. Locate horizontal joints as indicated.

i. Fabricate base **OR** ceiling, **as directed**, ring to match **OR** contrast with, **as directed**, column covers.

j. Fabricate with calk stop/stiffener ring.

k. Apply manufacturer's recommended sound-deadening insulation **OR** mastic, **as directed**, to backs of column covers.

H. Decorative-Metal-Clad Doors And Frames

1. Laminate metal sheets, of type and thickness indicated below, to faces of hollow-metal doors and frames and elevator entrances where indicated:

a. Bronze Sheet: 0.040 inch (1.02 mm).

1) Finish: Buffed finish, lacquered **OR** Hand-rubbed finish, lacquered **OR** Statuary conversion coating over satin finish, lacquered, **as directed**.

b. Brass Sheet: 0.040 inch (1.02 mm).

1) Finish: Buffed **OR** Hand-rubbed, **as directed**, finish lacquered.

c. Stainless-Steel Sheet: 0.038 inch (0.95 mm).

1) Finish: No. 2B **OR** No. 4 **OR** No. 6 **OR** No. 7 **OR** No. 8, **as directed**.

d. Titanium Sheet: 0.025 inch (0.64 mm).

1) Finish: Dull **OR** Bright, **as directed**, matte.

I. Escalator Enclosures

1. Form escalator enclosures from metal of type and thickness indicated below. Coordinate size of enclosures, location of cutouts, and method of attachment to adjoining construction.

a. Stainless-Steel Sheet: 0.062 inch (1.59 mm) **OR** Thickness required to comply with performance requirements, **as directed**.

1) Finish: No. 2B **OR** No. 4 **OR** No. 6 **OR** No. 7 **OR** No. 8, **as directed**.

b. Bronze Sheet: 0.081 inch (2.05 mm) **OR** Thickness required to comply with performance requirements, **as directed**.

1) Finish: Buffed finish, lacquered **OR** Hand-rubbed finish, lacquered **OR** Statuary conversion coating over satin finish, **as directed**.

J. Filler Panels
1. Form filler panels for closing ends of partition systems and for other applications indicated. Form from two sheets of metal of type and thickness indicated below, separated by channels formed from the same material, producing a panel of same thickness as partitions **OR** mullions, **as directed**, unless otherwise indicated. Incorporate reveals, trim, and concealed anchorages for attaching to adjacent surfaces.
   a. Galvanized-Steel Sheet: 0.064 inch (1.63 mm).
      1) Finish: Factory primed **OR** Baked enamel **OR** Siliconized polyester **OR** High-performance organic coating **OR** Powder coat, **as directed**.
   b. Steel Sheet: 0.060 inch (1.52 mm).
      1) Finish: Factory primed **OR** Baked enamel **OR** Powder coat, **as directed**.
   c. Filler panels may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.
2. Fill interior of panel with sound-deadening insulation permanently attached to inside panel faces.
3. Adhesively attach gaskets to filler panel edges where they abut mullions or glazing. Use 1-inch- (25-mm-) square material, unless otherwise indicated, set approximately 1/4 inch (6 mm) into channeled edge of filler panel.
   OR
   Attach gaskets to all edges of panels that abut adjacent surfaces to form a continuous seal. Use compressible gaskets or mastic sealing tape, applied to center of panel edges to be concealed from view, unless otherwise indicated.
4. Do not mechanically fasten filler panels to mullions.

K. Heating-Cooling Unit Enclosures
1. Fabricate heating-cooling unit enclosures from metal of type and thickness indicated below:
   a. Galvanized-Steel Sheet:
      1) Framing: 0.108 inch (2.74 mm) **OR** Thickness required to comply with performance requirements.
      2) Sills and Stools: 0.079 inch (2.01 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
      3) Front Panels and Bases: 0.064 inch (1.63 mm).
      4) Concealed Panels and Trim: 0.040 inch (1.02 mm).
      5) Finish: Factory primed **OR** Baked enamel **OR** Siliconized polyester **OR** High-performance organic coating **OR** Powder coat, **as directed**.
   b. Steel Sheet:
      1) Framing: 0.105 inch (2.66 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
      2) Sills and Stools: 0.075 inch (1.90 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
      3) Front Panels and Bases: 0.060 inch (1.52 mm).
      4) Concealed Panels and Trim: 0.036 inch (0.91 mm).
      5) Finish: Factory primed **OR** Baked enamel **OR** Powder coat, **as directed**.
2. Weld seams and connections unless otherwise indicated or unless other methods are necessary for access to heating and cooling equipment.
3. Incorporate stiffeners or laminated backing using noncombustible materials as needed for strength and rigidity.
   a. Fill space between stiffeners with sound-deadening insulation attached to face sheet with insulation adhesive unless otherwise indicated.
      OR
      Coat concealed faces of metal panels more than 6 inches (150 mm) wide with a heavy coating of sound-deadening mastic applied at the minimum rate of 20 sq. ft./gal. (0.5 sq. m/L).

4. Provide louvers and grilles of size, type, and materials indicated.
    a. For removable grilles, use modular units with recessed openings formed into surfaces of enclosures and without blank filler panels between grilles, so face panels and stools are continuous. Fabricate removable grilles and openings to precise tolerances to produce well-fitted assemblies free of warp or rattle, with grilles supported continuously along parallel edges and with tops flush with top of enclosure.
5. Incorporate removable tops and fronts where indicated or needed for access to heating-cooling units and to piping, ductwork, controls, and electrical service, with panels and openings as follows:
    a. Fabricate with a fitting tolerance of not less than 1/32 inch (0.8 mm) and not more than 1/16 inch (1.6 mm) at each edge, with face of panels flush with adjoining fixed surfaces of enclosure.
    b. Form panels for easy removal without interfering with adjoining construction or furniture. Hold panels in place with concealed clips and hardware that prevent warp and rattle.
6. Incorporate hinged access panels in enclosures for access to heating-cooling unit controls, as either separate elements or integrated with grille openings, as indicated or needed.
7. Coordinate construction, configuration, and dimensions of enclosures with those of heating-cooling units. Provide support for heating-cooling units and controls where indicated. Provide blind knockouts and supports for piping, ductwork, control lines, electrical conduit, and wiring where indicated or needed.
8. Locate fixed surfaces of enclosure to coincide precisely with window mullions and partition system terminations. Provide closures at ends of units, at recessed openings in base of units, and at other locations where needed to conceal unfinished wall or floor surfaces, piping, conduit, ductwork, or heating-cooling units.
    a. Provide built-in partitions (bulkheads) within enclosures between heating-cooling units, located to coincide with mullions and partition system terminations. Seal partitions to faces of enclosures with compressible gaskets or mastic sealing tape, and cover both sides of partitions with sound-deadening insulation attached to partitions with insulation adhesive.

L. Lighting Coves
1. Form lighting coves from metal of type and thickness indicated below. Coordinate size of coves, location of cutouts for electrical wiring, and method of attachment to adjoining construction.
    a. Aluminum Sheet: 0.063 inch (1.60 mm).
        1) Finish: Baked enamel or powder coat **OR** Siliconized polyester **OR** High-performance organic coating **OR** Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
    b. Galvanized-Steel Sheet: 0.052 inch (1.32 mm).
        1) Finish: Factory primed **OR** Baked enamel **OR** Siliconized polyester **OR** High-performance organic coating **OR** Powder coat, **as directed**.
    c. Steel Sheet: 0.048 inch (1.21 mm).
        1) Finish: Factory primed **OR** Baked enamel **OR** Powder coat, **as directed**.
    d. Fabricate light coves with hairline butt joints **OR** tapered edges for taping and spackling, **as directed**.
    e. Provide mitered corners, factory welded with backplates **OR** factory endcaps, **as directed**.
    f. Lighting coves may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.

M. Metal Base
1. Form metal base from metal of type and thickness indicated below:
    a. Aluminum Sheet: 0.063 inch (1.60 mm).
        1) Finish: Baked enamel or powder coat **OR** Siliconized polyester **OR** High-performance organic coating **OR** Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
    b. Stainless-Steel Sheet: 0.050 inch (1.27 mm).
        1) Finish: No. 2B **OR** No. 4 **OR** No. 6 **OR** No. 7 **OR** No. 8, **as directed**.

N. Mullion Cladding
1. Form mullion cladding from metal of type and thickness indicated below. Fabricate to fit tightly to adjoining construction.
   a. Aluminum Sheet: 0.063 inch (1.60 mm).
      1) Finish: Baked enamel or powder coat **OR** Siliconized polyester **OR** High-performance organic coating **OR** Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
   b. Galvanized-Steel Sheet: 0.052 inch (1.32 mm).
      1) Finish: Factory primed **OR** Baked enamel **OR** Siliconized polyester **OR** High-performance organic coating **OR** Powder coat, **as directed**.
   c. Stainless-Steel Sheet: 0.050 inch (1.27 mm).
      1) Finish: No. 2B **OR** No. 4 **OR** No. 6 **OR** No. 7 **OR** No. 8, **as directed**.

O. Pipe System Covers
1. Form pipe system covers from metal of type and thickness indicated below. Coordinate size of covers, location of cutouts for piping, and method of attachment to adjoining construction.
   a. Galvanized-Steel Sheet: 0.052 inch (1.32 mm).
      1) Finish: Factory primed **OR** Baked enamel **OR** Siliconized polyester **OR** High-performance organic coating **OR** Powder coat, **as directed**.
   b. Steel Sheet: 0.048 inch (1.21 mm).
      1) Finish: Factory primed **OR** Baked enamel **OR** Powder coat, **as directed**.

P. Pockets For Window Treatment
1. Form pockets from metal of type and thickness indicated below, with end closures. Coordinate dimensions and attachment methods with window treatment equipment, window frames, ceiling suspension system, and other related construction to produce a coordinated, closely fitting assembly.
   a. Aluminum Sheet: 0.063 inch (1.60 mm).
      1) Finish: Baked enamel or powder coat **OR** Siliconized polyester **OR** High-performance organic coating **OR** Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
   b. Galvanized-Steel Sheet: 0.052 inch (1.32 mm).
      1) Finish: Factory primed **OR** Baked enamel **OR** Siliconized polyester **OR** High-performance organic coating **OR** Powder coat, **as directed**.
   c. Steel Sheet: 0.048 inch (1.21 mm).
      1) Finish: Factory primed **OR** Baked enamel **OR** Powder coat, **as directed**.
   d. Pockets for window treatment may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.
2. Reinforce pockets for attaching window treatment equipment and hardware, or increase metal thickness.
3. Divide continuous pockets with built-in partitions located to separate adjoining drapery and blind units, to coincide with window mullions, and to receive filler panels at ends of partitions.

Q. Window Stools
1. Form window stools from metal of type and thickness indicated below, with end closures:
   a. Aluminum Sheet: 0.063 inch (1.60 mm).
      1) Finish: Baked enamel or powder coat **OR** Siliconized polyester **OR** High-performance organic coating **OR** Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
   b. Galvanized-Steel Sheet: 0.052 inch (1.32 mm).
      1) Finish: Factory primed **OR** Baked enamel **OR** Siliconized polyester **OR** High-performance organic coating **OR** Powder coat, **as directed**.
   c. Stainless-Steel Sheet: 0.050 inch (1.27 mm) **OR** 1.3 mm, **as directed**.
      1) Finish: No. 2B **OR** No. 4 **OR** No. 6 **OR** No. 7 **OR** No. 8, **as directed**.
   d. Bronze Sheet: 0.051 inch (1.29 mm).

1) Finish: Buffed finish, lacquered **OR** Hand-rubbed finish, lacquered **OR** Statuary conversion coating over satin finish, **as directed**.

2. Weld seams at end closures.
OR
Braze seams at end closures.
3. Apply sound-deadening insulation **OR** mastic, **as directed**, to underside of window stools.

R. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Complete mechanical finishes of flat sheet metal surfaces before fabrication where possible. After fabrication, finish all joints, bends, abrasions, and other surface blemishes to match sheet finish.
3. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
4. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.
5. Finish items indicated on Drawings after assembly.
6. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

S. Aluminum Finishes
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
3. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
   a. Color: Champagne **OR** Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from full range of industry colors and color densities, **as directed**.
4. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
5. Siliconized Polyester Finish: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
6. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

   OR

   High-Performance Organic Finish: Three **OR** Four, **as directed**,-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   b. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

T. Galvanized-Steel Sheet Finishes
1. Preparing Galvanized Items for Factory Priming: Thoroughly clean galvanized decorative formed metal of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.
2. Preparing Galvanized Items for Factory Finishing: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it.
3. Repairing Galvanized Surfaces: Clean welds and abraded areas and repair galvanizing to comply with ASTM A 780.
4. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
5. Factory-Painted Finish: Comply with Division 09 Section(s) "Exterior Painting" OR "High-performance Coatings", **as directed**.
   a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
6. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
7. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils (0.04 mm). Prepare, treat, and coat metal to comply with resin manufacturer's written instructions.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
8. Siliconized-Polyester Coating: Immediately after cleaning and pretreating, apply manufacturer's standard epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
9. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

   OR

   High-Performance Organic Finish: Three **OR** Four, **as directed**,-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

U. Steel Sheet Finishes
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."
2. Pretreatment: Immediately after cleaning, apply a conversion coating of type suited to organic coating applied over it.

3. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
4. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).
    a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
5. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils (0.04 mm). Prepare, treat, and coat metal to comply with resin manufacturer's written instructions.
    a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

V. Stainless-Steel Finishes
1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
    a. Run grain of directional finishes with long dimension of each piece.
3. Bright, Cold-Rolled, Unpolished Finish: No. 2B.
4. Directional Satin Finish: No. 4.
5. Dull Satin Finish: No. 6.
6. Satin, Reflective, Directional Polish: No. 7.
7. Mirrorlike Reflective, Nondirectional Polish: No. 8 finish.
8. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

W. Copper-Alloy Finishes
1. Finish designations for copper alloys comply with the system established for designating copper-alloy finish systems defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."
2. Buffed Finish: M21 (Mechanical Finish: buffed, smooth specular).
3. Hand-Rubbed Finish: M31-M34 (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed).
4. Medium-Satin Finish: M32 (Mechanical Finish: directionally textured, medium satin).
5. Fine-Matte Finish: M42 (Mechanical Finish: nondirectional finish, fine matte).
6. Buffed Finish, Lacquered: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear organic, air drying, as specified below).
    a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
7. Hand-Rubbed Finish, Lacquered: M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear organic, air drying, as specified below).
    a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
8. Medium-Satin Finish, Lacquered: M32-O6x (Mechanical Finish: directionally textured, medium satin; Coating: clear organic, air drying, as specified below).
    a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
9. Fine-Matte Finish, Lacquered: M42-O6x (Mechanical Finish: nondirectional finish, fine matte; Coating: clear organic, air drying, as specified below).

a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).

10. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide), with color matching the Owner's sample.
11. Statuary Conversion Coating over Satin Finish, Lacquered: M31-C55-O6x (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide; Coating: clear, organic, air drying, as specified below) , with color matching the Owner's sample:
    a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).

X. Titanium Finishes
1. General: Fabricate items from finished titanium sheet, taking care not to damage finish during fabrication. Protect finish as needed during fabrication by applying a strippable, temporary protective covering.
2. Dull Matte Finish: Pickled and annealed.
3. Bright Matte Finish: Vacuum annealed.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative formed metal.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation
1. Locate and place decorative formed metal items level and plumb and in alignment with adjacent construction. Perform cutting, drilling, and fitting required to install decorative formed metal.
    a. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.
2. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where needed to protect metal surfaces and to make a weathertight connection.
3. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers as indicated.
4. Install concealed gaskets, joint fillers, insulation, sealants, and flashings, as the Work progresses, to make exterior decorative formed metal items weatherproof.
5. Install concealed gaskets, joint fillers, sealants, and insulation, as the Work progresses, to make interior decorative formed metal items soundproof or lightproof as applicable to type of fabrication indicated.
6. Corrosion Protection: Apply bituminous paint or other permanent separation materials on concealed surfaces where metals would otherwise be in direct contact with substrate materials that are incompatible or could result in corrosion or deterioration of either material or finish.
7. Install decorative-formed-metal-clad doors and frames to comply with requirements specified in Division 08 Section "Hollow Metal Doors And Frames".
8. Apply joint treatment at joints of spackled-seam-type metal column covers. Comply with requirements in Division 09 Section "Gypsum Board".

C. Adjusting And Cleaning
1. Unless otherwise indicated, clean metals by washing thoroughly with clean water and soap, rinsing with clean water, and drying with soft cloths.

2. Clean copper alloys according to metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.
3. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
    a. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.
4. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
5. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units.

D. Protection
1. Protect finishes of decorative formed metal items from damage during construction period. Remove temporary protective coverings at time of Final Completion.

END OF SECTION 05 58 16 00

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Task	Specification	Specification Description
05 58 16 00	05 15 16 00	Ornamental Metal
05 59 65 00	01 22 16 00	No Specification Required

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SECTION 05 73 23 00 - MISCELLANEOUS ORNAMENTAL METALS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of Trap Pit Doors; Access to Pipe Trenches; Subway Type Gratings; Manhole, Catch and Retention Basins, Hoods; Iron Fences and Railways, Wicket Guard and Fence; Pipe Railings; Chimney Caps; Cast Iron Sills; Expansion Joints; Chimney Cleanout Doors; Ladders; Ladder Rungs; Retractable Ladders and Balconies, Staircases and Counter-Balanced Stairs; Vent Back Frames in Exhaust Opening of Toilet Rooms; Grilles in Exhaust Openings in Toilet Rooms; Access Doors, Dressing Compartment Seat Frames; Stainless Steel; Lumber Rack; Ganging Rods; Auditorium Loudspeaker Grilles; Bronze Saddles (Exterior), Bronze Expansion Saddles (Interior); Bronze Pipe and Tubes; Aluminum Hat and Coat Racks and Hook Strips; Aluminum Angles for Showers; Aluminum Railings; Miscellaneous Ornamental Metal Work; Hardware.

B. Submittals/Shop Drawings

1. Show all locations, markings, quantities, materials, sizes and shapes.
2. Indicate all methods of connecting, anchoring, fastening, bracing and attaching work of other trades.
3. Do not fabricate until approval of Shop Drawing.
4. Product Design Data: For each type of product indicated in 1.2.

C. Quality Assurance

1. Retractable Ladders, Balconies, and Staircases: For use as a supplemental escape device up to 30 feet (9144 mm), comply with requirements of:
   a. Underwriters Laboratories Inc. for use as a supplementary means of egress; provide UL listing data.
   b. ICC International Building Code.
   c. ICC International Fire Code.
2. For use as a mechanical equipment ladder, comply with requirements of ICC International Mechanical Code.
3. Provide Evaluation Reports showing compliance.

D. Product Handling

1. Before shipment to the job, all finished shall be adequately protected for transporting and erecting periods.
2. Replace damaged items with the approval of the Owner and at no additional cost to the Owner.

1.2 PRODUCTS

A. Frame and Covers

1. Aluminum: ASTM B 221, 6063-T6.
2. Bronze: ASTM B 455, Alloy C 38500.
3. Stainless Steel: ASTM A 167, Type 304.

B. Gratings

1. Aluminum Grating, Banding, and Kick Plate: Rectangular, pressure-locked bearing bars, ASTM B 221, 6063-T6, mill finish.
2. Steel Grating:
3. Grating: Rectangular, welded, ASTM A 569.
4. Bands and Kick Plate: ASTM A 36.
5. Finish: Galvanized, ASTM A 386, or painted with fabricator's standard shop primer.

C. Castings (Frames, Covers, Steps, and Sills)
1. Gray Iron: ASTM A 48, Class 30. Malleable Iron, ASTM A 47.
2. Steel: ASTM A 36; Galvanized, ASTM A 386.
3. Aluminum: ASTM B 26, 356-T6.
4. Stainless Steel: ASTM A 743, Grade CF8 or CF20
5. Bronze: ASTM B 455, Alloy C38500 and ASTM B 135, Alloy C2800.
6. Corner Protection: Steel angles with anchors, ASTM A 36; Galvanized, ASTM A 386.
7. Ventilation Boxes: Extruded Aluminum, ASTM B 221, 6063-T6.

D. Pipe and Tube Railings and Ladders
1. Post and rails: Steel pipe, ASTM A 53, Type E or S, Grade B, Schedule 40.
2. Bars and Rungs: ASTM A 36.
3. Finish: Galvanized, ASTM A 386 or shop primer, Fed. Spec. TT-P-86, Type I or II; TT-P-615, Type I, II, or V; TT-P-645.
4. Aluminum: ASTM B 221, 6063-T6, T-52.
5. Steel: ASTM A 36, A 500, A 501.
6. Stainless Steel: ASTM A 544, Grade MT304; ASTM A 312, Grade TP304; ASTM A 167, Type 304.

E. Retractable Ladders and Balconies
1. Ladders
   a. Maintenance-free, aluminum and stainless steel construction.
   b. Rungs: Extruded aluminum, 6005-T5 and 6005-T6 alloy.
   c. Stiles: Extruded aluminum, 6063-T6 alloy.
   d. Support 1,000 pounds (454 kg) per rung individually and 200 pounds per 6 feet (90 kg per 1.83 m) of length simultaneously.
   e. Ground support of gravity loads; building wall support for lateral stability.
   f. Provide deployment handle at each access level.
   g. Provide removable deployment handle at lower access point; provide locking hub and padlock.
   h. Provide dual safety rails at ladders with access from both sides.
   i. Provide reinforcement channel where ladders extend beyond wall support, such as at parapets and roof tops, or where ladder spans open areas in excess of 5 feet (1524 mm) between attachment points.
   j. Height: As directed.
2. Balconies
   a. Aluminum, 6063-T6 alloy.
   b. Provide aluminum access balconies at locations as directed.
   c. Size: As directed.
   d. Railing: 42-inch (1,067 mm) rail 2 sides, restraining chain 1 side.
   e. Platform Capacity: 100 pounds per square foot (488 kg/square m), unless directed otherwise.
   f. Railing Capacity: Uniform load of not less than 50 pounds per lineal foot (74.5 kg per lineal m), unless directed otherwise.
   g. Balustrade: Not less than 36 inches (914 mm) high.
   h. Pickets and Rails: Configured not to pass a sphere 4 inches (100 mm) in diameter. Exception; triangular openings formed by riser, tread, and rail, configured not to pass a sphere 6 inches (150 mm) in diameter.
3. Factory Finish: Clear anodized **OR** Manufacturer's standard shop-applied enamel **OR** As selected from manufacturer's standard colors **OR** Match paint sample supplied by the Owner, **as directed**.

F. Staircases and Counter-Balanced Stairs
1. Provide aluminum staircases, platforms, and counter-balanced stairs at locations indicated on the drawings.
2. Platform Capacity: 100 pounds per square foot (488 kg/square m), unless directed otherwise.

3. Railing Capacity: Uniform load of not less than 50 pounds per lineal foot (74.5 kg per lineal m), unless directed otherwise.
4. Required Width: Minimum 36 inches (914 mm).
5. Stair Rise: 4 inches (102 mm) minimum, 10 inches (254 mm) maximum.
6. Treads: 10 inches (254 mm) in depth.
7. Balustrade: Not less than 36 inches (914 mm) high.
8. Pickets and Rails: Configured not to pass a sphere 4 inches (101.6 mm) in diameter.
   a. Exception: Triangular openings formed by riser, tread, and rail configured not to pass a sphere 6 inches (152.4 mm) in diameter.
   b. Rail Projection: 3-1/2 inches (89 mm) maximum from each side of stairway into required width.

1.3 EXECUTION

A. Trap Pit Doors
1. Furnish and set trap pit doors and frames flush with the finish floors, pavement, grade or as otherwise required. Doors for interior pits shall be of 1/4 inch checkered steel plate set in angle frames having mitered and welded corners and angle seat for covers, provided with bronze lifting handles. Doors and frames for exterior pits shall be of cast iron and hinged with 3-1/2 x 5 inch extra heavy bronze hinges. All doors shall be provided with locking devices.

B. Access to Pipe Trenches
1. Checkered or flat steel plate access doors to pipe trenches below cellar floors shall be made in accordance with detail. Include angle iron frame, anchors, hardware, etc., complete. The steel plate access doors shall be flush with the adjoining floors. Hinges shall be approved bronze flush type. Provide bronze lift handle and approved locking device for each access door.
2. Doors shall be covered with resilient tile where required. Where cement floors occur, top of steel cover shall be flush, but depressed for other finishes as required by the thickness of floor finish. **See other Sections of Specifications for Finish.**
3. All doors under this section unless otherwise specified, shall be secured in place with bronze square shank locking device and brass deck plate with slot and socket holes. Furnish six (6) wrenches for brass deck plates for each different size of locking device.

C. Manhole, Catch and Retention Basins, Hoods
1. Furnish cast iron manhole covers, catch basin covers and cast iron hoods for masonry, manholes, catch basins and retention basins furnished and installed under Division 22 OR Division 28.
2. Manhole covers and frames for catch basins shall be of cast iron, with locking device and key, equal to Flockhart Company No. 35-139.
3. Covers and frames for catch basins shall be of cast iron, with locking device and key, equal to Flockhart Company No. 35-328.
4. Covers and frames for catch basins shall be of cast iron, with locking device and key, equal to Flockhart Company No. 18-919.
5. Cast iron hoods for catch basins and manhole shall be equal to Flockhart Company pattern number indicated.

D. Iron Fences and Railings
1. Furnish and erect iron railings, fences, and gates. Materials of fences and railings shall be medium steel, shapes as required.
2. Posts and braces shall be leaded into cast-iron shoes, which shall be embedded in the concrete pavements or blocks. Center picket of each panel of 6 foot fence shall be leaded 2 inches into curb or pavement. Fences and railings on stone copings, platforms, steps or check blocks shall be leaded into sockets cut in same. Gates shall be hung with hinges. Provide all hasps required for locking gates in both open and closed positions. Double and quadruple gates shall also be furnished with sliding lever bolts and galvanized, malleable iron catches having pipe anchor and

drain embedded in concrete. Gates shall be locked open or closed with Type C Padlocks. Rivet the padlocks to the gates as required. Single gates require 1 padlock; double gates, 2 padlocks; quadruple gates, 4 padlocks.

3. Furnish cast-iron shoes for fence posts and set them at the proper time so that they may be cast into the concrete footing and pavements with top flush with finished surfaces.
4. Folding swing gates shall have fast pin to hold in closed position.
5. Unless otherwise required center rails and side rails on outside steps shall be made of 1-1/4 inch solid posts with 2-1/2 inch by 1/2 inch horizontal flats spaced as required, with top rail of two bronze, aluminum or steel channels and steel stiffener. Post at upper level of center railings shall be of malleable cast iron of height required, tapering from 1-3/4 inches at bottom to 1-1/4 inches at top, with finial. All posts shall be leaded-in 4 inches in cheeks and steps.

E. Wicket Guard and Fence

1. Furnish and install wicket guard fence 12 inches high constructed of 1/2 inch round bent steel rods welded together, to form a continuous wicket fence around the concrete curbing at seeded and planted areas. This guard fence shall be set in concrete footing specified under Division 03 Section "Cast-in-place Concrete".

F. Pipe Railings

1. Furnish and erect wrought iron or steel pipe railings and hand rails together with all fittings, flanges, collars, brackets, bolts, etc. of sizes required, all put together and secured in place in a thorough manner. All pipe railings shall be welded assembly, with continuous "V" joints, full thickness of pipe wall, welds filled solid and ground smooth. All radii, curves, sweeps, bends, etc., as indicated on details for pipe fitting assembly shall be maintained in the welded assembly. For pipe handrails in connection with stairs, see Division 05 Section "Pipe And Tube Railings".
2. Center pipe rails and free standing end pipe railings on outside concrete steps shall be made of 1-1/2 inch nominal diameter pipe and have pipe uprights with cast-iron collar and cap fittings secured in place with tap screws. The uprights shall be leaded-in pipe sleeves. Upright at upper level of center radii shall be of 2 inch nominal diameter pipe with approved cap.
3. Handrails at side of outside steps against walls shall be 1 inch nominal diameter pipes, with returns against wall at ends, and supported on galvanized cast-iron brackets and wall plates same as specified for egress stair.
4. Handrails at side of outside steps against iron fences shall be 1 inch nominal diameter, with returns at ends and supported on wrought iron brackets and plates. Handrails at area walls shall be 1-1/4 inch nominal diameter.
5. All outside pipe railings and handrails including fittings, etc., shall be galvanized after fabrication.
6. Furnish the combined pipe sleeve and base plate and turn over same for setting in concrete work.
7. Exterior barrier rails (at areaways, etc.) shall be of 1-1/2 inch nominal diameter pipe; interior barrier rails (at pits, changes in floor levels, etc.) shall be 1-1/4 inch nominal diameter.

G. Chimney Caps

1. Chimneys shall be provided with cast-iron caps.

H. Cast-Iron Sills

1. Furnish cast-iron sills for exterior doors of bulkheads, etc. The sills shall be set in a bed of cement and be substantially secured with bolts or expansion bolts.

I. Expansion Joints

1. Furnish and install all rolled steel members with required anchors at structural expansion joints through slabs. Items cast in concrete shall be furnished when required for setting. Provide bronze plates as required; top surfaces of plates shall be "BRONZOGRIT" or approved equal.

J. Chimney Cleanout Doors

1. Furnish to the mason proper cleanout doors of sizes indicated for chimneys, of 10 gauge steel plate and steel flats. The doors shall have angle-iron frames with strap anchors. Hang door with two 4 x 4 inch steel hinges and secure door with a latch.

K. Ladders
   1. Furnish and set ladders 18 inches wide, constructed with steel plate stringers, 3/4 inch diameter single rung treads let in and welded to stringers, angle and flat braces, and when required shall have pipe hand rails all riveted together. Secure ladders with angle clip and expansion bolts at top, bottom and elsewhere as required.

L. Ladder Rungs
   1. When ladder rungs are indicated built into mason work, furnish to the mason 5/8 inch galvanized wrought-iron ladder rungs.
   2. Ladder rungs in concrete shall be 15 inches wide and shall be built into concrete every 14 inches in height projecting into walls 4 inches on each side.
   3. Ladder rungs in brickwork of chimney shall be 18 inches wide, and shall be built into brickwork every 5 courses in height, project 8 inches beyond face of wall and continue 8 inches into wall with a 2 inch return. First rung shall start 10 feet above roof level at chimney.

M. Retractable Ladders, Staircases and Counter-Balanced Stairs
   1. Fabrication: Shop fabricate and assemble to maximum extent practicable for installation on-site with minimal labor.
   2. Accessories
      a. Provide brackets, spacers, etc, necessary for a complete installation.
         1) Brackets: 6063-T6 aluminum alloy.
         2) Pivot Pins, Springs, Masonry Bolts, Fasteners, and Base Plates: Stainless steel.
      b. Provide removable deployment handle at lower access point of retractable ladders.
         OR
         Provide removable deployment handle at lower access point of retractable ladders and locking hub and padlock.
      c. Fasteners for securement to wood construction: Stainless steel lag bolts; 3/8-inch (9.5 mm) diameter, 4-inches (100 mm) minimum embedment.
      d. Fasteners for securement to steel construction: Stainless steel bolts, nuts, and washers; 3/8-inch (9.5 mm) diameter.
   3. Footing: Install concrete footing in accordance with manufacturer's requirements, and in compliance with Division 03 Section "Cast-in-place Concrete".
   4. Install components in strict compliance with manufacturer's instructions.
   5. Adjust And Clean
      a. Adjust operating parts for smooth deployment and storage.
      b. Remove scraps and debris; leave project site in clean and orderly condition.
      c. Instruct Owner's representative in proper operation.

N. Vent Back Frames in Exhaust Opening of Toilet Rooms
   1. Furnish and install 12 gauge bent steel frames in exhaust openings in partitions of toilet rooms. Frames shall be set plumb in partitions to receive the vent grilles. Baffle plates are not required.

O. Grilles in Exhaust Openings
   1. Furnish and set in frames at exhaust openings in toilet partitions, approved pressed steel bar type grilles with baked on primer, as manufactured by Tuttle and Bailey, Catalog No. T-80, or approved equal. Grilles shall be secured with tap screws to the frame. The bars of grilles shall be fixed and of rigid construction and shall be set at the angle required. Submit sample of grille for approval.
   2. Furnish and install individually adjustable shutters attached to grille frames, in certain toilets where required. Grilles shall be bar type, equal to Register and Grille Mfg. Co. No. 3311 or Tuttle and Bailey No. A-77.

3. In general, vent openings are provided in partitions of all toilet rooms back of water closets; however, certain smaller toilets, are mechanically vented by means of vent openings in ceiling or in partitions close to ceilings.

P. Access Doors
1. Access doors and frames that are to be furnished and installed as part of the work of this Contract shall be furnished and installed under Division 08 Section "Access Doors And Frames".
2. Access doors and frames that are to be furnished and installed in metal lath and plaster walls and ceilings as part of the work of this Contract shall be constructed of high grade sheet steel with 16 gauge frames and 14 gauge doors. Doors shall be equipped with concealed hinges and cylinder locks all keyed alike (furnish six (6) keys); doors in ceilings may have screwdriver operated type of lock. Doors shall have one piece plain trim set flush with finish surface. Stock doors manufactured by Columbia Metal Product Co., Karp Metal Products Co., or approved equal complying with the specifications, may be accepted. Submit sample for approval if not already approved.

Q. Dressing Compartment Seat Frames
1. Where seats are indicated in dressing compartments, furnish and set 1/4 x 1-1/2 inch flat galvanized bent steel brackets.

R. Stainless Steel
1. Stainless Steel and Cabinet Top Supports: Furnish and install adjustable, stainless steel tubing forming legs to support the tops of sinks and cabinets together with the stainless steel screens, collars, plates, etc., of sizes required. The screens shall be wrapped around and tap screwed to the legs of sink tubing.
2. Stainless Steel Jambs at Dressing Compartments: Furnish and install 14 gauge stainless steel tube jambs at doors to dressing compartments adjoining shower stalls. These jambs shall be anchored to the structural facing tile partition with 14 gauge stainless steel straps.
3. Package Slide: Furnish and install stainless steel half round strips and anchors (type 304 (18-8)) for package slide to Receiving Room. Strips shall be plug welded to anchors.
4. Angle and Channel Guards: Furnish and install angle and channel guards in the kitchen and auxiliary areas. Guards shall be 12 gauge stainless steel satin finish of length and dimensions required, secured in place with oval head stainless steel bolts in expansion shields.
5. Stainless Steel Shelf: Furnish and install stainless steel shelves complete with brackets, of gauges required, generally in helps' locker room, over sinks in locker rooms, in eraser cleaning closets, art room and medical office.

   Note: All stainless steel shall be chrome nickel cold rolled alloy designated by trade name Stainless Steel 18-8, No. 4 Finish; it shall contain a minimum of 18% chromium, 8% nickel, and not more than 0.12% carbon, non-magnetic (straight chrome iron not accepted).

S. Lumber Rack
1. Furnish a lumber rack for the woodworking room and general crafts shop, constructed with angles and provided with chains and hoods as required.

T. Hanging Rods
1. Furnish and erect hanging rods of diameters required of wrought-iron or steel pipe supported on approved hangers, brackets or flanges cabinets, closets and elsewhere throughout the building where required.

U. Auditorium Loudspeaker Grilles
1. Furnish and install complete, two (2) loudspeaker grilles in Auditorium. Grilles shall be equal to Blumcraft Deluxe-Line. Grille facets shall have a bronze anodized finish on faces and brushed finish on backs. Supporting bars #258 to have dull black anodized finish.
2. Frame of grilles shall be equal to Blumcraft's trim section WF-4, anodized black, and be secured to masonry with stainless steel screws (slack painted heads) in expansion shields.

3. Sub-frame shall be formed from 1/4" thick aluminum bar with corners mitered, continuously welded and ground smooth and firmly secured in place. Provide continuous piano hinge with 3/16" stop angle.
4. The inside surface of grille shall be entirely covered with black grille cloth equal to "Acousticloth", as manufactured by Merlang or "Lumite", as manufactured by Chicopee. Grille cloth shall be fastened in place. Submit samples for approval.
5. Include continuous angles and all other angles, plates, bars and reinforcing channels, all as required.
6. Contractor is to verify all dimensions at job before fabricating any of the work.
7. Loudspeaker enclosure and sound absorbing blanket will be furnished and installed as part of the work of Division 27 Section "Public Address And Mass Notification Systems".

V. Bronze Saddles (Exterior)
   1. All exterior door saddles shall be of bronze unless otherwise indicated. White bronze shall be provided for aluminum doors. Finish shall be "Bronzogrit" or an approved equal.

W. Bronze Expansion Saddles (Interior)
   1. Furnish and install bronze expansion saddles generally in the following areas: doors opening off auditorium platform or stage; gymnasium; dance room. None required in store room. Saddles shall consist of bronze flats, plates, and angle clips. Installation shall allow for 3/4 inch expansion. Exposed surfaces of plates and flats shall be "Bronzogrit" or approved equal.

X. Bronze Pipe and Tubes
   1. Furnish 1 inch square bronze tubes in toilet rooms and pipe spaces. Tubes shall be turned over to mason for installation. Tubes shall be of proper length (not less than full thickness of wall) and provided with bronze wire bars at one end.

Y. Aluminum Hat and Coat Racks and Hook Strips
   1. Furnish and install hat and coat racks and hook strips in locations required. Racks and hook strips shall be constructed of aluminum channels, flats and tubing of sizes required, toggle or expansion bolted to walls to suit conditions. Aluminum shall have alumilite finish.
   2. Submit shop drawings for approval.

Z. Aluminum Angles for Showers
   1. Furnish and install aluminum angle bracing as required. Angles shall have alumilite finish. Submit shop drawings for approval prior to fabrication.

AA. Aluminum Railings
   1. Center and side rails and wall handrails shall be of aluminum when required. Posts and horizontal members shall be solid. Posts shall be 1-1/2 inches square, extend through intermediate rails, secured to top rail with 3/8 inch stud bolts; posts at upper level shall be of height indicated, tapering from 1-3/4 inches at bottom to 1-1/4 inches at top, with finial. Posts shall be solidly set with molten sulphur or other approved non-electrolytic material into a combination 1/4 inch pipe sleeve and base plate welded to same, sleeve shall be welded to stair stringer or tread to suit condition, or set in concrete sub-stair.
   2. Exterior Aluminum Railings shall be constructed required. Aluminum posts shall be solid 1-1/2 inches square, extend through bottom rail, let into top rail and continuously welded. Center railing shall have tapered aluminum post of size and taper as required for "center rail". Rails shall be formed to shape indicated from, 3" x 1" solid aluminum flats with rounded edges.
   3. Roof railing shall be as required.
   4. Grab bars in toilets where indicated.
   5. All aluminum railings shall have finish equal to 204-C2 Aluminum Co. of America.

BB. Miscellaneous Ornamental Metal Work
   1. Include all other ornamental metal work. Submit shop drawings for approval.

CC. Hardware

1. All hardware specified under Ornamental Metal Work shall match the approved samples in the office of the Owner. One sample of each item shall be submitted for approval of the Owner.
2. The key to all locks furnished under Ornamental Metal Work shall be provided with brass tags attached to the key with a strong metal ring or link and be similar to the tags specified under Hardware. The tags shall have stamped upon them the letters the Owner and the name or number of the room, closets, etc., for which the keys are intended.
3. All type C padlocks mentioned in this Section will be furnished as specified under Hardware. The Contractor for Ornamental Metal Work shall rivet padlock chains referred to in this Section in place.

DD. Painting

1. All Ornamental Metal Work and cast-iron work excepting cast-iron work to be set in concrete and galvanized items shall be thoroughly cleaned and painted one shop coat specified in Division 07.
2. After installation, all damaged surfaces of shop coat and all rough surfaces shall be scraped or sanded smooth and then touched up.

END OF SECTION 05 73 23 00

SECTION 05 73 23 00a - ORNAMENTAL RAILINGS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for ornamental railings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Aluminum decorative railings with stainless-steel, wire-rope guard infill, **as directed**.
   b. Copper-alloy decorative railings.
   c. Stainless-steel decorative railings with stainless-steel, wire-rope guard infill, **as directed**.
   d. Steel and iron decorative railings with stainless-steel, wire-rope guard infill, **as directed**.
   e. Glass- and plastic-supported railings.
   f. Post-supported railings with glass infill.
   g. Illuminated decorative railings.

C. Definitions

1. Railings: Guards, handrails, and similar devices used for protection of occupants at open-sided floor areas, pedestrian guidance and support, visual separation, or wall protection.

D. Performance Requirements

1. Delegated Design: Design railings, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
   a. Aluminum: The lesser of minimum yield strength divided by 1.65 or minimum ultimate tensile strength divided by 1.95.
   b. Copper Alloys: 60 percent of minimum yield strength.
   c. Stainless Steel: 60 percent of minimum yield strength.
   d. Steel: 72 percent of minimum yield strength.
   e. Glass: 25 percent of mean modulus of rupture (50 percent probability of breakage), as listed in "Mechanical Properties" in AAMA's Aluminum Curtain Wall Series No. 12, "Structural Properties of Glass."
      1) Requirement above is based on the 2006 International Building Code (IBC) for safety factor of 4.
3. Structural Performance: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
   a. Loads below are based on the 2006 International Building Code (IBC).
      1) Handrails and Top Rails of Guards:
         a) Uniform load of 50 lbf/ft. (0.73 kN/m) applied in any direction.
         b) Concentrated load of 200 lbf (0.89 kN) applied in any direction.
         c) Uniform and concentrated loads need not be assumed to act concurrently.
      2) Infill of Guards:
         a) Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
         b) Infill load and other loads need not be assumed to act concurrently.
      3) Glass-Supported Railings: Support each section of top rail by a minimum of three glass panels or by other means so top rail will remain in place if any one panel fails.

4. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
   a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
5. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

E. Submittals
1. Product Data: For the following:
   a. Manufacturer's product lines of railings assembled from standard components.
   b. Grout, anchoring cement, and paint products.
2. LEED Submittals:
   a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
3. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   a. For illuminated railings, include wiring diagrams and roughing-in details.
4. Samples: For each type of exposed finish required.
   a. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
   b. Each type of glass required.
   c. Fittings and brackets.
   d. Welded connections.
   e. Brazed connections.
   f. Assembled Samples of railing systems, made from full-size components, including top rail, post, handrail, and infill. Show method of finishing members at intersections. Samples need not be full height.
5. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
6. Qualification Data: For qualified professional engineer **OR** testing agency, **as directed**.
7. Mill Certificates: Signed by manufacturers of stainless-steel products certifying that products furnished comply with requirements.
8. Welding certificates.
9. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

F. Quality Assurance
1. Source Limitations: Obtain each type of railing from single source from single manufacturer.
2. Product Options: Information on Drawings and in Specifications establishes requirements for system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including structural analysis, preconstruction testing, field testing, and in-service performance.
   a. Do not modify intended aesthetic effects, as judged solely by the Owner, except with the Owner's approval. If modifications are proposed, submit comprehensive explanatory data to the Owner for review.
3. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   c. AWS D1.6, "Structural Welding Code - Stainless Steel."

4. Safety Glazing Labeling: Permanently mark glass with certification label of the SGCC **OR** the SGCC or another certification agency acceptable to authorities having jurisdiction **OR** manufacturer, **as directed**. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
6. Preinstallation Conference: Conduct conference at Project site.

G. Project Conditions
1. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.

H. Coordination And Scheduling
1. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
2. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
3. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not suit structural performance requirements.

1.2 PRODUCTS

A. Metals, General
1. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
2. Brackets, Flanges, and Anchors: Same metal and finish as supported rails unless otherwise indicated.
   a. Provide cast-metal brackets with flange tapped for concealed anchorage to threaded hanger bolt.
   b. Provide either formed- or cast-metal brackets with predrilled hole for exposed bolt anchorage.
   c. Provide formed-steel brackets with predrilled hole for bolted anchorage and with snap-on cover that matches rail finish and conceals bracket base and bolt head.
   d. Provide extruded-aluminum brackets with interlocking pieces that conceal anchorage. Locate set screws on bottom of bracket.

B. Aluminum
1. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.
2. Extruded Bars and Shapes, Including Extruded Tubing: ASTM B 221 (ASTM B 221M), Alloy 6063-T5/T52.
3. Extruded Structural Pipe and Round Tubing: ASTM B 429/B 429M, Alloy 6063-T6.
   a. Provide Standard Weight (Schedule 40) pipe unless otherwise indicated.
4. Drawn Seamless Tubing: ASTM B 210 (ASTM B 210M), Alloy 6063-T832.
5. Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 5005-H32 **OR** Alloy 6061-T6, **as directed**.
6. Die and Hand Forgings: ASTM B 247 (ASTM B 247M), Alloy 6061-T6.
7. Castings: ASTM B 26/B 26M, Alloy A356.0-T6.
8. Perforated Metal: Aluminum sheet, ASTM B 209 (ASTM B 209M), Alloy 6061-T6, 0.063 inch (1.60 mm) thick, with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows.

9. Woven-Wire Mesh: Intermediate-crimp, diamond **OR** square, **as directed**, pattern, 2-inch (50-mm) woven-wire mesh, made from 0.162-inch (4.1-mm) nominal diameter wire complying with ASTM B 211 (ASTM B 211M), Alloy 6061-T94.

C. Copper Alloys
1. Copper and Copper Alloys, General: Provide alloys indicated and with temper to suit application and forming methods, but with strength and stiffness not less than Temper H01 (quarter hard) for plate, sheet, strip, and bars and Temper H55 (light drawn) for tube and pipe.
2. Extruded Shapes, Bronze: ASTM B 455, Alloy UNS No. C38500 (architectural bronze).
3. Extruded Shapes, Brass: ASTM B 249/B 249M, Alloy UNS No. C36000 (free-cutting brass).
4. Extruded Shapes, Nickel Silver: ASTM B 249/B 249M, Alloy UNS No. C79600.
5. Seamless Pipe, Bronze: ASTM B 43, Alloy UNS No. C23000 (red brass, 85 percent copper).
6. Seamless Tube, Bronze: ASTM B 135 (ASTM B 135M), Alloy UNS No. C23000 (red brass, 85 percent copper).
7. Seamless Tube, Brass: ASTM B 135 (ASTM B 135M), Alloy UNS No. C26000 (cartridge brass, 70 percent copper).
8. Seamless Tube, Copper: ASTM B 75 (ASTM B 75M), Alloy UNS No. C12200 (phosphorous deoxidized, high residual phosphorous copper).
9. Castings, Bronze: Composition bronze castings complying with ASTM B 62, Alloy UNS No. C83600 (85-5-5-5 or No. 1 composition commercial red brass) or sand castings complying with ASTM B 584, Alloy UNS No. C86500 (No. 1 manganese bronze).
10. Castings, Brass: Sand castings complying with ASTM B 584, Alloy UNS No. C85200 (high-copper yellow brass).
11. Castings, Copper: ASTM B 824, with a minimum of 99.9 percent copper.
12. Castings, Nickel Silver: ASTM B 584, Alloy UNS No. C97300 (12 percent leaded nickel silver).
13. Plate, Sheet, Strip, and Bars; Bronze: ASTM B 36/B 36M, Alloy UNS No. C28000 (muntz metal, 60 percent copper).
14. Plate, Sheet, Strip, and Bars; Brass: ASTM B 36/B 36M, Alloy UNS No. C26000 (cartridge brass, 70 percent copper).
15. Plate, Sheet, Strip, and Bars; Copper: ASTM B 152/B 152M, Alloy UNS No. C11000 (electrolytic tough pitch copper) or Alloy UNS No. C12200 (phosphorous deoxidized, high-residual phosphorous copper).

D. Stainless Steel
1. Tubing: ASTM A 554, Grade MT 304 **OR** Grade MT 316 **OR** Grade MT 316L, **as directed**.
2. Pipe: ASTM A 312/A 312M, Grade TP 304 **OR** Grade TP 316 **OR** Grade TP 316L, **as directed**.
3. Castings: ASTM A 743/A 743M, Grade CF 8 or CF 20 **OR** Grade CF 8M or CF 3M, **as directed**.
4. Sheet, Strip, Plate, and Flat Bar: ASTM A 666, Type 304 **OR** Type 316 **OR** Type 316L, **as directed**.
5. Bars and Shapes: ASTM A 276, Type 304 **OR** Type 316 **OR** Type 316L, **as directed**.
6. Wire Rope and Fittings:
   a. Wire Rope: 1-by-19 **OR** 7-by-7 **OR** 7-by-19, **as directed**, wire rope made from wire complying with ASTM A 492, Type 316.
   b. Wire-Rope Fittings: Connectors of types indicated, fabricated from stainless steel, and with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.
7. Expanded Metal: ASTM F 1267, Type **I** (expanded) **OR** Type **II** (expanded and flattened), **as directed**, Class 3 (corrosion-resisting steel), made from stainless-steel sheet complying with ASTM A 666, Type 304 **OR** Type 316, **as directed**.
   a. Style Designation: 3/4 number 13 **OR** 1-1/2 number 10, **as directed**.
8. Perforated Metal: Stainless-steel sheet, ASTM A 240/A 240M or ASTM A 666, Type 304 **OR** Type 316L, **as directed**, 0.062 inch (1.59 mm) thick, with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows.

9. Woven-Wire Mesh: Intermediate-crimp, diamond **OR** square, **as directed**, pattern, 2-inch (50-mm) woven-wire mesh, made from 0.135-inch (3.5-mm) nominal diameter wire complying with ASTM A 580/A 580M, Type 304 **OR** Type 316, **as directed**.

E. Steel And Iron
1. Recycled Content of Steel Products: Provide products with average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
2. Tubing: ASTM A 500 (cold formed) or ASTM A 513.
3. Bars: Hot-rolled, carbon steel complying with ASTM A 29/A 29M, Grade 1010.
4. Plates, Shapes, and Bars: ASTM A 36/A 36M.
5. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.
6. Expanded Metal: ASTM F 1267, Type I (expanded) **OR** Type II (expanded and flattened), **as directed**, Class 1 (uncoated).
   a. Style Designation: 3/4 number 13 **OR** 1-1/2 number 10, **as directed**.
7. Perforated Metal: Cold-rolled steel sheet, ASTM A 1008/A 1008M, or hot-rolled steel sheet, ASTM A 1011/A 1011M, commercial steel Type B, 0.060 inch (1.52 mm) thick, with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows.
   OR
   Perforated Metal: Galvanized-steel sheet, ASTM A 653/A 653M, G90 (Z275) coating, commercial steel Type B, 0.064 inch (1.63 mm) thick, with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows **OR** with 1/8-by-1-inch (3.2-by-25.4-mm) round end slotted holes in staggered rows, **as directed**.
8. Woven-Wire Mesh: Intermediate-crimp, diamond **OR** square, **as directed**, pattern, 2-inch (50-mm) woven-wire mesh, made from 0.135-inch (3.5-mm) nominal diameter wire complying with ASTM A 510 (ASTM A 510M).

F. Glass And Glazing Materials
1. Tempered Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated), Type 1 (transparent flat glass), Quality-Q3. Provide products that have been tested for surface and edge compression according to ASTM C 1048 and for impact strength according to 16 CFR 1201 for Category II materials.
   a. Glass Color: Clear **OR** Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
   b. Thickness for Structural Glass Balusters: As required by structural loads, but not less than 12.0 **OR** 19.0, **as diected**, mm.
   c. Thickness for Glass Infill Panels: As required by structural loads, but not less than 6.0 **OR** 10.0, **as directed**, mm.
      OR
      Thickness: As indicated on Drawings.
2. Laminated Glass: ASTM C 1172, Condition A (uncoated), Type I (transparent flat glass), Quality-Q3 with two plies of glass and polyvinyl butyral interlayer not less than 0.060 inch (1.52 mm) thick.
   a. Kind: LA (laminated annealed) **OR** LHS (laminated heat strengthened) **OR** LT (laminated tempered) **OR** As indicated, **as directed**.
   b. Glass Color: Clear **OR** Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
   c. Interlayer Color: Clear **OR** Blue-green **OR** Bronze light **OR** Gray **OR** As selected from manufacturer's full range, **as directed**.
   d. Glass Plies for Structural Glass Balusters: Thickness required by structural loads, but not less than 6.0 **OR** 8.0, **as directed**, mm thick, each.
   e. Glass Plies for Glass Infill Panels: Thickness required by structural loads, but not less than 3.0 **OR** 4.0 **OR** 5.0, **as directed**, mm, each.
3. Ceramic-Coated Glass: Heat-treated float glass, Condition C; with ceramic enamel applied by silk-screened process; complying with Specification No. 95-1-31 in GANA's "Engineering Standards Manual" and with other requirements specified.

a. Glass Color: Clear **OR** Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray **OR** As selected from manufacturer's full range, **as directed**.

4. Plastic Structural Glazing: Uncoated, transparent, monolithic acrylic sheet complying with ASTM D 4802, Category A-1 or A-2 (cell cast or continuous cast), Finish 1 (smooth or polished), and as follows:
   a. Color: Colorless (clear) **OR** Blue **OR** Blue-green **OR** Bronze **OR** Gray **OR** Green **OR** Match glass, **as directed**.
   b. Thickness: 12.0 mm **OR** Match glass thickness, **as directed**.
5. Glazing Cement and Accessories for Structural Glazing: Glazing cement, setting blocks, shims, and related accessories as recommended or supplied by railing manufacturer for installing structural glazing in metal subrails.
   a. Glazing Cement: Nonshrinking organic cement designed for curing by passing an electric current through metal subrail holding glass panel, as standard with manufacturer.
6. Glazing Gaskets for Glass Infill Panels: Glazing gaskets and related accessories recommended or supplied by railing manufacturer for installing glass infill panels in post-supported railings.

G. Fasteners
1. Fastener Materials: Unless otherwise indicated, provide the following:
   a. Aluminum Components: Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners.
   b. Copper-Alloy (Bronze) Components: Silicon bronze (Alloy 651 or Alloy 655) fasteners where concealed; muntz metal (Alloy 280) fasteners where exposed.
   c. Copper-Alloy (Brass) Components: Silicon bronze (Alloy 651 or Alloy 655) fasteners where concealed; brass (Alloy 260 or Alloy 360) fasteners where exposed.
   d. Stainless-Steel Components: Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners.
   e. Uncoated Steel Components: Plated-steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating where concealed; Type 304 stainless-steel fasteners where exposed.
   f. Galvanized-Steel Components: Plated-steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating.
   g. Dissimilar Metals: Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners.
2. Fasteners for Anchoring to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads, **as directed**.
3. Provide concealed fasteners for interconnecting railing components and for attaching railings to other work unless otherwise indicated **OR** exposed fasteners are unavoidable **OR** exposed fasteners are the standard fastening method for railings indicated,**as directed**.
   a. Provide Phillips **OR** tamper-resistant **OR** square or hex socket, **as directed**, flat-head machine screws for exposed fasteners unless otherwise indicated.
4. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
5. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.
   a. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
   b. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) **OR** Group 2 (A4), **as directed**, stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

H. Miscellaneous Materials
1. Wood Rails: Clear, straight-grained hardwood rails secured to recessed **OR** exposed, **as directed**, metal subrail.
   a. Species: Ash **OR** Cherry **OR** Red oak **OR** Walnut **OR** White oak, **as directed**.

b. Finish: Manufacturer's standard **OR** Transparent polyurethane **OR** Penetrating oil **OR** Acrylic impregnated, **as directed**.
c. Staining: None **OR** Match the Owner's sample **OR** As selected from manufacturer's full range, **as directed**.
d. Profile: Square, 1-3/4 by 1-3/4 inches (45 by 45 mm) with edges eased to 1/4-inch (6-mm) radius **OR** Rectangular, 1-3/4 by 5 inches (45 by 127 mm) with edges eased to 1/4-inch (6-mm) radius **OR** Round, 2-inch (50-mm) diameter **OR** As indicated, **as directed**.

OR

Wood Rails: Hardwood rails complying with Division 06 Section "Interior Architectural Woodwork"

2. Electrical Components: Provide internal, fluorescent light fixtures and electrical components, required as part of illuminated railings, that comply with NFPA 70 and that are listed and labeled by UL.
3. Plastic Handrail Caps: Thermoplastic rail covering, color as indicated or, if not indicated, as selected by the Owner from manufacturer's standard colors.
4. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
   a. For aluminum railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
5. Brazing Rods: For copper-alloy railings, provide type and alloy as recommended by producer of metal to be brazed and as required for color match, strength, and compatibility in fabricated items.
6. Lacquer for Copper Alloys: Clear acrylic lacquer specially developed for coating copper-alloy products.
7. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
8. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
9. Shop Primers: Provide primers that comply with Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
10. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
    a. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
11. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
12. Shop Primer for Galvanized Steel: Cementitious galvanized metal primer complying with MPI#26 **OR** Vinyl wash primer complying with MPI#80 **OR** Water-based galvanized metal primer complying with MPI#134, **as directed**.
13. Intermediate Coats and Topcoats: Provide products that comply with Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
14. Epoxy Intermediate Coat: Complying with MPI#77 and compatible with primer and topcoat.
15. Polyurethane Topcoat: Complying with MPI#72 and compatible with undercoat.
16. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
17. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
18. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
    a. Water-Resistant Product: At exterior locations and where indicated provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

I. Fabrication

1. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

2. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
3. Make up wire-rope assemblies in the shop to field-measured dimensions with fittings machine swaged. Minimize amount of turnbuckle take-up used for dimensional adjustment so maximum amount is available for tensioning wire ropes. Tag wire-rope assemblies and fittings to identify installation locations and orientations for coordinated installation.
4. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
5. Form work true to line and level with accurate angles and surfaces.
6. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.
7. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
8. Connections: Fabricate railings with welded or nonwelded connections unless otherwise indicated.
9. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
   a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   b. Obtain fusion without undercut or overlap.
   c. Remove flux immediately.
   d. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds: no evidence of a welded joint.
10. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.
11. Brazed Connections: Connect copper-alloy railings by brazing. Cope components at connections to provide close fit, or use fittings designed for this purpose. Braze corners and seams continuously.
   a. Use materials and methods that match color of base metal, minimize distortion, and develop maximum strength and corrosion resistance.
   b. Remove flux immediately.
   c. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and brazed surface matches contours of adjoining surfaces.
12. Mechanical Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
   a. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.
13. Form changes in direction as follows:
   a. As detailed.
      OR
      By bending or by inserting prefabricated elbow fittings.
      OR
      By flush bends or by inserting prefabricated flush-elbow fittings.
      OR
      By radius bends of radius indicated or by inserting prefabricated elbow fittings of radius indicated.
      OR
      By bending to smallest radius that will not result in distortion of railing member.
14. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
15. Close exposed ends of hollow railing members with prefabricated end fittings.

16. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns, unless clearance between end of rail and wall is 1/4 inch (6 mm) or less.
17. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
    a. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers, or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.
18. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.
19. For railing posts set in concrete, provide steel **OR** stainless-steel, **as directed**, sleeves not less than 6 inches (150 mm) long with inside dimensions not less than 1/2 inch (13 mm) greater than outside dimensions of post, with metal plate forming bottom closure.
20. For removable railing posts, fabricate slip-fit sockets from steel **OR** stainless-steel, **as directed**, tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height. Provide socket covers designed and fabricated to resist being dislodged.
    a. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.
21. Expanded-Metal Infill Panels: Fabricate infill panels from stainless-steel **OR** steel, **as directed**, expanded metal unless otherwise indicated.
    a. Edge panels with U-shaped channels made from same metal as infill; not less than 0.043 inch (1.1 mm) thick.
    b. Orient expanded metal with long dimension of diamonds parallel to top rail **OR** perpendicular to top rail **OR** horizontal **OR** vertical, **as directed**.
22. Perforated-Metal Infill Panels: Fabricate infill panels from perforated metal made from steel **OR** galvanized steel **OR** aluminum **OR** stainless steel **OR** same metal as railings in which they are installed, **as directed**.
    a. Edge panels with U-shaped channels made from metal sheet, of same metal as perforated metal and not less than 0.043 inch (1.1 mm) thick.
    b. Orient perforated metal with pattern parallel to top rail **OR** perpendicular to top rail **OR** horizontal **OR** vertical **OR** as indicated on Drawings, **as directed**.
23. Woven-Wire Mesh Infill Panels: Fabricate infill panels from woven-wire mesh crimped into 1-by-1/2-by-1/8-inch (25-by-13-by-3-mm) metal channel frames.
    a. Make wire mesh and frames from aluminum **OR** stainless steel **OR** steel, **as directed**, unless otherwise indicated.
    b. Orient wire mesh with diamonds vertical **OR** wires perpendicular and parallel to top rail **OR** wires horizontal and vertical, **as directed**.
24. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

J. Glazing Panel Fabrication
1. General: Fabricate to sizes and shapes required; provide for proper edge clearance and bite on glazing panels.
    a. Clean-cut or flat-grind edges at butt-glazed sealant joints to produce square edges with slight chamfers at junctions of edges and faces
    b. Grind smooth exposed edges, including those at open joints, to produce square edges with slight chamfers at junctions of edges and faces.
2. Structural Glass Balusters: Factory-bond glass to aluminum base and top-rail channels in railing manufacturer's plant using glazing cement to comply with manufacturer's written specifications, unless field glazing is standard with manufacturer.
3. Structural Balusters: Provide tempered **OR** laminated, heat-strengthened **OR** laminated, tempered, **as directed**, glass panels for both straight and curved sections, **as directed**.
   OR

Structural Balusters: Provide thermoformed, curved, plastic glazing panels for curved sections and tempered **OR** laminated, heat-strengthened **OR** laminated, tempered, **as directed**, glass panels for straight sections.

OR

Infill Panels: Provide tempered **OR** laminated, annealed **OR** laminated, heat-strengthened **OR** laminated, tempered, **as directed**, glass panels for both straight and curved sections, **as directed**.

K. Illuminated Railings

1. General: Comply with requirements in this Section for aluminum railings with welded connections.
2. Illuminated Units: Provide internal illumination using concealed, internally wired, fluorescent-strip fixture system to illuminate walking surfaces adjacent to railings without light leaks. Make provisions for servicing and for concealed connection to electric service. Coordinate electrical characteristics with those of the power supply provided.
   a. Fluorescent Tubes: Provide number of tubes indicated or required by railing length.
   b. Diffusers: UV-stabilized acrylic diffusers matching profile of railings.
   c. Ballasts: Energy-saving, high power factor, Class P, electromagnetic type; designed for use with high-output lamps, and with automatic-reset thermal protection. Ballasts comply with ANSI C82.1, bear Certified Ballast Manufacturer Certification labels, and are rated for 0 deg F (minus 17 deg C) **OR** minus 20 deg F (minus 29 deg C), **as directed**, starting temperature.

L. General Finish Requirements

1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.
3. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
4. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

M. Aluminum Finishes

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Mechanical Finish: AA-M3x (Mechanical Finish: as specified); sand top rails, handrails, and intermediate rails in one direction only, parallel to length of railing, with 120- and 320-grit abrasive. After installation, polish railings with No. 0 steel wool immersed in paste wax, then rub to a luster with a soft dry cloth.
3. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
4. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
   a. Color: Champagne **OR** Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from full range of industry colors and color densities, **as directed**.
5. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

6. Siliconized Polyester Finish: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
7. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

   OR

   High-Performance Organic Finish: Three **OR** Four, **as directed**,-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   b. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

N. Copper-Alloy Finishes
1. Finish designations for copper alloys comply with the system for designating copper-alloy finish systems defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."
2. Buffed Finish: M21 (Mechanical Finish: buffed, smooth specular).
3. Hand-Rubbed Finish: M31-M34 (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed).
4. Medium-Satin Finish: M32 (Mechanical Finish: directionally textured, medium satin).
5. Fine-Matte Finish: M42 (Mechanical Finish: nondirectional finish, fine matte).
6. Buffed Finish, Lacquered: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear organic, air drying, as specified below).
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
7. Hand-Rubbed Finish, Lacquered: M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear organic, air drying, as specified below).
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
8. Medium-Satin Finish, Lacquered: M32-O6x (Mechanical Finish: directionally textured, medium satin; Coating: clear organic, air drying, as specified below).
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
9. Fine-Matte Finish, Lacquered: M42-O6x (Mechanical Finish: nondirectional finish, fine matte; Coating: clear organic, air drying, as specified below).
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
10. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide), with color matching the Owner's sample.
11. Patina Conversion Coating: M36-C12-C52 (Mechanical Finish: directionally textured, uniform; Chemical Finish: nonetched cleaned, degreased; Chemical Finish: conversion coating, ammonium sulfate), with color matching the Owner's sample.

O. Stainless-Steel Finishes

1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
    a. Run grain of directional finishes with long dimension of each piece.
3. Directional Satin Finish: No. 4.
4. Dull Satin Finish: No. 6.
5. Satin, Reflective, Directional Polish: No. 7.
6. Mirrorlike Reflective, Nondirectional Polish: No. 8.
7. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
8. Sputter-Coated Finish: Titanium nitride coating deposited by magnetic sputter-coating process over indicated mechanical finish.

P. Steel And Iron Finishes
1. Galvanized Railings:
    a. Hot-dip galvanize steel **OR** exterior steel, **as directed**, and iron railings, including hardware, after fabrication.
    b. Hot-dip galvanize indicated steel and iron railings, including hardware, after fabrication.
    c. Comply with ASTM A 123/A 123M for hot-dip galvanized railings.
    d. Comply with ASTM A 153/A 153M for hot-dip galvanized hardware.
    e. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
    f. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
2. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
3. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.
4. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors to be embedded in exterior concrete or masonry.
5. Preparing Nongalvanized Items for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning" **OR** SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning" **OR** requirements indicated below, **as directed**:
    a. Exterior Railings: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
    b. Railings Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
    c. Railings Indicated to Receive Primers Specified in Division 9 Section "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
    d. Other Railings: SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
6. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.
    a. Shop prime uncoated railings with universal shop primer **OR** primers specified in Division 07, **as directed**, unless zinc-rich primer is **OR** primers specified in Division 09 Section "High-performance Coatings" are, **as directed**, indicated.
    b. Do not apply primer to galvanized surfaces.
7. Shop-Painted Finish: Comply with Division 09 Section(s) "Exterior Painting" OR "High-performance Coatings", **as directed**.
    a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
8. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.

a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

9. Powder-Coat Finish: Prepare, treat, and coat nongalvanized ferrous metal to comply with resin manufacturer's written instructions and as follows:
   a. Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   b. Treat prepared metal with iron-phosphate pretreatment, rinse, and seal surfaces.
   c. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils (0.04 mm).
   d. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
10. Powder-Coat Finish: Prepare, treat, and coat galvanized metal to comply with resin manufacturer's written instructions and as follows:
    a. Prepare galvanized metal by thoroughly removing grease, dirt, oil, flux, and other foreign matter.
    b. Treat prepared metal with zinc-phosphate pretreatment, rinse, and seal surfaces.
    c. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils (0.04 mm).
    d. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

1.3 EXECUTION

A. Examination
1. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

B. Installation, General
1. Fit exposed connections together to form tight, hairline joints.
2. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
   a. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
   b. Set posts plumb within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
   c. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet (5 mm in 3 m).
3. Corrosion Protection: Coat concealed surfaces of aluminum and copper alloys that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
4. Adjust railings before anchoring to ensure matching alignment at abutting joints.
5. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

C. Railing Connections
1. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.
2. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

3. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches (50 mm) beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches (150 mm) of post.

D. Anchoring Posts
1. Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.
2. Form or core-drill holes not less than 5 inches (125 mm) deep and 3/4 inch (20 mm) larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.
3. Cover anchorage joint with flange of same metal as post, welded to post after placing anchoring material **OR** attached to post with set screws, **as directed**.
OR
Leave anchorage joint exposed with 1/8-inch (3-mm) buildup, sloped away from post **OR** anchoring material flush with adjacent surface, **as directed**.
4. Anchor posts to metal surfaces with flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
   a. For aluminum railings, attach posts as indicated using fittings designed and engineered for this purpose.
   b. For copper-alloy railings, attach posts as indicated using fittings designed and engineered for this purpose.
   c. For stainless-steel railings, weld flanges to posts and bolt to metal-supporting surfaces.
   d. For steel railings, weld flanges to posts and bolt to metal-supporting surfaces.
5. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

E. Attaching Railings
1. Anchor railing ends to concrete and masonry with sleeves concealed within **OR** flanges connected to **OR** brackets on underside of rails connected to, **as directed**, railing ends and anchored to wall construction with anchors and bolts.
2. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends or connected to railing ends using nonwelded connections.
3. Attach handrails to walls with wall brackets except where end flanges are used. Provide brackets with 1-1/2-inch (38-mm) clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
   a. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt **OR** predrilled hole for exposed bolt anchorage, **as directed**.
   b. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
4. Secure wall brackets and railing end flanges to building construction as follows:
   a. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
   b. For hollow masonry anchorage, use toggle bolts.
   c. For wood stud partitions, use hanger or lag bolts set into wood backing between studs. Coordinate with carpentry work to locate backing members.
   d. For steel-framed partitions, use hanger or lag bolts set into fire-retardant-treated, **as directed**, wood backing between studs. Coordinate with stud installation to locate backing members.
   OR
   For steel-framed partitions, fasten brackets directly to steel framing or concealed steel reinforcements using self-tapping screws of size and type required to support structural loads.

OR
For steel-framed partitions, fasten brackets with toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

F. Installing Glass Panels
1. Glass-Supported Railings: Install assembly to comply with railing manufacturer's written instructions.
   a. Attach base channel to building structure, then insert and connect factory-fabricated and -assembled glass panels if glass was bonded to base and top rail channels in factory.
   b. Attach base channel to building structure, then insert glass into base channel and bond with glazing cement unless glass was bonded to base and top rail channels in factory.
      1) Support glass panels in base channel at quarter points with channel-shaped setting blocks that also act as shims to maintain uniform space for glazing cement. Fill remaining space in base channel with glazing cement for uniform support of glass.
   c. Adjust spacing of glass panels so gaps between panels are equal before securing in position.
   d. Erect glass railings under direct supervision of manufacturer's authorized technical personnel.
2. Post-Supported Glass Railings: Install assembly to comply with railing manufacturer's written instructions and with requirements in other Part 1.3 articles. Erect posts and other metal railing components, then set factory-cut glass panels. Do not cut, drill, or alter glass panels in field. Protect edges from damage.

G. Installing Plastic Handrail Caps
1. Apply plastic handrail caps to top rails and handrails, where indicated, complying with manufacturer's written instructions for cutting, mounting, forming, welding, cleaning, applying end caps, and finishing.
2. Minimize number of joints in plastic caps by installing in lengths as long as possible. Allow for shortening of plastic cap caused by welding and splicing process; butt ends together to produce hairline joint.
   a. Continuously weld, splice, miter, and end-cap joints using cap manufacturer's electric welding iron designed for this purpose. Remove welding flash while material is still soft.
   b. Weld only prongs on underside of plastic cap at splice, miter, and end-cap joints. After cutting plastic cap, dress ends with file to produce a hairline fit between abutting sections. After mounting cap, polish top surface with cap manufacturer's solvent designed for this purpose until joint becomes almost invisible.

H. Field Quality Control
1. Testing Agency: Perform field tests and inspections and prepare test reports.
2. Extent and Testing Methodology: Randomly select completed railing assemblies for testing that are representative of different railing designs and conditions in the completed Work. Railings will be tested according to ASTM E 894 and ASTM E 935 for compliance with performance requirements.
3. Remove and replace railings where test results indicate that they do not comply with specified requirements unless they can be repaired in a manner satisfactory to the Owner and will comply with specified requirements.
4. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Cleaning
1. Clean aluminum and stainless steel by washing thoroughly with clean water and soap, rinsing with clean water, and wiping dry.
2. Clean copper alloys according to metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.

3. Clean and polish glass and plastic glazing as recommended in writing by manufacturer. Wash both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Final Completion.
4. Clean wood rails and plastic handrail caps by wiping with a damp cloth and then wiping dry.
5. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   a. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

   OR

   Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
6. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

J. Protection
1. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Final Completion.
2. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 05 73 23 00a

Task	Specification	Specification Description
05 73 23 00	05 15 16 00	Ornamental Metal
05 75 00 00	05 15 16 00	Ornamental Metal
05 75 00 00	05 73 23 00	Miscellaneous Ornamental Metals
05 75 00 00	05 58 16 00	Ornamental Formed Metal

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SECTION 06 01 20 91 - WOOD RESTORATION

1.1 GENERAL

A. Description Of Work
  1. This specification covers the furnishing and installation of materials for wood restoration. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Work Included
  1. Provide labor, materials and equipment necessary to complete the work of this Section including, but not limited to the following:
    a. Removal of exterior finish systems at areas of wood restoration or repair
    b. Preservation and sealing of seams and joints
    c. Removal of decayed and contaminated wood
    d. Installation of borate wood preservatives
    e. Installation of wood repair compound materials
  2. Extent of wood restoration work is as required to meet Project requirements.

C. Submittals:
  1. Product data, installation instructions, and general recommendations from manufacturer for types of repair required including technical data sheets defining performance properties.
  2. Restoration Schedule: Submit schedule for each window, door, cornice, or area of wood trim to be restored, outlining in detail proposed restoration work to be performed on each component. Obtain written approval prior to commencement of repair work.
  3. Certification that materials comply with local VOC limitations.
  4. Qualification data for firms and persons specified in the “Quality Assurance” article to demonstrate their capabilities and experience. Include a list of completed projects with project name, address, names of Architects and Owners, and information specified.
    a. Five (5) business days after bid opening, submit a written qualification and experience of all lead personnel for work on the Project. List project manager or foreman’s name and experience relative to this Project.
    b. All work shall be performed by persons whose qualifications have been submitted and approved.

D. Quality Assurance
  1. Restorations Specialist: Work must be performed by a firm having not less than (5) years successful experience in comparable wood restoration work including work on at least three (3) buildings listed in the National Register of Historic Places under the direction of federal and state preservation agencies in the last five (5) years and employing personnel skilled in the restoration process and operations indicated.
    a. Restoration Specialist firm must be acceptable to, or certified by, manufactured of primary restoration materials.
    b. Work associated with work of this section, including (but limited to) paint removal and substrate preparation, is to be performed by Installer of the work.
    c. Only skilled workers who are thoroughly trained and experienced in wood repairs and restoration work at areas as noted, have the skills required for the work of this section, and are completely familiar with the materials and methods specified shall be used for wood restoration work.
    d. At least one skilled worker shall be present at all times during the execution of the work and shall personally direct the wood repairs and restoration work.
    e. In acceptance or rejection of the wood restoration work, no allowance will be made for lack of skill on the part of the workers.

2. Manufacturer: Obtain primary repair materials from a single manufacturer. Provide secondary materials as recommended by the manufacturer of the primary materials.

E. Delivery Storage And Handling
1. Deliver all materials in original unopened containers labeled with the manufacturer's name, brand name, item name and installation instructions.
2. Store materials in compliance with the manufacturer's requirements for temperature, maximum and minimum, and other conditions. Keep all materials under cover and dry. Protect against exposure to the weather.
3. Discard and remove from the job site any materials damaged in handling or storage and any materials that have been subjected to conditions contrary to the manufacturer's recommendations or whose maximum shelf life has expired.

F. Project Conditions
1. Lead: Existing paint may contain lead. Take all necessary precautions to ensure the safety of all persons engaged in removing lead-based paint and dispose of all residues generated from lead-based paint stripping in a legal manner in accordance with all local, state and federal codes.
2. Coordination: Coordinate wood repair with paint stripping so that the effected surfaces are exposed for a minimal time to avoid further damage to bare wood. Coordinate with painting so that all restored surfaces are primed as soon as possible after repair.
3. Weather: Proceed with the work of this section only when existing and foreseen weather conditions permit the work to be performed in accordance with the manufacturer's recommendations for temperature and humidity range, minimum and maximum.
4. Substrate Conditions: Do not proceed with product applications until substrates have been inspected and are determined to be in satisfactory conditions. Substrate moisture content shall not be in excess of 18°/0 during preparation and application.
   a. Remove all decayed wood to a clean, sound, unaffected substrate.
   b. Remove all built up paints, and other debris to a clean sound substrate.
   c. Remove all wood sawdust to a clean sound substrate.
5. Protection:
   a. Use all necessary means to protect interior of building from all damage caused by precipitation and other environmental conditions during the work of the Section.
   b. Protect all adjacent building surfaces from damage, staining or deterioration resulting from wood restoration work.
   c. Protect the restoration work in progress to prevent further deterioration exposed wood surfaces. Protect the completed work until the time of final inspection and acceptance by the Owner.
6. Safety: Contractor shall use all means necessary to ensure that no person (whether involved in the work of the Section or not) is harmed or injured due to the work of this Section. Comply with all applicable laws codes and regulations.
7. Security: Coordinate work with the Owner's project manager to ensure that the building is secured at the end of each work period. Review security procedures with the Owner prior to proceeding with the work in this Section.

1.2 PRODUCTS

A. General
1. Compatibility: provide products recommended by the manufacturers to be fully compatible with indicated substrate.

B. Epoxy Repair Products
1. Epoxy repair materials shall consist of 2 separate systems, a 2 part low viscosity epoxy primer/coupling agent and a 2 part thixotropic paste meeting the manufacturer's criteria.
2. Manufacturer of Repair Products and Equipment

a. Manufacturer: Subject to compliance with the requirements, provide product of the following or approved equal.
   1) Advanced Repair Technology
      Cherry Valley, NY
   2) Window Care Systems
      Pembroke, MA
   3) or approved equal

C. Repair Products
   1. Low viscosity epoxy coupling/bonding agent
   2. Epoxy repair compound
   3. Injectable Borate gel
   4. Borate rods

D. Paint Strippers
   1. Chemical Stripping Agent. Methylene chloride based, Thixotropic stripper
   2. Products: Subject to compliance with requirements, provide the following, or approved equal
      a. 509 Stripper
      b. ProSoCo
      c. or approved equal
   3. Low Temperature heat gun or heat plate, no open flame.

1.3 EXECUTION

A. Inspection
   1. Inspect all wood surfaces determine the extent of restoration and methods to be used.
      a. The decision regarding the extent of required repair, and extent of profile replication work shall be final.
      b. In wood surfaces where decay is present, determine the methods and treatment of repair.
      c. Areas that do not attach existing profiles, determine the level of restoration and replication to be achieved.
   2. Joints, Joinery and edges: Check wood members at joints, seams and edges for:
      a. Any open seams or failed conditions.
      b. Wood moisture content.
      c. The presence of wood decay, by probing surfaces.
   3. Sills and Trim
      a. Inspect wood surfaces for natural defects (knots) cracks and checks.
      b. Determine wood moisture content.
      c. Probe for the presence for wood decay.

B. Removal
   1. Removal of Finishes:
      a. Remove all peeling and loose paint by scraping, taking care not to damage sound wood and profiles.
      b. Strip all painted wood surface to bare wood, taking care not to damage sound wood and profiles by the application of stripping paste or by the use of a heat gun or plate
         1) Remove stripper and finishes as directed by manufacturer.
         2) Dispose of debris in accordance with approved methods.
      c. Wash all surfaces with recommended neutralizing agents to remove any foreign particle, dust and chemical residue, allow surface to thoroughly dry.

C. Preventative Systems
   1. Preservation and Sealing of seams and joints. Repair of wood “checking” due to weathering.
      a. Open or failed seams and checks shall be dilated to a width of 3/16” and depth of 1/2”.
      b. Remove all decayed, soft and weathered wood.

c. Check the moisture content and hardness of wood at and around the repair, maximum allowable moisture content 18°/0.
d. Sand bare wood to remove all loose fibers, paint, compounds. Remove all sawdust and dirt.
e. Pre-treat bare and sanded wood thoroughly with low viscosity epoxy coupling/bonding agent
f. Allow coupling agent to penetrate wood surface for a minimum of 10 minutes and maximum of 30 minutes, or as recommended by the manufacturer. Avoid applying in direct sunlight
g. Remove any excess bonding agent with absorbing paper
h. Apply epoxy repair compound over epoxy bonding agent while still tacky.
i. Epoxy compound shall have optimal contact with wood
j. Avoid inclusion of air pockets during application
k. Fill joints fill, even and smooth in one application
l. Allow full cure time as specified by manufacturer before application of paint or varnish.
m. After curing, sand surface even and smooth. Transitions and irregularities between wood and epoxy shall not be visible after sanding
n. If required, smooth any remaining irregularities with an additional application of epoxy repair compound. Always sand between coats.

D. Curative Systems
1. Preservation and Repair of Damaged/Decayed Wood:
a. Remove all paint and other coatings from area to be repaired.
b. Remove all decayed soft and discolored wood, to sound bright unaffected material
c. Check area of removal to determine complete elimination of decayed material.
1) Remaining wood should be even color without red-brown and/or gray spots.
2) No soft wood, existing brittle compound, or other previous repair materials should remain.
d. Check moisture content and hardness of the wood in and around the repair area
1) Moisture content of wood to be 18°/0 or less
e. Sand bare wood to remove all loose fibers, paint, compounds. Remove all sawdust and dirt.
f. Drill holes in effected area to receive borate gel and rods. Follow manufacturer's dose recommendations for dimensional lumber.
g. Inject recommended dose of borate gel. Gel should not come in contact with exposed wood surface.
h. Install borate rod in same hole as gel. Gel should not come in contact with exposed wood surface.
i. Pre-treat bare and sanded wood thoroughly with low viscosity epoxy coupling/bonding agent.
1) Allow coupling/bonding agent to penetrate wood surface for a minimum of 10 minutes and maximum of 30 minutes, or as recommended by the manufacturer. Avoid applying in direct sunlight
2) Remove any excess bonding agent with absorbing paper.
j. Apply epoxy repair compound over the uncured epoxy coupling agent.
1) Epoxy fill shall have optimal contact with wood
2) Avoid inclusion of air pockets during application
3) Fill joints fill, even and smooth in one application
4) Allow full cure time as specified by manufacturer before preparing for finishes.
k. After curing, sand surface even and smooth. Transitions and irregularities between wood and epoxy shall not be visible after sanding.
l. If required, smooth any remaining irregularities with an additional application of epoxy repair compound. Always sand between coats.

E. Adjustments: Repair or replace all defective work at no additional cost to the Owner.

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SECTION 06 01 40 91 - DOOR HARDWARE

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of material for door hardware. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes the following:
   a. Mechanical door hardware for the following:
      1) Swinging doors.
      2) Sliding doors.
      3) Folding doors.
   b. Cylinders for doors specified in other Sections.
   c. Electrified door hardware.
2. Products furnished, but not installed, under this Section include the products listed below. Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.
   a. Pivots, thresholds, weather stripping, and cylinders for locks specified in other Sections.
   b. Permanent cores to be installed by the Owner.

C. Action Submittals

1. Product Data: For each type of product indicated. Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Shop Drawings: Details of electrified door hardware, indicating the following:
   a. Wiring Diagrams: For power, signal, and control wiring and including the following:
      1) Details of interface of electrified door hardware and building safety and security systems.
      2) Schematic diagram of systems that interface with electrified door hardware.
      3) Point-to-point wiring.
      4) Risers.
      5) Elevations doors controlled by electrified door hardware.
   b. Operation Narrative: Describe the operation of doors controlled by electrified door hardware.
3. Samples for Initial Selection: For plastic protective trim units in each finish, color, and texture required for each type of trim unit indicated.
4. Samples for Verification: For exposed door hardware of each type required, in each finish specified, prepared on Samples of size indicated below. Tag Samples with full description for coordination with the door hardware schedule. Submit Samples before, or concurrent with, submission of door hardware schedule.
   a. Sample Size: Full-size units or minimum 2-by-4-inch (51-by-102-mm) Samples for sheet and 4-inch (102-mm) long Samples for other products.
      1) Full-size Samples will be returned to Contractor. Units that are acceptable and remain undamaged through submittal, review, and field comparison process may, after final check of operation, be incorporated into the Work, within limitations of keying requirements.
5. Other Action Submittals:
   a. Door Hardware Schedule: Prepared by or under the supervision of Installer, detailing fabrication and assembly of door hardware, as well as installation procedures and diagrams. Coordinate final door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1) Submittal Sequence: Submit door hardware schedule after or concurrent with submissions of Product Data, Samples, and Shop Drawings, **as directed**. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.
2) Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule." Double space entries, and number and date each page.
3) Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.
4) Content: Include the following information:
   a) Identification number, location, hand, fire rating, size, and material of each door and frame.
   b) Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
   c) Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
   d) Description of electrified door hardware sequences of operation and interfaces with other building control systems.
   e) Fastenings and other pertinent information.
   f) Explanation of abbreviations, symbols, and codes contained in schedule.
   g) Mounting locations for door hardware.
   h) List of related door devices specified in other Sections for each door and frame.

b. Keying Schedule: Prepared by or under the supervision of Installer, detailing the Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

D. Informational Submittals
1. Qualification Data: For Installer and Architectural Hardware Consultant.
2. Product Certificates: For electrified door hardware, from the manufacturer.
   a. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.
3. Product Test Reports: For compliance with accessibility requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.
4. Warranty: Special warranty specified in this Section.

E. Closeout Submittals
1. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware and keying schedule.

F. Quality Assurance
1. Installer Qualifications: An employer of workers trained and approved by lock manufacturer.
   a. Installer's responsibilities include supplying and installing door hardware and providing a qualified Architectural Hardware Consultant available during the course of the Work to consult with Contractor, Architect, and the Owner about door hardware and keying
2. Architectural Hardware Consultant Qualifications: A person who is currently certified by DHI as an Architectural Hardware Consultant **OR** one who meets the requirements necessary for certification, **as directed,** and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.
3. Source Limitations: Obtain each type of door hardware from a single manufacturer.
   a. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that perform electrical modifications and that

are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

4. Fire-Rated Door Assemblies: Where fire-rated door assemblies are indicated, provide door hardware rated for use in assemblies complying with NFPA 80 that are listed and labeled by a qualified testing, for fire protection ratings indicated, based on testing at positive pressure according to NFPA 252 **OR** UL 10C, unless otherwise indicated.
5. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meet requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
    a. Air Leakage Rate: Maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) at the tested pressure differential of 0.3-inch wg (75 Pa) of water.
6. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
7. Means of Egress Doors: Latches do not require more than 15 lbf (67 N) to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.
8. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines **OR** ICC/ANSI A117.1 **OR** HUD's "Fair Housing Accessibility Guidelines", **as directed.**
    a. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22.2 N).
    b. Comply with the following maximum opening-force requirements:
        1) Interior, Non-Fire-Rated Hinged Doors: 5 lbf (22.2 N) applied perpendicular to door.
        2) Sliding or Folding Doors: 5 lbf (22.2 N) applied parallel to door at latch.
        3) Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
    c. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch (13 mm) high and 3/4 inch (19 mm) high for exterior sliding doors.
    d. Adjust door closer sweep periods so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches (75 mm) from the latch, measured to the leading edge of the door.
9. Keying Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management And Coordination". In addition to the Owner, Contractor, and Architect, conference participants shall also include Installer's Architectural Hardware Consultant and Owner's security consultant. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:
    a. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
    b. Preliminary key system schematic diagram.
    c. Requirements for key control system.
    d. Requirements for access control.
    e. Address for delivery of keys.
10. Preinstallation Conference: conduct conference at Project site.
    a. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
    b. Inspect and discuss preparatory work performed by other trades.
    c. Inspect and discuss electrical roughing in for electrified door hardware.
    d. Review sequence of operation for each type of electrified door hardware.
    e. Review required testing, inspecting, and certifying procedures.

G. Delivery, Storage, And Handling
1. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
2. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.
3. Deliver keys to manufacturer of key control system for subsequent delivery to the Owner.
4. Deliver keys and permanent cores to the Owner by registered mail or overnight package service.

H. Coordination
1. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete. Concrete, reinforcement, and formwork requirements are specified in Division 03.
2. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
3. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.
4. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.
5. Existing Openings: Where hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide proper door operation.

I. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Structural failures including excessive deflection, cracking, or breakage.
      2) Faulty operation of doors and door hardware.
      3) Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
   b. Warranty Period: Three years from date of Final Completion, except as follows:
      1) Electromagnetic or Delayed-Egress Locks: Five years from date of Final Completion.
      2) Exit Devices: Two years from date of Final Completion.
      3) Manual Closers: 10 years from date of Final Completion.
      4) Concealed Floor Closers: Five **OR** 10 **OR** 25 years from date of Final Completion, **as directed**.

J. Maintenance Service
1. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.
2. Maintenance Service: Beginning at Final Completion, provide six months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door and door hardware operation. Provide parts and supplies that are the same as those used in the manufacture and installation of original products.

1.2 PRODUCTS

A. Scheduled Door Hardware
1. General: Provide door hardware for each door indicated in Part 1.3 "Door Hardware Sets" Article to comply with requirements in this Section.
   a. Door Hardware Sets: Provide quantity, item, size, finish or color indicated.
   b. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
2. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 1.3 "Door Hardware Sets" Article. Products are identified by descriptive titles corresponding to requirements specified in Part 1.2.

B. Hinges
1. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors ad hollow-metal frames.
2. Antifriction-Bearing Hinges:
a. Mounting: Full-Mortise (Butt) **OR** Half mortise **OR** Full surface **OR** Half surface, **as directed**.
b. Bearing Material: Manufacturer's standard antifriction bearing **OR** Ball bearing, **as directed**.
c. Grade: Grade 1 (heavy weight) **OR** Grade 2 (standard weight), **as directed**.
d. Base and Pin Metal:
1) Exterior Hinges: Stainless steel with stainless-steel pin **OR** Brass with stainless-steel pin body and brass protruding heads, **as directed.**
2) Interior Hinges: Brass with stainless-steel pin body and brass protruding heads **OR** Steel with steel pin **OR** Stainless steel with stainless-steel pin, **as directed**.
3) Hinges for Fire-Rated Assemblies: Steel with steel pin **OR** Stainless steel with stainless-steel pin, **as directed**.
e. Pins: Non-rising loose unless otherwise indicated **OR** Maximum security **OR** Nonremovable, **as directed**.
1) Outswinging Exterior Doors: Maximum security **OR** Nonremovable, **as directed.**
2) Outswinging Corridor Doors with Locks: Maximum security **OR** Nonremovable, **as directed.**
f. Tips: Flat button **OR** Hospital **OR** Oval **OR** Ball **OR** Steeple **OR** Urn **OR** Acorn, **as directed**.
g. Corners: Square **OR** 5/32-inch (4-mm) radius **OR** 1/4-inch (6-mm) radius **OR** 5/8-inch (16-mm) radius, **as directed.**
h. Options: Raised barrel **OR** Reverse safety stud **OR** Safety stud, **as directed.**
3. Electrified Antifriction-Bearing Hinges: Full-mortise mounting.
a. Bearing Material: Manufacturer's standard antifriction bearing **OR** Ball bearing, **as directed.**
b. Grade: Grade 1 (heavy weight) **OR** Grade 2 (standard weight), **as directed**.
c. Base and Pin Metal:
1) Exterior Hinges: Stainless steel with stainless-steel pin **OR** Brass with stainless-steel pin body and brass protruding heads, **as directed**.
2) Interior Hinges: Brass with stainless-steel pin body and brass protruding heads **OR** Steel with steel pin **OR** Stainless steel with stainless-steel pin, **as directed**.
3) Hinges for Fire-Rated Assemblies: Steel with steel pin **OR** Stainless steel with stainless-steel pin, **as directed**.
d. Pins: Non-rising loose unless otherwise indicated **OR** Maximum security **OR** Nonremovable, **as directed**.
1) Outswinging Exterior Doors: Maximum security **OR** Nonremovable, **as directed**.
2) Outswinging Corridor Doors with Locks: Maximum security **OR** Nonremovable, **as directed**.
e. Tips: Flat button **OR** Hospital **OR** Oval **OR** Ball **OR** Steeple **OR** Urn **OR** Acorn, **as directed**.
f. Corners: Square **OR** 5/32-inch (4-mm) radius **OR** 1/4-inch (6-mm) radius **OR** 5/8-inch (16-mm) radius, **as directed**.
g. Options: Raised barrel **OR** Reverse safety stud **OR** Safety stud, **as directed**.
h. Electric Option: Concealed electric through wires **OR** Concealed electric through wires with monitor **OR** Concealed electric monitor **OR** Concealed air transfer **OR** Concealed switch **OR** Exposed electric switch **OR** Exposed electric contacts, **as directed**.
4. Plain-Bearing Hinges: Grade 3 (standard weight).
a. Mounting: Full mortise (butts) **OR** Half mortise **OR** Full surface **OR** Half surface**, as directed.**
b. Base and Pin Metal: Brass with stainless-steel pin body and brass protruding heads **OR** Steel with steel pin**, as directed.**

c. Pins: Non-rising loose unless otherwise indicated **OR** Maximum security **OR** Nonremovable**, as directed.**
   1) Outswinging Corridor Doors with Locks: Maximum security **OR** Nonremovable**, as directed.**
d. Tips: Flat button **OR** Hospital **OR** Oval **OR** Ball **OR** Steeple **OR** Urn **OR** Acorn**, as directed.**
e. Corners: Square **OR** 5/32-inch (4-mm) radius **OR** 1/4-inch (6-mm) radius **OR** 5/8-inch (16-mm) radius**, as directed.**
f. Options: Raised barrel**, as directed.**

5. Electrified Plain-Bearing Hinges: Grade 3 (standard weight); full-mortise mounting.
   a. Mounting: Full mortise (butts) **OR** Half mortise **OR** Full surface **OR** Half surface**, as directed.**
   b. Pins: Non-rising loose unless otherwise indicated **OR** Maximum security **OR** Nonremovable**, as directed.**
      1) Outswinging Corridor Doors with Locks: Maximum security **OR** Nonremovable**, as directed.**
   c. Tips: Flat button **OR** Hospital **OR** Oval **OR** Ball **OR** Steeple **OR** Urn **OR** Acorn**, as directed.**
   d. Corners: Square **OR** 5/32-inch (4-mm) radius **OR** 1/4-inch (6-mm) radius **OR** 5/8-inch (16-mm) radius**, as directed.**
   e. Options: Raised barrel**, as directed.**
   f. Electric Option: Concealed electric through wires **OR** Concealed electric through wires with monitor **OR** Concealed electric monitor **OR** Concealed air transfer **OR** Concealed switch **OR** Exposed electric switch **OR** Exposed electric contacts**, as directed.**
6. Swing-Clear Hinges: Reversible.
   a. Mounting: Full mortise (butts) **OR** Half mortise **OR** Full surface **OR** Half surface**, as directed.**
   b. Bearing, and Grade: Antifriction bearing, Grade 1 (heavy weight) **OR** Antifriction bearing, Grade 2 (standard weight) **OR** Plain bearing, Grade 3 (standard weight)**, as directed.**
   c. Base Metal: Wrought brass or bronze **OR** Stainless steel **OR** Wrought, forged, or cast steel, or malleable iron**, as directed.**
   d. Pins: Non-rising loose unless otherwise indicated **OR** Maximum security **OR** Nonremovable**, as directed.**
      1) Outswinging Exterior Doors: Maximum security **OR** Nonremovable**, as directed.**
      2) Outswinging Corridor Doors with Locks: Maximum security **OR** Nonremovable**, as directed.**
   e. Tips: Flat button **OR** Hospital**, as directed.**
   f. Corners: Square **OR** 5/32-inch (4-mm) radius **OR** 1/4-inch (6-mm) radius **OR** 5/8-inch (16-mm) radius**, as directed.**
   g. Options: Raised barrel **OR** Reverse safety stud **OR** Safety stud**, as directed.**
7. Slip-in-Type Hinges: Full-mortise mounting.
   a. Bearing and Grade: Antifriction, Grade 1 (heavy weight) **OR** Antifriction, Grade 2 (standard weight) **OR** Plain, Grade 3 (standard weight)**, as directed.**
   b. Base Metal: Wrought brass or bronze **OR** Stainless steel **OR** Wrought, forged, or cast steel, or malleable iron**, as directed.**
   c. Swaging: 5/16-inch (7.9-mm) swaging **OR** 3/16-inch (4.8-mm) swaging, handed**, as directed.**
8. Anchor Hinge Set: Grade 1 (heavy weight); consisting of one anchor hinge plus two full-mortise hinges; antifriction bearing; handed; nonremovable pins; flat-button tips.
   a. Base Metal: Wrought brass or bronze **OR** Stainless steel **OR** Wrought, forged, or cast steel, or malleable iron**, as directed.**
   b. Electric Option for Center Hinge: Concealed electric through wires **OR** Concealed electric switch**, as directed.**

9. Pocket Hinges: Antifriction bearing; Grade 1 (heavy weight); jamb leaf visible when door is closed and both leaves concealed when door is in pocket; type required for application indicated; cast steel.
10. Double-Acting Pivot-Hinge Set: Grade 2; wrought, forged, or cast steel or malleable iron base metal; consisting of a top pivot and a bottom pivot, each with jamb brackets, and bottom pivot with thrust steel bearing.

C. Self-Closing Hinges And Pivots
1. Self-Closing Hinges and Pivots: BHMA A156.17.
2. Spring Hinges: Grade 1 **OR** Grade 2**, as directed**; wrought steel, with torsion spring.
    a. Type: Single **OR** Double**, as directed** acting.
    b. Mounting: Full mortise (butts) **OR** Half mortise **OR** Full surface **OR** Half surface**, as directed.**
3. Horizontal-Spring Pivot Sets: Grade 3; double acting; non-handed; consisting of wrought steel bottom pivot hinge with antifriction bearing and nylon top pivot and socket.
    a. Type: Hold-open **OR** Non-hold open**, as directed.**
    b. Tension: Adjustable **OR** Fixed**, as directed.**
    c. Bottom Pivot Trim: Steel **OR** Brass**, as directed.**
    d. Bottom Plate: For bottom hinge attachment to floor **OR** jamb**, as directed.**
4. Gate-Spring Pivot Sets: Grade 1; double acting; non-handed; consisting of bottom pivot with door and jamb bracket and top pivot assembly with jamb bracket.
    a. Mounting: Mortise **OR** Surface**, as directed.**
    b. Tension: Adjustable **OR** Fixed**, as directed.**
    c. Base Metal: Cast, forged, or extruded brass or bronze **OR** Malleable iron**, as directed.**
5. Gravity Pivot Sets: Grade 3; double acting; surface mounting; non-handed; consisting of bottom pivot with door and jamb bracket and top pivot assembly with jamb bracket.
    a. Tension: Adjustable **OR** Fixed**, as directed.**
    b. Base Metal: Wrought brass or bronze **OR** Steel**, as directed.**

D. Center-Hung And Offset Pivots
1. Center-Hung and Offset Pivots: BHMA A156.4.
2. Center-Hung Pivot Sets: Grade 1.
    a. Top Pivots: Walking-beam type with retractable pin and oil-impregnated bronze bearing; mortised into door and frame.
    b. Bottom Pivots: Surface floor mounted, **OR** Recessed in floor in cement case, **OR** Mortised into jamb, **as directed** and mortised into door; with thrust ball **OR** needle bearings**, as directed**.
    c. Base Metal: Brass **OR** Bronze **OR** Steel**, as directed.**
3. Offset Pivot Sets: Grade 1 **OR** 2**, as directed.**
    a. Offset: 3/4 inch (19 mm) **OR** 1-1/2 inches (38 mm)**, as directed.**
    b. Top Pivot: Full-mortise **OR** Half-surface **OR** Full-surface mounting**, as directed**; walking-beam type with retractable pin and oil-impregnated bronze bearing.
        1) Knuckle: Standard **OR** Asylum type**, as directed.**
        2) Option: With screw holes designed to straddle lead in the center of lead-lined door.
    c. Bottom Pivot: Surface floor mounted, **OR** Recessed in floor in cement case, **OR** Mortised into jamb**, as directed** and mortised into door; with thrust ball **OR** needle**, as directed** bearing.
    d. Base Metal: Brass **OR** Bronze **OR** Stainless steel **OR** Steel**, as directed.**
4. Offset Intermediate Pivots: Grade 1; for use with offset pivot sets; with oil-impregnated bronze bearings.
    a. Mounting: Full mortise, 3/4 inch (19 mm) offset **OR** Full mortise, 1-1/2 inches (38 mm) offset **OR** Half mortise **OR** Half surface **OR** Full surface**, as directed.**
    b. Knuckle: Standard **OR** Asylum type**, as directed.**
    c. Option: With screw holes designed to straddle lead in the center of lead-lined door.
    d. Electric Option: Concealed monitoring **OR** Concealed power transfer **OR** Concealed power transfer for use with electrical panic devices and locks**, as directed**.

e. Base Metal: Brass **OR** Bronze **OR** Stainless steel **OR** Steel**, as directed.**

5. Pocket Pivots: Grade 1; full-mortise mounting; non-handed; allows door to nest in pocket with door surface flush with corridor wall when open; maximum 90-degree swing.
   a. Base Metal: Bronze **OR** Stainless steel **OR** Steel**, as directed.**
   b. Electric Option: Concealed power transfer in one hinge per door**.**

E. Continuous Hinges
1. Continuous Hinges: BHMA A156.26; minimum 0.120-inch- (3.0-mm-) thick, hinge leaves with minimum overall width of 4 inches (102 mm); fabricated to full height of door and frame and to template screw locations; with components finished after milling and drilling are complete.
2. Pin-and-Barrel-Type Hinges:
   a. Grade: Grade 1-150 **OR** 1-300 **OR** 1-600 **OR** 2-150 **OR** 2-300 **OR** 2-600 **OR** 3-150 **OR** 3-300**, as directed**.
   b. Exterior Hinges: Stainless steel.
   c. Interior Hinges: Stainless steel **OR** Steel **OR** Aluminum**, as directed.**
   d. Hinges for Fire-Rated Assemblies: Stainless steel with steel fire pins to hold fire-rated doors in place if required by tested listing **OR** Steel**, as directed.**
   e. Type: Concealed leaf **OR** Swing clear **OR** Full surface with removable continuous caps over fasteners **OR** Half mortise, concealed door leaf and with removable continuous cap over fasteners on jamb leaf **OR** Half surface, concealed jamb leaf and with removable continuous cap over fasteners on door leaf**, as directed.**
   f. Electric Option: Electric monitoring switch **OR** Electric through wires and monitor **OR** Electric through wires **OR** Concealed power transfer **OR** Exposed power transfer contact switch**, as directed**.
3. Continuous, Gear-Type Hinges: Extruded-aluminum, pinless, geared hinge leaves joined by a continuous extruded-aluminum channel cap; with concealed, self-lubricating thrust bearings.
   a. Grade: Grade 1-150 **OR** 1-300 **OR** 1-600 **OR** 2-150 **OR** 2-300 **OR** 2-600 **OR** 3-150 **OR** 3-300**, as directed**.
   b. Hinges for Fire-Rated Assemblies: With steel fire pins to hold fire-rated doors in place if required by tested listing.
   c. Mounting: Concealed leaf **OR** Swing clear **OR** Full surface, with removable continuous caps over fasteners **OR** Half surface, concealed jamb leaf and with removable continuous cap over fasteners on door leaf**, as directed.**
   d. Electric Option: Electric monitor **OR** Electric through wires and monitor **OR** Electric through wires **OR** Electric power transfer **OR** Exposed switch **OR** Exposed contact **OR** Removable electric through wires**, as directed**.

F. Mechanical Locks And Latches
1. Lock Functions: As indicated in door hardware schedule.
2. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
   a. Bored Locks: Minimum 1/2-inch (13-mm) latchbolt throw.
   b. Mortise Locks: Minimum 3/4-inch (19-mm) latchbolt throw.
   c. Deadbolts: Minimum 1-inch (25-mm) **OR** 1.25-inch (32-mm) bolt throw**, as directed**.
3. Lock Backset: 2-3/4 inches (70 mm), unless otherwise indicated.
4. Lock Trim:
   a. Description: As indicated on Drawings**, as directed**.
   b. Levers: Wrought **OR** Forged **OR** Cast**, as directed.**
   c. Knobs: Wrought **OR** Forged **OR** Cast**, as directed.**
   d. Escutcheons (Roses): Wrought **OR** Forged **OR** Cast**, as directed.**
   e. Dummy Trim: Match knob **OR** lever, lock trim and escutcheons.
   f. Operating Device: Lever **OR** Knob**, as directed** with escutcheons (roses).
5. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

a. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
b. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
c. Aluminum-Frame Strike Box: Manufacturer's special strike box fabricated for aluminum framing.
d. Rabbet Front and Strike: Provide on locksets for rabbeted meeting stiles.

6. Bored Locks: BHMA A156.2; Grade 1 **OR** 2**, as directed**; Series 4000.
7. Mortise Locks: BHMA A156.13; Operational **OR** Security**, as directed** Grade 1 **OR** 2**, as directed**; stamped steel case with steel or brass parts; Series 1000.
8. Interconnected Locks: BHMA A156.12; Grade 1 **OR** 2**, as directed**; Series 5000.
9. Roller Latches: BHMA A156.16; Grade 1; rolling plunger that engages socket or catch, with adjustable roller projection.
   a. Material: Brass **OR** Bronze**, as directed.**
   b. Mounting: Surface **OR** Mortise**, as directed.**
10. Push-Pull Latches: Bored, BHMA A156.2; Series 4000 **OR** Mortise, BHMA A156.13**, as directed**; Grade 1 **OR** 2**, as directed**; with paddle handles that retract latchbolt; capable of being mounted vertically or horizontally.
   a. Lever and Escutcheon Material: Brass **OR** Bronze **OR** Stainless steel **OR** Aluminum**, as directed.**
   b. Lettering: Engrave with the words "Pull" and "Push."
   c. Lead Lining: 0.047 inch (1.2 mm) thick for escutcheon plate.

G. Auxiliary Locks

1. Bored Auxiliary Locks: BHMA A156.5: Grade 1 **OR** 2**, as directed**; with strike that suits frame.
   a. Backset: 2-3/8 inches (60 mm) **OR** 2-3/4 inches (70 mm)**, as directed.**
   b. Material: Aluminum **OR** Brass **OR** Bronze **OR** Stainless steel **OR** Zinc alloy**, as directed.**
   c. Deadlatches: Deadlocking latchbolt operated by key either side **OR** key outside and turn inside **OR** turn inside with no cylinder**, as directed.**
   d. Deadlocks: Deadbolt operated by key either side **OR** key outside and turn inside **OR** turn inside with no cylinder **OR** key outside, no trim inside**, as directed.**
2. Mortise Auxiliary Locks: BHMA A156.5; Grade 1 **OR** 2**, as directed**; with strike that suits frame.
   a. Backset: 2-3/4 inches (70 mm).
   b. Material: Aluminum **OR** Brass **OR** Bronze **OR** Stainless steel **OR** Zinc alloy**, as directed.**
   c. Deadlocks: Deadbolt operated by key either side **OR** outside and turn inside **OR** one side**, as directed.**
   d. Deadlatches: Latchbolt and auxiliary deadlatch operated by key either side **OR** outside and turn inside**, as directed.**
   e. Deadlocks for Sliding Doors: Expanding- or interlocking-type deadbolt operated by key either side **OR** outside and turn inside **OR** one side**, as directed.**
   f. Deadlatches for Sliding Doors: Hook-type latchbolt operated by key either side **OR** outside and handle inside**, as directed.**
3. Narrow Stile Auxiliary Locks: BHMA A156.5; Grade 1 **OR** 2**, as directed**; with strike that suits frame.
   a. Backset: 0.98 inch (25 mm) **OR** 1.125 inches (29 mm) **OR** 1.25 inches (32 mm) **OR** 1.5 inches (38 mm) **OR** 1.75 inches (44 mm) **OR** 2 inches (51 mm) **OR** 2.25 inches (57 mm) **OR** 2.5 inches (64 mm)**, as directed**.
   b. Strike: Flat **OR** Flat with extra-long lip **OR** Radius **OR** Radius with weatherstrip **OR** Bevel**, as directed.**
   c. Case Material: Steel **OR** Stainless steel**, as directed.**
   d. Armored Front and Strike Material: Aluminum **OR** Brass **OR** Bronze **OR** Stainless steel**, as directed.**
   e. Deadlock: Deadlocking bolt.
      1) Operation: Key both sides **OR** outside and operating trim inside**, as directed.**
      2) Door Application: Swinging **OR** Sliding door**, as directed**.
   f. Deadlatch: Latchbolt with auxiliary deadlatch operated by key outside and paddle or lever inside; for single swinging doors.

g. Multipoint Lock: Deadlocking bolt for pairs of swinging doors.
1) Operation: Key both sides **OR** outside and turn, lever, or knob inside**, as directed.**
2) Type: Two **OR** Three point**, as directed**.
h. Latch/Lock: Deadbolt and latchbolt; both operated by key both sides; inside handle operates only latchbolt.
4. Push-Button Combination Locks: BHMA A156.5; cylindrical; Grade 1 **OR** mortise; Grade 2**, as directed**; lock opens by entering a one- to five-digit code by pushing correct buttons in correct sequence; automatically relocks when door is closed; with strike that suits frame.
a. Lockset Configuration: Standard **OR** Privacy with inside push button**, as directed.**
b. Auxiliary Lock Configuration: Deadbolt **OR** Deadlocking latch **OR** Deadlocking rim latch**, as directed.**
c. Override: By key cylinder.

H. Electric Strikes
1. Electric Strikes: BHMA A156.31; Grade 1 **OR** 2**, as directed**; with faceplate to suit lock and frame.
a. Material: Steel **OR** Stainless steel **OR** Zinc-aluminum alloy**, as directed.**
b. Mounting: Mortised **OR** Semirim mounted **OR** Rim mounted**, as directed.**
2. Fire-Rated Door Assemblies: Use fail-secure electric strikes with fire-rated devices.
3. Monitoring: Mechanical latchbolt **OR** Infrared latchbolt **OR** Mechanical strike **OR** Infrared strike**, as directed.**
4. Options: Lip extension kit.

I. Electromagnetic Locks
1. Electromagnetic Locks: BHMA A156.23; electrically powered; with electromagnet attached to frame and armature plate attached to door; full-exterior or full-interior type, as required by application indicated.
a. Direct-Hold Type: Lock mounted on bottom of header; strike flush mounted on door push side **OR** face of header; strike angle mounted on door pull side **OR** side of jamb; strike flush mounted on door push side**, as directed.**
b. Shear Type: Lock mounted on face of header; strike angle mounted on door **OR** mortised in header; strike mortised in top of door **OR** mortised in jamb; strike mortised in edge of door **OR** mortised in bottom of door; strike mortised in floor **OR** mortised in floor; strike mortised in bottom of door**, as directed.**
c. Strength Ranking: 1500 lbf (6672 N) **OR** 1000 lbf (4448 N) **OR** 500 lbf (2224 N)**, as directed.**
d. Inductive Kickback Peak Voltage: Not more than 53 **OR** 0 V**, as directed**.
e. Residual Magnetism: Not more than 4 lbf (18 N) **OR** 0 lbf (0 N)**, as directed** to separate door from magnet.
f. Options:
1) Magnetic bond sensor.
2) Continuous housing for full width of door.
3) Continuous housing for full height of door.
4) Single LED indicators.
5) Double LED indicators.
6) Adjustable time delay with automatic relock.
7) Integral door position switch.
2. Delayed-Egress Electromagnetic Locks: BHMA A156.24, electrically powered, with electromagnet attached to frame and armature plate attached to door; depressing push bar for more than 3 seconds initiates irreversible alarm and 15-second delay for egress. When integrated with fire alarm, fire alarm voids 15-second delay.
a. Grade: Security Grade, activated from secure side of door by initiating device **OR** Movement Grade, activated by door movement as initiating device**, as directed.**

J. Electromechanical Locks

1. Electromechanical Locks: BHMA A156.25; Grade 1 **OR** 2**, as directed**; motor or solenoid driven; bored **OR** mortise latchbolt **OR** mortise deadbolt **OR** mortise deadlocking latchbolt**, as directed**; with strike that suits frame.

K. Self-Contained Electronic Locks
   1. Self-Contained Electronic Locks: BHMA A156.25, bored **OR** mortise**, as directed**; with internal, battery-powered, self-contained electronic locks; consisting of complete lockset, motor-driven lock mechanism, and actuating device; enclosed in zinc-dichromate-plated, wrought-steel case, and strike that suits frame. Provide key override, low-battery detection and warning, LED status indicators, and ability to program at the lock.
      a. Actuating Device: Digital keypad **OR** Magnetic-stripe card reader**, as directed.**
         1) Card: Manufacturer's standard **OR** 0.030-inch- (0.76-mm-) thick PVC or polyester **OR** Custom**, as directed.**
         2) Accessory: Card encoder and software.
      b. Faceplate Material: Wrought brass **OR** Wrought bronze **OR** Stainless steel**, as directed.**
      c. Trim: Lever **OR** Knob **OR** Match trim specified for mechanical locks**, as directed.**
      d. Function: Latch with **OR** Deadbolt with **OR** Latch without **OR** Deadbolt without**, as directed** key.

L. Exit Locks And Exit Alarms
   1. Exit Locks and Alarms: BHMA A156.29, Grade 1.
   2. Exit Locks: Surface mounted; battery powered, housed in metal case; with manufacturer's standard strike that suits frame; with red-and-white lettering reading "EMERGENCY EXIT PUSH TO OPEN--ALARM WILL SOUND."
      a. Single-Door **OR** Pairs-of-Door Type**, as directed**: Activated by arm, push plate, or paddle **OR** horizontal bar**, as directed.**
      b. Options:
         1) Low-battery alert.
         2) Outside key control.
         3) Audible alarm that sounds when unauthorized use of door occurs.
         4) Silent alarm with remote signal capability for connection to remote indicating panel.
         5) Strike: Surface **OR** Mortise**, as directed.**
   3. Stand-Alone Exit Alarms: Surface mounted on door **OR** Mounted separate from door and activated by door movement switch**, as directed.**
      a. Options:
         1) Low-battery alert.
         2) Outside key control.
         3) Audible alarm that sounds when unauthorized use of door occurs.
         4) Automatic rearming after authorized use, with adjustable time delay**, as directed.**
         5) Remote signal capability for connection to remote indicating panel.

M. Surface Bolts
   1. Surface Bolts: BHMA A156.16.
   2. Half-Round Surface Bolts: Grade 1 **OR** 2**, as directed**, 6-inch (152-mm) polished-brass or burnished-steel, half-round rod and knob; minimum 7/8-inch (22-mm) throw; with universal strike.
   3. Interlocking Surface Bolts: Grade 1 **OR** 2**, as directed**, 6-inch (152-mm) extruded-brass or aluminum, interlocking track and rod; minimum 15/16-inch (24-mm) throw; with universal or mortise strike.
   4. Fire-Rated Surface Bolts: Grade 1 **OR** 2**, as directed**, 8-inch (203-mm) steel bolt with 2 steel guides; minimum 1-inch (25-mm) throw; listed and labeled for fire-rated doors; with universal strike.
   5. Dutch-Door Surface Bolts: Grade 1 **OR** 2**, as directed**, polished-brass bolt and knob, minimum 3/4-inch (19-mm) throw, with standard strike.

N. Manual Flush Bolts

1. Manual Flush Bolts: BHMA A156.16; minimum 3/4-inch (19-mm) throw; designed for mortising into door edge.
2. Manual-Extension Flush Bolts: Grade 1 **OR** 2**, as directed**, fabricated from extruded brass or aluminum, with 12-inch (305-mm) rod actuated by flat lever; listed and labeled for fire-rated doors**, as directed.** Provide with matching **OR** dustproof strike**, as directed**.
3. Slide Flush Bolts: Grade 1 **OR** 2**, as directed**, cast brass, with rod actuated by slide. Provide with matching **OR** dustproof strike**, as directed**.
4. Tubular Bolts: Grade 1 **OR** 2**, as directed**, polished-brass or polished-bronze, oval turn knob and escutcheon; minimum 9/16-inch (14-mm) steel bolt with 1/2-inch (13-mm) throw. Provide with matching **OR** dustproof strike**, as directed**.
5. Dustproof Strikes: Locking type, Grade 1, polished wrought brass, with 3/4-inch- (19-mm-) diameter, spring-tension plunger.

O. Automatic And Self-Latching Flush Bolts
1. Automatic and Self-Latching Flush Bolts: BHMA A156.16; minimum 3/4-inch (19-mm) throw; designed for mortising into door edge.
2. Automatic Flush Bolts: Grade 1 **OR** 2**, as directed**, fabricated from steel and brass components, with spring-activated bolts that automatically retract when active leaf is opened and that automatically engage when active door depresses bolt trigger; listed and labeled for fire-rated doors**, as directed.** Provide brass or stainless-steel cover plate, top and bottom matching **OR** dustproof strikes**, as directed**, guides, guide supports, wear plates, and shims.
3. Self-Latching Flush Bolts: Grade 1 **OR** 2**, as directed**, fabricated from steel and brass components, with spring-activated bolts that automatically engage when active door depresses trigger; listed and labeled for fire-rated doors**, as directed.** Bolts are manually retracted by a slide in the bolt face. Provide brass or stainless-steel cover plate, matching **OR** dustproof**, as directed** top and bottom strikes, guides, guide supports, wear plates, and shims.
4. Dustproof Strikes: Locking type, Grade 1, polished wrought brass, with 3/4-inch- (19-mm-) diameter, spring-tension plunger.

P. Exit Devices And Auxiliary Items
1. Exit Devices and Auxiliary Items: BHMA A156.3.
2. Panic Exit Devices: Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.
3. Fire Exit Devices: Devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252.
4. Rim Exit Devices: Grade 1 **OR** 2**, as directed.**
   a. Type: Type 1, rim **OR** Type 4, narrow stile **OR** Type 28, incorporating a deadbolt**, as directed.**
   b. Grade: Grade 1 OR 2, **as directed**.
   c. Actuating Bar: Cross bar **OR** Push pad **OR** Narrow-stile push pad**, as directed.**
   d. Material: Brass **OR** Bronze **OR** Stainless steel **OR** Aluminum **OR** Wrought steel**, as directed.**
   e. Electrified Options:
      1) Pushpad monitor switch.
      2) Double-pushpad monitor switch.
      3) Electric locking and unlocking.
      4) Delayed egress.
      5) Alarm.
5. Mortise Exit Devices: Grade 1 **OR** 2**, as directed.**
   a. Type: Type 3 **OR** Type 10, narrow stile**, as directed.**
   b. Grade: Grade 1 OR 2, as directed.
   c. Actuating Bar: Cross bar **OR** Push pad **OR** Narrow-stile push pad**, as directed.**
   d. Material: Brass **OR** Bronze **OR** Stainless steel **OR** Aluminum **OR** Wrought steel**, as directed.**

e. Electrified Options:
   1) Pushpad monitor switch.
   2) Double-pushpad monitor switch.
   3) Electric locking and unlocking.
   4) Delayed egress.
   5) Alarm.

6. Surface Vertical-Rod Exit Devices: Grade 1 **OR** 2**, as directed.**
   a. Type: Type 2 **OR** Type 5, narrow stile**, as directed.**
   b. Grade: Grade 1 OR 2, as directed.
   c. Actuating Bar: Cross bar **OR** Push pad **OR** Narrow-stile push pad**, as directed.**
   d. Material: Brass **OR** Bronze **OR** Stainless steel **OR** Aluminum **OR** Wrought steel**, as directed.**
   e. Configuration: Top and bottom rods **OR** Top rod**, as directed.**
   f. Electrified Options:
      1) Pushpad monitor switch.
      2) Double-pushpad monitor switch.
      3) Electric locking and unlocking.
      4) Delayed egress.
      5) Alarm.
7. Concealed Vertical-Rod Exit Devices: Grade 1 **OR** 2**, as directed.**
   a. Type: Type 6, narrow stile **OR** Type 7, for wood doors **OR** Type 8, for metal doors**, as directed.**
   b. Grade: Grade 1 OR 2, as directed.
   c. Actuating Bar: Cross bar **OR** Push pad **OR** Narrow-stile push pad**, as directed.**
   d. Material: Brass **OR** Bronze **OR** Stainless steel **OR** Aluminum **OR** Wrought steel**, as directed.**
   e. Electrified Options:
      1) Pushpad monitor switch.
      2) Double-pushpad monitor switch.
      3) Electric locking and unlocking.
      4) Delayed egress.
      5) Alarm.
8. Combination Exit Devices: Grade 1 **OR** 2**, as directed.**
   a. Type: Type 9, rim and surface vertical rod **OR** Type 11, mortise and surface vertical rod **OR** Type 12, mortise and concealed vertical rod**, as directed.**
   b. Grade: Grade 1 OR 2, as directed.
   c. Actuating Bar: Cross bar **OR** Push pad **OR** Narrow-stile push pad**, as directed.**
   d. Material: Brass **OR** Bronze **OR** Stainless steel **OR** Aluminum **OR** Wrought steel**, as directed.**
   e. Electrified Options:
      1) Pushpad monitor switch.
      2) Double-pushpad monitor switch.
      3) Electric locking and unlocking.
      4) Delayed egress.
      5) Alarm.
9. Automatic Latching Two-Point Bolts: Grade 1.
   a. Type: Type 23, concealed **OR** Type 24, surface**, as directed.**
   b. Material: Brass **OR** Bronze **OR** Stainless steel**, as directed.**
10. Extension Flush Bolt Sets: BHMA A156.3; Grade 1.
   a. Type: Type 25, automatic **OR** Type 27, self-latching**, as directed.**
   b. Material: Brass **OR** Bronze **OR** Stainless steel**, as directed.**
11. Electronic Exit Bars: Nonlatching electronic actuating (releasing) device activated by an adjustable capacitance sensor and with no moving parts; listed and labeled as panic exit hardware. Fabricate bar from extruded aluminum, and provide door and frame transfer device and 16 feet (4.9 m) of cord to route wiring off the door frame.

12. Extruded-Aluminum Removable Mullions: With malleable-iron top and bottom retainers, and prepared for strikes as follows:
    a. Strikes: Two standard recessed strikes **OR** Two monitor strikes **OR** One standard and one electric strike**, as directed.**
13. Tube-Steel Removable Mullions: With malleable-iron top and bottom retainers, and prepared for strikes as follows:
    a. Strikes: Two standard recessed strikes **OR** Two monitor strikes **OR** One standard and one electric strike**, as directed.**
14. Fire-Exit Removable Mullions: Provide removable mullions for use with fire exit devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for fire and panic protection, based on testing according to UL 305 and NFPA 252. Use mullions only with exit devices for which they have been tested.
15. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
    a. Operation: Rigid **OR** Movable **OR** Movable with monitor switch**, as directed.**
16. Exit Device Outside Trim: Lever **OR** Lever with cylinder **OR** Knob **OR** Knob with cylinder **OR** Pull **OR** Pull with cylinder **OR** Thumb turn with cylinder**, as directed**; material and finish to match locksets, unless otherwise indicated.
    a. Match design for lock trim, unless otherwise indicated.
17. Through-Bolt Fasteners: For exit devices and trim on metal doors **OR** non-fire-rated wood doors **OR** fire-rated wood doors**, as directed.**

Q. Lock Cylinders
1. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.
2. Standard Lock Cylinders: BHMA A156.5; Grade 1 **OR** 1A **OR** 2**, as directed**; permanent cores that are interchangeable **OR** removable**, as directed**; face finished to match lockset.
    a. Number of Pins: Five **OR** Six **OR** Seven**, as directed.**
    b. Type: Mortise **OR** Rim **OR** Bored-lock**, as directed** type.
3. High-Security Lock Cylinders: BHMA A156.30; Grade 1 **OR** 2 **OR** 3**, as directed**; Type M, mechanical **OR** E, electrical**, as directed**; permanent cores that are removable; face finished to match lockset.
    a. Number of Pins: Six **OR** Seven**, as directed.**
    b. Type: Mortise **OR** Rim **OR** Bored-lock**, as directed** type.
4. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.
5. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

R. Keying
1. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference.
    a. No Master Key System: Only change keys operate cylinder.
    b. Master Key System: Change keys and a master key operate cylinders.
    c. Grand Master Key System: Change keys, a master key, and a grand master key operate cylinders.
    d. Great-Grand Master Key System: Change keys, a master key, a grand master key, and a great-grand master key operate cylinders.
    e. Existing System:
        1) Master key or grand master key locks to Owner's existing system.
        2) Re-key Owner's existing master key system into new keying system.
    f. Keyed Alike: Key all cylinders to same change key.
2. Keys: Nickel silver **OR** Brass**, as directed.**
    a. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:

1) Notation: "DO NOT DUPLICATE." **OR** Information to be furnished by Owner.**, as directed**

b. Quantity: In addition to one extra key blank for each lock, provide the following:
   1) Cylinder Change Keys: Three.
   2) Master Keys: Five.
   3) Grand Master Keys: Five.
   4) Great-Grand Master Keys: Five.

S. Key Control System

1. Key Control Cabinet: BHMA A156.5; metal cabinet with baked-enamel finish; containing key-holding hooks, labels, 2 sets of key tags with self-locking key holders, key-gathering envelopes, and temporary and permanent markers; with key capacity of 150 percent of the number of locks.
   a. Multiple-Drawer Cabinet: Cabinet with drawers equipped with key-holding panels and key envelope storage, and progressive-type ball-bearing suspension slides. Include single cylinder lock to lock all drawers.
   b. Wall-Mounted Cabinet: Cabinet with hinged-panel door equipped with key-holding panels and pin-tumbler cylinder door lock.
   c. Portable Cabinet: Tray for mounting in file cabinet, equipped with key-holding panels, envelopes, and cross-index system.
2. Key Lock Boxes: Designed for storage of two **OR** 10 keys**, as directed**, with tamper switches to connect to intrusion detection system**, as directed.**
3. Cross-Index System: Multiple **OR** Single**, as directed**-index system for recording key information. Include three receipt forms for each key-holding hook. Set up by key control manufacturer **OR** Installer**, as directed.**
4. Key Control System Software: BHMA A156.5, Grade 1; multiple-index system for recording and reporting key-holder listings, tracking keys and lock and key history, and printing receipts for transactions. Include instruction manual.

T. Operating Trim

1. Operating Trim: BHMA A156.6; aluminum **OR** brass **OR** bronze **OR** stainless steel**, as directed**, unless otherwise indicated.
2. Flat Push Plates: 0.050 inch (1.3 mm) **OR** 1/8 inch (3.2 mm) thick**, as directed**, 4 inches wide by 16 inches high (102 mm wide by 406 mm high)**,** with square corners and beveled edges; secured with exposed screws.
3. Push-Pull Plates: 1/8 inch (3.2 mm) thick, 3-1/2 inches wide by 15-3/4 inches high (89 mm wide by 400 mm high)**,** with square corners, beveled edges, and raised integral lip; secured with exposed screws.
4. Straight Door Pulls: With minimum clearance of 1-1/2 inches (38 mm) from face of door.
   a. Type: 3/4-inch (19-mm) constant-diameter **OR** variable-diameter **OR** flattened-round **OR** hospital-type pull**, as directed**.
   b. Mounting: Surface applied with concealed fasteners **OR** Through bolted with oval-head machine screws and countersunk washers **OR** Back to back with threaded sleeves**, as directed.**
   c. Overall Length: 9 inches (229 mm)**, as directed**.
5. Offset Door Pulls: 1-inch (25-mm) constant-diameter pull with minimum clearance of 2-1/4 inches (57 mm) from face of door and offset of 2 inches (51 mm).
   a. Mounting: Surface applied with concealed fasteners **OR** Through bolted with oval-head machine screws and countersunk washers **OR** Back to back with threaded sleeves**, as directed.**
   b. Overall Length: 9 inches (229 mm).
6. Flush Door Pulls: Mortised 1/2 inch (13 mm) deep; secured with screws.
   a. Shape: Rectangular with rectangular recess.
   b. Size: 3-1/2 inches wide by 4-3/4 inches high (89 mm wide by 121 mm high).
7. Straight Pull-Plate Door Pulls: 0.050-inch- (1.3-mm-) thick plate, 4 inches wide by 16 inches high (102 mm wide by 406 mm high) with square corners and beveled edges; pull with minimum clearance of 1-1/2 inches (38 mm) from face of door.

a. Type: 3/4-inch (19-mm) constant-diameter **OR** variable-diameter **OR** flattened-round **OR** hospital-type pull**, as directed**.
b. Mounting: Surface applied with concealed fasteners **OR** Through bolted with oval-head machine screws and countersunk washers **OR** Back to back with threaded sleeves**, as directed.**
c. Overall Pull Length: 9 inches (229 mm).
8. Offset Push-Pull Door Pulls: 0.050-inch- (1.3-mm-) thick plate, 4 inches wide by 16 inches high (102 mm wide by 406 mm high) with square corners and beveled edges; 1-inch (25-mm) constant-diameter pull with minimum clearance of 2-1/4 inches (57 mm) from face of door and offset of 2 inches (51 mm).
a. Overall Pull Length: 9 inches (229 mm)**.**
9. Single Push Bar: Horizontal bar, with minimum clearance of 1-1/2 inches (38 mm) from face of door.
a. Shape and Size: 1-inch (25-mm) constant-diameter round bar **OR** Minimum 3/8-by-1-1/4-inch (10-by-32-mm) flat bar**, as directed**.
b. Mounting: Surface applied with concealed fasteners **OR** Through bolted with oval-head machine screws and countersunk washers**, as directed.**
10. Double Pull Bar: Two horizontal bars connected by matching vertical pull bar and spaced at 8 inches (200 mm) o.c.; with minimum clearance of 1-1/2 inches (38 mm) from face of door.
a. Shape and Size: 1-inch (25-mm) constant-diameter round bars **OR** Minimum 3/8-by- 1-1/4-inch (10-by-32-mm) flat bars**, as directed**.
b. Mounting: Surface applied with concealed fasteners **OR** Through bolted with oval-head machine screws and countersunk washers**, as directed.**

U. Accessories For Pairs Of Doors
1. Coordinators: BHMA A156.3; consisting of active-leaf, hold-open lever and inactive-leaf release trigger; fabricated from steel with nylon-coated strike plates; with built-in, adjustable safety release; and with internal override.
2. Carry-Open Bars: BHMA A156.3; prevent the inactive leaf from opening before the active leaf; provide polished brass or bronze carry-open bars with strike plate for inactive leaves of pairs of doors unless automatic or self-latching bolts are used.
3. Flat Overlapping Astragals: BHMA A156.22; flat primed steel **OR** zinc-plated steel **OR** aluminum **OR** stainless steel **OR** brass metal bar**, as directed**, surface mounted on face of door with screws; minimum 1/8 inch (3.2 mm) thick by 2 inches (51 mm) wide by full height of door.
4. Rigid, Housed Astragals: BHMA A156.22; gasket material held in place by metal housing; fastened to face of door with screws.
a. Gasket Material: Closed-cell sponge silicone **OR** Closed-cell sponge neoprene **OR** Neoprene **OR** Silicone bulb**, as directed.**
b. Housing Material: Aluminum **OR** Copper alloy (brass or bronze)**, as directed.**
5. Overlapping-with-Gasket Astragals: BHMA A156.22; T-shaped metal, surface mounted on edge of door with screws; with integral gasket and base metal as follows:
a. Base Metal: Primed steel **OR** Zinc-plated steel **OR** Aluminum **OR** Stainless steel**, as directed.**
b. Gasket Material: Vinyl **OR** Silicone **OR** Sponge neoprene **OR** Brush pile **OR** Polypropylene**, as directed.**

V. Surface Closers
1. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
2. Cast-Aluminum Surface Closers: Grade 1 **OR** 2**, as directed**; Traditional Type with mechanism enclosed in cast-aluminum alloy shell.
a. Mounting: Hinge side **OR** Opposite hinge side **OR** Parallel arm **OR** Bracket**, as directed.**

b. Type: Regular arm **OR** Fusible-link holder arm **OR** Two-point hold-open arm **OR** Delayed action closing, **as directed.**
c. Backcheck: Factory preset **OR** Adjustable**, as directed**, effective between 60 and 85 degrees of door opening.

3. Surface Closer without Cover: Grade 1 **OR** 2 Modern Type**, as directed**.
   a. Mounting: Hinge side **OR** Opposite hinge side **OR** Parallel arm **OR** Bracket **OR** Hinge side top jamb **OR** Opposite side top jamb**, as directed.**
   b. Type: Regular arm **OR** Hold open **OR** Fusible-link holder arm **OR** Slide track arm **OR** Dead stop **OR** Dead stop hold open **OR** Delayed action closing**, as directed**.
   c. Backcheck: Factory preset **OR** Adjustable**, as directed**, effective between 60 and 85 degrees of door opening.
   d. Closing Power Adjustment: At least 50 **OR** 35 **OR** 15 percent more than minimum tested value**, as directed**.
4. Surface Closer with Cover: Grade 1 **OR** 2 Modern Type**, as directed**; with mechanism enclosed in cover.
   a. Mounting: Hinge side **OR** Opposite hinge side **OR** Parallel arm **OR** Bracket **OR** Hinge side, top jamb **OR** Opposite side, top jamb**, as directed.**
   b. Type: Regular arm **OR** Hold open **OR** Fusible-link holder arm **OR** Slide track arm **OR** Dead stop **OR** Dead stop hold open **OR** Delayed action closing**, as directed**.
   c. Backcheck: Factory preset **OR** Adjustable**, as directed**, effective between 60 and 85 degrees of door opening.
   d. Cover Material: Aluminum **OR** Plated steel **OR** Molded plastic**, as directed.**
   e. Closing Power Adjustment: At least 50 **OR** 35 **OR** 15 percent more than minimum tested value**, as directed**.

W. Concealed Closers

1. Concealed Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves. Comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
2. Concealed-in-Door Closer: Grade 1 **OR** 2**, as directed**; mortised into top rail of minimum 1-3/4-inch- (44-mm-) thick doors and track mortised into head frame; with double lever arm indicated.
   a. Type: Surface shoe **OR** Mortised soffit plate**, as directed.**
   b. Arm: Regular **OR** Hold open**, as directed.**
   c. Closing Power Adjustment: At least 50 **OR** 35 **OR** 15 percent more than minimum tested value**, as directed**.
3. Concealed Overhead Closer: Grade 1 **OR** 2**, as directed**; mortised into head frame; with cast-metal body and exposed cover plate.
   a. Type: Exposed arm with surface shoe, single acting **OR** Concealed arm and track, butt or pivot hung, single acting **OR** Concealed arm and track, center pivoted, single acting **OR** Concealed arm and track, center pivoted, double acting**, as directed.**
   b. Arm: Regular **OR** Automatic hold open **OR** Manually selected hold open **OR** Fusible-link holder arm**, as directed.**
   c. Track: Regular **OR** Automatic hold open **OR** Manually selected hold open**, as directed.**
   d. Cover Plate Material: Aluminum **OR** Plated steel**, as directed.**
   e. Backcheck: Factory preset **OR** Adjustable**, as directed.**
   f. Closing Power Adjustment: At least 50 **OR** 35 percent more than minimum tested value**, as directed**.
4. Concealed Floor Closer: Grade 1 **OR** 2**, as directed**; with cement case and cast-iron closer body case and top pivot; for single **OR** double-acting doors**, as directed**.
   a. Type: Center pivoted; include top pivot **OR** Offset pivoted; include top pivot **OR** Independently hung**, as directed.**
   b. Fire Rated: Listed for use with labeled fire-rated doors where indicated.
   c. Function: Regular **OR** Automatic hold open **OR** Manually selected hold open **OR** Delayed action closing**, as directed.**

d. Backcheck: Factory preset **OR** Adjustable**, as directed.**
e. Closing Power Adjustment: At least 50 **OR** 35 percent more than minimum tested value**, as directed**.
f. Case Depth: Regular, 4 inches (100 mm) **OR** Shallow, 2 inches (50 mm)**, as directed.**
g. Floor Plates: Provide flush cover plates matching door hardware finish **OR** recessed floor plates with insert of floor finish material and extended closer spindle to accommodate thickness of floor finish**, as directed** unless thresholds are indicated.
 1) Material: Aluminum **OR** Plated steel**, as directed.**

X. Closer Holder Release Devices
1. Closer Holder Release Devices: BHMA A156.15; Grade 1; closer connected with separate or integral releasing and fire- or smoke-detecting devices. Door shall become self-closing on interruption of signal to release device. Automatic release is activated by smoke detection system **OR** loss of power**, as directed.**
 a. Type: Single-point hold open **OR** Multiple-point hold open **OR** Free-swinging release**, as directed.**
 b. Mounting: Surface mounted on face of door **OR** Surface mounted on face of top jamb **OR** Surface mounted on stop **OR** Mortised into top rail of door **OR** Mortised into top jamb **OR** Recessed into floor**, as directed.**
 c. Options: Adjustable backcheck **OR** Integral smoke detector **OR** Adjustable spring power **OR** Adjustable hold-open manual release force**, as directed.**

Y. Mechanical Stops And Holders
1. Wall- and Floor-Mounted Stops: BHMA A156.16; polished cast brass, bronze, or aluminum base metal**, as directed**.
2. Rigid-Type Floor Stop: Grade 1 **OR** 2**, as directed**; with rubber bumper; for surface-screw **OR** expansion-shield**, as directed** application.
3. Dome-Type Floor Stop: Grade 1 **OR** 2**, as directed**; with minimum 1-inch- (25-mm-) high bumper for doors without threshold and 1-3/8-inch- (35-mm-) high bumper for doors with threshold; provide with extruded aluminum riser for carpet installations**.**
4. Combination Floor Stop and Holder: Grade 1 **OR** 2**, as directed**; for surface-screw **OR** expansion-shield application**, as directed**; with semiautomatic hold open **OR** automatic hold open and release by pushing door**, as directed.**
5. Manual Combination Floor Stop and Holder: Grade 1 **OR** 2**, as directed**; 3-1/2 inches (89 mm) long, with holder, keeper, and rubber bumper; for surface-screw **OR** expansion-shield application**, as directed**.
6. Chain Door Stops: Grade 2; welded chain, each end attached to compression springs, both covered with protective sleeve; for surface-screw application.
7. Wall Bumpers: Grade 1 **OR** 2**, as directed**; with rubber bumper; 2-1/2-inch (64-mm) diameter, minimum 3/4-inch (19-mm) projection from wall; with backplate for concealed fastener installation; with convex **OR** concave**, as directed** bumper configuration.
8. Roller-Type Wall Bumpers: Grade 1 **OR** 2**, as directed**; minimum 4-3/8-inch (111-mm) projection from wall; for surface-screw application.
9. Lever-Type Door Holders: Grade 1 **OR** 2**, as directed**; minimum 4-inch- (102-mm-) long arm that swings up and remains in vertical position; with replaceable rubber tip; for surface-screw application.
10. Plunger-Type Door Holders: Grade 1 **OR** 2**, as directed**; minimum 1-1/8-inch (29-mm) plunger throw; with replaceable rubber tip; for surface-screw application.

Z. Electromagnetic Stops And Holders
1. Electromagnetic Door Holders: BHMA A156.15, Grade 1; wall-mounted electromagnetic single **OR** floor-mounted electromagnet single **OR** floor-mounted electromagnet double unit**, as directed** with strike plate attached to swinging door; coordinated with fire detectors and interface with fire alarm system for labeled fire-rated door assemblies.

AA. Overhead Stops And Holders
1. Overhead Stops and Holders: BHMA A156.8.
2. Overhead Concealed Slide Holders: Type 1; Grade 1 **OR** 2**, as directed**; hold open and release by push and pull of door unless control is set in inactive position; with stop, shock absorber, and adjustable holding pressure; for single **OR** double**, as directed**-acting doors opening 110 degrees.
3. Overhead Concealed Slide Stops: Type 1; Grade 1 **OR** 2**, as directed**; release by push and pull of door unless control is set in inactive position; with stop, shock absorber, and adjustable holding pressure; for single **OR** double**, as directed**-acting doors opening 110 degrees.
4. Overhead Surface-Mounted Slide Holders: Type 2; Grade 1 **OR** 2**, as directed**; hold open and release by push and pull of door unless control is set in inactive position; with stop, shock absorber, and adjustable holding pressure; for single-acting doors opening 110 degrees.
5. Overhead Surface-Mounted, Concealed Slide Stops: Type 2; Grade 1 **OR** 2**, as directed**; release by push and pull of door unless control is set in inactive position; with stop, shock absorber, and adjustable holding pressure; for single-acting doors opening 110 degrees.
6. Overhead Surface-Mounted, Jointed-Arm Holders: Type 3; Grade 1 **OR** 2**, as directed**; hold open and release by push and pull of door; control capable of being set in inactive position; with stop and shock absorber; for single-acting doors opening 110 degrees.
7. Overhead Surface-Mounted, Jointed-Arm Stops: Type 3; Grade 1 **OR** 2**, as directed**; release by push and pull of door; control capable of being set in inactive position; with stop and shock absorber; for single-acting doors opening 110 degrees.
8. Overhead Concealed, Friction Slide Holders: Type 4; Grade 1 **OR** 2**, as directed**; with frictional element held under adjustable pressure, free-acting shoulder pivots, and shock absorber; for single **OR** double**, as directed**-acting doors opening 110 degrees.
9. Overhead Concealed, Nonfriction Slide Stops: Type 4; Grade 1 **OR** 2**, as directed**; with nonfrictional element held under adjustable pressure and shock absorber; for single **OR** double**, as directed**-acting doors opening 110 degrees.
10. Overhead Concealed, Nonfriction Slide Holders: Type 4; Grade 1 **OR** 2**, as directed**; with nonfrictional element held under adjustable pressure, automatic hold-open, and shock absorber; for single **OR** double**, as directed**-acting doors opening 110 degrees.
11. Overhead Surface-Mounted, Friction Slide Holders: Type 5; Grade 1 **OR** 2**, as directed**; with frictional element held under adjustable pressure, free-acting shoulder pivots, and shock absorber; for single-acting doors opening 110 degrees.
12. Overhead Surface-Mounted, Nonfriction Slide Stops: Type 5; Grade 1 **OR** 2**, as directed**; with nonfrictional element held under adjustable pressure and shock absorber; for single-acting doors opening 110 degrees.
13. Overhead Surface-Mounted, Nonfriction Slide Holders: Type 5; Grade 1 **OR** 2**, as directed**; with nonfrictional element held under adjustable pressure, automatic hold-open, and shock absorber; for single-acting doors opening 110 degrees.
14. Overhead Surface-Mounted Rod Holders: Type 8; Grade 1 **OR** 2**, as directed**; hold open and release by push and pull of door unless roller cam is set in inactive position; with stop, shock absorber, and adjustable spring tension; for single-acting doors opening 110 degrees.
15. Overhead Surface-Mounted Rod Stops: Type 8; Grade 1 **OR** 2**, as directed**; release by push and pull of door unless roller cam is set in inactive position; with stop, shock absorber, and adjustable spring tension; for single-acting doors opening 110 degrees.
16. Overhead Surface-Mounted Cantilever Holders: Type 9; Grade 1 **OR** 2**, as directed**; hold open and release by push and pull of door or thumb turn; with stop and shock absorber; for single-acting doors opening 110 degrees.
17. Overhead Surface-Mounted Cantilever Stops: Type 9; Grade 1 **OR** 2**, as directed**; release by push and pull of door or thumb turn; with stop and shock absorber; for single-acting doors opening 110 degrees.

BB. Door Gasketing
1. Door Gasketing: BHMA A156.22; air leakage not to exceed 0.50 cfm per foot (0.000774 cu. m/s per m) of crack length for gasketing other than for smoke control, as tested according to

ASTM E 283; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

2. Adhesive-Backed Perimeter Gasketing: Vinyl bulb **OR** Sponge silicone **OR** Silicone **OR** Neoprene bulb **OR** Sponge neoprene gasket material**, as directed** applied to frame rabbet with self-adhesive.
3. Spring-Metal Perimeter Gasketing: Minimum 0.008-inch- (0.20-mm-) thick brass or bronze **OR** 0.008-inch- (0.20-mm-) thick stainless steel **OR** 0.012-inch- (0.30-mm-) thick aluminum gasket material**, as directed** fastened to frame rabbet with nails or screws.
4. Rigid, Housed, Perimeter Gasketing: Sponge silicone **OR** Sponge neoprene **OR** Silicone bulb **OR** Polyurethane bulb **OR** Vinyl bulb **OR** Vinyl brush **OR** Nylon brush **OR** Thermoplastic elastomer**, as directed** gasket material held in place by aluminum **OR** brass or bronze **OR** stainless steel**, as directed** housing; fastened to frame stop with screws.
5. Adjustable, Housed, Perimeter Gasketing: Screw-adjustable sponge silicone **OR** sponge neoprene **OR** silicone bulb **OR** polyurethane bulb **OR** vinyl bulb **OR** vinyl brush **OR** nylon brush **OR** thermoplastic elastomer gasket material**, as directed,** held in place by aluminum **OR** brass or bronze **OR** stainless steel housing**, as directed**; fastened to frame stop with screws.
6. Interlocking Perimeter Gasketing: Minimum 0.018-inch- (0.46-mm-) thick zinc **OR** 0.015-inch- (0.38-mm-) thick bronze gasket material**, as directed** consisting of two pieces, one fastened to door and one fastened to frame, that interlock when door is closed; mounted with screws.
7. Overlapping Astragals for Meeting Stiles: EPDM strip **OR** Vinyl strip **OR** Nylon brush gasket material**, as directed** held in place by aluminum **OR** bronze**, as directed** housing and overlapping when doors are closed; mounted to face of meeting stile with screws; surface mounted to each **OR** one door**, as directed**.
8. Meeting Astragals for Meeting Stiles: Silicone bulb **OR** Neoprene bulb **OR** Vinyl bulb **OR** Nylon brush **OR** Brush pile **OR** Thermoplastic elastomer gasket material**, as directed** held in place by aluminum **OR** bronze housing**, as directed** mounted with screws.
   a. Mounting: Surface mounted on face of each door **OR** Surface mounted on face of one door **OR** Semimortised into edge of each door **OR** Semimortised into edge of one door **OR** Mortised into edge of each door **OR** Mortised into edge of one door**, as directed.**
9. Adjustable Astragals for Meeting Stiles: Screw-adjustable silicone **OR** neoprene **OR** vinyl **OR** vinyl-covered magnet **OR** brush pile **OR** thermoplastic elastomer gasket material**, as directed** held in place by aluminum **OR** bronze housing**, as directed** mounted with screws.
   a. Mounting: Surface mounted on face **OR** Semimortised into edge **OR** Mortised into edge of each door**, as directed**.
10. Door Sweeps: Neoprene **OR** Vinyl **OR** Nylon brush **OR** Polyurethane **OR** Silicone gasket material**, as directed** held in place by flat aluminum **OR** bronze**, as directed** housing or flange; surface mounted to face of door with screws.
11. Door Shoes: Vinyl **OR** Thermoplastic elastomer **OR** Neoprene **OR** Brush pile gasket material**, as directed** held in place by aluminum **OR** bronze housing**, as directed**; mounted to bottom edge of door with screws.
    a. Extended Housing: One side **OR** Both sides of door**, as directed**.
    b. Mounting: Surface mounted on **OR** Mortised into bottom edge of door**, as directed**.
12. Automatic Door Bottoms: Sponge neoprene **OR** Sponge silicone **OR** Thermoplastic elastomer **OR** Nylon brush gasket material**, as directed** held in place by aluminum **OR** bronze **OR** aluminum lined with 0.047-inch (1.2-mm) thick lead housing**, as directed** that automatically drops to form seal when door is closed; mounted to bottom edge of door with screws.
    a. Mounting: Surface mounted on face **OR** Semimortised into bottom **OR** Mortised into bottom of door**, as directed**.
    b. Type: Low-closing-force type for doors required to meet accessibility requirements.

CC. Thresholds

1. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.
2. Compressing-Top Thresholds: Metal member with compressible vinyl seal on top of threshold that seals against bottom of door; and base metal of aluminum **OR** extruded bronze **OR** stainless steel**, as directed.**

3. Saddle Thresholds:
   a. Type: Smooth top **OR** Fluted top **OR** Fluted top and offset **OR** Thermal break and fluted top **OR** Applied gasketed stop and fluted top **OR** Carpet separator with fluted top **OR** Fluted top, barrier free**, as directed.**
   b. Base Metal: Aluminum **OR** Extruded bronze **OR** Stainless steel**, as directed.**
4. Half-Saddle Thresholds: Fluted-top metal member; and base metal of aluminum **OR** extruded bronze**, as directed.**
5. Interlocking Thresholds: Fluted-top metal member with integral lip designed to engage a hook strip applied to door.
   a. Type: Single lip **OR** Double lip **OR** Double-lip water return **OR** Double-lip water return with aluminum pan **OR** Single lip with thermal barrier**, as directed.**
   b. Base Metal: Aluminum **OR** Extruded bronze**, as directed.**
6. Latching/Rabbeted Thresholds:
   a. Type: Fluted **OR** Smooth **OR** Offset with fluted top**, as directed**.
   b. Base Metal: Aluminum **OR** Extruded bronze**, as directed.**
7. Latching/Rabbeted Thresholds with Gasket: Fluted-top metal member with gasket.
   a. Type: Offset **OR** Thermal barrier**, as directed.**
   b. Base Metal: Aluminum **OR** Extruded bronze**, as directed.**
   c. Gasket Material: Vinyl **OR** Silicone **OR** Neoprene **OR** Brush pile **OR** Closed-cell sponge neoprene**, as directed.**
8. Latching/Rabbeted Panic Thresholds:
   a. Type: Fluted, barrier free **OR** Fluted with gasket top**, as directed**.
   b. Base Metal: Aluminum **OR** Extruded bronze**, as directed.**
9. Plate Thresholds: Solid metal plate.
   a. Top Surface: Fluted **OR** Fluted with slip-resistant abrasive**, as directed.**
   b. Base Metal: Aluminum **OR** Extruded brass or bronze **OR** Stainless steel**, as directed.**
10. Ramped Thresholds: Modular, interlocking, sloped, fluted-top metal assemblies with closed return ends; 1:12 slope.
    a. Top Surface: Fluted **OR** Fluted with slip-resistant abrasive**, as directed.**
    b. Base Metal: Aluminum **OR** Extruded bronze**, as directed.**
11. Saddle Thresholds for Floor Closers: Fluted top.
    a. Type: Type A, for center-hung doors; ends not mitered **OR** Type B, for offset-hung doors; ends not mitered **OR** Type C, for center-hung doors; ends mitered **OR** Type D, for offset-hung doors; ends mitered**, as directed.**
    b. Base Metal: Aluminum **OR** Extruded bronze**, as directed.**

DD. Sliding Door Hardware
1. Sliding Door Hardware: BHMA A156.14; consisting of complete sets including rails, hangers, supports, bumpers, floor guides, and accessories indicated.
2. Horizontal Sliding Door Hardware: Grade 1; rated for minimum door weight of 240 lb (109 kg) **OR** 320 lb (145 kg) **OR** 450 lb (205 kg) **OR** 560 lb (254 kg) **OR** 640 lb (290 kg) **OR** 800 lb (363 kg) **OR** 1000 lb (455 kg) **OR** 1500 lb (681 kg)**, as directed**.
   a. Material: Wrought steel **OR** Galvanized steel or anodized aluminum**, as directed.**
   b. Rail: Box without mounting brackets **OR** Box with attached mounting brackets **OR** Box with attached flashing **OR** Round without mounting brackets **OR** Round with attached mounting brackets**, as directed.**
   c. Rail Supports: Single sidewall **OR** Double sidewall **OR** Triple sidewall **OR** Single overhead **OR** Single overhead parallel **OR** Single overhead cross-ear **OR** Double overhead cross-ear **OR** Triple overhead cross-ear style**, as directed**.
      1) Provide intermediate, end, and splice type track supports as required by rail configuration and door weight indicated.
   d. Hanger Configuration: Four-wheel truck **OR** hanger assembly with top mounting plate **OR** hanger assembly with drop bolt **OR** hanger assembly with single drop strap **OR** hanger assembly with double drop strap**, as directed**.
      1) Wheel Assembly: Steel wheels with ball bearings.
   e. Accessories:

1) Continuous bottom guide.
2) Guide rail and guide rail brackets as required by rail configuration.
3) Bow handle, minimum 6 inches (150 mm) in overall length.
4) Flush pull, minimum 4 by 5-1/2 by 3/4 inch (100 by 140 by 19 mm), mortised into door.
5) Cane bolt, minimum 1/2-inch (13-mm) diameter by 12 inches (305 mm) long.
6) Stay roller, minimum 2-inch- (50-mm-) diameter wheel.
7) Floor center stop of cast iron.
8) End guide and stop.
9) Parallel door floor guides.
10) Door stop.
11) Sliding door latch.
12) Bumper shoe, minimum 0.0598-inch (1.5-mm) thickness.
13) Cremone bolt with lever handle, minimum 1/2-inch- (13-mm-) diameter oval or round rod, and rod guides at 24 inches (610 mm) o.c.
14) Top spring bolt, minimum 6 inches (150 mm) **OR** 8 inches (200 mm)**, as directed**; malleable iron and with angle or surface strike and 24-inch (610-mm) chain.
15) Foot bolt minimum 6 inches (150 mm) **OR** 8 inches (200 mm)**, as directed**; wrought steel, cast iron, or malleable iron.

3. Bypassing Sliding Door Hardware: Rails and door hardware that allow vertical adjustment and rated for doors weighing up to 120 lb (54 kg) (Grade 1) **OR** 80 lb (36 kg) (Grade 1) **OR** 40 lb (18 kg) (Grade 2)**, as directed.**
   a. Rail Material: Galvanized wrought steel **OR** Extruded aluminum**, as directed.**
   b. Rail Configuration: V-grooved double leg **OR** V-grooved double leg with fascia **OR** I-beam**, as directed.**
   c. Mounting: Top hung **OR** Bottom supporting with overhead guide**, as directed.**
   d. Wheel Assembly: Two wheel or four wheel, with roller bearings.
   e. Pulls: Flush, mortised into door **OR** Cast, forged, or extruded brass or bronze surface-applied type **OR** Wrought brass or bronze edge type, mortised into edge of door **OR** Sliding door latch **OR** Sliding door lock with emergency release**, as directed.**
   f. Accessories:
      1) Bumper stops; wrought steel.
      2) Floor guides.
4. Pocket Sliding Door Hardware: Grade 1; rated for doors weighing up to 120 lb (54 kg) **OR** 80 lb (36 kg)**, as directed**, overhead box rails and door hardware that allows vertical adjustment.
   a. Rail Material: Galvanized wrought steel **OR** Extruded aluminum**, as directed.**
   b. Door Type: Single **OR** Biparting**, as directed.**
   c. Rail Configuration: V-grooved double leg **OR** I-beam**, as directed.**
   d. Wheel Assembly: Two wheel or four wheel, roller bearings.
   e. Pulls: Flush, mortised into door **OR** Cast, forged, or extruded brass or bronze surface-applied type **OR** Wrought brass or bronze edge type, mortised into edge of door **OR** Sliding door latch **OR** Sliding door lock with emergency release**, as directed.**
   f. Accessories:
      1) Bumper stops; wrought steel.
      2) Floor guides installed within pocket.

EE. Folding Door Hardware
1. General: BHMA A156.14; complete sets including overhead rails, hangers, supports, bumpers, floor guides, and accessories indicated.
2. Bifolding Door Hardware: Rated for door panels weighing up to 50 lb (23 kg) (Grade 1) **OR** 30 lb (14 kg) (Grade 2)**, as directed**; with rails and door hardware that allow horizontal and vertical adjustment.
   a. Rail Material: Galvanized wrought steel **OR** Extruded aluminum**, as directed.**
   b. Rail Configuration: V-grooved double leg **OR** V-grooved double leg with fascia **OR** I-beam**, as directed.**

   c. Mounting: Surface mounted overhead **OR** Top and bottom hung**, as directed.**
   d. Wheel Assembly: Two wheel or four wheel, with roller bearings.
3. Multiple Folding Door Hardware: Rated for door panels weighing up to 50 lb (23 kg) (Grade 1) **OR** 30 lb (14 kg) (Grade 2)**, as directed**; with rails and door hardware that allows horizontal and vertical adjustment.
   a. Rail Material: Galvanized wrought steel **OR** Extruded aluminum**, as directed.**
   b. Rail Configuration: V-grooved double leg **OR** V-grooved double leg with fascia **OR** I-beam**, as directed.**
   c. Mounting: Surface mounted overhead **OR** Top and bottom hung**, as directed.**
   d. Wheel Assembly: Two wheel or four wheel, with roller bearing.

FF. Metal Protective Trim Units
1. Metal Protective Trim Units: BHMA A156.6; fabricated from 0.050-inch- (1.3-mm-) thick aluminum **OR** brass **OR** bronze **OR** stainless steel**, as directed**; with manufacturer's standard machine or self-tapping screw fasteners.
2. Armor Plates: 36 inches (914 mm) **OR** 40 inches (1016 mm) **OR** 42 inches (1067 mm) high**, as directed by** door width with allowance for frame stops.
3. Kick Plates: 8 inches (203 mm) **OR** 10 inches (254 mm) **OR** 12 inches (305 mm) high**, as directed by** door width with allowance for frame stops.
4. Mop Plates: 4 inches (102 mm) **OR** 6 inches (152 mm) high**, as directed by** 1 inch (25 mm) less than door width.
5. Stretcher Plates: 6 inches (152 mm) **OR** 8 inches (203 mm) high**, as directed by** door width with allowance for frame stops.
6. Nonmortise Angle Door Edging: 48-inch- (1220-mm-) **OR** 42-inch- (1067-mm-) high**, as directed by** minimum 0.050-inch- (1.3-mm-) thick metal sheet formed into angle shape; with 1-1/4-inch (32-mm) length of leg on face of door; for surface mounting on door.
   a. Leg Offset: To accommodate door protection plate of type indicated.
7. Mortise Angle Door Edging: 48-inch- (1220-mm) **OR** 42-inch- (1067-mm-) high**, as directed** by minimum 0.050-inch- (1.3-mm-) thick metal sheet formed into angle shape; with 7/8-inch (22-mm) length of leg on face of door; for mortise application into edge of door.
8. Nonmortise Cap Door Edging: 48-inch- (1220-mm) **OR** 42-inch- (1067-mm-) high**, as directed by** minimum 0.050-inch- (1.3-mm-) thick metal sheet formed into "U" shape; with 1-1/4-inch (32-mm) length of leg on faces of door; for surface mounting on door.
   a. Leg Offset: To accommodate door protection plate of type indicated.
9. Mortise Cap Door Edging: 48-inch- (1220-mm) **OR** 42-inch- (1067-mm-) high**, as directed by** minimum 0.050-inch- (1.3-mm-) thick metal sheet formed into "U" shape; with 7/8-inch (22-mm) length of leg on faces of door; for mortise application into edge of door.

GG. Plastic Protection Plates
1. Plastic Protection Plates: BHMA A156.6; fabricated with four sides beveled; plastic laminate; 1/8 inch (3.2 mm) thick; NEMA LD 3, Grade HGS **OR** rigid plastic; 0.060-inch- (1.5-mm-) thick, PVC or acrylic-modified vinyl plastic **OR** acrylic; 1/8 inch (3.2 mm) thick**, as directed.**
2. Armor Plates: 36 inches (914 mm) **OR** 40 inches (1016 mm) **OR** 42 inches (1067 mm)**,** high, **as directed by** door width with allowance for frame stops.
3. Kick Plates: 8 inches (203 mm) **OR** 10 inches (254 mm) **OR** 12 inches (305 mm) high **as directed by** door width with allowance for frame stops.
4. Mop Plates: 4 inches (102 mm) **OR** 6 inches (152 mm) high **as directed by** 1 inch (25 mm) less than door width.
5. Stretcher Plates: 6 inches (152 mm) **OR** 8 inches (203 mm) high **as directed by** door width with allowance for frame stops.
6. Colors and Textures: As selected by Architect from manufacturer's full range **OR** Match Architect's sample **OR** As indicated by manufacturer's designations in the door hardware schedule**, as directed.**

HH. Auxiliary Door Hardware
1. Auxiliary Hardware: BHMA A156.16.

2. Chain Door Guards: Grade 1 **OR** 2 **OR** 3**, as directed**; polished cast brass or bronze or extruded brass; with plate slotted to receive 6-inch- (150-mm-) long welded chain secured to an anchor plate. Guard allows door to be opened 3 inches (75 mm) with chain engaged in slotted plate. Equip with chain holder.
3. Rod-Type Door Guards: Grade 1 **OR** 2 **OR** 3**, as directed**; straight door-mounted rod that engages U-shaped, jamb-mounted rod. U-shaped rod can swing 180 degrees away from door; rod limits door opening when engaged. Fabricated from polished cast brass **OR** bronze **OR** aluminum**, as directed.**
4. Coat Hooks: Grade 1 **OR** 2 **OR** 3**, as directed**; two curved hooks with rounded ends; 3-inch (75-mm) projection from wall; for surface-screw application; fabricated from polished cast brass **OR** polished cast bronze **OR** burnished cast aluminum**, as directed.**
5. Garment Hooks: Grade 1 **OR** 2 **OR** 3**, as directed**; one long hat hook and one small coat hook; 3-3/4-inch (95-mm) projection from wall with 7-inch (178-mm) overall height; for surface-screw application; fabricated from polished cast brass **OR** burnished cast aluminum**, as directed.**
6. Door Knockers: Grade 1; solid brass with engraved number and nameplates**, as directed.**
7. Wide-Angle Door Viewers: Grade 1 **OR** 2 **OR** 3**, as directed**; solid brass with optical glass lenses; adjustable to door thickness and permitting 1-way observation with minimum 190-degree viewing angle.
8. Fire-Rated Door Viewers: Solid brass with optical glass lenses; listed and labeled for use in fire-rated door assemblies; adjustable to door thickness, and permitting 1-way observation with minimum 120 **OR** 150 **OR** 190-degree viewing angle **as directed**.
9. House Numbers: Grade 1; wrought, cast, or forged brass; 4 inches (102 mm) high; for screw application.
10. Letter Box Plates: Grade 1 **OR** 2 **OR** 3**, as directed**; with spring-loaded front plate with brass spring and inside covered gravity flap or hood; fabricated from wrought brass **OR** wrought bronze **OR** aluminum**, as directed.**
    a. Regular Size, Inswinging: Minimum 0.036-inch (0.9-mm) metal thickness, with minimum 7-by-1-5/8-inch (178-by-41-mm) opening.
    b. Regular Size, Outswinging: Minimum 0.036-inch (0.9-mm) metal thickness, with minimum 7-by-1-1/2-inch (178-by-38-mm) opening.
    c. Magazine Size, Outswinging: Minimum 0.051-inch (1.3-mm) metal thickness, with minimum 11-by-1-7/8-inch (279-by-48-mm) opening.
11. Silencers for Wood Door Frames: Grade 1; neoprene or rubber; minimum 5/8 by 3/4 inch (16 by 19 mm); fabricated for drilled-in application to frame.
12. Silencers for Metal Door Frames: Grade 1; neoprene or rubber; minimum diameter 1/2 inch (13 mm); fabricated for drilled-in application to frame.

II. Auxiliary Electrified Door Hardware
1. Boxed Power Supplies: Modular unit in NEMA ICS 6, Type 4 enclosure; filtered and regulated; voltage rating and type matching requirements of door hardware served; listed and labeled for use with fire alarm systems.
2. Monitor Strikes: Cast strike with toggle **OR** Dustbox monitor for installation under standard strike**, as directed.**
3. Door Position Switches: Magnetically operated reed switch designed for concealed mounting.
4. Door and Frame Transfer Devices: Steel housing for mortise in hinge stile of door, with flexible tube for wiring bundle; accommodating doors that swing open to 120 degrees.

JJ. FABRICATION
1. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rated labels and as otherwise approved by the Owner.
    a. Manufacturer's identification is permitted on rim of lock cylinders only.
2. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness.

Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.

3. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.
   a. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
4. Fire-Rated Applications:
   a. Wood or Machine Screws: For the following:
      1) Hinges mortised to doors or frames; use threaded-to-the-head wood screws for wood doors and frames, as directed.
      2) Strike plates to frames.
      3) Closers to doors and frames.
   b. Steel Through Bolts: For the following unless door blocking is provided:
      1) Surface hinges to doors.
      2) Closers to doors and frames.
      3) Surface-mounted exit devices.
5. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
6. Fasteners for Wood Doors: Comply with requirements in DHI WDHS.2, "Recommended Fasteners for Wood Doors."
7. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

KK. FINISHES
1. Provide finishes complying with BHMA A156.18.
2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

1.3 EXECUTION

A. Examination
1. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.
2. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Steel Doors and Frames: For Surface-Applied Door Hardware: Drill and tap doors and frames according to ANSI/SDI A250.6.
2. Wood Doors: Comply with DHI WDHS.5 “Recommended Hardware Reinforcement Locations for Mineral Core Wood Flush Doors.”

C. Installation

1. Mounting Heights: Mount door hardware units at heights indicated on Drawings **OR** as follows, **as directed,** unless otherwise indicated or required to comply with governing regulations.
   a. Standard Steel Doors and Frames: ANSI/SDI A250.8.
   b. Custom Steel Doors and Frames: HMMA 831.
   c. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
2. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09. Do not install surface-mounted items until finishes have been completed on substrates involved.
   a. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
   b. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
3. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches (750 mm) of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
4. Intermediate Offset Pivots: Where offset pivots are indicated, provide intermediate offset pivots in quantities indicated in door hardware schedule but not fewer than one intermediate offset pivot per door and one additional intermediate offset pivot for every 30 inches (750 mm) of door height greater than 90 inches (2286 mm).
5. Lock Cylinders: Install construction cores to secure building and areas during construction period.
   a. Replace construction cores with permanent cores as directed by the Owner.
   b. Furnish permanent cores to the Owner for installation.
6. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.
7. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings **OR** in equipment room, **as directed**. Verify location with the Owner.
   a. Configuration: Provide one power supply for each door opening **OR** least number of power supplies required to adequately serve doors, **as directed**.
8. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants".
9. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.
10. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
11. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
12. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

D. Field Quality Control
1. Independent Architectural Hardware Consultant: Engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.
   a. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

E. Adjusting
1. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
   a. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 30 degrees.

b. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
c. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
2. Occupancy Adjustment: Approximately three **OR** six months, **as directed,** after date of Final Completion, Installer's Architectural Hardware Consultant shall examine and readjust, including adjusting operating forces, each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.

F. Cleaning And Protection
1. Clean adjacent surfaces soiled by door hardware installation.
2. Clean operating items as necessary to restore proper function and finish.
3. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Final Completion.

G. Demonstration
1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes. Refer to Division 01 Section "Demonstration And Training".

END OF SECTION 06 01 40 91

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SECTION 06 05 23 00 - TIMBER BRIDGE COMPONENTS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of timber bridge components. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Timber for Bridges shall comply with the specifications for timber bridges contained in the standard specifications of the state in which the work occurs, AASHTO's "Standard Specifications for Highway Bridges," and National Forest Products Association's "National Design Specification for Wood Construction."

B. Preservative Treatment shall comply with the specifications for preservative treatment contained in the standard specifications of the state in which the work occurs, and American Wood-Preservers' Association's "Book of Standards." All timber shall be treated unless specified otherwise.

C. Hardware and Castings:
   1. Castings: Cast steel shall comply with ASTM A 27, Grade 70-36, or gray iron castings shall comply with AASHTO M105 Class No. 30, unless otherwise specified.
   2. Hardware:
      a. Machine Bolts, Drift-Bolts, and Dowels may be either wrought iron or rolled steel. Machine bolts shall have the square heads and nuts unless otherwise specified.
      b. Cast Washers shall be made of malleable or gray iron. The outside diameter shall not be less than 3 1/2 times the bolt diameter and its thickness equal to the bolt diameter. Plate washers shall be made of wrought iron or rolled steel. The outside diameter shall not be less than 3 1/2 times the bolt diameter, and they shall not be less than 1/4 inch thick.
      c. Nails and Spikes shall be hot-dip zinc coated per ASTM A 153 or of Type 304 stainless steel.
      d. Finish: Unless otherwise specified, all hardware for treated timber bridges shall be galvanized or cadmium-plated. Galvanizing shall comply with ASTM A 123 or A 153. Cadmium plating of steel shall comply with ASTM B 766.

D. Timber Connectors shall be ring type or plate type and shall be galvanized in compliance with ASTM A 123 or A 153.
   1. Split Ring: Fabricated from hot rolled steel sheet complying with ASTM A 570 (ASTM A 570M), Grade 33 of standard manufacture.
   2. Tooth Ring: Stamped cold form 16-gauge steel sheet fabricated from hot rolled steel sheet complying with ASTM A 570 (ASTM A 570M), Grade 33 standard manufacture.
   3. Shear-Plate Timber Connectors:
      a. Pressed Steel Type shall be fabricated from hot rolled steel sheet complying with ASTM A 570 (ASTM A 570M), Grade 33. Shear plates shall be of standard manufacture.
      b. Malleable Iron Type shall be ASTM A 47, Grade No. 32510 (ASTM A 47M, Grade 22010). Casting shall be of standard manufacture.

E. Structural Glue-Laminated Timber shall comply with DOC PS 20, American Structural Lumber Standard, AITC 190.1 and AITC 111. Lumber for laminating shall be of such stress grade as to provide glue-laminated members with allowable stress values of 2,000 psi in bending, 1,600 psi in tension, 1,500 psi in compression parallel to grain, and 385 psi in compression perpendicular to grain for dry condition of service.
1. Adhesives shall meet requirements for wet condition of service.
2. Surfaces of Members shall be sealed with a penetration sealer or sealed with a sealer coat.

F. Ties: Fabricate strap ties from hot-rolled steel sheet complying with ASTM A 570 (ASTM A 570M). Hot dip galvanize after fabrication to comply with ASTM A 123 or ASTM A 153 (ASTM A 153M).

G. Asphalt Cement shall comply with ASTM D946 for penetration-graded material.

H. Surface Coarse Aggregate shall be ASTM D 692, except the gradation shall be as follows:

Sieve Percent	Size Passing (Wt.)
1/2 in.	100
3/8 in.	94-100
No. 4	15-45
No. 16	0-4

1.3 EXECUTION

A. Preparation:
1. Traffic Control: When traffic is maintained on bridge under repair or is directed over a temporary run-around, furnish, erect, and maintain all barricades, flags, torches, lights, guardrails, temporary pavement markings, and traffic control signs required for the protection of the public and for the direction of traffic. Number, type, color, size and placement of all traffic control color, size, and placement of all traffic control devices and the use of a flagman shall comply with USDOT FHA MUTCD "Traffic Controls for Highway Construction and Maintenance Operations." All traffic control devices in advance of the construction limits shall also be the responsibility of the Contractor.
2. Treated Timber: Give all cuts, abrasions, and holes made after treatment 2 applications of 60 percent creosote oil and 40 percent roofing pitch or brush coat with 2 applications of hot creosote oil and covered with hot roofing pitch. Any unfilled holes, after being treated with preservative oil, shall be plugged with treated plugs.

B. Erection:
1. Holes:
   a. Drift Bolts and Dowels: Bore holes for round drift bolts and dowels with a bit 1/16 inch less in diameter than the bolt or dowel to be used. The diameter of holes for square drift bolts or dowels shall be equal to the least dimension of the bolt or dowel.
   b. Machine Bolts and Rods: Bore holes for field fabrication with a bit the same diameter as the bolt. Holes for fabrication prior to treatment shall be 1/16 inch larger than the bolt diameter.
   c. Lag Screws: Bore hole with a bit not larger than the body of the screw at the base of the thread.
2. Nuts and Washers: Use a washer of the size and type specified under all bolt heads and nuts except carriage bolts. The nuts of all bolts shall be locked by scoring threads after they have been finally tightened.
3. Countersinking: Paint all recesses in treated timber formed for countersinking with hot creosote oil. Fill recesses likely to collect injurious materials with hot pitch.
4. Framing: All lumber and timber shall be accurately cut and framed to a close fit in such manner that the joints will have even bearing over the entire contact surfaces. Place stringers in position so that knots near edges will be in the top portions of the stringer. Screw type fastenings shall be

screwed into place for the entire length of the fastener. Install the split ring and the shear plate in grooves cut by the Contractor. Force the toothed ring into the contact surfaces of the timbers jointed by means of pressure equipment.

5. Nailing: Nails and spikes shall be driven with just sufficient force to set the heads flush with the surface of the wood.

C. Maintenance and Repair Methods:

1. Timber Deck:
    a. Remove Existing Plank Floor Deck and Fasteners and replace with new planks and fasteners. Lay the floor planks at 45 degrees to centerline of roadway. When more than one length of plank is required, stagger joints between abutting ends at least 3 feet in any two adjacent lines of plank.
    b. Standard Wrought Washers shall be used under the heads of all lag screws and under the heads or nuts of all machine bolts. Where machine bolts are used for fastening the floor plank all nuts used shall be locknuts. Countersink heads of all lag screws and bolts in the surface of the floor. Fill recesses formed for countersinking with hot pitch.
    c. Bituminous Surface Coat: Clean the floor of foreign materials. Apply asphalt cement at a temperature of 275 F to 350 F and at a rate of approximately 1/4 gallon per square yard of surface. The deck shall be dry at the time of bitumen application. Cover the entire surface with a thin coating of aggregate in a sufficient quantity to take up any free bitumen.
2. Hardware: Remove all corrosion by sandblasting or wire brushing. Replace all loose bolts and screws, adding washers as required. Replace deteriorated hardware.
3. Metal Tread Plates: Remove and replace treads as directed. Before installing treads, remove high spots and rough spots in the plank floor so that the treads will be in contact with the floor for their full length and width. Treads shall be laid in a heavy mop coat of asphalt filler. Treads shall be laid with a space of 1/4 inch between adjacent ends and shall be fastened by means of 3/8-inch galvanized bolts. Where bolts cannot be used, use 3/8-inch by 3-inch galvanized lag screws.
4. Timber Railroad Bridge Deck: Remove defective ties and guardrail, including fasteners, and replace with similar ties, guardrail, and fasteners as directed.
5. Repair of Structural Timber Members: Repair, including removal and replacement, shall be as directed.

END OF SECTION 06 05 23 00

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SECTION 06 05 23 00a - MISCELLANEOUS CARPENTRY

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for miscellaneous carpentry. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Framing with dimension lumber.
      b. Rooftop equipment bases and support curbs.
      c. Wood blocking, cants, and nailers.
      d. Wood furring and grounds.
      e. Wood sleepers.
      f. Interior wood trim.
      g. Wood shelving and clothes rods.
      h. Plywood backing panels.

C. Definitions
   1. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater but less than 5 inches nominal (114 mm actual) in least dimension.
   2. Lumber grading agencies, and the abbreviations used to reference them, include the following:
      a. NeLMA: Northeastern Lumber Manufacturers' Association.
      b. NHLA: National Hardwood Lumber Association.
      c. NLGA: National Lumber Grades Authority.
      d. SPIB: The Southern Pine Inspection Bureau.
      e. WCLIB: West Coast Lumber Inspection Bureau.
      f. WWPA: Western Wood Products Association.

D. Submittals
   1. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
      a. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
      b. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
      c. For fire-retardant treatments specified to be High-Temperature (HT) type include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
      d. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
      e. Include copies of warranties from chemical treatment manufacturers for each type of treatment.
   2. LEED Submittals:
      a. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
      b. Product Data for Credit EQ 4.4: For composite-wood products, documentation indicating that product contains no urea formaldehyde.

c. Certificates for Credit MR 7: Chain-of-custody certificates certifying that products specified to be made from certified wood comply with forest certification requirements. Include evidence that mill is certified for chain of custody by an FSC-accredited certification body.
   1) Include statement indicating costs for each certified wood product.

3. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:
   a. Preservative-treated wood.
   b. Fire-retardant-treated wood.
   c. Power-driven fasteners.
   d. Powder-actuated fasteners.
   e. Expansion anchors.
   f. Metal framing anchors.

E. Quality Assurance
1. Forest Certification: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship":
   a. Dimension lumber framing.
   b. Miscellaneous lumber.
   c. Interior wood trim.
   d. Shelving and clothes rods.

F. Delivery, Storage, And Handling
1. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.
2. Deliver interior wood materials that are to be exposed to view only after building is enclosed and weatherproof, wet work other than painting is dry, and HVAC system is operating and maintaining temperature and humidity at occupancy levels.

1.2 PRODUCTS

A. Wood Products, General
1. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
   a. Factory mark each piece of lumber with grade stamp of grading agency.
   b. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
   c. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
   d. Provide dressed lumber, S4S, unless otherwise indicated.

B. Wood-Preservative-Treated Materials
1. Preservative Treatment by Pressure Process: AWPA C2, except that lumber that is not in contact with the ground and is continuously protected from liquid water may be treated according to AWPA C31 with inorganic boron (SBX).
   a. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
   b. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

2. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
3. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
   a. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
4. Application: Treat all miscellaneous carpentry, unless otherwise indicated **OR** items indicated on Drawings, and the following, **as directed**:
   a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
   b. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
   c. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
   d. Wood framing members that are less than 18 inches (460 mm) above the ground in crawl spaces or unexcavated areas.
   e. Wood floor plates that are installed over concrete slabs-on-grade.

C. Fire-Retardant-Treated Materials
1. General: Comply with performance requirements in AWPA C20 (lumber) and AWPA C27 (plywood).
   a. Use treatment that does not promote corrosion of metal fasteners.
   b. Use Exterior type for exterior locations and where indicated.
   c. Use Interior Type A, High Temperature (HT) for enclosed roof framing, framing in attic spaces, and where indicated.
   d. Use Interior Type A, unless otherwise indicated.
2. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
   a. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
3. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.
4. Application: Treat all miscellaneous carpentry, unless otherwise indicated **OR** items indicated on Drawings, and the following, **as directed**:
   a. Framing for raised platforms.
   b. Concealed blocking.
   c. Roof construction.
   d. Plywood backing panels.

D. Dimension Lumber Framing
1. Maximum Moisture Content: 15 percent **OR** 19 percent **OR** 15 percent for 2-inch nominal (38-mm actual) thickness or less, 19 percent for more than 2-inch nominal (38-mm actual) thickness, **as directed**.
2. Non-Load-Bearing Interior Partitions: Construction or No. 2 **OR** Construction, Stud, or No. 3 **OR** Standard, Stud, or No. 3, **as directed**, grade of any species.
3. Other Framing: No. 2 **OR** Construction or No. 2 **OR** Construction, Stud, or No., **as directed**, grade and any of the following species:
   a. Hem-fir (north); NLGA.
   b. Southern pine; SPIB.
   c. Douglas fir-larch; WCLIB or WWPA.
   d. Mixed southern pine; SPIB.
   e. Spruce-pine-fir; NLGA.
   f. Douglas fir-south; WWPA.
   g. Hem-fir; WCLIB or WWPA.

h. Douglas fir-larch (north); NLGA.
i. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.

E. Miscellaneous Lumber
1. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
a. Blocking.
b. Nailers.
c. Rooftop equipment bases and support curbs.
d. Cants.
e. Furring.
f. Grounds.
g. Utility shelving.
2. For items of dimension lumber size, provide Construction or No. 2 **OR** Standard, Stud, or No. 3, **as directed**, grade lumber with 15 **OR** 19, **as directed**, percent maximum moisture content of any species.
3. For exposed boards, provide lumber with 15 **OR** 19, **as directed**, percent maximum moisture content and any of the following species and grades:
a. Eastern white pine, Idaho white, lodgepole, ponderosa, or sugar pine; Premium or 2 Common (Sterling) **OR** Standard or No. 3 Common, **as directed**, grade; NeLMA, NLGA, WCLIB, or WWPA.
b. Mixed southern pine, No. 1 **OR** 2, **as directed**, grade; SPIB.
c. Hem-fir or hem-fir (north), Select Merchantable or No. 1 Common **OR** Construction or No. 2 Common, **as directed**, grade; NLGA, WCLIB, or WWPA.
d. Spruce-pine-fir (south) or spruce-pine-fir, Select Merchantable or No. 1 Common **OR** Construction or No. 2 Common, **as directed**, grade; NeLMA, NLGA, WCLIB, or WWPA.
4. For concealed boards, provide lumber with 15 **OR** 19, **as directed**, percent maximum moisture content and any of the following species and grades:
a. Mixed southern pine, No. 2 **OR** 3, **as directed**, grade; SPIB.
b. Hem-fir or hem-fir (north), Construction or 2 Common **OR** Standard or 3 Common, **as directed**, grade; NLGA, WCLIB, or WWPA.
c. Spruce-pine-fir (south) or spruce-pine-fir, Construction or 2 Common **OR** Standard or 3 Common, **as directed**, grade; NeLMA, NLGA, WCLIB, or WWPA.
d. Eastern softwoods, No. 2 **OR** 3, **as directed**, Common grade; NELMA.
e. Northern species, No. 2 **OR** 3, **as directed**, Common grade; NLGA.
f. Western woods, Construction or No. 2 Common **OR** Standard or No. 3 Common, **as directed**, grade; WCLIB or WWPA.
5. For blocking not used for attachment of other construction Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
6. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
7. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

F. Interior Wood Trim
1. General: Provide kiln-dried finished (surfaced) material without finger-jointing, unless otherwise indicated.
2. Softwood Lumber Trim for Transparent (Stain or Clear) Finish: Provide one of the following species and grade:
a. Grade C Select **OR** D Select **OR** Finish **OR** Premium, **as directed**, eastern white pine; NeLMA or NLGA.
b. Grade C Select (Choice) **OR** D Select (Quality) **OR** 1 Common (Colonial) **OR** 2 Common (Sterling), **as directed**, Idaho white, lodgepole, ponderosa, or sugar pine; NLGA or WWPA.

c. Grade Superior or C & Btr **OR** Prime or D, **as directed**, Finish Douglas fir-larch or Douglas fir-south; NLGA, WCLIB, or WWPA.
d. Clear Heart **OR** Grade A **OR** Grade B, **as directed**, western red cedar; NLGA, WCLIB, or WWPA.
3. Hardwood Lumber Trim for Transparent (Stain or Clear) Finish: Clear red oak **OR** white maple, **as directed**, selected for compatible grain and color, **as directed**.
4. Lumber Trim for Opaque (Painted) Finish: Either finger-jointed or solid lumber, of one of the following species and grades:
   a. Grade D Select **OR** Finish **OR** Premium, **as directed**, eastern white pine; NeLMA or NLGA.
   b. Grade D Select (Quality) **OR** 1 Common (Colonial) **OR** 2 Common (Sterling), **as directed**, Idaho white, lodgepole, ponderosa, or sugar pine; NLGA or WWPA.
   c. Grade A **OR** B, **as directed**, Finish aspen, basswood, cottonwood, gum, magnolia, red alder, soft maple, sycamore, tupelo, or yellow poplar; NHLA.
5. Moldings: Made to patterns included in WMMPA WM 7 and graded according to WMMPA WM 4.
   a. Moldings for Transparent (Stain or Clear) Finish: N-grade eastern white, Idaho white, lodgepole, ponderosa, or sugar pine **OR** western red cedar **OR** Douglas fir **OR** red oak **OR** white maple, **as directed**, selected for compatible grain and color.
   b. Moldings for Opaque (Painted) Finish: P-grade eastern white, Idaho white, lodgepole, ponderosa, or sugar pine **OR** aspen, basswood, cottonwood, gum, magnolia, soft maple, tupelo, or yellow poplar **OR** primed medium-density fiberboard, **as directed**.

G. Shelving And Clothes Rods
1. Shelving: Made from one of the following materials, 3/4-inch (19-mm) thick. Do not use particleboard or medium-density fiberboard that contains urea formaldehyde.
   a. Melamine-faced particleboard with radiused and filled front edge.
   b. Particleboard with radiused and filled **OR** solid-wood, **as directed**, front edge.
   c. Medium-density fiberboard with radiused **OR** solid-wood, **as directed**, front edge.
   d. Wood boards of same species and grade indicated above for interior lumber trim for opaque **OR** transparent, **as directed**, finish.
2. Shelf Cleats: 3/4-by-3-1/2-inch (19-by-89-mm) boards **OR** 3/4-by-5-1/2-inch (19-by-140-mm) boards with hole and notch to receive clothes rods, **as directed**, of same species and grade indicated above for interior lumber trim for opaque finish.
3. Shelf Brackets: Prime-painted formed steel with provision to support clothes rod where rod is indicated.
4. Clothes Rods:
   a. 1-1/2-inch- (38-mm-) diameter, clear, kiln-dried hardwood rods **OR** clear, kiln-dried softwood rods; either Douglas fir or southern pine **OR** aluminum tubes, **as directed**.
   OR
   1-1/4-inch- (32-mm-) diameter, chrome-plated steel **OR** stainless-steel, **as directed**, tubes.
5. Rod Flanges: Clear, kiln-dried hardwood turnings **OR** Clear, kiln-dried softwood turnings **OR** Aluminum **OR** Chrome-plated steel **OR** Stainless steel, **as directed**.

H. Plywood Backing Panels
1. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, **as directed**, in thickness indicated or, if not indicated, not less than 1/2-inch (13-mm) nominal thickness.

I. Fasteners
1. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
   a. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M **OR** of Type 304 stainless steel, **as directed**.
2. Nails, Brads, and Staples: ASTM F 1667.
3. Power-Driven Fasteners: NES NER-272.

4. Wood Screws: ASME B18.6.1.
5. Screws for Fastening to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
6. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).
7. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.
8. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
   a. Material:
      1) Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
         OR
         Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).

J. Metal Framing Anchors
1. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 (Z180) coating designation.
   a. Use for interior locations where stainless steel is not indicated.
2. Stainless-Steel Sheet: ASTM A 666, Type 304 **OR** 316, **as directed**.
   a. Use for exterior locations and where indicated.

K. Miscellaneous Materials
1. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.
   a. Use adhesives that have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1.3 EXECUTION

A. Installation, General
1. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
2. Framing Standard: Comply with AF&PA's "Details for Conventional Wood Frame Construction," unless otherwise indicated.
3. Metal Framing Anchors: Install metal framing to comply with manufacturer's written instructions.
4. Do not splice structural members between supports, unless otherwise indicated.
5. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
   a. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.
6. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
   a. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches (2438 mm) o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
   b. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches (2438 mm) o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal- (38-mm actual-) thickness.

c. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. (9.3 sq. m) and to solidly fill space below partitions.

d. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet (6 m) o.c.

7. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

8. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
   a. Use inorganic boron for items that are continuously protected from liquid water.
   b. Use copper naphthenate for items not continuously protected from liquid water.

9. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
   a. NES NER-272 for power-driven fasteners.
   b. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
   c. "Nailing Schedule," and Tables in Section 2304 of the ICC's International Building Code.
   d. Table 2306.1, "Fastening Schedule," in SBCCI's Standard Building Code.
   e. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
   f. Table 602.3(1), "Fastener Schedule for Structural Members," and Table 602.3(2), "Alternate Attachments," in ICC's International One- and Two-Family Dwelling Code.

10. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads, unless otherwise indicated.

B. Wood Ground, Sleeper, Blocking, And Nailer Installation

1. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
2. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.
3. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches (38 mm) wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

C. Wood Furring Installation

1. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
2. Furring to Receive Plywood or Hardboard Paneling: Install 1-by-3-inch nominal- (19-by-63-mm actual-) size furring horizontally **OR** vertically **OR** horizontally and vertically, **as directed**, at 24 inches (610 mm) **OR** 600 mm, **as directed**, o.c.
3. Furring to Receive Gypsum Board **OR** Plaster Lath, **as directed**: Install 1-by-2-inch nominal- (19-by-38-mm actual-) size furring vertically at 16 inches (406 mm) **OR** 400 mm, **as directed**, o.c.

D. Wood Trim Installation

1. Install with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Do not use pieces less than 24 inches (610 mm) long except where necessary. Stagger joints in adjacent and related standing and running trim. Cope at returns and miter at corners to produce tight-fitting joints with full-surface contact throughout length of joint. Use scarf joints for end-to-end joints.
   a. Match color and grain pattern across joints.
   b. Install trim after gypsum board joint-finishing operations are completed.

c. Drill pilot holes in hardwood before fastening to prevent splitting. Fasten to prevent movement or warping. Countersink fastener heads and fill holes.

d. Install to tolerance of 1/8 inch in 96 inches (3 mm in 2438 mm) for level and plumb. Install adjoining finish carpentry with 1/32-inch (0.8-mm) maximum offset for flush installation and 1/16-inch (1.6-mm) maximum offset for reveal installation.

E. Protection

1. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

2. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06 05 23 00a

SECTION 06 05 23 00b - HEAVY TIMBER CONSTRUCTION

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for heavy timber construction. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section includes framing using timbers and round wood poles.

C. Definitions
   1. Timbers: Lumber of 5 inches nominal (114 mm actual) or greater in least dimension.
   2. Poles: Round wood members, called either "poles" or "posts" in the referenced standards.
   3. Inspection agencies, and the abbreviations used to reference them, include the following:
      a. NeLMA - Northeastern Lumber Manufacturers Association.
      b. NHLA - National Hardwood Lumber Association.
      c. NLGA - National Lumber Grades Authority.
      d. SPIB - Southern Pine Inspection Bureau.
      e. WCLIB - West Coast Lumber Inspection Bureau.
      f. WWPA - Western Wood Products Association.

D. Submittals
   1. Product Data: For preservative-treated wood products and timber connectors.
      a. For preservative-treated wood products, include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
      b. For timber connectors, include installation instructions.
   2. LEED Submittals:
      a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood products comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
         1) Include statement indicating costs for each certified wood product.
   3. Shop Drawings: For heavy timber construction. Show layout, dimensions of each member, and details of connections.
   4. Certificates of Inspection: Issued by lumber grading agency for exposed timber not marked with grade stamp.

E. Quality Assurance
   1. Timber Standard: Comply with AITC 108, "Standard for Heavy Timber Construction."
   2. Forest Certification: Provide wood products obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

F. Delivery, Storage, And Handling
   1. Schedule delivery of heavy timber construction to avoid extended on-site storage and to avoid delaying the Work.
   2. Store materials under cover and protected from weather and contact with damp or wet surfaces. Provide for air circulation within and around stacks and under temporary coverings.

1.2 PRODUCTS

A. Timber
1. General: Comply with DOC PS 20 and with grading rules of lumber grading agencies certified by ALSC's Board of Review as applicable.
   a. Factory mark each item of timber with grade stamp of grading agency.
   b. For exposed timber indicated to receive a stained or natural finish, apply grade stamps to surfaces that will not be exposed to view, or omit grade stamps and provide certificates of grade compliance issued by grading agency.
2. Timber Species and Grade: Any species and grade that, for moisture content provided, complies with required structural properties.
   a. Allowable Stress Ratings for 12-Inch Nominal (286-mm Actual) Depth: Fb 1500 psi (10.3 MPa) and E 1,500,000 psi (10 340 MPa) **OR** Fb 1300 psi (9.0 MPa) and E 1,300,000 psi (8 960 MPa) **OR** As indicated on Drawings, **as directed**.
3. Moisture Content: Provide timber with 19 percent maximum moisture content at time of dressing or provide timber that is unseasoned at time of dressing but with 19 percent maximum moisture content at time of installation, **as directed**.
4. Dressing: Provide dressed timber (S4S) **OR** timber that is rough sawn (Rgh), **as directed**, unless otherwise indicated.
5. End Sealer: Manufacturer's standard, transparent, colorless wood sealer that is effective in retarding the transmission of moisture at cross-grain cuts and is compatible with indicated finish.
6. Penetrating Sealer: Manufacturer's standard, transparent, penetrating wood sealer that is compatible with indicated finish.

B. Round Wood Poles
1. Round Wood Poles: Clean-peeled wood poles complying with ASTM D 3200; with at least 80 percent of inner bark removed and with knots and limbs cut flush with the surface.

C. Preservative Treatment
1. Pressure treat timber with waterborne preservative according to AWPA C15 requirements for "sawn building poles and posts as structural members."
   a. Timber that is not in contact with the ground and is continuously protected from liquid water may be treated with inorganic boron (SBX) according to AWPA C31 instead of AWPA C15.
   b. Treatment with CCA shall include post-treatment fixation process.
2. Pressure treat poles with waterborne preservative to comply with AWPA C4.
   a. Treatment with CCA shall include post-treatment fixation process.
3. Preservative Chemicals: Acceptable to authorities having jurisdiction.
   a. Do not use chemicals containing arsenic or chromium except for marine (saltwater) applications.
4. Use process that includes water-repellent treatment.
5. Use process that does not include water repellents or other substances that might interfere with application of indicated finishes.
6. After treatment, redry timber and poles to 19 percent maximum moisture content.
7. Mark treated timber and poles with treatment quality mark of an inspection agency approved by ALSC's Board of Review.
   a. For exposed items indicated to receive a stained or natural finish, mark each piece on surface that will not be exposed or omit marking and provide certificates of treatment compliance issued by inspection agency.
8. Application: Treat all heavy timber construction unless otherwise indicated **OR** Treat items indicated on Drawings and the following, **as directed**:
   a. Sills and similar members in contact with masonry or concrete.
   b. Timber framing members less than 18 inches (460 mm) above grade.

D. Timber Connectors
1. General: Unless otherwise indicated, fabricate from the following materials:

a. Structural-steel shapes, plates, and flat bars complying with ASTM A 36/A 36M.
b. Round steel bars complying with ASTM A 575, Grade M 1020.
c. Hot-rolled steel sheet complying with ASTM A 1011/A 1011M, Structural Steel, Type SS, Grade 33.
d. Stainless-steel plate and flat bars complying with ASTM A 666, Type 304 **OR** Type 316, **as directed**.
e. Stainless-steel bars and shapes complying with ASTM A 276, Type 304 **OR** Type 316, **as directed**.
f. Stainless-steel sheet complying with ASTM A 666, Type 304 **OR** Type 316, **as directed**.

2. Fabricate beam seats from steel **OR** stainless steel, **as directed**, with 0.239-inch (6-mm) **OR** 3/16-inch (8-mm) **OR** 3/8-inch (9.5-mm), **as directed**, bearing plates, 3/4-inch- (19-mm-) diameter-by-12-inch- (300-mm-) long deformed bar anchors, and 0.239-inch (6-mm) side plates.
3. Fabricate beam hangers from steel **OR** stainless steel, **as directed**, with 0.179-inch (4.6-mm) stirrups and 0.239-inch (6-mm) top plates.
4. Fabricate strap ties from steel **OR** stainless steel, **as directed**, 2-1/2 inches (63 mm) wide by 0.179 inch (4.6 mm) **OR** 3 inches (75 mm) wide by 0.239 inch (6 mm), **as directed**, thick.
5. Fabricate tie rods from round steel bars with upset threads connected with forged-steel turnbuckles complying with ASTM A 668/A 668M.
6. Provide bolts, 3/4 inch (19 mm) unless otherwise indicated, complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); provide nuts complying with ASTM A 563 (ASTM A 563M); and, where indicated, provide flat washers.
7. Provide shear plates, 2-5/8 inches (66.7 mm) **OR** 4 inches (102 mm), **as directed**, in diameter, complying with ASTM D 5933.
8. Finish steel assemblies and fasteners with rust-inhibitive primer, 2-mil (0.05-mm) dry film thickness.
9. Hot-dip galvanize steel assemblies and fasteners after fabrication to comply with ASTM A 123/A 123M or ASTM A 153/A 153M.

E. Fabrication

1. Camber: Fabricate horizontal members and inclined members with a slope of less than 1:1, with natural convex bow (crown) up, to provide camber.
2. Shop fabricate members by cutting and restoring exposed surfaces to match specified surfacing. Finish exposed surfaces to remove planing or surfacing marks, and to provide a finish equivalent to that produced by machine sanding with No. 120 grit sandpaper.
3. Predrill for fasteners and assembly of units.
4. Where preservative-treated members are indicated, fabricate (cut, drill, surface, and sand) before treatment to greatest extent possible. Where fabrication must be done after treatment, apply a field-treatment preservative to comply with AWPA M4.
   a. Use inorganic boron (SBX) treatment for members not in contact with the ground and continuously protected from liquid water.
   b. Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.
5. Coat crosscuts with end sealer.
6. Seal Coat: After fabricating and surfacing each unit, apply a saturation coat of penetrating sealer on surfaces of each unit except for treated wood where the treatment included a water repellent.

1.3 EXECUTION

A. Installation

1. General: Erect heavy timber construction true and plumb. Provide temporary bracing to maintain lines and levels until permanent supporting members are in place.
   a. Install heavy timber construction to comply with Shop Drawings.
   b. Install horizontal and sloping members with crown edge up and provide not less than 4 inches (102 mm) of bearing on supports. Provide continuous members unless otherwise indicated; tie together over supports if not continuous.

c. Handle and temporarily support heavy timber construction to prevent surface damage, compression, and other effects that might interfere with indicated finish.

2. Framing Built into Masonry: Provide 1/2-inch (13-mm) clearance at tops, sides, and ends of members built into masonry, bevel cut ends 3 inches (76 mm); do not embed more than 4 inches (102 mm) unless otherwise indicated.
3. Cutting: Avoid extra cutting after fabrication. Where field fitting is unavoidable, comply with requirements for shop fabrication.
   OR
   Fit members by cutting and restoring exposed surfaces to match specified surfacing. Predrill for fasteners and assembly of units.
   a. Finish exposed surfaces to remove planing or surfacing marks, and to provide a finish equivalent to that produced by machine sanding with No. 120 grit sandpaper.
   b. Coat crosscuts with end sealer.
   c. Where preservative-treated members must be cut during erection, apply a field-treatment preservative to comply with AWPA M4.
      1) Use inorganic boron (SBX) treatment for members not in contact with the ground and continuously protected from liquid water.
      2) Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.
4. Install timber connectors as indicated.
   a. Unless otherwise indicated, install bolts with same orientation within each connection and in similar connections.
   b. Install bolts with orientation as indicated or, if not indicated, as directed by the Owner.

B. Adjusting
1. Repair damaged surfaces and finishes after completing erection. Replace damaged heavy timber construction if repairs are not approved by the Owner.

END OF SECTION 06 05 23 00b

Task	Specification	Specification Description
06 05 23 00	06 10 00 00	Rough Carpentry
06 05 73 13	01 22 16 00	No Specification Required

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SECTION 06 05 73 33 - WOOD DECKING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for wood decking. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Solid-sawn wood roof and floor decking.
b. Glued-laminated wood roof and floor decking.

C. Submittals
1. Product Data: For each type of product indicated.
a. For glued-laminated wood decking, include installation instructions and data on lumber, adhesives, and fabrication.
b. For preservative-treated wood products, include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
2. LEED Submittals:
a. Product Data for Credit EQ 4.1: For sealants and installation adhesives, including printed statement of VOC content.
b. Product Data for Credit EQ 4.4: For laminating adhesive used for glued-laminated decking, indicating that product contains no urea formaldehyde.

D. Quality Assurance
1. Standard for Solid-Sawn Wood Decking: Comply with AITC 112.

E. Delivery, Storage, And Handling
1. Schedule delivery of wood decking to avoid extended on-site storage and to avoid delaying the Work.
2. Store materials under cover and protected from weather and contact with damp or wet surfaces. Provide for air circulation within and around stacks and under temporary coverings. Stack wood decking with surfaces that are to be exposed in the final Work protected from exposure to sunlight.

1.2 PRODUCTS

A. Wood Decking, General
1. General: Comply with DOC PS 20 and with applicable grading rules of inspection agencies certified by ALSC's Board of Review.
2. Moisture Content: Provide wood decking with 15 **OR** 19, **as directed**, percent maximum moisture content at time of dressing.

B. Solid-Sawn Wood Decking
1. Decking Species: Alaska cedar **OR** Balsam fir **OR** Douglas fir-larch or Douglas fir-larch (North) **OR** Eastern spruce **OR** Hem-fir or hem-fir (North) **OR** Southern pine, **as directed**.
2. Decking Nominal Size: 2x6 **OR** 2x8 **OR** 3x6 **OR** 4x6, **as directed**.
3. Decking Grade:
a. Select(ed) **OR** Commercial, **as directed**, Decking.
OR

Dense Standard **OR** Dense Select **OR** Select **OR** Dense Commercial **OR** Commercial, **as directed**, Decking.
OR
Select(ed) Decking or Select Dex **OR** Commercial Decking or Commercial Dex, **as directed**.
4. Grade Stamps: Factory mark each item with grade stamp of grading agency. Apply grade stamp to surfaces that will not be exposed to view.
5. Face Surface: Rough sanded or wire brushed **OR** Saw textured **OR** Smooth, **as directed**.
6. Edge Pattern: Beaded edge **OR** Bullnosed **OR** Channel grooved **OR** Vee grooved, **as directed**.
7. Preservative Treatment: Pressure treat solid-sawn wood decking according to AWPA C31 with inorganic boron (SBX) and redry wood to 15 **OR** 19, **as directed**, percent maximum moisture content.

C. Glued-Laminated Wood Decking
1. Face Species: Alaska cedar **OR** Douglas fir-larch or Douglas fir-larch (North) **OR** Ponderosa pine **OR** Southern pine **OR** Western cedars or western cedars (North), **as directed**.
2. Decking Nominal Size: 2x6 **OR** 2x8 **OR** 3x6 **OR** 3x8 **OR** 4x6 **OR** 4x8 **OR** 5x6 **OR** 5x8, **as directed**.
3. Decking Configuration: For glued-laminated wood decking indicated to be of diaphragm design and construction, provide tongue-and-groove configuration that complies with research/evaluation report.
4. Face Grade:
a. Custom or Supreme: Clear face is required. Occasional pieces may contain a small knot or minor characteristic that does not detract from the overall appearance.
OR
Decorative: Sound knots and natural characteristics are allowed, including chipped edge knots, short end splits, seasoning checks, and some pin holes. Face knot holes, stain, end slits, skip, roller split, and planer burn are not allowed.
OR
Service: Face knot holes, stain, end splits, skip, roller split, planer burn, and other nonstrength-reducing characteristics are allowed. Strength-reducing characteristics are not allowed.
5. Face Surface: Rough sanded or wire brushed **OR** Saw textured **OR** Smooth, **as directed**.
6. Edge Pattern: Beaded edge **OR** Bullnosed **OR** Channel grooved **OR** Vee grooved, **as directed**.
7. Laminating Adhesive: Wet-use type complying with ASTM D 2559.
a. Use adhesive that contains no urea-formaldehyde resins.
8. Preservative Treatment: Pressure treat lumber before gluing according to AWPA C28 for aboveground use.
a. Use oxine copper (copper-8-quinolinolate) in a light petroleum solvent.
OR
Use copper naphthenate in a light petroleum solvent.
OR
Use waterborne preservative that is acceptable to authorities having jurisdiction and that contains no arsenic or chromium. After treating, redry wood to 15 **OR** 19, **as directed**, percent maximum moisture content.
OR
Use preservative solution without water repellents or substances that might interfere with application of indicated finishes.
OR
After dressing and fabricating decking, apply copper naphthenate according to AWPA M4 to surfaces cut to a depth of more than 1/16 inch (1.5 mm).

D. Accessory Materials
1. Fasteners for Solid-Sawn Decking: Provide fastener size and type complying with decking standard for thickness of deck used.

2. Fasteners for Glued-Laminated Decking: Provide fastener size and type complying with requirements in "Installation" Article for installing laminated decking.
3. Nails: Common; complying with ASTM F 1667, Type I, Style 10.
4. Spikes: Round; complying with ASTM F 1667, Type III, Style 3.
5. Fastener Material: Hot-dip galvanized **OR** Stainless, **as directed**, steel.
6. Bolts for Anchoring Decking to Walls:
   a. Carbon steel; complying with ASTM A 307 (ASTM F 568M) with ASTM A 563/A 563M hex nuts and, where indicated, flat washers, all hot-dip zinc coated, **as directed**.
      OR
      Stainless steel; complying with ASTM F 593, Alloy Group 1 or 2 (ASTM F 738M, Grade A1 or A4); with ASTM F 594, Alloy Group 1 or 2 (ASTM F 836M, Grade A1 or A4) hex nuts and, where indicated, flat washers.
7. Installation Adhesive: For glued-laminated wood decking indicated to be of diaphragm design and construction, provide adhesive that complies with research/evaluation report.
   a. Use adhesive that has a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
8. Sealant: Latex sealant compatible with substrates **OR** Elastomeric joint sealant complying with requirements in Division 07 Section "Joint Sealants" for Use NT (nontraffic) and for Uses M, G, A, and, as applicable to joint substrates indicated, O joint substrates, **as directed**.
   a. Use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. Penetrating Sealer: Clear sanding sealer complying with Division 09 Section "Staining And Transparent Finishing" and compatible with topcoats specified for use over it.

E. Fabrication
1. Shop Fabrication: Where preservative-treated decking is indicated, complete cutting, trimming, surfacing, and sanding before treating.
2. Predrill decking for lateral spiking to adjacent units to comply with referenced decking standard.
3. Seal Coat: After fabricating and surfacing decking, apply a saturation coat of penetrating sealer in fabrication shop, **as directed**.

1.3 EXECUTION

A. Installation
1. Install solid-sawn wood decking to comply with referenced decking standard.
   a. Locate end joints for two-span continuous lay-up **OR** combination simple and two-span continuous lay-up **OR** controlled random lay-up **OR** lay-up indicated, **as directed**.
2. Install laminated wood decking to comply with manufacturer's written instructions.
   a. Locate end joints for two-span continuous lay-up **OR** combination simple and two-span continuous lay-up **OR** controlled random lay-up **OR** lay-up indicated, **as directed**.
   b. Nail each course of glued-laminated wood decking at each support with one nail slant nailed above the tongue and one nail straight nailed through the face.
      1) Use 12d nails for 2x6 and 2x8 decking.
      2) Use 30d nails for 3x6 and 3x8 decking.
      3) Use 60d nails for 4x6 and 4x8 decking. Predrill decking to prevent splitting.
      4) Use 30d tongue nails in bottom tongue and 3/8-inch (10-mm) face spikes for 5x6 and 5x8 decking. Predrill decking at spikes to prevent splitting.
   c. Slant nail each course of glued-laminated wood decking to the tongue of the adjacent course at 30 inches (750 mm) o.c. and within 12 inches (300 mm) of the end of each unit. Stagger nailing in adjacent courses 15 inches (380 mm).
      1) Use 6d nails for 2x6 and 2x8 decking.
      2) Use 8d nails for 3x6 and 3x8 decking.
      3) Use 10d nails for 4x6 and 4x8 decking.
      4) Use 16d nails for 5x6 and 5x8 decking.

d. Glue adjoining decking courses together by applying a 3/8-inch (10-mm) bead of adhesive on the top of tongues according to research/evaluation report.

3. Anchor wood roof decking, where supported on walls, with bolts as indicated.
4. Where preservative-treated decking must be cut during erection, apply a field-treatment preservative to comply with AWPA M4.
   a. For solid-sawn decking, use inorganic boron (SBX).
   b. For laminated decking, use copper naphthenate.
5. Apply joint sealant to seal roof decking at exterior walls at the following locations:
   a. Between decking and supports located at exterior walls.
   b. Between decking and exterior walls that butt against underside of decking.
   c. Between tongues and grooves of decking over exterior walls and supports at exterior walls.

B. Adjusting
   1. Repair damaged surfaces and finishes after completing erection. Replace damaged decking if repairs are not approved by the Owner.

C. Protection
   1. Provide temporary waterproof covering as the Work progresses to protect roof decking until roofing is applied.

END OF SECTION 06 05 73 33

Task	Specification	Specification Description
06 05 73 33	06 05 23 00	Timber Bridge Components
06 05 73 33	06 10 00 00	Rough Carpentry
06 05 73 33	06 05 23 00a	Miscellaneous Carpentry
06 05 73 33	06 05 23 00b	Heavy Timber Construction

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SECTION 06 10 00 00 - ROUGH CARPENTRY

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for rough carpentry. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Framing with dimension lumber.
      b. Framing with timber.
      c. Framing with engineered wood products.
      d. Rooftop equipment bases and support curbs.
      e. Wood blocking, cants, and nailers.
      f. Wood furring and grounds.
      g. Wood sleepers.
      h. Utility shelving.
      i. Plywood backing panels.

C. Definitions
   1. Exposed Framing: Framing not concealed by other construction.
   2. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater but less than 5 inches nominal (114 mm actual) in least dimension.
   3. Timber: Lumber of 5 inches nominal (114 mm actual) or greater in least dimension.
   4. Lumber grading agencies, and the abbreviations used to reference them, include the following:
      a. NeLMA: Northeastern Lumber Manufacturers' Association.
      b. NLGA: National Lumber Grades Authority.
      c. RIS: Redwood Inspection Service.
      d. SPIB: The Southern Pine Inspection Bureau.
      e. WCLIB: West Coast Lumber Inspection Bureau.
      f. WWPA: Western Wood Products Association.

D. Submittals
   1. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
      a. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
      b. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
      c. For fire-retardant treatments specified to be High-Temperature (HT) type, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
      d. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
      e. Include copies of warranties from chemical treatment manufacturers for each type of treatment.
   2. LEED Submittals:

a. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
b. Product Data for Credit EQ 4.4: For composite-wood products, documentation indicating that product contains no urea formaldehyde.
c. Certificates for Credit MR 7: Chain-of-custody certificates certifying that products specified to be made from certified wood comply with forest certification requirements. Include evidence that mill is certified for chain of custody by an FSC-accredited certification body.
    1) Include statement indicating costs for each certified wood product.

3. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
4. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:
    a. Wood-preservative-treated wood.
    b. Fire-retardant-treated wood.
    c. Engineered wood products.
    d. Power-driven fasteners.
    e. Powder-actuated fasteners.
    f. Expansion anchors.
    g. Metal framing anchors.

E. Quality Assurance
1. Forest Certification: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship":
    a. Dimension lumber framing.
    b. Timber.
    c. Laminated-veneer lumber.
    d. Parallel-strand lumber.
    e. Prefabricated wood I-joists.
    f. Rim boards.
    g. Miscellaneous lumber.

F. Delivery, Storage, And Handling
1. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

1.2 PRODUCTS

A. Wood Products, General
1. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
    a. Factory mark each piece of lumber with grade stamp of grading agency.
    b. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
    c. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
    d. Provide dressed lumber, S4S, unless otherwise indicated.

2. Engineered Wood Products: Provide engineered wood products acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.
   a. Allowable Design Stresses: Provide engineered wood products with allowable design stresses, as published by manufacturer, that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

B. Wood-Preservative-Treated Lumber
1. Preservative Treatment by Pressure Process: AWPA C2, except that lumber that is not in contact with the ground and is continuously protected from liquid water may be treated according to AWPA C31 with inorganic boron (SBX).
   a. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
   b. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
2. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
3. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
   a. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
4. Application: Treat all rough carpentry, unless otherwise indicated, **OR** items indicated on Drawings, and the following, **as directed**:
   a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
   b. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
   c. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
   d. Wood framing members that are less than 18 inches (460 mm) above the ground in crawlspaces or unexcavated areas.
   e. Wood floor plates that are installed over concrete slabs-on-grade.

C. Fire-Retardant-Treated Materials
1. General: Comply with performance requirements in AWPA C20 (lumber) and AWPA C27 (plywood).
   a. Use Exterior type for exterior locations and where indicated.
   b. Use Interior Type A, High Temperature (HT) for enclosed roof framing, framing in attic spaces, and where indicated.
   c. Use Interior Type A, unless otherwise indicated.
2. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
   a. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
3. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.
4. Application: Treat all rough carpentry, unless otherwise indicated, **OR** items indicated on Drawings, and the following, **as directed**:
   a. Framing for raised platforms.
   b. Concealed blocking.
   c. Framing for non-load-bearing partitions.

d. Framing for non-load-bearing exterior walls.
e. Roof construction.
f. Plywood backing panels.

D. Dimension Lumber Framing

1. Maximum Moisture Content: 15 percent **OR** 19 percent **OR** 15 percent for 2-inch nominal (38-mm actual) thickness or less, 19 percent for more than 2-inch nominal (38-mm actual) thickness **OR** 15 percent for 2-inch nominal (38-mm actual) thickness or less, no limit for more than 2-inch nominal (38-mm actual) thickness **OR** 19 percent for 2-inch nominal (38-mm actual) thickness or less, no limit for more than 2-inch nominal (38-mm actual) thickness, **as directed**.
2. Non-Load-Bearing Interior Partitions: Construction or No. 2 **OR** Construction, Stud, or No. 3 **OR** Standard, Stud, or No. 3, **as directed**, grade of any species.
3. Exterior and Load-Bearing Walls **OR** Framing Other Than Non-Load-Bearing Interior Partitions **OR** Framing Other Than Interior Partitions, **as directed**: Any species and grade with a modulus of elasticity of at least 1,500,000 psi (10 350 MPa) **OR** 1,300,000 psi (8970 MPa) **OR** 1,100,000 psi (7590 MPa) **OR** 1,000,000 psi (6900 MPa) **OR** 900,000 psi (6210 MPa), **as directed**, and an extreme fiber stress in bending of at least 1000 psi (6.9 MPa) **OR** 850 psi (5.86 MPa) **OR** 700 psi (4.83 MPa) **OR** 600 psi (4.14 MPa) **OR** 500 psi (3.45 MPa), **as directed**, for 2-inch nominal (38-mm actual) thickness and 12-inch nominal (286-mm actual) width for single-member use.
4. Ceiling Joists (Non-Load-Bearing): Construction or No. 2 **OR** Construction, Stud, or No. 3 **OR** Standard, Stud, or No. 3, **as directed**, grade of any species.
5. Joists, Rafters, and Other Framing Not Listed Above: Any species and grade with a modulus of elasticity of at least 1,500,000 psi (10 350 MPa) **OR** 1,300,000 psi (8970 MPa) **OR** 1,100,000 psi (7590 MPa) **OR** 1,000,000 psi (6900 MPa) **OR** 900,000 psi (6210 MPa), **as directed**, and an extreme fiber stress in bending of at least 1000 psi (6.9 MPa) **OR** 850 psi (5.86 MPa) **OR** 700 psi (4.83 MPa) **OR** 600 psi (4.14 MPa) **OR** 500 psi (3.45 MPa), **as directed**, for 2-inch nominal (38-mm actual) thickness and 12-inch nominal (286-mm actual) width for single-member use.
6. Exposed Exterior **OR** Interior, **as directed**, Framing Indicated to Receive a Stained or Natural Finish: Provide material hand-selected for uniformity of appearance and freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot-holes, shake, splits, torn grain, and wane.
   a. Species and Grade: As indicated above for load-bearing construction of same type.
   b. Species and Grade: Hem-fir (north), Select Structural **OR** No. 1, **as directed**, grade; NLGA.
   c. Species and Grade: Southern pine, Select Structural **OR** No. 1 **OR** No. 2, **as directed**, grade; SPIB.
   d. Species and Grade: Douglas fir-larch; Select Structural **OR** No. 1, **as directed**, grade; WCLIB, or WWPA.
   e. Species and Grade: Mixed southern pine, Select Structural **OR** No. 1 **OR** No. 2, **as directed**, grade; SPIB.
   f. Species and Grade: Spruce-pine-fir, Select Structural **OR** No. 1, **as directed**, grade; NLGA.
   g. Species and Grade: Douglas fir-south; Select Structural **OR** No. 1, **as directed**, grade; WWPA.
   h. Species and Grade: Hem-fir; Select Structural **OR** No. 1, **as directed**, grade; WCLIB, or WWPA.
   i. Species and Grade: Douglas fir-larch (north); Select Structural **OR** No. 1, **as directed**, grade; NLGA.
   j. Species and Grade: Spruce-pine-fir (south), Select Structural **OR** No. 1, **as directed**, grade; NeLMA, WCLIB, or WWPA.
   k. Species and Grade: Eastern hemlock-balsam fir or eastern hemlock-tamarack; Select Structural **OR** No. 1, **as directed**, grade; NeLMA.
   l. Species and Grade: Beech-birch-hickory, Select Structural **OR** No. 1, **as directed**, grade; NeLMA.

m. Species and Grade: Northern red oak, Select Structural **OR** No. 1, **as directed**, grade; NeLMA.
n. Species and Grade: Redwood, Clear Heart Structural **OR** Clear Structural **OR** Select Structural **OR** No. 1, **as directed**, grade; RIS.
o. Species and Grade: Mixed oak, Select Structural **OR** No. 1, **as directed**, grade; NeLMA.
p. Species and Grade: Mixed maple, Select Structural **OR** No. 1, **as directed**, grade; NeLMA.
q. Species and Grade: Western cedars, Select Structural **OR** No. 1, **as directed**, grade; WCLIB, or WWPA.

E. Timber Framing
1. Provide timber framing complying with the following requirements, according to grading rules of grading agency indicated:
a. Species and Grade: Douglas fir-larch, Douglas fir-larch (north), or Douglas fir-south; Select Structural **OR** No. 1, **as directed**, grade; NLGA, WCLIB, or WWPA.
b. Species and Grade: Eastern hemlock, eastern hemlock-tamarack, or eastern hemlock-tamarack (north); Select Structural **OR** No. 1, **as directed**, grade; NeLMA or NLGA.
c. Species and Grade: Hem-fir or hem-fir (north), Select Structural **OR** No. 1, **as directed**, grade; NLGA, WCLIB, or WWPA.
d. Species and Grade: Mixed maple, Select Structural **OR** No. 1, **as directed**, grade; NeLMA.
e. Species and Grade: Mixed oak, Select Structural **OR** No. 1, **as directed**, grade; NeLMA.
f. Species and Grade: Southern pine, Select Structural **OR** No. 1, **as directed**, grade; SPIB.
g. Maximum Moisture Content: 20 **OR** 23, **as directed**, percent.
h. Additional Restriction: Free of heart centers.

F. Engineered Wood Products
1. Laminated-Veneer Lumber: Structural composite lumber made from wood veneers with grain primarily parallel to member lengths, evaluated and monitored according to ASTM D 5456 and manufactured with an exterior-type adhesive complying with ASTM D 2559 and containing no urea formaldehyde.
a. Extreme Fiber Stress in Bending, Edgewise: 3100 psi (21.3 MPa) **OR** 2900 psi (20.0 MPa) **OR** 2600 psi (17.9 MPa) **OR** 2250 psi (15.5 MPa), **as directed**, for 12-inch nominal- (286-mm actual-) depth members.
b. Modulus of Elasticity, Edgewise: 2,000,000 psi (13 700 MPa) **OR** 1,800,000 psi (12 400 MPa) **OR** 1,500,000 psi (10 300 MPa), **as directed**.
2. Parallel-Strand Lumber: Structural composite lumber made from wood strand elements with grain primarily parallel to member lengths, evaluated and monitored according to ASTM D 5456 and manufactured with an exterior-type adhesive complying with ASTM D 2559 and containing no urea formaldehyde.
a. Extreme Fiber Stress in Bending, Edgewise: 2900 psi (20 MPa) for 12-inch nominal- (286-mm actual-) depth members.
b. Modulus of Elasticity, Edgewise: 2,200,000 psi (15 100 MPa).
3. Wood I-Joists: Prefabricated units, I-shaped in cross section, made with solid or structural composite lumber flanges and wood-based structural panel webs, let into and bonded to flanges. Provide units complying with material requirements of and with structural capacities established and monitored according to ASTM D 5055.
a. Provide I-joists manufactured without urea formaldehyde.
b. Web Material: Either oriented strand board or plywood, complying with DOC PS 1 or DOC PS 2, Exposure 1 **OR** Plywood, complying with DOC PS 1 or DOC PS 2, Exposure 1 **OR** Plywood, complying with DOC PS 1, Exterior grade, **as directed**.
c. Structural Properties: Provide units with depths and design values not less than those indicated.
d. Provide units complying with APA PRI-400, factory marked with APA trademark indicating nominal joist depth, joist class, span ratings, mill identification, and compliance with APA standard.

4. Rim Boards: Product designed to be used as a load-bearing member and to brace wood I-joists at bearing ends, complying with research/evaluation report for I-joists.
   a. Manufacturer: Provide products by same manufacturer as I-joists.
   b. Material: All-veneer product **OR** glued-laminated wood **OR** product made from any combination solid lumber, wood strands, and veneers, **as directed**. Provide rim boards made without urea formaldehyde.
   c. Thickness: 1 inch (25 mm) **OR** 1-1/8 inches (28 mm) **OR** 1-1/4 inches (32 mm), **as directed**.
   d. Provide performance-rated product complying with APA PRR-401, rim board **OR** rim board plus, **as directed**, grade, factory marked with APA trademark indicating thickness, grade, and compliance with APA standard.

G. Miscellaneous Lumber
1. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
   a. Blocking.
   b. Nailers.
   c. Rooftop equipment bases and support curbs.
   d. Cants.
   e. Furring.
   f. Grounds.
   g. Utility shelving.
2. For items of dimension lumber size, provide Construction or No. 2 **OR** Standard, Stud, or No. 3, **as directed,** grade lumber with 15 **OR** 19, **as directed,** percent maximum moisture content of any species.
3. For items of dimension lumber size, provide Construction or No. 2 **OR** Standard, Stud, or No. 3, **as directed**, grade lumber with 15 **OR** 19, **as directed,** percent maximum moisture content and any of the following species:
   a. Hem-fir (north); NLGA.
   b. Mixed southern pine; SPIB.
   c. Spruce-pine-fir; NLGA.
   d. Hem-fir; WCLIB, or WWPA.
   e. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
   f. Western woods; WCLIB or WWPA.
   g. Northern species; NLGA.
   h. Eastern softwoods; NeLMA.
4. For exposed boards, provide lumber with 15 **OR** 19, **as directed,** percent maximum moisture content and any of the following species and grades:
   a. Eastern white pine, Idaho white, lodgepole, ponderosa, or sugar pine; Premium or 2 Common (Sterling) **OR** Standard or No. 3 Common, **as directed,** grade; NeLMA, NLGA, WCLIB, or WWPA.
   b. Mixed southern pine, No. 1 **OR** 2, **as directed,** grade; SPIB.
   c. Hem-fir or hem-fir (north), Select Merchantable or No. 1 Common **OR** Construction or No. 2 Common, **as directed**, grade; NLGA, WCLIB, or WWPA.
   d. Spruce-pine-fir (south) or spruce-pine-fir, Select Merchantable or No. 1 Common **OR** Construction or No. 2 Common, **as directed**, grade; NeLMA, NLGA, WCLIB, or WWPA.
5. For concealed boards, provide lumber with 15 **OR** 19, **as directed,** percent maximum moisture content and any of the following species and grades:
   a. Mixed southern pine, No. 2 **OR** 3, **as directed,** grade; SPIB.
   b. Hem-fir or hem-fir (north), Construction or 2 Common **OR** Standard or 3 Common, **as directed,** grade; NLGA, WCLIB, or WWPA.
   c. Spruce-pine-fir (south) or spruce-pine-fir, Construction or 2 Common **OR** Standard or 3 Common, **as directed,** grade; NeLMA, NLGA, WCLIB, or WWPA.
   d. Eastern softwoods, No. 2 **OR** 3, **as directed,** Common grade; NeLMA.
   e. Northern species, No. 2 **OR** 3, **as directed,** Common grade; NLGA.

f. Western woods, Construction or No. 2 Common **OR** Standard or No. 3 Common, **as directed,** grade; WCLIB or WWPA.

6. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
7. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
8. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

H. Plywood Backing Panels

1. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated**, as directed**, in thickness indicated or, if not indicated, not less than 1/2-inch (13-mm) nominal thickness.

I. Fasteners

1. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
   a. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M **OR** of Type 304 stainless steel, **as directed**.
2. Nails, Brads, and Staples: ASTM F 1667.
3. Power-Driven Fasteners: NES NER-272.
4. Wood Screws: ASME B18.6.1.
5. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).
6. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.
7. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
   a. Material:
      1) Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
      OR
      Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).

J. Metal Framing Anchors

1. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those indicated **OR** of basis-of-design products, **as directed**. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.
2. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 (Z180) coating designation.
   a. Use for interior locations where stainless steel is not indicated.
3. Stainless-Steel Sheet: ASTM A 666, Type 304 **OR** 316, **as directed**.
   a. Use for exterior locations and where indicated.
4. Joist Hangers: U-shaped joist hangers with 2-inch- (50-mm-) long seat and 1-1/4-inch- (32-mm-) wide nailing flanges at least 85 percent of joist depth.
5. I-Joist Hangers: U-shaped joist hangers with 2-inch- (50-mm-) long seat and 1-1/4-inch- (32-mm-) wide nailing flanges full depth of joist. Nailing flanges provide lateral support at joist top chord.
6. Top Flange Hangers: U-shaped joist hangers, full depth of joist, formed from metal strap with tabs bent to extend over and be fastened to supporting member.
7. Bridging: Rigid, V-section, nailless type, 0.050 inch (1.3 mm) thick, length to suit joist size and spacing.

8. Post Bases: Adjustable-socket type for bolting in place with standoff plate to raise post 1 inch (25 mm) above base and with 2-inch- (50-mm-) minimum side cover, socket 0.062 inch (1.6 mm) thick, and standoff and adjustment plates 0.108 inch (2.8 mm) thick.
9. Joist Ties: Flat straps, with holes for fasteners, for tying joists together over supports.
10. Rafter Tie-Downs: Bent strap tie for fastening rafters or roof trusses to wall studs below, 1-1/2 inches (38 mm) wide by 0.050 inch (1.3 mm) thick. Tie fastens to side of rafter or truss, face of top plates, and side of stud below.
11. Rafter Tie-Downs (Hurricane or Seismic Ties): Bent strap tie for fastening rafters or roof trusses to wall studs below, 2-1/4 inches (57 mm) wide by 0.062 inch (1.6 mm) thick. Tie fits over top of rafter or truss and fastens to both sides of rafter or truss, face of top plates, and side of stud below.
12. Floor-to-Floor Ties: Flat straps, with holes for fasteners, for tying upper floor wall studs to band joists and lower floor studs, 1-1/4 inches (32 mm) wide by 0.050 inch (1.3 mm) thick by 36 inches (914 mm) long.
13. Hold-Downs: Brackets for bolting to wall studs and securing to foundation walls with anchor bolts or to other hold-downs with threaded rods and designed with first of two bolts placed seven bolt diameters from reinforced base.
14. Wall Bracing:
    a. T-shaped bracing made for letting into studs in saw kerf, 1-1/8 inches (29 mm) wide by 9/16 inch (14 mm) deep by 0.034 inch (0.85 mm) thick with hemmed edges.
    OR
    Wall Bracing: Angle bracing made for letting into studs in saw kerf, 15/16 by 15/16 by 0.040 inch (24 by 24 by 1 mm) thick with hemmed edges.

K. Miscellaneous Materials
1. Sill-Sealer Gaskets:
    a. Glass-fiber-resilient insulation, fabricated in strip form, for use as a sill sealer; 1-inch (25-mm) nominal thickness, compressible to 1/32 inch (0.8 mm); selected from manufacturer's standard widths to suit width of sill members indicated.
    OR
    Closed-cell neoprene foam, 1/4 inch (6.4 mm) thick, selected from manufacturer's standard widths to suit width of sill members indicated.
2. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.
    a. Use adhesives that have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Water-Repellent Preservative: NWWDA-tested and -accepted formulation containing 3-iodo-2-propynyl butyl carbamate, combined with an insecticide containing chloropyrifos as its active ingredient.

1.3 EXECUTION

A. Installation, General
1. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
2. Framing Standard: Comply with AF&PA's "Details for Conventional Wood Frame Construction," unless otherwise indicated.
3. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.
4. Metal Framing Anchors: Install metal framing to comply with manufacturer's written instructions.
5. Do not splice structural members between supports, unless otherwise indicated.

6. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
   a. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.
7. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
   a. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches (2438 mm) o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
   b. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches (2438 mm) o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal- (38-mm actual-) thickness.
   c. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. (9.3 sq. m) and to solidly fill space below partitions.
   d. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet (6 m) o.c.
8. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
9. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
   a. Use inorganic boron for items that are continuously protected from liquid water.
   b. Use copper naphthenate for items not continuously protected from liquid water.
10. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
   a. NES NER-272 for power-driven fasteners.
   b. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
   c. "Nailing Schedule," and Tables in Section 2304, of ICC's International Building Code.
   d. Table 2306.1, "Fastening Schedule," in SBCCI's Standard Building Code.
   e. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
   f. Table 602.3(1), "Fastener Schedule for Structural Members," and Table 602.3(2), "Alternate Attachments," in ICC's International One- and Two-Family Dwelling Code.
11. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads, unless otherwise indicated.
12. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.
   a. Comply with approved **OR** indicated, **as directed,** fastener patterns where applicable. Before fastening, mark fastener locations, using a template made of sheet metal, plastic, or cardboard.
   b. Use finishing nails, unless otherwise indicated. Do not countersink nail heads **OR** Countersink nail heads and fill holes with wood filler, **as directed**.

B. Wood Ground, Sleeper, Blocking, And Nailer Installation
   1. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
   2. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.

3. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches (38 mm) wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

C. Wood Furring Installation
1. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
2. Furring to Receive Plywood or Hardboard Paneling: Install 1-by-3-inch nominal- (19-by-63-mm actual-) size furring horizontally **OR** vertically **OR** horizontally and vertically, **as directed,** at 24 inches (610 mm) **OR** 600 mm, **as directed,** o.c.
3. Furring to Receive Gypsum Board **OR** Plaster Lath, **as directed**: Install 1-by-2-inch nominal- (19-by-38-mm actual-) size furring vertically at 16 inches (406 mm) **OR** 400 mm, **as directed,** o.c.

D. Wall And Partition Framing Installation
1. General: Provide single bottom plate and double top plates using members of 2-inch nominal (38-mm actual) thickness whose widths equal that of studs, except single top plate may be used for non-load-bearing partitions and for load-bearing partitions where framing members bearing on partition are located directly over studs. Fasten plates to supporting construction, unless otherwise indicated.
   a. For exterior walls, provide 2-by-6-inch nominal- (38-by-140-mm actual-) **OR** 2-by-4-inch nominal- (38-by-89-mm actual-), **as directed,** size wood studs spaced 24 inches (610 mm) **OR** 16 inches (406 mm) **OR** 600 mm **OR** 400 mm, **as directed**, o.c., unless otherwise indicated.
   b. For interior partitions and walls, provide 2-by-6-inch nominal- (38-by-140-mm actual-) **OR** 2-by-4-inch nominal- (38-by-89-mm actual-) **OR** 2-by-3-inch nominal- (38-by-64-mm actual-), **as directed**, size wood studs spaced 24 inches (610 mm) **OR** 16 inches (406 mm) **OR** 600 mm **OR** 400 mm, **as directed**, o.c., unless otherwise indicated.
   c. Provide continuous horizontal blocking at midheight of partitions more than 96 inches (2438 mm) high, using members of 2-inch nominal (38-mm actual) thickness and of same width as wall or partitions.
2. Construct corners and intersections with three or more studs, except that two studs may be used for interior non-load-bearing partitions.
3. Frame openings with multiple studs and headers. Provide nailed header members of thickness equal to width of studs. Support headers on jamb studs.
   a. For non-load-bearing partitions, provide double-jamb studs and headers not less than 4-inch nominal (89-mm actual) depth for openings 48 inches (1200 mm) and less in width, 6-inch nominal (140-mm actual) depth for openings 48 to 72 inches (1200 to 1800 mm) in width, 8-inch nominal (184-mm actual) depth for openings 72 to 120 inches (1800 to 3000 mm) in width, and not less than 10-inch nominal (235-mm actual) depth for openings 10 to 12 feet (3 to 3.6 m) in width.
   b. For load-bearing walls, provide double-jamb studs for openings 60 inches (1500 mm) and less in width, and triple-jamb studs for wider openings. Provide headers of depth indicated or, if not indicated, according to Table R502.5(1) or Table R502.5(2), as applicable, in ICC's International Residential Code for One- and Two-Family Dwellings.
4. Provide diagonal bracing in exterior walls, at both walls of each external corner **OR** walls, at locations indicated, **as directed**, at 45-degree angle, full-story height, unless otherwise indicated. Use 1-by-4-inch nominal- (19-by-89-mm actual-) size boards, let-in flush with faces of studs **OR** metal wall bracing, let into studs in saw kerf, **as directed**.

E. Floor Joist Framing Installation
1. General: Install floor joists with crown edge up and support ends of each member with not less than 1-1/2 inches (38 mm) of bearing on wood or metal, or 3 inches (76 mm) on masonry. Attach floor joists as follows:
   a. Where supported on wood members, by toe nailing or by using metal framing anchors.

b. Where framed into wood supporting members, by using wood ledgers as indicated or, if not indicated, by using metal joist hangers.

2. Fire Cuts: At joists built into masonry, bevel cut ends 3 inches (76 mm) and do not embed more than 4 inches (102 mm).
3. Frame openings with headers and trimmers supported by metal joist hangers; double headers and trimmers where span of header exceeds 48 inches (1200 mm).
4. Do not notch in middle third of joists; limit notches to one-sixth depth of joist, one-third at ends. Do not bore holes larger than 1/3 depth of joist; do not locate closer than 2 inches (50 mm) from top or bottom.
5. Provide solid blocking of 2-inch nominal (38-mm actual) thickness by depth of joist at ends of joists unless nailed to header or band.
6. Lap members framing from opposite sides of beams, girders, or partitions not less than 4 inches (102 mm) or securely tie opposing members together. Provide solid blocking of 2-inch nominal (38-mm actual) thickness by depth of joist over supports.
7. Anchor members paralleling masonry with 1/4-by-1-1/4-inch (6.4-by-32-mm) metal strap anchors spaced not more than 96 inches (2438 mm) o.c., extending over and fastening to 3 joists. Embed anchors at least 4 inches (102 mm) into grouted masonry with ends bent at right angles and extending 4 inches (102 mm) beyond bend.
8. Provide solid blocking between joists under jamb studs for openings.
9. Under non-load-bearing partitions, provide double joists separated by solid blocking equal to depth of studs above.
   a. Provide triple joists separated as above, under partitions receiving ceramic tile and similar heavy finishes or fixtures.
10. Provide bridging of type indicated below, at intervals of 96 inches (2438 mm) o.c., between joists.
    a. Diagonal wood bridging formed from bevel-cut, 1-by-3-inch nominal- (19-by-64-mm actual-) size lumber, double-crossed and nailed at both ends to joists.
    b. Steel bridging installed to comply with bridging manufacturer's written instructions.

F. Ceiling Joist And Rafter Framing Installation

1. Ceiling Joists: Install ceiling joists with crown edge up and complying with requirements specified above for floor joists. Face nail to ends of parallel rafters.
   a. Where ceiling joists are at right angles to rafters, provide additional short joists parallel to rafters from wall plate to first joist; nail to ends of rafters and to top plate and nail to first joist or anchor with framing anchors or metal straps. Provide 1-by-8-inch nominal- (19-by-184-mm actual-) size or 2-by-4-inch nominal- (38-by-89-mm actual-) size stringers spaced 48 inches (1200 mm) o.c. crosswise over main ceiling joists.
2. Rafters: Notch to fit exterior wall plates and toe nail or use metal framing anchors. Double rafters to form headers and trimmers at openings in roof framing, if any, and support with metal hangers. Where rafters abut at ridge, place directly opposite each other and nail to ridge member or use metal ridge hangers.
   a. At valleys, provide double-valley rafters of size indicated or, if not indicated, of same thickness as regular rafters and 2 inches (50 mm) deeper. Bevel ends of jack rafters for full bearing against valley rafters.
   b. At hips, provide hip rafter of size indicated or, if not indicated, of same thickness as regular rafters and 2 inches (50 mm) deeper. Bevel ends of jack rafters for full bearing against hip rafter.
3. Provide collar beams (ties) as indicated or, if not indicated, provide 1-by-6-inch nominal- (19-by-140-mm actual-) size boards between every third pair of rafters, but not more than 48 inches (1219 mm) o.c. Locate below ridge member, at third point of rafter span. Cut ends to fit roof slope and nail to rafters.
4. Provide special framing as indicated for eaves, overhangs, dormers, and similar conditions, if any.

G. Timber Framing Installation

1. Install timber with crown edge up and provide not less than 4 inches (102 mm) of bearing on supports. Provide continuous members, unless otherwise indicated; tie together over supports as indicated if not continuous.
2. Where beams or girders are framed into pockets of exterior concrete or masonry walls, provide 1/2-inch (13-mm) air space at sides and ends of wood members.
3. Install wood posts using metal anchors indicated.
4. Treat ends of timber beams and posts exposed to weather by dipping in water-repellent preservative for 15 minutes.

H. Stair Framing Installation

1. Provide stair framing members of size, space, and configuration indicated or, if not indicated, to comply with the following requirements:
   a. Stringer Size: 2-by-12-inch nominal- (38-by-286-mm actual-) size, minimum.
   b. Stringer Material: Laminated-veneer lumber **OR** parallel-strand lumber **OR** solid lumber, **as directed**.
   c. Notching: Notch stringers to receive treads, risers, and supports; leave at least 3-1/2 inches (89 mm) of effective depth.
   d. Stringer Spacing: At least 3 stringers for each 36-inch (914-mm) clear width of stair.
2. Provide stair framing with no more than 3/16-inch (4.7-mm) variation between adjacent treads and risers and no more than 3/8-inch (9.5-mm) variation between largest and smallest treads and risers within each flight.

I. Protection

1. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
2. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06 10 00 00

Task	Specification	Specification Description
06 11 13 00	06 10 00 00	Rough Carpentry
06 11 13 00	06 05 23 00a	Miscellaneous Carpentry

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SECTION 06 11 16 00 - ROUGH CARPENTRY RENOVATION

1.1 DESCRIPTION OF WORK

A. This specification covers the furnishing and installation of materials for rough carpentry renovation. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 GENERAL

A. Quality Assurance
   1. Regulatory Requirements:
      a. Fire Retardant Treated Lumber and Plywood: Bear UL FR-S classification label.
      b. Preservative Treated Wood: Provide all heart redwood, cedar, or cyprus; or preservative-treated wood at following conditions in accordance with applicable building code:
         1) Wood framing, woodwork, and plywood up to and including subflooring at first-floor level of structures having crawl spaces, when bottoms of such items are 150 mm (6 inches) or less from earth underneath.
         2) Exterior wood steps, platforms, and railings.
         3) Wood sills, soles, plates, furring, and sleepers that are less than 150 mm (6 inches) from earth, furring and nailers that are set into or in contact with concrete or masonry.
         4) Nailers, edge strips, crickets, curbs, and cants for roof decks.
         5) Furring strips used on walls or partitions below grade and exterior walls above grade.
         6) Wood members used for rough framing of openings in exterior concrete or masonry walls.

B. Delivery, Storage, And Handling
   1. General: Deliver material to site, off-load, and handle in manner that will not damage material. Store material off ground and cover with waterproof covering. Provide adequate ventilation.
      a. Interior Fire-Retardant Treated Wood: Keep dry at all times. Replace material that has become wet. Store off ground, in building, or covered with unbroken water-tight cover in storage yard, during transit, and at job site. Keep ventilated to avoid moisture condensation.

C. Project Conditions
   1. Environmental Requirements: Execute demolition and renovation in manner to limit unnecessary dust and noise, and in compliance with applicable codes and federal or state requirements. Burning of materials on site not allowed.
   2. Existing Conditions: See Detailed Scope of Work. Do not interfere with use of occupied buildings or portions of buildings. Maintain free and safe passage to and from occupied areas.
   3. Protection:
      a. Provide necessary temporary shoring and bracing to support and protect portions of existing buildings during demolition operations. Leave such shoring in place until permanent supports have been installed. Be solely responsible for design, safety, and adequacy of temporary shoring and bracing and its ability to carry load for which intended.
      b. Contractor: Protect grounds, plantings, buildings, and any other facilities or property from damage caused by construction operations.

4. Safety: Cease operations at endangered area, and notify the Owner immediately if safety of structure appears to be endangered. Take precautions to properly support structure. Do not resume work in endangered area until safety is restored.

D. Scheduling And Sequencing
1. Scheduling and Completion: Comply with requirements of Detailed Scope of Work.

1.3 PRODUCTS

A. Materials
1. Materials for Patching, Extending, and Matching:
a. Provide same products or types of construction as in existing structure, as needed to patch, extend, or match existing work.
1) Generally, Contract Documents will not define products or standards of workmanship present in existing construction. Determine products by inspection and testing as necessary, and required workmanship by reference to existing as sample of comparison.
2) Patching, extending, and matching existing work and systems shall result in complete, finished system.
b. Presence of product, finish, or type of construction requires that patching, extending, or matching be performed as necessary to make work complete and consistent.
2. Lumber: Each Piece of Lumber: Grade stamped by recognized association or independent inspection agency certified by American Lumber Standards Committee's Board of Review.
a. New Replacement Studs and Joists: Match existing and complies with Reference Standards.
b. Wood Studs and Joists: No. 2 Grade or better.
c. Sill Plates on Concrete: All heart redwood, cedar, or cyprus: or preservative-treated wood.
d. Blocking and Furring: Standard Grade or Better.
e. Preservative-Treated: AWPB LP-2, pressure-treated with waterborne preservative. Penta or creosote not allowed.
1) Treat drilled holes and cuts across grain in accordance with AWPA M4.
f. Fire-Retardant Treated:
1) Lumber: AWPA C20 Interior Type A.
2) Plywood: AWPA C27 Interior Type A.
3) Bear UL FR-S classification label.
g. Pressure-Treated Lumber: Bear AWPA Quality Mark C-2.
h. Seasoning: Kiln dry to following (including treated material):
i. Lumber Up to 50 mm (2 inches): 19 percent or less moisture content.
j. Preservative- and Fire-Retardant Treated Material: Mill or rip material parallel to grain prior to treatment.
3. Plywood: PS-1: Each panel identified with APA grade trademark.
a. Subfloor: APA Rated Sheathing, Tongue and groove, Exposure 1 (interior with exterior glue).
1) Span Rating: Not less than spacing of framing members.
2) Thickness: In accordance with APA Recommendations.
b. Roof Sheathing: APA Rated Sheathing, Exposure 1 (interior with exterior glue).
1) Span Rating: Not less than spacing of framing members.
2) Thickness: In accordance with APA Recommendations.
c. Wall Sheathing: APA CD, Exposure 1 (Interior with exterior glue).
1) Span Rating: Not less than spacing of framing members.
2) Thickness: As indicated.
d. Panel Edge Clips: Extruded aluminum or hot-dipped galvanized steel, H-shaped clips to prevent differential deflection of roof sheathing.
e. Fire-Retardant Treated Plywood: Bear UL FR-S classification label.

1) Interior Plywood Fire Retardant Treatment: AWPA C27 Interior Type A.
2) Exterior Plywood Fire Retardant Treatment: AWPA C27 Exterior Type.

f. Seasoning: Kiln dry plywood to 15 percent or less moisture content.
   1) Pressure Treated Plywood: Kiln dry lumber after treatment.
g. Nails: Type and size as recommended by APA.

4. Metal Framing Anchors: Punched and formed for nailing so that nails will be stressed in shear only.
   a. General: Provide with nails and bolts according to manufacturers requirements.
      1) Nails: Zinc coated.
   b. Types: As indicated and as required to accommodate framing.
   c. Sizes: Of sufficient size and strength to develop full strength of supported member in accordance with applicable building code.
   d. Metal Bridging: Minimum No. 16 U.S. Standard gage.
   e. Finish: Hot-dipped galvanized.
5. Anchor Bolts: Furnish anchors to be built into concrete and masonry for anchorage of wood.
6. Rough Hardware: Provide necessary bolts, screws, nails, clips, plates, straps, hangers, etc., necessary for completion of renovation work. Provide correct material of proper size and strength for purpose intended, conforming to Reference Standards and applicable building codes.
   a. Exterior Locations and for Fire-Retardant- and Preservative-Treated Wood: Provide galvanized rough hardware.
7. Vapor Barrier at Crawl Spaces: ASTM D 2103, 0.15 mm (6 mil) polyethylene sheeting.
8. Insulation: Type and R-value to comply with applicable codes and regulations.
   a. Blanket Insulation: ASTM C 665 fiberglass blankets. Exposed insulation shall be foil-faced with flame-spread rating of 25 or less in accordance with ASTM E 84, where required by applicable codes and regulations.

1.4 EXECUTION

A. Examination
1. Units, Spaces, and Areas to be Renovated: Comply with Detailed Scope of Work.
   a. Verify that surfaces to receive rough carpentry are prepared to require grades and dimensions.

B. Preparation
1. Dust Protection: Comply with Detailed Scope of Work.
2. Building Occupation: Carry out demolition and renovation work to cause as little inconvenience to occupants as possible. See Detailed Scope of Work.
3. Protection: See Detailed Scope of Work.
4. Selective Demolition: Comply with Detailed Scope of Work.

C. Laying Out Work
1. Discrepancies: Verify dimensions and elevations indicated in layout of existing work.
   a. Prior to commencing work, carefully compare and check Drawings (if any) for discrepancies in locations or elevations of work to be executed.
   b. Refer discrepancies among Drawings (if any), Specifications, and existing conditions to the Owner for adjustment before work affected is performed.
      1) Failure to make such notification shall place responsibility on Contractor to carry out work in satisfactory, workmanlike manner.
2. Contractor: Responsible for location and elevation of construction contemplated by Construction Documents.

D. Performance
1. Patching: Patch and extend existing work using skilled mechanics who are capable of matching existing quality of workmanship.

a. Quality of Patched or Extended Work: Not less than specified for new work. If similar new work is not specified, equal to existing work.

2. General: Perform in accordance with AF&PA National Design Specification for Wood Construction, latest Edition.
    a. Framing: Erect plumb, level and true and rigidly anchor in place. Cut framing square on bearings, closely fit, accurately set to required lines and levels.
    b. Nail or spike members in accordance with applicable codes.
    c. Framing: 400 mm (16 inches) OC unless otherwise indicated.
    d. Shims: Do not use shims for leveling on wood or metal bearings. Use steel or slate shims with full bearing on masonry or concrete.
    e. Do not splice framing members between bearing points.
    f. Metal Framing Anchors: Install where required for proper connections in accordance with manufacturer recommendations. Drive nail in each nail hole provided in anchor.
3. Wood Framing:
    a. Openings: Frame members for passage of pipes and ducts to avoid cutting structural members. Do not cut, notch, or bore framing members for passage of pipes or conduits without the Owner's permission. Reinforce framing members as directed where damaged by cuffing.
    b. Firestopping: Firestop concealed spaces in framing. No shutoff by framing members to prevent drafts from one space to another. Use 50 mm (2 inch) nominal thick accurately fit wood blocking to fill opening.
    c. Joists and Beams: Sizes and spacing as indicated.
        1) Set crown edge-up with 90 mm (3-1/2 inch) bearing unless noted otherwise.
        2) Toe nail joists to wood sills with 16d nails both sides or secure with metal connectors. Lap and spike joists over supports.
        3) Double joists to form headers and trimmers at openings over 1,200 mm (4 feet) and support with metal joist hangers.
        4) Provide joist hangers at joists framing into flush wood beams.
    d. Provide blocking or suitable edge support between members as necessary to support edges of sheathing.
    e. Replace warped lumber in walls and joists prior to installation of finish surface.
4. Anchors: Unless otherwise indicated, bolt plates firmly to concrete or masonry with anchor bolts in accordance with applicable code.
    a. In Masonry: Embed anchor bolts minimum 400 mm (16 inches) and provide each with nut and 50 mm (2 inch) diameter washer at bottom end. Grout bolts with mortar.
    b. In Concrete: Embed anchor bolts minimum 200 mm (8 inches) and provide each with nut and 50 mm (2 inch) diameter washer at bottom end. 90 degree bent end may be substituted for nut and washer.
5. Wood Studs: Install at 400 mm (16 inches) OC with single bottom plate and double top plate with joints staggered.
    a. Double studs at openings and triple at corners and intersections. Double headers with double trimmers over openings.
6. Plywood Sheathing: Install in accordance with APA Recommendations.
    a. Provide space at end and side joints as recommended by APA.
    b. Install panels with face grain perpendicular to supports with end-joints supported. Stagger ends of adjacent sheets 1 200 mm (4 feet) where possible.
    c. Where support spacing exceeds maximum span for unsupported edge, provide adequate blocking, tongue and groove edges, or panel edge clips, in accordance with APA E30-L.
    d. Nail in accordance with APA's Recommendations.
7. Preservative- and Fire-Retardant Material: Milling or ripping material parallel to grain not allowed unless material is treated after milling or ripping.
    a. Preservative-Treated Material: Treat drilled holes and cuts across grain in accordance with AWPA M4.

E. Flooring Work

1. Defective Joists and Subfloor: Remove defective joists and subfloor which no longer satisfy structural requirements with now material to fulfill their structural function.
   a. Remove ceiling, subfloor, and joists in safe manner and at minimum inconvenience to residents.
   b. Splice, strengthen, support, or replace rotted or otherwise defective joists to fulfill their anticipated structural function.
   c. New Replacement Joists: Comply with requirements of appropriate section specifying new flooring, including flooring manufacturer's recommendations.
   d. Ceiling Replacement: Include removal and replacement of ceiling finish to match existing.
      1) Glue and screw new ceiling material to bottom of joists.
      2) Paint entire ceiling of space affected by replacement matching color of existing walls in accordance with Division 9 Section "Painting."
   e. Crawl-Space Insulation: Replace insulation damaged by or removed during construction operations. If there is no existing insulation, provide new insulation, where required.
      1) Insulation: Type and R-value to comply with applicable codes and regulations.
   f. New Replacement Subfloor: Install in accordance with APA Recommendations and with requirements of appropriate section specifying new flooring, including flooring manufacturer's recommendations.
      1) Glue and nail new subfloor to joists.
      2) Nail in accordance with APA's Recommendations and sufficiently to avoid squeaking floors.
   g. Base at walls: Replace wood base (including coves and corner rounds) with new wood base to match existing.
2. Above-Grade Floors to Receive Resilient Flooring: Examine to ensure that vapor-barrier sheet is laid over ground, sheets lapped, edge joints sealed and sufficient cross ventilation exists to insure dryness.
   a. If vapor barrier does not cover ground in crawl space, install vapor barrier in accordance with applicable codes and regulations.
      1) Completely cover ground at crawl spaces with minimum 150 mm (6 inch) lapped joints.
      2) Tape all lapped joints with water-resistive tape in accordance with manufacturer's recommendations.
      3) Protect vapor barrier from puncture and displacement. Lay heavy objects such as pieces of masonry at intervals not over 1 200 mm (4 feet) OC at lapped joints to hold in place. If punctures occur in vapor barrier, repair by placing patches of vapor-barrier material over punctures and taping all lapped joints.
   b. If crawl space does not have enough ventilation, install additional vents in accordance with applicable codes and regulations.
3. Floors Damaged by Construction Operations: Patch floor damage to match existing floor surfaces, and comply with requirements for new flooring.

F. Roofing Work
1. Removal of Existing Roofing: Roofing may contain asbestos fibers. Comply with applicable codes, laws, and regulations regarding asbestos materials.
2. Defective Rafters and Sheathing: Remove defective rafters and sheathing which no longer satisfy structural requirements with new material to match existing.
   a. Remove sheathing and rafters in safe manner and at minimum inconvenience to residents.
   b. Splice, strengthen, support, or replace rotted or otherwise defective rafters to fulfill their anticipated structural function.
   c. New Replacement Sheathing: Install in accordance with APA Recommendations and with requirements of applicable Division 7 roofing Sections.
      1) Nail in accordance with APA s Recommendations.

G. Blocking And Furring
1. Blocking: Install wood blocking as required for proper support of hardware, bath accessories, cabinets, and other wall-mounted hems.

a. Set true to line, level, or plumb, well-secured in stud wall and flush with back of drywall or other wall finish.

b. Coordinate exact locations with other sections.

2. Rough Wood Bucks: Set true and plumb and anchor to concrete or masonry with steel straps extending into wall minimum 200 mm (8 inches). Place anchors near top and bottom of buck and space uniformly at maximum 600 mm (24 inches) OC. Provide nominal 50 mm (2 inch) thick if not indicated.

3. Wood Furring: Install wood furring on masonry or concrete walls in sizes and spacing as indicated on Drawings (if any). Provide minimum 25 mm by 75-mm (1 inch by 3 inch) nominal furring strips spaced at maximum of 400 mm (16 inches) OC if not indicated.

a. Securely fasten wood furring at maximum 900 mm (3 feet) OC with toggle or expansion bolts, cut concrete nails or ramset anchors as required. Do not use wood plugs.

b. Install furring around openings and at corners.

c. Erect furring plumb and level, and shim out as required to provide true, even plane with surfaces suitable to receive required finish.

END OF SECTION 06 11 16 00

Task	Specification	Specification Description
06 11 16 00	01 22 16 00	No Specification Required
06 11 16 00	06 10 00 00	Rough Carpentry
06 11 16 00	06 05 23 00a	Miscellaneous Carpentry

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SECTION 06 15 13 00 - EXTERIOR ROUGH CARPENTRY

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for exterior rough carpentry. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Elevated decks including wood decking, plastic decking, stairs, railings, and support framing.
b. Wood benches.

C. Definitions
1. Boards: Lumber of less than 2 inches nominal (38 mm actual) in thickness and 2 inches nominal (38 mm actual) or greater width.
2. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater but less than 5 inches nominal (114 mm actual) in least dimension.
3. Timber: Lumber of 5 inches nominal (114 mm actual) or greater in least dimension.
4. Lumber grading agencies, and the abbreviations used to reference them, include the following:
a. NeLMA: Northeastern Lumber Manufacturers' Association.
b. NLGA: National Lumber Grades Authority.
c. RIS: Redwood Inspection Service.
d. SPIB: The Southern Pine Inspection Bureau.
e. WCLIB: West Coast Lumber Inspection Bureau.
f. WWPA: Western Wood Products Association.

D. Submittals
1. Product Data: For preservative-treated wood products, plastic decking, and metal framing anchors.
2. LEED Submittal:
a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood products comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
3. Material Certificates:
a. For lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by ALSC's Board of Review.
b. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.
4. Evaluation Reports: For the following, from an approved organization/model code, as directed by the Owner:
a. Preservative-treated wood products.
b. Plastic decking.
c. Expansion anchors.
d. Metal framing anchors.
e. Decking fasteners.

E. Quality Assurance
1. Forest Certification: Provide wood products obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

F. Delivery, Storage, And Handling
1. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.
2. Handle and store plastic lumber to comply with manufacturer's written instructions.

1.2 PRODUCTS

A. Lumber, General
1. Lumber: Comply with DOC PS 20 and with applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by ALSC's Board of Review. Provide lumber graded by an agency certified by ALSC's Board of Review to inspect and grade lumber under the rules indicated.
a. Factory mark each item with grade stamp of grading agency.
b. For items that are exposed to view in the completed Work, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
c. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry wood products.
d. Provide dressed lumber, S4S, unless otherwise indicated.

B. Dimension Lumber
1. Maximum Moisture Content: 15 percent **OR** 19 percent **OR** 15 percent for 2-inch nominal (38-mm actual) thickness or less; 19 percent for more than 2-inch nominal (38-mm actual) thickness **OR** 15 percent for 2-inch nominal (38-mm actual) thickness or less; no limit for more than 2-inch nominal (38-mm actual) thickness **OR** 19 percent for 2-inch nominal (38-mm actual) thickness or less; no limit for more than 2-inch nominal (38-mm actual) thickness, **as directed**.
2. Deck and Stair Framing: Select Structural **OR** No. 1 **OR** No. 2 **OR** Construction or No. 2 **OR** Construction, Stud, or No. 3, **as directed**, grade and as selected from the following species:
a. Hem-fir (North); NLGA.
b. Southern pine; SPIB.
c. Douglas fir-larch; WCLIB or WWPA.
d. Mixed southern pine; SPIB.
e. Spruce-pine-fir; NLGA.
f. Douglas fir-south; WWPA.
g. Hem-fir; WCLIB or WWPA.
h. Douglas fir-larch (North); NLGA.
i. Spruce-pine-fir (South); NeLMA, WCLIB, or WWPA.

OR

Deck and Stair Framing: Any species and grade with a modulus of elasticity of at least 1,500,000 psi (10 350 MPa) **OR** 1,300,000 psi (8970 MPa) **OR** 1,100,000 psi (7590 MPa) **OR** 1,000,000 psi (6900 MPa) **OR** 900,000 psi (6210 MPa), **as directed**, and an extreme fiber stress in bending of at least 1000 psi (6.9 MPa) **OR** 850 psi (5.86 MPa) **OR** 700 psi (4.83 MPa) **OR** 600 psi (4.14 MPa) **OR** 500 psi (3.45 MPa), **as directed**, for 2-inch nominal (38-mm actual) thickness and 12-inch nominal (286-mm actual) width for single-member use.
3. Dimension Lumber Posts: No. 2 **OR** Construction or No. 2 **OR** Construction, Stud, or No. 3, **as directed**, grade and as selected from the following species:
a. Hem-fir or hem-fir (North); NLGA, WCLIB, or WWPA.
b. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
c. Mixed southern pine; SPIB.
d. Spruce-pine-fir or spruce-pine-fir (South); NeLMA, NLGA, WCLIB, or WWPA.
e. Northern species; NLGA.
f. Eastern softwoods; NeLMA.

g. Western woods; WCLIB or WWPA.

4. Dimension Lumber Decking and Stair Treads: No. 2 **OR** Construction or No. 2, **as directed**, grade and as selected from the following species:
   a. Hem-fir or hem-fir (North); NLGA, WCLIB, or WWPA.
   b. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
   c. Mixed southern pine; SPIB.
   d. Redwood; RIS.

   OR

   Dimension Lumber Decking and Stair Treads: Deck Heart or Construction Heart **OR** Deck Common or Construction Common, **as directed**, redwood; RIS.
5. Dimension Lumber Railing Members: Select Structural **OR** No. 1 **OR** No. 2 **OR** Construction or No. 2, **as directed**, grade and as selected from the following species:
   a. Hem-fir or hem-fir (North); NLGA, WCLIB, or WWPA.
   b. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
   c. Mixed southern pine; SPIB.
   d. Redwood; RIS.
   e. Spruce-pine-fir or spruce-pine-fir (South); NeLMA, NLGA, WCLIB, or WWPA.

   OR

   Dimension Lumber Railing Members: Heart Clear **OR** Heart B or Select Heart, **as directed**, redwood; RIS.
6. Dimension Lumber for Benches: Select Structural **OR** No. 1, **as directed**, grade and as selected from the following species:
   a. Hem-fir or hem-fir (North); NLGA, WCLIB, or WWPA.
   b. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
   c. Mixed southern pine; SPIB.
   d. Redwood; RIS.
   e. Spruce-pine-fir or spruce-pine-fir (South); NeLMA, NLGA, WCLIB, or WWPA.

   OR

   Dimension Lumber for Benches: Heart Clear **OR** Heart B or Select Heart, **as directed**, redwood; RIS.

C. Boards
1. Maximum Moisture Content: 15 **OR** 19, **as directed**, percent.
2. Board Decking and Stair Treads: 1-1/4-inch- (32-mm-) thick radius-edged decking of any of the following species and grades:
   a. Douglas fir-larch or Douglas fir-south, Patio 1 **OR** Patio 2, **as directed**, WWPA.
   b. Douglas fir-larch, Select Dex **OR** Commercial Dex, **as directed**, WCLIB.
   c. Douglas fir-larch (North), Select Patio **OR** Commercial Patio, **as directed**, NLGA.
   d. Hem-fir, Patio 1 **OR** Patio 2, **as directed**, WWPA.
   e. Hem-fir, Select Dex **OR** Commercial Dex, **as directed**, WCLIB.
   f. Hem-fir (North), Select Patio **OR** Commercial Patio, **as directed**, NLGA.
   g. Redwood, Heart Clear **OR** Heart B or Select Heart, **as directed**; RIS.
   h. Southern pine, Premium **OR** Standard, **as directed**, SPIB.
   i. Western red cedar, Patio 1 **OR** Patio 2, **as directed**, WWPA.
   j. Western red cedar, Select Dex **OR** Commercial Dex, **as directed**, WCLIB.
   k. Western red cedar (North), Select Patio **OR** Commercial Patio, **as directed**, NLGA.
3. Railing Boards: Any of the following species and grades:
   a. Douglas fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA.
   b. Hem-fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA.
   c. Redwood, Heart Clear **OR** Heart B or Select Heart, **as directed**; RIS.
   d. Southern pine, B & B finish; SPIB.
4. Boards for Benches: Any of the following species and grades:
   a. Douglas fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA.
   b. Hem-fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA.
   c. Redwood, Heart Clear **OR** Heart B or Select Heart, **as directed**; RIS.

d. Southern pine, Edge Grain B & B finish **OR** Near Rift B & B finish **OR** B & B finish, **as directed**; SPIB.

D. Timber
1. Maximum Moisture Content: 19 percent **OR** No limit, **as directed**.
2. Dressing: Provide dressed timber (S4S) or timber that is rough sawn (Rgh) unless otherwise indicated.
3. Timber Posts:
a. Balsam fir, Douglas fir-larch, Douglas fir-larch (North), eastern hemlock tamarack (North), hem-fir, southern pine, western hemlock, or western hemlock (North); No. 1 **OR** No. 2, **as directed**, NeLMA, NLGA, SPIB, WCLIB, or WWPA.
b. Alaska cedar; No. 1 **OR** No. 2, **as directed**, WCLIB.
c. Southern pine; No. 1 **OR** No. 2, **as directed**, SPIB.

E. Round Wood Poles
1. Round Wood Poles: Clean-peeled wood poles complying with ASTM D 3200; with at least 80 percent of inner bark removed and with knots and limbs cut flush with the surface.
2. Species: as directed by the Owner.

F. Preservative Treatment
1. Pressure treat boards and dimension lumber with waterborne preservative according to AWPA C2.
2. Pressure treat timber with waterborne preservative according to AWPA C15 requirements for "sawn building poles and posts as structural members."
a. Treatment with CCA shall include post-treatment fixation process.
3. Pressure treat poles with waterborne preservative to comply with AWPA C4.
a. Treatment with CCA shall include post-treatment fixation process.
4. Preservative Chemicals: Acceptable to authorities having jurisdiction.
a. Do not use chemicals containing arsenic or chromium except for timber posts **OR** except for poles, **as directed**.
5. Use process that includes water-repellent treatment.
OR
Use process that does not include water repellents or other substances that might interfere with application of indicated finishes.
6. After treatment, redry boards**,** dimension lumber, timber, and poles to 19 percent maximum moisture content.
7. Mark treated wood with treatment quality mark of an inspection agency approved by ALSC's Board of Review.
a. For items indicated to receive a stained or natural finish, mark each piece on surface that will not be exposed or omit marking and provide certificates of treatment compliance issued by inspection agency.
8. Application: Treat all exterior rough carpentry unless otherwise indicated **OR** Treat items indicated on Drawings and the following, **as directed**:
a. Framing members less than 18 inches (460 mm) above grade.
b. Sills and ledgers.
c. Members in contact with masonry or concrete.
d. Posts.
e. Round wood poles.
f. Decking.
g. Stair treads.

G. Plastic Decking
1. Plastic Lumber, General: Products acceptable to authorities having jurisdiction and for which current model code evaluation reports exist that show compliance with building code in effect for Project for indicated occupancy and type of construction.

a. Allowable loads and spans, as documented in evaluation reports or in information referenced in evaluation reports, shall not be less than design loads and spans indicated.
2. Composite Plastic Lumber: Solid or hollow shapes made from a mixture of cellulose fiber and polyethylene or polypropylene.
   a. Configuration: Provide product with grooved edges designed for fastening with concealed splines.
   b. Surface Texture: Woodgrain **OR** Smooth **OR** Manufacturer's standard, **as directed**.
   c. Color: As selected from manufacturer's full range.
3. All-Plastic Lumber: Solid or hollow shapes made from high-density polyethylene (HDPE) **OR** PVC **OR** polystyrene **OR** cellular PVC, **as directed**, with no cellulose fiber.
   a. Configuration: Provide product with grooved edges designed for fastening with concealed splines **OR** tongue-and-groove edges designed for concealed fastening, **as directed**.
   b. Surface Texture: Woodgrain **OR** Smooth **OR** Manufacturer's standard, **as directed**.
   c. Color: As selected from manufacturer's full range.

H. Fasteners
1. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than 1-1/2 inches (38 mm) into wood substrate.
   a. Use stainless steel **OR** fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M or ASTM F 2329, **as directed**, unless otherwise indicated.
   b. For pressure-preservative-treated wood, use stainless-steel fasteners.
   c. For plastic **OR** wood, **as directed**, decking, use stainless-steel fasteners where fasteners are exposed to view.
   d. For redwood, use brass/bronze **OR** stainless-steel **OR** hot-dip galvanized-steel, **as directed**, fasteners.
2. Nails: ASTM F 1667.
3. Power-Driven Fasteners: NES NER-272.
4. Wood Screws: ASME B18.6.1.
5. Lag Screws: ASME B18.2.1 (ASME B18.2.3.8M).
6. Carbon-Steel Bolts: ASTM A 307 (ASTM F 568M) with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers all hot-dip zinc coated.
7. Stainless-Steel Bolts: ASTM F 593, Alloy Group 1 or 2 (ASTM F 738M, Grade A1 or A4); with ASTM F 594, Alloy Group 1 or 2 (ASTM F 836M, Grade A1 or A4) hex nuts and, where indicated, flat washers.
8. Postinstalled Anchors: Stainless-steel, chemical or torque-controlled expansion anchors with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry assemblies and equal to four times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
   a. Stainless-steel bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).

I. Metal Framing Anchors
1. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those indicated on Drawings **OR** of basis-of-design products, **as directed**. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.
2. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 (Z180) **OR** G90 (Z270) **OR** G185 (Z550), **as directed**, coating designation.
3. Stainless-Steel Sheet: ASTM A 666, Type 304 **OR** Type 316, **as directed**.
4. Joist Hangers: U-shaped, with 2-inch- (50-mm-) long seat and 1-1/4-inch- (32-mm-) wide nailing flanges at least 85 percent of joist depth.
5. Top Flange Hangers: U-shaped joist hangers, full depth of joist, formed from metal strap with tabs bent to extend over and be fastened to supporting member.

6. Post Bases: Adjustable-socket type for bolting in place with standoff plate to raise post 1 inch (25 mm) above base and with 2-inch- (50-mm-) minimum side cover, socket 0.062 inch (1.6 mm) thick, and standoff and adjustment plates 0.108 inch (2.8 mm) thick.
7. Joist Ties: Flat straps, with holes for fasteners, for tying joists together over supports.

J. Concealed Decking Fasteners
1. Deck Splines: Plastic splines designed to fit in grooves routed into the sides of decking material and be fastened to deck framing with screws. Splines provide uniform spacing of decking material. Splines are made from UV-resistant polypropylene.
2. Deck Clips: Black oxide coated stainless-steel clips designed to be fastened to deck framing with screws, and to secure decking material with teeth that also provide uniform spacing of decking material.
3. Deck Tracks: Formed metal strips designed to be fastened to deck framing and to secure decking material from underside with screws. Made from epoxy powder-coated, hot-dip galvanized steel **OR** stainless steel, **as directed**.

1.3 EXECUTION

A. Preparation
1. Clean substrates of projections and substances detrimental to application.
2. Prime lumber to be painted, including both faces and edges. Cut to required lengths and prime ends. Comply with requirements in Division 09 Section "Exterior Painting".

B. Installation, General
1. Set exterior rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit exterior rough carpentry to other construction; scribe and cope as needed for accurate fit.
2. Framing Standard: Comply with AF&PA's "Details for Conventional Wood Frame Construction" unless otherwise indicated.
3. Install wood decking and stair treads with crown up (bark side down).
4. Install plastic lumber to comply with manufacturer's written instructions.
5. Secure decking to framing with concealed decking fasteners.
6. Install metal framing anchors to comply with manufacturer's written instructions.
7. Do not splice structural members between supports unless otherwise indicated.
8. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
9. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
10. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
    a. Use inorganic boron (SBX) for items that are continuously protected from liquid water.
    b. Use copper naphthenate for items not continuously protected from liquid water.
11. Securely attach exterior rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
    a. NES NER-272 for power-driven fasteners.
    b. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
    c. "Nailing Schedule," and Tables in Section 2304 of the ICC's International Building Code.
    d. Table 2306.1, "Fastening Schedule," in SBCCI's Standard Building Code.
    e. Table R602.3(1), "Fastener Schedule for Structural Members" and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
12. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view. Make tight connections

between members. Install fasteners without splitting wood; do not countersink nail heads unless otherwise indicated.

13. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.

C. Elevated Deck Joist Framing Installation

1. General: Install joists with crown edge up and support ends of each member with not less than 1-1/2 inches (38 mm) of bearing on wood or metal, or 3 inches (76 mm) on masonry. Attach floor joists where framed into wood supporting members by using wood ledgers as indicated or, if not indicated, by using metal joist hangers. Do not notch joists.
2. Frame openings with headers and trimmers supported by metal joist hangers; double headers and trimmers where span of header exceeds 48 inches (1200 mm).
3. Lap members framing from opposite sides of beams or girders not less than 4 inches (102 mm) or securely tie opposing members together. Provide solid blocking of 2-inch nominal (38-mm actual) thickness by depth of joist over supports.
4. Provide solid blocking of 2-inch nominal (38-mm actual) thickness by depth of joist at intervals of 96 inches (2438 mm) o.c., between joists.

D. Stair Installation

1. Provide stair framing members of size, space, and configuration indicated or, if not indicated, to comply with the following requirements:
   a. Stringer Size: 2 by 12 inches nominal (38 by 286 mm actual), minimum.
   b. Notching: Notch stringers to receive treads, risers, and supports; leave at least 3-1/2 inches (89 mm) of effective depth.
   c. Stringer Spacing: At least three stringers for each 36-inch (914-mm) clear width of stair.
2. Provide stair framing with no more than 3/16-inch (4.7-mm) variation between adjacent treads and risers and no more than 3/8-inch (9.5-mm) variation between largest and smallest treads and risers within each flight.
3. Treads and Risers: Secure by gluing and nailing **OR** screwing, **as directed**, to carriages. Countersink fastener heads, fill flush, and sand filler. Extend treads over carriages and finish with bullnose edge.

E. Railing Installation

1. Balusters: Fit to railings, glue, and nail **OR** screw, **as directed**, in place. Countersink fastener heads, fill flush, and sand filler.
2. Newel Posts: Secure to stringers and risers with through bolts **OR** lag screws **OR** countersunk-head wood screws and glue, **as directed**.
3. Railings: Secure wall rails with metal brackets. Fasten freestanding railings to newel posts and to trim at walls with countersunk-head wood screws or rail bolts and glue.

END OF SECTION 06 15 13 00

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Task	Specification	Specification Description
06 15 13 00	06 10 00 00	Rough Carpentry
06 15 13 00	06 05 23 00a	Miscellaneous Carpentry
06 15 13 00	06 05 73 33	Wood Decking
06 15 13 00	06 11 16 00	Rough Carpentry Renovation

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SECTION 06 16 23 00 - SHEATHING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for sheathing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Wall sheathing.
b. Roof sheathing.
c. Composite nail base insulated roof sheathing.
d. Subflooring.
e. Underlayment.
f. Building paper.
g. Building wrap.
h. Sheathing joint-and-penetration treatment.
i. Flexible flashing at openings in sheathing.

C. Submittals
1. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
a. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
b. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
c. For fire-retardant treatments specified to be High-Temperature (HT) type, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5516.
d. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
e. Include copies of warranties from chemical treatment manufacturers for each type of treatment.
f. For building wrap, include data on air-/moisture-infiltration protection based on testing according to referenced standards.
2. LEED Submittals:
a. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
b. Product Data for Credit EQ 4.4: For composite-wood products, documentation indicating that product contains no urea formaldehyde.
c. Certificates for Credit MR 7: Chain-of-custody certificates certifying that products specified to be made from certified wood comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
1) Include statement indicating costs for each certified wood product.
3. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:
a. Preservative-treated plywood.
b. Fire-retardant-treated plywood.

c. Foam-plastic sheathing.
d. Building wrap.

D. Quality Assurance
1. Fire-Test-Response Characteristics: For assemblies with fire-resistance ratings, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.
2. Forest Certification: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship":
a. Plywood.
b. Oriented strand board.
c. Fiberboard wall sheathing.
d. Particleboard underlayment.
e. Hardboard underlayment.

E. Delivery, Storage, And Handling
1. Stack plywood and other panels flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

1.2 PRODUCTS

A. Wood Panel Products, General
1. Plywood: DOC PS 1 **OR** Either DOC PS 1 or DOC PS 2, unless otherwise indicated, **as directed**.
2. Oriented Strand Board: DOC PS 2.
3. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.
4. Factory mark panels to indicate compliance with applicable standard.

B. Preservative-Treated Plywood
1. Preservative Treatment by Pressure Process: AWPA C9.
a. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
2. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
3. Application: Treat all plywood, unless otherwise indicated **OR** Treat items indicated on Drawings, **as directed**, and plywood in contact with masonry or concrete or used with roofing, flashing, vapor barriers, and waterproofing.

C. Fire-Retardant-Treated Plywood
1. General: Comply with performance requirements in AWPA C27.
a. Use treatment that does not promote corrosion of metal fasteners.
b. Use Exterior type for exterior locations and where indicated.
c. Use Interior Type A, High Temperature (HT) for roof sheathing and where indicated.
d. Use Interior Type A, unless otherwise indicated.
2. Kiln-dry material after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.
3. Identify fire-retardant-treated plywood with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.
4. Application: Treat all plywood, unless otherwise indicated **OR** Treat plywood indicated on Drawings, and the following, **as directed**:
a. Roof and wall sheathing within 48 inches (1220 mm) of fire **OR** party, **as directed**, walls.

b. Roof sheathing.
c. Subflooring and underlayment for raised platforms.

D. Wall Sheathing
1. Plywood Wall Sheathing: Exterior, Structural I **OR** Exterior **OR** Exposure 1, Structural I **OR** Exposure 1, **as directed**, sheathing.
2. Oriented-Strand-Board Wall Sheathing: Exposure 1, Structural I **OR** Exposure 1, **as directed**, sheathing.
3. Paper-Surfaced Gypsum Wall Sheathing: ASTM C 79/C 79M or ASTM C 1396/C 1396M, gypsum sheathing; with water-resistant-treated core and with water-repellent paper bonded to core's face, back, and long edges.
   a. Type and Thickness: Regular, 1/2 inch (13 mm) **OR** Type X, 5/8 inch (15.9 mm), **as directed**, thick.
4. Glass-Mat Gypsum Wall Sheathing: ASTM C 1177/1177M.
   a. Type and Thickness: Regular, 1/2 inch (13 mm) **OR** Type X, 5/8 inch (15.9 mm), **as directed**, thick.
5. Cellulose Fiber-Reinforced Gypsum Sheathing: ASTM C 1278/C 1278M, gypsum sheathing.
   a. Type and Thickness: Regular, 1/2 inch (13 mm) **OR** Type X, 5/8 inch (15.9 mm), **as directed**, thick.
6. Fiberboard Wall Sheathing: ASTM C 208, Type IV, Grade 1 (Regular) **OR** 2 (Structural), **as directed**, cellulosic fiberboard sheathing with square edges, 1/2 inch (13 mm) **OR** 25/32 inch (20 mm), **as directed**, thick.
7. Extruded-Polystyrene-Foam Wall Sheathing: ASTM C 578, Type IV, in manufacturer's standard lengths and widths with tongue-and-groove or shiplap long edges as standard with manufacturer.
   a. Thickness: 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** As indicated, **as directed**.
8. Foil-Faced, Polyisocyanurate-Foam Wall Sheathing: ASTM C 1289, Type I, Class 2, aluminum-foil-faced, glass-fiber-reinforced, rigid, cellular, polyisocyanurate thermal insulation. Foam-plastic core and facings shall have a flame-spread index of 25 or less when tested individually.
   a. Thickness: 7/16 inch (11.1 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (15.9 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** As indicated, **as directed**.

E. Roof Sheathing
1. Plywood Roof Sheathing: Exterior, Structural I **OR** Exterior **OR** Exposure 1, Structural I **OR** Exposure 1, **as directed**, sheathing.
2. Oriented-Strand-Board Roof Sheathing: Exposure 1, Structural I **OR** Exposure 1, **as directed**, sheathing.

F. Composite Nail Base Insulated Roof Sheathing
1. Oriented-Strand-Board-Surfaced, Polyisocyanurate-Foam Sheathing: Rigid, cellular, polyisocyanurate thermal insulation with oriented strand board laminated to one face complying with ASTM C 1289, Type V.
2. Vented, Oriented-Strand-Board-Surfaced, Polyisocyanurate-Foam Sheathing:
   a. Rigid, cellular, polyisocyanurate thermal insulation complying with ASTM C 1289, Type II, Class 1, with oriented strand board adhered to spacers on one face.
      OR
      Rigid, cellular, polyisocyanurate thermal insulation with oriented strand board laminated to one face complying with ASTM C 1289, Type V. Oriented-strand-board face has a second layer of oriented strand board adhered to it with spacers between.
      1) Polyisocyanurate-Foam Thickness: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 2-1/2 inches (64 mm) **OR** 3 inches (76 mm) **OR** 3-1/2 inches (89 mm) **OR** 4 inches (102 mm), **as directed**.
      2) Oriented-Strand-Board Nominal Thickness: 7/16 inch (11.1 mm) **OR** 5/8 inch (15.9 mm), **as directed**.
      3) Spacers: Wood furring strips or blocks not less than 3/4 inch (19 mm) thick and spaced not more than 12 inches (300 mm) **OR** 16 inches (400 mm) **OR** 24 inches (600 mm), **as directed**, o.c.

G. Subflooring And Underlayment

1. Plywood Combination Subfloor-Underlayment: DOC PS 1, Exterior, Structural I, C-C Plugged **OR** Exterior, C-C Plugged **OR** Exposure 1, Structural I, Underlayment **OR** Exposure 1, Underlayment, **as directed**, single-floor panels.
2. Oriented-Stand-Board Combination Subfloor-Underlayment: Exposure 1 single-floor panels.
3. Plywood Subflooring: Exterior, Structural I **OR** Exterior **OR** Exposure 1, Structural I **OR** Exposure 1, **as directed**, single-floor panels or sheathing.
4. Oriented-Strand-Board Subflooring: Exposure 1, Structural I sheathing **OR** single-floor panels or sheathing, **as directed**.
5. Underlayment, General: Provide underlayment in nominal thicknesses indicated or, if not indicated, not less than 1/4 inch (6.4 mm) over smooth subfloors and not less than 3/8 inch (9.5 mm) over board or uneven subfloors.
6. Plywood Underlayment for Resilient Flooring: DOC PS 1, Exterior A-C **OR** Exterior B-C **OR** Exterior, C-C Plugged **OR** Exposure 1 Underlayment, **as directed**, with fully sanded face.
7. Plywood Underlayment for Ceramic Tile: DOC PS 1, Exterior, C-C Plugged, not less than 5/8-inch (15.9-mm) nominal thickness, for ceramic tile set in organic **OR** epoxy, **as directed**, adhesive.
8. Plywood Underlayment for Carpet: DOC PS 1, Exterior, C-C Plugged **OR** Exposure 1, Underlayment **OR** Interior, Underlayment, **as directed**.
9. Particleboard Underlayment: ANSI A208.1, Grade PBU **OR** M-2, Exterior Glue, complying with dimensional tolerances and thickness swell requirements of Grade PBU, **as directed**.
10. Hardboard Underlayment: AHA A135.4, Class 4 (Service), Surface S1S; with back side sanded.

H. Fasteners

1. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
   a. For roof and wall, **as directed**, sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M **OR** of Type 304 stainless steel, **as directed**.
2. Nails, Brads, and Staples: ASTM F 1667.
3. Power-Driven Fasteners: NES NER-272.
4. Wood Screws: ASME B18.6.1.
5. Screws for Fastening Wood Structural Panels to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
   a. For wall and roof sheathing panels, provide screws with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.
6. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing board to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.
   a. For steel framing less than 0.0329 inch (0.835 mm) thick, attach sheathing to comply with ASTM C 1002.
   b. For steel framing from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick, attach sheathing to comply with ASTM C 954.
7. Screws for Fastening Oriented-Strand-Board-Surfaced, Polyisocyanurate-Foam Sheathing to Metal Roof Deck: Steel drill screws, in type and length recommended by sheathing manufacturer for thickness of sheathing board to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117. Provide washers or plates if recommended by sheathing manufacturer.

I. Weather-Resistant Sheathing Paper

1. Building Paper:
   a. ASTM D 226, Type 1 (No. 15 asphalt-saturated organic felt), unperforated.
   OR

IBC Standard 1404.2, Grade D (water-vapor-permeable, kraft building paper), except that water resistance shall be not less than 1 hour and water-vapor transmission shall be not less than 75 g/sq. m x 24 h.

2. Building Wrap: ASTM E 1677, Type I air retarder; with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, when tested according to ASTM E 84; UV stabilized; and acceptable to authorities having jurisdiction.
   a. Water-Vapor Permeance: Not less than 535 **OR** 152 **OR** 125 **OR** 63, **as directed**, g through 1 sq. m of surface in 24 hours per ASTM E 96, Desiccant Method (Procedure A).
   b. Allowable UV Exposure Time: Not less than three months.
3. Building-Wrap Tape: Pressure-sensitive plastic tape recommended by building-wrap manufacturer for sealing joints and penetrations in building wrap.

J. Sheathing Joint-And-Penetration Treatment Materials
1. Sealant for Paper-Surfaced **OR** Glass-Mat, **as directed**, Gypsum Sheathing Board:
   a. Elastomeric, medium-modulus, neutral-curing silicone joint sealant compatible with joint substrates formed by gypsum sheathing and other materials, recommended by sheathing manufacturer for application indicated, and complying with requirements for elastomeric sealants specified in Division 07 Section "Joint Sealants".
   OR
   Silicone emulsion sealant complying with ASTM C 834, compatible with sheathing tape and sheathing, and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.
2. Sheathing Tape for Glass-Mat Gypsum Sheathing Board: Self-adhering glass-fiber tape, minimum 2 inches (50 mm) wide, 10 by 10 or 10 by 20 threads/inch (390 by 390 or 390 by 780 threads/m), of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing board and with a history of successful in-service use.
3. Sheathing Tape for Foam-Plastic Sheathing: Pressure-sensitive plastic tape recommended by sheathing manufacturer for sealing joints and penetrations in sheathing.

K. Miscellaneous Materials
1. Adhesives for Field Gluing Panels to Framing: Formulation complying with APA AFG-01 **OR** ASTM D 3498, **as directed**, that is approved for use with type of construction panel indicated by manufacturers of both adhesives and panels.
   a. Use adhesives that have a VOC content of 50 **OR** 70, **as directed**, g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.025 inch (0.6 mm) **OR** 0.030 inch (0.8 mm) **OR** 0.040 inch (1.0 mm), **as directed**.
3. Primer for Flexible Flashing: Product recommended by manufacturer of flexible flashing for substrate.

1.3 EXECUTION

A. Installation, General
1. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
2. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction, unless otherwise indicated.
3. Securely attach to substrate by fastening as indicated, complying with the following:
   a. NES NER-272 for power-driven fasteners.
   b. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."
   c. "Nailing Schedule," and Tables in Section 2304 of the ICC's International Building Code.
   d. Table 2306.1, "Fastening Schedule," in SBCCI's "Standard Building Code."

   e. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's "International Residential Code for One- and Two-Family Dwellings."
   f. Table 602.3(1), "Fastener Schedule for Structural Members," and Table 602.3(2), "Alternate Attachments," in ICC's "International One- and Two-Family Dwelling Code."
4. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.
5. Coordinate wall and roof sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
6. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
7. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

B. Wood Structural Panel Installation
1. General: Comply with applicable recommendations in APA Form No. E30S, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.
2. Fastening Methods: Fasten panels as indicated below:
   a. Combination Subfloor-Underlayment:
      1) Glue and nail **OR** Nail, **as directed**, to wood framing.
      2) Screw to cold-formed metal framing.
      3) Space panels 1/8 inch (3 mm) apart at edges and ends.
   b. Subflooring:
      1) Glue and nail **OR** Nail **OR** Nail or staple, **as directed**, to wood framing.
      2) Screw to cold-formed metal framing.
      3) Space panels 1/8 inch (3 mm) apart at edges and ends.
   c. Wall and Roof Sheathing:
      1) Nail **OR** Nail or staple, **as directed**, to wood framing. Apply a continuous bead of glue to framing members at edges of wall sheathing panels.
      2) Screw to cold-formed metal framing.
      3) Space panels 1/8 inch (3 mm) apart at edges and ends.
   d. Underlayment:
      1) Nail **OR** Nail or staple, **as directed**, to subflooring.
      2) Space panels 1/32 inch (0.8 mm) apart at edges and ends.
      3) Fill and sand edge joints of underlayment receiving resilient flooring right before installing flooring.

C. Gypsum Sheathing Installation
1. Comply with GA-253 and with manufacturer's written instructions.
   a. Fasten gypsum sheathing to wood framing with nails **OR** screws, **as directed**.
   b. Fasten gypsum sheathing to cold-formed metal framing with screws.
   c. Install boards with a 3/8-inch (9.5-mm) gap where non-load-bearing construction abuts structural elements.
   d. Install boards with a 1/4-inch (6.4-mm) gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.
2. Apply fasteners so heads bear tightly against face of sheathing boards but do not cut into facing.
3. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent boards without forcing. Abut ends of boards over centers of studs, and stagger end joints of adjacent boards not less than one stud spacing. Attach boards at perimeter and within field of board to each steel stud.

a. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of boards.
b. For sheathing under stucco cladding, boards may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.

4. Vertical Installation: Install board vertical edges centered over studs. Abut ends and edges of each board with those of adjacent boards. Attach boards at perimeter and within field of board to each stud.
   a. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of boards.
   b. For sheathing under stucco cladding, boards may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.

D. Fiberboard Sheathing Installation
1. Comply with ASTM C 846 and with manufacturer's written instructions.
2. Fasten fiberboard sheathing panels to intermediate supports and then at edges and ends. Use galvanized roofing nails or galvanized staples, **as directed**; comply with manufacturer's recommended spacing and referenced fastening schedule. Drive fasteners flush with surface of sheathing and locate perimeter fasteners at least 3/8 inch (9.5 mm) from edges and ends.
3. Install sheathing vertically with long edges parallel to, and centered over, studs. Install solid wood blocking where end joints do not occur over framing. Allow 1/8-inch (3-mm) open space between edges and ends of adjacent units. Stagger horizontal joints if any.
4. Cover sheathing as soon as practical after installation to prevent deterioration from wetting.

E. Foam-Plastic Sheathing Installation
1. Comply with manufacturer's written instructions.
2. Foam-Plastic Wall Sheathing: Install vapor-relief strips or equivalent for permitting escape of moisture vapor that otherwise would be trapped in stud cavity behind sheathing.

F. Particleboard Underlayment Installation
1. Comply with the National Particleboard Association's recommendations for type of subfloor indicated. Fill and sand gouges, gaps, and chipped edges. Sand uneven joints flush.
   a. Fastening Method: Glue and nail **OR** Nail **OR** Nail or staple, **as directed**, underlayment to subflooring.

G. Hardboard Underlayment Installation
1. Comply with AHA's "Application Instructions for Basic Hardboard Products" and with hardboard manufacturer's written instructions for preparing and applying hardboard underlayment.
   a. Fastening Method: Nail **OR** Nail or staple, **as directed**, underlayment to subflooring.

H. Weather-Resistant Sheathing-Paper Installation
1. General: Cover sheathing with weather-resistant sheathing paper as follows:
   a. Cut back barrier 1/2 inch (13 mm) on each side of the break in supporting members at expansion- or control-joint locations.
   b. Apply barrier to cover vertical flashing with a minimum 4-inch (100-mm) overlap, unless otherwise indicated.
2. Building Paper: Apply horizontally with a 2-inch (50-mm) overlap and a 6-inch (150-mm) end lap; fasten to sheathing with galvanized staples or roofing nails.
3. Building Wrap: Comply with manufacturer's written instructions.
   a. Seal seams, edges, fasteners, and penetrations with tape.
   b. Extend into jambs of openings and seal corners with tape.

I. Sheathing Joint-And-Penetration Treatment
1. Seal sheathing joints according to sheathing manufacturer's written instructions.

a. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient quantity of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.

b. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing board joints, and apply and trowel silicone emulsion sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.

c. Apply sheathing tape to joints between foam-plastic sheathing panels and at items penetrating sheathing. Apply at upstanding flashing to overlap both flashing and sheathing.

J. Flexible Flashing Installation

1. Apply flexible flashing where indicated to comply with manufacturers written instructions.

a. Prime substrates as recommended by flashing manufacturer.

b. Lap seams and junctures with other materials at least 4 inches (100 mm), except that at flashing flanges of other construction, laps need not exceed flange width.

c. Lap flashing over weather-resistant building paper at bottom and sides of openings.

d. Lap weather-resistant building paper over flashing at heads of openings.

e. After flashing has been applied, roll surfaces with a hard rubber or metal roller to ensure that flashing is completely adhered to substrates.

K. Protection

1. Paper-Surfaced Gypsum Sheathing: Protect sheathing by covering exposed exterior surface of sheathing with weather-resistant sheathing paper securely fastened to framing. Apply covering immediately after sheathing is installed.

END OF SECTION 06 16 23 00

Task	Specification	Specification Description
06 16 23 00	06 10 00 00	Rough Carpentry
06 16 23 00	06 05 23 00a	Miscellaneous Carpentry
06 16 33 00	06 10 00 00	Rough Carpentry
06 16 33 00	06 05 23 00a	Miscellaneous Carpentry
06 16 33 00	06 16 23 00	Sheathing
06 16 43 00	06 10 00 00	Rough Carpentry
06 16 43 00	06 05 23 00a	Miscellaneous Carpentry
06 16 43 00	06 16 23 00	Sheathing
06 16 43 00	06 11 16 00	Rough Carpentry Renovation

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SECTION 06 17 13 00 - STRUCTURAL GLUED-LAMINATED TIMBER

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for structural glued-laminated timber. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes framing using structural glued-laminated timber.

C. Definitions
1. Structural Glued-Laminated (Glulam) Timber: An engineered, stress-rated timber product assembled from selected and prepared wood laminations bonded together with adhesives and with the grain of the laminations approximately parallel longitudinally.

D. Performance Requirements
1. Delegated Design: Design structural glued-laminated timber and connectors, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Structural Performance: Structural glued-laminated timber and connectors shall withstand the effects of structural loads shown on Drawings without exceeding allowable design working stresses listed in AITC 117 or determined according to ASTM D 3737 and acceptable to authorities having jurisdiction.
3. Seismic Performance: Structural glued-laminated timber and connectors shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

E. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood used for structural glued-laminated timber complies with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
      1) Include statement indicating costs for each certified wood product.
   b. Product Data for Credit EQ 4.4: For laminating adhesive used for structural glued-laminated timber, indicating that product contains no urea formaldehyde.
3. Delegated-Design Submittal: For structural glued-laminated timber and timber connectors indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
4. Certificates of Conformance: Issued by a qualified testing and inspecting agency indicating that structural glued-laminated timber complies with requirements in AITC A190.1.

F. Quality Assurance
1. Manufacturer Qualifications: Provide factory-glued structural units produced by an AITC- or APA-licensed firm that is certified for chain of custody by an FSC-accredited certification body.
   a. Factory mark each piece of structural glued-laminated timber with AITC Quality Mark or APA-EWS trademark. Place mark on surfaces that will not be exposed in the completed Work.
2. Quality Standard: Comply with AITC A190.1.

3. Forest Certification: Provide structural glued-laminated timber produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

G. Delivery, Storage, And Handling
1. General: Comply with provisions in AITC 111.
2. Individually wrap members using plastic-coated paper covering with water-resistant seams.

1.2 PRODUCTS

A. Structural Glued-Laminated Timber
1. General: Provide structural glued-laminated timber that complies with AITC 117 or research/evaluation reports acceptable to authorities having jurisdiction.
   a. Provide structural glued-laminated timber made from solid lumber laminations; do not use laminated veneer lumber.
   b. Provide structural glued-laminated timber made with wet-use adhesive complying with ASTM D 2559.
      1) Use adhesive that contains no urea-formaldehyde resins.
2. Species and Grades for Structural Glued-Laminated Timber:
   a. Alaska cedar **OR** Douglas fir-larch **OR** Southern pine **OR** Any species, **as directed**, in grades needed to comply with "Performance Requirements" Article.
      OR
      Alaska cedar **OR** Douglas fir-larch **OR** Southern pine **OR** Any species, **as directed**, that complies with structural properties **OR** combination symbols **OR** beam stress classifications, **as directed**, indicated.
3. Species and Grades for Beams and Purlins:
   a. Species and Beam Stress Classification: Ponderosa pine, 16F-1.3E **OR** Alaska cedar, 20F-1.5E **OR** Eastern spruce, 20F-1.5E **OR** Any species, 20F-1.5E **OR** Any species, 24F-1.7E **OR** Douglas fir-larch, 24F-1.8E **OR** Southern pine, 24F-1.8E **OR** Douglas fir-larch or southern pine, 24F-1.8E **OR** Southern pine, 30F-2.1E, **as directed**.
   b. Lay-up: Balanced **OR** Either balanced or unbalanced, **as directed**.
4. Species and Grades for Columns and Truss Members:
   a. Species and Combination Symbol: Alaska cedar, 70 **OR** Douglas fir-larch, 1 **OR** Douglas fir-larch, 3 **OR** Southern pine, 47 **OR** Southern pine, 50, **as directed**.
5. Appearance Grade: Premium **OR** Architectural **OR** Industrial **OR** Framing, **as directed**, complying with AITC 110.
6. Preservative Treatment after Fabrication: Where preservative-treated structural glued-laminated timber is indicated, pressure treat after fabrication according to AWPA C28.
   a. Use oxine copper (copper-8-quinolinolate) in a light petroleum solvent.
      OR
      Use copper naphthenate in a light petroleum solvent.
      OR
      Use preservative solution without water repellents or substances that might interfere with application of indicated finishes.
      OR
      Do not incise structural glued-laminated timber.
7. Preservative Treatment before Fabrication: Where preservative-treated structural glued-laminated timber is indicated, pressure treat lumber before gluing according to AWPA C28.
   a. Use oxine copper (copper-8-quinolinolate) in a light petroleum solvent.
      OR
      Use copper naphthenate in a light petroleum solvent.
      OR
      Use a waterborne preservative that is acceptable to authorities having jurisdiction and that contains no arsenic or chromium.

OR
Use preservative solution without water repellents or substances that might interfere with application of indicated finishes.
OR
Do not incise wood used for producing structural glued-laminated timber.
OR
After dressing and fabricating members, apply a field-treatment preservative to comply with AWPA M4 to surfaces cut to a depth of more than 1/16 inch (1.5 mm).

1) Use inorganic boron (SBX) treatment for members not in contact with the ground and continuously protected from liquid water.
OR
Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.

8. End Sealer: Manufacturer's standard, transparent, colorless wood sealer that is effective in retarding the transmission of moisture at cross-grain cuts and is compatible with indicated finish.
9. Penetrating Sealer: Manufacturer's standard, transparent, penetrating wood sealer that is compatible with indicated finish.

B. Timber Connectors

1. General: Unless otherwise indicated, fabricate from the following materials:
   a. Structural-steel shapes, plates, and flat bars complying with ASTM A 36/A 36M.
   b. Round steel bars complying with ASTM A 575, Grade M 1020.
   c. Hot-rolled steel sheet complying with ASTM A 1011/A 1011M, Structural Steel, Type SS, Grade 33.
   d. Stainless-steel plate and flat bars complying with ASTM A 666, Type 304 **OR** Type 316, **as directed**.
   e. Stainless-steel bars and shapes complying with ASTM A 276, Type 304 **OR** Type 316, **as directed**.
   f. Stainless-steel sheet complying with ASTM A 666, Type 304 **OR** Type 316, **as directed**.
2. Fabricate beam seats from steel **OR** stainless steel, **as directed**, with 0.239-inch (6-mm) **OR** 3/16-inch (5-mm) **OR** 3/8-inch (9.5-mm), **as directed**, bearing plates, 3/4-inch- (19-mm-) diameter-by-12-inch- (300-mm-) long deformed bar anchors, and 0.239-inch (6-mm) side plates.
3. Fabricate arch base shoes from steel **OR** stainless steel, **as directed**, with 1-inch (25-mm) base plates and 3/8-inch (9.5-mm) side plates.
4. Fabricate beam hangers from steel **OR** stainless steel, **as directed**, with 0.179-inch (4.6-mm) stirrups and 0.239-inch (6-mm) top plates.
5. Fabricate hinge connectors from steel **OR** stainless steel, **as directed**, with 0.179-inch (4.6-mm) side plates and 3/4-inch (19-mm) **OR** 1-inch (25-mm), **as directed**, top and bottom plates.
6. Fabricate strap ties from steel **OR** stainless steel, **as directed**, 2-1/2 inches (63 mm) wide by 0.179 inch (4.6 mm) **OR** 3 inches (75 mm) wide by 0.239 inch (6 mm), **as directed**, thick.
7. Fabricate tie rods from round steel bars with upset threads connected with forged-steel turnbuckles complying with ASTM A 668/A 668M.
8. Provide bolts, 3/4 inch (19 mm) unless otherwise indicated, complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); nuts complying with ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
9. Provide shear plates, 2-5/8 inches (66.7 mm) **OR** 4 inches (102 mm), **as directed**, in diameter, complying with ASTM D 5933.
10. Finish steel assemblies and fasteners with rust-inhibitive primer, 2-mil (0.05-mm) dry film thickness.
11. Hot-dip galvanize steel assemblies and fasteners after fabrication to comply with ASTM A 123/A 123M or ASTM A 153/A 153M.

C. Fabrication

1. Shop fabricate for connections to greatest extent possible, including cutting to length and drilling bolt holes.

a. Dress exposed surfaces to remove planing or surfacing marks and to provide a finish equivalent to that produced by machine sanding with No. 120 grit sandpaper.

2. Camber: Fabricate horizontal and inclined members of less than 1:1 slope with either circular or parabolic camber equal to 1/500 of span.
3. End-Cut Sealing: Immediately after end cutting each member to final length and after preservative treatment, apply a saturation coat of end sealer to ends and other cross-cut surfaces, keeping surfaces flood coated for not less than 10 minutes.
4. Seal Coat: After fabricating, sanding, and end-coat sealing, apply a heavy saturation coat of penetrating sealer on surfaces of each unit, except for preservative-treated wood where treatment included a water repellent.

D. Factory Finishing
1. Wiped Stain Finish: Manufacturer's standard, dry-appearance, penetrating acrylic stain and sealer; oven dried and resistant to mildew and fungus.
   a. Color: As selected by the Owner from manufacturer's full range.
2. Clear Finish: Manufacturer's standard, two-coat, clear conversion varnish finish; oven dried and resistant to mildew and fungus.

1.3 EXECUTION

A. Installation
1. General: Erect structural glued-laminated timber true and plumb, and with uniform, close-fitting joints. Provide temporary bracing to maintain lines and levels until permanent supporting members are in place.
   a. Lift with padded slings and protect corners with wood blocking.
   b. Install structural glued-laminated timber to comply with Shop Drawings.
   c. Install timber connectors as indicated.
2. Framing Built into Masonry: Provide 1/2-inch (13-mm) clearance at tops, sides, and ends of members built into masonry; bevel cut ends 3 inches (76 mm); and do not embed more than 4 inches (102 mm) unless otherwise indicated.
3. Fit structural glued-laminated timber by cutting and restoring exposed surfaces to match specified surfacing and finishing.
   a. Predrill for fasteners using timber connectors as templates.
   b. Dress exposed surfaces to remove planing or surfacing marks and to provide a finish equivalent to that produced by machine sanding with No. 120 grit sandpaper.
   c. Coat cross cuts with end sealer.
   d. Where preservative-treated members must be cut during erection, apply a field-treatment preservative to comply with AWPA M4.
      1) Use inorganic boron (SBX) treatment for members not in contact with the ground and continuously protected from liquid water.
         OR
         Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.
4. Cutting: Avoid cutting after fabrication. Where field fitting is unavoidable, comply with requirements for shop fabrication.
   a. Where preservative-treated members must be cut during erection, apply a field-treatment preservative to comply with AWPA M4.
      1) Use inorganic boron (SBX) treatment for members not in contact with the ground and continuously protected from liquid water.
         OR
         Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.

B. Adjusting

1. Repair damaged surfaces and finishes after completing erection. Replace damaged structural glued-laminated timber if repairs are not approved by the Owner.

C. Protection
1. Do not remove wrappings on individually wrapped members until they no longer serve a useful purpose including protection from weather, sunlight, soiling, and damage from work of other trades.
a. Coordinate wrapping removal with finishing work specified in Division 07. Retain wrapping where it can serve as a painting shield.

END OF SECTION 06 17 13 00

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Task	Specification	Specification Description
06 17 13 00	06 05 23 00	Timber Bridge Components
06 17 13 00	06 10 00 00	Rough Carpentry
06 17 23 00	06 10 00 00	Rough Carpentry
06 17 23 00	06 05 23 00a	Miscellaneous Carpentry
06 17 23 00	06 11 16 00	Rough Carpentry Renovation
06 17 43 00	06 05 23 00	Timber Bridge Components
06 17 43 00	06 10 00 00	Rough Carpentry
06 17 43 00	06 17 13 00	Structural Glued-Laminated Timber

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SECTION 06 17 53 00 - METAL-PLATE-CONNECTED WOOD TRUSSES

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for metal-plate-connected wood trusses. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes the following:
   a. Wood roof trusses.
   b. Wood floor trusses.
   c. Wood girder trusses.
   d. Wood truss bracing.
   e. Metal truss accessories.

C. Definitions

1. Metal-Plate-Connected Wood Trusses: Planar structural units consisting of metal-plate-connected members fabricated from dimension lumber and cut and assembled before delivery to Project site.
2. TPI: Truss Plate Institute, Inc.
3. Lumber grading agencies, and the abbreviations used to reference them, include the following:
   a. NeLMA: Northeastern Lumber Manufacturers' Association.
   b. NLGA: National Lumber Grades Authority.
   c. SPIB: The Southern Pine Inspection Bureau.
   d. WCLIB: West Coast Lumber Inspection Bureau.
   e. WWPA: Western Wood Products Association.

D. Performance Requirements

1. Structural Performance: Provide metal-plate-connected wood trusses capable of withstanding design loads within limits and under conditions indicated. Comply with requirements in TPI 1 unless more stringent requirements are specified below.
   a. Design Loads: As indicated.
   b. Maximum Deflection Under Design Loads:
      1) Roof Trusses: Vertical deflection of 1/180 **OR** 1/240 **OR** 1/360, **as directed**, of span.
      2) Floor Trusses: Vertical deflection of 1/360 **OR** 1/480 **OR** 1/600, **as directed**, of span.

E. Submittals

1. Product Data: For wood-preservative-treated lumber, fire-retardant treated lumber, metal-plate connectors, metal truss accessories, and fasteners.
   a. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
   b. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
   c. For fire-retardant treatments specified to be High-Temperature (HT) type, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.

d. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to truss fabricator.
e. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

2. Shop Drawings: Prepared by or under the supervision of a qualified professional engineer. Show fabrication and installation details for trusses.
   a. Show location, pitch, span, camber, configuration, and spacing for each type of truss required.
   b. Indicate sizes, stress grades, and species of lumber.
   c. Indicate locations of permanent bracing required to prevent buckling of individual truss members due to design loads.
   d. Indicate type, size, material, finish, design values, orientation, and location of metal connector plates.
   e. Show splice details and bearing details.
   f. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
3. LEED Submittal:
   a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood used to produce metal-plate-connected wood trusses complies with forest certification requirements. Include evidence that mill is certified for chain of custody by an FSC-accredited certification body.
      1) Include statement indicating costs for each certified wood product.
4. Qualification Data: For metal-plate manufacturer, professional engineer, fabricator, and Installer.
5. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:
   a. Wood-preservative-treated lumber.
   b. Fire-retardant-treated wood.
   c. Metal-plate connectors.
   d. Metal truss accessories.

F. Quality Assurance

1. Metal Connector-Plate Manufacturer Qualifications: A manufacturer that is a member of TPI and that complies with quality-control procedures in TPI 1 for manufacture of connector plates.
   a. Manufacturer's responsibilities include providing professional engineering services needed to assume engineering responsibility.
   b. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
2. Fabricator Qualifications: Shop that participates in a recognized quality-assurance program that complies with quality-control procedures in TPI 1 and that involves third-party inspection by an independent testing and inspecting agency acceptable to the Owner and authorities having jurisdiction.
3. Comply with applicable requirements and recommendations of the following publications:
   a. TPI 1, "National Design Standard for Metal Plate Connected Wood Truss Construction."
   b. TPI DSB, "Recommended Design Specification for Temporary Bracing of Metal Plate Connected Wood Trusses."
   c. TPI HIB, "Commentary and Recommendations for Handling, Installing & Bracing Metal Plate Connected Wood Trusses."
4. Wood Structural Design Standard: Comply with applicable requirements in AF&PA's "National Design Specifications for Wood Construction" and its "Supplement."
5. Forest Certification: Provide metal-plate-connected wood trusses produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

G. Delivery, Storage, And Handling

1. Handle and store trusses to comply with recommendations of TPI HIB, "Commentary and Recommendations for Handling, Installing & Bracing Metal Plate Connected Wood Trusses."
   a. Store trusses flat, off of ground, and adequately supported to prevent lateral bending.
   b. Protect trusses from weather by covering with waterproof sheeting, securely anchored.
   c. Provide for air circulation around stacks and under coverings.
2. Inspect trusses showing discoloration, corrosion, or other evidence of deterioration. Discard and replace trusses that are damaged or defective.

1.2 PRODUCTS

A. Dimension Lumber
1. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
   a. Factory mark each piece of lumber with grade stamp of grading agency.
   b. For exposed lumber indicated to receive a stained or natural finish, omit grade stamp and provide certificates of grade compliance issued by grading agency.
   c. Provide dressed lumber, S4S.
   d. Provide dry lumber with 19 **OR** 15, **as directed**, percent maximum moisture content at time of dressing.
2. Grade and Species: For truss chord and web members, provide dimension lumber of any species, graded visually or mechanically, and capable of supporting required loads without exceeding allowable design values according to AF&PA's "National Design Specifications for Wood Construction" and its "Supplement."
3. Permanent Bracing: Provide wood bracing that complies with requirements for miscellaneous lumber in Division 06 Section(s) "Rough Carpentry" OR "Miscellaneous Rough Carpentry", **as directed**.

B. Wood-Preservative-Treated Lumber
1. Preservative Treatment by Pressure Process: AWPA C2, except that trusses that are not in contact with the ground and are continuously protected from liquid water may be made from lumber treated according to AWPA C31 with inorganic boron (SBX).
   a. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
   b. For exposed trusses indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
2. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
3. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
   a. For exposed trusses indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
4. Application: Treat all trusses, unless otherwise indicated **OR** trusses where indicated on Drawings, **as directed**.

C. Fire-Retardant-Treated Wood
1. General: Comply with performance requirements in AWPA C20.
   a. Use Exterior type for exterior locations and where indicated.
   b. Use Interior Type A, High Temperature (HT) for enclosed roof trusses and where indicated.
   c. Use Interior Type A, unless otherwise indicated.
2. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.

a. For exposed trusses and bracing indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
3. For exposed trusses indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.
4. Application: Treat all trusses, unless otherwise indicated **OR** items indicated on Drawings, and the following, **as directed**:
   a. Floor trusses for bowling lanes and raised platforms.
   b. Roof trusses.

D. Metal Connector Plates
1. General: Fabricate connector plates to comply with TPI 1.
2. Hot-Dip Galvanized Steel Sheet: ASTM A 653/A 653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G60 (Z180) coating designation; and not less than 0.036 inch (0.9 mm) thick.
   a. Use for interior locations where stainless steel is not indicated.
3. Stainless-Steel Sheet: ASTM A 666, Type 304 **OR** 316, **as directed**, and not less than 0.035 inch (0.88 mm) thick.
   a. Use for exterior locations and where indicated.

E. Fasteners
1. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
   a. Where trusses are exposed to weather, in ground contact, made from pressure-preservative treated wood, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M **OR** of Type 304 stainless steel, **as directed**.
2. Nails, Brads, and Staples: ASTM F 1667.
3. Power-Driven Fasteners: NES NER-272.
4. Wood Screws: ASME B18.6.1.
5. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).
6. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.
7. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
   a. Material:
      1) Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
      OR
      Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).

F. Metal Truss Accessories
1. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those \indicated **OR** of basis-of-design products, **as directed**. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.
2. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 (Z180) coating designation.
   a. Use for interior locations where stainless steel is not indicated.
3. Stainless-Steel Sheet: ASTM A 666, Type 304 **OR** 316, **as directed**.
   a. Use for exterior locations and where indicated.

4. Truss Tie-Downs: Bent strap tie for fastening roof trusses to wall studs below, 1-1/2 inches (38 mm) wide by 0.050 inch (1.3 mm) thick. Tie fastens to one side of truss, top plates, and side of stud below.
5. Truss Tie-Downs (Hurricane or Seismic Ties):
   a. Bent strap tie for fastening roof trusses to wall studs below, 2-1/4 inches (57 mm) wide by 0.062 inch (1.6 mm) thick. Tie fits over top of truss and fastens to both sides of truss, top plates, and one side of stud below.
      OR
      Bent strap tie for fastening roof trusses to wall studs below, 2-1/2 inches (63 mm) wide by 0.062 inch (1.6 mm) thick. Tie fits over top of truss and fastens to both sides of truss, inside face of top plates, and both sides of stud below.
6. Roof Truss Clips: Angle clips for bracing bottom chord of roof trusses at non-load-bearing walls, 1-1/4 inches (32 mm) wide by 0.050 inch (1.3 mm) thick. Clip is fastened to truss through slotted holes to allow for truss deflection.
7. Floor Truss Hangers: U-shaped hangers, full depth of floor truss, with 1-3/4-inch- (44-mm-) long seat; formed from metal strap 0.062 inch (1.6 mm) thick with tabs bent to extend over and be fastened to supporting member.
8. Roof Truss Bracing/Spacers: U-shaped channels, 1-1/2 inches (38 mm) wide by 1 inch (25 mm) deep by 0.040 inch (1.0 mm) thick, made to fit between 2 adjacent trusses and accurately space them apart, and with tabs having metal teeth for fastening to trusses.

G. Miscellaneous Materials
1. Galvanizing Repair Paint: SSPC-Paint 20, with dry film containing a minimum of 94 percent zinc dust by weight.
2. Protective Coatings: SSPC-Paint 22, epoxy-polyamide primer **OR** SSPC-Paint 16, coal-tar epoxy-polyamide paint, **as directed**.

H. Fabrication
1. Cut truss members to accurate lengths, angles, and sizes to produce close-fitting joints.
2. Fabricate metal connector plates to sizes, configurations, thicknesses, and anchorage details required to withstand design loads for types of joint designs indicated.
3. Assemble truss members in design configuration indicated; use jigs or other means to ensure uniformity and accuracy of assembly with joints closely fitted to comply with tolerances in TPI 1. Position members to produce design camber indicated.
   a. Fabricate wood trusses within manufacturing tolerances in TPI 1.
4. Connect truss members by metal connector plates located and securely embedded simultaneously in both sides of wood members by air or hydraulic press.

1.3 EXECUTION

A. Installation
1. Install wood trusses only after supporting construction is in place and is braced and secured.
2. If trusses are delivered to Project site in more than one piece, assemble trusses before installing.
3. Hoist trusses in place by lifting equipment suited to sizes and types of trusses required, exercising care not to damage truss members or joints by out-of-plane bending or other causes.
4. Install and brace trusses according to TPI recommendations and as indicated.
5. Install trusses plumb, square, and true to line and securely fasten to supporting construction.
6. Space trusses 16 inches (406 mm) o.c. **OR** 24 inches (610 mm) o.c. **OR** as indicated, **as directed**; adjust and align trusses in location before permanently fastening.
7. Anchor trusses securely at bearing points; use metal truss tie-downs or floor truss hangers as applicable. Install fasteners through each fastener hole in truss accessories according to manufacturer's fastening schedules and written instructions.
8. Securely connect each truss ply required for forming built-up girder trusses.
   a. Anchor trusses to girder trusses as indicated.

9. Install and fasten permanent bracing during truss erection and before construction loads are applied. Anchor ends of permanent bracing where terminating at walls or beams.
    a. Install bracing to comply with Division 06 Section(s) "Rough Carpentry" OR "Miscellaneous Rough Carpentry", **as directed**.
    b. Install and fasten strongback bracing vertically against vertical web of parallel-chord floor trusses at centers indicated.
10. Install wood trusses within installation tolerances in TPI 1.
11. Do not cut or remove truss members.
12. Replace wood trusses that are damaged or do not meet requirements.
    a. Do not alter trusses in field.

B. Repairs And Protection
1. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
2. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
3. Repair damaged galvanized coatings on exposed surfaces with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
4. Protective Coating: Clean and prepare exposed surfaces of metal connector plates. Brush apply primer, when part of coating system, and one coat of protective coating.
    a. Apply materials to provide minimum dry film thickness recommended by coating system manufacturer.

END OF SECTION 06 17 53 00

Task	Specification	Specification Description
06 18 13 00	06 05 73 33	Wood Decking
06 18 16 00	06 05 23 00	Timber Bridge Components
06 18 16 00	06 10 00 00	Rough Carpentry

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SECTION 06 22 13 00 - EXTERIOR FINISH CARPENTRY

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for exterior finish carpentry. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Exterior standing and running trim.
      b. Lumber, Plywood, and Hardboard siding.
      c. Plywood and Hardboard soffits.
      d. Exterior stairs and railings.
      e. Exterior ornamental wood columns.

C. Definitions
   1. Lumber grading agencies, and the abbreviations used to reference them, include the following:
      a. NeLMA: Northeastern Lumber Manufacturers' Association.
      b. NLGA: National Lumber Grades Authority.
      c. RIS: Redwood Inspection Service.
      d. SPIB: The Southern Pine Inspection Bureau.
      e. WCLIB: West Coast Lumber Inspection Bureau.
      f. WWPA: Western Wood Products Association.

D. Submittals
   1. Product Data: For each type of process and factory-fabricated product.
   2. Samples: For each type of siding indicated.
   3. LEED Submittal:
      a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that products specified to be made from certified wood comply with forest certification requirements. Include evidence that mill is certified for chain of custody by an FSC-accredited certification body.
         1) Include statement indicating costs for each certified wood product.
   4. Research/Evaluation Reports: For fire-retardant-treated wood.
   5. Compliance Certificates:
      a. For lumber that is not marked with grade stamp.
      b. For preservative-treated wood that is not marked with treatment quality mark.
      c. For fire-retardant-treated wood that is not marked with classification marking of testing and inspecting agency.
   6. Warranties: Special warranties specified in this Section.

E. Quality Assurance
   1. Forest Certification: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship":
      a. Exterior standing and running trim.
      b. Exterior lumber, plywood, and hardboard siding.
      c. Exterior plywood and hardboard soffits.
      d. Exterior stairs and railings.
      e. Exterior ornamental wood columns.

F. Delivery, Storage, And Handling

1. Protect materials against weather and contact with damp or wet surfaces. Stack lumber, plywood, and other panels flat with spacers between each bundle to provide air circulation. Provide for air circulation within and around stacks and under temporary coverings.

G. Warranty
1. Special Warranty for Cellular PVC Trim: Manufacturer's standard form, signed by manufacturer, Installer, and Contractor, in which manufacturer agrees to repair or replace trim that fails due to defects in manufacturing within 25 years from date of Final Completion. Failures include, but are not limited to rotting, corrosion, delamination, and excessive swelling from moisture.
2. Special Warranty for Hardboard Siding and Trim: Manufacturer's standard form, signed by manufacturer, Installer, and Contractor, in which manufacturer agrees to repair or replace siding that fails in materials or workmanship within specified warranty period. Failures include, but are not limited to, deformation or deterioration beyond normal weathering.
   a. Warranty Period for Factory-Applied Finish: Five years from date of Final Completion.
   b. Warranty Period for Siding and Trim (Excluding Finish): 25 years from date of Final Completion.
3. Special Warranty for Columns: Manufacturer's standard form, signed by manufacturer, Installer, and Contractor, in which manufacturer agrees to repair or replace columns that fail in materials or workmanship within five years from date of Final Completion.

1.2 PRODUCTS

A. Materials, General
1. Lumber: DOC PS 20 and applicable grading rules of inspection agencies certified by ALSC's Board of Review.
2. Softwood Plywood: DOC PS 1.
3. Hardboard: AHA A135.4.

B. Wood-Preservative-Treated Materials
1. Water-Repellent Preservative Treatment by Nonpressure Process: AWPA N1 (dip, spray, flood, or vacuum-pressure treatment).
   a. Preservative Chemicals: 3-iodo-2-propynyl butyl carbamate (IPBC), combined with an insecticide containing chloropyrifos (CPF).
   b. Use chemical formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants in solution to distinguish treated material from untreated material.
   c. Application: Items not required to be pressure-preservative treated.
   d. Application: Exterior trim and wood siding.
2. Preservative Treatment by Pressure Process:
   a. Lumber: AWPA C2 except that lumber that is not in contact with the ground and is continuously protected from liquid water may be treated according to AWPA C31 with inorganic boron (SBX). Kiln dry after treatment to a maximum moisture content of 19 percent.
   b. Plywood: AWPA C9. Kiln dry after treatment to a maximum moisture content of 18 percent.
   c. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
   d. For exposed items indicated to receive transparent finish, do not use chemical formulations that contain colorants or that bleed through or otherwise adversely affect finishes.
   e. Do not use material that is warped or does not comply with requirements for untreated material.
   f. Mark lumber with treatment quality mark of an inspection agency approved by ALSC's Board of Review.

1) For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.

g. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.

1) For exposed plywood indicated to receive a stained or natural finish, mark back of each piece.

h. Application: Where indicated **OR** All exterior lumber and plywood, **as directed**.

C. Fire-Retardant-Treated Materials

1. Lumber: Comply with performance requirements in AWPA C20, Exterior type. Kiln dry after treatment to a maximum moisture content of 19 percent.
2. Plywood: Comply with performance requirements in AWPA C27, Exterior type. Kiln dry after treatment to a maximum moisture content of 15 percent.
3. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not contain colorants and provide materials that do not have marks from spacer sticks on the exposed face.
4. Do not use material that does not comply with requirements for untreated material or is warped or discolored.
5. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
   a. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
   b. For exposed plywood indicated to receive a stained or natural finish, mark back of each piece.
6. Application: Where indicated **OR** All exterior lumber and plywood, **as directed**.

D. Standing And Running Trim

1. Lumber Trim for Semitransparent-Stained Finish **OR** Clear Finish **OR** Unfinished Applications, **as directed**:
   a. Species and Grade: Redwood, Clear All Heart **OR** Hart B **OR** Clear **OR** Grade B, **as directed**; RIS.
   b. Species and Grade: Western red cedar, Clear Heart VG (Vertical Grain) **OR** Clear Heart **OR** Grade A **OR** Grade B, **as directed**; NLGA, WCLIB, or WWPA.
   c. Species and Grade: Hem-fir, pressure-preservative treated; 1 **OR** 2, **as directed**, Common; NLGA, WCLIB, or WWPA.
   d. Species and Grade: Southern pine, pressure-preservative treated; B & B **OR** C & Btr **OR** D, **as directed**; SPIB.
   e. Maximum Moisture Content: 19 **OR** 15, **as directed**, percent with at least 85 percent of shipment at 12 percent or less, **as directed**.
   f. Finger Jointing: Not allowed **OR** Allowed if made with wet-use adhesive complying with ASTM D 5572, **as directed**.
   g. Face Surface: Surfaced (smooth) **OR** Saw textured, **as directed**.
2. Lumber Trim for Opaque-Stained **OR** Painted, **as directed**, Finish:
   a. Species and Grade: Redwood, Clear **OR** Grade B, **as directed**; RIS.
   b. Species and Grade: Western red cedar, Grade A **OR** B, **as directed**; NLGA, WCLIB, or WWPA.
   c. Species and Grade: Hem-fir, Prime or D finish **OR** 1 Common **OR** 2 Common, **as directed**; NLGA, WCLIB, or WWPA.
   d. Species and Grade: Eastern white pine, eastern hemlock-balsam fir-tamarack, eastern spruce, or white woods; D Select (Quality) **OR** Finish or 1 Common (Colonial) **OR** Premium or 2 Common (Sterling), **as directed**; NeLMA, NLGA, WCLIB, or WWPA.
   e. Species and Grade: Northern white cedar, D Select **OR** 1 Common **OR** 2 Common, **as directed**; NeLMA or NLGA.

f. Maximum Moisture Content: 19 **OR** 15, **as directed**, percent with at least 85 percent of shipment at 12 percent or less, **as directed**.
g. Finger Jointing: Not allowed **OR** Allowed if made with wet-use adhesive complying with ASTM D 5572, **as directed**.
h. Face Surface: Surfaced (smooth) **OR** Saw textured, **as directed**.

3. Moldings for Semitransparent-Stained Finish **OR** Clear Finish **OR** Unfinished Applications, **as directed**: WMMPA WM 4, N-grade wood moldings, without finger jointing. Made from kiln-dried stock to patterns included in WMMPA WM 12.
   a. Species: Redwood **OR** Western red cedar **OR** Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine, **as directed**.
   b. Brick-Mold Pattern: WM 180, 1-1/4 by 2 inches (32 by 51 mm).
   c. Drip-Cap Pattern: WM 197, 11/16 by 1-5/8 inches (17 by 41 mm).
   d. Bed-Mold Pattern: WM 75, 9/16 by 1-5/8 inches (14 by 41 mm).
   e. Screen-Bead Pattern: WM 144, 1/4 by 3/4 inch (6 by 19 mm).
4. Moldings for Opaque-Stained **OR** Painted, **as directed**, Finish: WMMPA WM 4, P-grade wood moldings. Made from kiln-dried stock to patterns included in WMMPA WM 12.
   a. Species: Redwood **OR** Western red cedar **OR** Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine, **as directed**.
   b. Finger Jointing: Not allowed **OR** Allowed if made with wet-use adhesive complying with ASTM D 5572, **as directed**.
   c. Brick-Mold Pattern: WM 180, 1-1/4 by 2 inches (32 by 51 mm).
   d. Drip-Cap Pattern: WM 197, 11/16 by 1-5/8 inches (17 by 41 mm).
   e. Bed-Mold Pattern: WM 75, 9/16 by 1-5/8 inches (14 by 41 mm).
   f. Screen-Bead Pattern: WM 144, 1/4 by 3/4 inch (6 by 19 mm).
5. MDO Trim: Exterior Grade B-B, MDO plywood.
6. Cellular PVC Trim: Extruded, expanded PVC with a small-cell microstructure, made from UV- and heat-stabilized, rigid material.
   a. Density: Not less than 31 lb/cu. ft. (500 kg/cu. m).
   b. Heat Deflection Temperature: Not less than 130 deg F (54 deg C), per ASTM D 648.
   c. Coefficient of Thermal Expansion: Not more than 4.5 x 10^{-5} inches/inch x deg F (8.1 x 10^{-5} mm/mm x deg C).
   d. Water Absorption: Not more than 1 percent, per ASTM D 570.
   e. Flame-Spread Index: 75 or less, per ASTM E 84.
7. Foam Plastic Moldings: Molded product of shapes indicated, with a tough outer skin on exposed surfaces; factory primed. Exposed surfaces shall not be shaped after molding. Product is recommended by manufacturer for exterior use.
   a. Density: Not less than 20 lb/cu. ft. (320 kg/cu. m).
   b. Flame-Spread Index: Not more than 75 when tested according to ASTM E 84.
   c. Thickness: Not more than 1/2 inch (12.7 mm).
   d. Width: Not more than 8 inches (204 mm).
   e. Patterns: As indicated by manufacturer's designations.

E. Lumber Siding
1. Provide kiln-dried lumber siding complying with DOC PS 20, factory coated with exterior alkyd primer, **as directed**.
2. Species and Grade:
   a. Clear All Heart VG **OR** Clear All Heart **OR** Clear VG (Vertical Grain) **OR** Clear **OR** Grade B, **as directed**, redwood; RIS.
   b. Clear VG (Vertical Grain) Heart **OR** Grade A **OR** Grade B, **as directed** western red cedar; NLGA, WCLIB, or WWPA.
   c. Grade 1 **OR** 2, **as directed**, Common spruce-pine-fir; NeLMA, NLGA, WCLIB, or WWPA.
   d. Grade Prime or D finish **OR** 1 Common **OR** 2 Common, **as directed**, pressure-preservative-treated hem-fir; NLGA, WCLIB, or WWPA.

e. Grade D Select (Quality) **OR** Finish or 1 Common (Colonial) **OR** Premium or 2 Common (Sterling), **as directed**, eastern white pine, eastern hemlock-balsam fir-tamarack, eastern spruce, or white woods; NeLMA, NLGA, WCLIB, or WWPA.
f. Grade D Select **OR** 1 Common **OR** 2 Common, **as directed**, northern white cedar; NeLMA or NLGA.
g. Grade B & B **OR** C & Btr **OR** D **OR** 1 Common **OR** 2 Common, **as directed**, pressure-preservative-treated southern pine; SPIB.

3. Pattern:
   a. Bevel siding, S1S2E, actual overall dimensions of 5-1/2 by 11/16 inch (140 by 17 mm) **OR** 5-1/2 by 3/4 inch (140 by 19 mm) **OR** 7-1/4 by 3/4 inch (184 by 19 mm) **OR** 9-1/4 by 3/4 inch (235 by 19 mm) **OR** 9-1/4 by 1-3/32 inches (235 by 28 mm), **as directed**, measured on the face and thick edge at 19 percent moisture content.
   b. Drop siding, SPIB or WWPA pattern No. 105, actual face width (coverage) and thickness of 4-7/8 by 9/16 inch (124 by 14 mm) **OR** 4-7/8 by 23/32 inch (124 by 18 mm) **OR** 6-5/8 by 23/32 inch (168 by 18 mm) **OR** 8-5/8 by 23/32 inch (219 by 18 mm), **as directed**, measured at 19 percent moisture content.
   c. V-edge, smooth-faced tongue-and-groove pattern with eased edges, actual face width (coverage) and thickness of 3-1/8 by 9/16 inch (79 by 14 mm) **OR** 3-1/8 by 23/32 inch (79 by 18 mm) **OR** 5-1/8 by 23/32 inch (130 by 18 mm) **OR** 6-7/8 by 23/32 inch (175 by 18 mm), **as directed**, measured at 19 percent moisture content.

F. Plywood Siding
1. Plywood Type: APA-rated siding, pressure-preservative treated, **OR** factory coated with exterior acrylic latex stain, **as directed**, in panel sizes indicated.
   a. Face Grade: 303-OC **OR** OL **OR** NR **OR** SR, **as directed**.
   b. Face Grade: 303-6 **OR** 18 **OR** 30, **as directed**-S **OR** W **OR** S/W, **as directed**.
2. Thickness: 11/32 inch (8.7 mm) **OR** 3/8 inch (9.5 mm) **OR** 15/32 inch (11.9 mm) **OR** 1/2 inch (12.7 mm) **OR** 19/32 inch (15.1 mm) **OR** 5/8 inch (15.9 mm) **OR** As indicated, **as directed**.
3. Face Species: Southern pine **OR** Douglas fir **OR** Western red cedar **OR** Redwood, **as directed**.
4. Pattern: Plain **OR** Channel groove; grooves 4 inches (101.6 mm) o.c. **OR** Texture 1-11; grooves 4 inches (101.6 mm) o.c. **OR** Reverse board-and-batten; grooves 12 inches (304.8 mm) o.c., **as directed.**
5. Surface: Smooth **OR** Rough sawn, **as directed**.

G. Hardboard Siding
1. Hardboard Siding: AHA A135.6, primed with manufacturer's standard exterior primer.
   a. Type:
      1) 7/16-inch- (11-mm-) thick-by-6-inch- (152-mm-) **OR** 8-inch- (203-mm-), **as directed**, wide lap siding.
      2) 1/2-inch- (12.7-mm-) thick-by-8-inch- (203-mm-) wide, beaded-edge lap siding.
      3) 7/16-inch- (11-mm-) thick, shiplap-edge panels; with grooves 3-5/8 inches (92 mm) o.c., simulating wood drop siding.
      4) 1/2-inch- (12.7-mm-) thick, shiplap-edge panels; with grooves 5-1/2 inches (140 mm) o.c., simulating wood drop siding.
      5) 7/16-inch- (11-mm-) thick, square-edge flat panels; without grooves.
      6) 7/16-inch- (11-mm-) thick, shiplap-edge panels; channel grooved with grooves 8 inches (203.2 mm) o.c.
   b. Texture: Smooth **OR** Wood grain **OR** Shingle **OR** Stucco, **as directed**.
2. Primed Hardboard Trim: High-temperature-cured, high-resin, wood-fiber composite; factory primed on faces and edges. Recommended by manufacturer for exterior use.
3. Colors, Textures, and Patterns: As selected by the Owner from manufacturer's full range.

H. Plywood Soffits
1. Plywood Type: Exterior, Grade A-C **OR** Grade B-C **OR** Grade C-C, plugged and touch sanded **OR** APA-rated siding, **as directed**.
   a. Face Grade: 303-OC **OR** OL **OR** NR **OR** SR, **as directed**.

b. Face Grade: 303-6 **OR** 18 **OR** 30, **as directed**,-S **OR** W **OR** S/W, **as directed**.
2. Thickness: 11/32 inch (8.7 mm) **OR** 3/8 inch (9.5 mm) **OR** 15/32 inch (11.9 mm) **OR** 1/2 inch (12.7 mm) **OR** 19/32 inch (15.1 mm) **OR** As indicated, **as directed**.
3. Face Species: Southern pine **OR** Douglas fir **OR** Western red cedar **OR** Redwood, **as directed**.
4. Pattern: Plain **OR** Channel groove; grooves 4 inches (101.6 mm) o.c. **OR** Texture 1-11; grooves 4 inches (101.6 mm) o.c., **as directed.**
5. Surface: Smooth **OR** Rough sawn, **as directed**.

I. Hardboard Soffits
1. Hardboard Soffits: Primed hardboard, complying with AHA A135.6, with manufacturer's standard exterior primer.
   a. Type: 7/16-inch- (11-mm-) **OR** 1/2-inch- (12.7-mm-), **as directed**, thick flat panels, smooth **OR** wood-grain textured **OR** stucco textured, **as directed**.
2. Colors, Textures, and Patterns: As selected by the Owner from manufacturer's full range.

J. Stairs And Railings
1. Stairs:
   a. Treads: 1-1/4-inch (32-mm) thick, kiln-dried, pressure-preservative-treated stepping with half-round or rounded edge nosing.
      1) Species and Grade: Douglas fir, C & Btr VG (Vertical Grain) stepping; NLGA, WCLIB, or WWPA **OR** Hem-fir, C & Btr VG (Vertical Grain) stepping; NLGA, WCLIB, or WWPA **OR** Southern pine, B & B stepping; SPIB, **as directed**.
   b. Risers: 3/4-inch (19-mm) thick, kiln-dried, pressure-preservative-treated finish boards.
      1) Species and Grade: Douglas fir, C & Btr or Superior finish; NLGA, WCLIB, or WWPA **OR** Hem-fir, C & Btr or Superior finish; NLGA, WCLIB, or WWPA **OR** Southern pine, B & B; SPIB, **as directed**
2. Railings: Clear, kiln-dried, solid, yellow poplar **OR** pressure-preservative-treated Douglas fir **OR** pressure-preservative-treated southern pine, **as directed**; railing stock of pattern indicated.
3. Balusters: 1-1/16-inch- (27-mm-) square, clear, kiln-dried, solid, yellow poplar **OR** pressure-preservative-treated Douglas fir **OR** pressure-preservative-treated southern pine, **as directed**.
4. Newel Posts: Clear, kiln-dried, yellow poplar **OR** pressure-preservative-treated, Douglas fir **OR** pressure-preservative-treated, southern pine, **as directed**, turned newel posts of pattern and size indicated.
5. Newel Posts: 2-3/4-inch- (70-mm-) square, clear, kiln-dried yellow poplar **OR** pressure-preservative-treated Douglas fir **OR** pressure-preservative-treated southern pine, **as directed**; either solid or laminated.

K. Ornamental Wood Columns
1. Factory fabricate columns from clear stock, either solid or finger jointed, with a moisture content of not more than 15 **OR** 19, **as directed**, percent.
   a. Wood Species: Redwood **OR** Western red cedar **OR** Eastern white, Idaho white, lodgepole, ponderosa, or sugar pine, **as directed.**
2. Shafts: Built up from tongue-and-groove staves joined with waterproof glue. Lathe turn shafts to provide base diameter indicated and true architectural entasis taper. Precisely mill flutes as indicated.
3. Capital and Base: Molded glass-fiber-reinforced plastic **OR** Built up from wood components with waterproof glue. Turn circular elements on lathes.
4. Plinths: Cast-aluminum or molded glass-fiber-reinforced plastic, constructed to ventilate the interior of column shaft.
5. Treatment and Finishing:
   a. Treat wood columns with water-repellant preservative by nonpressure process.
   b. Coat inside of column shafts with bituminous mastic.
   c. Prime columns with two coats of exterior alkyd wood primer compatible with specified topcoats.

L. Miscellaneous Materials
1. Fasteners for Exterior Finish Carpentry: Provide nails or screws, in sufficient length to penetrate not less than 1-1/2 inches (38 mm) into wood substrate.
   a. For face-fastening siding, provide ringed-shank siding nails unless hot-dip galvanized nails are used.
   b. For redwood, provide brass/bronze **OR** stainless-steel **OR** hot-dip galvanized steel, **as directed**, fasteners.
   c. For prefinished items, provide matching prefinished aluminum fasteners where face fastening is required.
   d. For pressure-preservative-treated wood, provide stainless-steel **OR** hot-dip galvanized steel, **as directed**, fasteners.
   e. For applications not otherwise indicated, provide stainless-steel **OR** hot-dip galvanized steel **OR** aluminum, **as directed**, fasteners.
2. Wood Glue: Waterproof resorcinol glue recommended by manufacturer for exterior carpentry use.
3. Adhesive for Cellular PVC Trim: Product recommended by trim manufacturer.
4. Flashing: Comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim" for flashing materials installed in exterior finish carpentry.
   a. Horizontal Joint Flashing for Panel Siding: Preformed, galvanized steel **OR** aluminum **OR** prefinished aluminum **OR** stainless-steel, **as directed**, Z-shaped flashing.
5. Insect Screening for Soffit Vents: Aluminum, 18-by-16 (1.4-by-1.6-mm) mesh **OR** PVC-coated glass-fiber fabric, 18-by-14 (1.4-by-1.8-mm) or 18-by-16 (1.4-by-1.6-mm) mesh **OR** Stainless steel, 18-by-18 (1.4-by-1.4-mm) mesh, **as directed**.
6. Continuous Soffit Vents: Aluminum hat channel shape with stamped louvers **OR** perforations, **as directed**, 2 inches (51 mm) wide, and in lengths not less than 96 inches (2438 mm).
   a. Net Free Area: 4 sq. in./linear ft. (280 sq. cm/m) **OR** 6 sq. in./linear ft. (420 sq. cm/m) **OR** 8 sq. in./linear ft. (560 sq. cm/m), **as directed**.
   b. Finish: Mill finish **OR** White paint **OR** Brown paint, **as directed**.
7. Round Soffit Vents: Stamped aluminum louvered vents, 2 inches (51 mm) **OR** 2-1/2 inches (64 mm) **OR** 3 inches (76 mm) **OR** 4 inches (102 mm), **as directed**, in diameter, made to be inserted into round holes cut into soffit.
   a. Finish: Mill finish **OR** White paint **OR** Brown paint, **as directed**.
8. Sealants: Latex, complying with ASTM C 834, Type P, Grade NF and with applicable requirements in Division 07 Section "Joint Sealants", recommended by sealant manufacturer and manufacturer of substrates for intended application.

M. Fabrication
1. Back out or kerf backs of standing and running trim wider than 5 inches (125 mm), except members with ends exposed in finished work.
2. Ease edges of lumber less than 1 inch (25 mm) in nominal thickness to 1/16-inch (1.5-mm) radius and edges of lumber 1 inch (25 mm) or more in nominal thickness to 1/8-inch (3-mm) radius.

1.3 EXECUTION

A. Preparation
1. Clean substrates of projections and substances detrimental to application.
2. Prime lumber to be painted, including both faces and edges. Cut to required lengths and prime ends. Comply with requirements in Division 09 Section "Exterior Painting".

B. Installation, General
1. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, or too small to fabricate with proper jointing arrangements.
   a. Do not use manufactured units with defective surfaces, sizes, or patterns.
2. Install exterior finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.

a. Scribe and cut exterior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
b. Install to tolerance of 1/8 inch in 96 inches (3 mm in 2438 mm) for level and plumb. Install adjoining exterior finish carpentry with 1/32-inch (0.8-mm) maximum offset for flush installation and 1/16-inch (1.5-mm) maximum offset for reveal installation.
c. Install stairs with no more than 3/16-inch (4.7-mm) variation between adjacent treads and risers and with no more than 3/8-inch (9.5-mm) variation between largest and smallest treads and risers within each flight.
d. Coordinate exterior finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate exterior finish carpentry.

C. Standing And Running Trim Installation
1. Install flat grain lumber with bark side exposed to weather.
2. Install cellular PVC trim to comply with manufacturer's written instructions.
3. Install trim with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Do not use pieces less than 24 inches (610 mm) long except where necessary.
   a. Use scarf joints for end-to-end joints.
   b. Stagger end joints in adjacent and related members.
4. Fit exterior joints to exclude water. Cope at returns and miter at corners to produce tight-fitting joints with full-surface contact throughout length of joint. Plane backs of casings to provide uniform thickness across joints, where necessary for alignment.
5. Unless otherwise indicated, countersink fasteners, fill surface flush, and sand where face fastening is unavoidable.

D. Siding Installation
1. Install siding to comply with manufacturer's written instructions and warranty requirements.
2. Horizontal Lumber Siding: Apply starter strip along bottom edge of sheathing or sill. Install first course of siding with lower edge at least 1/8 inch (3 mm) below starter strip and subsequent courses lapped 1 inch (25 mm) over course below. Nail at each stud. Do not allow nails to penetrate more than one thickness of siding.
3. Diagonal Lumber Siding: Begin application at corner with tongue edge up. Install subsequent courses with tongue-and-groove edges tightly fitted together. Nail at each stud.
   a. Leave 1/8-inch (3-mm) gap at trim and corners unless otherwise recommended by manufacturer, and apply sealant.
   b. Butt joints only over framing or blocking, nailing top and bottom on each side and staggering joints in subsequent courses.
   c. Install prefabricated outside corners as recommended by manufacturer of siding materials.
4. Plywood Siding: Install panels with edges over framing or blocking. Nail at 6 inches (150 mm) o.c. at panel perimeter and 12 inches (300 mm) o.c. at intermediate supports unless manufacturer recommends closer spacing. Leave 1/16-inch (1.5-mm) gap between adjacent panels and 1/8-inch (3-mm) gap at perimeter, openings, and horizontal joints unless otherwise recommended by panel manufacturer.
   a. Seal butt joints at inside and outside corners and at trim locations.
   b. Install continuous metal flashing at horizontal panel joints.
   c. Apply battens and corner trim as indicated. Countersink nail heads, fill flush, and sand filler.
   d. Conceal fasteners to greatest practical extent by countersinking and filling, by placing in grooves of siding pattern or by concealing with applied trim or battens as detailed. Do not nail through overlapping pieces.
5. Hardboard Siding: Install hardboard siding complying with AHA's "Recommended Basic Application and Painting Instructions for Hardboard Siding." Install panels with edges over framing or blocking. Leave 3/16-inch (5-mm) gap at perimeter, openings, and horizontal panel joints unless otherwise recommended by panel manufacturer.
   a. Seal butt joints at inside and outside corners and at trim locations.

b. Install continuous metal flashing at horizontal panel joints.
c. Apply battens and corner trim as indicated.
d. Conceal fasteners to greatest practical extent by placing in grooves of siding pattern or by concealing with applied trim or battens as detailed.

6. Flashing: Install metal flashing as indicated on Drawings and as recommended by siding manufacturer.
7. Finish: Apply finish within two weeks of installation.

E. Stair And Railing Installation

1. Treads and Risers at Exterior Stairs: Secure treads and risers by gluing and nailing to carriages. Countersink nail heads, fill flush, and sand filler. Extend treads over carriages and finish with bullnose edge.
2. Balusters: Fit balusters to treads, glue, and nail in place. Countersink nail heads, fill flush, and sand filler. Let into railings and glue in place.
3. Newel Posts: Secure newel posts to stringers and risers with through bolts **OR** lag screws **OR** countersunk-head wood screws and glue, **as directed**.
4. Railings: Secure wall rails with metal brackets. Fasten freestanding railings to newel posts and to trim at walls with countersunk-head wood screws or rail bolts, and glue.

F. Ornamental Column Installation

1. Install columns to comply with manufacturer's written instructions. Comply with requirements below unless manufacturer's written instructions state otherwise.
2. Lay out column locations on soffits and beams and plumb down to locate column locations at supports.
3. Set plinths in location, shim as required to temporarily level, and scribe and trim as required so that top of plinths will sit level without use of shims. Fasten plinths in place to support using pins or fasteners as recommended by manufacturer.
4. Scribe and trim tops of columns to fit to soffits and beams. Maintain ventilation passages to interior of columns.
5. Seal ends of columns with two coats of wood sealer or primer.
6. Install column caps and flashing on columns and fasten to column. Install caps and flashing so that loads are not imposed on caps and so that ventilation of column interior is not blocked.
7. Secure columns in place at top and bottom with fasteners recommended by manufacturer.

G. Adjusting

1. Replace exterior finish carpentry that is damaged or does not comply with requirements. Exterior finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing. Adjust joinery for uniform appearance.

H. Cleaning

1. Clean exterior finish carpentry on exposed and semiexposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.

I. Protection

1. Protect installed products from damage from weather and other causes during construction.
2. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.
   a. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
   b. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 06 22 13 00

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SECTION 06 22 13 00a - INTERIOR FINISH CARPENTRY

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for interior finish carpentry. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Interior standing and running trim.
      b. Fire-rated interior door and sidelight frames.
      c. Plywood, Hardboard, and Board paneling.
      d. Shelving and clothes rods.
      e. Interior stairs and railings.
      f. Interior ornamental wood columns.

C. Definitions
   1. Lumber grading agencies, and the abbreviations used to reference them, include the following:
      a. NeLMA: Northeastern Lumber Manufacturers' Association.
      b. NHLA: National Hardwood Lumber Association.
      c. NLGA: National Lumber Grades Authority.
      d. SPIB: The Southern Pine Inspection Bureau.
      e. WCLIB: West Coast Lumber Inspection Bureau.
      f. WWPA: Western Wood Products Association.
   2. MDF: Medium-density fiberboard.
   3. MDO Plywood: Plywood with a medium-density overlay on the face.

D. Submittals
   1. Product Data: For each type of process and factory-fabricated product.
   2. Samples: For each type of paneling indicated.
   3. LEED Submittals:
      a. Product Data for Credit EQ 4.1: For adhesives and glues used at Project site, including printed statement of VOC content.
      b. Product Data for Credit EQ 4.4: For composite-wood products, documentation indicating that product contains no urea formaldehyde.
      c. Certificates for Credit MR 7: Chain-of-custody certificates certifying that products specified to be made from certified wood comply with forest certification requirements. Include evidence that mill is certified for chain of custody by an FSC-accredited certification body.
         1) Include statement indicating costs for each certified wood product.
   4. Research/Evaluation Reports: Showing that fire-retardant-treated wood complies with building code in effect for Project.
   5. Warranty: Special warranty specified in this Section.

E. Quality Assurance
   1. Forest Certification: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship":
      a. Interior standing and running trim.
      b. Interior plywood, hardboard, and board paneling.
      c. Shelving and clothes rods.
      d. Interior stairs and railings.

e. Interior ornamental wood columns.

F. Delivery, Storage, And Handling
1. Protect materials against weather and contact with damp or wet surfaces. Stack lumber, plywood, and other panels flat with spacers between each bundle to provide air circulation. Provide for air circulation within and around stacks and under temporary coverings.
2. Deliver interior finish carpentry materials only when environmental conditions meet requirements specified for installation areas. If interior finish carpentry materials must be stored in other than installation areas, store only where environmental conditions meet requirements specified for installation areas.

G. Warranty
1. Special Warranty for Columns: Manufacturer's standard form, signed by manufacturer, Installer, and Contractor, in which manufacturer agrees to repair or replace columns that fail in materials or workmanship five years from date of Final Completion.

1.2 PRODUCTS

A. Materials, General
1. Lumber: DOC PS 20 and applicable grading rules of inspection agencies certified by ALSC's Board of Review.
2. Softwood Plywood: DOC PS 1.
3. Hardboard: AHA A135.4.
4. MDF: ANSI A208.2, Grade 130, made with binder containing no urea-formaldehyde resin.
5. Particleboard: ANSI A208.1, Grade M-2 **OR** M-2-Exterior Glue **OR** M-2, made with binder containing no urea-formaldehyde resin, **as directed**.
6. Melamine-Faced Particleboard: Particleboard complying with ANSI A208.1, Grade M-2, finished on both faces with thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.

B. Wood-Preservative-Treated Materials
1. Lumber: AWPA C2 **OR** AWPA C31 (treated with inorganic boron), **as directed**. Kiln dry after treatment to a maximum moisture content of 19 percent.
2. Plywood: AWPA C9. Kiln dry after treatment to a maximum moisture content of 18 percent.
3. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
4. For exposed items indicated to receive transparent finish, do not use chemical formulations that contain colorants or that bleed through or otherwise adversely affect finishes.
5. Do not use material that is warped or does not comply with requirements for untreated material.
6. Mark lumber with treatment quality mark of an inspection agency approved by ALSC's Board of Review.
7. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
8. Application: Where indicated.

C. Fire-Retardant-Treated Materials
1. Lumber: Comply with performance requirements in AWPA C20, Exterior type **OR** Interior Type A, **as directed**. Kiln dry after treatment to a maximum moisture content of 19 percent.
2. Plywood: Comply with performance requirements in AWPA C27, Exterior type **OR** Interior Type A, **as directed**. Kiln dry after treatment to a maximum moisture content of 15 percent.
3. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not contain colorants and provide materials that do not have marks from spacer sticks on the exposed face.

4. Do not use material that does not comply with requirements for untreated material or is warped or discolored.
5. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
6. Application: Where indicated **OR** All interior lumber and plywood, **as directed**.

D. Standing And Running Trim
1. Softwood Lumber Trim for Transparent Finish (Stain or Clear Finish):
    a. Species and Grade:
        1) Eastern white pine, C Select **OR** D Select **OR** Finish or 1 Common **OR** Premium or 2 Common, **as directed**; NeLMA or NLGA.
        2) Idaho white, lodgepole, ponderosa, radiata, or sugar pine; C Select (Choice) **OR** D Select (Quality) **OR** 1 Common (Colonial) **OR** 2 Common (Sterling), **as directed**; NLGA or WWPA.
        3) Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine; C Select (Choice) **OR** D Select (Quality) **OR** Finish or 1 Common (Colonial) **OR** Premium or 2 Common (Sterling), **as directed**; NeLMA, NLGA, or WWPA.
        4) White woods, C Select **OR** D Select **OR** 1 Common **OR** 2 Common, **as directed**; WWPA.
        5) Douglas fir-larch or Douglas fir south, Superior or C & Btr **OR** Prime or D, **as directed**, finish; NLGA, WCLIB, or WWPA.
        6) Southern pine, B & B **OR** C & Btr, **as directed**, finish; SPIB.
        7) Western red cedar, Clear Heart **OR** Grade A **OR** Grade B, **as directed**; NLGA, WCLIB, or WWPA.
    b. Maximum Moisture Content: 19 **OR** 15, **as directed**, percent with at least 85 percent of shipment at 12 percent or less, **as directed**.
    c. Finger Jointing: Allowed **OR** Not allowed, **as directed**.
    d. Face Surface: Surfaced (smooth) **OR** Saw textured, **as directed**.
2. Hardwood Lumber Trim for Transparent Finish (Stain or Clear Finish):
    a. Species and Grade: Red oak **OR** White maple **OR** Alder **OR** Aspen, basswood, cottonwood, sap gum, sycamore, white maple, or yellow poplar, **as directed**; Clear **OR** A finish **OR** B finish, **as directed**; NHLA.
    b. Maximum Moisture Content: 13 **OR** 10 **OR** 9, **as directed**, percent.
    c. Finger Jointing: Not allowed.
    d. Gluing for Width: Allowed **OR** Not allowed **OR** Use for lumber trim wider than 6 inches (150 mm), **as directed**.
    e. Veneered Material: Allowed **OR** Not allowed **OR** Use for lumber trim wider than 6 inches (150 mm), **as directed**.
    f. Face Surface: Surfaced (smooth) **OR** Saw textured, **as directed**.
    g. Matching: Selected for compatible grain and color.
3. Lumber Trim for Opaque Finish (Painted):
    a. Species and Grade:
        1) Eastern white pine, D Select **OR** Finish or 1 Common **OR** Premium or 2 Common, **as directed**; NeLMA or NLGA.
        2) Idaho white, lodgepole, ponderosa, radiata, or sugar pine; D Select (Quality) **OR** 1 Common (Colonial) **OR** 2 Common (Sterling), **as directed**; NLGA or WWPA.
        3) Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine; D Select (Quality) **OR** Finish or 1 Common (Colonial) **OR** Premium or 2 Common (Sterling), **as directed**; NeLMA, NLGA, or WWPA.
        4) White woods, D Select **OR** 1 Common **OR** 2 Common, **as directed**; WWPA.
        5) Douglas fir-larch or Douglas fir south, Superior or C & Btr **OR** Prime or D, **as directed**, finish; NLGA, WCLIB, or WWPA.
        6) Spruce-pine-fir, 1 **OR** 2, **as directed**, Common; NeLMA, NLGA, WCLIB, or WWPA.
        7) Alder, aspen, basswood, cottonwood, gum, magnolia, soft maple, sycamore, tupelo, or yellow poplar; A **OR** B, **as directed**, finish; NHLA.

b. Maximum Moisture Content: 19 **OR** 15, **as directed**, percent with at least 85 percent of shipment at 12 percent or less, **as directed**.
c. Finger Jointing: Allowed **OR** Not allowed, **as directed**.
d. Face Surface: Surfaced (smooth) **OR** Saw textured, **as directed**.
e. Optional Material: Primed MDF of same actual dimensions as lumber indicated may be used in lieu of lumber.

4. Softwood Moldings for Transparent Finish (Stain or Clear Finish): WMMPA WM 4, N-grade wood moldings. Made to patterns included in WMMPA WM 12.
a. Species: Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine **OR** Southern pine **OR** Western red cedar **OR** Douglas fir, **as directed**.
b. Maximum Moisture Content: 15 percent with at least 85 percent of shipment at 12 percent or less.
c. Finger Jointing: Not allowed.
d. Matching: Selected for compatible grain and color.
e. Base Pattern: WM 623, 9/16-by-3-1/4-inch (14-by-83-mm) ogee **OR** WM 713, 9/16-by-3-1/4-inch (14-by-83-mm) ranch **OR** WM 753, 9/16-by-3-1/4-inch (14-by-83-mm) beaded-edge **OR** WM 620, 9/16-by-4-1/4-inch (14-by-108-mm) ogee **OR** WM 750, 9/16-by-4-1/4-inch (14-by-108-mm) beaded-edge, **as directed**, base.
f. Shoe-Mold Pattern: WM 129, 7/16-by-11/16-inch (11-by-17-mm) quarter-round **OR** WM 126, 1/2-by-3/4-inch (13-by-19-mm) quarter-round **OR** WM 131, 1/2-by-3/4-inch (13-by-19-mm) ogee, **as directed**, shoe mold.
g. Casing Pattern: WM 327, 11/16-by-2-1/4-inch (17-by-57-mm) clamshell **OR** WM 366, 11/16-by-2-1/4-inch (17-by-57-mm) featheredge **OR** WM 376, 11/16-by-2-1/4-inch (17-by-57-mm) beaded-edge, **as directed**, casing.
h. Mull-Casing Pattern: WM 957, 3/8-by-1-3/4-inch (9.5-by-44-mm) beaded-edge **OR** WM 973, 3/8-by-1-3/4-inch (9.5-by-44-mm) bullnose **OR** WM 983, 3/8-by-1-3/4-inch (9.5-by-44-mm) featheredge, **as directed**, casing.
i. Stop Pattern: WM 856, 3/8-by-1-3/8-inch (9.5-by-35-mm) ranch **OR** WM 946, 3/8-by-1-3/8-inch (9.5-by-35-mm) ogee **OR** WM 886, 3/8-by-1-3/8-inch (9.5-by-35-mm) bullnose, **as directed**, stop.
j. Chair-Rail Pattern: WM 297, 11/16-by-3-inch (17-by-76-mm) chair rail.

5. Hardwood Moldings for Transparent Finish (Stain or Clear Finish): WMMPA HWM 2, N-grade wood moldings made to patterns included in WMMPA HWM 1.
a. Species: Red oak **OR** White maple **OR** Aspen, basswood, cottonwood, sap gum, sycamore, white maple, or yellow poplar, **as directed**.
b. Kiln-dried softwood or MDF, with exposed surfaces veneered with species indicated, may be used in lieu of solid wood.
c. Maximum Moisture Content: 9 percent.
d. Finger Jointing: Not allowed.
e. Matching: Selected for compatible grain and color.
f. Base Pattern: HWM 633, 7/16-by-3-1/4-inch (11-by-83-mm) ogee **OR** HWM 713, 7/16-by-3-1/4-inch (11-by-83-mm) ranch **OR** HWM 753, 7/16-by-3-1/4-inch (11-by-83-mm) beaded-edge **OR** WM 620, 7/16-by-4-1/4-inch (11-by-108-mm) ogee, **as directed**, base.
g. Shoe-Mold Pattern: HWM 129, 7/16-by-11/16-inch (11-by-17-mm) quarter-round **OR** HWM 126, 1/2-by-3/4-inch (13-by-19-mm) quarter-round **OR** HWM 131, 1/2-by-3/4-inch (13-by-19-mm) ogee, **as directed**, shoe mold.
h. Casing Pattern: HWM 328, 1/2-by-2-1/4-inch (13-by-57-mm) clamshell **OR** HWM 366, 1/2-by-2-1/4-inch (13-by-57-mm) featheredge **OR** HWM 376, 1/2-by-2-1/4-inch (13-by-57-mm) beaded-edge, **as directed**, casing.
i. Mull-Casing Pattern: HWM 989, 3/16-by-2-inch (5-by-51-mm) square-edge **OR** HWM 988, 3/8-by-1-1/2-inch (9.5-by-38-mm) featheredge **OR** HWM 987, 3/8-by-2-inch (9.5-by-51-mm) featheredge, **as directed**, casing.
j. Stop Pattern: HWM 856, 3/8-by-1-3/8-inch (9.5-by-35-mm) ranch **OR** HWM 946, 3/8-by-1-3/8-inch (9.5-by-35-mm) ogee **OR** HWM 886, 3/8-by-1-3/8-inch (9.5-by-35-mm) bullnose, **as directed**, stop.

k. Chair-Rail Pattern: HWM 297, 11/16-by-3-inch (17-by-76-mm) chair rail.

6. Moldings for Opaque Finish (Painted): Made to patterns included in WMMPA WM 12.
   a. Softwood Moldings: WMMPA WM 4, P-grade.
      1) Species: Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine.
      2) Maximum Moisture Content: 15 percent with at least 85 percent of shipment at 12 percent or less.
   b. Hardwood Moldings: WMMPA HWM 2, P-grade.
      1) Species: Aspen, basswood, cottonwood, gum, magnolia, soft maple, tupelo, or yellow poplar.
      2) Maximum Moisture Content: 9 percent.
   c. Optional Material: Primed MDF.
   d. Finger Jointing: Allowed **OR** Not allowed, **as directed**.
   e. Base Pattern: WM 623, 9/16-by-3-1/4-inch (14-by-83-mm) ogee **OR** WM 713, 9/16-by-3-1/4-inch (14-by-83-mm) ranch **OR** WM 753, 9/16-by-3-1/4-inch (14-by-83-mm) beaded-edge **OR** WM 620, 9/16-by-4-1/4-inch (14-by-108-mm) ogee **OR** WM 750, 9/16-by-4-1/4-inch (14-by-108-mm) beaded-edge, **as directed**, base.
   f. Shoe-Mold Pattern: WM 129, 7/16-by-11/16-inch (11-by-17-mm) quarter-round **OR** WM 126, 1/2-by-3/4-inch (13-by-19-mm) quarter-round **OR** WM 131, 1/2-by-3/4-inch (13-by-19-mm) ogee, **as directed**, shoe mold.
   g. Casing Pattern: WM 327, 11/16-by-2-1/4-inch (17-by-57-mm) clamshell **OR** WM 366, 11/16-by-2-1/4-inch (17-by-57-mm) featheredge **OR** WM 376, 11/16-by-2-1/4-inch (17-by-57-mm) beaded-edge, **as directed**, casing.
   h. Mull-Casing Pattern: WM 957, 3/8-by-1-3/4-inch (9.5-by-44-mm) beaded-edge **OR** WM 973, 3/8-by-1-3/4-inch (9.5-by-44-mm) bullnose **OR** WM 983, 3/8-by-1-3/4-inch (9.5-by-44-mm) featheredge, **as directed**, casing.
   i. Stop Pattern: WM 856, 3/8-by-1-3/8-inch (9.5-by-35-mm) ranch **OR** WM 946, 3/8-by-1-3/8-inch (9.5-by-35-mm) ogee **OR** WM 886, 3/8-by-1-3/8-inch (9.5-by-35-mm) bullnose, **as directed**, stop.
   j. Chair-Rail Pattern: WM 297, 11/16-by-3-inch (17-by-76-mm) chair rail.

7. PVC-Wrapped Moldings: WMMPA WM 2 and made to patterns included in WMMPA WM 12.
   a. Base Pattern: WM 623, 9/16-by-3-1/4-inch (14-by-83-mm) ogee **OR** WM 713, 9/16-by-3-1/4-inch (14-by-83-mm) ranch, **as directed**, base.
   b. Shoe-Mold Pattern: WM 129, 7/16-by-11/16-inch (11-by-17-mm) quarter-round **OR** WM 126, 1/2-by-3/4-inch (13-by-19-mm) quarter-round, **as directed**, shoe mold.
   c. Casing Pattern: WM 327, 11/16-by-2-1/4-inch (17-by-57-mm) clamshell **OR** WM 366, 11/16-by-2-1/4-inch (17-by-57-mm) featheredge, **as directed**, casing.
   d. Mull-Casing Pattern: WM 973, 3/8-by-1-3/4-inch (9.5-by-44-mm) bullnose **OR** WM 983, 3/8-by-1-3/4-inch (9.5-by-44-mm) featheredge, **as directed**, casing.
   e. Stop Pattern: WM 856, 3/8-by-1-3/8-inch (9.5-by-35-mm) ranch **OR** WM 886, 3/8-by-1-3/8-inch (9.5-by-35-mm) bullnose, **as directed**, stop.
   f. Chair-Rail Pattern: WM 297, 11/16-by-3-inch (17-by-76-mm) chair rail.
   g. Colors, Textures, and Grain Patterns: As selected by the Owner from manufacturer's full range.

8. Foam Plastic Moldings: Molded product of shapes indicated, with a tough outer skin on exposed surfaces; factory primed. Exposed surfaces shall not be shaped after molding.
   a. Density: Not less than 20 lb/cu. ft. (320 kg/cu. m).
   b. Flame-Spread Index: Not more than 75 when tested according to ASTM E 84.
   c. Thickness: Not more than 1/2 inch (12.7 mm).
   d. Width: Not more than 8 inches (204 mm).
   e. Patterns: As indicated by manufacturer's designations.

E. Fire-Rated Interior Door And Sidelight Frames

1. Frames, complete with casings, fabricated from fire-retardant particleboard or fire-retardant MDF with veneered exposed surfaces, or from solid fire-retardant-treated wood. Frames shall comply with NFPA 80 and be listed and labeled by a testing and inspecting agency acceptable to

authorities having jurisdiction, based on testing according to NFPA 252 **OR** IBC Standard 703, **as directed**.

a. Species: Red oak **OR** White oak **OR** White maple **OR** Cherry, **as directed**.
b. Fire Rating: 20 minutes **OR** 30 minutes **OR** 45 minutes **OR** 60 minutes **OR** 90 minutes **OR** As indicated, **as directed**.

F. Paneling

1. Hardwood Veneer Plywood Paneling: Manufacturer's stock hardwood plywood panels complying with HPVA HP-1, made without urea-formaldehyde adhesive.
    a. Face Veneer Species and Cut: Rotary-cut white birch **OR** Plain-sliced red oak **OR** Plain-sliced hickory, **as directed**.
    b. Veneer Matching: Random match **OR** Selected for similar color and grain, **as directed**.
    c. Backing Veneer Species: Same species as face veneer **OR** Any hardwood compatible with face species, **as directed**.
    d. Construction: Veneer core.
    e. Thickness: 1/8 inch (3.2 mm) **OR** 5/32 inch (4 mm) **OR** 5 mm **OR** 1/4 inch (6.4 mm) **OR** 5/16 inch (7.9 mm) **OR** 7/16 inch (11 mm), **as directed**.
    f. Glue Bond: Type II (interior) **OR** I (exterior), **as directed**.
2. Hardboard Paneling: Interior factory-finished hardboard paneling complying with AHA 135.5.
    a. Thickness: 1/8 inch (3.2 mm) **OR** 5/32 inch (4 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
    b. Finish: Class I **OR** II, **as directed**.
    c. Surface-Burning Characteristics: As follows, tested per ASTM E 84:
        1) Flame-Spread Index: 25 or less.
        2) Smoke-Developed Index: 450 or less.
3. Board Paneling: Interior wood board paneling complying with WMMPA WM 9.
    a. Species: Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine **OR** Southern pine **OR** Western red cedar **OR** Figured red gum, **as directed**.
    b. Grade: Clear No. 1 **OR** Clear No. 2 **OR** Knotty No. 1 **OR** Knotty No. 2 **OR** Finger jointed, **as directed**.
    c. Maximum Moisture Content: 15 percent with at least 85 percent of shipment at 12 percent or less **OR** 9 percent, **as directed**.
4. Board Paneling:
    a. Species and Grade:
        1) Eastern white pine, C Select **OR** D Select **OR** Finish or 1 Common **OR** Premium or 2 Common, **as directed**; NeLMA or NLGA.
        2) Idaho white, lodgepole, ponderosa, radiata, or sugar pine; C Select (Choice) **OR** D Select (Quality) **OR** 1 Common (Colonial) **OR** 2 Common (Sterling), **as directed**; NLGA or WWPA.
        3) Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine; C Select (Choice) **OR** D Select (Quality) **OR** Finish or 1 Common (Colonial) **OR** Premium or 2 Common (Sterling), **as directed**; NeLMA, NLGA, or WWPA.
        4) Southern pine, B & B **OR** C & Btr **OR** No. 2, **as directed**, Paneling; SPIB.
        5) Western red cedar, Clear Heart **OR** Grade A **OR** Grade B, **as directed**; NLGA, WCLIB, or WWPA.
    b. Maximum Moisture Content: 19 **OR** 15, **as directed**, percent with at least 85 percent of shipment at 12 percent or less, **as directed**.

G. Shelving And Clothes Rods

1. Exposed **OR** Closet **OR** Utility, **as directed**, Shelving: Made from one of the following materials, **as directed**, 3/4 inch (19 mm) thick. Do not use particleboard or MDF that contains urea formaldehyde.
    a. Particleboard with radiused and filled **OR** solid-wood, **as directed**, front edge.
    b. MDF with radiused **OR** solid-wood, **as directed**, front edge.
    c. MDO softwood plywood with solid-wood edge.

d. Melamine-faced particleboard with radiused and filled **OR** applied PVC, **as directed**, front edge.
e. Wood boards as specified above for lumber trim for opaque **OR** softwood lumber trim for transparent **OR** hardwood lumber trim for transparent, **as directed**, finish.
f. Softwood Boards: Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine; C Select (Choice) **OR** D Select (Quality) **OR** Finish or 1 Common (Colonial) **OR** Premium or 2 Common (Sterling), **as directed**; NeLMA, NLGA, or WWPA; kiln dried.
g. Softwood Boards: Douglas fir-larch, Douglas fir south, or hem-fir; Superior or C & Btr **OR** Prime or D, **as directed**, finish; NLGA, WCLIB, or WWPA; or southern pine, B & B **OR** C, **as directed**, finish; SPIB; kiln dried.

2. Shelf Cleats: 3/4-by-3-1/2-inch (19-by-89-mm) boards **OR** 3/4-by-5-1/2-inch (19-by-140-mm) boards **OR** 3/4-by-5-1/2-inch (19-by-140-mm) boards with hole and notch to receive clothes rods, **as directed**, as specified above for shelving **OR** lumber trim for opaque finish **OR** softwood lumber trim for transparent finish **OR** hardwood lumber trim for transparent finish, **as directed**.
3. Shelf Brackets with Rod Support: BHMA A156.16, B04051; prime-painted formed steel.
4. Shelf Brackets without Rod Support: BHMA A156.16, B04041; prime-painted formed steel.
5. Standards for Adjustable Shelf Brackets: BHMA A156.9, B04102; powder-coat finished **OR** brass-finished **OR** zinc-plated, **as directed**, steel.
6. Adjustable Shelf Brackets: BHMA A156.9, B04112; powder-coat finished steel **OR** brass-finished steel **OR** zinc-plated steel **OR** bronze-anodized aluminum **OR** black-anodized aluminum **OR** natural aluminum, **as directed**.
7. Standards for Adjustable Shelf Supports: BHMA A156.9, B04071; powder-coat finished **OR** brass-finished **OR** zinc-plated, **as directed**, steel.
8. Adjustable Shelf Supports: BHMA A156.9, B04081 or B04091; powder-coat finished **OR** brass-finished **OR** zinc-plated, **as directed**, steel.
9. Clothes Rods: 1-1/2-inch- (38-mm-) diameter, clear, kiln-dried hardwood **OR** clear, kiln-dried softwood; either Douglas fir or southern pine, **as directed**.
10. Clothes Rods: 1-5/16-inch- (33-mm-) diameter, aluminum tubes **OR** chrome-plated steel tubes **OR** chrome-plated steel telescoping tubes with end brackets for mounting on shelf cleats, **as directed**.
11. Rod Flanges: Clear, kiln-dried, Douglas fir or southern pine **OR** eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine **OR** red oak **OR** white maple **OR** aspen, basswood, cottonwood, sap gum, white maple, or yellow poplar, **as directed**, turnings.
12. Rod Flanges: Aluminum **OR** Chrome-plated steel **OR** Stainless steel, **as directed**.

H. Stairs And Railings

1. Treads: 1-1/16-inch (27-mm), clear, kiln-dried, edge-glued, rift-sawn red oak **OR** red oak **OR** hard maple **OR** poplar, **as directed**, stepping with half-round nosing.
2. Risers: 13/16-inch (21-mm), clear, kiln-dried, edge-glued red oak **OR** hard maple **OR** poplar, **as directed**, stock.
3. Risers: 3/4-inch (19-mm) finish boards as specified above for interior lumber trim for opaque finish.
4. Finished Stringers: 3/4-inch (19-mm) finish boards as specified above for interior lumber trim for opaque finish.
5. Interior Railings: Clear, kiln-dried red oak **OR** hard maple **OR** yellow poplar, **as directed**.
6. Balusters: Clear, kiln-dried, red oak **OR** hard maple **OR** yellow poplar, **as directed**.
7. Newel Posts: Clear, kiln-dried, red oak **OR** hard maple **OR** yellow poplar, **as directed**.
8. Factory fabricate columns for transparent finish from clear, kiln-dried eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine **OR** aspen, basswood, cottonwood, sap gum, white maple, or yellow poplar **OR** red oak **OR** white maple **OR** mahogany, **as directed**.
9. Factory fabricate columns for opaque finish from clear, kiln-dried eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine **OR** aspen, basswood, cottonwood, sap gum, white maple, or yellow poplar, **as directed**. Column staves may be finger jointed.
10. Shafts: Built up from tongue-and-groove staves joined with waterproof glue. Lathe turn shafts to provide indicated base diameter and true architectural entasis taper. Precisely mill flutes as indicated.

11. Capital and Base: Molded glass-fiber-reinforced plastic **OR** Built up from wood components with waterproof glue. Turn circular elements on lathes, **as directed**.
12. Prime columns for opaque finish with one coat of interior wood primer compatible with specified topcoats.

I. Miscellaneous Materials
1. Fasteners for Interior Finish Carpentry: Nails, screws, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.
    a. Where galvanized finish is indicated, provide fasteners and anchorages with hot-dip galvanized coating complying with ASTM A 153/A 153M.
2. Glue: Aliphatic-resin, polyurethane, or resorcinol wood glue recommended by manufacturer for general carpentry use.
    a. Use wood glue that has a VOC content of 30 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Installation Adhesive for Foam Plastic Moldings: Product recommended for indicated use by foam plastic molding manufacturer.
    a. Use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
4. Paneling Adhesive: Comply with paneling manufacturer's written recommendations for adhesives.
    a. Use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
5. Multipurpose Construction Adhesive: Formulation complying with ASTM D 3498 that is recommended for indicated use by adhesive manufacturer.
    a. Use adhesive that has a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

J. Fabrication
1. Back out or kerf backs of the following members except those with ends exposed in finished work:
    a. Interior standing and running trim except shoe and crown molds.
    b. Wood board paneling.
2. Ease edges of lumber less than 1 inch (25 mm) in nominal thickness to 1/16-inch (1.5-mm) radius and edges of lumber 1 inch (25 mm) or more in nominal thickness to 1/8-inch (3-mm) radius.

1.3 EXECUTION

A. Preparation
1. Clean substrates of projections and substances detrimental to application.
2. Before installing interior finish carpentry, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours unless longer conditioning is recommended by manufacturer.

B. Installation, General
1. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, or too small to fabricate with proper jointing arrangements.
    a. Do not use manufactured units with defective surfaces, sizes, or patterns.
2. Install interior finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.
    a. Scribe and cut interior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
    b. Countersink fasteners, fill surface flush, and sand where face fastening is unavoidable.

c. Install to tolerance of 1/8 inch in 96 inches (3 mm in 2438 mm) for level and plumb. Install adjoining interior finish carpentry with 1/32-inch (0.8-mm) maximum offset for flush installation and 1/16-inch (1.5-mm) maximum offset for reveal installation.
d. Install stairs with no more than 3/16-inch (4.7-mm) variation between adjacent treads and risers and with no more than 3/8-inch (9.5-mm) variation between largest and smallest treads and risers within each flight.
e. Coordinate interior finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate interior finish carpentry.

C. Standing And Running Trim Installation
1. Install with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Do not use pieces less than 24 inches (610 mm) long, except where necessary. Stagger joints in adjacent and related standing and running trim. Cope at returns and miter at corners to produce tight-fitting joints with full-surface contact throughout length of joint. Use scarf joints for end-to-end joints. Plane backs of casings to provide uniform thickness across joints where necessary for alignment.
a. Match color and grain pattern of trim for transparent finish (stain or clear finish) across joints.
b. Install trim after gypsum board joint finishing operations are completed.
c. Drill pilot holes in hardwood before fastening to prevent splitting. Fasten to prevent movement or warping. Countersink fastener heads on exposed carpentry work and fill holes.

D. Paneling Installation
1. Plywood Paneling: Select and arrange panels on each wall to minimize noticeable variations in grain character and color between adjacent panels. Leave 1/4-inch (6-mm) gap to be covered with trim at top, bottom, and openings. Install with uniform tight joints between panels.
a. Attach panels to supports with manufacturer's recommended panel adhesive and fasteners. Space fasteners as recommended by panel manufacturer.
b. Conceal fasteners to greatest practical extent.
c. Arrange panels with grooves and joints over supports. Fasten to supports with nails of type and at spacing recommended by panel manufacturer. Use fasteners with prefinished heads matching groove color.
2. Hardboard Paneling: Install according to manufacturer's written recommendations. Leave 1/4-inch (6-mm) gap to be covered with trim at top, bottom, and openings. Butt adjacent panels with moderate contact. Use fasteners with prefinished heads matching paneling color.
a. Wood Stud or Furring Substrate: Install with 1-inch (25-mm) annular-ring shank hardboard nails.
b. Plaster or Gypsum Board Substrate: Install with 1-5/8-inch (41-mm) annular-ring shank hardboard nails.
c. Nailing: Space nails 4 inches (100 mm) o.c. at panel perimeter and 8 inches (200 mm) o.c. at intermediate supports unless otherwise required by manufacturer.
3. Board Paneling: Install according to manufacturer's written instructions. Arrange in random-width pattern suggested by manufacturer unless boards or planks are of uniform width.
a. Install in full lengths without end joints.
OR
Stagger end joints in random pattern to uniformly distribute joints on each wall.
b. Install with uniform end joints with only end-matched (tongue-and-groove) joints within each field of paneling.
OR
Install with uniform end joints. Locate end joints only over furring or blocking.
c. Select and arrange boards on each wall to minimize noticeable variations in grain character and color between adjacent boards. Install with uniform tight joints between boards.
d. Fasten paneling by face nailing, setting nails, and filling over nail heads.
OR

Fasten paneling with trim screws, set below face and filled.
OR
Fasten paneling by blind nailing through tongues.
OR
Fasten paneling with paneling system manufacturer's concealed clips.
OR
Fasten paneling to gypsum wallboard with panel adhesive.

E. Shelving And Clothes Rod Installation
1. Cut shelf cleats at ends of shelves about 1/2 inch (13 mm) less than width of shelves and sand exposed ends smooth.
2. Install shelf cleats by fastening to framing or backing with finish nails or trim screws, set below face and filled. Space fasteners not more than 16 inches (400 mm) o.c. Use 2 fasteners at each framing member or fastener location for cleats 4 inches nominal (89 mm actual) in width and wider.
    a. Apply a bead of multipurpose construction adhesive to back of shelf cleats right before installing. Remove adhesive that is squeezed out immediately after fastening shelf cleats in place.
3. Install shelf brackets according to manufacturer's written instructions, spaced not more than 36 inches (900 mm) o.c. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors.
4. Install standards for adjustable shelf supports according to manufacturer's written instructions. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors. Space fasteners not more than 12 inches (300 mm) o.c.
5. Install standards for adjustable shelf brackets according to manufacturer's written instructions, spaced not more than 36 inches (900 mm) o.c. and within 6 inches (150 mm) of end of shelves. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors.
6. Cut shelves to neatly fit openings with only enough gap to allow shelves to be removed and reinstalled. Install shelves, fully seated on cleats, brackets, and supports.
    a. Fasten shelves to cleats with finish nails or trim screws, set flush.
    b. Fasten shelves to brackets to comply with bracket manufacturer's written instructions.
7. Install rod flanges for rods as indicated. Fasten to shelf cleats, framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors. Install rods in rod flanges.

F. Stair And Railing Installation
1. Treads and Risers at Interior Stairs: Secure treads and risers by gluing and nailing to rough carriages.
    a. Closed Stringers: House treads and risers into wall stringers, glue, and wedge into place **OR** Cope wall stringers to fit tightly over treads and risers, **as directed**.
    b. Open Stringers: Miter risers and stringer at open stringers. Extend tread over open stringers and finish with bullnose edge cut from tread stock and fitted to tread with mitered return at nosing.
2. Balusters: Dovetail or mortise balusters into treads, glue, and nail in place. Let into railings and glue in place.
3. Newel Posts: Secure newel posts to stringers, rough carriages, and risers with countersunk-head wood screws and glue.
4. Railings: Secure wall rails with metal brackets. Fasten freestanding railings to newel posts and to trim at walls with countersunk-head wood screws or rail bolts, and glue. Assemble railings at goosenecks, easements, and splices with rail bolts and glue.

G. Ornamental Column Installation
1. Install columns to comply with manufacturer's written instructions. Comply with requirements below unless manufacturer's written instructions state otherwise.
2. Lay out column locations on ceiling and plumb down to locate column locations at floor.

3. Set plinths in location, shim to temporarily level, and scribe and trim as required so that tops of plinths will sit level without use of shims. Seal cut surfaces with wood sealer or primer and fasten plinths to floor using pins or fasteners as recommended by manufacturer.
4. Set columns in location, shim as required to temporarily plumb, scribe and trim as required so that columns will sit plumb without shims.
5. Scribe and trim tops of columns to fit to ceiling.
6. Seal ends of columns with wood sealer or primer.
7. Install column caps on columns and fasten to columns.
8. Secure columns in place at top and bottom with fasteners recommended by manufacturer.

H. Adjusting
1. Replace interior finish carpentry that is damaged or does not comply with requirements. Interior finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing. Adjust joinery for uniform appearance.

I. Cleaning
1. Clean interior finish carpentry on exposed and semiexposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.

J. Protection
1. Protect installed products from damage from weather and other causes during remainder of the construction period.
2. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.
    a. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
    b. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 06 22 13 00a

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Task	Specification	Specification Description
06 22 13 00	06 05 23 00a	Miscellaneous Carpentry

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SECTION 06 25 16 00 - PANELING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for paneling. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
    a. Board paneling.
    b. Flush wood paneling.
    c. Plastic-laminate-clad flush paneling.
    d. Stile and rail wood paneling.

C. Definitions
1. Paneling includes wood furring, blocking, and shims for installing paneling, unless concealed within other construction before paneling installation.

D. Submittals
1. Product Data: For each type of product indicated, including finishing materials and processes.
    a. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.
2. Shop Drawings: Show location of paneling, large-scale details, attachment devices, and other components. Include dimensioned plans and elevations.
    a. For paneling produced from premanufactured sets, show finished panel sizes, set numbers, sequence numbers within sets, and method of cutting panels to produce indicated sizes.
    b. For paneling veneered in fabrication shop, show veneer leaves with dimensions, grain direction, exposed face, and identification numbers indicating the flitch and sequence within the flitch for each leaf.
    c. Apply WI-certified compliance label to first page of Shop Drawings, **as directed**.
3. Samples:
    a. Lumber and panel products for transparent finish, for each species and cut, finished on one side and one edge.
    b. Veneer leaves representative of and selected from flitches to be used for transparent-finished paneling.
    c. Veneer-faced panel products with or for transparent finish, for each species and cut. Include at least one face-veneer seam and finish as specified.
    d. Lumber and panel products with shop-applied opaque finish, for each finish system and color, with 1/2 of exposed surface finished.
    e. Plastic laminates, 8 by 10 inches (200 by 250 mm), for each type, color, pattern, and surface finish, with 1 sample applied to core material.
    f. Corner pieces for stile and rail paneling, 18 inches (450 mm) high by 18 inches (450 mm) wide by 6 inches (150 mm) deep.
4. LEED Submittals:
    a. Product Data for Credit EQ 4.1: For installation adhesives, including printed statement of VOC content.
    b. Product Data for Credit EQ 4.4: For composite-wood products and fabrication adhesives, documentation indicating that products contain no urea formaldehyde.

c. Product Data for Credit(s) MR 4.1 and MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
1) Include statement indicating costs for each product having recycled content.
d. Certificates for Credit MR 7: Chain-of-custody certificates certifying that products specified to be made from certified wood comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
1) Include statement indicating costs for each certified wood product.
5. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates **OR** WI-certified compliance certificates, **as directed**.

E. Quality Assurance
1. Installer Qualifications: Fabricator of products.
2. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards"**OR** WIC's "Manual of Millwork," **as directed**.
a. Provide AWI Quality Certification Program labels and certificates for woodwork, including installation.
b. Provide WIC-certified compliance labels and certificates for woodwork, including installation.
3. Fire-Test-Response Characteristics: Where fire-retardant materials or products are indicated, provide materials and products with specified fire-test-response characteristics as determined by testing identical products per test method indicated by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify with appropriate markings of applicable testing and inspecting agency in the form of separable paper label or, where required by authorities having jurisdiction, imprint on surfaces of materials that will be concealed from view after installation.
4. Forest Certification: Provide paneling produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
5. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Do not deliver paneling until painting and similar operations that could damage paneling have been completed in installation areas. If paneling must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

G. Project Conditions
1. Environmental Limitations: Do not deliver or install paneling until building is enclosed, wet work is complete, and HVAC system is operating and will maintain temperature and relative humidity at occupancy levels during the remainder of the construction period.

1.2 PRODUCTS

A. Materials
1. General: Provide materials that comply with requirements of AWI's **OR** WI's, **as directed**, quality standard for quality grade specified, unless otherwise indicated.
2. Wood Products: Comply with the following:
a. Medium-Density Fiberboard: ANSI A208.2, Grade MD, made with binder containing no urea formaldehyde.
b. Particleboard: ANSI A208.1, Grade M-2 **OR** M-2-Exterior Glue, **as directed**.
c. Particleboard: Straw-based particleboard complying with requirements in ANSI A208.1, Grade M-2, except for density.

d. Softwood Plywood: DOC PS 1, Medium Density Overlay.
e. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1, made with adhesive containing no urea formaldehyde.

3. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated, or if not indicated, as required by woodwork quality standard.
4. Adhesives: Do not use adhesives that contain urea formaldehyde.
5. Adhesive for Bonding Plastic Laminate: Unpigmented contact cement **OR** Contact cement **OR** PVA **OR** Urea formaldehyde **OR** Resorcinol, **as directed**.
   a. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.
6. VOC Limits for installation Adhesives and Glues: Use installation adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   a. Wood Glues: 30 g/L.
   b. Panel Adhesives: 50 g/L.
   c. Contact Adhesive: 80 g/L.
   d. Special Purpose Contact Adhesive (contact adhesive that is used to bond melamine covered board, metal, unsupported vinyl, Teflon, ultra-high molecular weight polyethylene, rubber or wood veneer 1/16 inch or less in thickness to any surface): 250 g/L.

B. Fire-Retardant-Treated Materials
1. General: Where fire-retardant-treated materials are indicated, use materials that are acceptable to authorities having jurisdiction and that comply with requirements in this Article and with fire-test-response characteristics specified.
   a. Do not use treated materials that do not comply with requirements of referenced woodworking standard or that are warped, discolored, or otherwise defective.
   b. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
   c. Identify fire-retardant-treated materials with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.
2. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Comply with performance requirements of AWPA C20 (lumber) and AWPA C27 (plywood). Use the following treatment type:
   a. Exterior Type: Organic-resin-based formulation thermally set in wood by kiln drying.
   b. Interior Type A: Low-hygroscopic formulation.
   c. Mill lumber after treatment, within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking plant certified by testing and inspecting agency.
   d. Mill lumber before treatment and implement special procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.
   e. Kiln-dry materials before and after treatment to levels required for untreated materials.
3. Fire-Retardant Particleboard: Panels complying with the following requirements, made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less per ASTM E 84.
4. Fire-Retardant Fiberboard: Medium-density fiberboard panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less per ASTM E 84.

C. Installation Materials
1. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, fire-retardant-treated, **as directed**, kiln-dried to less than 15 percent moisture content.

2. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

D. Fabrication, General
1. Paneling Grade: Provide Premium **OR** Custom **OR** Economy, **as directed**, grade paneling complying with referenced quality standard.
2. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.
3. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.
4. Arrange paneling in shop or other suitable space in proposed sequence for examination by the Owner. Mark units with temporary sequence numbers to indicate position in proposed layout.
   a. Lay out one elevation at a time if approved by the Owner.
   b. Notify the Owner seven days in advance of the date and time when layout will be available for viewing.
   c. Provide lighting of similar type and level as that of final installation for viewing layout, unless otherwise approved by the Owner.
   d. Rearrange paneling as directed by the Owner until layout is approved.
   e. Do not trim end units and other nonmodular size units to less than modular size until after the Owner's approval of layout. Indicate trimming by masking edges of units with nonmarking material.
   f. Obtain the Owner's approval of layout before start of assembly. Mark units and Shop Drawings with assembly sequence numbers based on approved layout.
5. Complete fabrication, including assembly and finishing, **as directed**, to maximum extent possible, before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
6. Shop cut openings, to maximum extent possible, to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

E. Board Paneling For Transparent Finish
1. Grade: Provide Premium **OR** Custom **OR** Economy, **as directed**.
2. Wood Species and Cut: Hickory, quarter sawn **OR** Red gum, plain sawn **OR** Western white pine, plain sawn **OR** Cypress, plain sawn, **as directed**.
3. Pattern: 1-by-6, vee joint, tongue and groove, 5-1/16-inch (129-mm) coverage **OR** 1-by-8, pickwick paneling (WWPA Pattern WP-2), 6-3/4-inch (172-mm) coverage **OR** 1-by-4, beaded ceiling, 3-3/16-inch (81-mm) coverage **OR** As indicated, **as directed**.
4. Shop fabricate board paneling in lengths to provide pieces that are uninterrupted by joints **OR** random-lengths, **as directed**. Machine edges of boards to provide joint profiles indicated.
5. Preassemble board paneling into largest units that can be delivered into installation areas using permanent or temporary backing members as indicated. To maximum extent possible, fabricate units in sizes determined by field measurements of existing conditions and that will avoid fitting in the field; make provision for separate scribing pieces to be fitted to adjoining finished surfaces. Provide shop-prepared detachable pieces for forming joints with other units at Project site and with other types of architectural woodwork.

F. Board Paneling For Opaque Finish
1. Grade: Provide Premium **OR** Custom **OR** Economy, **as directed**.
2. Wood Species: Eastern white pine, sugar pine, or western white pine **OR** Any closed-grain hardwood, **as directed**.

3. Pattern: 1-by-6, vee joint, tongue and groove, 5-1/16-inch (129-mm) coverage **OR** 1-by-8, pickwick paneling (WWPA Pattern WP-2), 6-3/4-inch (172-mm) coverage **OR** 1-by-4, beaded ceiling, 3-3/16-inch (81-mm) coverage **OR** As indicated, **as directed**.
4. Shop fabricate board paneling in lengths to provide pieces that are uninterrupted by joints **OR** random-lengths, **as directed**. Machine edges of boards to provide joint profiles indicated.
5. Preassemble board paneling into largest units that can be delivered into installation areas using permanent or temporary backing members as indicated. To maximum extent possible, fabricate units in sizes determined by field measurements of existing conditions and that will avoid fitting in the field; make provision for separate scribing pieces to be fitted to adjoining finished surfaces. Provide shop-prepared detachable pieces for forming joints with other units at Project site and with other types of architectural woodwork.

G. Flush Wood Paneling For Transparent Finish
1. Grade: Provide Premium **OR** Custom **OR** Economy, **as directed**.
2. Wood Species and Cut: White oak, rift sliced **OR** Cherry, plain sliced **OR** Butternut, plain sliced **OR** Avodire, quarter sliced, **as directed**.
    a. Lumber Trim and Edges: At paneling fabricator's option, trim and edges indicated as solid wood (except moldings) may be either lumber or veneered construction of same species and cut as panel faces and compatible with grain and color of panel faces.
3. Matching of Adjacent Veneer Leaves: Book **OR** Slip **OR** Random, **as directed** match.
4. Matching within Panel Face: Running **OR** Balance **OR** Center-balance, **as directed**, match.
5. Panel-Matching Method:
    a. No matching is required between panels. Select and arrange panels for similarity of grain pattern and color between adjacent panels.
    OR
    Premanufactured sets used full width **OR** Premanufactured sets selectively reduced in width **OR** Sequence-matched, uniform-size sets **OR** Blueprint-matched panels and components, **as directed**, within each separate area.
6. Vertical Panel-Matching Method: Continuous match; veneer leaves of upper panels are continuations of veneer leaves of lower panels **OR** Vertical book match; veneer leaves are individually book matched from lower panels to upper panels **OR** Vertical slip match; veneer leaves are individually slip matched from lower panels to upper panels **OR** Panel vertical book match; panels are book matched from lower panels to upper panels **OR** Panel vertical slip match; panels are slip matched from lower panels to upper panels, **as directed**.
7. Panel Core Construction: Hardwood veneer-core plywood **OR** Particleboard or medium-density fiberboard **OR** Fire-retardant particleboard or fire-retardant, medium-density fiberboard, **as directed**.
8. Exposed Panel Edges: Solid wood or wood veneer matching faces **OR** Legs of metal channels forming reveals **OR** Bronze flat bars 1/16 inch (1.6 mm) thick by depth of panels, **as directed**.
9. Panel Reveals: Matte black plastic laminate **OR** Bronze sheet **OR** Stainless-steel sheet **OR** Bronze channels, 1 by 1 by 1/8 inch (25.4 by 25.4 by 3.2 mm) thick **OR** Stainless-steel channels, 1 by 1 by 1/16 inch (25.4 by 25.4 by 1.6 mm) thick, **as directed**.
10. Fire-Retardant-Treated Paneling: Provide panels consisting of wood-veneer and fire-retardant particleboard or fire-retardant, medium-density fiberboard. Panels shall have a flame-spread index of 75 **OR** 25, **as directed**, or less and a smoke-developed index of 450 or less per ASTM E 84.
    a. Provide paneling of 3/4-inch (19-mm) minimum thickness.

H. Plastic-Laminate-Clad Flush Paneling
1. Grade: Provide Premium **OR** Custom **OR** Economy, **as directed**.
2. Plastic-Laminate Cladding: High-pressure decorative laminate, in the following grades:
    a. Faces: Grade HGS **OR** VGS **OR** SGF **OR** HGF **OR** VGF, **as directed**.
    b. Backs: Grade BKH **OR** BKV **OR** BKL, **as directed**.
    c. Exposed Edges: Same as faces or Grade VGS.
3. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed surfaces complying with the following requirements:

a. As indicated by manufacturer's designations.
b. Match the Owner's samples.
c. As selected by the Owner from laminate manufacturer's full range in the following categories:
1) Solid colors, gloss **OR** matte, **as directed,** finish.
2) Solid colors with core same color as surface, gloss **OR** matte, **as directed**, finish.
3) Wood grains, gloss **OR** matte, **as directed**, finish.
4) Patterns, gloss **OR** matte, **as directed**, finish.

4. Panel Core Construction: Particleboard or medium-density fiberboard **OR** Fire-retardant particleboard or fire-retardant, medium-density fiberboard, **as directed**.
5. Fire-Retardant-Treated Paneling: Provide panels consisting of fire-retardant plastic laminate and fire-retardant particleboard or fire-retardant, medium-density fiberboard. Panels shall have a flame-spread index of 75 **OR** 25, **as directed**, or less and a smoke-developed index of 450 or less per ASTM E 84.
a. Provide paneling of 3/4-inch (19-mm) minimum thickness.

I. Stile And Rail Wood Paneling For Transparent Finish
1. Grade: Premium **OR** Custom **OR** Economy, **as directed**.
2. Wood Species: White oak, rift sawn/sliced **OR** Figured English ash, quarter sawn/sliced **OR** Butternut, plain sawn/sliced **OR** Figured red gum, plain-sawn/sliced panels, quarter-sawn/sliced stiles and rails, **as directed**.
3. Stiles and Rails: At fabricator's option, stiles and rails may be either lumber or veneered construction with edges banded or with lumber moldings, as indicated, to conceal core and veneer joints.
4. Panels: Flat panels **OR** Raised panels with veneered faces and solid lumber rims **OR** Raised panels with veneered faces extending across rims **OR** Raised panels made from edge-glued solid lumber, **as directed**.
5. Insert Panels:
a. Blueprint matched in a horizontal sequence for adjacent panels and doors, with continuous vertical matching between adjacent panels. Book and balance **OR** Book, balance, and center, **as directed**, match face-veneer leaves within each panel.
OR
Cut panels from premanufactured, sequence-matched sets of book-matched veneered panels. Cut panels with an even **OR** even or odd, **as directed**, number of veneer leaves centered in each panel and with each of the remainders at least half as wide as the full veneer leaves, **as directed**. Cut panels with continuous matching between vertically adjacent panels; veneer leaves of upper panels are continuations of veneer leaves of panels below them.
OR
Book and balance match face veneers within panels. No matching is required between adjacent panels; select and arrange panels for similarity of grain pattern and color between adjacent panels.
6. Shop assemble stile and rail paneling into largest units practical for delivery and installation. Provide shop-prepared detachable joints for necessary field connections. Sand and pull joints tight in shop so field joints will comply with joint tolerances for specified grade. Unless otherwise indicated, provide continuous mortise-and-tenon joints between panel units and provide removable temporary protection for joints during handling and delivery.
a. Outside Corner of Stile and Rail Paneling: Shop prepare using lock-mitered or mitered-and-splined construction. Assemble, sand, and glue in shop, if site conditions permit.

J. Stile And Rail Wood Paneling For Opaque Finish
1. Grade: Premium **OR** Custom **OR** Economy, **as directed**.
2. Wood Species: Any closed-grain hardwood **OR** Eastern white pine, ponderosa pine, sugar pine, or western white pine, **as directed**.

3. Stiles and Rails: Either solid lumber or particleboard, shop filled on face, with veneered or lumber-banded edges, at paneling fabricator's option.
4. Flat Insert Panels: Medium-density fiberboard or particleboard with shop-filled face.
5. Raised Insert Panels: Medium-density overlaid softwood plywood (Exterior) APA MDO EXT, machined to profile indicated and shop filled on exposed machined surfaces **OR** Medium-density fiberboard, machined to profile indicated, **as directed**.
6. Provide fire-retardant treatment of stile and rail paneling as indicated below. For components of paneling fabricated from solid lumber, mill pieces before treatment.
   a. For stiles and rails, use fire-retardant-treated lumber or fire-retardant medium-density fiberboard.
   b. For built-up stiles and rails, use fire-retardant particleboard with fire-retardant lumber edge-bands or fire-retardant medium-density fiberboard.
   c. For insert panels, use fire-retardant medium-density fiberboard.
      OR
      For insert panels, use fire-retardant particleboard with closed-grain hardwood veneer on face and back.
7. Shop assemble stile and rail paneling into largest units practical for delivery and installation. Provide shop-prepared detachable joints for necessary field connections. Sand and pull joints tight in shop so field joints will comply with joint tolerances for specified grade. Unless otherwise indicated, provide continuous mortise-and-tenon joints between panel units and provide removable temporary protection for joints during handling and delivery.
   a. Outside Corner of Stile and Rail Paneling: Shop prepare using lock-mitered or mitered-and-splined construction. Assemble, sand, and glue in shop, if site conditions permit.

K. Shop Finishing
1. Grade: Provide finishes of same grades as paneling to be finished.
2. General:
   a. Finish paneling at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.
      OR
      Shop finish transparent-finished paneling at fabrication shop as specified in this Section. Refer to Division 07 for finishing of opaque-finished paneling.
      OR
      Drawings indicate paneling that is required to be shop finished. Finish such paneling at fabrication shop as specified in this Section. Refer to Division 07 for finishing paneling not indicated to be shop finished.
3. Shop Priming: Shop apply the prime coat including backpriming, if any, for transparent-finished paneling specified to be field finished. Refer to Division 07 for material and application requirements.
4. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing paneling, as applicable to each unit of work.
   a. Backpriming: Apply two coats of sealer or primer, compatible with finish coats, to concealed surfaces of paneling. Concealed surfaces of plastic-laminate-clad paneling do not require backpriming when surfaced with plastic laminate.
5. Transparent Finish:
   a. Grade: Premium **OR** Custom **OR** Economy, **as directed**.
   b. AWI Finish System: TR-0, synthetic penetrating oil **OR** TR-3, cellulose acetate butyrate or water-reducible acrylic lacquer **OR** TR-4, conversion varnish **OR** TR-5, catalyzed vinyl lacquer, **as directed**.
   c. WIC Finish System: 2, water-reducible acrylic lacquer **OR** 3b., catalyzed vinyl lacquer **OR** 4, conversion varnish **OR** 6, penetrating oil, **as directed**.
   d. Staining: None required **OR** Match approved sample for color **OR** Match the Owner's sample, **as directed**.
   e. Wash Coat for Stained Finish: Apply wash-coat sealer to woodwork made from closed-grain wood before staining and finishing.

f. Open Finish for Open-Grain Woods: Do not apply filler to open-grain woods.
g. Filled Finish for Open-Grain Woods: After staining (if any), apply paste wood filler to open-grain woods and wipe off excess. Tint filler to match stained wood.
   1) Apply wash-coat sealer after staining and before filling.
h. Sheen: Flat, 15-30 **OR** Satin, 31-45 **OR** Semigloss, 46-60 **OR** Gloss, 61-100, **as directed**, gloss units measured on 60-degree gloss meter per ASTM D 523.

6. Opaque Finish: Comply with requirements indicated below for grade, finish system, color, effect, and sheen, with sheen measured on 60-degree gloss meter per ASTM D 523.
   a. Grade: Premium **OR** Custom **OR** Economy, **as directed**.
   b. AWI Finish System: OP-4, conversion varnish **OR** OP-5, catalyzed vinyl, **as directed**.
   c. WIC Finish System: 3b., catalyzed vinyl lacquer **OR** 4, conversion varnish **OR** 7a., synthetic enamel, **as directed**.
   d. Color: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
   e. Sheen: Flat, 10-25 **OR** Satin, 30-50 **OR** Semigloss, 55-75 **OR** Gloss, 80-100, **as directed**, gloss units.

1.3 EXECUTION

A. Preparation
1. Before installation, condition paneling to average prevailing humidity conditions in installation areas.
2. Before installing paneling, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

B. Installation
1. Grade: Install paneling to comply with requirements for same grade specified in Part 1.2 for fabrication of type of paneling involved.
2. Install paneling level, plumb, true, and straight with no distortions. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm). Install with no more than 1/16 inch in 96-inch (1.6 mm in 2400-mm) vertical cup or bow and 1/8 inch in 96-inch (3 mm in 2400-mm) horizontal variation from a true plane.
   a. For flush paneling with revealed joints, install with variations in reveal width, alignment of top and bottom edges, and flushness between adjacent panels not exceeding 1/32 inch (0.8 mm) **OR** 1/16 inch (1.5 mm), **as directed**.
3. Scribe and cut paneling to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
4. Anchor paneling to supporting substrate with concealed panel-hanger clips **OR** splined connection strips **OR** blind nailing, **as directed**. Do not use face fastening unless covered by trim **OR** otherwise indicated, **as directed**.
5. Complete finishing work specified in this Section to extent not completed at shop or before installation of paneling. Fill nail holes with matching filler where exposed. Apply specified finish coats, including stains and paste fillers if any, to exposed surfaces where only sealer/prime coats are applied in shop.
6. Refer to Division 07 for final finishing of installed paneling.

C. Adjusting And Cleaning
1. Repair damaged and defective paneling, where possible, to eliminate functional and visual defects; where not possible to repair, replace paneling. Adjust for uniform appearance.
2. Clean paneling on exposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 06 25 16 00

SECTION 06 41 13 00 - INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior standing and running trim.
2. Closet and utility shelving.
3. Interior frames and jambs.
4. Interior stairs and railings.
5. Wood furring, blocking, shims, and hanging strips for installing interior architectural woodwork items that are not concealed within other construction.
6. Shop priming of interior architectural woodwork.
7. Shop finishing of interior architectural woodwork.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing interior architectural woodwork that are concealed within other construction before interior architectural woodwork installation.
2. Section 062023 "Interior Finish Carpentry" for interior carpentry exposed to view that is not specified in this Section.

1.2 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections, to ensure that interior architectural woodwork can be supported and installed as indicated.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**>.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Anchors.
2. Adhesives.
3. Shop finishing materials.
4. Wood-Preservative Treatment:

   a. Include data and warranty information from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
   b. Indicate type of preservative used and net amount of preservative retained.
   c. Include chemical-treatment manufacturer's written instructions for finishing treated material and manufacturer's written warranty.

5. Fire-Retardant Treatment: Include data and warranty information from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
6. Waterborne Treatments: For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

B. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for recycled content.>
2. <Double click to insert sustainable design text for regional materials.>
3. <Double click to insert sustainable design text for certified wood.>
4. <Double click to insert sustainable design text for adhesives.>
5. <Double click to insert sustainable design text for composite wood.>

C. Shop Drawings:

1. Include the following:

   a. Dimensioned plans, elevations, and sections.
   b. Attachment details.

2. Show [**large-scale**] [**full-size**] details.
3. Show locations and sizes of furring, blocking, and hanging strips, including blocking and reinforcement concealed by construction and specified in other Sections.
4. Apply [**AWI Quality Certification**] [**WI Certified Compliance**] Program label to Shop Drawings.

D. Samples: For each exposed product and for each shop-applied color and finish specified.

1. Size:

   a. Panel Products: 12 inches by 12 inches (300 mm by 300 mm).
   b. Lumber Products: Not less than [**5 inches (125 mm) wide by 12 inches (300 mm) long**] [**5 inches (125 mm) wide by 24 inches (600 mm) long**], for each species and cut, finished on one side and one edge.

E. Samples for Initial Selection: For each type of shop-applied exposed finish.

1. Size:

   a. Panel Products: 12 inches by 12 inches (300 mm by 300 mm).
   b. Lumber Products: Not less than [**5 inches (125 mm) wide by 12 inches (300 mm) long**] [**5 inches (125 mm) wide by 24 inches (600 mm) long**], for each species and cut, finished on one side and one edge.

F. Samples for Verification: For the following:

1. Lumber for Transparent Finish: Not less than [**5 inches (125 mm) wide by 12 inches (300 mm) long**] [**5 inches (125 mm) wide by 24 inches (600 mm) long**], for each species and cut, finished on one side and one edge.
2. Veneer Leaves: Representative of and selected from flitches to be used for transparent-finished interior architectural woodwork.
3. Lumber and Panel Products with Shop-Applied Opaque Finish: 5 inches (125 mm) wide by 12 inches (300 mm) long for lumber and [**8 by 10 inches (200 by 250 mm)**] [**12 by 12 inches (300 by 300 mm)**] for panels, for each finish system and color.

a. Finish [**entire**] [**one-half of**] exposed surface.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**architectural woodwork manufacturer**] [**and**] [**Installer**].

B. Product Certificates: For the following:

1. Composite wood products.
2. Adhesives.

C. Evaluation Reports: For [**preservative-treated**] [**and**] [**fire-retardant-treated**] wood materials, from ICC-ES.

D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTLAS

A. Quality Standard Compliance Certificates: [**AWI Quality Certification Program**] [**WI Certified Compliance Program**] certificates.

1.7 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

1. Manufacturer's Certification: Licensed participant in [**AWI's Quality Certification Program**] [**WI's Certified Compliance Program**].
2. Installer Qualifications: [**Manufacturer of products**] [**and**] [**Licensed participant in AWI's Quality Certification Program**] [**Licensed participant in WI's Certified Compliance Program**].

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups of [**typical interior architectural woodwork as shown on Drawings**] <**Insert description**>.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with the Architectural Woodwork Standards, Section 2.

B. Do not deliver interior architectural woodwork until painting and similar finish operations that might damage woodwork have been completed in installation areas.

C. Store woodwork in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1. Handle and store fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions.

1.9 FIELD CONDITIONS

A. Environmental Limitations without Humidity Control: Do not deliver or install interior architectural woodwork until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels designed for building occupants for the remainder of the construction period.

B. Environmental Limitations with Humidity Control: Do not deliver or install interior architectural woodwork until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F (16 and 32 deg C) and relative humidity between [**25 and 55**] [**43 and 70**] [**20 and 50**] <**Insert number**> percent during the remainder of the construction period.

C. Field Measurements: Where interior architectural woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings.

1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being concealed by construction, and indicate measurements on Shop Drawings.

D. Established Dimensions: Where interior architectural woodwork is indicated to fit to other construction, establish dimensions for areas where woodwork is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Frames: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated on Drawings, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.

1. Smoke- and Draft-Control Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.

B. Fire-Rated, Borrowed-Lite Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing in accordance with NFPA 257 or UL 9.

2.2 ARCHITECTURAL WOODWORK MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**] [**provide products by one of the following**] [**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. <**Insert, in separate subparagraphs, names of preapproved architectural woodworking firms**>.

2.3 ARCHITECTURAL WOODWORK, GENERAL

A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.

1. Provide [**labels**] [**and**] [**certificates**] from [**AWI**] [**WI**] certification program indicating that woodwork[**and installation**] complies with requirements of grades specified.

a. This project has been registered with AWI as AWI Quality Certification Program Number <**Insert number**>.

2. The Contract Documents contain requirements that are more stringent than the Architectural Woodwork Standards. Comply with Contract Documents and Architectural Woodwork Standards.

B. <Double click to insert sustainable design text for regional wood materials.>

C. <Double click to insert sustainable design text for certified wood.>

2.4 INTERIOR STANDING AND RUNNING TRIM FOR TRANSPARENT FINISH

A. Architectural Woodwork Standards Grade: [**Premium**] [**Custom**] [**Economy**].

B. Hardwood Lumber:

1. Wood Species and Cut:[**Match species and cut indicated for other types of transparent-finished architectural woodwork located in same area of building unless otherwise indicated.**]
2. Species: [**Red oak**] [**White oak**] [**White ash**] [**Hickory**] <**Insert species**>.
3. Cut: [**Plain sliced/plain sawn**] [**Rift cut/rift sawn**] [**Quarter cut/quarter sawn**].
4. Wood Moisture Content: [**5 to 10**] [**8 to 13**] [**4 to 9**] percent.
5. Provide split species on trim that faces areas with different wood species, matching each face of woodwork to species and cut of finish wood surfaces in areas finished.
6. For trim items[**other than base**] wider than available lumber, use veneered construction. Do not glue for width.

a. For veneered base, use hardwood lumber core, glued for width.

7. For base wider than available lumber, glue for width. Do not use veneered construction.
8. For rails thicker than available lumber, use veneered construction. Do not glue for thickness.

C. Softwood Lumber:

1. Wood Species and Cut:[**Match species and cut indicated for other types of transparent-finished architectural woodwork located in same area of building unless otherwise indicated.**]
2. Species: [**Eastern white pine**] [**Sugar pine**] [**Western white pine**] [**Douglas fir**] <**Insert species**>.
3. Cut: [**Plain sawn**] <**Insert cut**>.
4. Wood Moisture Content: [**5 to 10**] [**8 to 13**] [**4 to 9**] percent.

5. Provide split species on trim that faces areas with different wood species, matching each face of woodwork to species and cut of finish wood surfaces in areas finished.
6. For trim items[**other than base**] wider than available lumber, use veneered construction. Do not glue for width.

    a. For veneered base, use softwood lumber core, glued for width.

7. For base wider than available lumber, glue for width. Do not use veneered construction.
8. For rails thicker than available lumber, use veneered construction. Do not glue for thickness.
9. Do not use plain-sawn softwood lumber with exposed, flat surfaces more than 3 inches (76 mm) wide.

2.5 INTERIOR STANDING AND RUNNING TRIM FOR OPAQUE FINISH

A. Architectural Woodwork Standards Grade: [**Premium**] [**Custom**] [**Economy**].

1. Wood Species: [**Any closed-grain hardwood**] [**Eastern white pine, sugar pine, or western white pine**] <**Insert species**>.
2. Wood Moisture Content: [**5 to 10**] [**8 to 13**] [**4 to 9**] percent.

2.6 CLOSET AND UTILITY SHELVING

A. Architectural Woodwork Standards Grade: [**Premium**] [**Custom**] [**Economy**].

B. Shelf Material: 3/4-inch (19-mm) [**solid lumber**] [**veneer-faced panel product with solid-lumber edge**] [**veneer-faced panel product with veneer edge banding**] [**thermoset decorative panel with solid-lumber edge**] [**thermoset decorative panel with PVC T-mold edge**] [**MDF with solid-lumber edge**] [**particleboard with solid-lumber edge**] [**MDF with radiused edge**] [**particleboard with radiused and filled edge**].

C. Cleats: 3/4-inch (19-mm) [**solid lumber**] [**thermoset decorative panel**] [**panel product**].

D. Wood Species: [**Red oak**] [**Match species indicated for other types of transparent-finished architectural woodwork located in same area of building unless otherwise indicated**] [**Match species indicated for door to closet where shelving is located**] [**Any closed-grain hardwood**] [**Eastern white pine, sugar pine, or western white pine**] <**Insert species**>.

E. Wood Closet Rods: 1-1/2-inch- (38-mm-) diameter, [**red oak**] [**hardwood**] [**Douglas fir or southern pine**] <**Insert species**>.

F. Metal Closet Rods: 1-5/16-inch- (33-mm-) diameter, [**aluminum**] [**chrome-plated-steel**] [**color-coated-steel**] [**stainless steel**] tubes complying with BHMA A156.16, L03131.

G. Wood Rod Flanges: Clear, kiln-dried, [**red oak**] [**hardwood**] [**Douglas fir or southern pine**] [**eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine**] <**Insert species**> turnings.

H. Metal Rod Flanges: [**Aluminum**] [**Chrome-plated steel**] [**Stainless steel**].

I. Wood Finish: [**Transparent**] [**Opaque**] [**As indicated on Drawings or in schedules**] <**Insert requirements**>.

2.7 INTERIOR FRAMES AND JAMBS FOR TRANSPARENT FINISH

A. Architectural Woodwork Standards Grade: [**Premium**] [**Custom**] [**Economy**].

B. Wood Species and Cut:[**Match species and cut indicated for other types of transparent-finished architectural woodwork located in same area of building unless otherwise indicated.**]

1. Species: [**Red oak**] [**White oak**] [**White ash**] [**Hickory**] <**Insert species**>.
2. Cut: [**Plain sliced/plain sawn**] [**Rift cut/rift sawn**] [**Quarter cut/quarter sawn**].
3. Wood Moisture Content: [**5 to 10**] [**8 to 13**] [**4 to 9**] percent.
4. Provide split species on frames and jambs that face areas with different wood species, matching each face of woodwork to species and cut of finish wood surfaces in areas finished.

C. For frames or jambs wider than available lumber, use veneered construction. Do not glue for width.

1. Do not use plain-sawn softwood lumber with exposed, flat surfaces more than 3 inches (76 mm) wide.

D. Fire-Rated Interior Frames and Jambs: Products fabricated from fire-retardant particleboard or fire-retardant MDF with veneered exposed surfaces and listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing in accordance with NFPA 252.

1. Fire Rating: 20 minutes.

2.8 INTERIOR FRAMES AND JAMBS FOR OPAQUE FINISH

A. Architectural Woodwork Standards Grade: [**Premium**] [**Custom**] [**Economy**].

B. Wood Species: [**Any closed-grain hardwood**] [**Eastern white pine, sugar pine, or western white pine**] <**Insert species**>.

1. Do not use plain-sawn softwood lumber with exposed, flat surfaces more than 3 inches (76 mm) wide.
2. Wood Moisture Content: [**5 to 10**] [**8 to 13**] [**4 to 9**] percent.

C. Fire-Rated Interior Frames and Jambs: Products fabricated from fire-retardant particleboard with veneered exposed surfaces or fire-retardant MDF and listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing in accordance with NFPA 252.

1. Fire Rating: 20 minutes.

2.9 INTERIOR WOOD STAIRS AND RAILINGS

A. Architectural Woodwork Standards Grade: [**Premium**] [**Custom**] [**Economy**].

B. Wood for Transparent Finish:

1. Species and cut:

   a. Stringers: [**Red oak, plain sawn**] [**Red oak, quarter sawn**] [**Hard maple, plain sawn**] <**Insert species and cut**>.

b. Risers: [**Red oak, plain sawn**] [**Red oak, quarter sawn**] [**Hard maple, plain sawn**] <**Insert species and cut**>.
c. Treads: [**Red oak, plain sawn**] [**Red oak, quarter sawn**] [**Hard maple, plain sawn**] <**Insert species and cut**>.
d. Railings: [**Red oak, plain sawn**] [**Red oak, quarter sawn**] [**Hard maple, plain sawn**] <**Insert species and cut**>.
e. Balusters: [**Red oak, plain sawn**] [**Red oak, quarter sawn**] [**Hard maple, plain sawn**] <**Insert species and cut**>.
f. Newels: [**Red oak, plain sawn**] [**Red oak, quarter sawn**] [**Hard maple, plain sawn**] <**Insert species and cut**>.
g. Moldings: [**Red oak, plain sawn**] [**Red oak, quarter sawn**] [**Hard maple, plain sawn**] <**Insert species and cut**>.

2. Wood Moisture Content: [**5 to 10**] [**8 to 13**] [**4 to 9**] percent.

C. Wood for Opaque Finish:

1. Species: [**Any closed-grain hardwood**] [**Eastern white pine, sugar pine, or western white pine**] [**Any closed-grain hardwood, except that eastern white pine, sugar pine, or western white pine may be used for risers, stringers, and moldings**] <**Insert species**>.
2. Wood Moisture Content: [**5 to 10**] [**8 to 13**] [**4 to 9**] percent.

D. Rough Carriage Stairs:

1. Laminated veneer lumber, made with an exterior-type adhesive complying with ASTM D2559, and with the following allowable design values as determined in accordance with ASTM D5456:

a. Extreme Fiber Stress in Bending, Edgewise: [**3100 psi (21.3 MPa)**] [**2900 psi (20.0 MPa)**] [**2600 psi (17.9 MPa)**] [**2250 psi (15.5 MPa)**] <**Insert value**> for 12-inch nominal- (286-mm actual-) depth members.
b. Modulus of Elasticity, Edgewise: [**2,000,000 psi (13 800 MPa)**] [**1,800,000 psi (12 400 MPa)**] [**1,500,000 psi (10 300 MPa)**] <**Insert value**>.

2. [**Select Structural**] [**No. 1**] [**No. 2**] grade, kiln-dried to 15 percent maximum moisture content:

a. Acceptable Species:

1) Hem-fir (north).
2) Southern pine.
3) Douglas fir-larch.
4) Douglas fir-larch (north).
5) Spruce-pine-fir.
6) Hem-fir.
7) Douglas fir-south.
8) Spruce-pine-fir (south).

E. Finishes for Stair Parts:

1. Treads: [**Transparent**] [**Opaque**].
2. Risers: [**Transparent**] [**Opaque**].
3. Stringers: [**Transparent**] [**Opaque**].
4. Balusters: [**Transparent**] [**Opaque**].
5. Handrails: [**Transparent**] [**Opaque**].
6. Scotia, Cove, and Other Moldings: [**Transparent**] [**Opaque**].

F. Handrail Brackets: [**Cast nickel-silver**] [**Cast aluminum**] [**Cast bronze**] [**Cast stainless steel**] with wall flange drilled [**for exposed anchor**] [**and tapped for concealed hanger bolt**] and with support arm for screwing to underside of rail. Size to provide 1-1/2-inch (38-mm) clearance between handrail and face of wall.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

G. Handrail/Bumper Rail Brackets: Pairs of extruded-aluminum channels: one for fastening to back of rail and one for fastening to face of wall, assembled in overlapping fashion and fastened together at top and bottom with self-tapping screws. Size to provide 1-1/2-inch (38-mm) clearance between handrail and wall.

2.10 HARDWOOD SHEET MATERIALS

A. Composite Wood Products: Provide materials that comply with requirements of the Architectural Woodwork Standards for each type of interior architectural woodwork and quality grade specified unless otherwise indicated.

1. <Double click to insert sustainable design text for recycled content.>
2. <Double click to insert sustainable design text for composite wood products.>
3. Medium-Density Fiberboard (MDF): ANSI A208.2, [**Grade 130**] <**Insert grade**>.
4. Particleboard: ANSI A208.1, [**Grade M-2**] [**Grade M-2-Exterior Glue**].
5. Softwood Plywood: DOC PS 1[**, medium-density overlay**].
6. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1.

2.11 PRESERVATIVE-TREATED-WOOD MATERIALS

A. Preservative-Treated-Wood Materials: Provide with water-repellent preservative treatment complying with AWPA N1 (dip, spray, flood, or vacuum-pressure treatment).

1. Preservative Chemicals: 3-iodo-2-propynyl butyl carbamate (IPBC)[**, combined with a compatible EPA-registered insecticide**].
2. Use chemical formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants in solution to distinguish treated material from untreated material.

B. Extent of Preservative-Treated Wood Materials: Treat [**interior architectural woodwork in contact with concrete or masonry**] <**Insert requirements**>.

1. Items fabricated from the following wood species need not be treated:

a. [**Redwood**] [**All-heart redwood**].
b. [**Western red cedar**] [**All-heart western red cedar**].
c. White oak.
d. African mahogany.
e. Honduras mahogany.
f. Ipe.
g. Dark red meranti.
h. Teak.

2.12 FIRE-RETARDANT-TREATED WOOD MATERIALS

A. Fire-Retardant-Treated Wood Materials: Where fire-retardant-treated materials are indicated, use materials complying with requirements that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products in accordance with test method indicated by a qualified testing agency.

1. Use treated materials that comply with requirements of the Architectural Woodwork Standards. Do not use materials that are warped, discolored, or otherwise defective.
2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.

B. Fire-Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested in accordance with ASTM E84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.

1. Kiln-dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.
2. For items indicated to receive a stained, transparent, or natural finish, use organic resin chemical formulation.
3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking shop certified by testing and inspecting agency.
4. Mill lumber before treatment, and implement procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.

C. Fire-Retardant Particleboard: Made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture, to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less in accordance with ASTM E84.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. For panels 3/4 inch (19 mm) thick and less, comply with ANSI A208.1 for Grade M-2, except for the following minimum properties: modulus of rupture, 1600 psi (11 MPa); modulus of elasticity, 300,000 psi (2070 MPa); internal bond, 80 psi (550 kPa); and screw-holding capacity on face and edge, 250 and 225 lbf (1100 and 1000 N), respectively.
3. For panels 13/16 to 1-1/4 inches (20 to 32 mm) thick, comply with ANSI A208.1 for Grade M-1, except for the following minimum properties: modulus of rupture, 1300 psi (9 MPa); modulus of elasticity, 250,000 psi (1720 MPa); linear expansion, 0.50 percent; and screw-holding capacity on face and edge, 250 and 175 lbf (1100 and 780 N), respectively.

D. Fire-Retardant Fiberboard: Medium-density fiberboard (MDF) panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture, to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less in accordance with ASTM E84.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.13 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Nailers: [**Softwood or hardwood lumber**] [**Fire-retardant-treated softwood lumber**], kiln-dried to less than 15 percent moisture content.

1. Preservative Treatment: Provide softwood lumber treated by pressure process, AWPA U1; Use Category UC3b.

a. Provide [**where indicated**] [**where in contact with concrete or masonry**] <**Insert requirements**>.
b. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent.
c. Preservative Chemicals: Acceptable to authorities having jurisdiction[**and containing no arsenic or chromium**].
d. Mark lumber with treatment quality mark of an inspection agency approved by the American Lumber Standards Committee's (ALSC) Board of Review.

2. Fire-Retardant Treatment: Complying with requirements; provide [**where indicated**] <**Insert requirements**>.

B. Provide self-drilling screws for metal-framing supports, as recommended by metal-framing manufacturer.

C. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage.

1. Provide metal expansion sleeves or expansion bolts for post-installed anchors.
2. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

D. <u><Double click to insert sustainable design text for adhesives.></u>

E. Installation Adhesive: Product recommended by fabricator for each substrate for secure anchorage.

1. <u><Double click to insert sustainable design text for VOC content of adhesive.></u>
2. <u><Double click to insert sustainable design text for adhesives.></u>

2.14 FABRICATION

A. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.

B. Fabricate interior architectural woodwork to dimensions, profiles, and details indicated.

1. Ease edges to radius indicated for the following:

a. Edges of Solid-Wood (Lumber) Members: 1/16 inch (1.5 mm) unless otherwise indicated.
b. Edges of Rails and Similar Members More Than 3/4 Inch (19 mm) Thick: 1/8 inch (3 mm).

C. Complete fabrication, including assembly, to maximum extent possible before shipment to Project site.

1. Disassemble components only as necessary for shipment and installation.
2. Where necessary for fitting at site, provide allowance for scribing, trimming, and fitting.
3. Notify Architect seven days in advance of the dates and times interior architectural woodwork fabrication will be complete.
4. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled.

a. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting.
b. Verify that parts fit as intended, and check measurements of assemblies against field measurements indicated on approved Shop Drawings before disassembling for shipment.

D. Stairs: Cut rough carriages to accurately fit treads and risers.

1. Glue treads to risers, and glue and nail treads and risers to carriages.

2. House [**wall**] [**and**] [**face**] stringers, and glue and wedge treads and risers.
3. Fabricate stairs with treads and risers no more than 1/8 inch (3 mm) from indicated position and no more than 1/16 inch (1.5 mm) out of relative position for adjacent treads and risers.

2.15 SHOP PRIMING

A. Preparations for Finishing: Comply with the Architectural Woodwork Standards for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing interior architectural woodwork, as applicable to each unit of work.

B. Interior Architectural Woodwork for Opaque Finish: Shop prime with one coat of wood primer as specified in Section 099123 "Interior Painting."

1. Backpriming: Apply one coat of primer, compatible with finish coats, to concealed surfaces of woodwork.[**Apply two coats to surfaces installed in contact with concrete or masonry and to end-grain surfaces.**]

C. Interior Architectural Woodwork for Transparent Finish: Shop-seal concealed surfaces with required pretreatments and first coat of finish as specified in Section 099300 "Staining and Transparent Finishing."

1. Backpriming: Apply one coat of sealer, compatible with finish coats, to concealed surfaces of woodwork.[**Apply two coats to surfaces installed in contact with concrete or masonry and to end-grain surfaces.**]

2.16 SHOP FINISHING

A. Finish interior architectural woodwork [**with transparent finish**] [**indicated on Drawings**] at fabrication shop. Defer only final touchup, cleaning, and polishing until after installation.

B. Preparation for Finishing: Comply with Architectural Woodwork Standards, Section 5 for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing interior architectural woodwork, as applicable to each unit of work.

1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of interior architectural woodwork. Apply two coats to end-grain surfaces.

C. Transparent Finish:

1. Architectural Woodwork Standards Grade: [**Premium**] [**Custom**] [**Economy**] [**Same as item to be finished**].
2. Finish System - 1: Lacquer, Nitrocellulose.
3. Finish System - 2: Lacquer, Pre Catalyzed.
4. Finish System - 3: Lacquer, Post Catalyzed.
5. Finish System - 4: Latex Acrylic, Water Based.
6. Finish System - 5: Varnish, Conversion.
7. Finish: System - 6: Oil, Synthetic Penetrating.
8. Finish System - 7: Vinyl, Catalyzed.
9. Finish System - 8: Acrylic Cross Linking, Water Based.
10. Finish System - 9: UV Curable, Acrylated Epoxy, Polyester, or Urethane.
11. Finish System - 10: UV Curable, Water Based.
12. Finish System - 11: Polyurethane, Catalyzed.
13. Finish System - 12: Polyurethane, Water Based.

14. Finish System - 13: Polyester, Catalyzed.
15. Wash Coat for Closed-Grain Woods: Apply wash-coat sealer to woodwork made from closed-grain wood before staining and finishing.
16. Staining: [**None required**] [**Match approved sample for color**] [**Match Architect's sample**].
17. Open Finish for Open-Grain Woods: Do not apply filler to open-grain woods.
18. Filled Finish for Open-Grain Woods:[**After staining, apply wash-coat sealer and allow to dry.**] Apply paste wood filler and wipe off excess. Tint filler to match stained wood.
19. Sheen: [**Flat, 8-14**] [**Satin, 15-25**] [**Satin Gloss, 26-49**] [**Semigloss, 50-70**] [**Gloss, 71-90**] gloss units measured on 60-degree gloss meter in accordance with ASTM D523.

D. Opaque Finish:

1. Architectural Woodworking Standards Grade: [**Premium**] [**Custom**] [**Economy**] [**Same as item to be finished**].
2. Finish System - 1: Lacquer, Nitrocellulose.
3. Finish System - 2: Lacquer, Pre Catalyzed.
4. Finish System - 3: Lacquer, Post Catalyzed.
5. Finish System - 4: Latex Acrylic, Water Based.
6. Finish System - 5: Varnish, Conversion.
7. Finish System - 7: Vinyl, Catalyzed.
8. Finish System - 8: Acrylic Cross Linking, Water Based.
9. Finish System - 9: UV Curable, Acrylated Epoxy, Polyester, or Urethane.
10. Finish System - 10: UV Curable, Water Based.
11. Finish System - 11: Polyurethane, Catalyzed.
12. Finish System - 12: Polyurethane, Water Based.
13. Finish System - 13: Polyester, Catalyzed.
14. Color: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**].
15. Sheen: [**Flat, 8-14**] [**Satin, 15-25**] [**Satin Gloss, 26-49**] [**Semigloss, 50-70**] [**Gloss, 71-90**] gloss units measured on 60-degree gloss meter in accordance with ASTM D523.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before installation, condition interior architectural woodwork to humidity conditions in installation areas for not less than 72 hours prior to beginning of installation.

B. Before installing interior architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming of concealed surfaces.

3.2 INSTALLATION

A. Grade: Install interior architectural woodwork to comply with same grade as item to be installed.

B. Assemble interior architectural woodwork and complete fabrication at Project site to the extent that it was not completed during shop fabrication.

C. Install interior architectural woodwork level, plumb, true in line, and without distortion.

1. Shim as required with concealed shims.
2. Install level and plumb to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm).

D. Scribe and cut interior architectural woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

E. Preservative-Treated Wood: Where cut or drilled in field, treat cut ends and drilled holes in accordance with AWPA M4.

F. Fire-Retardant-Treated Wood: Install fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions, including those for adhesives used to install woodwork.

G. Anchor interior architectural woodwork to anchors or blocking built in or directly attached to substrates.

1. Secure with countersunk, concealed fasteners and blind nailing.
2. Use fine finishing nails[**or finishing screws**] for exposed fastening, countersunk and filled flush with interior architectural woodwork.
3. For shop-finished items, use filler matching finish of items being installed.

H. Standing and Running Trim:

1. Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible.
2. Do not use pieces less than [**36 inches (900 mm)**] [**60 inches (1500 mm)**] [**96 inches (2400 mm)**] long, except where shorter single-length pieces are necessary.
3. Scarf running joints and stagger in adjacent and related members.
4. Fill gaps, if any, between top of base and wall with [**plastic wood filler; sand smooth; and finish same as wood base if finished**] [**latex sealant, painted to match wall**].
5. Install standing and running trim with no more variation from a straight line than 1/8 inch in 96 inches (3 mm in 2400 mm).

I. Stairs: Securely anchor carriages to supporting substrates.

1. Install stairs with treads and risers no more than 1/8 inch (3 mm) from indicated position.
2. Secure with countersunk, concealed fasteners and blind nailing.
3. Use fine finishing nails[**or finishing screws**] for exposed fastening, countersunk and filled flush with wood surface.

J. Railings:

1. Install rails with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) variation from a straight line.
2. Stair Rails: Glue and dowel or pin balusters to treads and railings, and railings to newel posts.

   a. Secure with countersunk, concealed fasteners and blind nailing.
   b. Use fine finishing nails[**or finishing screws**] for exposed fastening, countersunk and filled flush with wood surface.

3. Wall Rails: Support rails on wall brackets securely fastened to wall framing.

   a. Space rail brackets not more than <**Insert dimension**> o.c.

3.3 FIELD QUALITY CONTROL

A. Inspections: Provide inspection of installed Work through [**AWI's Quality Certification Program**] [**WI's Certified Compliance Program**] certifying that woodwork, including installation, complies with requirements of the Architectural Woodwork Standards for the specified grade.

1. Inspection entity is to prepare and submit report of inspection.

3.4 REPAIR

A. Repair damaged and defective interior architectural woodwork, where possible, to eliminate functional and visual defects[**and to result in interior architectural woodwork being in compliance with requirements of Architectural Woodwork Standards for the specified grade**].

B. Where not possible to repair, replace defective woodwork.

C. Shop Finish: Touch up finishing work specified in this Section after installation of interior architectural woodwork.

1. Fill nail holes with matching filler where exposed.
2. Apply specified finish coats, including stains and paste fillers if any, to exposed surfaces where only sealer/prime coats are shop applied.

D. Field Finish: See [**Section 099123 "Interior Painting"**] [**and**] [**Section 099300 "Staining and Transparent Finishing"**] for final finishing of installed interior architectural woodwork not indicated to be shop finished.

3.5 CLEANING

A. Clean interior architectural woodwork on exposed and semiexposed surfaces.

END OF SECTION 06 41 13 00

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SECTION 06 41 13 00a - WOOD-VENEER-FACED ARCHITECTURAL CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wood cabinets for transparent finish.
2. Wood cabinets for opaque finish.
3. Wood materials.
4. Fire-retardant-treated material.
5. Cabinet hardware and accessories.
6. Miscellaneous materials.
7. Shop finishing.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing cabinets that are concealed within other construction before cabinet installation.

1.2 ALLOWANCES

A. Wood Veneer Allowance: Wood veneer for architectural cabinets is part of [**Wood Veneer Allowance**] <**Insert name of allowance**>. Allowance includes the cost of veneer that is wasted due to selection, cutting, and trimming.

1.3 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to support loads imposed by installed and fully loaded cabinets.

B. Hardware Coordination: Distribute copies of approved hardware schedule specified in [**Section 087100 "Door Hardware"**] [**Section 087111 "Door Hardware (Descriptive Specification)"**] to manufacturer of architectural cabinets; coordinate Shop Drawings and fabrication with hardware requirements.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**>.

1.5 ACTION SUBMITTALS

A. Product Data:

1. Wood cabinets for transparent finish.
2. Wood cabinets for opaque finish.
3. Wood materials.
4. Fire-retardant-treated material.

5. Cabinet hardware and accessories.
6. Miscellaneous materials.
7. Shop finishing.

B. Product Data Submittals: For each product.

1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.

C. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for recycled content.>
2. <Double click to insert sustainable design text for regional materials.>
3. <Double click to insert sustainable design text for certified wood.>
4. <Double click to insert sustainable design text for adhesives.>
5. <Double click to insert sustainable design text for composite wood.>

D. Shop Drawings: For architectural cabinets.

1. Include plans, elevations, sections, and attachment details.
2. Show [**large-scale**] [**full-size**] details.
3. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
4. Show locations and sizes of cutouts and holes for items installed in architectural cabinets.
5. Show veneer leaves with dimensions, grain direction, exposed face, and identification numbers indicating the flitch and sequence within the flitch for each leaf.
6. Apply [**AWI Quality Certification**] [**WI Certified Compliance**] Program label to Shop Drawings.

E. Samples: For each exposed product and for each color and finish specified, in manufacturer's standard size.

F. Samples for Initial Selection: For each type of exposed finish.

G. Samples for Verification: For the following:

1. Lumber for Transparent Finish: Not less than [**5 inches (125 mm) wide by 12 inches (300 mm) long**] [**5 inches (125 mm) wide by 24 inches (600 mm) long**], for each species and cut, finished on one side and one edge.
2. Veneer Leaves: Representative of and selected from flitches to be used for transparent-finished cabinets.
3. Lumber and Panel Products with Shop-Applied Opaque Finish: 5 inches (125 mm) wide by 12 inches (300 mm) long for lumber and [**8 by 10 inches (200 by 250 mm)**] [**12 by 12 inches (300 by 300 mm)**] for panels, for each finish system and color.

   a. Finish [**entire**] [**one-half of**] exposed surface.

4. Thermally Fused Laminate (TFL) Panels: [**8 by 10 inches (200 by 250 mm)**] [**12 by 12 inches (300 by 300 mm)**], for each color, pattern, and surface finish.

   a. Provide edge banding on one edge.

5. Corner Pieces:

   a. Cabinet-front frame joints between stiles and rails and at exposed end pieces, 18 inches (450 mm) high by 18 inches (450 mm) wide by 6 inches (150 mm) deep.

b. Miter joints for standing trim.

6. Exposed Cabinet Hardware and Accessories: One full-size unit for each type and finish.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**manufacturer**] [**and**] [**Installer**].

B. Product Certificates: For [**each type of product.**] [**the following:**]

1. Composite wood products.
2. Thermally fused laminate panels.
3. Glass.
4. Adhesives.

C. Evaluation Reports: For fire-retardant-treated materials, from ICC-ES.

D. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Quality Standard Compliance Certificates: [**AWI Quality Certification Program**] [**WI Certified Compliance Program**] certificates.

1.8 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

1. Manufacturer's Certification: Licensed participant in [**AWI's Quality Certification Program**] [**WI's Certified Compliance Program**].

B. Installer Qualifications: [**Manufacturer of products**] [**Licensed participant in AWI's Quality Certification Program**] [**Licensed participant in WI's Certified Compliance Program**].

C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups of [**typical architectural cabinets as shown on Drawings**] <**Insert description**>.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver cabinets until painting and similar finish operations that might damage architectural cabinets have been completed in installation areas. Store cabinets in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.10 FIELD CONDITIONS

A. Environmental Limitations without Humidity Control: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

B. Environmental Limitations with Humidity Control: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F (16 and 32 deg C) and relative humidity between [**25 and 55**] [**43 and 70**] [**20 and 50**] <**Insert numbers**> percent during the remainder of the construction period.

C. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed/concealed by construction, and indicate measurements on Shop Drawings.

D. Established Dimensions: Where cabinets are indicated to fit to other construction, establish dimensions for areas where cabinets are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 ARCHITECTURAL CABINETS

A. Source Limitations: Engage a qualified woodworking firm to assume responsibility for production of architectural cabinets with sequence-matched wood veneers [**wood paneling**] [**wood doors with face veneers that are sequence matched with architectural cabinets**] [**and**] [**transparent-finished wood doors that are required to be of same species as architectural cabinets**].

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**] [**provide products by one of the following**] [**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. <**Insert, in separate subparagraphs, names of preapproved woodworking firms**>.

2.2 CABINETS, GENERAL

A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of architectural cabinets indicated for construction, finishes, installation, and other requirements.

1. Provide [**labels**] [**and**] [**certificates**] from [**AWI**] [**WI**] certification program indicating that woodwork[**and installation**] complies with requirements of grades specified.

a. This Project has been registered with AWI as AWI Quality Certification Program Number <**Insert number**>.

2. The Contract Documents contain requirements that are more stringent than the referenced woodwork quality standard. Comply with requirements of Contract Documents in addition to those of the referenced quality standard.

2.3 WOOD CABINETS FOR TRANSPARENT FINISH

A. Architectural Woodwork Standards Grade: [**Premium**] [**Custom**] [**Economy**].

B. <Double click to insert sustainable design text for regional wood materials.>

C. <Double click to insert sustainable design text for certified wood.>

D. Type of Construction: [**Frameless**] [**Face frame**].

E. Door and Drawer-Front Style: [**Flush overlay**] [**Reveal overlay**] [**Lipped**] [**Flush inset**].

1. Reveal Dimension: [**1/2 inch (13 mm)**] [**As indicated on Drawings**] <**Insert dimension**>.

F. Wood for Exposed Surfaces:[**As indicated on Drawings.**]

1. Species: [**Red oak**] [**White oak**] [**White ash**] [**White birch**] <**Insert species**>.
2. Blueprint Matching: Comply with veneer and other matching requirements indicated for blueprint-matched paneling.
3. Cut: [**Plain sliced/plain sawn**] [**Rift cut/rift sawn**] [**Quarter cut/quarter sawn**].
4. Grain Direction: [**Vertically for drawer fronts, doors, and fixed panels**] [**Horizontally for drawer fronts, doors, and fixed panels**] [**Vertically for doors and fixed panels, horizontally for drawer fronts**] [**As indicated on Drawings**].
5. Matching of Veneer Leaves: [**Book**] [**Slip**] [**Random**] match.
6. Veneer Matching within Panel Face: [**Running**] [**Balance**] [**Center-balance**] match.
7. Veneer Matching within Room: Provide cabinet veneers in each room or other space from a single flitch with doors, drawer fronts, and other surfaces matched in a sequenced set with continuous match where veneers are interrupted perpendicular to the grain.

G. Semiexposed Surfaces:

1. Surfaces Other Than Drawer Bodies: [**Same species and cut indicated for exposed surfaces**] [**Thermally fused laminate panels**] [**Compatible species to that indicated for exposed surfaces, stained to match**] <**Insert requirements**>.

a. Edges of Thermally Fused Laminate Panel Shelves: PVC or polyester edge banding.

2. Drawer Subfronts, Backs, and Sides: [**Solid-hardwood lumber, same species indicated for exposed surfaces**] [**Solid-hardwood lumber, stained to match species indicated for exposed surfaces**] [**Solid-hardwood lumber**] [**Thermally fused laminate panels with PVC or polyester edge banding**] <**Insert requirements**>.
3. Drawer Bottoms: [**Hardwood plywood**] [**Thermally fused laminate panels**] <**Insert requirements**>.

H. Dust Panels: 1/4-inch (6.4-mm) plywood or tempered hardboard above compartments and drawers unless located directly under tops.

I. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.

1. Join subfronts, backs, and sides with [**glued rabbeted joints supplemented by mechanical fasteners**] [**or**] [**glued dovetail joints**].

2.4 WOOD CABINETS FOR OPAQUE FINISH

A. Architectural Woodwork Standards Grade: [**Premium**] [**Custom**] [**Economy**].

B. <Double click to insert sustainable design text for regional wood materials.>

C. <Double click to insert sustainable design text for certified wood.>

D. Type of Construction: [**Frameless**] [**Face frame**].

E. Door and Drawer-Front Style: [**Flush overlay**] [**Reveal overlay**] [**Lipped**] [**Flush inset**].

1. Reveal Dimension: [**1/2 inch (13 mm)**] [**As indicated on Drawings**] <**Insert dimension**>.

F. Species for Exposed Lumber Surfaces: Any closed-grain hardwood.

G. Panel Product for Exposed Surfaces: [**MDF**] [**Medium-density overlay**].

H. Semiexposed Surfaces:

1. Surfaces Other Than Drawer Bodies: [**Match materials indicated for exposed surfaces**] [**Thermally fused laminate panels**] <**Insert requirements**>.

a. Edges of Thermally Fused Laminate Panel Shelves: PVC or polyester edge banding.

2. Drawer Sides and Backs: [**Solid-hardwood lumber**] [**Thermally fused laminate panels with PVC or polyester edge banding**] <**Insert requirements**>.
3. Drawer Bottoms: [**Hardwood plywood**] [**Thermally fused laminate panels**] <**Insert requirements**>.

I. Dust Panels: 1/4-inch (6.4-mm) plywood or tempered hardboard above compartments and drawers unless located directly under tops.

J. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.

1. Join subfronts, backs, and sides with [**glued rabbeted joints supplemented by mechanical fasteners**] [**or**] [**glued dovetail joints**].

2.5 WOOD MATERIALS

A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.

1. Do not use plain-sawn softwood lumber with exposed, flat surfaces more than 3 inches (75 mm) wide.
2. Wood Moisture Content: [**5 to 10**] [**8 to 13**] [**4 to 9**] percent.

B. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.

1. <Double click to insert sustainable design text for recycled content.>
2. <Double click to insert sustainable design text for composite wood products.>
3. Medium-Density Fiberboard (MDF): ANSI A208.2, [**Grade 130**] <**Insert grade**>.
4. Particleboard (Medium Density): ANSI A208.1, [**Grade M-2**] [**Grade M-2-Exterior Glue**].
5. Softwood Plywood: DOC PS 1[**, medium-density overlay**].
6. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1.
7. Thermally Fused Laminate (TFL) Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper[**and complying with requirements of ISO 4586**].

2.6 FIRE-RETARDANT-TREATED MATERIAL

A. Fire-Retardant-Treated Materials, General: Where fire-retardant-treated materials are indicated, use materials that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

1. Use treated materials that comply with requirements of referenced quality standard. Do not use materials that are warped, discolored, or otherwise defective.
2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.

B. Fire-Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested in accordance with ASTM E84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.

1. Kiln-dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.
2. For items indicated to receive a stained or natural finish, use organic resin chemical formulation.
3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking shop certified by testing and inspecting agency.
4. Mill lumber before treatment and implement procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of architectural cabinets.

C. Fire-Retardant Particleboard: Made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less per ASTM E84.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. For panels 3/4 inch (19 mm) thick and less, comply with ANSI A208.1 for Grade M-2 except for the following minimum properties: modulus of rupture, 1600 psi (11 MPa); modulus of elasticity, 300,000 psi (2070 MPa); internal bond, 80 psi (550 kPa); and screw-holding capacity on face and edge, 250 and 225 lbf (1100 and 1000 N), respectively.
3. For panels 13/16 to 1-1/4 inches (20 to 32 mm) thick, comply with ANSI A208.1 for Grade M-1 except for the following minimum properties: modulus of rupture, 1300 psi (9 MPa); modulus of elasticity, 250,000 psi (1720 MPa); linear expansion, 0.50 percent; and screw-holding capacity on face and edge, 250 and 175 lbf (1100 and 780 N), respectively.

D. Fire-Retardant Fiberboard: MDF panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less per ASTM E84.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.7 CABINET HARDWARE AND ACCESSORIES

A. Cabinet Hardware: Provide cabinet hardware and accessory materials associated with architectural cabinets except for items specified in [**Section 087100 "Door Hardware."**] [**Section 087111 "Door Hardware (Descriptive Specification)."**]

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Butt Hinges: 2-3/4-inch (70-mm), five-knuckle steel hinges made from 0.095-inch- (2.4-mm-) thick metal, and as follows:

1. Semiconcealed Hinges for Flush Doors: ANSI/BHMA A156.9, B01361.
2. Semiconcealed Hinges for Overlay Doors: ANSI/BHMA A156.9, B01521.

C. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, B01602, [**100**] [**135**] [**170**] degrees of opening[**, self-closing**].

D. Back-Mounted Pulls: ANSI/BHMA A156.9, B02011.

E. Wire Pulls: Back mounted, solid [**metal**] [**plastic**], [**4 inches (100 mm) long, 5/16 inch (8 mm) in diameter**] [**5 inches (127 mm) long, 2-1/2 inches (63.5 mm) deep, and 5/16 inch (8 mm) in diameter**].

F. Catches: [**Magnetic catches, ANSI/BHMA A156.9, B03141**] [**Push-in magnetic catches, ANSI/BHMA A156.9, B03131**] [**Roller catches, ANSI/BHMA A156.9, B03071**] [**Ball friction catches, ANSI/BHMA A156.9, B03013**].

G. Adjustable Shelf Standards and Supports: [**ANSI/BHMA A156.9, B04071; with shelf rests, B04081**] [**ANSI/BHMA A156.9, B04102; with shelf brackets, B04112**].

H. Shelf Rests: ANSI/BHMA A156.9, B04013; [**metal**] [**plastic**] [**two-pin plastic with shelf hold-down clip**].

I. Drawer Slides: ANSI/BHMA A156.9.

1. Standard Duty (Grade 1 and Grade 2): [**Side mount**] [**Undermount**][**and extending under bottom edge of drawer**].
2. Heavy-Duty (Grade 1HD-100 and Grade 1HD-200): [**Side mount**] [**Undermount**].

   a. Type: [**Full**] [**Full overtravel**] [**Partial**] extension.
   b. Material: [**Aluminum**] [**Epoxy-coated polymer**] [**Galvanized steel ball bearing**] [**Stainless steel**] [**Zinc-plated ball bearing**] slides.
   c. Motion Feature: [**Push to open**] [**and**] [**soft close dampener**] [**self-closing mechanism**].

3. Pencil drawers not more than 3 inches (75 mm) high and not more than 24 inches (600 mm) wide, provide [**50 lb (22.7 kg)**] <**Insert weight**> load capacity.

4. General purpose drawers more than 3 inches (75 mm) high, but not more than 6 inches (150 mm) high and not more than 24 inches (600 mm) wide, provide [**75 lb (34 kg)**] <**Insert weight**> load capacity.
5. File drawers more than 6 inches (150 mm) high or more than 24 inches (600 mm) wide, provide [**100 lb (45 kg)**] <**Insert weight**> load capacity.
6. Lateral file drawers more than 6 inches (150 mm) high and more than 24 inches (600 mm) but not more than 30 inches (762 mm) wide, provide [**150 lb (68 kg)**] <**Insert weight**> load capacity.
7. Lateral file drawers more than 6 inches (150 mm) high and more than 30 inches (762 mm) wide, provide [**200 lb (90.7 kg)**] <**Insert weight**> load capacity.
8. Computer keyboard tray, provide [**75 lb (34 kg)**] <**Insert weight**> load capacity.

J. Slides for Sliding Glass Doors: ANSI/BHMA A156.9, B07063; [**plastic**] [**aluminum**].

K. Door Locks: ANSI/BHMA A156.11, E07121.

L. Drawer Locks: ANSI/BHMA A156.11, E07041.

M. Door and Drawer Silencers: ANSI/BHMA A156.16, L03011.

N. Float Glass for Cabinet Doors: ASTM C1036, Type I, [**Class 1 (clear)**] [**Class 2 or 3 (tinted)**], Quality-Q3.

1. Thickness: [**3.0 mm**] [**4.0 mm**] [**5.0 mm**] [**6.0 mm**].
2. Tint Color: [**Blue-green**] [**Bronze**] [**Green**] [**Gray**] <**Insert color**>.

O. Tempered Float Glass for Cabinet Doors: ASTM C1048, Kind FT, Condition A, Type I, [**Class 1 (clear)**] [**Class 2 or 3 (tinted)**], Quality-Q3, 6 mm thick unless otherwise indicated.

1. Tint Color: [**Blue-green**] [**Bronze**] [**Green**] [**Gray**] <**Insert color**>.
2. Unframed Glass Doors: Seam exposed edges seamed before tempering.

P. Mirror Glass for Cabinet Doors: ASTM C1503, Mirror [**Select**] [**Glazing**], Quality-Q3.

1. Thickness: [**3.0 mm**] [**4.0 mm**] [**5.0 mm**] [**6.0 mm**].

Q. Decorative Glass for Cabinet Doors: Provide decorative glass complying with Section 088113 "Decorative Glass Glazing."

R. Tempered Float Glass for Cabinet Shelves: ASTM C1048, Kind FT, Condition A, Type I, [**Class 1 (clear)**] [**Class 2 or 3 (tinted)**], Quality-Q3; with exposed edges seamed before tempering, 6 mm thick.

1. Tint Color: [**Blue-green**] [**Bronze**] [**Green**] [**Gray**] <**Insert color**>.

S. Grommets for Cable Passage: [**1-1/4-inch (32-mm)**] [**2-inch (51-mm)**] <**Insert dimension**> OD, molded-plastic grommets and matching plastic caps with slot for wire passage.

1. Color: [**Brown**] [**Black**] <**Insert color**>.

T. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with ANSI/BHMA A156.18 for BHMA finish number indicated.

1. Dark, Oxidized, Satin Bronze, Oil Rubbed: ANSI/BHMA 613 for bronze base; ANSI/BHMA 640 for steel base; match Architect's sample.
2. Bright Brass, Clear Coated: ANSI/BHMA 605 for brass base; ANSI/BHMA 632 for steel base.

3. Bright Brass, Vacuum Coated: ANSI/BHMA 723 for brass base; ANSI/BHMA 729 for zinc-coated-steel base.
4. Satin Brass, Blackened, Bright Relieved, Clear Coated: ANSI/BHMA 610 for brass base; ANSI/BHMA 636 for steel base.
5. Satin Chromium Plated: ANSI/BHMA 626 for brass or bronze base; ANSI/BHMA 652 for steel base.
6. Bright Chromium Plated: ANSI/BHMA 625 for brass or bronze base; ANSI/BHMA 651 for steel base.
7. Satin Stainless Steel: ANSI/BHMA 630.

U. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in ANSI/BHMA A156.9.

2.8 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: [**Softwood or hardwood lumber**] [**Fire-retardant-treated softwood lumber**], kiln-dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

C. <Double click to insert sustainable design text for adhesives.>

2.9 FABRICATION

A. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.

B. Fabricate architectural cabinets to dimensions, profiles, and details indicated. Ease edges and corners to 1/16-inch (1.5-mm) radius unless otherwise indicated.

C. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

1. Notify Architect seven days in advance of the dates and times architectural cabinet fabrication will be complete.
2. Trial fit assemblies at manufacturer's shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.

D. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

E. Install glass to comply with applicable requirements in Section 088000 "Glazing" and in GANA's "Glazing Manual."

1. For glass in wood frames, secure glass with removable stops.
2. For exposed glass edges, polish and grind smooth.

2.10 SHOP FINISHING

A. Finish architectural cabinets at manufacturer's shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.

B. Shop-finish transparent-finished architectural cabinets at manufacturer's shop as specified in this Section. See Section 099123 "Interior Painting" for field finishing of opaque-finished architectural cabinets.

C. Drawings indicate items that are required to be shop finished. Finish these items at manufacturer's shop as specified in this Section. See [**Section 099123 "Interior Painting"**] [**and**] [**Section 099300 "Staining and Transparent Finishing"**] for field finishing of architectural cabinets.

D. Shop Priming: Shop apply the prime coat including backpriming, if any, for[**transparent-finished**] items specified to be field finished. See [**Section 099123 "Interior Painting"**] [**and**] [**Section 099300 "Staining and Transparent Finishing"**] for material and application requirements.

E. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural cabinets, as applicable to each unit of work.

1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of cabinets.

F. Transparent Finish:

1. Architectural Woodwork Standards Grade: [**Premium**] [**Custom**] [**Economy**] [**Same as item to be finished**].
2. Finish: System - [**1, nitrocellulose lacquer**] [**2, precatalyzed lacquer**] [**3, postcatalyzed lacquer**] [**4, water-based latex acrylic**] [**5, conversion varnish**] [**6, synthetic penetrating oil**] [**7, catalyzed vinyl**] [**8, water-based crosslinking acrylic**] [**9, UV-curable acrylated epoxy, polyester, or urethane**] [**10, water-based UV curable**] [**11, catalyzed polyurethane**] [**12, water-based polyurethane**] [**13, catalyzed polyester**].
3. Wash Coat for Closed-Grain Woods: Apply wash-coat sealer to cabinets made from closed-grain wood before staining and finishing.
4. Staining: [**None required**] [**Match approved sample for color**] [**Match Architect's sample**].
5. Open Finish for Open-Grain Woods: Do not apply filler to open-grain woods.
6. Filled Finish for Open-Grain Woods:[**After staining, apply wash-coat sealer and allow to dry.**] Apply paste wood filler and wipe off excess. Tint filler to match stained wood.
7. Sheen: [**Flat, 15-30**] [**Satin, 31-45**] [**Semigloss, 46-60**] [**Gloss, 61-100**] gloss units measured on 60-degree gloss meter per ASTM D523.

G. Opaque Finish:

1. Architectural Woodwork Standards Grade: [**Premium**] [**Custom**] [**Economy**] [**Same as item to be finished**].
2. Finish: System - [**1, nitrocellulose lacquer**] [**2, precatalyzed lacquer**] [**3, postcatalyzed lacquer**] [**4, water-based latex acrylic**] [**5, conversion varnish**] [**7, catalyzed vinyl**] [**8, water-based crosslinking acrylic**] [**9, UV-curable acrylated epoxy, polyester, or urethane**] [**10, water-based UV curable**] [**11, catalyzed polyurethane**] [**12, water-based polyurethane**] [**13, catalyzed polyester**].
3. Color: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**].
4. Sheen: [**Flat, 15-30**] [**Satin, 31-45**] [**Semigloss, 46-60**] [**Gloss, 61-100**] gloss units measured on 60-degree gloss meter per ASTM D523.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.

3.2 INSTALLATION

A. Architectural Woodwork Standards Grade: Install cabinets to comply with quality standard grade of item to be installed.

B. Assemble cabinets and complete fabrication at Project site to extent that it was not completed in the shop.

C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing. Use fine finishing nails[**or finishing screws**] for exposed fastening, countersunk and filled flush with cabinet surface.

1. For shop-finished items, use filler matching finish of items being installed.

D. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm) using concealed shims.

1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
3. Maintain veneer sequence matching of cabinets with transparent finish.
4. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches (400 mm) o.c. with [**No. 10 wafer-head screws sized for not less than 1-1/2-inch (38-mm) penetration into wood framing, blocking, or hanging strips**] [**No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish**] [**toggle bolts through metal backing or metal framing behind wall finish**].

E. Shop Finishes: Touch up finishing after installation of architectural cabinets. Fill nail holes with matching filler.

1. Apply specified finish coats, including stains and paste fillers if any, to exposed surfaces where only sealer/prime coats are shop applied.

F. Field Finishing: See [**Section 099123 "Interior Painting"**] [**and**] [**Section 099300 "Staining and Transparent Finishing"**] for finishing of installed architectural cabinets.

3.3 FIELD QUALITY CONTROL

A. Inspections: Provide inspection of installed Work through [**AWI's Quality Certification Program**] [**WI's Certified Compliance Program**] certifying that woodwork, including installation, complies with requirements of the Architectural Woodwork Standards for the specified grade.

1. Inspection entity is to prepare and submit report of inspection.

3.4 ADJUSTING AND CLEANING

A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects. Where not possible to repair, replace architectural cabinets. Adjust joinery for uniform appearance.

B. Clean, lubricate, and adjust hardware.

C. Clean cabinets on exposed and semiexposed surfaces. Touch up finishes to restore damaged or soiled areas.

END OF SECTION 06 41 13 00a

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Task	Specification	Specification Description
06 41 93 00	06 01 40 91	Door Hardware
06 42 13 00	06 25 16 00	Paneling
06 42 16 00	06 25 16 00	Paneling

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SECTION 06 42 19 00 - PLASTIC PANELING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for plastic paneling. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes glass-fiber reinforced plastic (FRP) wall paneling and trim accessories.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content and chemical components.
   b. Product Data for Credit EQ 4.4: For laminating adhesive and composite wood products used in factory-laminated plastic panels, indicating that product contains no urea formaldehyde.
3. Samples: For plastic paneling and trim accessories.

D. Quality Assurance
1. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   a. Flame-Spread Index: 25 **OR** 200, **as directed**, or less.
   b. Smoke-Developed Index: 450 or less.
   c. Testing Agency: Acceptable to authorities having jurisdiction **OR** FM Approvals **OR** UL, **as directed**.

1.2 PRODUCTS

A. Plastic Sheet Paneling
1. General: Gelcoat-finished, glass-fiber reinforced plastic panels complying with ASTM D 5319.
   a. Nominal Thickness: Not less than 0.075 inch (1.9 mm) **OR** 0.09 inch (2.3 mm) **OR** 0.12 inch (3.0 mm), **as directed**.
   b. Surface Finish: Smooth **OR** Molded pebble texture **OR** Smooth surface with filled grooves at 4 inches (102 mm) o.c. to resemble tile **OR** As selected by the Owner from manufacturer's full range, **as directed**.
   c. Color: White **OR** As selected by the Owner from manufacturer's full range, **as directed**.

B. Factory-Laminated Plastic Panels
1. General: Gelcoat-finished, glass-fiber reinforced plastic panels complying with ASTM D 5319, laminated to plywood **OR** oriented strand board **OR** fire-retardant particleboard **OR** gypsum board **OR** high-impact gypsum board **OR** moisture- and mold-resistant gypsum board, **as directed**.
   a. Glass-Fiber Reinforced Plastic Panel Nominal Thickness: Not less than 0.03 inch (0.76 mm) **OR** 0.05 inch (1.3 mm) **OR** 0.075 inch (1.9 mm) **OR** 0.09 inch (2.3 mm), **as directed**.
   b. Surface Finish: Smooth **OR** Molded pebble texture **OR** Smooth surface with filled grooves at 4 inches (102 mm) o.c. to resemble tile **OR** As selected by the Owner from manufacturer's full range, **as directed**.
   c. Color: White **OR** As selected by the Owner from manufacturer's full range, **as directed**.

d. Plywood: DOC PS 1, Exterior B-C, 1/4 inch (6.4 mm) **OR** 3/8 inch (9.5 mm) **OR** 1/2 inch (12.7 mm) **OR** 5/8 inch (15.9 mm) **OR** 3/4 inch (19.1 mm), **as directed**, thick.
e. Oriented Strand Board: DOC PS 2, 1/4 inch (6.4 mm) **OR** 3/8 inch (9.5 mm) **OR** 1/2 inch (12.7 mm) **OR** 3/4 inch (19.1 mm), **as directed**, thick.
f. Fire-Retardant Particleboard: Product complying with ANSI A208.1, Grade M-S, except for modulus of rupture; with flame-spread index of 25 or less per ASTM E 84; and 3/8 inch (9.5 mm) **OR** 1/2 inch (12.7 mm), **as directed**, thick.
g. Gypsum Board: ASTM C 1396/C 1396M, Regular, 1/2 inch (12.7 mm) **OR** Type X, 5/8 inch (15.9 mm), **as directed**.
h. High-Impact Gypsum Board: ASTM C 1396/C 1396M, 5/8 inch (15.9 mm), with Type X core, and 0.010-inch (0.254-mm) **OR** 0.020-inch (0.508-mm) **OR** 0.030-inch (0.762-mm) **OR** 0.081-inch (2.057-mm), **as directed**, plastic film laminated to back side for greater resistance to through penetration (impact resistance).
i. Moisture- and Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M or ASTM C 1178/C 1178M, 5/8 inch (15.9 mm), Type X, with moisture- and mold-resistant core and surfaces.
j. Laminating Adhesive: Manufacturers standard adhesive that does not contain urea formaldehyde.

C. Accessories
1. Trim Accessories: Manufacturer's standard one-piece **OR** two-piece, snap-on, **as directed**, vinyl extrusions designed to retain and cover edges of panels. Provide division bars, inside corners, outside corners, and caps as needed to conceal edges.
   a. Color: White **OR** Match panels **OR** As selected by the Owner from manufacturer's full range, **as directed**.
2. Exposed Fasteners: Nylon drive rivets recommended by panel manufacturer.
3. Concealed Mounting Splines: Continuous, H-shaped aluminum extrusions designed to fit into grooves routed in edges of factory-laminated panels and to be fastened to substrate.
4. Adhesive: As recommended by plastic paneling manufacturer.
   a. VOC Content: 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
5. Sealant: Single-component, mildew-resistant, neutral-curing silicone **OR** Single-component, mildew-resistant, acid-curing silicone **OR** Latex, **as directed**, sealant recommended by plastic paneling manufacturer and complying with requirements in Division 07 Section "Joint Sealants".
   a. VOC Content: 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1.3 EXECUTION

A. Preparation
1. Remove wallpaper, vinyl wall covering, loose or soluble paint, and other materials that might interfere with adhesive bond.
2. Prepare substrate by sanding high spots and filling low spots as needed to provide flat, even surface for panel installation.
3. Clean substrates of substances that could impair bond of adhesive, including oil, grease, dirt, and dust.
4. Condition panels by unpacking and placing in installation space before installation according to manufacturer's written recommendations.
5. Lay out paneling before installing. Locate panel joints where indicated **OR** to provide equal panels at ends of walls not less than half the width of full panels **OR** so that trimmed panels at corners are not less than 12 inches (300 mm) wide, **as directed**.
   a. Mark plumb lines on substrate at trim accessory **OR** panel joint, **as directed**, locations for accurate installation.

b. Locate trim accessories **OR** panel joints, **as directed**, to allow clearance at panel edges according to manufacturer's written instructions.

B. Installation
1. Install plastic paneling according to manufacturer's written instructions.
OR
Install panels in a full spread of adhesive.
OR
Install panels with fasteners. Layout fastener locations and mark on face of panels so that fasteners are accurately aligned.
a. Drill oversized fastener holes in panels and center fasteners in holes.
b. Apply sealant to fastener holes before installing fasteners.
2. Install factory-laminated panels using concealed mounting splines in panel joints.
3. Install trim accessories with adhesive and nails or staples. Do not fasten through panels.
4. Fill grooves in trim accessories with sealant before installing panels and bed inside corner trim in a bead of sealant.
5. Maintain uniform space between panels and wall fixtures. Fill space with sealant.
6. Maintain uniform space between adjacent panels and between panels and floors, ceilings, and fixtures. Fill space with sealant.
7. Remove excess sealant and smears as paneling is installed. Clean with solvent recommended by sealant manufacturer and then wipe with clean dry cloths until no residue remains.

END OF SECTION 06 42 19 00

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Task	Specification	Specification Description
06 42 19 00	06 25 16 00	Paneling
06 43 13 00	06 41 13 00	Interior Architectural Woodwork
06 43 16 00	06 41 13 00	Interior Architectural Woodwork
06 44 39 00	06 41 13 00	Interior Architectural Woodwork
06 46 13 00	06 05 23 00a	Miscellaneous Carpentry
06 46 13 00	06 22 13 00	Exterior Finish Carpentry
06 46 13 00	06 22 13 00a	Interior Finish Carpentry
06 46 19 00	01 22 16 00	No Specification Required
06 46 19 00	06 05 23 00a	Miscellaneous Carpentry
06 46 19 00	06 22 13 00	Exterior Finish Carpentry
06 46 19 00	06 22 13 00a	Interior Finish Carpentry
06 46 19 00	06 41 13 00	Interior Architectural Woodwork
06 46 23 00	06 41 13 00	Interior Architectural Woodwork
06 46 26 00	06 41 13 00	Interior Architectural Woodwork

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SECTION 06 46 29 00 - EXTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior standing and running trim.
2. Exterior frames and jambs.
3. Exterior shutters.
4. Exterior [**stairs**] [**and**] [**railings**].
5. Wood furring, blocking, shims, and hanging strips for installing exterior architectural woodwork items that are not concealed within other construction.
6. Shop priming of exterior architectural woodwork.
7. Shop finishing of exterior architectural woodwork.

B. Related Requirements:

1. [**Section 061000 "Rough Carpentry"**] for wood furring, blocking, shims, and hanging strips required for installing exterior architectural woodwork that are concealed within other construction before exterior architectural woodwork installation.
2. Section 062013 "Exterior Finish Carpentry" for exterior carpentry exposed to view that is not specified in this Section.

1.2 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections, to ensure that exterior architectural woodwork can be supported and installed as indicated.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**>.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Wood-Preservative Treatment:

   a. Include data and warranty information from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
   b. Indicate type of preservative used and net amount of preservative retained.
   c. Include chemical-treatment manufacturer's written instructions for finishing treated material and manufacturer's written warranty.

2. Fire-Retardant Treatment: Include data and warranty information from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.

3. Waterborne Treatments: For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

B. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for recycled content.>
2. <Double click to insert sustainable design text for regional materials.>
3. <Double click to insert sustainable design text for certified wood.>
4. <Double click to insert sustainable design text for adhesives.>

C. Shop Drawings:

1. Include dimensioned plans, elevations, sections, and attachment details.
2. Show [**large-scale**] [**full-size**] details.
3. Show locations and sizes of furring, blocking, and hanging strips, including blocking and reinforcement concealed by construction and specified in other Sections.
4. Apply [**AWI Quality Certification**] [**WI Certified Compliance**] Program label to Shop Drawings.

D. Samples: For each exposed product and for each color and finish specified.

1. Size:

    a. Panel Products: 12 inches by 12 inches (300 mm by 300 mm).
    b. Lumber Products: Not less than [**5 inches (125 mm) wide by 12 inches (300 mm) long**] [**5 inches (125 mm) wide by 24 inches (600 mm) long**], for each species and cut, finished on one side and one edge.

E. Samples for Initial Selection: For each type of exposed finish.

1. Size:

    a. Panel Products: 12 inches by 12 inches (300 mm by 300 mm).
    b. Lumber Products: Not less than [**5 inches (125 mm) wide by 12 inches (300 mm) long**] [**5 inches (125 mm) wide by 24 inches (600 mm) long**], for each species and cut, finished on one side and one edge.

F. Samples for Verification: For the following:

1. Lumber for Exterior Wood-Stain Finish: Not less than 5 inches (125 mm) wide by 12 inches (300 mm) long, for each species, with one-half of exposed surface finished.
2. Lumber for Transparent Finish: Not less than [**5 inches (125 mm) wide by 12 inches (300 mm) long**] [**5 inches (125 mm) wide by 24 inches (600 mm) long**], for each species and cut, finished on one side and one edge.
3. Lumber and Panel Products with Shop-Applied Opaque Finish: 5 inches (125 mm) wide by 12 inches (300 mm) long for lumber and [**8 by 10 inches (200 by 250 mm)**] [**12 by 12 inches (300 by 300 mm)**] for panels, for each finish system and color.

    a. Finish [**entire**] [**one-half of**] exposed surface.

4. Shutter Hardware: Full-size samples for each type and size of hardware in each finish, and color required.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**architectural woodwork manufacturer**] [**and**] [**Installer**].

B. Evaluation Reports: For [**preservative-treated**] [**and**] [**fire-retardant-treated**] wood materials, from ICC-ES.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Quality Standard Compliance Certificates: [**AWI Quality Certification Program**] [**WI Certified Compliance Program**] certificates.

1.7 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

1. Manufacturer's Certification: Licensed participant in [**AWI's Quality Certification Program**] [**WI's Certified Compliance Program**].

B. Installer Qualifications: [**Fabricator of products**] [**Licensed participant in AWI's Quality Certification Program**] [**Licensed participant in WI's Certified Compliance Program**].

C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups of [**typical exterior architectural woodwork as shown on Drawings**] <**Insert description**>.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with Architectural Woodwork Standards, Section 2.

B. Store woodwork in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1. Handle and store fire-retardant-treated wood to comply with chemical-treatment manufacturer's written instructions.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation of exterior architectural woodwork only when existing and forecasted weather conditions permit work to be performed and at least one coat of specified finish to be applied without exposure to rain, snow, or dampness.

B. Field Measurements: Where exterior architectural woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings.

1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being concealed by construction, and indicate measurements on Shop Drawings.

C. Established Dimensions: Where exterior architectural woodwork is indicated to fit to other construction, establish dimensions for areas where woodwork is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 ARCHITECTURAL WOODWORK MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**] [**provide products by one of the following**] [**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. <**Insert, in separate subparagraphs, names for preapproved architectural woodworking firms**>.

2.2 ARCHITECTURAL WOODWORK, GENERAL

A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of exterior architectural woodwork indicated for construction, finishes, installation, and other requirements.

1. Provide [**labels**] [**and**] [**certificates**] from [**AWI**] [**WI**] certification program indicating that woodwork[**and installation**] complies with requirements of grades specified.

a. This project has been registered with AWI as AWI Quality Certification Program Number <**Insert number**>.
b. Contractor is to register the Work under this Section with the AWI Quality Certification Program at www.awiqcp.org or by calling 800-345-0991.

2. The Contract Documents contain requirements that are more stringent than the Architectural Woodwork Standards. Comply with Contract Documents and the Architectural Woodwork Standards.

B. <Double click to insert sustainable design text for regional wood materials.>

C. <Double click to insert sustainable design text for certified wood.>

2.3 EXTERIOR STANDING AND RUNNING TRIM FOR TRANSPARENT FINISH

A. Architectural Woodwork Standards Grade: [**Premium**] [**Custom**] [**Economy**].

B. Backout or groove backs of flat trim members and kerf backs of other wide, flat members, except for members with ends exposed in finished work.

C. Wood Species: [**All-heart redwood**] [**Western red cedar**] [**Ponderosa pine or sugar pine**] [**Eastern white pine**] <**Insert species**>.

1. Do not use plain-sawn softwood lumber with exposed, flat surfaces more than 3 inches (76 mm) wide.
2. Wood Moisture Content: [**9 to 15**] [**10 to 15**] [**7 to 12**] percent.

2.4 EXTERIOR STANDING AND RUNNING TRIM FOR OPAQUE FINISH

A. Architectural Woodwork Standards Grade: [**Premium**] [**Custom**] [**Economy**].

B. Backout or groove backs of flat trim members, and kerf backs of other wide, flat members, except for members with ends exposed in finished work.

C. Wood Species: [**All-heart redwood**] [**Western red cedar**] [**Ponderosa pine or sugar pine**] [**Eastern white pine, sugar pine, or western white pine**] [**Any closed-grain hardwood**] <**Insert species**>.

1. Do not use plain-sawn softwood lumber with exposed, flat surfaces more than 3 inches (76 mm) wide.
2. Wood Moisture Content: [**9 to 15**] [**10 to 15**] [**7 to 12**] percent.

2.5 EXTERIOR FRAMES AND JAMBS FOR TRANSPARENT FINISH

A. Architectural Woodwork Standards Grade: [**Premium**] [**Custom**] [**Economy**].

B. Wood Species: [**Teak**] [**All-heart redwood**] [**Western red cedar**] [**White oak**] [**Ponderosa pine or sugar pine**] <**Insert species**>.

1. Do not use plain-sawn softwood lumber with exposed, flat surfaces more than 3 inches (76 mm) wide.
2. Wood Moisture Content: [**9 to 15**] [**10 to 15**] [**7 to 12**] percent.

2.6 EXTERIOR FRAMES AND JAMBS FOR OPAQUE FINISH

A. Architectural Woodwork Standards Grade: [**Premium**] [**Custom**] [**Economy**].

B. Wood Species: [**All-heart redwood**] [**Western red cedar**] [**Ponderosa pine**] [**Ponderosa pine or sugar pine**] [**Eastern white pine, sugar pine, or western white pine**] [**Any closed-grain hardwood**] <**Insert species**>.

1. Do not use plain-sawn softwood lumber with exposed, flat surfaces more than 3 inches (76 mm) wide.
2. Wood Moisture Content: [**9 to 15**] [**10 to 15**] [**7 to 12**] percent.

2.7 EXTERIOR SHUTTERS FOR TRANSPARENT FINISH

A. Architectural Woodwork Standards Grade: [**Premium**] [**Custom**] [**Economy**].

B. Wood Species: [**Teak**] [**African mahogany**] [**All-heart redwood**] [**Ponderosa pine or sugar pine**] <**Insert species**>.

1. Do not use plain-sawn softwood lumber with exposed, flat surfaces more than 3 inches (76 mm) wide.
2. Wood Moisture Content: [**9 to 15**] [**10 to 15**] [**7 to 12**] percent.

2.8 EXTERIOR SHUTTERS FOR OPAQUE FINISH

A. Architectural Woodwork Standards Grade: [**Premium**] [**Custom**] [**Economy**].

B. Wood Species: [**All-heart redwood**] [**Ponderosa pine**] [**Ponderosa pine or sugar pine**] <**Insert species**>.

1. Do not use plain-sawn softwood lumber with exposed, flat surfaces more than 3 inches (76 mm) wide.
2. Wood Moisture Content: [**9 to 15**] [**10 to 15**] [**7 to 12**] percent.

2.9 EXTERIOR STAIRS AND RAILINGS

A. Architectural Woodwork Standards Grade: [**Premium**] [**Custom**] [**Economy**].

B. Hand select wood for freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot holes, shake, splits, torn grain, and wane.

C. Stair Treads:

1. [**1-1/4-inch- (32-mm-)**] [**1-inch- (25-mm-)**] thick, kiln-dried[**, pressure-preservative-treated**] stepping with half-round or rounded edge nosing, of any of the following:

    a. Douglas fir, NLGA, WCLIB, or WWPA C & Btr VG (Vertical Grain) stepping.
    b. Hem-fir, NLGA, WCLIB, or WWPA C & Btr VG (Vertical Grain) stepping.
    c. Southern pine, SPIB B & B stepping.

2. [**1-1/4-inch- (32-mm-)**] [**1 inch- (25 mm-)**] actual thickness, kiln-dried with half-round or rounded edge nosing.

    a. Redwood, RIS [**Deck Heart or Construction Heart**] [**Deck Common or Construction Common**].
    b. Redwood, RIS [**Heart Clear**] [**Heart B or Select Heart**].
    c. Western red cedar, WWPA [**Patio 1**] [**Patio 2**].
    d. Western red cedar, WCLIB [**Select Dex**] [**Commercial Dex**].
    e. Western red cedar (North), NLGAS [**Select Patio**] [**Commercial Patio**].

3. [**1-1/4-inch- (32-mm-)**] [**1-inch- (25-mm-)**] [**3/4-inch- (19-mm-)**] actual thickness radius-edged S4S boards, with one face free of planer skip, machine burn, and torn or chipped grain.

    a. Species: [**Ipe**] [**Teak**] [**Cumaru**] [**Garapa**] [**Goncalo alves**] <**Insert name**>.
    b. Grade Characteristics:

        1) Clear[**one face; small pin knots and worm holes allowed on back face**].
        2) Sound; small pin knots, worm holes, and fixed knots allowed.

3) All heart[**one face**].
4) Straight grained and parallel cut.
5) Free of heart centers.
6) No decay, incipient decay, honeycomb, knot holes, shakes, splits, or wane.
7) No discoloration.

D. Stair Risers:

1. 3/4-inch- (19-mm-) thick, kiln-dried[**, pressure-preservative-treated**] finish boards, of any of the following:

a. Douglas fir, NLGA, WCLIB, or WWPA C & Btr or Superior finish.
b. Hem-fir, NLGA, WCLIB, or WWPA C & Btr or Superior finish.
c. Southern pine, SPIB B & B.

2. 3/4-inch- (19-mm-) actual thickness, kiln-dried with half-round or rounded edge nosing.

a. Redwood, RIS [**Deck Heart or Construction Heart**] [**Deck Common or Construction Common**].
b. Redwood, RIS [**Heart Clear**] [**Heart B or Select Heart**].
c. Western red cedar, WWPA [**Patio 1**] [**Patio 2**].
d. Western red cedar, WCLIB [**Select Dex**] [**Commercial Dex**].
e. Western red cedar (North), NLGAS [**Select Patio**] [**Commercial Patio**].

3. 3/4-inch- (19-mm-) actual thickness radius-edged S4S boards, with one face free of planer skip, machine burn, and torn or chipped grain.

a. Species: [**Ipe**] [**Teak**] [**Cumaru**] [**Garapa**] [**Goncalo alves**] <**Insert name**>.
b. Grade Characteristics:

1) Clear[**one face; small pin knots and worm holes allowed on back face**].
2) Sound; small pin knots, worm holes, and fixed knots allowed.
3) All heart[**one face**].
4) Straight grained and parallel cut.
5) Free of heart centers.
6) No decay, incipient decay, honeycomb, knot holes, shakes, splits, or wane.
7) No discoloration.

E. Railing Members:

1. Clear, kiln-dried, solid, [**yellow poplar**] [**pressure-preservative-treated Douglas fir**] [**pressure-preservative-treated southern pine**]; railing stock of pattern indicated on Drawings.
2. [**Select Structural**] [**No. 1**] [**No. 2**] [**Construction or No. 2**] grade and[**any of**] the following species:

a. Hem-fir or hem-fir (North); NLGA, WCLIB, or WWPA.
b. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
c. Mixed southern pine; SPIB.
d. Redwood; RIS.
e. Spruce-pine-fir or spruce-pine-fir (South); NeLMA, NLGA, WCLIB, or WWPA.

3. Redwood, RIS [**Heart Clear**] [**Heart B or Select Heart**].
4. [**Any of the following species and grades:**]

a. Douglas fir, NLGA, WCLIB, or WWPA C & Btr finish or C Select.
b. Hem-fir, NLGA, WCLIB, or WWPA C & Btr finish or C Select.

c. Redwood, RIS [**Heart Clear**] [**Heart B or Select Heart**].
d. Southern pine, SPIM B & B finish.

5. Radius-edged [**Ipe**] [**Teak**] S4S boards, [**same grade as stair treads**] [**clear**] [**clear all heart**] [**, straight grained and parallel cut**].

F. Balusters:

1. 1-1/16-inch- (27-mm-) square, clear, kiln-dried, solid, [**yellow poplar**] [**pressure-preservative-treated Douglas fir**] [**pressure-preservative-treated southern pine**].
2. 1-1/16-inch- (27-mm-) square, [**Select Structural**] [**No. 1**] [**No. 2**] [**Construction or No. 2**] grade, and[**any of**] the following species:

a. Hem-fir or hem-fir (North); NLGA, WCLIB, or WWPA.
b. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
c. Mixed southern pine; SPIB.
d. Redwood; RIS.
e. Spruce-pine-fir or spruce-pine-fir (South); NeLMA, NLGA, WCLIB, or WWPA.

3. 1-1/16-inch- (27-mm-) square, redwood, RIS [**Heart Clear**] [**Heart B or Select Heart**].
4. 1-1/16-inch- (27-mm-) square,[**and any of the following species and grades:**]

a. Douglas fir, NLGA, WCLIB, or WWPA C & Btr finish or C Select.
b. Hem-fir, NLGA, WCLIB, or WWPA C & Btr finish or C Select.
c. Redwood, RIS [**Heart Clear**] [**Heart B or Select Heart**].
d. Southern pine, SPIM B & B finish.

5. 1-1/16-inch- (27-mm-) square, radius-edged [**Ipe**] [**Teak**] S4S boards, [**same grade as stair treads**] [**clear**] [**clear all heart**] [**, straight grained and parallel cut**].

G. Newel Posts:

1. 2-3/4-inch- (70-mm-) square, clear, kiln-dried, [**yellow poplar**] [**pressure-preservative-treated Douglas fir**] [**pressure-preservative-treated southern pine**], turned newel posts of pattern and size indicated on Drawings.
2. 2-3/4-inch- (70-mm-) square, [**Select Structural**] [**No. 1**] [**No. 2**] [**Construction or No. 2**] grade, and[**any of**] the following species:

a. Hem-fir or hem-fir (North); NLGA, WCLIB, or WWPA.
b. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
c. Mixed southern pine; SPIB.
d. Redwood; RIS.
e. Spruce-pine-fir or spruce-pine-fir (South); NeLMA, NLGA, WCLIB, or WWPA.

3. 2-3/4-inch- (70-mm-) square, redwood, RIS [**Heart Clear**] [**Heart B or Select Heart**].
4. 2-3/4-inch- (70-mm-) square,[**and any of the following species and grades:**]

a. Douglas fir, NLGA, WCLIB, or WWPA C & Btr finish or C Select.
b. Hem-fir, NLGA, WCLIB, or WWPA C & Btr finish or C Select.
c. Redwood, RIS [**Heart Clear**] [**Heart B or Select Heart**].
d. Southern pine, SPIM B & B finish.

5. 2-3/4-inch- (70-mm-) square, radius-edged [**Ipe**] [**Teak**] S4S boards, [**same grade as stair treads**] [**clear**] [**clear all heart**] [**, straight grained and parallel cut**].

2.10 WOOD MATERIALS

A. Hardboard: ANSI A135.4.

B. Softwood Plywood: DOC PS 1, exterior[**, medium-density overlay**].

2.11 PRESERVATIVE-TREATED-WOOD MATERIALS

A. Preservative-Treated-Wood Materials: Provide with water-repellent preservative treatment complying with AWPA N1 (dip, spray, flood, or vacuum-pressure treatment).

1. Preservative Chemicals: 3-iodo-2-propynyl butyl carbamate (IPBC)[**, combined with a compatible EPA-registered insecticide**].
2. Use chemical formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants in solution to distinguish treated material from untreated material.

B. Extent of Preservative-Treated Wood Materials: Treat wood materials [**unless otherwise indicated on Drawings**] [**except items indicated to be fire-retardant treated**] <**Insert requirements**>.

1. Items fabricated from the following wood species need not be treated:

a. [**Redwood**] [**All-heart redwood**].
b. [**Western red cedar**] [**All-heart western red cedar**].
c. White oak.
d. African mahogany.
e. Honduras mahogany.
f. Ipe.
g. Dark red meranti.
h. Teak.

2.12 FIRE-RETARDANT-TREATED WOOD MATERIALS

A. Fire-Retardant-Treated Wood Materials, General: Where fire-retardant-treated materials are indicated, use materials complying with requirements that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products in accordance with test method indicated by a qualified testing agency.

1. Use treated materials that comply with requirements of the Architectural Woodwork Standards for the grade specified. Do not use materials that are warped, discolored, or otherwise defective.
2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.

B. Exterior Fire-Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested in accordance with ASTM E84 after being subjected to accelerated weathering in accordance with ASTM D2898, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.

1. Kiln-dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.

2. For items indicated to receive a stained, transparent, or natural finish, use organic resin chemical formulation.
3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking shop certified by testing and inspecting agency.
4. Mill lumber before treatment and implement procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.

C. Extent of Fire-Retardant-Treated Wood Materials:

1. Exterior architectural woodwork located more than 40 feet (12.192 m) above grade.
2. Exterior architectural woodwork in locations with a fire-separation distance of 5 feet (1.524 m) or less.
3. [**Where indicated on Drawings**] <**Insert requirements**>.

2.13 SHUTTER HARDWARE

A. Offset Strap Hinges: For inset shutters and with tapered strap. Shutters can lift off pintles after installation. Provide top and bottom hinges for each shutter and matching wood screws for installation.

1. Offset: [**1/2 inch (13 mm)**] [**1-1/2 inches (38 mm)**] [**2-1/4 inches (57 mm)**] [**3-1/4 inches (83 mm)**] <**Insert dimension**>.
2. Strap Length: [**10 inches (254 mm)**] [**12 inches (300 mm)**] [**14 inches (356 mm)**] [**16 inches (406 mm)**] <**Insert dimension**>.
3. Strap Width: [**1-3/4 inches (45 mm)**] <**Insert dimension**> at widest point.
4. Pintle Plate: [**3-1/2 by 1-1/2 by 1/8 inches (89 by 38 by 3 mm)**] <**Insert dimensions**>.
5. Pintle Diameter: [**3/8 inch (10 mm)**] <**Insert dimension**>.
6. Material and Finish: [**Zinc-chromate-plated steel with black finish**] <**Insert requirements**>.

B. New York-Style Hinges: Offset type for full-inset shutters. Provide top and bottom hinges for each shutter and matching wood screws for installation.

1. Overall Hinge Dimensions: [**4-1/4 by 5 inches (108 by 127 mm)**] [**6 by 6-3/4 inches (152 by 172 mm)**] <**Insert dimensions**>.
2. Offset: [**1-1/16 inches (27 mm)**] [**1-1/4 inches (32 mm)**] [**2-1/8 inches (54 mm)**] [**2-1/4 inches (57 mm)**] <**Insert dimension**>.
3. Pintle Plate: [**2 by 1-1/8 inches (51 by 29 mm)**] [**3-1/8 by 1-1/8 inches (79 by 29 mm)**] [**3-5/8 by 1-3/16 inches (92 by 30 mm)**] <**Insert dimensions**>.
4. Material and Finish: [**Cast iron with rust-inhibiting primer and black matte powder-coated polyurethane finish**] [**Galvanized steel**] [**Solid bronze with wax finish**] <**Insert requirements**>.

C. L-Type Hinges: Offset type for inset shutters; with tapered long-leg of L-shape oriented horizontally. Shutters can lift off pintles after installation. Provide top and bottom hinges[**and matching middle, straight-plate hinge**] for each shutter and matching wood screws for installation.

1. L-Shape Plate: [**5-inch- (127-mm-) long vertical leg and 6-inch- (152-mm-) long horizontal leg**] <**Insert requirements**>.
2. Maximum Leg Width: [**1-3/8 inches (35 mm)**] <**Insert dimension**>.
3. Offset: [**1/2 inch (13 mm)**] [**1-1/2 inches (38 mm)**] [**2-1/4 inches (57 mm)**] <**Insert dimension**>.
4. Pintle Plate: [**3-1/2 by 1-1/2 by 1/8 inch (89 by 38 by 3 mm)**] <**Insert dimensions**>.
5. Pintle Diameter: [**3/8 inch (10 mm)**] <**Insert dimension**>.
6. Material and Finish: [**Zinc-chromate-plated steel with wrought-iron black finish**] <**Insert requirements**>.

D. Connecticut-Style Hinges: Strap-type, loose-joint hinges with threaded pintle. Provide top and bottom hinges[**and matching middle hinge**] for each shutter and matching wood screws for installation.

1. Type: [**No offset**] [**1-1/4-inch (32-mm) offset**] [**2-3/16-inch (56-mm) offset**] <**Insert description**>.
2. Strap Dimensions: [**1 by 4-1/4 inches (25 by 108 mm)**] [**1 by 6-1/2 inches (25 by 165 mm)**] <**Insert dimensions**>.
3. Pintle: [**2-3/8 inches (60 mm) long with 5/16-inch- (8-mm-) diameter thread**] [**2-3/4 inches (70 mm) long with 1/4-inch- (6-mm-) diameter thread**] [**4-1/2 inches (114 mm) long with 3/8-inch- (10-mm-) diameter thread**] [**4-1/2 inches (114 mm) long with 7/16-inch- (11-mm-) diameter thread**] <**Insert requirements**>.
4. Material and Finish: [**Galvanized steel**] [**Stainless steel with black finish**] <**Insert requirements**>.

E. Bermuda-Style Hinges: For top-hung shutters. Provide [**two**] <**Insert number**> hinges and one matching, shutter stay per shutter. Provide matching wood screws for installation.

1. Overall Hinge Dimensions: [**6-3/16 by 3-1/2 inches (157 by 89 mm)**] <**Insert dimensions**>.
2. Hinge Leg Width: Approximately [**1-1/16 inches (27 mm)**] <**Insert dimension**>.
3. Hinge Material Thickness: Approximately [**1/4 inch (6 mm)**] <**Insert dimension**>.
4. Shutter Stay: [**24-inch- (610-mm-)**] <**Insert dimension**> long.
5. Material and Finish: [**Cast iron and coated with a black textured powder coat**] <**Insert requirements**>.

F. Shutter Dogs: For holding shutters in open position.

1. Type: [**Traditional scroll design**] <**Insert requirements**>.
2. Overall Dimensions: [**6-3/4 by 2-3/8 inches (172 by 60 mm)**] [**8-1/8 by 3-1/4 inches (206 by 83 mm)**] <**Insert dimensions**>.
3. Material and Finish: [**Steel with rough black, rust-inhibiting finish**] <**Insert requirements**>.

2.14 FASTENERS

A. General: Provide fasteners of size and type indicated, acceptable to authorities having jurisdiction, and that comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than 1-1/2 inches (38 mm) into wood substrate.

1. Use [**stainless steel**] [**fasteners with hot-dip zinc coating complying with ASTM A153/A153M or ASTM F2329/F2329M**] unless otherwise indicated.
2. For pressure-preservative-treated wood, use stainless steel fasteners.
3. For redwood, use [**brass/bronze**] [**stainless steel**] [**hot-dip galvanized-steel**] fasteners.

B. Nails: ASTM F1667.

C. Power-Driven Fasteners: ICC-ES AC70.

D. Wood Screws and Lag Screws: ASME B18.2.1, ASME B18.6.1, or ICC-ES AC233.

E. Carbon-Steel Bolts: ASTM A307 with ASTM A563 (ASTM A563M) hex nuts and, where indicated, flat washers all hot-dip zinc coated.

F. Stainless Steel Bolts: ASTM F593, Alloy Group 1 or 2; with ASTM F594, Alloy Group 1 or 2 (ASTM F836M, Grade A1 or Grade A4) hex nuts and, where indicated, flat washers.

G. Postinstalled Anchors: Stainless steel, [**chemical**] [**or**] [**torque-controlled expansion**] anchors with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing in accordance with ASTM E488/E488M conducted by a qualified independent testing and inspecting agency.

1. Stainless steel bolts and nuts complying with ASTM F593 and ASTM F594, Alloy Group 1 or 2 (ASTM F836M, Grade A1 or Grade A4).

2.15 MISCELLANEOUS MATERIALS

A. Blocking, Shims, and Nailers: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.

1. Wood-Preservative Treatment: By pressure process, AWPA U1; Use Category UC3b.

a. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent.
b. Preservative Chemicals: Acceptable to authorities having jurisdiction[**and containing no arsenic or chromium**].
c. Mark lumber with treatment quality mark of an inspection agency approved by the American Lumber Standards Committee's (ALSC) Board of Review.

2. Fire-Retardant Treatment: Complying with requirements; provide [**where indicated on Drawings**] <**Insert requirements**>.

B. <Double click to insert sustainable design text for adhesives.>

2.16 FABRICATION

A. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.

B. Fabricate exterior architectural woodwork to dimensions, profiles, and details indicated.

1. Ease edges to radius indicated for the following:

a. Edges of Solid-Wood (Lumber) Members: 1/16 inch (1.5 mm) unless otherwise indicated.
b. Edges of Rails and Similar Members More Than 3/4 Inch (19 mm) Thick: 1/8 inch (3 mm).

C. Complete fabrication, including assembly, to maximum extent possible before shipment to Project site.

1. Disassemble components only as necessary for shipment and installation.
2. Where necessary for fitting at site, provide allowance for scribing, trimming, and fitting.
3. Notify Architect seven days in advance of the dates and times exterior architectural woodwork fabrication will be complete.
4. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled.

a. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting.
b. Verify that parts fit as intended, and check measurements of assemblies against field measurements indicated on approved Shop Drawings before disassembling for shipment.

2.17 SHOP PRIMING

A. Preparations for Finishing: Comply with the Architectural Woodwork Standards for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing exterior architectural woodwork, as applicable to each unit of work.

B. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork.[**Apply two coats to surfaces installed in contact with concrete or masonry and to end-grain surfaces.**]

C. Exterior Architectural Woodwork for Opaque Finish: Shop prime all surfaces with one coat of wood primer as specified in Section 099113 "Exterior Painting."

D. Exterior Architectural Woodwork for Transparent Finish:

1. Shop seal surfaces to be concealed
2. Shop seal exposed surfaces with stain (if specified), other required pretreatments, and first coat of finish as specified in Section 099300 "Staining and Transparent Finishing."

2.18 SHOP FINISHING

A. Finish exterior architectural woodwork [**with transparent finish**] [**indicated on Drawings**] at fabrication shop. Defer only final touchup, cleaning, and polishing until after installation.

B. Preparation for Finishing: Comply with the Architectural Woodwork Standards for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing exterior architectural woodwork, as applicable to each unit of work.

1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of exterior architectural woodwork. Apply two coats to end-grain surfaces.

C. Transparent Finish: Comply with Section 099300 "Staining and Transparent Finishing."

D. Opaque Finish: Comply with Section 099113 "Exterior Painting."

PART 3 - EXECUTION

3.1 PREPARATION

A. Before installation, condition exterior architectural woodwork to average prevailing humidity conditions at Project site.

B. Before installing exterior architectural woodwork, examine shop-fabricated work for completion, and complete work as required, including removing packing and backpriming concealed surfaces.

3.2 INSTALLATION

A. Grade: Install exterior architectural woodwork to comply with same grade as item to be installed.

B. Assemble exterior architectural woodwork, and complete fabrication at Project site to the extent that it was not completed during shop fabrication.

C. Install exterior architectural woodwork level, plumb, true in line, and without distortion.

1. Shim as required with concealed shims.
2. Install level and plumb to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm).

D. Standing and Running Trim:

1. Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible.
2. Do not use pieces less than [**36 inches (900 mm)**] [**60 inches (1500 mm)**] [**96 inches (2400 mm)**] long, except where shorter single-length pieces are necessary.
3. Scarf running joints and stagger in adjacent and related members.

E. Scribe and cut exterior architectural woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

F. Preservative-Treated Wood Materials: Where field cut or drilled, treat cut ends and drilled holes in accordance with AWPA M4.

G. Fire-Retardant-Treated Wood Materials: Install fire-retardant-treated materials to comply with chemical treatment manufacturer's written instructions.

H. Anchor exterior architectural woodwork to anchors or blocking built in or directly attached to substrates.

1. Secure with countersunk, concealed fasteners and blind nailing.
2. Use fine finishing nails[**or finishing screws**] for exposed fastening, countersunk and filled flush with exterior architectural woodwork.
3. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced and with adjacent rows staggered.
4. For shop-finished items, use filler matching finish of items being installed.

I. Stair and Railing Installation:

1. Treads and Risers:

    a. Install stair tread with crown side up (bark side down).
    b. Secure treads and risers by gluing and nailing to carriages.

        1) Extend treads over carriages[**and finish with bullnose edge**].

    c. Countersink nail heads, fill flush, and sand filler.

2. Balusters:

    a. Fit balusters to treads, glue, and nail in place.
    b. Countersink nail heads, fill flush, and sand filler.
    c. Let into railings and glue in place.

3. Newel Posts: Secure newel posts to stringers and risers with [**through bolts**] [**lag screws**] [**countersunk-head wood screws and glue**].
4. Railings:

    a. Secure wall rails with metal brackets.

b. Fasten freestanding railings to newel posts and to trim at walls with glue and countersunk-head wood screws or rail bolts.

5. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced and with adjacent rows staggered.
6. Install stairs with no more than 3/16-inch (4.7-mm) variation between adjacent treads and risers and with no more than 3/8-inch (10-mm) variation between largest and smallest treads and risers within each flight.

J. Touch up finishing work specified in this Section after installation of exterior architectural woodwork.

1. Fill nail holes with matching filler where exposed.
2. Apply specified finish coats, including stains and paste fillers if any, to exposed surfaces where only sealer/prime coats are shop applied.

K. Field Finishing: See [**Section 099113 "Exterior Painting"**] [**and**] [**Section 099300 "Staining and Transparent Finishing"**] for final finishing of installed exterior architectural woodwork.

3.3 FIELD QUALITY CONTROL

A. Inspections: Provide inspection of installed Work through [**AWI's Quality Certification Program**] [**WI's Certified Compliance Program**] certifying that woodwork, including installation, complies with requirements of the Architectural Woodwork Standards for the specified grade.

1. Inspection entity is to prepare and submit report of inspection.

3.4 REPAIR

A. Repair damaged and defective exterior architectural woodwork, where possible, to eliminate functional and visual defects[**and to result in exterior architectural woodwork being in compliance with requirements of the Architectural Woodwork Standards for the specified grade**].

B. Where not possible to repair, replace defective woodwork.

3.5 CLEANING

A. Clean exterior architectural woodwork on exposed and semiexposed surfaces.

END OF SECTION 06 46 29 00

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Task	Specification	Specification Description
06 46 29 00	06 41 13 00	Interior Architectural Woodwork
06 46 36 00	06 41 13 00	Interior Architectural Woodwork

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SECTION 06 48 13 00 - WOOD DOORS

1.1 DESCRIPTION OF WORK

A. This specification covers the furnishing and installation of materials for wood doors. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 GENERAL

A. Definitions
1. Supply-and-Delivery-Only Contract: Includes supply and delivery to site FOB destination. Freight prepaid. Unless otherwise specified or scheduled, unloading and handling at site is by the Owner.
2. Supply-and-Install Contract: Includes supply, delivery to site FOB destination, freight prepaid, unloading and handling at site, and installation.

B. System Description
1. Door Assemblies: Include doors, frames, and hardware.
a. Provide with fire rating as indicated or specified.
2. Security Entry Door System (Assembly) Performance Requirements:
a. Forced Entry: ASTM F 476, Grade 40.

C. Submittals
1. Shop Drawings:
a. Indicate location, size, elevation, details of construction, marks used to identify doors, location and extent of hardware blocking, fire rating, factory preparation requirements for each door type. Drawings shall include catalog cuts or descriptive data for weatherstripping and thresholds to be used.
2. Quality Assurance/Control Submittals:
a. Test Reports: Results of testing by accredited independent laboratory demonstrating compliance of door systems with specified performance requirements.
1) Indicate that tests were performed in accordance with standard referenced.
b. Certificates: Manufacturer's written certification that door systems meet or exceed specified requirements.
c. Manufacturer’s installation instructions.
3. Closeout Submittals:
a. Operation and maintenance data.
b. Special warranty.

D. Quality Assurance
1. Regulatory Requirements: Comply with following:
a. Fire-Rated Label: Determined using ASTM E 152, and bear label of UL or other recognized fire-rating program acceptable to authorities having jurisdiction,
1) If any door or frame scheduled to be fire-rated cannot qualify for appropriate labeling because of Its design, hardware, or any other reason, advise the Owner prior to submission of bids.
b. Accessibility: (Required for accessible units only, including main building entrances.)
1) Architectural Barriers Act of 1968 as amended (42 USC 4152-4157) and HUD implementing regulations (24 CFR Part 40).
a) Uniform Federal Accessibility Standards (UFAS).

2) Section 504 of the Rehabilitation Act of 1973 as amended (29 USC 794) and HUD implementing regulations (24 CFR Part 8).
3) Fair Housing Accessibility Guidelines (24 CFR Chapter 1).
4) Americans with Disabilities Act of 1990 (ADA) (28 CFR Part 35).

2. Mock-ups: Install one mock-up of each type of door system, including doors, frames, hardware, thresholds, and accessories.
   a. Location: As directed.
   b. Approved Mock-up: Standard for rest of work, and may remain part of completed project.

E. Delivery, Storage, And Handling
1. Packing, Shipping, Handling, and Unloading: Pack materials at manufacturing plant to prevent damage during shipping.
   a. Delivery: Do not deliver doors to building until it is entirely enclosed, drywall and concrete work is completed, and humidity in building has reached average relative humidity of locality.
   b. Storage: Stack doors flat and off floor in manner to prevent warping or twisting, and to provide ventilation. Do not drag doors across one another.
   c. Protection: Protect doors during transit, storage, and handling to prevent damage, soiling, and deterioration, and from extremes in temperature and humidity. Comply with “On-site Care" recommendations of NWWDA Care and Finishing of Wood Doors, and with manufacturer's recommendations.
2. Acceptance at Site: Inspect door systems upon delivery. Replace damaged or defective materials before installation.

F. Project Conditions
1. Field Measurements: Field measure openings for door systems before start of fabrication.

G. Scheduling And Sequencing
1. Scheduling and Completion: Comply with requirements of Detailed Scope of Work.

H. Warranty
1. Special Warranty:
   a. Swinging Doors and Standard Closet Doors Warranty: Provide one-year written warranty covering materials and installation for wood doors.
      1) Include coverage of hardware.
      2) Cover warping (bow, cup, or twist), photographing of construction below face veneers, tolerance limitations of NWWDA I.S. 1-A.
      3) Cover delamination.
      4) Glazing not included.
      5) Defects resulting from vandalism not included.
   b. Heavy-Duty Closet Doors Warranty: Provide manufacturer's five-year written warranty covering materials and installation for bifold closet doors.
   c. For Supply-and-Delivery-Only Contract:
      1) Contractor: Agrees to supply and deliver to the Owner, free of charge, any required replacement parts that can be readily installed by the Owner without special tools.
      2) Contractor: Agrees to supply and deliver to the Owner, free of charge, complete replacement door, when defective part or parts cannot be installed without use of special tools.
   d. For Supply-and-Install Contract: Contractor: Agrees to supply and install. free of charge, any required replacement parts or complete replacement door.

1.3 PRODUCTS

A. Door Frames

1. Wood Frames: Kiln dried Ponderosa Pine, toxic-treated, and primed.
    a. Applied stops are permitted, unless otherwise indicated.
2. Steel Frames:
    a. Steel: ASTM A 366 cold rolled steel.
    b. Steel Frames and/or Adapter Frames: Minimum of 18 gage (1.07 mm) galvanized bonderized steel, pre-drilled and reinforced for hinges as required.
        1) Shape of Frame: Generally L-shaped.
    c. Heavy-Duty Door Frames: 16 gage (1.35 mm) minimum thickness.
        1) When required, provide B-Label, 1-1 /2 hour fire rating.
    d. Security Door Frames: Comply with SDI 100, minimum of 14 gage (1.70 mm) galvanized bonderized steel, pre-drilled and reinforced for hinges as required.
        1) When required, provide B-Label, 1-1 /2 hour fire rating.
        2) Comply with Performance Requirements in this Section.
    e. Preparation for Hardware: Machine and reinforce frames for attachment of hardware, including mortising, drilling, and tapping for hinges and mortised hardware.
    f. Frame Anchors: Provide jamb anchors as suitable for wall conditions and floor anchors, minimum 18 gage.
        1) Provide welded type frames with temporary spreader bars.

B. Interior Wood Swinging Doors
1. Standard Products: Doors shall be of type, size, and design indicated, and shall be standard products of manufacturers regularly engaged in manufacture of wood doors.
    a. Marking: Each door shall bear stamp, brand. or other identifying mark indicating quality and construction of door. Identifying mark or separate certification shall include identification of standard on which construction of door is based, and identity of manufacturing plant.
2. Interior Wood Doors: NWWDA I.S. 1-A.
    a. Thickness: 44.4 mm (1-3/4 inch) unless otherwise indicated or scheduled.
    b. Adhesives: NWWDA I.S. 1-A, Type II.
    c. Prefitting: Provide doors prefitted or unfitted at option of Contractor.
    d. Faces. stiles. and rails bonded to cores.
3. Core Construction:
    a. Solid Core Door NWWDA Construction Type: One of following (as specified):
        1) PC-5 or PC-7 (5- or 7-ply) with particleboard core, bonded.
            a) Stiles: Full core thickness and minimum 34 mm (1-3/8 inch) face width.
        2) SLC-5 or SLC-7 (5- or 7-ply) provide with glued wood-block core, bonded.
            a) Stiles: Full core thickness and minimum 19 mm (3/4 inch) face width.
        3) Stiles and Rails: Top and bottom rails for particleboard and wood-block core doors shall have minimum 29 mm (1-1/8 inch) face width by full core thickness.
    b. Hollow-Core Doors: NWWDA IHC (Institutional Hollow Core) or SHC (Standard Hollow Core), as specified.
        1) Provide with heavy-duty wood stiles, rails, lock blocks and other reinforcement inside core as required to allow for secure screw attachment of hardware.
        2) Hinge Stile: Minimum 25 mm (1 inch) minimum thick.
    c. Stile Edge Bands: Mill option specie.
        1) No visible finger-joints acceptable in stile edge bands.
        2) When used, locate finger-joints under hardware.
    d. Fire-Rated Door NWWDA Construction Type: As required for fire rating indicated or scheduled.
        1) Mineral Core Doors: Provide with heavy duty wood stiles, rails, lock blocks, and other reinforcement inside core as required to allow for secure screw attachment of hardware including closers and exit devices.
            a) Reinforcement Blocking: In compliance with manufacturer's labeling requirements.
        2) Provide factory prefitting and premachining as required for fire-rated labels.

3) Means of Egress Fire Doors: Provide doors with maximum 232 degrees C (450 degree F) temperature rise rating in 30 minutes of fire exposure.

e. Wood Stiles, Rails, Lock Blocks, and Other Reinforcement: Wood:
1) Rail Blocks: Not less than 125 mm (5 inches) wide by full core thickness.
2) Split Resistance: NWWDA TM-5, average of ten test samples shall be not less than 225 load kilograms (500 load pounds).
3) Direct Screw Withdrawal: NWWDA TM-10, average of ten test samples shall be not less than 315 load kilograms (700 load pounds) when tested for direct screw withdrawal using steel, fully threaded wood screw.
4) Cycle/Swing: NWWDA TM-7. 200,000 cycles with no loose hinge screws or other visible signs of failure.

f. Under Cutting: Preserve full bottom rail.

4. Face Panels:
a. Painted Finish: NWWDA I.S. 1-A, minimum 3 mm (1/8 inch) thick hardboard.
b. Plastic Laminate Finish: NEMA LD 3, high pressure decorative laminate, Grade GP50, 1.3 mm (0.050 inch) thick.
1) Faces: Adhesively apply over minimum 3 mm (1/8 inch) thick hardboard.
2) Edges: Adhesively apply plastic laminate matching face panels.
3) Color and Pattern: As selected.

C. Hardware
1. General: Comply with ANSI/BHMA A156.1 and applicable accessibility regulatory requirements and perform functions for which It was intended.
2. Butts and Hinges: ANSI/BHMA A156.1, as scheduled.
a. Install non-rising pins (NRP) on out-swing residential unit entry doors.
b. Self Closing: ANSI/BHMA A156.17.
c. Security Door: Comply with Performance Requirements in this Section.
3. Fire-Rated Door Hardware: Comply with NFPA 80.
a. Exit Doors: Comply with NFPA 101 (Life Safety Code) for exit doors, as well as other requirements specified.
b. Labeling and Listing: Listed in UL Building Materials Directory.
1) In Lieu of UL Labeling and Listing: Test reports from nationally recognized testing agency showing that hardware has been tested in accordance with UL test methods and conforms to NFPA requirements.
c. Install minimum latch throw as specified on label of individual door.
d. Provide hardware listed by UL, except where heavier materials, larger sizes, or higher grades are specified.
e. Closers: ANSI/BHMA A156.4.
4. Lock Sets and Passage Sets: As scheduled. Comply with following standards:
a. Bored and Preassembled Locks and Latches: ANSI/BHMA A156.2, Grade 2.
b. Dead Bolt: ANSI/BHMA A156.5.
c. Mortise Locks and Latches: ANSI/BHMA A156.13, Grade 1 or Security Grade, single or multiple throw.
d. Interconnected Deadlock and Passage Set: ANSI/BHMA A156.12, Grade 2.
e. Cylindrical Lock: Grade 2 cylindrical deadbolt lock/passage set combination.
f. Security Door Locksets: ANSI/BHMA A156.13 Security Grade or UL 437 Key locks.
1) Comply with Performance Requirements in this Section.
g. Keys: Provide two keys for each lock provided. Provide master keying and keying alike on any locks as directed at no additional charge.
h. Locks: Provide with interchangeable cores.
5. Door Viewers: ANSI/BHMA A156.16.

D. Factory Fitting And Machining
1. Doors: Prefit, bevel, mortise, and machine doors at factory in accordance with NWWDA I.S. 1-A.

a. Comply with hardware schedules and door frame Shop Drawings with hardware templates to ensure proper fit of doors and hardware.
1) Take accurate field measurements of hardware mortises in metal frames to verify dimensions and alignment before proceeding with machining in factory.
b. Machine doors for hardware requiring cutting of doors.
c. Fit doors to frame bevel lock edge of doors (1/8 inch) for each (2 inches) of door thickness.
d. Finish all surfaces, including both faces, top and bottom and edges of doors smooth to touch.
2. Edge Sealing: Seal wood end grain exposed at edges and cutouts of doors against moisture penetration prior to shipment.
a. Sealer: Two coats of spar varnish or other sealer recommended by door manufacturer.
3. Tolerances: Comply with NWWDA tolerance requirements for prefitting.

E. Door Assemblies
1. Prehung Swinging Doors: Prehung door with matching wood frame complete with hinges, lockset or passage set, and other hardware, as indicated or specified.
2. Fire-Rated Doors and Frames: NFPA 80 and bear identifying label of UL or nationally recognized testing agency qualified to perform certification programs indicating that units conform to requirements for class indicated.
a. Labels: Metal with raised or incised markings.
b. Hardware: As required to maintain fire rating and receive label.
3. Security Entry Frames and Doors:
a. Comply with Performance Requirements in this Section.
b. Fire Rating: When required, provide B-Label, 1-1/2 hour fire rating.

F. Closet Doors
1. Heavy-Duty Bifold Closet Doors: Particleboard bifold doors, prime painted, factory premachined, complete with manufacturer's standard hardware to provide complete operating bifold doors.
a. Panels: 721 kg/ cubic m (45 PCF) industrial-grade particle board, 19.1 mm (3/4 inch) thick.
1) Long Edges: Plasticized.
2) Room Side: Filled and prime painted.
3) Closet Side: Prime painted.
4) Exposed Surfaces Finish: Painted or plastic laminate as indicated or scheduled.
b. Track: No. 6063-T6 extruded aluminum, 20.5 mm (13/16 inch) by 32 mm (1-1/4 inch).
1) Track Guides: Delrin.
c. Hardware: Factory-applied to doors and track.
1) Pivot and Mounting Hardware: 14 gage cold-rolled steel, carbonized for strength and durability.
2) Top Pivot and Guide Pins: 75 mm (3 inch) removable compensating pins.
3) Toggle Pivot: Ensure doors remain in place.
4) Spring Enclosure: Provide positive closing with little effort and keep doors closed.
5) Bottom Pivot: Carry weight of door, floor-mounted, and designed for vertical and horizontal adjustment.
6) Panel Brackets: Wrap-around feature to eliminate unnecessary stress on screws.
7) Panels: Hinged together with continuous piano hinges inserted into routed grooves and secured with tempered pins.
8) Pulls: As selected from manufacturer's standards.
d. Doors: Comply with accessibility requirements (as specified).
2. Standard Bifold Closet Doors: Provide complete manufacturer’s standard hardware, including tracks, hinges, guides, and pulls to provide complete operating bifold doors.
a. Hollow-Core Doors: NWWDA I.S. 1-A and NWWDA IHC (Institutional Hollow Core).
1) Provide with heavy-duty wood stiles, rails, lock blocks and other reinforcement inside core as required to allow for secure screw attachment of hardware.
b. Doors: 34.9 mm (1-3/8 inch) thick unless otherwise indicated.
c. Surface-Mounted Pulls: As selected from manufacturer standards.

3. Standard Sliding Closet Doors: Provide complete manufacturer's standard hardware, including tracks, guides, and pulls to provide complete operating sliding doors.
    a. Hollow-Core Doors: NWWDA I.S. 1-A and NWWDA IHC (Institutional Hollow Core).
        1) Provide with heavy-duty wood stiles, rails, lock blocks and other reinforcement inside core as required to allow for secure screw attachment of hardware.
    b. Doors: 34.9 mm (1-3/8 inch) thick unless otherwise indicated.
    c. Recessed Pulls: As selected from manufacturer standards.
4. Standard Closet Door Face Panels:
    a. Painted Finish: NWWDA I.S. 1-A, minimum 3 mm (1/8 inch) thick hardboard.
    b. Plastic Laminate Finish: NEMA LD 3, high-pressure decorative laminate, Grade GP50, 1.3 mm (0.050 inch) thick.
        1) Faces: Adhesively apply over minimum 3 mm (1/8 inch) thick hardboard.
        2) Edges: Adhesively apply plastic laminate matching face panels.
        3) Color and Pattem: As selected.

G. Finishes
1. Painted Wood Finish: One of following as indicated or scheduled:
    a. Factory Finish: NWWDA System No. 10-Conversion Varnish.
        1) Color: As selected.
    b. Field Finish: Factory primed for field paint under Division 9 Section "Painting."
2. Painted Steel Finish: Clean and free from serious surface blemishes.
    a. Exposed Surfaces: ASTM A 591 electrolytic zinc-coated steel, Class A.
    b. Primer: ANSI A224.1, factory-applied primer.
    c. Finish Coat: One of following as specified or scheduled:
        1) Factory Finish: Electrostatically factory applied baked-on enamel finish.
            a) Color: As selected from manufacturer's list of colors.
        2) Field Finish: Factory-primed for field paint under Division 9 Section "Painting."

1.4 EXECUTION

A. Examination
1. Site Verification of Conditions:
    a. Existing Conditions: Examine openings before beginning installation.
    b. Field Measurements: Verify field measurements are as indicated on Shop Drawings.
    c. Before installation of doors, verify that frames are proper size, location, type, and swing characteristics for door, and are installed with plumb jambs and level heads as required for proper installation of doors.
    d. Reject doors with defects.
    e. Do not proceed with installation until conditions are satisfactory.

B. Preparation
1. Protection: Protect adjacent elements from damage and disfiguration in accordance with Detailed Scope of Work.
    a. Contractor: Responsible for damage to buildings and any other facilities or property caused by construction operations.
    b. Repair or replace damaged elements in accordance with Detailed Scope of Work.
2. Existing Doors: Remove existing doors and debris from site in accordance with Detailed Scope of Work.
3. Preparation: Prepare existing openings in accordance with ASTM E 737, manufacturer's recommendations, and approved Shop Drawings.
4. Wood Door Preparation:
    a. Conditioning: Condition wood doors to average humidity in installation area prior to hanging.

b. Prefitting: Prefit wood doors to frames and machine for hardware to whatever extent not previously worked at factory as required for proper fit and uniform clearance at each edge.
c. Sealing: Before installation of hardware on wood doors, brush apply sealer to all job site cut or planed surfaces.

C. Door Frame Installation
1. Door Frames: Install in accordance with ASTM E 737, manufacturer's recommendations, and approved Shop Drawings.
 a. Set frames accurately in accordance with details, straight and free of twist with head level, jambs plumb, and without distortion. Rigidly anchor to walls and partitions and securely brace until surrounding work is completed.
2. Wood Frames: Set plumb and square, and rigidly anchor In place using finish type nails. Provide double wedge blocking near top, bottom, and midpoint of each jamb.
3. Steel Frames: Comply with SDI 105:
 a. Fire-Rated Openings: Place frames and provide clearances in accordance with NFPA 80 and GA 253.
 b. Field Welds: Make welds full length of joints. Remove splatter, and grind exposed welds to match adjacent surfaces. Provide the Owner with ample notice to review welds before finish operations begin.
 c. Wherever possible, leave spreader bars in place until frames are securely anchored.

D. Wood Door Installation
1. General: Install doors in accordance with NWWDA I.S. 1-A, ASTM E 737, manufacturer's recommendations, and approved Shop Drawings.
 a. Install doors and frames securely, straight, plumb, and level without distortion.
2. Wood Doors: Install wood doors in accordance with manufacturers recommendations.
 a. Prefit Doors: Fit to frames for uniform clearance at each edge.
 b. Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted with fire-rated doors.
 c. Hanging: After sizing doors, fit and machine for hardware as scheduled.
  1) Hang doors to be free of binding, with hardware functioning properly.
 d. Clearances for Nonfire-Rated Doors:
  1) Jamb: 3 mm (1/8 inch), 3 mm (1/8 inch) bevel in 50 mm (2 inches).
  2) Head: 3 mm (1/8 inch).
  3) Bottom at Decorative Floor Finish or Covering: 13 mm (1/2 inch).
  4) Bottom at Threshold: 6 mm (1/4 inch) between bottom of door and top of threshold.
 e. Clearances for Fire Rated Doors: Comply with NFPA 80 and local code.
  1) Bevel fire-rated doors 3 mm in 50 mm (1/8 inch in 2 inches) at lock edge; trim stiles and rails only to extent permitted by labeling agency.
 f. Seal cut surfaces after fitting and machining as specified above.
3. Fire-Rated Doors:
 a. Installation, Hardware, and Operational Characteristics: Comply with NFPA 80, NFPA 101, and manufacturer's recommendations.
 b. Factory-Applied Labels: Remain intact where installed. Do not trim labeled hinge stile edge and top edge of door.
  1) Do not paint over labels.
 c. Clearances for Fire-Rated Doors: Comply with NFPA 80 and local code.
  1) Lockstile Edge and Bottom Edge: May be trimmed only to extent recommended by door manufacturer.
  2) Bevel fire-rated doors 3 mm in 50 mm (1/8 inch in 2 inches) at lock edge; trim stiles and rails only to extent permitted by labeling agency.
 d. Seal cut surfaces after fitting and machining as specified above.

E. Hardware Installation

1. General: Install hardware in accordance with SDI 109, DHI recommended locations, and manufacturers recommendations.
2. Fastening: Furnish items of hardware with attachment screws, bolts. nuts. etc., as required to attach hardware to type of material involved and with finish to match adjacent hardware.
    a. Make attachments to metal by template machine screws.
    b. Through-bolt hardware such as door closers, forearm shoes of closers, holding devices, and panic hardware mounted on doors or panels.
    c. Attach hardware to masonry or concrete with expansion bolts or similar drilled anchors to develop full strength of attached device. Set expansion anchors in solid masonry, not mortar joints.
3. Accessories:
    a. Smoke Seals and Sound-stripping: Run full height of both jambs and full width of head.
    b. Thresholds: Run full width of opening. Install thresholds with continuous threshold anchors cast into slab and set in sealant.

F. Door Assemblies Installation
1. Prehung Wood Doors in Frames with Hardware: Install in accordance with manufacturer's recommendations.
2. Bifold Closet Doors with Hardware: Install in accordance with manufacturers recommendations.
3. Sliding Closet Doors with Hardware: Install in accordance with manufacturer's recommendations.

G. Adjusting And Cleaning
1. Adjusting: At completion of job, check, adjust. and lubricate hardware as required, and leave doors and hardware in proper operating condition.
    a. Operation: Rehang or replace doors which do not swing or operate freely.
2. Cleaning: Comply with requirements of Detailed Scope of Work.
    a. Clean doors after installation to remove foreign matter and surface blemishes.
    b. Scratched or Abraded Painted Surfaces: Touch-up with primer and enamel paint compatible with factory finish.

H. Protection
1. Installed Work: Protect doors from damage after installation. as recommended by door manufacturer. to ensure that doors will be without damage or deterioration at project completion.
2. Replacement: Refinish or replace doors damaged during installation.
    a. Causes for Rejection of Wood Doors: Include warp, chips, scratches, or gouges of veneer. and finish defects.

END OF SECTION 06 48 13 00

Task	Specification	Specification Description
06 48 16 00	06 48 13 00	Wood Doors

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SECTION 06 51 13 00 - PLASTIC LUMBER

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of plastic lumber. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Basic Uses
1. For both residential and municipal applications, high-density polyethylene (HDPE) products are well suited for decking, porch flooring, docks, piers, furnishings, fencing, and lawn and garden items. HDPE products are cost-effective alternatives for ground contact and animal contact, wet, and environmentally harsh conditions.

C. Submittals
1. Product Data and Certificates: For each product indicated.
   a. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
2. Shop Drawings: Show location of paneling, large-scale details, attachment devices, and other components. Include dimensioned plans and elevations.
   a. Show details full size.
   b. Show locations and sizes of furring and blocking, including concealed blocking specified in other Sections.
   c. Apply WI Certified Compliance Program label to first page of Shop Drawings.
3. Samples for initial selection for high-pressure decorative laminates.
4. Samples for verification for plastic laminates, 8 by 10 inches (200 by 250 mm) **OR** 12 by 12 inches (300 by 300 mm), **as directed,** for each type, color, pattern, and surface finish, with one sample applied to core material and specified edge material applied to one edge.
5. Qualification Data: For Installer **OR** Fabricator, **as directed**.
6. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates **OR** WI Certified Compliance Program certificates, **as directed**.
7. Evaluation Reports: For fire-retardant-treated materials from ICC-ES.

D. Limitations
1. Plastic lumber has less rigidity (modulus of elasticity) and greater elongation than wood lumber. Therefore, it is not recommended for use as a true structural member. Examples of applications that are inappropriate would be load-bearing walls, deck framing, and floor joists. It is recommended that an engineering study be performed prior to use of HDPE products if the application involves structural requirements. For commercial applications where the system design calls for concentrated loads, structural plastic lumber should be considered.
2. When utilizing HDPE products for decking or flooring, pay careful attention to joist spacing and joist spans. Consult manufacturer for allowable live loads, deflection limits, joist spacing, and joist spans.

E. Quality Assurance
1. Plastic lumber shall meet applicable standards established by ASTM for recycled plastic lumber and hygrothermal testing.
2. Plastic lumber shall pass testing by UL and meet flammability standards established by ASTM.

1.2 PRODUCTS

A. Materials
1. High-density polyethylene (HDPE), UV-inhibited pigment systems, foaming compounds, and selected process additives, shall be derived from post-consumer bottle waste, such as milk and detergent bottles, then compounded into a rigid board stock material, with the resulting finished product containing minimum 75% recycled plastic by weight.
2. Plastic lumber shall have exceptional resistance to corrosive substances, oil and fuels, insects, fungi, salt spray, and other environmental stresses. They shall not absorb moisture; nor shall they rot, splinter, or crack.
3. HDPE products shall be manufactured in standard dimensional lumber sizes, and shapes.
4. Color of plastic lumber shall be selected from manufacturer's standard colors.

1.3 EXECUTION

A. Installation
1. HDPE products shall have the capability of being fabricated and installed with the same tools used to work wood lumber. The product shall cut and drill very cleanly, as there is no grain to split or chip. It shall not be necessary to pre-drill the plastic lumber when fastening. Stainless steel or coated decking nails and screws are recommended for use with HDPE products. Screws offer the best form of attachment; however, nails and staples may also be utilized in some applications.
2. The use of full length boards is suggested to avoid unattractive butt-to-butt joints.
3. HDPE products offer multiple deck board attachment options to accommodate expansion and contraction concerns in different climatic conditions and to address specific installation parameters. These options include:
   a. Tongue and groove deck board attachment with toe screwing options.
   b. Direct screw attachment with feature strip options.
   c. Floating attachment with clip options.
   d. Floating attachment with groove & groove options.

B. Maintenance
1. HDPE products are unaffected by most corrosive substances and will not absorb moisture. To maintain the original finish, clean the lumber with soap and water. No sealing or painting is required; as a general rule, paint will not adhere to HDPE products.
2. Clean graffiti from the plastic lumber with the use of a conventional all-purpose cleaner or petroleum-based cleaner.
3. If the skin or surface layer of an HDPE product becomes marred or blemished, sand off the top skin. The surface can also be buffed to eliminate abrasions.

END OF SECTION 06 51 13 00

SECTION 06 51 13 00a - COMPOSITE PLASTIC LUMBER

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of composite plastic lumber. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Basic Uses
1. Composite plastic lumber or boards are well designed for deck, porch, boardwalk, dock, and similar applications. These boards may also be used for many lumber applications, where a non-load bearing member is required. This material is particularly well suited for outdoor uses due to its durability characteristics. Composite boards have many beneficial properties for decking applications, including:
   a. Low moisture absorption.
   b. No rotting, splitting or splintering.
   c. Inherent termite and UV resistance.
   d. Excellent dimensional stability and wet/dry traction.
   e. No toxic compounds (CCA) to leach into soil or groundwater.
   f. Workability and appearance of natural lumber products.

C. Submittals
1. Product Data and Certificates: For each product indicated.
   a. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
2. Shop Drawings: Show location of paneling, large-scale details, attachment devices, and other components. Include dimensioned plans and elevations.
   a. Show details full size.
   b. Show locations and sizes of furring and blocking, including concealed blocking specified in other Sections.
   c. Apply WI Certified Compliance Program label to first page of Shop Drawings.
3. Samples for initial selection for high-pressure decorative laminates.
4. Samples for verification for plastic laminates, 8 by 10 inches (200 by 250 mm) **OR** 12 by 12 inches (300 by 300 mm), **as directed,** for each type, color, pattern, and surface finish, with one sample applied to core material and specified edge material applied to one edge.
5. Qualification Data: For Installer **OR** Fabricator, **as directed**.
6. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates **OR** WI Certified Compliance Program certificates, **as directed**.
7. Evaluation Reports: For fire-retardant-treated materials from ICC-ES.

D. Limitations
1. Composite plastic lumber has less rigidity (modulus of elasticity) than wood lumber and is more flexible. Therefore, this material should not be employed as a structural component unless an engineering study indicates that its use is appropriate. These boards are not intended to be used as joists, beams, studs, columns or stringers.
2. When utilizing composite plastic lumber products for decking, pay careful attention to joist spacing and joist spans. Consult manufacturer for allowable live loads, deflection limits, joist spacing, and joist spans.

E. Quality Assurance
1. Composite plastic lumber shall meet applicable standards established by ASTM for recycled plastic lumber.

2. Plastic lumber shall meet flammability standards established by ASTM.

F. Handling
1. This material is more flexible and more dense than wood, which should be considered when handling boards.
2. Storing boards on uneven or unsupported surfaces may lead to deformation of the material. Therefore, always store boards on a flat surface, or support with dunnage on centers of 24" or less.

1.2 PRODUCTS

A. Materials
1. Composite plastic lumber products shall be composed of approximately 65% recycled wood/natural fiber and 35% recycled plastic, with selected process additives. The plastic raw material utilized in this product is recycled plastic. It shall be processed to a uniform feedstock, compounded with recovered fibers and extruded into a rigid board product.
2. Colors and sizes of composite plastic lumber shall be selected from manufacturer's standard.

1.3 EXECUTION

A. Installation
1. Composite plastic lumber products shall have the capability of being fabricated and installed with the same tools used to work wood lumber. The product shall cut and drill very cleanly, as there is no grain to split or chip. For best results, use carbide-tipped blades and bits.
2. For optimum water drainage, allow a gap of 3/16" to 1/4" between boards.
3. Both nails and screws may be used to attach USPL composite boards; stainless steel or coated screw type fasteners are recommended.
4. #8, 2 1/2" stainless steel or ceramic-coated deck screws are recommended for 5/4x6 boards, and #10, 3" stainless steel or ceramic-coated deck screws are recommended for 2x6 boards for best results.
5. In cold weather, consider pre-drilling screw holes. Do not use fasteners within 3/4" of the edge of a board. Pneumatic nail guns work with this material.

B. Maintenance
1. Composite boards will weather to a lighter hue during the first few months; fading may take much longer in shaded areas.
2. To clean dirt and most stains from the deck boards, use common deck cleaners available in hardware stores, home centers and lumberyards. Oil stains from grills and foods may require the use of a degreasing cleaner or light sanding to remove the stain. Mold and mildew are common on many exterior surfaces, and they may form on composite plastic lumber. Use common deck washes that contain sodium hypochlorite for best cleaning results.

END OF SECTION 06 51 13 00a

SECTION 06 51 13 00b - STRUCTURAL PLASTIC LUMBER

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of structural plastic lumber. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Basic Uses
1. Structural plastic lumber products are used in a variety of commercial and marine applications and are often the product of choice for exterior applications where resistance to salt and fresh water, marine borers, and other environmentally harsh conditions is required. Due to the unique composition of structural plastic lumber, the product can be used for a number of structural members in commercial and shoreline timberwork.
2. It is well suited for:
   a. Dock and deck planks
   b. Wale timbers
   c. Sheet piling
   d. Camels
   e. Pilings
   f. Fenders
   g. Channel markers
   h. Posts, beams, and joists

C. Submittals
1. Product Data and Certificates: For each product indicated.
   a. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
2. Shop Drawings: Show location of paneling, large-scale details, attachment devices, and other components. Include dimensioned plans and elevations.
   a. Show details full size.
   b. Show locations and sizes of furring and blocking, including concealed blocking specified in other Sections.
   c. Apply WI Certified Compliance Program label to first page of Shop Drawings.
3. Samples for initial selection for high-pressure decorative laminates.
4. Samples for verification for plastic laminates, 8 by 10 inches (200 by 250 mm) **OR** 12 by 12 inches (300 by 300 mm), **as directed,** for each type, color, pattern, and surface finish, with one sample applied to core material and specified edge material applied to one edge.
5. Qualification Data: For Installer **OR** Fabricator, **as directed**.
6. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates **OR** WI Certified Compliance Program certificates, **as directed**.
7. Evaluation Reports: For fire-retardant-treated materials from ICC-ES.

D. Limitations
1. This type of plastic lumber product has a significantly higher modulus of elasticity (MOE) than conventional forms of plastic lumber. However, the MOE of structural plastic lumber is lower than wood timber in good condition; therefore, it is important to evaluate the suitability of this product for specific uses. It is recommended that an engineering study be performed prior to use of structural plastic lumber products for structural applications. Building code regulations vary by region, so all users should consult local building and safety codes prior to installation for specific requirements.

E. Quality Assurance
1. Structural plastic lumber shall meet applicable standards established by ASTM for recycled plastic lumber and hygrothermal testing.
2. Plastic lumber shall meet flammability standards established by ASTM.

1.2 PRODUCTS

A. Materials
1. Structural plastic lumber shall be a high-performance construction material consisting of a patented formula of recycled plastic, fiberglass, and selected additives. The plastic raw material utilized in structural plastic lumber is derived from post-consumer bottle waste such as milk and detergent bottles. This material is compounded into a consistent, reinforced plastic timber product using reactive compatibilizers, creating a strong and stable plastic/fiber matrix.
2. Colors, sizes, and shapes of structural plastic lumber shall be selected from manufacturer's standard.

1.3 EXECUTION

A. Installation
1. Structural plastic lumber can be fabricated and installed with the same tools used to work wood lumber. The product will cut and drill very cleanly, as there is no grain to split or chip, or knots to bind tools and bend fasteners. It is reinforced with glass fibers, and precautions should be taken when fabricating this product. Maintain adequate ventilation when generating fabrication dust, and personal respiratory protection such as dust masks should be employed during fabrication, as well as safety glasses or goggles.
2. Pilings and sheet piling products can be driven with piledriving equipment such as vibratory hammers, land-based or barge-mounted drop hammers, or waterjets. For sheet piling installations, backfill soils should always be analyzed to determine that the proper amount of force would be exerted on the sheet piling system. For shoreline timberwork applications, structural plastic lumber is used with conventional hardware such as stainless or galvanized bolts, tie rods, nuts, washers, and anchor systems.
3. When utilizing structural plastic lumber products for decking, pay careful attention to joist spacing and joist spans. Consult manufacturer for allowable live loads, deflection limits, joist spacing, and joist spans.

B. Maintenance
1. Structural plastic lumber products are unaffected by most corrosive substances and will not absorb moisture. To maintain the original finish, clean the lumber with soap and water. No sealing or painting is required; as a general rule, paint will not adhere well to these products.
2. Clean graffiti from the plastic lumber with the use of a conventional all-purpose cleaner or petroleum-based cleaner. If the skin or surface layer of plastic lumber becomes marred or blemished, sand off the top skin. The surface can also be buffed to eliminate abrasions.

END OF SECTION 06 51 13 00b

Task	Specification	Specification Description
06 65 00 00	06 05 23 00a	Miscellaneous Carpentry

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SECTION 06 74 13 00 - PULTRUDED FIBERGLASS INDUSTRIAL GRATING

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for pultruded fiberglass industrial grating. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals

1. Shop drawings of all fabricated gratings and accessories in accordance with the provisions of this Section.
2. Manufacturer's shop drawings clearly showing material sizes, types, styles, part or catalog numbers, complete details for the fabrication of and erection of components including, but not limited to, location, lengths, type and sizes of fasteners, clip angles, member sizes, and connection details.
3. Manufacturer's published literature including structural design data, structural properties data, grating load/deflection tables, corrosion resistance tables, certificates of compliance, test reports as applicable, concrete anchor systems and their allowable load tables, and design calculations for systems not sized or designed in the contract documents.
4. Sample pieces of each item specified herein for acceptance as to quality and color. Sample pieces shall be manufactured by the method to be used in the work.

C. Quality Assurance

1. All items to be provided under this Section shall be furnished only by manufacturers having experience in the design and manufacture of similar products and systems. If requested, experience shall be demonstrated by a record of at least five (5) previous, separate, similar successful installations in the last five (5) years.

D. Product Delivery And Storage

1. Delivery of Materials: Manufactured materials shall be delivered in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturer. Adhesives, resins and their catalysts and hardeners shall be crated or boxed separately and noted as such to facilitate their movement to a dry indoor storage facility.
2. Storage of Products: All materials shall be carefully handled to prevent them from abrasion, cracking, chipping, twisting, other deformations, and other types of damage. Store items in an enclosed area and free from contact with soil and water. Store adhesives, resins and their catalysts and hardeners in dry indoor storage facilities between 70 and 85 degrees Fahrenheit (21 to 29 degrees Celsius) until they are required.

1.2 PRODUCTS

A. General

1. All FRP items furnished under this Section shall be composed of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements and dimensions as necessary to meet the design requirements and dimensions as specified or required.
2. Fiberglass reinforcement shall be a combination of continuous roving, continuous strand mat, and surfacing veil in sufficient quantities as needed by the application and/or physical properties required.
3. Resins shall be vinyl ester or isophthalic with chemical formulations as necessary to provide the corrosion resistance, strength and other physical properties as required.

4. All finished surfaces of FRP items and fabrications shall be smooth, resin-rich, free of voids and without dry spots, cracks, crazes or unreinforced areas. All glass fibers shall be well covered with resin to protect against their exposure due to wear or weathering.
5. All pultruded structural shapes shall be further protected from ultraviolet (UV) light with 1) integral UV inhibitors in the resin and 2) a synthetic surfacing veil to help produce a resin rich surface.
6. All FRP products shall have a tested flame spread rating of 15 or less per ASTM E-84 Tunnel Test. Gratings shall also have a tested burn time of less than 30 seconds and an extent of burn rate of less than or equal to 10 millimeters per ASTM D-635.
7. All grating clips shall be manufactured of Type 316SS (stainless steel).

B. Pultruded Grating
1. Manufacture: Grating components shall be high strength and high stiffness pultruded elements having a maximum of 70% and a minimum of 60% glass content (by weight) of continuous roving and continuous strand mat fiberglass reinforcements. The finished surface of the product shall be provided with a surfacing veil to provide a resin rich surface which improves corrosion resistance and resistance to ultraviolet degradation. Bearing bars shall be interlocked and epoxied in place with a two piece cross rod system to provide a mechanical and chemical lock.
2. Non-slip surfacing: Grating shall be provided with a quartz grit bonded and baked to the top surface of the finished grating product.
3. Fire rating: Grating shall be fire retardant with a tested flame spread rating of 15 or less when tested in accordance with ASTM E 84. Manufacturer may be required to provide certification of ASTM E84 test on grating panels from an independent testing laboratory. Certification shall be dated within the past two years. Test data shall be from full scale testing of actual production grating, of the same type and material supplied on the project. Test data performed only on the base resin shall not be acceptable.
4. Resin system: The resin system used in the manufacture of the grating shall be VEFR, vinyl ester or ISOFR, isophthalic . Manufacturer may be required to submit corrosion data from tests performed on actual grating products in standard chemical environments. Corrosion resistance data of the base resin from the manufacturer is not a true indicator of grating corrosion resistance and shall not be accepted.
5. Color: Gray or Yellow.
6. Depth: 2" deep load bars with a tolerance of plus or minus 1/32".
7. Mesh Configuration: 2" load bar spacing, 6" tie bar spacing on centers.
8. Load/Deflection: Grating shall meet manufacturer's published safe recommended loadings with deflection not to exceed the following:
   a. Uniform distributed load over a 66" span: 50 pounds per square foot, with a maximum deflection of 0.13".
9. Substitutions: Other products of equal strength, stiffness, corrosion resistance and overall quality may be submitted with the proper supporting data to the engineer for approval.

C. Grating Fabrication
1. Measurements: Grating supplied shall meet the minimum dimensional requirements as shown or specified. The Contractor shall provide and/or verify measurements in field for work fabricated to fit field conditions as required by grating manufacturer to complete the work.
   a. Determine correct size and locations of required holes or cutouts from field dimensions before grating fabrication.
2. Layout: Each grating section shall be readily removable, except where indicated on drawings. Manufacturer to provide openings and holes where located on the contract drawings. Grating supports shall be provided at openings in the grating by contractor where necessary to meet load/deflection requirements specified herein. Grating openings which fit around protrusions (pipes, cables, machinery, etc.) shall be discontinuous at approximately the centerline of opening so each section of grating is readily removable. Gratings shall be fabricated free from warps, twists, or other defects which affect appearance and serviceability.

3. Sealing: All shop fabricated grating cuts shall be coated with vinyl ester resin to provide maximum corrosion resistance. All field fabricated grating cuts shall be coated similarly by the contractor in accordance with the manufacturer's instructions.
4. Hardware: Type 316 stainless steel hold-down clips shall be provided and spaced at a maximum of four feet apart with a minimum of four per piece of grating, or as recommended by the manufacturer.

1.3 EXECUTION

A. Inspection

1. Shop inspection is authorized as required by the Owner and shall be at Owner's expense. The fabricator shall give ample notice to Contractor prior to the beginning of any fabrication work so that inspection may be provided.
2. The grating shall be as free, as commercially possible, from visual defects such as foreign inclusions, delamination, blisters, resin burns, air bubbles and pits.

B. Installation

1. Contractor shall install gratings in accordance with manufacturer’s assembly drawings. Lock grating panels securely in place with hold-down fasteners as specified herein. Field cut and drill fiberglass reinforced plastic products with carbide or diamond tipped bits and blades. Seal cut or drilled surfaces in accordance with manufacturer's instructions. Follow manufacturer's instructions when cutting or drilling fiberglass products or using resin products; provide adequate ventilation.

END OF SECTION 06 74 13 00

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Task	Specification	Specification Description
06 74 13 00	05 53 13 00	Gratings

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SECTION 06 82 00 00 - PULTRUDED FIBERGLASS STRUCTURAL SHAPES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of pultruded fiberglass structural shapes. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Shop drawings of all fabricated structural systems and accessories.
2. Manufacturer's shop drawings clearly showing material sizes, types, styles, part or catalog numbers, complete details for the fabrication of and erection of components including, but not limited to, location, lengths, type and sizes of fasteners, clip angles, member sizes, and connection details.
3. Manufacturer’s published literature including structural design data, structural properties data, corrosion resistance tables, certificates of compliance, test reports as applicable, and design calculations for systems not sized or designed in the contract documents, sealed by a Professional Engineer.
4. Sample pieces of each item specified herein for acceptance as to quality and color. Sample pieces shall be manufactured by the method to be used in the work.

C. Quality Assurance
1. All items to be provided under this Section shall be furnished only by manufacturers having experience in the design and manufacture of similar products and systems. If requested, experience shall be demonstrated by a record of at least five (5) previous, separate, similar successful installations in the last five (5) years.

D. Product Delivery and Storage
1. Delivery of Materials: Manufactured materials shall be delivered in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturer. Adhesives, resins and their catalysts and hardeners shall be crated or boxed separately and noted as such to facilitate their movement to a dry indoor storage facility.
2. Storage of Products: All materials shall be carefully handled to prevent them from abrasion, cracking, chipping, twisting, other deformations, and other types of damage. Store items in an enclosed area and free from contact with soil and water. Store adhesives, resins and their catalysts and hardeners in dry indoor storage facilities between 70 and 85 degrees Fahrenheit (21 to 29 degrees Celsius) until they are required.

1.2 PRODUCTS

A. Materials
1. All structural shapes shall be manufactured by the pultrusion process with a glass content minimum of 45%, maximum of 55% by weight for maximum sunlight and chemical resistance. The structural shapes shall be composed of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements and dimensions as necessary to meet the design requirements and dimensions as specified in the Contract Documents.
2. Fiberglass reinforcement shall be a combination of continuous roving, continuous strand mat, and surfacing veil in sufficient quantities as needed by the application and/or physical properties required.
3. Resins shall be ISO, non-fire retardant isophthalic polyester; ISOFR, fire retardant isophthalic polyester or VEFR, vinyl ester, with chemical formulation necessary to provide the corrosion resistance, strength and other physical properties as required.

4. All finished surfaces of FRP items and fabrications shall be smooth, resin-rich, free of voids and without dry spots, cracks, crazes or unreinforced areas. All glass fibers shall be well covered with resin to protect against their exposure due to wear or weathering.
5. All pultruded structural shapes shall be further protected from ultraviolet (UV) attack with 1) integral UV inhibitors in the resin and 2) a synthetic surfacing veil to help produce a resin rich surface.
6. All FRP products shall have a tested flame spread rating of 25 or less per ASTM E-84 Tunnel Test.

B. Pultruded structural shapes shall have the minimum longitudinal mechanical properties listed below:

Property	**ASTM Method**	**Value**	**Units**
Tensile Strength	D-638	30,000 (206)	psi (MPa)
Tensile Modulus	D-638	2.5×10^6 (17.2)	psi (GPa)
Flexural Strength	D-790	30,000 (206)	psi (MPa)
Flexural Modulus	D-790	1.8×10^6 (12.4)	psi (GPa)
Flexural Modulus (Full Section)	N/A	2.8×10^6 (19.3)	psi (GPa)
Short Beam Shear (Transverse)	D-2344	4,500 (31)	psi (MPa)
Shear Modulus (Transverse)	N/A	4.5×10^5 (3.1)	psi (GPa)
Coefficient of Thermal Expansion	D-696	8.0×10^{-6} (1.4×10^{-6})	in/in/°F (cm/cm/°C)
Flame Spread	E-84	25 or less	N/A

1.3 EXECUTION

A. Fabrication
1. Measurements: Structural Shapes supplied shall meet the minimum dimensional requirements as shown or specified. The Contractor shall provide and/or verify measurements in field for work fabricated to fit field conditions as required by manufacturer to complete the work. Determine correct size and locations of required holes or coping from field dimensions before structural shape fabrication.
2. Sealing: All shop fabricated cuts or drilling shall be coated with vinyl ester resin to provide maximum corrosion resistance. All field fabricated cuts or drilling shall be coated similarly by the contractor in accordance with the manufacturer's instructions.
3. Hardware: Type 316 stainless steel connection hardware shall be provided.

B. Inspection
1. Shop inspection shall be authorized as required by the Owner and shall be at Owner's expense. The fabricator shall give ample notice to Contractor prior to the beginning of any fabrication work so that inspection may be provided.
2. The structural shapes shall be as free, as commercially possible, from visual defects such as foreign inclusions, delamination, blisters, resin burns, air bubbles and pits.

END OF SECTION 06 82 00 00

SECTION 07 01 50 81 - BUILT-UP COAL-TAR ROOFING

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for built-up coal-tar roofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Built-up coal-tar roofing.
      b. Vapor retarder.
      c. Roof insulation.
   2. Section includes the installation of insulation strips in ribs of acoustical roof deck. Insulation strips are furnished under Division 05 Section "Steel Decking".

C. Definitions
   1. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to built-up roofing.
   2. Bitumen: A generic term for either asphalt or coal-tar pitch.
   3. Hot Coal-Tar Pitch: Coal-tar pitch heated to its equiviscous temperature, the temperature at which its viscosity is 25 centipoise for either mopping or mechanical application, within a range of plus or minus 25 deg F (14 deg C), measured at the mop cart or mechanical spreader immediately before application.
   4. Hot Roofing Asphalt: Roofing asphalt heated to its equiviscous temperature, the temperature at which its viscosity is 125 centipoise for mop-applied roofing asphalt and 75 centipoise for mechanical spreader-applied roofing asphalt, within a range of plus or minus 25 deg F (14 deg C), measured at the mop cart or mechanical spreader immediately before application.

D. Performance Requirements
   1. General Performance: Installed built-up roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Built-up roofing and base flashings shall remain watertight.
   2. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by built-up roofing manufacturer based on testing and field experience.
   3. Roofing System Design (if built-up roofing system is to be designed to withstand uplift pressure established by ASCE/SEI 7): Provide built-up roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
      a. Corner Uplift Pressure: as directed by the Owner.
      b. Perimeter Uplift Pressure: as directed by the Owner.
      c. Field-of-Roof Uplift Pressure: as directed by the Owner.
   4. FM Approvals Listing (if Project is FM Global insured or if FM Approvals requirements will set a minimum quality standard): Provide built-up roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a built-up roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.
      a. Fire/Windstorm Classification: Class 1A-60 **OR** Class 1A-75 **OR** Class 1A-90 **OR** Class 1A-105 **OR** Class 1A-120, **as directed**.
      b. Hail Resistance Rating: MH **OR** SH, **as directed**.

5. Energy Performance (if required for LEED-NC Credit SS 7.2): Provide roofing system with initial Solar Reflectance Index not less than 78 when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.
6. Energy Performance (for roofs that must comply with the DOE's ENERGY STAR requirements): Provide roofing system that is listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.
7. Energy Performance (for roofs that must comply with California Energy Commission's CEC-Title 24): Provide roofing system with initial solar reflectance not less than 0.70 and emissivity not less than 0.75 when tested according to CRRC-1.

E. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
    a. Product Test Reports for Credit SS 7.2: For roof materials, indicating that roof materials comply with Solar Reflectance Index requirement.
    b. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: For built-up roofing. Include plans, elevations, sections, details, and attachments to other work.
    a. Base flashings and built-up terminations.
    b. Tapered insulation, including slopes.
    c. Crickets, saddles, and tapered edge strips, including slopes.
    d. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
4. Samples: For the following products:
    a. Built-up roofing materials, including base sheet, ply sheet and flashing sheet, of color specified.
    b. Roof insulation.
    c. 3 lb (1.5 kg) of aggregate surfacing material in gradation and color indicated.
    d. Walkway pads.
    e. Six insulation fasteners of each type, length, and finish.
5. Qualification Data: For qualified Installer and manufacturer.
6. Manufacturer Certificates: Signed by roofing manufacturer certifying that built-up roofing complies with requirements specified in "Performance Requirements" Article.
    a. Submit evidence of compliance with performance requirements.
7. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of built-up roofing.
8. Research/Evaluation Reports: For components of built-up roofing, from the ICC-ES **OR** other applicable model code organization, **as directed**.
9. Maintenance Data: For built-up roofing to include in maintenance manuals.
10. Warranties: Sample of special warranties.

F. Quality Assurance
1. Manufacturer Qualifications: A qualified manufacturer that is UL listed **OR** FM Approvals approved, **as directed**, for built-up roofing identical to that used for this Project.
2. Installer Qualifications (if Project is FM Global insured and if a certified roofing installer is required): A qualified firm that is approved, authorized, or licensed by built-up roofing manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
3. Source Limitations (if required to comply with FM Approvals, UL, or another building code, or to comply with provisions of manufacturer's special warranty): Obtain components including roof insulation and fasteners for built-up roofing from same manufacturer as built-up roofing or approved by built-up roofing manufacturer.
4. Exterior Fire-Test Exposure: ASTM E 108, Class A **OR** Class B **OR** Class C, **as directed**; for application and roof slopes indicated, as determined by testing identical built-up roofing materials

by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.

5. Fire-Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
6. Preinstallation Roofing Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling

1. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
2. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing manufacturer. Protect stored liquid material from direct sunlight.
   a. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
3. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
4. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

H. Project Conditions

1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing to be installed according to manufacturer's written instructions and warranty requirements.

I. Warranty

1. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of built-up roofing that fail in materials or workmanship within specified warranty period.
   a. Special warranty includes built-up roofing membrane, base flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories, roof pavers, and other components of built-up roofing.
   b. Warranty Period: 10 **OR** 15 **OR** 20 **OR** 25 **OR** 30, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Base-Sheet Materials

1. Sheathing Paper: Red-rosin type, minimum 3 lb/100 sq. ft. (0.16 kg/sq. m).
2. Base Sheet: ASTM D 4601, Type I **OR** II, **as directed**, nonperforated, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.
   OR
   Base Sheet: ASTM D 4897, Type II, venting, nonperforated, heavyweight, asphalt-impregnated and -coated, glass-fiber base sheet with coarse granular surfacing or embossed venting channels on bottom surface.
   OR
   Base Sheet: ASTM D 2626, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.

B. Roofing Membrane Plies

1. Ply Sheet: ASTM D 227, coal-tar-saturated organic felt.
   OR

Ply Sheet: ASTM D 4990, Type I, coal-tar-impregnated, glass-fiber felt and the physical properties of ASTM D 2178, Type IV **OR** VI, **as directed**.

C. Base Flashing Sheet Materials
1. Backer Sheet: ASTM D 2178, Type IV, asphalt-impregnated, glass-fiber felt.
   OR
   Backer Sheet: Roofing manufacturer's standard spun-bonded, nonwoven, polyester-reinforced fabric, of standard color and weight, suitable for application method specified.
2. Granule-Surfaced Flashing Sheet: ASTM D 6164, Grade G, Type I or II, polyester-reinforced, SBS-modified asphalt sheet; granular surfaced base flashing; suitable for application method specified, and as follows:
   a. Granule Color: White **OR** Gray **OR** Tan, **as directed**.
3. Polyester Flashing Sheet: Roofing manufacturer's standard asphalt-coated, polyester-reinforced fabric, base flashing, suitable for application method specified.
4. Fabric Termination: Roofing manufacturer's standard polyester cloth, suitable for application and for reinforcing top seal of base flashing.

D. Bitumen Materials
1. Asphalt Primer: ASTM D 41.
   OR
   Coal-Tar Primer: ASTM D 43.
2. Coal-Tar Pitch: ASTM D 450, Type I.
3. Roofing Asphalt: ASTM D 312, Type III **OR** IV **OR** III or IV as recommended by built-up roofing manufacturer for application, **as directed**.
   OR
   Roofing Asphalt: ASTM D 6152, SEBS modified.

E. Auxiliary Built-Up Roofing Materials
1. General: Auxiliary materials recommended by built-up roofing manufacturer for intended use and compatible with built-up roofing.
   a. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
   b. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
      1) Plastic Foam Adhesives: 50 g/L.
      2) Gypsum Board and Panel Adhesives: 50 g/L.
      3) Multipurpose Construction Adhesives: 70 g/L.
      4) Fiberglass Adhesives: 80 g/L.
      5) Contact Adhesives: 80 g/L.
      6) Other Adhesives: 250 g/L.
      7) Nonmembrane Roof Sealants: 300 g/L.
      8) Sealant Primers for Nonporous Substrates: 250 g/L.
      9) Sealant Primers for Porous Substrates: 775 g/L.
2. Cold-Applied Adhesive: Roofing manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive specially formulated for compatibility and use with built-up base flashings.
3. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required by roofing manufacturer for application.
4. SBS-Modified Asphalt Flashing Cement: Roofing manufacturer's standard, asbestos free, of consistency required for application.
5. Coal-Tar Roofing Cement: ASTM D 5643, coal-tar-based roofing cement, asbestos free.
6. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening built-up roofing components

to substrate, tested by manufacturer for required pullout strength, and acceptable to roofing manufacturer.
7. Metal Flashing Sheet: Metal flashing sheet is specified in Division 07 Section "Sheet Metal Flashing And Trim".
8. Metal Termination Bars: Roofing manufacturer's standard predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.
9. Roof Coatings: ASTM D 2824, Type I, nonfibered **OR** III, fibered, asbestos-free, **as directed**, aluminum-pigmented asphaltic coating.
OR
Roof Coatings: ASTM D 6083, acrylic elastomer emulsion coating, formulated for use on bituminous roof surfaces.
    a. Color: White **OR** Gray **OR** Buff, **as directed**.
10. Aggregate Surfacing: ASTM D 1863, No. 6 or No. 67, clean, dry, opaque, water-worn gravel or crushed stone, free of sharp edges **OR** crushed slag, free of sharp edges, **as directed**.
11. Walkway Pads: Mineral-granule-surfaced, reinforced asphaltic composition **OR** Polymer-modified, reconstituted solid-rubber, surface-textured, **as directed**, slip-resisting pads, manufactured as a traffic pad for foot traffic and acceptable to built-up roofing manufacturer, 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, thick, minimum.
12. Miscellaneous Accessories: Provide miscellaneous accessories recommended by built-up roofing manufacturer.

F. Substrate Boards
1. Substrate Board: ASTM C 1396/C 1396M, Type X gypsum board, 5/8 inch (16 mm) thick.
OR
Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** Type X, 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.
OR
Substrate Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
OR
Substrate Board: ASTM C 728, perlite board, 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick, seal coated.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

G. Vapor Retarder
1. Polyethylene Film: ASTM D 4397, 6 mils (0.15 mm) thick, minimum, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
    a. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
    OR
    Adhesive: Manufacturer's standard lap adhesive, FM Approvals approved for vapor-retarder application.
2. Laminated Sheet: Kraft paper/polyethylene laminate, two layers, reinforced with woven fiberglass yarn, laminated and edge reinforced, with maximum permeance rating of 0.50 perm (29 ng/Pa x s x sq. m) and with manufacturer's standard adhesive, **as directed**.
3. Self-Adhering Sheet Vapor Retarder: ASTM D 1970, minimum of 40-mil- (1.0-mm-) thick, polyethylene film laminated to layer of rubberized asphalt adhesive; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold-applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.
OR
Self-Adhering Sheet Vapor Retarder: 30- to 40-mil- (0.76- to 1.0-mm-) thick, polyethylene film laminated to layer of butyl rubber adhesive; maximum permeance rating of 0.1 perm (6 ng/Pa x s

x sq. m); cold-applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

4. Glass-Fiber Felts: ASTM D 2178, Type IV, asphalt impregnated.

H. Roof Insulation

1. General: Preformed roof insulation boards manufactured or approved by roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation, **as directed**.
2. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2 **OR** Type II, Class I, Grade 3, **as directed**, felt or glass-fiber mat facer on both major surfaces.
3. Composite Polyisocyanurate Board Insulation: ASTM C 1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other surface.
   a. Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick.
   b. Type V, OSB facer, 7/16 inch (11 mm) thick.
   c. Type VII, glass mat faced gypsum board facer, 1/4 inch (6 mm) thick.
4. Perlite Board Insulation: ASTM C 728, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.
5. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 1, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.
6. Cellular-Glass Board Insulation: ASTM C 552, Type IV, rigid, cellular-glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.
7. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/8 inch per 12 inches (1:96) **OR** 1/4 inch per 12 inches (1:48), **as directed**, unless otherwise indicated.
8. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

I. Insulation Accessories

1. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatible with built-up roofing.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate and acceptable to roofing manufacturer.
3. Modified Asphaltic Insulation Adhesive: Insulation manufacturer's recommended modified asphaltic, asbestos-free, cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.
4. Bead-Applied Insulation Adhesive: Insulation manufacturer's recommended bead-applied, low-rise, one- or multicomponent urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
5. Full-Spread Applied Insulation Adhesive: Insulation manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
6. Insulation Cant Strips: ASTM C 728, perlite insulation board.
   OR
   Insulation Cant Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.
7. Wood Nailer Strips: Comply with requirements in Division 6 Section "Rough Carpentry" **OR** “Miscellaneous Carpentry", **as directed**.
8. Tapered Edge Strips: ASTM C 728, perlite insulation board.
   OR
   Tapered Edge Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.
9. Cover Board: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, 1/2 inch (13 mm) thick.
   OR

Cover Board: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
OR
Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.
OR
Cover Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.

10. Substrate Joint Tape: 6- or 8-inch- (150- or 200-mm-) wide, coated, glass fiber.

1.3 EXECUTION

A. Examination

1. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
   a. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
   b. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
   c. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 5 Section "Steel Deck."
   d. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of 1/16 inch (1.6 mm) out of plane relative to adjoining deck.
   e. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
   f. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
      1) Test for moisture by pouring 1 pint (0.5 L) of hot roofing asphalt on deck at start of each day's work and at start of each roof area or plane. Do not proceed with roofing work if test sample foams or can be easily and cleanly stripped after cooling.
   g. Verify that concrete curing compounds that will impair adhesion of roofing components to roof deck have been removed.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation

1. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing manufacturer's written instructions. Remove sharp projections.
2. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
3. Prime surface of concrete deck with asphalt **OR** coal-tar, **as directed**, primer at a rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
4. Install insulation strips in ribs of acoustical roof decks according to acoustical roof deck manufacturer's written instructions.

C. Substrate Board Installation

1. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
   a. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' "RoofNav" and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.
      OR
      Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to built-up roofing manufacturers' written instructions.

D. Vapor-Retarder Installation
1. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
   a. Continuously seal side and end laps with tape **OR** adhesive, **as directed**.
2. Laminate Sheet: Install laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively. Bond vapor retarder to substrate as follows:
   a. Apply adhesive at rate recommended by vapor-retarder manufacturer. Seal laps with adhesive.
      OR
      Apply ribbons of hot roofing asphalt at spacing, temperature, and rate recommended by vapor-retarder manufacturer. Seal laps with hot roofing asphalt.
3. Self-Adhering Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 inches (90 mm) and 6 inches (150 mm), respectively. Seal laps by rolling.
4. Built-up Vapor Retarder: Install two glass-fiber felt plies lapping each felt 19 inches (483 mm) over preceding felt. Embed each felt in a solid mopping of hot roofing asphalt. Glaze-coat completed surface with hot roofing asphalt. Apply hot roofing asphalt within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
5. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into built-up roofing system.

E. Insulation Installation
1. Comply with built-up roofing manufacturer's written instructions for installing roof insulation.
2. Install one lapped base sheet course and mechanically fasten to substrate according to built-up roofing manufacturer's written instructions.
3. Nailer Strips: Mechanically fasten 4-inch nominal- (89-mm actual-) width wood nailer strips of same thickness as insulation perpendicular to sloped roof deck, spaced 16 feet (4.88 m) apart for roof slopes greater than 1/4 inch per 12 inches (1:48) **OR** 1/2 inch per 12 inches (1:24), **as directed**.
4. Insulation Cant Strips: Install and secure preformed 45-degree insulation cant strips at junctures of built-up roofing with vertical surfaces or angle changes greater than 45 degrees.
5. Install tapered insulation under area of roofing to conform to slopes indicated.
6. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
   a. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
7. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.
   a. Where installing composite and noncomposite board insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
8. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
9. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.
10. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
    a. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
    b. Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
       OR

Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
OR
Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

11. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
    a. If Project is FM Global insured or if FM Approvals requirements are proposed as a performance standard, fasten insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
    b. If number of fasteners will be based on ASCE/SEI 7's uplift pressure, fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.
12. Mechanically Fastened and Adhered Insulation: Install first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
    a. If Project is FM Global insured or if FM Approvals requirements are proposed as a performance standard, fasten first layer of insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
    b. If fastening is calculated from ASCE/SEI 7's uplift pressure, fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
    c. Set each subsequent layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
    OR
    Set each subsequent layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
    OR
    Set each subsequent layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
13. If cover boards will be field installed over roof insulation and immediately below built-up roofing, install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction. Loosely butt cover boards together and fasten to roof deck, **as directed**. Tape joints if required by roofing manufacturer.
    a. Fasten cover boards according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
    OR
    Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.
    b. Apply hot roofing asphalt to underside and immediately bond cover board to substrate.

F. Built-Up Roofing Installation, General
1. If referencing NRCA's roof assembly identification matrix system, install roofing membrane according to roofing manufacturer's written instructions and applicable recommendations of ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing."
    a. Install roofing system BU-3 **OR** 4 **OR** 5, **as directed**,-N **OR** I **OR** C, **as directed**,-A-A, according to roof assembly identification matrix and roof assembly layout illustrations in NRCA's "The NRCA Roofing and Waterproofing Manual" and requirements in this Section.
2. For roofing that exceeds requirements of NRCA's roof assemblies, install built-up roofing membrane according to roofing manufacturer's written instructions and applicable recommendations of ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing" and as follows:
    a. Deck Type: N (nailable) **OR** I (insulated) **OR** C (concrete or nonnailable), **as directed**.
    b. Base Sheet: 1 **OR** 1, installed over sheathing paper, **as directed**.
    c. Number of Organic Felt Ply Sheets: 2 **OR** 3 **OR** 4, **as directed**.
    d. Number of Glass Fiber Ply Sheets: 1, top ply **OR** 2 **OR** 3 **OR** 4, **as directed**.
    e. Surfacing Type: A (aggregate).

3. Start installation of built-up roofing in presence of manufacturer's technical personnel.
4. Where roof slope exceeds 1/4 inch per 12 inches (1:48) **OR** 1/2 inch per 12 inches (1:24), **as directed**, install built-up roofing sheets parallel with slope.
   a. Backnail built-up roofing sheets to nailer strips **OR** substrate, **as directed**, according to roofing manufacturer's written instructions.
5. Cooperate with testing agencies engaged or required to perform services for installing roofing system.
6. Coordinate installation of built-up roofing so insulation and other components of built-up roofing not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.
   a. Provide tie-offs at end of each day's work to cover exposed built-up roofing sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt with joints and edges sealed.
   b. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
   c. Remove and discard temporary seals before beginning work on adjoining roofing.
7. Bitumen Heating: Do not raise bitumen temperature above equiviscous temperature range more than one hour before time of application. Do not exceed bitumen manufacturer's recommended temperature limits during bitumen heating. Do not heat bitumen within 25 deg F (14 deg C) of flash point. Discard bitumen maintained for more than 4 hours at a temperature exceeding 325 deg F (163 deg C) for coal-tar pitch or finished blowing temperature for roofing asphalt, **as directed**.
   a. Mopping Weights: For interply and other moppings, unless otherwise indicated, apply solid moppings of hot coal-tar pitch between ply sheets at a minimum rate of 20 lb/100 sq. ft. (1 kg/sq. m).
8. SEBS-Asphalt Heating: Heat and apply SEBS-modified roofing asphalt according to roofing manufacturer's written instructions.
9. Substrate-Joint Penetrations: Prevent bitumen and adhesives from penetrating substrate joints, entering building, or damaging built-up roofing components or adjacent building construction.

G. Roofing Membrane Installation
1. If sheathing paper is required over wood decks by built-up roofing manufacturer, loosely lay one course of sheathing paper, lapping edges and ends a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
2. Install lapped base sheet course, extending sheet over and terminating beyond cants. Attach base sheet as follows:
   a. Mechanically fasten to substrate, for nailable substrate.
      OR
      Spot- or strip-mop to substrate with hot roofing asphalt.
      OR
      Adhere to substrate in a solid mopping of hot roofing asphalt **OR** uniform coating of cold-applied adhesive, **as directed**, for nonnailable or insulated substrates.
3. Monolithic Membrane: Install two **OR** three **OR** four, **as directed**, ply sheets starting at low point of roofing system. Align ply sheets without stretching. Shingle side laps of ply sheets uniformly to achieve required number of plies throughout thickness of roofing membrane. Shingle in direction to shed water. Extend ply sheets over and terminate beyond cants. Embed each ply sheet in a solid mopping of hot coal-tar pitch to form a uniform membrane without ply sheets touching.
   OR
   Composite Membrane: Install two **OR** three **OR** four, **as directed**, organic felt ply sheets starting at low point of roofing system. Align organic felt ply sheets without stretching. Shingle side laps of organic felt ply sheets uniformly to achieve required number of plies throughout thickness of roofing membrane. Shingle in direction to shed water.
   a. Install finish layer of one lapped coal-tar, glass-fiber ply sheet course over shingled organic felt ply sheets, starting at low point of built-up roofing. Offset laps from laps of preceding

ply sheets and align coal-tar, glass-fiber ply sheet without stretching. Lap in direction to shed water.

b. Extend ply sheets over and terminate beyond cants.

c. Embed each ply sheet in a solid mopping of hot coal-tar pitch applied at rate required by built-up roofing manufacturer, to form a uniform membrane without ply sheets touching.

4. If delayed flood coating and aggregate surfacing of coal-tar, glass-fiber membrane or finish layer are permitted, glaze-coat roofing membrane surface with hot coal-tar pitch applied at a rate of 10 to 15 lb/100 sq. ft. (0.5 to 0.75 kg/sq. m) if aggregate surfacing is not applied immediately.

5. Aggregate Surfacing: If surfacing roofing membrane with aggregate, promptly after installing and testing roofing membrane, base flashing, and stripping, flood-coat roof surface with 70 lb/100 sq. ft. (3.5 kg/sq. m) of hot coal-tar pitch. While flood coat is hot and fluid, cast the following average weight of aggregate in a uniform course:

a. Aggregate Weight: 400 lb/100 sq. ft. (20 kg/sq. m) for gravel or crushed stone or 300 lb/100 sq. ft. (15 kg/sq. m) for slag.

b. Sweep loose aggregate from roof surface and apply another flood coat of not less than 85 lb/100 sq. ft. (4.15 kg/sq. m) of hot coal-tar pitch. While flood coat is hot and fluid, apply a uniform course of aggregate at the following rate. Sweep away loose aggregate and fully embed aggregate by lightly rolling into finished roof surface.

1) Aggregate Weight: 300 lb/100 sq. ft. (15 kg/sq. m) for gravel or crushed stone 200 lb/100 sq. ft. (10 kg/sq. m) for slag, average.

6. Walkway Pads: Install walkway pads using units of size indicated or, if not indicated, of manufacturer's standard size according to walkway pad manufacturer's written instructions.

a. Sweep away loose aggregate surfacing and set walkway pads in additional flood coat of hot coal-tar pitch.

H. Flashing And Stripping Installation

1. Install base flashing over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through roof, and secure to substrates according to built-up roofing manufacturer's written instructions and as follows:

a. Prime substrates with asphalt primer if required by built-up roofing manufacturer.

b. Backer Sheet Application: Install single backer sheet and adhere to substrate in a solid mopping of hot roofing asphalt **OR** asphalt roofing cement **OR** SBS-modified asphalt roofing cement **OR** cold-applied adhesive, **as directed**.

OR

Backer Sheet Application: Install two **OR** three, **as directed**, backer sheets and adhere to substrate in a solid mopping of hot roofing asphalt **OR** asphalt roofing cement, **as directed**.

c. Flashing Sheet Application: Adhere flashing sheet to substrate in a solid mopping of hot roofing asphalt applied at not less than 425 deg F (218 deg C). Apply hot roofing asphalt to back of flashing sheet if recommended by roofing manufacturer.

OR

Flashing Sheet Application: Adhere flashing sheet to substrate in SBS-modified asphalt roofing cement **OR** asphalt roofing cement, **as directed**.

2. Extend base flashing up walls or parapets a minimum of 8 inches (200 mm) above built-up roofing and 4 inches (100 mm) onto field of built-up roofing.

3. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.

a. Securely fasten top termination of base flashing with continuous metal termination bar anchored into substrate.

b. Seal top termination of base flashing with a strip of glass-fiber fabric set in asphalt roofing cement, **as directed.**

4. Apply roof coatings to smooth base flashings according to manufacturer's written instructions, by spray, roller, or other suitable application method.

5. Install stripping, according to roofing system manufacturer's written instructions, where metal flanges and edgings are set on built-up roofing.

a. Flashing-Sheet Stripping: Install flashing-sheet stripping in a cold-applied adhesive or in a solid mopping of hot coal-tar pitch and extend onto roofing membrane.

OR
Built-up Stripping: Install stripping of not less than two roofing membrane ply sheets, setting each ply in a continuous coal-tar roofing cement or in a solid mopping of hot coal-tar pitch, and extend onto roofing membrane 4 inches (100 mm) and 6 inches (150 mm), respectively.

6. Roof Drains: Set 30-by-30-inch (760-by-760-mm) metal flashing in bed of asphalt roofing cement on completed built-up roofing. Cover metal flashing with built-up roofing cap-sheet stripping and extend a minimum of 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, beyond edge of metal flashing onto field of built-up roofing. Clamp built-up roofing, metal flashing, and stripping into roof-drain clamping ring.
   a. Flashing-Sheet Stripping: Install flashing-sheet stripping in cold-applied adhesive or in a solid mopping of hot coal-tar pitch and extend onto roofing membrane.
      OR
      Built-up Stripping: Install stripping of not less than 2 roofing membrane ply sheets, setting each ply in a continuous coating of coal-tar roofing cement or in a solid mopping of hot coal-tar pitch, and extend onto roofing membrane 4 inches (100 mm) and 6 inches (150 mm), respectively.

I. Field Quality Control
1. Testing Agency: Perform roof tests and inspections, observe flood tests, and prepare test reports.
2. Test Cuts: Test specimens will be removed to evaluate problems observed during quality-assurance inspections of built-up roofing as follows:
   a. Approximate quantities of components within built-up roofing will be determined according to ASTM D 3617.
   b. Test specimens will be examined for interply voids according to ASTM D 3617 and to comply with criteria established in Appendix 3 of ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing."
   c. Repair areas where test cuts were made according to built-up roofing manufacturer's written instructions.
3. Flood Testing: Flood test each roofing membrane area for leaks, according to recommendations in ASTM D 5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.
   a. Flood to an average depth of 2-1/2 inches (65 mm) with a minimum depth of 1 inch (25 mm) and not exceeding a depth of 4 inches (100 mm). Maintain 2 inches (50 mm) of clearance from top of base flashing.
   b. Flood each area for 24 **OR** 48 **OR** 72, **as directed**, hours.
   c. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.
4. Repair or remove and replace components of roofing system where test results or inspections indicate that they do not comply with specified requirements.
   a. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

J. Protecting And Cleaning
1. Protect built-up roofing from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to the Owner.
2. Correct deficiencies in or remove built-up roofing that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Final Completion and according to warranty requirements.
3. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 01 50 81

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SECTION 07 01 50 81a - PREPARATION FOR RE-ROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for preparation for re-roofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Roof tear-off.
b. Partial roof tear-off.
c. Temporary roofing membrane.
d. Roof re-cover preparation.
e. Removal of base flashings.

C. Materials Ownership
1. Except for items or materials indicated to be reused, reinstalled, or otherwise indicated to remain the Owner's property, demolished materials shall become Contractor's property and shall be removed from Project site.

D. Definitions
1. Roofing Terminology: Refer to ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.
2. Existing Membrane Roofing System: Built-up asphalt, Built-up coal-tar, EPDM, CSPE, PVC, TPO, APP-modified bituminous, or SBS-modified bituminous roofing membrane, roof insulation, surfacing, and components and accessories between deck and roofing membrane.
3. Roof Re-Cover Preparation: Existing roofing membrane that is to remain and be prepared for reuse.
4. Roof Tear-Off: Removal of existing membrane roofing system from deck.
5. Partial Roof Tear-Off: Removal of a portion of existing membrane roofing system from deck or removal of selected components and accessories from existing membrane roofing system.
6. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and reinstalled.
7. Existing to Remain: Existing items of construction that are not indicated to be removed.

E. Submittals
1. Product Data: For each type of product indicated.
2. Temporary Roofing: Include Product Data and description of temporary roofing system. If temporary roof will remain in place, submit surface preparation requirements needed to receive permanent roof, and submit a letter from roofing membrane manufacturer stating acceptance of the temporary membrane and that its inclusion will not adversely affect the roofing system's resistance to fire and wind or its FM Global rating, **as directed**.
3. Coal tar roofs can't be mixed with asphalt roofs. Test materials in accordance with the American Society for Testing and Materials (ASTM).
4. Fastener pull-out test report.
5. Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including exterior and interior finish surfaces that might be misconstrued as having been damaged by reroofing operations. Submit before Work begins.
6. Landfill Records: Indicate receipt and acceptance of hazardous wastes, such as asbestos-containing material, by a landfill facility licensed to accept hazardous wastes.

7. Qualification Data: For Installer including certificate that Installer is licensed to perform asbestos abatement and is approved by warrantor of existing roofing system.

F. Quality Assurance
1. Installer Qualifications: Installer of new membrane roofing system, licensed to perform asbestos abatement in the State or jurisdiction where Project is located, **as directed**, and approved by warrantor of existing roofing system to work on existing roofing, **as directed**.
2. Regulatory Requirements: Comply with governing EPA notification regulations before beginning membrane roofing removal. Comply with hauling and disposal regulations of authorities having jurisdiction.
3. Reroofing Conference: Conduct conference at Project site.

G. Project Conditions
1. the Owner will occupy portions of building immediately below reroofing area. Conduct reroofing so the Owner's operations will not be disrupted. Provide the Owner with not less than 72 hours' notice of activities that may affect the Owner's operations.
   a. Coordinate work activities daily with the Owner so the Owner can place protective dust or water leakage covers over sensitive equipment or furnishings, shut down HVAC and fire-alarm or -detection equipment if needed, and evacuate occupants from below the work area.
   b. Before working over structurally impaired areas of deck, notify the Owner to evacuate occupants from below the affected area. Verify that occupants below the work area have been evacuated before proceeding with work over the impaired deck area.
2. Protect building to be reroofed, adjacent buildings, walkways, site improvements, exterior plantings, and landscaping from damage or soiling from reroofing operations.
3. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.
4. Conditions existing at time of inspection for bidding will be maintained by the Owner as far as practical.
   a. A roof moisture survey of existing membrane roofing system is available for Contractor's reference.
   b. The results of an analysis of test cores from existing membrane roofing system are available for Contractor's reference.
   c. Construction Drawings and Project Manual for existing roofing system are provided for Contractor's reference. Contractor is responsible for conclusions derived from existing documents.
5. Limit construction loads on roof, as directed by the Owner. Rooftop equipment wheel loads and for uniformly distributed loads.
6. Weather Limitations: Proceed with reroofing preparation only when existing and forecasted weather conditions permit Work to proceed without water entering existing roofing system or building.
7. Hazardous Materials: It is not expected that hazardous materials such as asbestos-containing materials will be encountered in the Work.
   a. Hazardous materials will be removed by the Owner before start of the Work. Existing roof will be left no less watertight than before removal.
   b. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify the Owner. Hazardous materials will be removed by the Owner under a separate contract.

   OR

   Hazardous Materials: Present in building to be reroofed. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
   a. Hazardous material remediation is specified elsewhere in the Contract Documents.
   b. Do not disturb hazardous materials or items suspected of containing hazardous materials except according to procedures specified elsewhere in the Contract Documents.

c. Coordinate with hazardous material remediation subcontractor to prevent water from entering existing roofing system or building.

H. Warranty
1. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during reroofing, by methods and with materials so as not to void existing roofing system warranty. Notify warrantor before proceeding.
a. Notify warrantor of existing roofing system on completion of reroofing, and obtain documentation verifying that existing roofing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

1.2 PRODUCTS

A. Infill Materials
1. Use infill materials matching existing membrane roofing system materials unless otherwise indicated.
a. Infill materials are specified in a Division 07.

B. Temporary Roofing Materials
1. Design and selection of materials for temporary roofing are responsibilities of Contractor.
2. Sheathing Paper: Red-rosin type, minimum 3 lb/100 sq. ft. (0.16 kg/sq. m).
3. Base Sheet: ASTM D 4601, Type II, nonperforated, asphalt-impregnated and -coated, glass-fiber sheet.
4. Glass-Fiber Felts: ASTM D 2178, Type IV, asphalt-impregnated, glass-fiber felt.
5. Asphalt Primer: ASTM D 41.
6. Roofing Asphalt: ASTM D 312, Type III or IV.

C. Recover Boards
1. Recover Board: ASTM C 208, Type II, Grade 1 **OR** 2, **as directed**, cellulosic-fiber insulation board; 1/2 inch (13 mm) thick.
OR
Recover Board: Fan-folded, unfaced, extruded-polystyrene board insulation; 3/16-inch (5-mm) **OR** 1/4-inch (6-mm) **OR** 3/8-inch (10-mm), **as directed**, nominal thickness.
OR
Recover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate; 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** Type X, 5/8 inch (16 mm), **as directed**, thick.
OR
Recover Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate; 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
OR
Recover Board: ASTM C 728, perlite board; 1/2 inch (13 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick.
2. Fasteners: Factory-coated steel fasteners, No. 12 or 14, and metal or plastic plates listed in FM Approval's "Approval Guide," designed for fastening recover boards to deck.

D. Auxiliary Reroofing Materials
1. General: Auxiliary reroofing preparation materials recommended by roofing system manufacturer for intended use and compatible with components of existing and new membrane roofing system.
2. Base Sheet Fasteners: Capped head, factory-coated steel fasteners, listed in FM Approval's "Approval Guide."
3. Metal Flashing Sheet: Metal flashing sheet is specified in Division 07 Section "Sheet Metal Flashing And Trim".

1.3 EXECUTION

A. Preparation
1. Protect existing membrane roofing system that is indicated not to be reroofed.
   a. Loosely lay 1-inch- (25-mm-) minimum thick, molded expanded polystyrene (MEPS) insulation over the roofing membrane in areas indicated. Loosely lay 15/32-inch (12-mm) plywood or OSB panels over MEPS. Extend MEPS past edges of plywood or OSB panels a minimum of 1 inch (25 mm).
   b. Limit traffic and material storage to areas of existing roofing membrane that have been protected.
   c. Maintain temporary protection and leave in place until replacement roofing has been completed. Remove temporary protection on completion of reroofing.
2. Coordinate with the Owner to shut down air-intake equipment in the vicinity of the Work. Cover air-intake louvers before proceeding with reroofing work that could affect indoor air quality or activate smoke detectors in the ductwork.
3. During removal operations, have sufficient and suitable materials on-site to facilitate rapid installation of temporary protection in the event of unexpected rain.
4. Maintain roof drains in functioning condition to ensure roof drainage at end of each workday. Prevent debris from entering or blocking roof drains and conductors. Use roof-drain plugs specifically designed for this purpose. Remove roof-drain plugs at end of each workday, when no work is taking place, or when rain is forecast.
   a. If roof drains are temporarily blocked or unserviceable due to roofing system removal or partial installation of new membrane roofing system, provide alternative drainage method to remove water and eliminate ponding. Do not permit water to enter into or under existing membrane roofing system components that are to remain.
5. Verify that rooftop utilities and service piping have been shut off before beginning the Work.

B. Roof Tear-Off
1. General: Notify the Owner each day of extent of roof tear-off proposed for that day and obtain authorization to proceed.
2. Remove aggregate ballast from roofing membrane. Store aggregate ballast for reuse, **as directed**.
3. Remove loose aggregate from aggregate-surfaced built-up bituminous roofing using a power broom.
4. Remove pavers and accessories from roofing membrane. Store and protect pavers and accessories for reuse, **as directed**. Discard cracked pavers, **as directed**.
5. Remove protection mat and extruded-polystyrene insulation from protected roofing membrane.
   a. Discard extruded-polystyrene insulation that is wet and exceeds 8 lb/cu. ft. (128 kg/cu. m).
   b. Store extruded-polystyrene insulation for reuse and protect from physical damage.
6. Roof Tear-Off: Remove existing roofing membrane and other membrane roofing system components down to the deck.
   a. Remove cover boards **OR** roof insulation **OR** substrate boards, **as directed**.
   b. Bitumen and felts that are firmly bonded to concrete decks are permitted to remain if felts are dry. Remove unadhered bitumen and felts and wet felts.
   c. Remove excess asphalt from steel deck. A maximum of 15 lb/100 sq. ft. (0.72 kg/sq. m) of asphalt is permitted to remain on steel decks.
   d. Remove fasteners from deck or cut fasteners off slightly above deck surface, **as directed**.
7. Partial Roof Tear-Off: Where indicated, remove existing roofing membrane and other membrane roofing system components down to the deck.
   a. Remove cover boards **OR** roof insulation **OR** substrate boards, **as directed**.
   b. Bitumen and felts that are firmly bonded to concrete decks are permitted to remain if felts are dry. Remove unadhered bitumen and felts and wet felts.
   c. Remove excess asphalt from steel deck. A maximum of 15 lb/100 sq. ft. (0.72 kg/sq. m) of asphalt is permitted to remain on steel decks.
   d. Remove fasteners from deck or cut fasteners off slightly above deck surface, **as directed**.

OR
Partial Roof Tear-Off: Remove existing roofing membrane and immediately check for presence of moisture by visually observing cover boards **OR** roof insulation **OR** substrate boards, **as directed**, that will remain.

a. Coordinate with the Owner's inspector to schedule times for tests and inspections immediately after membrane removal.
b. With an electrical capacitance moisture-detection meter, spot check cover boards **OR** roof insulation **OR** substrate boards, **as directed**, that will remain.
c. Remove wet or damp boards and roof insulation. Removal will be paid for by adjusting the Contract Sum according to unit prices included in the Contract Documents, **as directed**.
d. Bitumen and felts that are firmly bonded to concrete decks are permitted to remain if felts are dry. Remove unadhered bitumen and felts and wet felts.
e. Remove excess asphalt from steel deck. A maximum of 15 lb/100 sq. ft. (0.72 kg/sq. m) of asphalt is permitted to remain on steel decks.
f. Remove fasteners from deck or cut fasteners off slightly above deck surface, **as directed**.

C. Deck Preparation
1. Inspect deck after tear-off **OR** partial tear-off, **as directed**, of membrane roofing system.
2. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263 or by pouring 1 pint (0.5 L) of hot roofing asphalt on deck at start of each day's work and at start of each roof area or plane. Do not proceed with roofing work if moisture condenses under the plastic sheet or if asphalt test sample foams or can be easily and cleanly stripped after cooling.
3. If broken or loose fasteners that secure deck panels to one another or to structure are observed or if deck appears or feels inadequately attached, immediately notify the Owner. Do not proceed with installation until directed by the Owner.
4. If deck surface is not suitable for receiving new roofing or if structural integrity of deck is suspect, immediately notify the Owner. Do not proceed with installation until directed by the Owner.
5. Provide additional deck securement as indicated on Drawings.
6. Replace deck as indicated on Drawings. Replacement deck is specified in Division 31 OR Division 03 OR Division 21 Section(s) "Fire-suppression Standpipes".

D. Infill Materials Installation
1. Immediately after removal of selected portions of existing membrane roofing system, and inspection and repair, if needed, of deck, fill in the tear-off areas to match existing membrane roofing system construction.
    a. Installation of infill materials is specified in Division 07.
    b. Install new roofing membrane patch over roof infill area. If new roofing membrane is installed the same day tear-off is made, roofing membrane patch is not required.

E. Temporary Roofing Membrane
1. Install approved temporary roofing membrane over area to be reroofed.
   OR
   Install temporary roofing membrane over area to be reroofed. Install two glass-fiber felts **OR** Mechanically fasten base sheet and install a glass-fiber felt, **as directed**, lapping each sheet 19 inches (483 mm) over preceding sheet. Embed glass-fiber felt in a solid mopping of hot roofing asphalt applied within equiviscous temperature range. Glaze-coat completed surface with hot roofing asphalt.
2. Remove temporary roofing membrane before installing new roofing membrane.
   OR
   Prepare the temporary roof to receive new roofing membrane according to approved temporary roofing membrane proposal **OR** by patching and repairing temporary roofing membrane, **as directed**. Restore temporary roofing membrane to watertight condition. Obtain approval for temporary roof substrate from roofing membrane manufacturer and the Owner before installing new roof.

F. Roof Re-Cover Preparation

1. Remove blisters, ridges, buckles, mechanically attached roofing membrane fastener buttons projecting above the membrane, **as directed**, and other substrate irregularities from existing roofing membrane that inhibit new recover boards from conforming to substrate.
   a. Remove loose aggregate from aggregate-surfaced built-up bituminous roofing with a power broom.
   b. Scarify the surface of sprayed polyurethane foam as necessary to achieve a sufficiently uniform plane to receive new recover boards.
   c. Broom clean existing substrate.
   d. Coordinate with the Owner's inspector to schedule times for tests and inspections before proceeding with installation of recover boards.
   e. Verify that existing substrate is dry before proceeding with installation of recover boards. Spot check substrates with an electrical capacitance moisture-detection meter.
   f. Remove materials that are wet or damp. Removal will be paid for by adjusting the Contract Sum according to unit prices included in the Contract Documents.
2. Remove blisters, ridges, buckles, mechanically attached roofing membrane fastener buttons projecting above the membrane, **as directed**, and other substrate irregularities from existing roofing membrane that inhibit new recover boards **OR** roofing membrane, **as directed**, from conforming to substrate.
   a. Remove loose aggregate from aggregate-surfaced built-up bituminous roofing with a power broom.
   b. Scarify the surface of sprayed polyurethane foam as necessary to achieve a sufficiently uniform plane to receive new recover boards **OR** roofing membrane, **as directed**.
   c. Broom clean existing substrate.
   d. Coordinate with the Owner's inspector to schedule times for tests and inspections.
   e. Verify that existing substrate is dry before proceeding with installation. Spot check substrates with an electrical capacitance moisture-detection meter.
   f. Remove materials that are wet and damp. Removal will be paid for by adjusting the Contract Sum according to unit prices included in the Contract Documents.
3. Remove blisters and areas of membrane not fully adhered.
   OR
   Remove mechanically attached roofing membrane fastener buttons projecting above the membrane and other, **as directed**, substrate irregularities that inhibit new recover boards from conforming to substrate.
   a. Remove loose aggregate from aggregate-surfaced built-up bituminous roofing with a power broom.
   b. Clean substrate of contaminants such as dirt, debris, oil, and grease that can affect adhesion of coated foamed roofing.
   c. Power vacuum the existing roof surface. If recommended by foam manufacturer, prime dried surface at recommended rate with recommended primer.
   d. Scarify the surface of coated polyurethane roofing as necessary to achieve a suitable substrate for new roofing.
   e. Provide additional uplift securement for existing roofing system with new screws and plates applied to each roof zone at the following densities:
      1) Field of roof, one fastener for each.
      2) Corners of roof, one fastener for each.
      3) Perimeters of roof, one fastener for each. Width of perimeter zone of roof as directed by the Owner.
   f. Verify that surface is dry by pressing litmus paper to surface areas most likely to retain moisture, such as shaded areas and low spots. If paper changes color, surface is too wet to apply foam.
   g. Build up isolated low spots on existing roofing membrane with sprayed foam specified in Division 07 Section "Coated Foamed Roofing" to prevent ponding.

G. Existing Base Flashings

1. Remove existing base flashings around parapets, curbs, walls, and penetrations.
    a. Clean substrates of contaminants such as asphalt, sheet materials, dirt, and debris.
2. Do not damage metal counterflashings that are to remain. Replace metal counterflashings damaged during removal with counterflashings of same metal, weight or thickness, and finish **OR** specified in Division 07 Section "Sheet Metal Flashing And Trim" **OR** specified in Division 07 Section "Roof Specialties", **as directed**.
3. Inspect parapet sheathing for deterioration and damage. If parapet sheathing has deteriorated, immediately notify the Owner.
4. Remove existing parapet sheathing and replace with new pressure-preservative **OR** exterior fire-retardant, **as directed**,-treated plywood sheathing, 19/32 inch (15 mm) thick. If parapet framing has deteriorated, immediately notify the Owner.
    a. Plywood parapet sheathing is specified in Division 06 Section(s) "Rough Carpentry" OR "Miscellaneous Rough Carpentry", **as directed**.

H. Fastener Pull-Out Testing
1. Perform **OR** Retain independent testing and inspecting agency to conduct, **as directed**, fastener pull-out tests according to SPRI FX-1, and submit test report to the Owner **OR** roofing membrane manufacturer, **as directed**, before installing new membrane roofing system.
    a. Obtain the Owner's **OR** roofing membrane manufacturer's, **as directed**, approval to proceed with specified fastening pattern. the Owner **OR** Roofing membrane manufacturer, **as directed**, may furnish revised fastening pattern commensurate with pull-out test results.

I. Recover Board Installation
1. Install recover boards over roof insulation **OR** roofing membrane, **as directed**, with long joints in continuous straight lines and end joints staggered between rows. Loosely butt recover boards together and fasten to deck, **as directed**.
    a. Tape joints of recover boards if required by roofing membrane manufacturer.
    b. Fasten recover boards to resist wind-uplift pressure at corners, perimeter, and field of roof specified in Division 07 Section "Built-up Asphalt Roofing".
    c. Install additional fasteners near board corners and edges as necessary to conform boards to substrate and to adjacent boards.

J. Disposal
1. Collect demolished materials and place in containers. Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.
    a. Storage or sale of demolished items or materials on-site is not permitted.
2. Transport and legally dispose of demolished materials off the Owner's property.

END OF SECTION 07 01 50 81a

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Task	Specification	Specification Description
07 01 50 81	07 51 13 00	Built-Up Asphalt Roofing
07 01 50 81	07 53 16 00	EPDM Membrane Roofing

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SECTION 07 05 13 00 - CSPE MEMBRANE ROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for chlorosulfonate-polyethylene (CSPE) roofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Adhered CSPE membrane roofing system.
   b. Mechanically fastened CSPE membrane roofing system.
   c. Loosely laid and ballasted CSPE membrane roofing system.
   d. Vapor retarder.
   e. Roof insulation.
2. Section includes the installation of acoustical roof deck rib insulation strips furnished under Division 05 Section "Steel Decking".

C. Definitions
1. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.

D. Performance Requirements
1. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.
2. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.
3. Roofing System Design: Provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
4. FM Approvals Listing, **as directed**: Provide membrane roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a membrane roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.
   a. Fire/Windstorm Classification: Class 1A-60 **OR** Class 1A-75 **OR** Class 1A-90 **OR** Class 1A-105 **OR** Class 1A-120 **OR** Class 1A-135 **OR** Class 1A-150 **OR** Class 1A-165, **as directed**.
   b. Hail Resistance: MH **OR** SH, **as directed**.
5. Energy Performance: Provide roofing system with initial Solar Reflectance Index not less than 78 **OR** 29, **as directed**, when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.
6. Energy Performance: Provide roofing system that is listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low **OR** steep, **as directed**,-slope roof products.
7. Energy Performance (for roofs that must comply with California Energy Commission's CEC-Title 24): Provide roofing system with initial solar reflectance not less than 0.70 and emissivity not less than 0.75 when tested according to CRRC-1.

E. Submittals
1. Product Data: For each type of product indicated.

2. LEED Submittals:
   a. Product Test Reports for Credit SS 7.2: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirement.
   b. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.
4. Samples: For each product included in the roofing system.
5. Research/evaluation reports.
6. Field quality-control reports.
7. Maintenance data.
8. Warranties: Sample of special warranties.

F. Quality Assurance
1. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
2. Source Limitations: Obtain components for membrane roofing system from same manufacturer as membrane roofing or approved by membrane roofing manufacturer.
3. Exterior Fire-Test Exposure: ASTM E 108, Class A **OR** Class B **OR** Class C, **as directed**; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.
4. Fire-Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
5. Preinstallation Roofing Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
2. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
   a. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
3. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
4. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

H. Project Conditions
1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

I. Warranty
1. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within 10 **OR** 15, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. CSPE Membrane Roofing
1. CSPE: ASTM D 5019, Type 1, Grade 2, 45-mil- (1.1-mm-) thick, reinforced, flexible uncured sheet formed from CSPE, and as follows:
a. Exposed Face Color: White **OR** Blue **OR** Light gray **OR** Tan, **as directed**.

B. Auxiliary Membrane Roofing Materials
1. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use, and compatible with membrane roofing.
a. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
b. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
1) Plastic Foam Adhesives: 50 g/L.
2) Gypsum Board and Panel Adhesives: 50 g/L.
3) Multipurpose Construction Adhesives: 70 g/L.
4) Fiberglass Adhesives: 80 g/L.
5) Contact Adhesive: 80 g/L.
6) Single-Ply Roof Membrane Sealants: 450 g/L.
7) Nonmembrane Roof Sealants: 300 g/L.
8) Sealant Primers for Nonporous Substrates: 250 g/L.
9) Sealant Primers for Porous Substrates: 775 g/L.
10) Other Adhesives and Sealants: 250 g/L.
2. Sheet Flashing: 45-mil- (1.1-mm-) thick, reinforced and 55-mil- (1.4-mm-) thick, non-reinforced CSPE as recommended by roofing system manufacturer for intended use.
3. Bonding Adhesive: Manufacturer's standard, water based, **as directed**.
4. Slip Sheet: Manufacturer's standard, of thickness required for application.
5. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.
6. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick (25 mm wide by 1.3 mm thick), prepunched.
7. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.
8. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

C. Substrate Boards
1. Substrate Board: ASTM C 1396/C 1396M, Type X gypsum board, 5/8 inch (16 mm) thick.
OR
Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** Type X, 5/8 inch (16 mm), **as directed**, thick.
OR
Substrate Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
OR
Substrate Board: ASTM C 728, perlite board, 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick, seal coated.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

D. Vapor Retarder

1. Polyethylene Film: ASTM D 4397, 6 mils (0.15 mm) thick, minimum, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
   a. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
   b. Adhesive: Manufacturer's standard lap adhesive, FM Approvals approved for vapor-retarder application.
2. Laminated Sheet: Kraft paper, two layers, laminated with asphalt and edge reinforced with woven fiberglass yarn with maximum permeance rating of 0.50 perm (29 ng/Pa x s x sq. m) and with manufacturer's standard adhesive, **as directed**.
3. Glass-Fiber Felts: ASTM D 2178, Type IV, asphalt impregnated.

E. Roof Insulation
1. General: Preformed roof insulation boards manufactured or approved by CSPE membrane roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation, **as directed**.
2. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.6-lb/cu. ft. (26-kg/cu. m) **OR** Type X, 1.3-lb/cu. ft. (21-kg/cu. m), **as directed**, minimum density, square edged.
3. Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density.
4. Composite Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density, with factory-applied facings, as follows:
   a. Facer: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick.
      OR
      Facer: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
5. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2 **OR** Type II, Class I, Grade 3, **as directed**, felt or glass-fiber mat facer on both major surfaces.
6. Composite Polyisocyanurate Board Insulation: ASTM C 1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other.
   a. Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick.
   b. Type V, OSB facer, 7/16 inch (11 mm) thick.
   c. Type VII, glass mat faced gypsum board facer, 1/4 inch (6 mm) thick.
7. Perlite Board Insulation: ASTM C 728, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.
8. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.
9. Cellular-Glass Board Insulation: ASTM C 552, Type IV, rigid, cellular-glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.
10. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48) unless otherwise indicated.
11. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

F. Insulation Accessories
1. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards, **as directed**, to substrate, and acceptable to roofing system manufacturer.

3. Modified Asphaltic Insulation Adhesive: Insulation manufacturer's recommended modified asphalt, asbestos-free, cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.
4. Bead-Applied Insulation Adhesive: Insulation manufacturer's recommended bead-applied, low-rise, one- or multicomponent urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
5. Full-Spread Applied Insulation Adhesive: Insulation manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
6. Cover Board: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, 1/2 inch (13 mm) thick.
   OR
   Cover Board: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
   OR
   Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.
   OR
   Cover Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
7. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric, water permeable and resistant to UV degradation, type and weight as recommended by roofing system manufacturer for application.

G. Asphalt Materials
1. Roofing Asphalt: ASTM D 312, Type III or Type IV **OR** ASTM D 6152, SEBS modified, **as directed**.
2. Asphalt Primer: ASTM D 41.

H. Aggregate Ballast (for loosely laid and aggregate-ballasted installations)
1. Aggregate Ballast: Provide aggregate ballast that will withstand weather exposure without significant deterioration and will not contribute to membrane degradation, of the following type and size:
   a. Aggregate Type: Smooth, washed, riverbed gravel or other acceptable smooth-faced stone **OR** Crushed gravel or crushed stone, **as directed**.
   b. Size: ASTM D 448, Size 4, ranging in size from 3/4 to 1-1/2 inches (19 to 38 mm).
      OR
      Size: ASTM D 448, Size 2, ranging in size from 1-1/2 to 2-1/2 inches (38 to 63 mm).
      OR
      Size: ASTM D 448, Size 3, ranging in size from 1 to 2 inches (25 to 50 mm).

I. Roof Pavers
1. Lightweight Roof Pavers: Interlocking, lightweight concrete units, specially factory cast for use as roof ballast; grooved back, with four-way drainage capability; beveled, doweled, or otherwise profiled; and as follows:
   a. Size: 8 by 16 inches (200 by 400 mm) **OR** 12 by 12 inches (300 by 300 mm) **OR** 12 by 16-1/2 inches (300 by 420 mm) **OR** 12 by 18 inches (300 by 450 mm), **as directed**.
   b. Weight: At least 10 lb/sq. ft. (50 kg/sq. m) but not exceeding 18 lb/sq. ft. (90 kg/sq. m).
   c. Compressive Strength: 2500 psi (17 MPa) **OR** 5000 psi (34 MPa), **as directed**, minimum.
   d. Colors and Textures: As selected from manufacturer's full range.
2. Heavyweight Roof Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C 67; and as follows:

a. Size: 12 by 12 inches (300 by 300 mm) **OR** 18 by 18 inches (450 by 450 mm) **OR** 24 by 24 inches (600 by 600 mm), **as directed**. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch (1.6 mm) in length, height, and thickness.
b. Weight: 18 lb/sq. ft. (90 kg/sq. m) **OR** 22 lb/sq. ft. (110 kg/sq. m), **as directed**.
c. Compressive Strength: 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, minimum.
d. Colors and Textures: As selected from manufacturer's full range.

J. Walkways
1. Flexible Walkways: Factory-formed, nonporous, heavy-duty, solid-rubber, slip-resisting, surface-textured walkway pads **OR** rolls, **as directed**, approximately 3/16 inch (5 mm) thick, and acceptable to membrane roofing system manufacturer.
2. Walkway Roof Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C 67; and as follows:
a. Size: 12 by 12 inches (300 by 300 mm) **OR** 18 by 18 inches (450 by 450 mm) **OR** 24 by 24 inches (600 by 600 mm), **as directed**. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch (1.6 mm) in length, height, and thickness.
b. Weight: 18 lb/sq. ft. (90 kg/sq. m) **OR** 22 lb/sq. ft. (110 kg/sq. m), **as directed**.
c. Compressive Strength: 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, minimum.
d. Colors and Textures: As selected from manufacturer's full range.

1.3 EXECUTION

A. Preparation
1. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
2. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
3. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.
4. Install acoustical roof deck rib insulation strips, specified in Division 05 Section "Steel Decking", according to acoustical roof deck manufacturer's written instructions, immediately before installation of overlying construction and to remain dry.

B. Substrate Board
1. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
a. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' "RoofNav" and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.
OR
Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to membrane roofing system manufacturers' written instructions.

C. Vapor-Retarder Installation
1. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
a. Continuously seal side and end laps with tape **OR** adhesive, **as directed**.

2. Laminate Sheet: Install laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively. Bond vapor retarder to substrate as follows:
    a. Apply adhesive at rate recommended by vapor-retarder manufacturer. Seal laps with adhesive.
       OR
       Apply ribbons of hot roofing asphalt at spacing, temperature, and rate recommended by vapor-retarder manufacturer. Seal laps with hot roofing asphalt.
3. Built-Up Vapor Retarder: Install two glass-fiber felt plies lapping each felt 19 inches (483 mm) over preceding felt. Embed each felt in a solid mopping of hot roofing asphalt. Glaze-coat completed surface with hot roofing asphalt. Apply hot roofing asphalt within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
4. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into membrane roofing system.

D. Insulation Installation
1. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
2. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.
3. Install tapered insulation under area of roofing to conform to slopes indicated.
4. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.
    a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
5. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
6. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
    a. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
7. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
    a. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
    b. Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
    c. Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
       OR
       Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
8. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
    a. Fasten insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
       OR
       Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.
9. Mechanically Fastened and Adhered Insulation: Install each layer of insulation and secure first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
    a. Fasten first layer of insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.

OR
Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
b. Set each subsequent layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
OR
Set each subsequent layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
OR
Set each subsequent layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
10. Loosely Laid Insulation: Loosely lay insulation units over substrate.
11. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction. Loosely butt cover boards together and fasten to roof deck, **as directed**.
a. Fasten cover boards according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
OR
Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.
12. Install slip sheet over insulation **OR** cover board, **as directed**, and immediately beneath membrane roofing.

E. Adhered Membrane Roofing Installation
1. Adhere membrane **OR** fabric-backed membrane, **as directed**, roofing over area to receive roofing according to membrane roofing system manufacturer's written instructions. Unroll membrane roofing and allow to relax before installing.
2. Start installation of membrane roofing in presence of membrane roofing system manufacturer's technical personnel.
3. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
4. Bonding Adhesive: Apply to substrate and underside of membrane roofing at rate required by manufacturer and allow to partially dry before installing membrane roofing. Do not apply to splice area of membrane roofing.
5. In addition to adhering, mechanically fasten membrane roofing securely at terminations, penetrations, and perimeter of roofing.
6. Apply membrane roofing with side laps shingled with slope of roof deck where possible.
7. Seams: Clean seam areas, overlap membrane roofing, and weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation. Complete welding of seams within 24 hours of exposing CSPE sheet or before curing of CSPE sheet has begun. Weld seams as follows:
a. Weld Method: Hot air **OR** Solvent, **as directed**.
b. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
c. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
d. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
8. Spread sealant bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
9. Install membrane roofing and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition and to not void warranty for existing membrane roofing system.

F. Mechanically Fastened Membrane Roofing Installation
1. Mechanically fasten membrane roofing over area to receive roofing and install according to roofing system manufacturer's written instructions.
a. For in-splice attachment, install membranes roofing with long dimension perpendicular to steel roof deck flutes.

2. Start installation of membrane roofing in presence of roofing system manufacturer's technical personnel.
3. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
4. Mechanically fasten or adhere membrane roofing securely at terminations, penetrations, and perimeter of roofing.
5. Apply membrane roofing with side laps shingled with slope of roof deck where possible.
6. In-Seam Attachment: Secure one edge of CSPE sheet using fastening plates or metal battens centered within membrane seam and mechanically fasten CSPE sheet to roof deck.
7. Seams: Clean seam areas, overlap membrane roofing, and weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation. Complete welding of seams within 24 hours of exposing CSPE sheet or before curing of CSPE sheet has begun. Weld seams as follows:
   a. Weld Method: Hot air **OR** Solvent, **as directed**.
   b. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
   c. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
   d. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
8. Spread sealant bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
9. Install membrane roofing and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition and to not void warranty for existing membrane roofing system.

G. Loosely Laid And Ballasted Membrane Roofing Installation
1. Loosely lay membrane roofing over area to receive roofing and install according to roofing system manufacturer's written instructions.
   a. Comply with requirements in SPRI RP-4 for System 1 **OR** System 2 **OR** System 3, **as directed**.
2. Start installation of membrane roofing in presence of roofing system manufacturer's technical personnel.
3. Accurately align membrane roofing, without stretching, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
4. Mechanically fasten or adhere perimeter of membrane roofing according to requirements in SPRI RP-4.

   OR

   Mechanically fasten **OR** adhere, **as directed**, membrane roofing at corners, perimeters, and transitions according to requirements in SPRI RP-4.
   a. At corners and perimeters, omit aggregate ballast leaving membrane roofing exposed.
   b. At corners and perimeters, adhere a second layer of membrane roofing.
5. Apply membrane roofing with side laps shingled with slope of deck where possible.
6. Seams: Clean seam areas, overlap membrane roofing, and weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation. Complete welding of seams within 24 hours of exposing CSPE sheet or before curing of CSPE sheet has begun. Weld seams as follows:
   a. Weld Method: Hot air **OR** Solvent, **as directed**.
   b. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
   c. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
   d. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
7. Spread sealant bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
8. Install membrane roofing and auxiliary materials to tie in to existing roofing.
9. Install protection mat over membrane roofing, overlapping a minimum of 6 inches (150 mm). Install an additional protection mat layer at projections, pipes, vents, and drains, overlapping a minimum of 12 inches (300 mm).

10. Aggregate Ballast: Apply uniformly over membrane roofing at the rate required by membrane roofing system manufacturer, but not less than the following, spreading with care to minimize possibility of damage to membrane roofing system. Lay ballast as membrane roofing is installed, leaving membrane roofing ballasted at the end of the workday.
    a. Ballast Weight: Size 4 aggregate, 10 lb/sq. ft. (50 kg/sq. m).
       OR
       Ballast Weight: Size 2 aggregate, 13 lb/sq. ft. (65 kg/sq. m), at corners and perimeter; Size 4 aggregate, 10 lb/sq. ft. (50 kg/sq. m), elsewhere.
       OR
       Ballast Weight: Size 2 aggregate, 13 lb/sq. ft. (65 kg/sq. m).
11. Roof-Paver Ballast: Install lightweight **OR** heavyweight, **as directed**, roof-paver ballast according to manufacturer's written instructions.
    OR
    Roof-Paver and Aggregate Ballast: Install heavyweight roof pavers according to manufacturer's written instructions on roof corners and perimeter.
    a. Install Size 4 aggregate ballast elsewhere on roofing at a minimum rate of 10 lb/sq. ft. (50 kg/sq. m).
       OR
       Install Size 2 aggregate ballast elsewhere on roofing at a minimum rate of 13 lb/sq. ft. (65 kg/sq. m).

H. Base Flashing Installation
1. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.
2. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.
3. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
4. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Weld side and end laps to ensure a watertight seam installation. Complete welding of seams within 24 hours of exposing CSPE sheet or before curing of CSPE sheet has begun.
5. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars, **as directed**.

I. Walkway Installation
1. Flexible Walkways: Install walkway products in locations indicated. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.
2. Roof-Paver Walkways: Install walkway roof pavers according to manufacturer's written instructions in locations indicated, to form walkways. Leave 3 inches (75 mm) of space between adjacent roof pavers.

J. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform inspections.
2. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
3. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.
4. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

K. Protecting And Cleaning
1. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for

deterioration and damage, describing its nature and extent in a written report, with copies to Owner.

2. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Final Completion and according to warranty requirements.
3. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

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SECTION 07 05 13 00a - APP-MODIFIED BITUMINOUS MEMBRANE ROOFING

1.1 GENERAL

A. Description Of Work:

1. This specification covers the furnishing and installation of materials for atactic-polypropylene (APP) modified bituminous membrane roofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Atactic-polypropylene (APP) modified bituminous membrane roofing.
   b. Hybrid roofing system that combines built-up ply sheets with APP-modified bituminous membrane.
   c. Vapor retarder.
   d. Roof insulation.
2. Section includes the installation of insulation strips in ribs of acoustical roof deck. Insulation strips are furnished under Division 05 Section "Steel Decking".

C. Definitions

1. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.
2. Hot Roofing Asphalt: Roofing asphalt heated to its equiviscous temperature, the temperature at which its viscosity is 125 centipoise for mop-applied roofing asphalt and 75 centipoise for mechanical spreader-applied roofing asphalt, within a range of plus or minus 25 deg F (14 deg C), measured at the mop cart or mechanical spreader immediately before application.

D. Performance Requirements

1. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.
2. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.
3. Roofing System Design: If membrane roofing system is to be designed to withstand uplift pressure established by ASCE/SEI 7, provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
   a. Corner Uplift Pressure: as directed by the Owner.
   b. Perimeter Uplift Pressure: as directed by the Owner.
   c. Field-of-Roof Uplift Pressure: as directed by the Owner.
4. FM Approvals Listing: If Project is FM Global insured or if FM Approvals requirements will set a minimum quality standard, provide membrane roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a membrane roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.
   a. Fire/Windstorm Classification: Class 1A-60 **OR** Class 1A-75 **OR** Class 1A-90 **OR** Class 1A-105 **OR** Class 1A-120, **as directed**.
   b. Hail Resistance Rating: MH **OR** SH, **as directed**.
5. Energy Performance (if required for LEED-NC Credit SS 7.2): Provide roofing system with initial Solar Reflectance Index not less than 78 when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.

OR
Energy Performance(for roofs that must comply with DOE's ENERGY STAR requirements): Provide roofing system that is listed on DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.
OR
Energy Performance(for roofs that must comply with California Energy Commission's CEC-Title 24): Provide roofing system with initial Solar Reflectance not less than 0.70 and Thermal Emittance not less than 0.75 when tested according to Cool Roof Rating Council's CRRC-1.

E. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Product Test Reports for Credit SS 7.2: For roof materials, indicating that roof materials comply with Solar Reflectance Index requirement.
   b. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.
   a. Base flashings and membrane terminations.
   b. Tapered insulation, including slopes.
   c. Crickets, saddles, and tapered edge strips, including slopes.
   d. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
4. Samples: For the following products:
   a. Sheet roofing materials, including base sheet, base-ply sheet, roofing membrane sheet, flashing backer sheet, membrane cap sheet and flashing sheet, of color specified.
   b. Roof insulation.
   c. Walkway pads or rolls.
   d. Six insulation fasteners of each type, length, and finish.
5. Qualification Data: For qualified Installer, manufacturer and testing agency.
6. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
   a. Submit evidence of complying with performance requirements.
7. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of membrane roofing system.
8. Research/Evaluation Reports: For components of membrane roofing system, from the ICC-ES **OR** applicable model code organization, **as directed**.
9. Maintenance Data: For roofing system to include in maintenance manuals.
10. Warranties: Sample of special warranties.

F. Quality Assurance
1. Manufacturer Qualifications: A qualified manufacturer that is UL listed **OR** FM Approvals approved, **as directed**, for membrane roofing system identical to that used for this Project.
2. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
3. Source Limitations: Obtain components including roof insulation and fasteners for membrane roofing system from same manufacturer as membrane roofing or approved by membrane roofing manufacturer.
4. Exterior Fire-Test Exposure: ASTM E 108, Class A **OR** Class B **OR** Class C, **as directed**; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.
5. Fire-Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

6. Preinstallation Roofing Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
2. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
   a. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
3. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
4. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

H. Project Conditions
1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

I. Warranty
1. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period.
   a. Special warranty includes membrane roofing, base flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories, and other components of membrane roofing system.
   b. Warranty Period: 10 **OR** 15 **OR** 20 **OR** 25 **OR** 30, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. APP-Modified Asphalt-Sheet Materials
1. Roofing Membrane Sheet: ASTM D 6222, Grade S, Type **I** or **II**, APP-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6223, Grade S, Type **I** or **II**, APP-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; smooth surfaced; suitable for application method specified.
2. Smooth-Surfaced Roofing Membrane Cap Sheet: ASTM D 6222, Grade S, Type **I** or **II**, APP-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6223, Grade S, Type **I** or **II**, APP-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; smooth surfaced; suitable for application method specified.
   OR
   Granule-Surfaced Roofing Membrane Cap Sheet: ASTM D 6222, Grade G, Type **I** or **II**, APP-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6223, Grade G, Type **I** or **II**, APP-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; granular surfaced; suitable for application method specified, and as follows:
   a. Granule Material: Mineral ceramic coated **OR** slate, **as directed**.
   b. Granule Color: White **OR** Gray **OR** Tan, **as directed**.

B. Base-Sheet Materials
1. Sheathing Paper: Red-rosin type, minimum 3 lb/100 sq. ft. (0.16 kg/sq. m).
2. Base Sheet: ASTM D 4601, Type **II**, SBS-modified, asphalt-impregnated and -coated sheet, with glass-fiber-reinforcing mat, dusted with fine mineral surfacing on both sides.

a. Weight: 25 lb/100 sq. ft. (1.2 kg/sq. m) **OR** 40 lb/100 sq. ft. (1.95 kg/sq. m) **OR** 50 lb/100 sq. ft. (2.4 kg/sq. m) **OR** 60 lb/100 sq. ft. (2.9 kg/sq. m) **OR** 75 lb/100 sq. ft. (3.7 kg/sq. m), **as directed**, minimum.

OR

Base Sheet: ASTM D 4601, Type **I** **OR** Type **II**, **as directed**, nonperforated, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.

OR

Base Sheet: ASTM D 4897, Type **II**, venting, nonperforated, heavyweight, asphalt-impregnated and -coated, glass-fiber base sheet with coarse granular surfacing or embossed venting channels on bottom surface.

OR

Base Sheet: ASTM D 2626, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.

C. Base-Ply Sheet Materials

1. Glass-Fiber Base-Ply Sheet: ASTM D 2178, Type IV **OR** Type VI, **as directed**, asphalt-impregnated, glass-fiber felt.

D. Base Flashing Sheet Materials

1. Backer Sheet: ASTM D 4601, Type **I** **OR** Type **II**, **a directed**, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.

   OR

   Backer Sheet: ASTM D 2626, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.

   OR

   Backer Sheet: ASTM D 6222, Grade S, Type **I** or **II**, APP-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6223, Grade S, Type **I** or **II**, APP-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; smooth surfaced; suitable for application method specified.
2. Smooth-Surfaced Flashing Sheet: ASTM D 6222, Grade S, Type **I** or **II**, APP-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6223, Grade S, Type **I** or **II**, APP-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; smooth surfaced; suitable for application method specified.

   OR

   Granule-Surfaced Flashing Sheet: ASTM D 6222, Grade G, Type **I** or **II**, APP-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6223, Grade G, Type **I** or **II**, APP-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; granular surfaced; suitable for application method specified, and as follows:
   a. Granule Color: White **OR** Gray **OR** Tan, **as directed**.
3. Glass-Fiber Fabric: Woven glass-fiber cloth, treated with asphalt, complying with ASTM D 1668, Type **I**.

E. Auxiliary Roofing Membrane Materials

1. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing membrane.
   a. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
   b. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
      1) Plastic Foam Adhesives: 50 g/L.
      2) Gypsum Board and Panel Adhesives: 50 g/L.
      3) Multipurpose Construction Adhesives: 70 g/L.
      4) Fiberglass Adhesives: 80 g/L.
      5) Contact Adhesive: 80 g/L.

6) Other Adhesives: 250 g/L.
7) Nonmembrane Roof Sealants: 300 g/L.
8) Sealant Primers for Nonporous Substrates: 250 g/L.
9) Sealant Primers for Porous Substrates: 775 g/L.

2. Asphalt Primer: ASTM D 41.
3. Roofing Asphalt: ASTM D 312, Type III **OR** Type IV **OR** Type III or IV as recommended by roofing system manufacturer for application, **as directed**.
   OR
   Roofing Asphalt: ASTM D 6152, SEBS modified.
4. Cold-Applied Adhesive: Roofing system manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive specially formulated for compatibility and use with roofing membrane and base flashings.
5. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required by roofing system manufacturer for application.
6. Mastic Sealant: Polyisobutylene, plain or modified bitumen; nonhardening, nonmigrating, nonskinning, and nondrying.
7. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing membrane components to substrate; tested by manufacturer for required pullout strength, and acceptable to roofing system manufacturer.
8. Metal Flashing Sheet: As specified in Division 07 Section "Sheet Metal Flashing And Trim".
9. Roofing Granules: Ceramic-coated **OR** Slate, **as directed**, roofing granules, No. 11 screen size with 100 percent passing No. 8 (2.36-mm) sieve and 98 percent of mass retained on No. 40 (0.425-mm) sieve, color to match roofing membrane.
10. Miscellaneous Accessories: Provide those recommended by roofing system manufacturer.

F. Substrate Boards

1. Substrate Board: ASTM C 1396/C 1396M, Type X gypsum board, 5/8 inch (16 mm) thick.
   OR
   Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** Type X, 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.
   OR
   Substrate Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
   OR
   Substrate Board: ASTM C 728, perlite board, 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick, seal coated.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

G. Vapor Retarder

1. Polyethylene Film: ASTM D 4397, 6 mils (0.15 mm) thick, minimum, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
   a. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
      OR
      Adhesive: Manufacturer's standard lap adhesive, FM Approvals approved for vapor-retarder application.
2. Laminated Sheet: Kraft paper, two layers, laminated with asphalt and edge reinforced with woven fiberglass yarn, with maximum permeance rating of 0.50 perm (29 ng/Pa x s x sq. m) and with manufacturer's standard adhesive, **as directed**.
3. Self-Adhering Sheet Vapor Retarder: ASTM D 1970, minimum of 40-mil- (1.0-mm-) thick, polyethylene film laminated to layer of rubberized asphalt adhesive; maximum permeance rating

of 0.1 perm (6 ng/Pa x s x sq. m); cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.
OR
Self-Adhering Sheet Vapor Retarder: 30- to 40-mil- (0.76- to 1.0-mm-) thick, polyethylene film laminated to layer of butyl rubber adhesive; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

4. Glass-Fiber Felt: ASTM D 2178, Type IV, asphalt impregnated.

H. Roof Insulation

1. General: Preformed roof insulation boards manufactured or approved by roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation, **as directed**.
2. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.6-lb/cu. ft. (26-kg/cu. m) **OR** Type X, 1.3-lb/cu. ft. (21-kg/cu. m), **as directed**, minimum density, square edged.
3. Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density.
4. Composite Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density, with factory-applied facings, as follows:
   a. Facer: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick.
      OR
      Facer: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
5. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2 **OR** Type II, Class I, Grade 3, **as directed**, felt or glass-fiber mat facer on both major surfaces.
6. Composite Polyisocyanurate Board Insulation: ASTM C 1289, with factory-applied facing board, as indicated below by type, on one major surface and felt or glass-fiber mat facer on the other surface.
   a. Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick.
   b. Type V, OSB facer, 7/16 inch (11 mm) thick.
   c. Type VII, glass-mat-faced gypsum board facer, 1/4 inch (6 mm) thick.
7. Perlite Board Insulation: ASTM C 728, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.
8. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.
9. Cellular-Glass Board Insulation: ASTM C 552, Type IV, rigid, cellular-glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.
10. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48) unless otherwise indicated.
11. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

I. Insulation Accessories

1. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards, **as directed**, to substrate, and acceptable to roofing system manufacturer.
3. Modified Asphaltic Insulation Adhesive: Insulation manufacturer's recommended modified asphaltic, asbestos-free, cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.

OR
Bead-Applied Insulation Adhesive: Insulation manufacturer's recommended bead-applied, low-rise, one-component or multicomponent urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
OR
Full-Spread Applied Insulation Adhesive: Insulation manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.

4. Insulation Cant Strips: ASTM C 728, perlite insulation board.
   OR
   Insulation Cant Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.
5. Wood Nailer Strips: Comply with requirements in Division 06 Section(s) "Rough Carpentry" OR "Miscellaneous Rough Carpentry", **as directed**.
6. Tapered Edge Strips: ASTM C 728, perlite insulation board.
   OR
   Tapered Edge Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.
7. Cover Board: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, 1/2 inch (13 mm) thick.
   OR
   Cover Board: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
   OR
   Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.
   OR
   Cover Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
8. Substrate Joint Tape: 6- or 8-inch- (150- or 200-mm-) wide, coated, glass-fiber joint tape.

J. Coating Materials
1. Roof Coating: ASTM D 1227, Type II, Class 1, mineral-colloid-emulsified, fibered **OR** Class 2, chemically emulsified, filled or fibered, **as directed**, asphalt emulsion, asbestos free.
2. Roof Coating: ASTM D 1227, Type III, Class 1, mineral-colloid-emulsified **OR** Class 2, chemically emulsified, **as directed**, asphalt emulsion, nonfibered.
3. Roof Coating: ASTM D 2824, Type I, nonfibered **OR** Type III, fibered, asbestos-free, **as directed**, aluminum-pigmented asphaltic coating.
4. Roof Coating: Acrylic elastomer emulsion coating, formulated for use on bituminous roof surfaces and complying with ASTM D 6083.
   a. Color: White **OR** Gray **OR** Buff, **as directed**.

K. Walkways
1. Walkway Pads: Reinforced asphaltic composition pads with slip-resisting mineral-granule surface **OR** Polymer-modified, reconstituted rubber pads with slip-resisting textured surface, **as directed**, manufactured as a traffic pad for foot traffic and acceptable to roofing system manufacturer, 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, thick, minimum.
2. Walkway Backer Strips: ASTM D 6222, Grade S, Type I or II, APP-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6223, Grade S, Type I or II, APP-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; smooth surfaced; suitable for application method specified.
3. Walkway Cap Sheet Strips: ASTM D 6222, Grade G, Type I or II, APP-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6223, Grade G, Type I or II, APP-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; granular surfaced; suitable for application method specified, and as follows:
   a. Granule Material: Mineral ceramic coated **OR** slate, **as directed**.
   b. Granule Color: White **OR** Gray **OR** Tan, **as directed**.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
   a. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
   b. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
   c. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 05 Section "Steel Decking".
   d. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
   e. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
      1) Test for moisture by pouring 1 pint (0.5 L) of hot roofing asphalt on deck at start of each day's work and at start of each roof area or plane. Do not proceed with roofing work if test sample foams or can be easily and cleanly stripped after cooling.
   f. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
   g. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of 1/16 inch (1.6 mm) out of plane relative to adjoining deck.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
2. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
3. Prime surface of concrete deck with asphalt primer at a rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
4. Install insulation strips in ribs of acoustical roof deck according to acoustical roof deck manufacturer's written instructions.

C. Substrate Board Installation
1. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
   a. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' "RoofNav" and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.
      OR
      Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to membrane roofing system manufacturers' written instructions.

D. Vapor-Retarder Installation
1. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
   a. Continuously seal side and end laps with tape **OR** adhesive, **as directed**.
2. Laminate Sheet: Install laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively. Bond vapor retarder to substrate as follows:

a. Apply adhesive at rate recommended by vapor-retarder manufacturer. Seal laps with adhesive.
OR
Apply ribbons of hot roofing asphalt at spacing, temperature, and rate recommended by vapor-retarder manufacturer. Seal laps with hot roofing asphalt.

3. Self-Adhering Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 inches (90 mm) and 6 inches (150 mm), respectively. Seal laps by rolling.
4. Built-up Vapor Retarder: Install two glass-fiber felt plies lapping each felt 19 inches (483 mm) over preceding felt. Embed each felt in a solid mopping of hot roofing asphalt. Glaze-coat completed surface with hot roofing asphalt. Apply hot roofing asphalt within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
5. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into membrane roofing system.

E. Insulation Installation
1. Comply with roofing system manufacturer's written instructions for installing roof insulation.
2. If mechanically fastening base sheet to substrate before adhering first layer of insulation, install one lapped base-sheet course and mechanically fasten to substrate according to roofing system manufacturer's written instructions.
3. Nailer Strips: Mechanically fasten 4-inch nominal- (89-mm actual-) width wood nailer strips of same thickness as insulation perpendicular to sloped roof deck at the following spacing:
   a. 16 feet (4.88 m) apart for roof slopes steeper than 1 inch per 12 inches (1:12) but less than 3 inches per 12 inches (3:12).
   b. 48 inches (1220 mm) apart for roof slopes steeper than 3 inches per 12 inches (3:12).
4. Insulation Cant Strips: Install and secure preformed 45-degree insulation cant strips at junctures of roofing membrane system with vertical surfaces or angle changes more than 45 degrees.
5. Install tapered insulation under area of roofing to conform to slopes indicated.
6. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
   a. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
7. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or more, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.
   a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
8. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
9. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.
10. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
   a. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
   b. Set each layer of insulation in a solid mopping of hot roofing asphalt applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
   OR
   Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
   OR
   Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
11. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.

a. If Project is FM Global insured or if FM Approvals requirements are proposed as a performance standard, fasten insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
b. If number of fasteners will be based on ASCE/SEI 7's uplift pressure or SPRI's factored-design uplift pressure, fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.

12. Mechanically Fastened and Adhered Insulation: Install first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
a. If Project is FM Global insured or if FM Approvals requirements are proposed as a performance standard, fasten first layer of insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
b. If fastening is calculated from ASCE/SEI 7's uplift pressure or SPRI's factored-design uplift pressure, fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
1) Set each subsequent layer of insulation in a solid mopping of hot roofing asphalt applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
OR
Set each subsequent layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
OR
Set each subsequent layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
c. If cover boards will be field installed over roof insulation and immediately below roofing membrane, install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints a minimum of 6 inches (150 mm) in each direction from joints of insulation below. Loosely butt cover boards together and fasten to roof deck, **as directed**. Tape joints if required by roofing system manufacturer.
1) Fasten cover boards according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
OR
Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.
2) Apply hot roofing asphalt to underside, and immediately bond cover board to substrate.

F. Roofing Membrane Installation, General

1. If referencing NRCA's roof assembly identification matrix system, install roofing membrane system according to roofing system manufacturer's written instructions and applicable recommendations in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."
a. Install roofing system MBA **OR** MBAH, **as directed**,-3 **OR** 4, **as directed**,-N **OR** I **OR** C, **as directed**,-T **OR** L, **as directed**,-S **OR** M, **as directed**, according to roof assembly identification matrix and roof assembly layout illustrations in NRCA's "The NRCA Roofing and Waterproofing Manual" and to requirements in this Section.
2. For roof system that exceeds requirements of NRCA's roof assemblies, install roofing membrane system according to roofing system manufacturer's written instructions and applicable recommendations in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing" and as follows:
a. Deck Type: N (nailable) **OR** I (insulated) **OR** C (concrete or nonnailable), **as directed**.
b. Adhering Method: T (torched) **OR** L (cold-applied adhesive), **as directed**.
c. Base Sheet: One **OR** One, installed over sheathing paper, **as directed**.
d. Number of Glass-Fiber Base-Ply Sheets: One **OR** Two, **as directed**.
e. Number of APP-Modified Asphalt Sheets: One **OR** Two, **as directed**.
f. Surfacing Type: S (smooth) **OR** M (mineral-granule-surfaced cap sheet), **as directed**.

3. Start installation of roofing membrane in presence of roofing system manufacturer's technical personnel.
4. Where roof slope exceeds 1/2 inch per 12 inches (1:24) **OR** 3/4 inch per 12 inches (1:18), **as directed**, install roofing membrane sheets parallel with slope.
   a. Backnail roofing membrane sheets to nailer strips **OR** substrate, **as directed**, according to roofing system manufacturer's written instructions.
5. Cooperate with testing agencies engaged or required to perform services for installing roofing system.
6. Coordinate installation of roofing system so insulation and other components of the roofing membrane system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.
   a. At end of each day's work, provide tie-offs to cover exposed roofing membrane sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt, with joints and edges sealed.
   b. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
   c. Remove and discard temporary seals before beginning work on adjoining roofing.
7. Asphalt Heating: Do not raise roofing asphalt temperature above equiviscous temperature range more than one hour before time of application. Do not exceed roofing asphalt manufacturer's recommended temperature limits during roofing asphalt heating. Do not heat roofing asphalt within 25 deg F (14 deg C) of flash point. Discard roofing asphalt maintained at a temperature exceeding finished blowing temperature for more than four hours.
   OR
   Asphalt Heating: Heat and apply SEBS-modified roofing asphalt according to roofing system manufacturer's written instructions.
8. Substrate-Joint Penetrations: Prevent roofing asphalt and adhesives from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

G. Base-Sheet Installation
1. If sheathing paper is required over wood decks by roofing system manufacturer, loosely lay one course of sheathing paper, lapping edges and ends a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
2. Install lapped base-sheet course, extending sheet over and terminating beyond cants. Attach base sheet as follows:
   a. Mechanically fasten to substrate, for nailable substrate.
      OR
      Spot- or strip-mop to substrate with hot roofing asphalt.
      OR
      Adhere to substrate in a solid mopping of hot roofing asphalt **OR** uniform coating of cold-applied adhesive, **as directed**, for nonnailable or insulated substrates.

H. Base-Ply Sheet Installation
1. Install glass-fiber base-ply sheets according to roofing system manufacturer's written instructions starting at low point of roofing system. Align glass-fiber base-ply sheets without stretching. Extend sheets over and terminate beyond cants.
   a. Shingle side laps of glass-fiber base-ply sheets uniformly to ensure that required number of glass-fiber base-ply sheets covers substrate at any point. Shingle in direction to shed water.
   b. Embed each glass-fiber base-ply sheet in a continuous void-free mopping of hot roofing asphalt to form a uniform membrane without glass-fiber base-ply sheets touching.

I. APP-Modified Bituminous Membrane Installation
1. Install modified bituminous roofing membrane cap sheet **OR** sheet and cap sheet, **as directed**, according to roofing manufacturer's written instructions, starting at low point of roofing system. Extend roofing membrane sheets over and terminate beyond cants, installing as follows:

a. Adhere to substrate in cold-applied adhesive.
OR
Torch apply to substrate.
b. Unroll roofing membrane sheets and allow them to relax for minimum time period required by manufacturer.
2. Laps: Accurately align roofing membrane sheets, without stretching, and maintain uniform side and end laps. Stagger end laps. Completely bond and seal laps, leaving no voids.
a. Repair tears and voids in laps and lapped seams not completely sealed.
b. Apply roofing granules to cover exuded bead at laps while bead is hot.
3. Install roofing membrane sheets so side and end laps shed water.

J. Flashing And Stripping Installation
1. Install base flashing over cant strips and other sloped and vertical surfaces, at roof edges, and at penetrations through roof; secure to substrates according to roofing system manufacturer's written instructions, and as follows:
a. Prime substrates with asphalt primer if required by roofing system manufacturer.
b. Backer Sheet Application: Mechanically fasten backer sheet to walls or parapets. Adhere backer sheet over roofing membrane at cants in cold-applied adhesive, **as directed**.
OR
Backer Sheet Application: Adhere backer sheet to substrate in a solid mopping of hot roofing asphalt **OR** cold-applied adhesive at rate required by roofing system manufacturer, **as directed**.
c. Flashing Sheet Application: Adhere flashing sheet to substrate in cold-applied adhesive at rate required by roofing system manufacturer.
OR
Flashing Sheet Application: Adhere flashing sheet to substrate in asphalt roofing cement at rate required by roofing system manufacturer.
OR
Flashing Sheet Application: Torch apply flashing sheet to substrate.
2. Extend base flashing up walls or parapets a minimum of 8 inches (200 mm) above roofing membrane and 4 inches (100 mm) onto field of roofing membrane.
3. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.
a. Seal top termination of base flashing with a strip of glass-fiber fabric set in asphalt roofing cement, **as directed**.
4. Install roofing membrane cap-sheet stripping where metal flanges and edgings are set on membrane roofing according to roofing system manufacturer's written instructions.
5. Roof Drains: Set 30-by-30-inch- (760-by-760-mm-) square metal flashing in bed of roofing-manufacturer-approved asphaltic adhesive on completed roofing membrane. Cover metal flashing with roofing membrane cap-sheet stripping and extend a minimum of 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, beyond edge of metal flashing onto field of roofing membrane. Clamp roofing membrane, metal flashing, and stripping into roof-drain clamping ring.
a. Install stripping according to roofing system manufacturer's written instructions.

K. Coating Installation
1. Apply coating to roofing membrane **OR** roofing membrane and base flashings, **as directed**, according to manufacturer's written instructions, by spray, roller, or other suitable application method to provide a dry film thickness of not less than 20 mils (0.5 mm), **as directed**.

L. Walkway Installation
1. Walkway Pads: Install walkway pads in cold-applied adhesive, using units of size indicated or, if not indicated, of manufacturer's standard size according to walkway pad manufacturer's written instructions.
2. Walkway Strips: Install walkway cap sheet **OR** backer and cap sheet, **as directed**, strips over roofing membrane using same application method as used for roofing membrane cap sheet.

M. Field Quality Control
1. Testing Agency: Perform tests and inspections and to prepare test reports.
2. Test Cuts: Test specimens will be removed to evaluate problems observed during quality-assurance inspections of roofing membrane as follows:
    a. Approximate quantities of components within roofing membrane will be determined according to ASTM D 3617.
    b. Test specimens will be examined for interply voids according to ASTM D 3617 and to comply with criteria established in Appendix 3 in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."
    c. Repair areas where test cuts were made according to roofing system manufacturer's written instructions.
3. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
    a. Notify the Owner 48 hours in advance of date and time of inspection.
4. Roofing system will be considered defective if it does not pass tests and inspections.
    a. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

N. Protecting And Cleaning
1. Protect roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to the Owner.
2. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Final Completion and according to warranty requirements.
3. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 05 13 00a

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SECTION 07 05 13 00b - SBS-MODIFIED BITUMINOUS MEMBRANE ROOFING

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for styrene-butadiene-styrene (SBS) modified bituminous membrane roofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Styrene-butadiene-styrene (SBS) modified bituminous membrane roofing.
      b. Hybrid roofing system that combines built-up ply sheets with SBS-modified bituminous membrane roofing.
      c. Vapor retarder.
      d. Roof insulation.
   2. Section includes the installation of insulation strips in ribs of acoustical roof deck. Insulation strips are furnished under Division 05 Section "Steel Decking".

C. Definitions
   1. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.
   2. Hot Roofing Asphalt: Roofing asphalt heated to its equiviscous temperature, the temperature at which its viscosity is 125 centipoise for mop-applied roofing asphalt and 75 centipoise for mechanical spreader-applied roofing asphalt, within a range of plus or minus 25 deg F (14 deg C), measured at the mop cart or mechanical spreader immediately before application.

D. Performance Requirements
   1. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.
   2. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.
   3. Roofing System Design: If membrane roofing system is to be designed to withstand uplift pressure established by ASCE/SEI 7, provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
      a. Corner Uplift Pressure: <Insert **lbf/sq. ft. (kPa/sq. m)**>.
      b. Perimeter Uplift Pressure: <Insert **lbf/sq. ft. (kPa/sq. m)**>.
      c. Field-of-Roof Uplift Pressure: <Insert **lbf/sq. ft. (kPa/sq. m)**>.
   4. FM Approvals Listing: If Project is FM Global insured or if FM Approvals requirements will set a minimum quality standard, provide membrane roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a membrane roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.
      a. Fire/Windstorm Classification: Class 1A-60 **OR** Class 1A-75 **OR** Class 1A-90 **OR** Class 1A-105 **OR** Class 1A-120, **as directed**.
      b. Hail Resistance Rating: MH **OR** SH, **as directed**.
   5. Energy Performance (if required for LEED-NC Credit SS 7.2): Provide roofing system with initial Solar Reflectance Index not less than 78 when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.

6. Energy Performance (for roofs that must comply with DOE's ENERGY STAR requirements): Provide roofing system that is listed on DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.
7. Energy Performance (for roofs that must comply with California Energy Commission's CEC-Title 24): Provide roofing system with initial Solar Reflectance not less than 0.70 and Thermal Emittance not less than 0.75 when tested according to Cool Roof Rating Council's CRRC-1.

E. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Product Test Reports for Credit SS 7.2: For roof materials, indicating that roof materials comply with Solar Reflectance Index requirement.
   b. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.
   a. Base flashings and membrane terminations.
   b. Tapered insulation, including slopes.
   c. Crickets, saddles, and tapered edge strips, including slopes.
   d. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
4. Samples: For the following products:
   a. Sheet roofing materials, including base sheet, base-ply sheet, roofing membrane sheet, flashing backer sheet, membrane cap sheet and flashing sheet, of color specified.
   b. Roof insulation.
   c. 3 lb (1.5 kg) of aggregate surfacing material in gradation and color indicated.
   d. Walkway pads or rolls.
   e. Six insulation fasteners of each type, length, and finish.
5. Qualification Data: For qualified Installer, manufacturer and testing agency.
6. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
   a. Submit evidence of complying with performance requirements.
7. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of membrane roofing system.
8. Research/Evaluation Reports: For components of membrane roofing system, from the ICC-ES **OR** applicable model code organization, **as directed**.
9. Maintenance Data: For roofing system to include in maintenance manuals.
10. Warranties: Sample of special warranties.

F. Quality Assurance
1. Manufacturer Qualifications: A qualified manufacturer that is UL listed **OR** FM Approvals approved, **as directed**, for membrane roofing system identical to that used for this Project.
2. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
3. Source Limitations: Obtain components including roof insulation and fasteners for membrane roofing system from same manufacturer as membrane roofing or approved by membrane roofing manufacturer.
4. Exterior Fire-Test Exposure: ASTM E 108, Class A **OR** Class B **OR** Class C, **as directed**; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.
5. Fire-Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
6. Preinstallation Roofing Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
2. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
   a. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
3. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
4. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

H. Project Conditions
1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

I. Warranty
1. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period.
   a. Special warranty includes membrane roofing, base flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories, and other components of membrane roofing system.
   b. Warranty Period: 10 **OR** 15 **OR** 20 **OR** 25 **OR** 30, **as directed,** years from date of Final Completion.

1.2 PRODUCTS

A. SBS-Modified Asphalt-Sheet Materials
1. Roofing Membrane Sheet: ASTM D 6164, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6163, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with glass fibers) **OR** ASTM D 6162, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; smooth surfaced; suitable for application method specified.
2. Smooth-Surfaced Roofing Membrane Cap Sheet: ASTM D 6164, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6163, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with glass fibers) **OR** ASTM D 6162, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; smooth surfaced; suitable for application method specified.
   OR
   Granule-Surface Roofing Membrane Cap Sheet: ASTM D 6164, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6163, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with glass fibers) **OR** ASTM D 6162, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; granular surfaced; suitable for application method specified, and as follows:
   a. Granule Color: White **OR** Gray **OR** Tan, **as directed**.
3. Metal-Foil-Surfaced Roofing Membrane Cap Sheet: ASTM D 6298, metal-foil surfaced SBS-modified asphalt sheet (reinforced with glass fibers); suitable for application method specified, and as follows:
   a. Foil Surfacing: Aluminum **OR** Copper **OR** Stainless steel **OR** Aluminum, fluoropolymer-coated finish, of color and gloss selected from manufacturer's full range, **as directed**.

B. Base-Sheet Materials
1. Sheathing Paper: Red-rosin type, minimum 3 lb/100 sq. ft. (0.16 kg/sq. m).
2. Base Sheet: ASTM D 4601, Type II, SBS-modified, asphalt-impregnated and -coated sheet, with glass-fiber-reinforcing mat, dusted with fine mineral surfacing on both sides.
a. Weight: 25 lb/100 sq. ft. (1.2 kg/sq. m) **OR** 40 lb/100 sq. ft. (1.95 kg/sq. m) **OR** 50 lb/100 sq. ft. (2.4 kg/sq. m) **OR** 60 lb/100 sq. ft. (2.9 kg/sq. m) **OR** 75 lb/100 sq. ft. (3.7 kg/sq. m), **as directed**, minimum.

OR

Base Sheet: ASTM D 4601, Type I **OR** Type II, **as directed**, nonperforated, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.

OR

Base Sheet: ASTM D 4897, Type II, venting, nonperforated, heavyweight, asphalt-impregnated and -coated, glass-fiber base sheet with coarse granular surfacing or embossed venting channels on bottom surface.

OR

Base Sheet: ASTM D 2626, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.

C. Base-Ply Sheet Materials
1. Glass-Fiber Base-Ply Sheet: ASTM D 2178, Type IV **OR** Type VI, **as directed**, asphalt-impregnated, glass-fiber felt.

D. Base Flashing Sheet Materials
1. Backer Sheet: ASTM D 4601, Type I **OR** Type II, **as directed**, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.

OR

Backer Sheet: ASTM D 2626, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.

OR

Backer Sheet: ASTM D 6164, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6163, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with glass fibers) **OR** ASTM D 6162, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; smooth surfaced; suitable for application method specified.
2. Granule-Surfaced Flashing Sheet: ASTM D 6164, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6163, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with glass fibers) **OR** ASTM D 6162, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; granular surfaced; suitable for application method specified, and as follows:
a. Granule Color: White **OR** Gray **OR** Tan, **as directed**.

OR

Metal-Foil-Surfaced Flashing Sheet: ASTM D 6298, metal-foil surfaced SBS-modified asphalt sheet (reinforced with glass fibers); suitable for application method specified, and as follows:
a. Foil Surfacing: Aluminum **OR** Copper **OR** Stainless steel **OR** Aluminum, fluoropolymer-coated finish, of color and gloss selected from manufacturer's full range, **as directed**.
3. Glass-Fiber Fabric: Woven glass-fiber cloth, treated with asphalt, complying with ASTM D 1668, Type I.

E. Auxiliary Roofing Membrane Materials
1. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing membrane.
a. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.

b. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   1) Plastic Foam Adhesives: 50 g/L.
   2) Gypsum Board and Panel Adhesives: 50 g/L.
   3) Multipurpose Construction Adhesives: 70 g/L.
   4) Fiberglass Adhesives: 80 g/L.
   5) Contact Adhesive: 80 g/L.
   6) Other Adhesives: 250 g/L.
   7) Nonmembrane Roof Sealants: 300 g/L.
   8) Sealant Primers for Nonporous Substrates: 250 g/L.
   9) Sealant Primers for Porous Substrates: 775 g/L.

2. Asphalt Primer: ASTM D 41.
3. Roofing Asphalt: ASTM D 312, Type III **OR** Type IV **OR** Type III or IV as recommended by roofing system manufacturer for application, **as directed**.
   OR
   Roofing Asphalt: ASTM D 6152, SEBS modified.
4. Cold-Applied Adhesive: Roofing system manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive specially formulated for compatibility and use with roofing membrane and base flashings.
5. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required by roofing system manufacturer for application.
6. Mastic Sealant: Polyisobutylene, plain or modified bitumen; nonhardening, nonmigrating, nonskinning, and nondrying.
7. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing membrane components to substrate; tested by manufacturer for required pullout strength, and acceptable to roofing system manufacturer.
8. Metal Flashing Sheet: As specified in Division 07 Section "Sheet Metal Flashing And Trim".
9. Roofing Granules: Ceramic-coated roofing granules, No. 11 screen size with 100 percent passing No. 8 (2.36-mm) sieve and 98 percent of mass retained on No. 40 (0.425-mm) sieve, color to match roofing membrane.
10. Aggregate Surfacing: ASTM D 1863, No. 6 or No. 67, clean, dry, opaque, water-worn gravel or crushed stone, free of sharp edges **OR** crushed slag, free of sharp edges, **as directed**.
11. Miscellaneous Accessories: Provide those recommended by roofing system manufacturer.

F. Substrate Boards
1. Substrate Board: ASTM C 1396/C 1396M, Type X gypsum board, 5/8 inch (16 mm) thick.
   OR
   Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** Type X, 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.
   OR
   Substrate Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
   OR
   Substrate Board: ASTM C 728, perlite board, 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick, seal coated.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

G. Vapor Retarder
1. Polyethylene Film: ASTM D 4397, 6 mils (0.15 mm) thick, minimum, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).

a. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
OR
Adhesive: Manufacturer's standard lap adhesive, FM Approvals approved for vapor-retarder application.
2. Laminated Sheet: Kraft paper, two layers, laminated with asphalt and edge reinforced with woven fiberglass yarn, with maximum permeance rating of 0.50 perm (29 ng/Pa x s x sq. m) and with manufacturer's standard adhesive, **as directed**.
3. Self-Adhering Sheet Vapor Retarder: ASTM D 1970, minimum of 40-mil- (1.0-mm-) thick, polyethylene film laminated to layer of rubberized asphalt adhesive; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.
OR
Self-Adhering Sheet Vapor Retarder: 30- to 40-mil- (0.76- to 1.0-mm-) thick, polyethylene film laminated to layer of butyl rubber adhesive; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.
4. Glass-Fiber Felt: ASTM D 2178, Type IV, asphalt impregnated.

H. Roof Insulation
1. General: Preformed roof insulation boards manufactured or approved by roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation, **as directed**.
2. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.6-lb/cu. ft. (26-kg/cu. m) **OR** Type X, 1.3-lb/cu. ft. (21-kg/cu. m), **as directed**, minimum density, square edged.
3. Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density.
4. Composite Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density, with factory-applied facings, as follows:
a. Facer: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick.
OR
Facer: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
5. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2 **OR** Type II, Class I, Grade 3, **as directed**, felt or glass-fiber mat facer on both major surfaces.
6. Composite Polyisocyanurate Board Insulation: ASTM C 1289, with factory-applied facing board, as indicated below by type, on one major surface and felt or glass-fiber mat facer on the other surface.
a. Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick.
b. Type V, OSB facer, 7/16 inch (11 mm) thick.
c. Type VII, glass-mat-faced gypsum board facer, 1/4 inch (6 mm) thick.
7. Perlite Board Insulation: ASTM C 728, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.
8. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.
9. Cellular-Glass Board Insulation: ASTM C 552, Type IV, rigid, cellular-glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.
10. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48) unless otherwise indicated.
11. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

I. Insulation Accessories
1. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.
3. Modified Asphaltic Insulation Adhesive: Insulation manufacturer's recommended modified asphaltic, asbestos-free, cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.
OR
Bead-Applied Insulation Adhesive: Insulation manufacturer's recommended bead-applied, low-rise, one-component or multicomponent urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
OR
Full-Spread Applied Insulation Adhesive: Insulation manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
4. Insulation Cant Strips: ASTM C 728, perlite insulation board.
OR
Insulation Cant Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.
5. Wood Nailer Strips: Comply with requirements in Division 06 Section(s) "Rough Carpentry" OR "Miscellaneous Rough Carpentry", **as directed**.
6. Tapered Edge Strips: ASTM C 728, perlite insulation board.
OR
Tapered Edge Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.
7. Cover Board: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, 1/2 inch (13 mm) thick.
OR
Cover Board: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
OR
Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.
OR
Cover Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
8. Substrate Joint Tape: 6- or 8-inch- (150- or 200-mm-) wide, coated, glass-fiber joint tape.

J. Walkways
1. Walkway Pads: Reinforced asphaltic composition pads with slip-resisting mineral-granule surface **OR** Polymer-modified, reconstituted rubber pads with slip-resisting textured surface, **as directed**, manufactured as a traffic pad for foot traffic and acceptable to roofing system manufacturer, 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, thick, minimum.
2. Walkway Cap Sheet Strips: ASTM D 6164, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6163, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with glass fibers) **OR** ASTM D 6162, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; granular surfaced; suitable for application method specified, and as follows:
a. Granule Color: White **OR** Gray **OR** Tan, **as directed**.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:

a. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
b. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
c. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 5 Section "Steel Deck."
d. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
e. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
    1) Test for moisture by pouring 1 pint (0.5 L) of hot roofing asphalt on deck at start of each day's work and at start of each roof area or plane. Do not proceed with roofing work if test sample foams or can be easily and cleanly stripped after cooling.
f. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
g. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of 1/16 inch (1.6 mm) out of plane relative to adjoining deck.

2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
2. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
3. Prime surface of concrete deck with asphalt primer at a rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
4. Install insulation strips in ribs of acoustical roof decks according to acoustical roof deck manufacturer's written instructions.

C. Substrate Board Installation
1. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
    a. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' "RoofNav" and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.
    OR
    Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to membrane roofing system manufacturers' written instructions.

D. Vapor-Retarder Installation
1. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
    a. Continuously seal side and end laps with tape **OR** adhesive, **as directed**.
2. Laminate Sheet: Install laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively. Bond vapor retarder to substrate as follows:
    a. Apply adhesive at rate recommended by vapor-retarder manufacturer. Seal laps with adhesive.
    OR
    Apply ribbons of hot roofing asphalt at spacing, temperature, and rate recommended by vapor-retarder manufacturer. Seal laps with hot roofing asphalt.

3. Self-Adhering Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 inches (90 mm) and 6 inches (150 mm), respectively. Seal laps by rolling.
4. Built-up Vapor Retarder: Install two glass-fiber felt plies lapping each felt 19 inches (483 mm) over preceding felt. Embed each felt in a solid mopping of hot roofing asphalt. Glaze-coat completed surface with hot roofing asphalt. Apply hot roofing asphalt within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
5. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into membrane roofing system.

E. Insulation Installation
1. Comply with roofing system manufacturer's written instructions for installing roof insulation.
2. Install one lapped base-sheet course and mechanically fasten to substrate according to roofing system manufacturer's written instructions.
3. Nailer Strips: Mechanically fasten 4-inch nominal- (89-mm actual-) width wood nailer strips of same thickness as insulation perpendicular to sloped roof deck at the following spacing:
    a. 16 feet (4.88 m) apart for roof slopes steeper than 1 inch per 12 inches (1:12) but less than 3 inches per 12 inches (3:12).
    b. 48 inches (1220 mm) apart for roof slopes steeper than 3 inches per 12 inches (3:12).
4. Insulation Cant Strips: Install and secure preformed 45-degree insulation cant strips at junctures of roofing membrane system with vertical surfaces or angle changes more than 45 degrees.
5. Install tapered insulation under area of roofing to conform to slopes indicated.
6. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
    a. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
7. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or more, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.
    a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
8. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
9. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.
10. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
    a. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
    b. Set each layer of insulation in a solid mopping of hot roofing asphalt applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
       OR
       Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
       OR
       Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
11. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
    a. If Project is FM Global insured or if FM Approvals requirements are proposed as a performance standard, fasten insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
    b. If number of fasteners will be based on ASCE/SEI 7's uplift pressure or SPRI's factored design uplift pressure, fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.

12. Mechanically Fastened and Adhered Insulation: Install first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.

13. If Project is FM Global insured or if FM Approvals requirements are proposed as a performance standard, fasten first layer of insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
14. If fastening is calculated from ASCE/SEI 7's uplift pressure or SPRI's factored design uplift pressure, fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
    a. Set each subsequent layer of insulation in a solid mopping of hot roofing asphalt applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
       OR
       Set each subsequent layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
       OR
       Set each subsequent layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

F. If cover boards will be field installed over roof insulation and immediately below roofing membrane, install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints a minimum of 6 inches (150 mm) in each direction from joints of insulation below. Loosely butt cover boards together and fasten to roof deck, **as directed**. Tape joints if required by roofing system manufacturer.
    a. Fasten cover boards according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
       OR
       Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.
    b. Apply hot roofing asphalt to underside, and immediately bond cover board to substrate.

G. Roofing Membrane Installation, General
1. If referencing NRCA's roof assembly identification matrix system, install roofing membrane system according to roofing system manufacturer's written instructions and applicable recommendations in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."
    a. Install roofing system MBS **OR** MBSH, **as directed**,-2 **OR** 3 **OR** 4, **as directed**,-N **OR** I **OR** C, **as directed**,-T **OR** M **OR** L, **as directed**,-A **OR** M **OR** F, **as directed**, according to roof assembly identification matrix and roof assembly layout illustrations in NRCA's "The NRCA Roofing and Waterproofing Manual" and to requirements in this Section.
2. For roof system that exceeds requirements of NRCA's roof assemblies, install roofing membrane system according to roofing system manufacturer's written instructions and applicable recommendations in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing" and as follows:
    a. Deck Type: N (nailable) **OR** I (insulated) **OR** C (concrete or nonnailable), **as directed**.
    b. Adhering Method: T (torched) **OR** M (mopped) **OR** L (cold-applied adhesive), **as directed**.
    c. Base Sheet: One **OR** One, installed over sheathing paper, **as directed**.
    d. Number of Glass-Fiber Base-Ply Sheets: One **OR** Two, **as directed**.
    e. Number of SBS-Modified Asphalt Sheets: One **OR** Two, **as directed**.
    f. Surfacing Type: A (aggregate) **OR** M (mineral-granule-surfaced cap sheet) **OR** F (foil-surfaced cap sheet), **as directed**.
3. Start installation of roofing membrane in presence of roofing system manufacturer's technical personnel.
4. Where roof slope exceeds 1/2 inch per 12 inches (1:24) **OR** 3/4 inch per 12 inches (1:18), **as directed**, install roofing membrane sheets parallel with slope.

a. Backnail roofing membrane sheets to nailer strips **OR** substrate, **as directed**, according to roofing system manufacturer's written instructions.
5. Cooperate with testing agencies engaged or required to perform services for installing roofing system.
6. Coordinate installation of roofing system so insulation and other components of the roofing membrane system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.
   a. At end of each day's work, provide tie-offs to cover exposed roofing membrane sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt, with joints and edges sealed.
   b. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
   c. Remove and discard temporary seals before beginning work on adjoining roofing.
7. Asphalt Heating: Do not raise roofing asphalt temperature above equiviscous temperature range more than one hour before time of application. Do not exceed roofing asphalt manufacturer's recommended temperature limits during roofing asphalt heating. Do not heat roofing asphalt within 25 deg F (14 deg C) of flash point. Discard roofing asphalt maintained at a temperature exceeding finished blowing temperature for more than four hours.
   OR
   Asphalt Heating: Heat and apply SEBS-modified roofing asphalt according to roofing system manufacturer's written instructions.
8. Substrate-Joint Penetrations: Prevent roofing asphalt and adhesives from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

H. Base-Sheet Installation
1. Loosely lay one course of sheathing paper, lapping edges and ends a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
2. Install lapped base-sheet course, extending sheet over and terminating beyond cants. Attach base sheet as follows:
   a. Mechanically fasten to substrate, for nailable substrate.
      OR
      Spot- or strip-mop to substrate with hot roofing asphalt.
      OR
      Adhere to substrate in a solid mopping of hot roofing asphalt **OR** uniform coating of cold-applied adhesive, **as directed**, for nonnailable or insulated substrates.

I. Base-Ply Sheet Installation
1. Install glass-fiber base-ply sheets according to roofing system manufacturer's written instructions starting at low point of roofing system. Align glass-fiber base-ply sheets without stretching. Extend sheets over and terminate beyond cants.
   a. Shingle side laps of glass-fiber base-ply sheets uniformly to ensure that required number of glass-fiber base-ply sheets covers substrate at any point. Shingle in direction to shed water.
   b. Embed each glass-fiber base-ply sheet in a continuous void-free mopping of hot roofing asphalt to form a uniform membrane without glass-fiber base-ply sheets touching.

J. SBS-Modified Bituminous Membrane Installation
1. Install modified bituminous roofing membrane cap sheet **OR** sheet and cap sheet, **as directed**, according to roofing manufacturer's written instructions, starting at low point of roofing system. Extend roofing membrane sheets over and terminate beyond cants, installing as follows:
   a. Adhere to substrate in a solid mopping of hot roofing asphalt applied at not less than 425 deg F (218 deg C).
      OR
      Adhere to substrate in cold-applied adhesive.
      OR

Torch apply to substrate.
b. Unroll roofing membrane sheets and allow them to relax for minimum time period required by manufacturer.
2. Laps: Accurately align roofing membrane sheets, without stretching, and maintain uniform side and end laps. Stagger end laps. Completely bond and seal laps, leaving no voids.
a. Repair tears and voids in laps and lapped seams not completely sealed.
b. Apply roofing granules to cover exuded bead at laps while bead is hot.
3. Install roofing membrane sheets so side and end laps shed water.
4. Aggregate Surfacing: Promptly after installing and testing roofing membrane, base flashing, and stripping, flood-coat roof surface with 60 lb/100 sq. ft. (3 kg/sq. m) of hot roofing asphalt. While flood coat is hot and fluid, cast the following average weight of aggregate in a uniform course:
a. Aggregate Weight: 400 lb/100 sq. ft. (20 kg/sq. m) for gravel or crushed stone or 300 lb/100 sq. ft. (15 kg/sq. m) for slag.

K. Flashing And Stripping Installation
1. Install base flashing over cant strips and other sloped and vertical surfaces, at roof edges, and at penetrations through roof; secure to substrates according to roofing system manufacturer's written instructions, and as follows:
a. Prime substrates with asphalt primer if required by roofing system manufacturer.
b. Backer Sheet Application: Mechanically fasten backer sheet to walls or parapets. Adhere backer sheet over roofing membrane at cants in a solid mopping of hot roofing asphalt **OR** cold-applied adhesive, **as directed**.
OR
Backer Sheet Application: Adhere backer sheet to substrate in a solid mopping of hot roofing asphalt **OR** cold-applied adhesive at rate required by roofing system manufacturer, **as directed**.
c. Flashing Sheet Application: Adhere flashing sheet to substrate in a solid mopping of hot roofing asphalt applied at not less than 425 deg F (218 deg C). Apply hot roofing asphalt to back of flashing sheet if recommended by roofing system manufacturer.
OR
Flashing Sheet Application: Adhere flashing sheet to substrate in cold-applied adhesive at rate required by roofing system manufacturer.
OR
Flashing Sheet Application: Adhere flashing sheet to substrate in asphalt roofing cement at rate required by roofing system manufacturer.
OR
Flashing Sheet Application: Torch apply flashing sheet to substrate.
2. Extend base flashing up walls or parapets a minimum of 8 inches (200 mm) above roofing membrane and 4 inches (100 mm) onto field of roofing membrane.
3. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.
a. Seal top termination of base flashing with a strip of glass-fiber fabric set in asphalt roofing cement, **as directed**.
4. Install roofing membrane cap-sheet stripping where metal flanges and edgings are set on membrane roofing according to roofing system manufacturer's written instructions.
5. Roof Drains: Set 30-by-30-inch- (760-by-760-mm-) square metal flashing in bed of asphalt roofing cement on completed roofing membrane. Cover metal flashing with roofing membrane cap-sheet stripping and extend a minimum of 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, beyond edge of metal flashing onto field of roofing membrane. Clamp roofing membrane, metal flashing, and stripping into roof-drain clamping ring.
a. Install stripping according to roofing system manufacturer's written instructions.

L. Walkway Installation
1. Walkway Pads: Install walkway pads using units of size indicated or, if not indicated, of manufacturer's standard size according to walkway pad manufacturer's written instructions.
a. Set walkway pads in cold-applied adhesive.

OR
Set walkway pads in additional pour coat of hot roofing asphalt after aggregate surfacing of modified bituminous roofing membrane.

2. Walkway Cap Sheet Strips: Install walkway cap sheet strips over roofing membrane using same application method as used for roofing membrane cap sheet. Install walkway cap sheet strips before flood coat and aggregate surface is applied, **as directed**.

M. Field Quality Control
1. Testing Agency: Perform tests and inspections and to prepare test reports.
2. Test Cuts: Test specimens will be removed to evaluate problems observed during quality-assurance inspections of roofing membrane as follows:
   a. Approximate quantities of components within roofing membrane will be determined according to ASTM D 3617.
   b. Test specimens will be examined for interply voids according to ASTM D 3617 and to comply with criteria established in Appendix 3 in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."
   c. Repair areas where test cuts were made according to roofing system manufacturer's written instructions.
3. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
   a. Notify the Owner 48 hours in advance of date and time of inspection.
4. Roofing system will be considered defective if it does not pass tests and inspections.
   a. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

N. Protecting And Cleaning
1. Protect roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to the Owner.
2. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Final Completion and according to warranty requirements.
3. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 05 13 00b

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Task	Specification	Specification Description
07 05 13 00	07 01 50 81	Built-Up Coal-Tar Roofing
07 05 13 00	07 53 16 00	EPDM Membrane Roofing
07 05 13 00	07 01 50 81a	Preparation for Re-Roofing

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SECTION 07 11 13 00 - BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. This specification covers the furnishing and installation of materials for bituminous dampproofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 SUMMARY

A. Section Includes:

1. Hot-applied asphalt dampproofing.
2. Cold-applied, cut-back-asphalt dampproofing.
3. Cold-applied, emulsified-asphalt dampproofing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.2: For dampproofing, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For dampproofing, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

1.4 FIELD CONDITIONS

A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit dampproofing to be performed according to manufacturers' written instructions.

B. Ventilation: Provide adequate ventilation during application of dampproofing in enclosed spaces. Maintain ventilation until dampproofing has cured.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Source Limitations: Obtain primary dampproofing materials and primers from single source from single manufacturer. Provide protection course, molded-sheet drainage panels and auxiliary materials recommended in writing by manufacturer of primary materials.

B. VOC Content: Products shall comply with VOC content limits of authorities having jurisdiction unless otherwise required.

2.2 HOT-APPLIED ASPHALT DAMPPROOFING

A. Hot-Applied Asphalt: ASTM D 449, Type II **OR** Type III, **as directed**.

B. VOC Content: 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Low-Emitting Materials: Dampproofing shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 COLD-APPLIED, CUT-BACK-ASPHALT DAMPPROOFING

A. Trowel Coats: ASTM D 4586, Type I, Class 1, fibered.

B. Brush and Spray Coats: ASTM D 4479, Type I, fibered or nonfibered.

C. VOC Content: 250 **OR** 300, **as directed,** g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Low-Emitting Materials: Dampproofing shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Trowel Coats: ASTM D 1227, Type II, Class 1.

B. Fibered Brush and Spray Coats: ASTM D 1227, Type II, Class 1.

C. Brush and Spray Coats: ASTM D 1227, Type III, Class 1.

D. VOC Content: Zero **OR** 30 g/L or less, **as directed**.

E. Low-Emitting Materials: Dampproofing shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.5 AUXILIARY MATERIALS

A. General: Furnish auxiliary materials recommended in writing by dampproofing manufacturer for intended use and compatible with bituminous dampproofing.

B. Cut-Back-Asphalt Primer: ASTM D 41.

C. Emulsified-Asphalt Primer: ASTM D 1227, Type III, Class 1, except diluted with water as recommended in writing by manufacturer.

1. Primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Asphalt-Coated Glass Fabric: ASTM D 1668, Type I.

E. Patching Compound: Epoxy or latex-modified repair mortar **OR** Asbestos-free fibered mastic**, as directed,** of type recommended in writing by dampproofing manufacturer.

F. Protection Course: ASTM D 6506, 1/8-inch- (3-mm-) thick, semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners.

G. Protection Course: Fan folded, with a core of extruded-polystyrene board insulation faced on one side or both sides with plastic film, nominal thickness 1/4 inch (6 mm), with a compressive strength of not less than 8 psi (55 kPa) per ASTM D 1621, and maximum water absorption by volume of 0.6 percent per ASTM C 272.

H. Protection Course: Extruded-polystyrene board insulation, unfaced, ASTM C 578, Type X, 1/2 inch (13 mm) thick.

I. Protection Course: Smooth-surfaced roll roofing complying with ASTM D 6380, Class S, Type III.

2.6 MOLDED-SHEET DRAINAGE PANELS

A. Molded-Sheet Drainage Panel: Comply with Section 334600 "Subdrainage."

B. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Composite subsurface drainage panel consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21-mm) sieve laminated to one side of the core; and with a vertical flow rate of 9 to 15 gpm per ft. (112 to 188 L/min. per m).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions with Applicator present, for compliance with requirements for surface smoothness, surface moisture, and other conditions affecting performance of bituminous dampproofing work.

1. Test for surface moisture according to ASTM D 4263.

B. Proceed with application only after substrate construction and penetrating work have been completed and unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Mask or otherwise protect adjoining exposed surfaces from being stained, spotted, or coated with dampproofing. Prevent dampproofing materials from entering and clogging weep holes and drains.

B. Clean substrates of projections and substances detrimental to the dampproofing work; fill voids, seal joints, and remove bond breakers if any, as recommended in writing by prime material manufacturer.

C. Apply patching compound to patch and fill tie holes, honeycombs, reveals, and other imperfections; cover with asphalt-coated glass fabric.

3.3 APPLICATION, GENERAL

A. Comply with manufacturer's written instructions for dampproofing application, cure time between coats, and drying time before backfilling unless more stringent requirements are indicated.

1. Apply dampproofing to provide continuous plane of protection.
2. Apply additional coats if recommended in writing by manufacturer or to achieve a smooth surface and uninterrupted coverage.

B. Where dampproofing footings and foundation walls, apply from finished-grade line to top of footing; extend over top of footing and down a minimum of 6 inches (150 mm) over outside face of footing.

1. Extend dampproofing 12 inches (300 mm) onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.
2. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where shown as "reinforced," by embedding an 8-inch- (200-mm-) wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat for embedding fabric is in addition to other coats required.

C. Where dampproofing exterior face of inner wythe of exterior masonry cavity walls, lap dampproofing at least 1/4 inch (6 mm) onto flashing, masonry reinforcement, veneer ties, and other items that penetrate inner wythe.

1. Extend dampproofing over outer face of structural members and concrete slabs that interrupt inner wythe.
2. Lap dampproofing at least 1/4 inch (6 mm) onto shelf angles supporting veneer.

D. Where dampproofing interior face of above-grade, exterior concrete and masonry single-wythe masonry walls, continue dampproofing through intersecting walls by keeping vertical mortar joints at intersection temporarily open or by dampproofing wall before constructing intersecting walls.

3.4 HOT-APPLIED ASPHALT DAMPPROOFING

A. Do not apply hot asphalt when substrate condition causes foaming.

B. Kettle Temperature: Comply with dampproofing-material manufacturer's written instructions, and keep at least 25 deg F (14 deg C) below the flash point.

C. Prime masonry and other porous substrates.

D. Apply a uniform coat of hot asphalt by mopping or spraying at not less than 20 lb or 2.5 gal./100 sq. ft. (1 kg or 1 L/sq. m).

1. Apply a second coat to below-grade foundation walls and where first application has failed to produce a smooth surface and uninterrupted coverage. Apply second coat at the rate specified for first coat.

3.5 COLD-APPLIED, CUT-BACK-ASPHALT DAMPPROOFING

A. Concrete Foundations and Parged Masonry Foundation Walls: Apply two brush or spray coats at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat or one trowel coat at not less than 4 gal./100 sq. ft. (1.6 L/sq. m).

B. Unparged Masonry Foundation Walls: Apply primer and two brush or spray coats at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat or primer and one trowel coat at not less than 4 gal./100 sq. ft. (1.6 L/sq. m).

C. Unexposed Face of Concrete Retaining Walls: Apply one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).

D. Unexposed Face of Masonry Retaining Walls: Apply primer and one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).

E. Concrete Backup for Brick Veneer Assemblies, Stone Veneer Assemblies and Dimension Stone Cladding: Apply one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

F. Masonry Backup for Brick Veneer Assemblies, Stone Veneer Assemblies and Dimension Stone Cladding: Apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

G. Exterior Face of Inner Wythe of Cavity Walls: Apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

3.6 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Concrete Foundations and Parged Masonry Foundation Walls: Apply two brush or spray coats at not less than 1.5 gal./100 sq. ft. (0.6 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat one fibered brush or spray coat at not less than 3 gal./100 sq. ft. (1.2 L/sq. m) or one trowel coat at not less than 4 gal./100 sq. ft. (1.6 L/sq. m).

B. Unparged Masonry Foundation Walls: Apply primer and two brush or spray coats at not less than 1.5 gal./100 sq. ft. (0.6 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat primer and one fibered brush or spray coat at not less than 3 gal./100 sq. ft. (1.2 L/sq. m) or primer and one trowel coat at not less than 5 gal./100 sq. ft. (2 L/sq. m).

C. Unexposed Face of Concrete Retaining Walls: Apply one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).

D. Unexposed Face of Masonry Retaining Walls: Apply primer and one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).

E. Concrete Backup for Brick Veneer Assemblies, Stone Veneer Assemblies and Dimension Stone Cladding: Apply one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

F. Masonry Backup for Brick Veneer Assemblies, Stone Veneer Assemblies and Dimension Stone Cladding: Apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

G. Exterior Face of Inner Wythe of Cavity Walls: Apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

H. Interior Face of Exterior Concrete Walls: Where above grade and indicated to be furred and finished, apply one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

I. Interior Face of Single-Wythe Exterior Masonry Walls: Where above grade and indicated to be furred and finished, apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

3.7 INSTALLATION OF PROTECTION COURSE

A. Where indicated, install protection course over completed-and-cured dampproofing. Comply with dampproofing-material and protection-course manufacturers' written instructions for attaching protection course.

1. Support protection course over cured coating with spot application of adhesive type recommended in writing by protection-board manufacturer.
2. Install protection course on same day **OR** within 24 hours, **as directed,** of installation of dampproofing (while coating is tacky) to ensure adhesion.

3.8 INSTALLATION OF MOLDED-SHEET DRAINAGE PANELS

A. Place and secure molded-sheet drainage panels, with geotextile facing away from wall substrate, according to manufacturer's written instructions. Use adhesives or other methods that do not penetrate dampproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.

1. Install protection course before installing drainage panels.

3.9 CLEANING

A. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 07 11 13 00

Task	Specification	Specification Description
07 11 13 00	07 14 16 00	Cold Fluid-Applied Waterproofing

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SECTION 07 13 13 00 - BITUMINOUS WATERPROOFING

1.1 GENERAL

A. Description Of Work:

1. This specification covers the furnishing and installation of materials for bituminous waterproofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals

1. Product Data: For each type of product indicated. Include recommendations for method of application, primer, number of coats, coverage or thickness, and protection course.

C. Delivery, Storage And Handling

1. Waterproofing materials shall be delivered to the project site in the original sealed containers bearing the name of the manufacturer, contents and brand name. Asphalt shall be protected from freezing in a weathertight enclosure. Reinforcement fabrics shall be protected from moisture damage and moisture absorption in a weathertight enclosure or shall be stored off the ground on pallets, and covered on top and all sides with breathable-type canvas tarpaulins. Plastic sheets cause condensation buildup and therefore shall not be used to cover waterproofing materials. Damaged or deteriorated materials shall be removed from project site.

D. Project Conditions

1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit waterproofing to be performed according to manufacturers' written instructions.
2. Ventilation: Provide adequate ventilation during application of waterproofing in enclosed spaces. Maintain ventilation until waterproofing has cured.

1.2 PRODUCTS

A. Asphalt Waterproofing

1. Primer: Primer for hot-applied asphalt waterproofing shall conform to ASTM D41, asbestos-free, non-fibrated, manufactured with highly ductile soft asphalts and selected hydrocarbons.
2. Above-Grade Hot-Applied Asphalt: For above-grade applications where asphalt will not be exposed to temperatures exceeding 122 degrees F (50 degrees C), hot-applied asphalt for membrane waterproofing system shall conform to ASTM D449, Type II. For above-grade applications where asphalt will be exposed to sunlight and temperatures exceeding 122 degrees F (50 degrees C), hot-applied asphalt shall conform to ASTM D449, Type III.
3. Below-Grade Hot-Applied Asphalt: Hot-applied asphalt for below-grade applications shall conform to ASTM D449, Type I, asbestos-free, manufactured from crude petroleum, suitable for use with membrane waterproofing systems.
4. Reinforcement Fabrics
   a. Cotton Fabrics: Cotton fabrics shall be woven entirely of cotton conforming with ASTM D173, thoroughly and uniformly saturated with asphalt.
   b. Woven Burlap Fabrics: Woven burlap fabrics shall be composed of 100 percent jute fiber and two cotton threads at each selvage conforming with ASTM D1327, thoroughly and uniformly saturated with asphalt. The fabric mesh shall not be completely closed or sealed by the process of saturation. Sufficient porosity shall be maintained to allow successive moppings of the plying asphalt to seep through. The surface shall not be coated or covered with talc or any other substances that will interfere with the adhesion between fabric and plying asphalt. The fabric surface shall be uniformly smooth and free of

irregularities, folds and knots. The finished woven burlap fabrics shall be free of ragged edges, untrue edges, breaks or cracks, and other visible external defects.

c. Glass Fabrics: Glass fabrics shall conform to ASTM D1668 Type I, asphalt-treated woven glass waterproofing fabrics coated with asphalt.

d. Flashing Cement: Flashing cement shall conform to ASTM D4586, Type I, trowel grade, asbestos free, manufactured from asphalts characterized as adhesive, healing and ductile.

B. Insulation Boards

1. Insulation boards shall conform to ASTM C208 cellulosic fiber boards, construction grade, 1/2 inch (13 mm) thick, fibrous-felted homogeneous panel. Insulation boards shall be manufactured from ligno-cellulosic fibers (wood or cane) by a felting or molding process, asphalt-saturated or coated, with a density of 10 to 31 psf (49 to 151 kg/square meter). Surfaces of insulation boards shall be free of cracks, lumps, excessive departure from planeness, or other defects that adversely affect performance.

1.3 EXECUTION

A. Surface Preparation

1. Surfaces scheduled for bituminous waterproofing shall be prepared in accordance with waterproofing manufacturer's recommendations. Surface preparation shall be approved prior to waterproofing application.
2. Protection of Surrounding Areas: Before starting the waterproofing work, the surrounding areas and surfaces shall be protected from spillage and migration of asphalt onto other work. Drains and conductors shall be protected from clogging with asphalt.
3. Masonry Surfaces: Surfaces shall be free of oil, grease, dirt, laitance, loose material, frost, debris and other contaminants. Mortar joints shall be flush and free of extraneous mortar and chipped or broken masonry.
4. Concrete Surfaces: Surfaces shall be properly cured, free of form release agents, oil, grease, dirt, laitance, loose material, frost, debris and other contaminants. Form ties shall be cut flush with surface. Sharp protrusions and form match lines shall be removed. Holes, voids, spalled areas and cracks which can damage waterproofing materials shall be repaired. Rough surfaces shall be parged with a well-adhering coat of cement mortar.
5. Metal Surfaces: Surfaces shall be dry and be free of rust, scale, loose paint, oil, grease, dirt, frost and debris.

B. Hot-Applied Asphalt Waterproofing

1. Asphalt waterproofing shall be applied when the ambient temperature is 40 degrees F (4 degrees C) or above. Heating kettles and tanks shall be provided with automatic thermostatic control capable of maintaining asphalt temperature. Controls shall be calibrated and maintained in working order for duration of work. At time of application, asphalt shall not be heated above the equiviscous temperature (EVT) recommended by manufacturer. Immediately before use, temperature shall be measured with a portable thermometer at the point of application. EVT and flashpoint temperatures of asphalt in kettle shall be conspicuously posted on kettle. Asphalt with a temperature not conforming to the manufacturer's recommendations shall be returned to the kettle. Asphalt overheated by more than 50 degrees F (10 degrees C) for more than 1 hour shall be removed from site.
2. Below-Grade Wall Waterproofing: Waterproofing for foundation walls shall consist of a 1-ply **OR** 2-ply **OR** 3-ply **OR** 4-ply **OR** 5-ply, **as directed**, hot-applied asphalt membrane system. Fabrics shall be installed using the "shingle" method. Joints shall be caulked prior to primer applications. Primer shall be applied at a rate of 1/2 gallon per 100 square feet (0.2 L/square meter). Fabrics shall be overlapped at ends and staggered a minimum 10 inch (250 mm) for 1-ply **OR** 19 inch (480 mm) for 2-ply **OR** 24 inch (610 mm) for 3-ply **OR** 27 inch (685 mm) for 4-ply **OR** 30 inch (750 mm) for 5-ply, **as directed**, system. End-to-end taping is not acceptable. Each fabric shall be firmly embedded into a solid uniform coating of hot asphalt at a rate of 20 pounds per 100 square

feet (0.98 kg/square meter) by pressing with broom. Fabrics shall not touch fabrics. Hot asphalt shall penetrate each fabric to provide the required adhesion. Asphalt between fabrics shall not be excessive to prevent slippage. Waterproofing system consisting of two or more fabrics shall be provided with fabric reinforcement at corners, angles, over construction joints, and in locations where waterproofing fabrics are subject to unusual stress.

3. Floor Waterproofing: Primer shall be applied at a rate of 1/2 gallon per 100 square feet (0.2 L/square meter). Primer shall not be left in puddles. Primer shall be dry to the touch before application of asphalt. Where slab abuts walls, first reinforcing fabric shall extend 6 inches (150 mm) minimum on slab and 8 inches (200 mm) on wall. At vertical corners, first fabric shall extend minimum 5 inches (125 mm) from corner on each side. Second fabric shall lap the first fabric 2 inches (50 mm) minimum. At floor drains, and elsewhere as indicated, the fabric shall extend into a clamping device, set in a heavy coating of flashing cement, and securely clamped.

C. Flood Testing

1. Prior to concealment, waterproofed floors over occupied spaces shall be tested for watertightness. Drains shall be plugged and floors shall be submerged with 3 inches (75 mm) of clean water. Water shall be permitted to stand for a minimum of 24 hours. If leaks occur, water shall be drained and repairs made. Upon completion of repairs, floors shall be flooded with 3 inches (75 mm) of clean water and flood testing shall be repeated for minimum of 24 hours from the time each leak is repaired. Waterproofing system shall be completely watertight, and shall be approved in writing before covering up with other materials. Additional coats of asphalt are not an acceptable method for repairing leaks.

D. Clean-Up

1. Surfaces of other work which are stained with waterproofing materials shall be cleaned with a cleaner recommended by waterproofing manufacturer.

E. Protection Of Completed Work

1. Floor Waterproofing: The completed waterproofing work shall be protected from damage during and after construction. Protective covering shall be placed immediately before proceeding with the work which will conceal the waterproofing.
2. Wall Waterproofing: Waterproofing against which backfill is to be placed shall be protected with a single layer of insulation board. Insulation boards shall be pressed into the final mopping while the asphalt is still hot, with edges of boards placed into moderate contact and joints staggered. For two-layer installation, joints in second layer shall be staggered over joints in first layer. Where surfaced insulation board is used, the surfaced side shall face outward. Boards shall be carefully and neatly fitted around projections, and shall cover the entire surface of the waterproofing materials. Waterproofing system not covered with protection board shall be protected to prevent damage from subsequent building operations. Installed boards shall not remain exposed at the end of a work day.

END OF SECTION 07 13 13 00

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Task	Specification	Specification Description
07 13 13 00	07 11 13 00	Bituminous Dampproofing

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SECTION 07 13 53 00 - ELASTOMERIC SHEET WATERPROOFING

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for elastomeric sheet waterproofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Butyl rubber sheet waterproofing.
      b. EPDM rubber sheet waterproofing.
      c. Molded-sheet drainage panels.
      d. Insulation.
      e. Plaza deck pavers and paver pedestals.

C. Submittals
   1. Product Data: Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.
   2. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
   3. Product test reports.
   4. Special warranties.

D. Quality Assurance
   1. Installer Qualifications: A firm that is approved or licensed by **OR** acceptable to, **as directed**, waterproofing manufacturer for installation of units required for this Project.
   2. Preinstallation Conference: Conduct conference at Project site.
      a. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.

E. Delivery, Storage, And Handling
   1. Deliver liquid materials to Project site in original packages with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.
   2. Store liquid materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by waterproofing manufacturer.
   3. Remove and replace liquid materials that cannot be applied within their stated shelf life.
   4. Store rolls according to manufacturer's written instructions.
   5. Protect stored materials from direct sunlight.

F. Project Conditions
   1. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.

G. Warranty

1. Special Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to replace waterproofing material that does not comply with requirements or that fails to remain watertight within 10 **OR** 20, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Sheet Waterproofing
1. Butyl Rubber Sheet: ASTM D 6134, Type II, 60-mil- (1.5-mm-) **OR** 90-mil- (2.3-mm-) **OR** 120-mil- (3.0-mm-), **as directed**, thick flexible sheet, unreinforced, formed from isobutylene-isoprene rubber.
2. EPDM Rubber Sheet: ASTM D 6134, Type I, 60-mil- (1.5-mm-) thick flexible sheet, unreinforced, formed from EPDM.

B. Auxiliary Materials
1. General: Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.
   a. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.
2. Concealed Sheet Flashing: Same material, construction, and thickness as sheet waterproofing or 60-mil- (1.5-mm-) thick, uncured EPDM as required by manufacturer.
3. Exposed Sheet Flashing: 60-mil- (1.5-mm-) thick EPDM, cured or uncured, as required by manufacturer.
4. Bonding Adhesives: Adhesive for bonding polymeric sheets and sheet flashings to substrates and projections.
5. Splicing Cement and Cleaner: Single-component butyl splicing cement and solvent-based splice cleaner.
   a. Butyl Gum Tape: 30-mil- (0.76-mm-) thick-by-6-1/4-inch- (160-mm-) wide, uncured butyl with polyethylene release film.
6. Lap Sealant: Single-component sealant.
7. In-Seam Sealant: Single-component sealant.
8. Water Cutoff Mastic: Butyl mastic sealant.
9. Waterproofing and Sheet Flashing Accessories: Provide sealants, pourable sealers, cone and vent flashings, inside and outside corner flashings, termination reglets, and other accessories recommended by waterproofing manufacturer for intended use.
10. Metal Termination Bars: Manufacturer's standard aluminum bars, approximately 1 inch (25 mm) wide, prepunched, with zinc-alloy-body fasteners and stainless-steel pins.
11. Protection Course: ASTM D 6506, semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners and as follows:
    a. Thickness: 1/8 inch (3 mm), nominal, for vertical applications; 1/4 inch (6 mm), nominal, elsewhere.
    b. Adhesive: Rubber-based solvent type recommended by waterproofing manufacturer for type of protection course.
12. Protection Course:
    a. Faced, fan folded, with a core of extruded-polystyrene board insulation sandwiched between 2 sheets of plastic film, nominal thickness 1/4 inch (6 mm), with compressive strength of not less than 8 psi (55 kPa) per ASTM D 1621, and maximum water absorption by volume of 0.6 percent per ASTM C 272.
    b. Unfaced, fan-folded, extruded-polystyrene board insulation, nominal thickness 1/4 inch (6 mm) with compressive strength of not less than 8 psi (55 kPa) per ASTM D 1621.
    c. Extruded-polystyrene board insulation, unfaced, ASTM C 578, Type X, 1/2 inch (13 mm) thick.
    d. Molded-polystyrene board insulation, ASTM C 578, Type I, 0.90-lb/cu. ft. (15-kg/cu. m) minimum density, 1-inch (25-mm) minimum thickness.

C. Molded-Sheet Drainage Panels
1. Molded-Sheet Drainage Panel: Comply with Division 33 Section "Subdrainage".
2. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21-mm) sieve laminated to one side with or without a polymeric film bonded to the other side of a studded, nonbiodegradable, molded-plastic-sheet drainage core, with a vertical flow rate of 9 to 15 gpm per ft. (112 to 188 L/min. per m).
3. Woven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a woven-geotextile facing with an apparent opening size not exceeding No. 40 (0.425-mm) sieve laminated to one side with or without a polymeric film bonded to the other side of a studded, nonbiodegradable, molded-plastic-sheet drainage core, with a horizontal flow rate not less than 2.8 gpm per ft. (35 L/min. per m).

D. Insulation
1. Board Insulation: Extruded-polystyrene board insulation complying with ASTM C 578, square or shiplap edged.
   a. Type IV, 25-psi (173-kPa) minimum compressive strength.
   b. Type VI, 40-psi (276-kPa) minimum compressive strength.
   c. Type VII, 60-psi (414-kPa) minimum compressive strength.
   d. Type V, 100-psi (690-kPa) minimum compressive strength.
2. Unfaced Wall Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type IV, 25-psi (173-kPa) or Type VI, 40-psi (276-kPa) minimum compressive strength; unfaced; fabricated with shiplap or channel edges and with 1 side having grooved drainage channels.
3. Geotextile-Faced Wall Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type IV, 25-psi (173-kPa) or Type VI, 40-psi (276-kPa) minimum compressive strength; fabricated with tongue-and-groove edges and with 1 side having grooved drainage channels faced with nonwoven geotextile filter fabric.
4. Unfaced Plaza Deck Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type VI, 40-psi (276-kPa) **OR** Type VII, 60-psi (414-kPa), **as directed**, minimum compressive strength; unfaced; fabricated with shiplapped or channel edges and with 1 side having ribbed drainage channels.
5. Geotextile-Faced Plaza Deck Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type VII, 60-psi (414-kPa) minimum compressive strength; fabricated with tongue-and-groove edges and with 1 side having grooved drainage channels faced with manufacturer's standard, nonwoven geotextile filter fabric.

E. Plaza Deck Pavers
1. Plaza Deck Pavers: Brick **OR** Concrete **OR** Asphalt-block, **as directed**, pavers specified in Division 32 Section "Unit Paving".
2. Plaza Deck Pavers: Granite **OR** Limestone **OR** Marble **OR** Quartz-based stone **OR** Slate, **as directed**, pavers specified in Division 09 Section "Stone Flooring".
3. Plaza Deck Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, manufactured for use as plaza deck pavers; minimum compressive strength 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, ASTM C 140; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C 67.
   a. Color: As selected from manufacturer's full range.
4. Setting Bed: Provide aggregate **OR** mortar **OR** bituminous, **as directed**, setting-bed materials specified in Division 32 Section "Unit Paving".
5. Paver Pedestals: Paver manufacturer's standard SBR rubber, HDPE, or polyurethane paver support assembly, including fixed-height **OR** adjustable or stackable, **as directed**, pedestals, shims, and spacer tabs for joint spacing of 1/8 inch (3 mm) **OR** 3/16 inch (5 mm) **OR** 1/8 to 3/16 inch (3 to 5 mm), **as directed**.
   a. Concrete Fill: ACI 301, compressive strength of 5000 psi (34 MPa) at 28 days and air content of 6 percent.

1.3 EXECUTION

A. Surface Preparation
1. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.
2. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
3. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
4. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids.
5. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D 4258.
6. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions.

B. Fully Adhered Sheet Installation
1. Install fully adhered sheets over entire area to receive waterproofing according to manufacturer's written instructions and recommendations in ASTM D 5843.
2. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required. Stagger end laps.
3. Apply bonding adhesive to substrates at required rate and allow to partially dry.
4. Apply bonding adhesive to sheets and firmly adhere sheets to substrates. Do not apply bonding adhesive to splice area of sheet.
5. Install fully adhered sheets and auxiliary materials to tie into existing waterproofing.
6. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending beyond repaired areas in all directions.
7. Horizontal Application: Apply sheets with side laps shingled with slope of deck where possible.
   a. Spread sealant bed over deck drain flange at deck drains and securely seal sheet waterproofing in place with clamping ring.

C. Partially Adhered Sheet Installation
1. Install partially adhered sheets over entire area to receive waterproofing according to manufacturer's written instructions.
2. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required. Stagger end laps.
3. Apply bonding adhesive to the following areas of substrates and to each sheet at required rate and allow to partially dry:
   a. Upper 25 percent of length of each sheet and 18 inches (457 mm) around perimeter of each sheet.
4. Firmly adhere sheets to substrate. Do not apply bonding adhesive to splice area of sheet.
5. Install partially adhered sheets and auxiliary materials to tie into existing waterproofing.
6. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending beyond repaired areas in all directions.

D. Compartmented, Loosely Laid Sheet Installation
1. Install compartmented, loosely laid sheets over entire area to receive waterproofing according to manufacturer's written instructions.
2. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required. Stagger end laps.
3. Apply continuous beads of water cutoff mastic, of size recommended by waterproofing manufacturer, to substrates in a 60-by-60-inch (1500-by-1500-mm) grid pattern before installing sheet.

4. Apply sheets with side laps shingled with slope of deck where possible.
5. Spread sealant bed over deck drain flange at deck drains and securely seal sheet waterproofing in place with clamping ring.
6. Install compartmented, loosely laid sheets and auxiliary materials to tie into existing waterproofing.
7. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending beyond repaired areas in all directions.

E. Seam Installation
1. Cement Splice: Clean splice areas, apply splicing cement and in-seam sealant, and firmly roll side and end laps of overlapping sheets according to manufacturer's written instructions to produce a splice not less than 6 inches (150 mm) wide and to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet terminations.
2. Cement and Tape Splice: Clean splice areas, apply splicing cement and butyl gum tape, and firmly roll side and end laps of overlapping sheets according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet terminations.

F. Sheet Flashing Installation
1. Install sheet flashings and preformed flashing accessories and adhere to substrates according to waterproofing manufacturer's written instructions.
2. Form wall flashings using exposed sheet flashing.
3. Extend deck sheet waterproofing to form wall flashings.
   a. Flash penetrations and field-formed inside and outside corners with uncured sheet flashing.
   b. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.
4. Cover expansion joints and discontinuous deck-to-wall or deck-to-deck joints by extending deck sheet waterproofing over joints.
5. Terminate and seal top of sheet flashings with mechanically anchored termination bars.

G. Protection Course Installation
1. Install protection course over waterproofing membrane according to manufacturer's written instructions and before beginning subsequent construction operations. Minimize exposure of membrane.
   a. Molded-sheet drainage panels **OR** Insulation drainage panels **OR** Board insulation, **as directed**, may be used in place of a separate protection course to vertical applications when approved by waterproofing manufacturer.

H. Molded-Sheet Drainage Panel Installation
1. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate, according to manufacturer's written instructions. Use adhesives or mechanical fasteners that do not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.
   a. For vertical applications, install board insulation **OR** protection course, **as directed**, before installing drainage panels.

I. Insulation Installation
1. Install one or more layers of board insulation to achieve required thickness and insulation drainage panels over waterproofed surfaces. Cut and fit to within 3/4 inch (19 mm) of projections and penetrations.
2. On vertical surfaces, place and secure insulation units according to manufacturer's written instructions.

3. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

J. Plaza Deck Paver Installation
1. Setting Bed: Install setting bed in locations and of thickness indicated to comply with requirements in Division 32 Section(s) "Unit Paving" OR Division 09 Section(s) "Stone Flooring", **as directed**.
2. Install concrete pavers in locations indicated according to manufacturer's written instructions.
3. Accurately install fixed **OR** adjustable, **as directed**,-height paver pedestals and accessories in locations and to elevations required. Adjust for final level and slope with shims.
    a. Fill paver pedestal with concrete mix, strike smooth with top of pedestal, and cure according to ACI 301.
4. Loosely lay pavers on pedestals, maintaining a uniform open joint width. Tightly seat pavers against spacers to eliminate lateral movement or drift of paving assembly. Align joint patterns parallel in each direction.
    a. Lay out pavers to avoid less-than-half-width pavers at perimeter or other terminations.
5. Install pavers to not vary more than 1/16 inch (1.6 mm) in elevation between adjacent pavers or more than 1/16 inch (1.6 mm) from surface plane elevation of individual paver.
6. Maintain tolerances of paving installation within 1/4 inch in 10 feet (1:48) of surface plane in any direction.

K. Protection And Cleaning
1. Do not permit foot or vehicular traffic on unprotected membrane.
2. Protect waterproofing from damage and wear during remainder of construction period.
3. Protect installed board insulation **OR** insulation drainage panels, **as directed**, from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation will be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
4. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 13 53 00

Task	Specification	Specification Description
07 13 53 00	03 01 30 71a	Self-Adhering Sheet Waterproofing

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SECTION 07 14 13 00 - HOT FLUID-APPLIED RUBBERIZED ASPHALT WATERPROOFING

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for hot fluid-applied rubberized asphalt waterproofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Rubberized-asphalt waterproofing membrane, unreinforced and reinforced.
      b. Molded-sheet drainage panels.
      c. Insulation.
      d. Plaza deck pavers.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins to adjoining waterproofing, and other termination conditions.
      a. Include setting drawings showing layout, sizes, sections, profiles, and joint details of pedestal-supported concrete pavers.
   3. Product test reports.
   4. Sample warranties.

D. Quality Assurance
   1. Installer Qualifications: A firm that is approved or licensed by **OR** acceptable to, **as directed**, manufacturer for installation of waterproofing required for this Project and is eligible to receive special warranties specified.
   2. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
   1. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by waterproofing manufacturer.
   2. Remove and replace liquid materials that cannot be applied within their stated shelf life.
   3. Protect stored materials from direct sunlight.

F. Project Conditions
   1. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate, or when temperature is below 0 deg F (minus 18 deg C).
      a. Do not apply waterproofing in snow, rain, fog, or mist.
   2. Maintain adequate ventilation during application and curing of waterproofing materials.

G. Warranty
   1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace waterproofing and sheet flashings that do not comply with requirements or that fail to remain watertight within five **OR** 10, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Waterproofing Membrane
1. Hot Fluid-Applied, Rubberized-Asphalt Waterproofing Membrane: Single component; 100 percent solids; hot fluid-applied, rubberized asphalt.

B. Flashing Sheet Materials
1. Elastomeric Flashing Sheet: 50-mil- (1.3-mm-) minimum, uncured sheet neoprene as follows:
a. Tensile Strength: 1400 psi (9.6 MPa) minimum; ASTM D 412, Die C.
b. Elongation: 300 percent minimum; ASTM D 412.
c. Tear Resistance: 125 psi (860 kPa) minimum; ASTM D 624, Die C.
d. Brittleness: Does not break at minus 30 deg F (34 deg C); ASTM D 2137.

C. Auxiliary Materials
1. Primer: ASTM D 41, asphaltic primer.
2. Elastomeric Sheet: 50-mil- (1.3-mm-) minimum, uncured sheet neoprene as follows:
a. Tensile Strength: 1400 psi (9.6 MPa) minimum; ASTM D 412, Die C.
b. Elongation: 300 percent minimum; ASTM D 412.
c. Tear Resistance: 125 psi (860 kPa) minimum; ASTM D 624, Die C.
d. Brittleness: Does not break at minus 30 deg F (34 deg C); ASTM D 2137.
3. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum termination bars; approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.
4. Sealants and Accessories: Manufacturer's recommended sealants and accessories.
5. Reinforcing Fabric: Manufacturer's recommended, spun-bonded polyester fabric.
6. Protection Course: ASTM D 6506, semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners and nominal thickness of 1/8 inch (3 mm) **OR** 1/4 inch (6 mm), **as directed**.
7. Protection Course: Manufacturer's standard, 80- to 90-mil- (2.0- to 2.3-mm-) thick, fiberglass-reinforced rubberized asphalt or modified bituminous sheet.

D. Molded-Sheet Drainage Panels
1. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21-mm) sieve, laminated to one side with **OR** without, **as directed**, a polymeric film bonded to the other side of a studded, nonbiodegradable, molded-plastic-sheet drainage core, with a vertical flow rate of 9 to 15 gpm/ft. (112 to 188 L/min. per m).
2. Woven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a woven-geotextile facing with an apparent opening size not exceeding No. 40 (0.43-mm) sieve, laminated to one side with **OR** without, **as directed**, a polymeric film bonded to the other side of a studded, nonbiodegradable, molded-plastic-sheet drainage core, with a horizontal flow rate not less than 2.8 gpm/ft. (35 L/min. per m).

E. Insulation
1. Board Insulation: Extruded-polystyrene board insulation complying with ASTM C 578, square **OR** shiplap, **as directed**, edged.
a. Type IV, 25-psi (173-kPa) minimum compressive strength.
b. Type VI, 40-psi (276-kPa) minimum compressive strength.
c. Type VII, 60-psi (414-kPa) minimum compressive strength.
d. Type V, 100-psi (690-kPa) minimum compressive strength.
2. Unfaced Wall Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type IV, 25-psi (173-kPa) **OR** Type VI, 40-psi (276-kPa), **as directed**, minimum compressive strength; unfaced; fabricated with shiplap or channel edges and with one side having grooved drainage channels.

3. Geotextile-Faced Wall Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type IV, 25-psi (173-kPa) **OR** Type VI, 40-psi (276-kPa), **as directed**, minimum compressive strength; fabricated with tongue-and-groove edges and with one side having grooved drainage channels faced with a nonwoven, geotextile filter fabric.
4. Unfaced Plaza Deck Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type VI, 40-psi (276-kPa) **OR** Type VII, 60-psi (414-kPa), **as directed**, minimum compressive strength; unfaced; fabricated with shiplapped or channel edges and with one side having ribbed drainage channels.
5. Geotextile-Faced Plaza Deck Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type VII, 60-psi (414-kPa) minimum compressive strength; fabricated with tongue-and-groove edges and with one side having grooved drainage channels faced with a nonwoven, geotextile filter fabric.

F. Plaza Deck Pavers
1. Plaza Deck Pavers:
   a. Brick **OR** Concrete **OR** Asphalt-block, **as directed**, pavers specified in Division 32 Section "Unit Paving".
      OR
      Granite **OR** Limestone **OR** Marble **OR** Quartz-based stone **OR** Slate, **as directed**, pavers specified in Division 09 Section "Stone Flooring".
      OR
      Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, manufactured for use as plaza deck pavers; minimum compressive strength 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, ASTM C 140; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C 67.
      1) Thickness: 1-5/8 inches (41 mm) **OR** 1-3/4 inches (45 mm) **OR** 2 inches (51 mm) **OR** 2-3/8 inches (60 mm), **as directed**.
      2) Face Size: 8-7/8 inches (225 mm) square **OR** 9 inches (229 mm) square **OR** 9 by 18 inches (229 by 457 mm) **OR** 12 inches (305 mm) square **OR** 12 by 24 inches (305 by 610 mm) **OR** 18 inches (457 mm) square **OR** 24 inches (610 mm) square, **as directed**.
      3) Color: As selected from manufacturer's full range.
2. Setting Bed: Provide aggregate **OR** mortar **OR** bituminous, **as directed**, setting-bed materials specified in Division 32 Section "Unit Paving".
3. Paver Supports: Paver manufacturer's standard SBR rubber, high-density polyethylene, or polyurethane paver support assembly, including fixed-height **OR** adjustable or stackable, **as directed**, pedestals, shims, and spacer tabs for joint spacing of 1/8 inch (3 mm) **OR** 3/16 inch (5 mm), **as directed**.
   a. Concrete Fill: ACI 301, compressive strength of 5000 psi (34 MPa) at 28 days, and air content of 6 percent.

1.3 EXECUTION

A. Preparation
1. Clean and prepare substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for waterproofing application.
2. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
3. Close off deck drains and other deck penetrations to prevent spillage and migration of waterproofing fluids.
4. Remove grease, oil, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

a. Abrasive blast clean concrete surfaces uniformly to expose top surface of fine aggregate according to ASTM D 4259 with a self-contained, recirculating, blast-cleaning apparatus. Remove material to provide a sound surface free of laitance, glaze, efflorescence, curing compounds, concrete hardeners, or form-release agents. Remove remaining loose material and clean surfaces according to ASTM D 4258.

5. Remove fins, ridges, and other projections and fill honeycomb, aggregate pockets, and other voids.

B. Joints, Cracks, And Terminations

1. Prepare and treat substrates to receive waterproofing membrane, including joints and cracks, deck drains, corners, and penetrations according to manufacturer's written instructions.
   a. Rout and fill joints and cracks in substrate. Before filling, remove dust and dirt according to ASTM D 4258.
   b. Adhere strip of elastomeric sheet to substrate in a layer of hot rubberized asphalt. Extend elastomeric sheet a minimum of 6 inches (150 mm) on each side of moving joints and cracks or joints and cracks exceeding 1/8 inch (3 mm) thick, and beyond deck drains and penetrations. Apply second layer of hot fluid-applied, rubberized asphalt over elastomeric sheet.
   c. Embed strip of reinforcing fabric into a layer of hot rubberized asphalt. Extend reinforcing fabric a minimum of 6 inches (150 mm) on each side of nonmoving joints and cracks not exceeding 1/8 inch (3 mm) thick, and beyond roof drains and penetrations.
      1) Apply second layer of hot fluid-applied, rubberized asphalt over reinforcing fabric.
2. At expansion joints and discontinuous deck-to-wall or deck-to-deck joints, bridge joints with elastomeric sheet extended a minimum of 6 inches (150 mm) on each side of joints and adhere to substrates in a layer of hot rubberized asphalt. Apply second layer of hot fluid-applied, rubberized asphalt over elastomeric sheet.

C. Flashing Installation

1. Install elastomeric flashing sheets at terminations of waterproofing membrane according to manufacturer's written instructions.
2. Prime substrate with asphalt primer.
3. Install elastomeric flashing sheet and adhere to deck and wall substrates in a layer of hot rubberized asphalt.
4. Extend elastomeric flashing sheet up walls or parapets a minimum of 8 inches (200 mm) above plaza deck pavers and 6 inches (150 mm) onto deck to be waterproofed.
5. Install termination bars and mechanically fasten to top of elastomeric flashing sheet at terminations and perimeter of roofing.

D. Membrane Application

1. Apply primer, at manufacturer's recommended rate, over prepared substrate and allow to dry.
2. Heat and apply rubberized asphalt according to manufacturer's written instructions.
   a. Heat rubberized asphalt in an oil- or air-jacketed melter with mechanical agitator specifically designed for heating rubberized asphalt.
3. Start application with manufacturer's authorized representative present.
4. Unreinforced Membrane: Apply hot rubberized asphalt to substrates and adjoining surfaces indicated. Spread to form a uniform, unreinforced, seamless membrane, 180-mil (4.5-mm) minimum thickness **OR** 180-mil (4.5-mm) average thickness, but not less than 125 mil (3.2 mm) thick, **as directed**.
5. Reinforced Membrane: Apply hot rubberized asphalt to substrates and adjoining surfaces indicated. Spread to a thickness of 90 mils (2.3 mm); embed reinforcing fabric, overlapping sheets 2 inches (50 mm); spread another 125-mil- (3.2-mm-) thick layer to provide a uniform, reinforced, seamless membrane 215 mils (5.5 mm) thick.
6. Apply waterproofing over prepared joints and up wall terminations and vertical surfaces to heights indicated or required by manufacturer.

7. Cover waterproofing with protection course with overlapped joints before membrane is subject to backfilling **OR** construction or vehicular traffic, **as directed**.

E. Molded-Sheet Drainage Panel Installation
   1. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate according to manufacturer's written instructions. Use methods that do not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.
      a. For vertical applications, install board insulation **OR** protection course, **as directed**, before installing drainage panels.

F. Insulation Installation
   1. Install one or more layers of board insulation to achieve required thickness and insulation drainage panels over waterproofed surfaces. Cut and fit to within 3/4 inch (19 mm) of projections and penetrations.
   2. On vertical surfaces, set insulation units into rubberized asphalt according to manufacturer's written instructions.
   3. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

G. Plaza Deck Paver Installation
   1. Setting Bed: Install setting bed in locations and of thickness indicated to comply with requirements in Division 32 Section(s) "Unit Paving" OR Division 09 Section(s) "Stone Flooring", **as directed**.
   2. Install concrete pavers in locations indicated according to manufacturer's written instructions.
   3. Accurately install fixed-height **OR** adjustable-height, **as directed**, paver pedestals and accessories in locations and to elevations required. Adjust for final level and slope with shims.
      a. Fill paver pedestal with concrete mix, strike smooth with top of pedestal, and cure according to ACI 301.
   4. Loosely lay pavers on pedestals, maintaining a uniform open joint width. Tightly seat pavers against spacers to eliminate lateral movement or drift of paving assembly. Align joint patterns parallel in each direction.
      a. Lay out pavers to avoid less-than-half-width pavers at perimeter or other terminations.
   5. Install pavers to not vary more than 1/16 inch (1.6 mm) in elevation between adjacent pavers or more than 1/16 inch (1.6 mm) from surface plane elevation of individual paver.
   6. Maintain tolerances of paving installation within 1/4 inch in 10 feet (1:48) of surface plane in any direction.

H. Cleaning And Protection
   1. Protect waterproofing from damage and wear during remainder of construction period.
   2. Protect installed board insulation **OR** insulation drainage panels, **as directed**, from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation will be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
   3. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 14 13 00

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SECTION 07 14 16 00 - COLD FLUID-APPLIED WATERPROOFING

1.1 GENERAL

A. Description Of Work:

1. This specification covers the furnishing and installation of materials for cold fluid-applied waterproofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Single-component polyurethane waterproofing.
   b. Two-component polyurethane waterproofing.
   c. Polyester waterproofing.
   d. Latex-rubber waterproofing.
   e. Molded-sheet drainage panels.
   f. Insulation.
   g. Plaza deck pavers.

C. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
3. Product test reports.

D. Quality Assurance

1. Installer Qualifications: A firm that is approved or licensed by **OR** acceptable to, **as directed**, waterproofing manufacturer for installation of waterproofing required for this Project.
2. Preinstallation Conference: Conduct conference at Project site.
   a. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and flashings, installation procedures, testing and inspection procedures, and protection and repairs.

E. Delivery, Storage, And Handling

1. Deliver liquid materials to Project site in original containers with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, shelf life, and directions for storing and mixing with other components.
2. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by waterproofing manufacturer.
3. Remove and replace liquid materials that cannot be applied within their stated shelf life.
4. Protect stored materials from direct sunlight.

F. Project Conditions

1. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate, when relative humidity exceeds 85 percent, or when temperatures are less than 5 deg F (3 deg C) above dew point.

G. Warranty

1. Special Manufacturer's Warranty: Manufacturer's standard form in which waterproofing manufacturer and Installer agree to repair or replace waterproofing that does not comply with requirements or that fails to remain watertight within specified warranty period.
   a. Warranty Period: Five years from date of Final Completion.

1.2 PRODUCTS

A. Single-Component Polyurethane Waterproofing
   1. Single-Component, Modified Polyurethane Waterproofing: Comply with ASTM C 836 and with manufacturer's written physical requirements.
   2. Single-Component, Reinforced, Modified Polyurethane Waterproofing: Comply with ASTM C 836 and with manufacturer's written physical requirements.
   3. Single-Component, Unmodified Polyurethane Waterproofing: Comply with ASTM C 836 and with manufacturer's written physical requirements.

B. Two-Component Polyurethane Waterproofing
   1. Two-Component, Modified Polyurethane Waterproofing: Comply with ASTM C 836 and with manufacturer's written physical requirements.
   2. Two-Component, Unmodified Polyurethane Waterproofing: Comply with ASTM C 836 and with manufacturer's written physical requirements.
   3. Two-Component, Reinforced, Unmodified Polyurethane Waterproofing: Comply with ASTM C 836 and with manufacturer's written physical requirements.

C. Polyester Waterproofing
   1. Two-Component, Reinforced, Unsaturated Polyester Waterproofing: Comply with ASTM C 836 and with manufacturer's written physical requirements.

D. Latex-Rubber Waterproofing
   1. Two-Component, Unreinforced, Latex-Rubber Waterproofing: Comply with ASTM C 836 and with manufacturer's written physical requirements.
   2. Two-Component, Reinforced, Latex-Rubber Waterproofing: Comply with ASTM C 836 and with manufacturer's written physical requirements.

E. Auxiliary Materials
   1. General: Provide auxiliary materials recommended by manufacturer to be compatible with one another and with waterproofing, as demonstrated by waterproofing manufacturer, based on testing and field experience.
   2. Primer: Manufacturer's standard, factory-formulated polyurethane or epoxy primer.
   3. Sheet Flashing: 50-mil- (1.3-mm-) minimum, nonstaining, uncured sheet neoprene.
      a. Adhesive: Manufacturer's recommended contact adhesive.
   4. Membrane-Reinforcing Fabric: Nonwoven, needle-punched white polyester fabric, 6-oz./sq. yd. (200-g/sq. m) **OR** 5-oz./sq. yd. (169-g/sq. m) **OR** 3.2-oz./sq. yd. (109-g/sq. m) **OR** manufacturer's standard, **as directed**, weight.
   5. Joint Reinforcing Strip: Manufacturer's recommended fiberglass mesh or polyester fabric.
   6. Joint Sealant: Multicomponent polyurethane sealant, compatible with waterproofing, complying with ASTM C 920 Type M, Class 25; Grade NS for sloping and vertical applications or Grade P for deck applications; Use NT exposure; and as recommended by manufacturer for substrate and joint conditions.
      a. Backer Rod: Closed-cell polyethylene foam.

F. Protection Course
   1. Protection Course: ASTM D 6506, semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners and as follows:

a. Thickness: 1/8 inch (3 mm), nominal, for vertical applications; 1/4 inch (6 mm), nominal, elsewhere.
b. Adhesive: Rubber-based solvent type recommended by waterproofing manufacturer for type of protection course.

2. Protection Course: Fan folded, with a core of extruded-polystyrene board insulation faced one or both side(s) with plastic film, nominal thickness of 1/4 inch (6 mm), with compressive strength not less than 8 psi (55 kPa) per ASTM D 1621 and maximum water absorption by volume of 0.6 percent per ASTM C 272.
3. Protection Course: Unfaced, fan-folded, rigid, extruded-polystyrene board insulation; nominal thickness of 1/4 inch (6 mm) with compressive strength of not less than 8 psi (55 kPa) per ASTM D 1621.
4. Protection Course: Fan folded, with a core of molded-polystyrene board insulation faced both sides with plastic film, nominal thickness of 1/4 inch (6 mm) **OR** 3/8 inch (9.5 mm) **OR** 1/2 inch (13 mm), **as directed**, with compressive strength not less than 12 psi (83 kPa) per ASTM D 1621 and water absorption by volume of less than 1 percent per ASTM C 272.
5. Protection Course: Unfaced, extruded-polystyrene board insulation; ASTM C 578, Type X, 1/2 inch (13 mm) thick.
6. Protection Course: Molded-polystyrene board insulation, ASTM C 578, Type I, 0.90-lb/cu. ft. (15-kg/cu. m) minimum density, 1-inch (25-mm) minimum thickness.

G. Molded-Sheet Drainage Panels
1. Molded-Sheet Drainage Panel: Comply with Division 33 Section "Subdrainage".
2. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21-mm) sieve laminated to one side with or without a polymeric film bonded to the other side of a studded, nonbiodegradable, molded-plastic-sheet drainage core, with a vertical flow rate of 9 to 15 gpm per ft. (112 to 188 L/min. per m).
3. Woven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a woven-geotextile facing with an apparent opening size not exceeding No. 40 (0.43-mm) sieve, laminated to one side with or without a polymeric film bonded to the other side of a studded, nonbiodegradable, molded-plastic-sheet drainage core, with a horizontal flow rate not less than 2.8 gpm per ft. (35 L/min. per m).

H. Insulation
1. Board Insulation: Extruded-polystyrene board insulation complying with ASTM C 578, square or shiplap edged.
   a. Type IV, 25-psi (173-kPa) minimum compressive strength.
   b. Type VI, 40-psi (276-kPa) minimum compressive strength.
   c. Type VII, 60-psi (414-kPa) minimum compressive strength.
   d. Type V, 100-psi (690-kPa) minimum compressive strength.
2. Unfaced, Wall Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type IV, 25-psi (173-kPa) **OR** Type VI, 40-psi (276-kPa), **as directed**, minimum compressive strength; unfaced; fabricated with shiplap or channel edges and with one side having grooved drainage channels.
3. Geotextile-Faced, Wall Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type IV, 25-psi (173-kPa) **OR** Type VI, 40-psi (276-kPa), **as directed**, minimum compressive strength; fabricated with tongue-and-groove edges and with one side having grooved drainage channels faced with a nonwoven-geotextile filter fabric.
4. Unfaced, Plaza Deck, Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type VI, 40-psi (276-kPa) **OR** Type VII, 60-psi (414-kPa), **as directed**, minimum compressive strength; unfaced; fabricated with shiplapped or channel edges and with one side having ribbed drainage channels.
5. Geotextile-Faced, Plaza Deck, Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type VII, 60-psi (414-kPa) minimum compressive strength; fabricated with tongue-and-groove edges and with one side having grooved drainage channels faced with manufacturer's standard, nonwoven-geotextile filter fabric.

I. Plaza Deck Pavers
1. Plaza Deck Pavers: Brick **OR** Concrete **OR** Asphalt-block, **as directed**, pavers specified in Division 32 Section "Unit Paving".
2. Plaza Deck Pavers: Granite **OR** Limestone **OR** Marble **OR** Quartz-based stone **OR** Slate, **as directed**, pavers specified in Division 09 Section "Stone Flooring".
3. Plaza Deck Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, manufactured for use as plaza deck pavers; minimum compressive strength of 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, ASTM C 140; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C 67.
   a. Thickness: 1-5/8 inches (41 mm) **OR** 1-3/4 inches (45 mm) **OR** 2 inches (51 mm) **OR** 2-3/8 inches (60 mm), **as directed**.
   b. Face Size: 8-7/8 inches (225 mm) square **OR** 9 inches (229 mm) square **OR** 9-by-18 inches (229-by-457 mm) **OR** 12 inches (305 mm) square **OR** 12-by-24 inches (305-by-610 mm) **OR** 18 inches (457 mm) square **OR** 24 inches (610 mm) square **OR** As indicated, **as directed**.
   c. Color: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
4. Setting Bed: Provide aggregate **OR** mortar **OR** bituminous, **as directed**, setting-bed materials specified in Division 32 Section "Unit Paving".
5. Paver Pedestals: Paver manufacturer's standard SBR rubber, high-density polyethylene, or polyurethane paver support assembly, including fixed-height **OR** adjustable or stackable, **as directed**, pedestals, shims, and spacer tabs for joint spacing of 1/8 inch (3 mm) **OR** 3/16 inch (5 mm) **OR** 1/8 to 3/16 inch (3 to 5 mm), **as directed**.
   a. Concrete Fill: ACI 301, compressive strength of 5000 psi (34 MPa) at 28 days and air content of 6 percent.

1.3 EXECUTION

A. Surface Preparation
1. Clean and prepare substrate according to manufacturer's written recommendations. Provide clean, dust-free, and dry substrate for waterproofing application.
2. Mask off adjoining surfaces not receiving waterproofing to prevent spillage or overspray affecting other construction.
3. Close off deck drains and other deck penetrations to prevent spillage and migration of waterproofing fluids.
4. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, acid residues, and other penetrating contaminants or film-forming coatings from concrete.
   a. Abrasive blast clean concrete surfaces uniformly to expose top surface of fine aggregate according to ASTM D 4259 with a self-contained, recirculating, blast-cleaning apparatus. Remove material to provide a sound surface free of laitance, glaze, efflorescence, curing compounds, concrete hardeners, or form-release agents. Remove remaining loose material and clean surfaces according to ASTM D 4258.
5. Remove fins, ridges, and other projections and fill honeycomb, aggregate pockets, and other voids.

B. Preparation At Terminations And Penetrations
1. Prepare vertical and horizontal surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, and sleeves according to ASTM C 898 **OR** ASTM C 1471, **as directed**, and manufacturer's written instructions.
2. Prime substrate unless otherwise instructed by waterproofing manufacturer.
3. Apply waterproofing in two separate applications, and embed a joint reinforcing strip in the first preparation coat when recommended by waterproofing manufacturer.

a. Provide sealant cants around penetrations and at inside corners of deck-to-wall butt joints when recommended by waterproofing manufacturer.

C. Joint And Crack Treatment
1. Prepare, treat, rout, and fill joints and cracks in substrate according to ASTM C 898 **OR** ASTM C 1471, **as directed**, and waterproofing manufacturer's written instructions. Remove dust and dirt from joints and cracks, complying with ASTM D 4258, before coating surfaces.
a. Comply with ASTM C 1193 for joint-sealant installation.
b. Apply bond breaker between sealant and preparation strip.
c. Prime substrate and apply a single thickness of preparation strip extending a minimum of 3 inches (75 mm) along each side of joint. Apply waterproofing in two separate applications and embed a joint reinforcing strip in the first preparation coat.
2. Install sheet flashing and bond to deck and wall substrates where indicated or required according to waterproofing manufacturer's written instructions.
a. Extend sheet flashings onto perpendicular surfaces and other work penetrating substrate according to ASTM C 898.

D. Waterproofing Application
1. Apply waterproofing according to ASTM C 898 **OR** ASTM C 1471, **as directed**, and manufacturer's written instructions.
2. Start installing waterproofing in presence of manufacturer's technical representative.
3. Apply primer over prepared substrate.
4. Unreinforced Waterproofing Applications: Mix materials and apply waterproofing by spray, roller, notched squeegee, trowel, or other application method suitable to slope of substrate.
a. Apply one or more coats of waterproofing to obtain a seamless membrane free of entrapped gases, with an average dry film thickness of 60 mils (1.5 mm) and a minimum dry film thickness of 50 mils (1.3 mm) at any point **OR** 120 mils (3 mm), **as directed**.
b. Apply waterproofing to prepared wall terminations and vertical surfaces.
c. Verify wet film thickness of waterproofing every 100 sq. ft. (9.3 sq. m).
5. Reinforced Waterproofing Applications: Mix materials and apply waterproofing by roller, notched squeegee, trowel, or other suitable application method.
a. Apply first coat of waterproofing, embed membrane-reinforcing fabric, and apply second coat of waterproofing to completely saturate reinforcing fabric and to obtain a seamless reinforced membrane free of entrapped gases, with an average dry film total thickness of 70 mils (1.8 mm) **OR** 80 mils (2 mm) **OR** 120 mils (3 mm)**as directed**, .
b. Apply reinforced waterproofing to prepared wall terminations and vertical surfaces.
c. Verify wet film thickness of waterproofing every 100 sq. ft. (9.3 sq. m).
6. Install protection course with butted joints over nominally cured membrane before starting subsequent construction operations.
a. Molded-sheet drainage panels **OR** Insulation drainage panels **OR** Board insulation, **as directed**, may be used in place of a separate protection course to vertical applications when approved by waterproofing manufacturer.

E. Molded-Sheet Drainage Panel Installation
1. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate, according to manufacturer's written instructions. Use adhesives or mechanical fasteners that do not penetrate waterproofing. Lap edges and ends of geotextile fabric to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.
a. For vertical applications, install board insulation **OR** protection course, **as directed**, before installing drainage panels.

F. Insulation Installation
1. Install one or more layers of board insulation to achieve required thickness **OR** insulation drainage panels, **as directed**, over waterproofed surfaces. Cut and fit to within 3/4 inch (19 mm) of projections and penetrations.

2. On vertical surfaces, set insulation units in adhesive applied according to manufacturer's written instructions. Use type of adhesive recommended in writing by insulation manufacturer.
3. On horizontal surfaces, place insulation units unadhered according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

G. Plaza Deck Paver Installation
1. Setting Bed: Install setting bed in locations and of thickness indicated to comply with requirements in Division 32 Section(s) "Unit Paving" OR Division 09 Section(s) "Stone Flooring", **as directed**.
2. Install concrete pavers, in locations indicated, according to manufacturer's written instructions.
3. Accurately install fixed **OR** adjustable, **as directed**,-height paver pedestals in locations and to elevations required. Adjust for final level and slope with shims.
    a. Fill paver pedestal with concrete mix, strike smooth with top of pedestal, and cure according to ACI 301.
4. Loosely lay pavers on pedestals, maintaining a uniform open joint width. Tightly seat pavers against spacers to eliminate lateral movement or drift of paving assembly. Align joint patterns parallel in each direction.
    a. Lay out pavers to avoid less-than-half-width pavers at perimeter or other terminations.
5. Install pavers to not vary more than 1/16 inch (1.6 mm) in elevation between adjacent pavers or more than 1/16 inch (1.6 mm) from surface plane elevation of individual paver.
6. Maintain tolerances of paving installation within 1/4 inch in 10 feet (1:48) of surface plane in any direction.

H. Field Quality Control
1. Flood Testing: Flood test each deck area for leaks, according to recommendations in ASTM D 5957, after completing waterproofing but before overlaying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.
    a. Flood to an average depth of 2-1/2 inches (64 mm) with a minimum depth of 1 inch (25 mm) and not exceeding a depth of 4 inches (100 mm). Maintain 2 inches (50 mm) of clearance from top of sheet flashings.
    b. Flood each area for 24 **OR** 48 **OR** 72, **as directed**, hours.
    c. After flood testing, repair leaks, repeat flood tests, and make further repairs until waterproofing installation is watertight.
2. Engage an independent testing agency to observe flood testing and examine underside of decks and terminations for evidence of leaks during flood testing.

I. Curing, Protection, And Cleaning
1. Cure waterproofing according to manufacturer's written recommendations, taking care to prevent contamination and damage during application stages and curing.
    a. Do not permit foot or vehicular traffic on unprotected membrane.
2. Protect waterproofing from damage and wear during remainder of construction period.
3. Protect installed board insulation **OR** insulation drainage panels, **as directed**, from damage due to ultraviolet light, harmful weather exposures, physical abuse, and other causes. Immediately after installation, provide temporary coverings where insulation will be subject to abuse and cannot be concealed and protected by permanent construction.
4. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 14 16 00

SECTION 07 16 13 00 - MODIFIED CEMENT WATERPROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for modified cement waterproofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes polymer-modified cement waterproofing for positive or negative-side application to concrete, concrete unit masonry, and clay masonry.

C. Submittals
1. Product Data: For each type of product indicated. Include construction details, material descriptions and installation instructions for polymer-modified cement waterproofing.
2. Samples: For each type of polymer-modified cement waterproofing indicated.
3. Qualification Data: For Applicator.
4. Product Certificates: For waterproofing, patching, and plugging materials, from manufacturer.
5. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for each type of polymer-modified cement waterproofing.
6. Field quality-control reports.

D. Quality Assurance
1. Applicator Qualifications: A firm experienced in applying polymer-modified cement waterproofing similar in material, design, and extent to that indicated for this Project, whose work has resulted in applications with a record of successful in-service performance, and that employs workers trained and approved by manufacturer.
2. Preinstallation Conference: Conduct conference at Project site.

E. Project Conditions
1. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit polymer-modified cement waterproofing to be performed according to manufacturer's written instructions.
2. Proceed with waterproofing work only after pipe sleeves, vents, curbs, inserts, drains, and other projections through the substrate to be waterproofed have been completed. Proceed only after substrate defects, including honeycombs, voids, and cracks, have been repaired to provide a sound substrate free of forming materials, including reveal inserts.
3. Ambient Conditions: Proceed with waterproofing work only if temperature is maintained at 40 deg F (4.4 deg C) or above during work and cure period, and space is well ventilated and kept free of water.

1.2 PRODUCTS

A. Field-Mixed, Polymer-Modified Cement Waterproofing
1. Admixture for Field Mixing: Manufacturer's standard polymer admixture for mixing with portland cement and sand to produce a waterproof coating that is suitable for vertical and horizontal applications below or above grade, is breathable, resists positive-side **OR** negative-side, **as directed**, hydrostatic pressure, has VOC content complying with limits of authorities having jurisdiction, and has properties meeting or exceeding the criteria specified below.

a. Water Permeability: Maximum zero for water at 30 feet (9 m) when tested according to CE CRD-C 48.
b. Compressive Strength: Minimum 4000 psi (27.6 MPa) at 28 days when tested according to ASTM C 109/C 109M.
c. Flexural Strength: Minimum 710 psi (4.8 MPa) at 28 days when tested according to ASTM C 348.
d. Bond Strength: Minimum 220 psi (1.5 MPa) at 14 days when tested according to ASTM C 321.

B. Prepackaged, Polymer-Modified Cement Waterproofing
1. Negative-Side, Polymer-Modified Cement Waterproofing: Manufacturer's proprietary blend of dry cementitious and other ingredients for mixing with potable water **OR** polymer admixture, **as directed**, to produce a waterproof coating that is suitable for vertical and horizontal applications below or above grade, is breathable, resists negative-side hydrostatic pressure, has VOC content complying with limits of authorities having jurisdiction, and has properties meeting or exceeding the criteria specified below.
a. Water Permeability: Maximum zero for water at 30 feet (9 m) when tested according to CE CRD-C 48.
b. Compressive Strength: Minimum 4000 psi (27.6 MPa) at 28 days when tested according to ASTM C 109/C 109M.
c. Flexural Strength: Minimum 710 psi (4.8 MPa) at 28 days when tested according to ASTM C 348.
d. Bond Strength: Minimum 220 psi (1.5 MPa) at 14 days when tested according to ASTM C 321.
e. Color: White **OR** Gray **OR** As selected from full range **OR** As indicated in a color schedule, **as directed**.
2. Positive-Side, Polymer-Modified Cement Waterproofing: Manufacturer's proprietary blend of dry cementitious and other ingredients for mixing with potable water or polymer admixture to produce a waterproof coating that is suitable for vertical and horizontal applications below or above grade, is breathable, resists positive-side hydrostatic pressure, has VOC content complying with limits of authorities having jurisdiction, and has properties meeting or exceeding the criteria specified below.
a. Water Permeability: Maximum zero for water at 30 feet (9 m) when tested according to CE CRD-C 48.
b. Compressive Strength: Minimum 4000 psi (27.6 MPa) at 28 days when tested according to ASTM C 109/C 109M.
c. Flexural Strength: Minimum 710 psi (4.8 MPa) at 28 days when tested according to ASTM C 348.
d. Bond Strength: Minimum 220 psi (1.5 MPa) at 14 days when tested according to ASTM C 321.
e. Color: White **OR** Gray **OR** As selected from full range **OR** As indicated in a color schedule, **as directed**.

C. Accessory Materials
1. Patching Compound: Factory-premixed cementitious repair mortar, crack filler, or sealant recommended by waterproofing manufacturer for filling and patching tie holes, honeycombs, reveals, and other imperfections; compatible with substrate and other materials indicated; and VOC content complying with limits of authorities having jurisdiction.
2. Plugging Compound: Factory-premixed cementitious compound with hydrophobic properties and recommended by waterproofing manufacturer; resistant to water and moisture but vapor permeable for all standard applications (vertical, overhead, and horizontal surfaces not exposed to vehicular traffic); compatible with substrate and other materials indicated; and VOC content complying with limits of authorities having jurisdiction.
3. Portland Cement: ASTM C 150, Type I.
4. Slurry-Coat and Protective-Topping Sand: ASTM C 144.

5. Trowel-Coat Sand: ASTM C 33, fine aggregate.
6. Polymer Admixture for Protective Topping: Polymer bonding agent and admixture designed to improve adhesion to prepared substrates and to not create a vapor barrier.
7. Water: Potable.

D. Mixes
1. Field-Mixed, Polymer-Modified Cement Waterproofing: Add polymer admixture to portland cement and sand according to manufacturer's written instructions. Blend together with mechanical mixer or by hand to required consistency.
OR
Prepackaged, Polymer-Modified Cement Waterproofing: Add prepackaged dry ingredients to mixing liquid according to manufacturer's written instructions. Mix together with mechanical mixer or by hand to required consistency.
2. Protective Topping: Measure, batch, and mix portland cement and sand in the proportion of 1:3 and water gaged with a polymer admixture. Blend together with mechanical mixer to required consistency.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Applicator present, for suitable conditions where waterproofing is to be applied.
2. Proceed with application only after unsatisfactory conditions have been corrected.
3. Notify the Owner in writing of active leaks or defects that would affect system performance.

B. Preparation
1. Protect other work from damage caused by cleaning, preparation, and application of waterproofing. Provide temporary enclosure to confine spraying operation and to ensure adequate ambient temperatures and ventilation conditions for application.
2. Do not allow waterproofing, patching, and plugging materials to enter reveals or annular spaces intended for resilient sealants or gaskets, such as joint spaces between pipes and pipe sleeves.
3. Stop active water leaks with plugging compound according to waterproofing manufacturer's written instructions.
4. Repair damaged or unsatisfactory substrate with patching compound according to manufacturer's written instructions.
   a. At holes and cracks in substrate, remove loosened chips and cut reveal with sides perpendicular to surface, not tapered, and approximately 1 inch (25.4 mm) deep. Fill reveal with patching compound flush with surface.
5. Surface Preparation: Comply with waterproofing manufacturer's written instructions to remove efflorescence, chalk, dust, dirt, mortar spatter, grease, oils, paint, curing compounds, and form-release agents to ensure that waterproofing bonds to surfaces.
   a. Clean concrete surfaces according to ASTM D 4258.
      1) Scratch- and Float-Finished Concrete: Etch with 10 percent muriatic (hydrochloric) acid solution according to ASTM D 4260.
      2) Prepare smooth-formed and trowel-finished concrete by mechanical abrading or abrasive-blast cleaning according to ASTM D 4259.
   b. Clean concrete unit masonry surfaces according to ASTM D 4261.
      1) Lightweight Concrete Unit Masonry: Etch with 10 percent muriatic (hydrochloric) acid solution or abrade surface by wire brushing. Remove acid residue until pH readings of water after rinse are not more than 1.0 pH lower or 2.0 pH higher than pH of water before rinse.
      2) Medium- and Normal-Weight Concrete Unit Masonry: Sandblast or bushhammer to a depth of 1/16 inch (1.6 mm).
   c. Clean clay masonry surfaces according to ASTM D 5703.

d. Concrete Joints: Clean reveals according to waterproofing manufacturer's written instructions.

C. Application
1. General: Comply with waterproofing manufacturer's written instructions for application and curing.
   a. Saturate surface with water for several hours prior to application with water and maintain damp condition until applying waterproofing. Remove standing water.
   b. Apply waterproofing to surfaces indicated on Drawings.
   c. Number of Coats: Number required for specified water permeability **OR** Two **OR** Three, **as directed**.
      1) Coating Thickness: Maximum application thickness of 47 mils (1.2 mm) per coat for total thickness as required for specified water permeability **OR** of 100 mils (2.5 mm), **as directed**.
      2) Apply first coat as a slurry with brush or roller, and apply subsequent coats with brush, roller, spray, or trowel.
      3) Vigorously work first coat onto the substrate, forcing the material into surface voids. Apply each subsequent coat into full contact with previous coat.
      4) Allow manufacturer's recommended time between coats. Dampen surface between coats.
2. Final Coat Finish: Smooth troweled **OR** Brushed **OR** Textured, **as directed**.
3. Curing: Air-cure waterproofing for not less than five days immediately after application and prior to being placed in service.
4. Curing: Moist-cure waterproofing for not less than three days immediately after application has set, followed by air drying prior to being placed in service unless otherwise recommended in writing by manufacturer.
5. Waterproofing Treatment Extensions: Extend waterproofing treatment as follows:
   a. Onto columns integral with treated walls.
   b. Onto interior nontreated walls intersecting exterior treated walls, for a distance of 24 inches (600 mm) for cast-in-place concrete and 48 inches (1200 mm) for masonry.
   c. Onto exterior walls and onto both exterior and interior columns, for a height of 12 inches (300 mm), where floors, but not walls, are treated.
   d. Onto every substrate in areas indicated for treatment, including pipe trenches, pipe chases, pits, sumps, and similar offsets and features.
6. Protective Floor Topping: Apply 1-inch- (25.4-mm-) thick, protective topping over floor surfaces.

D. Field Quality Control
1. Inspection: Engage manufacturer's representative to inspect completed application and provide a written report that application complies with manufacturer's written instructions.

END OF SECTION 07 16 13 00

SECTION 07 16 16 00 - CRYSTALLINE WATERPROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for crystalline waterproofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes crystalline waterproofing for positive or negative-side application to concrete and concrete unit masonry.

C. Submittals
1. Product Data: For each type of product indicated. Include construction details, material descriptions and installation instructions for crystalline waterproofing.
2. Qualification Data: For Applicator.
3. Product Certificates: For waterproofing, patching, and plugging materials, from manufacturer.
4. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for crystalline waterproofing.
5. Field quality-control reports.

D. Quality Assurance
1. Applicator Qualifications: A firm experienced in applying crystalline waterproofing similar in material, design, and extent to that indicated for this Project, whose work has resulted in applications with a record of successful in-service performance, and that employs workers trained and approved by manufacturer.
2. Preinstallation Conference: Conduct conference at Project site.

E. Project Conditions
1. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit crystalline waterproofing to be performed according to manufacturer's written instructions.
2. Proceed with waterproofing work only after pipe sleeves, vents, curbs, inserts, drains, and other projections through the substrate to be waterproofed have been completed. Proceed only after substrate defects, including honeycombs, voids, and cracks, have been repaired to provide a sound substrate free of forming materials, including reveal inserts.
3. Ambient Conditions: Proceed with waterproofing work only if temperature is maintained at 40 deg F (4.4 deg C) or above during work and cure period, and space is well ventilated and kept free of water.

1.2 PRODUCTS

A. Waterproofing Materials
1. Crystalline Waterproofing: Prepackaged, gray-colored **OR** white-colored, **as directed**, proprietary blend of portland cement, specially treated sand, and active chemicals that, when mixed with water and applied, penetrates into concrete and concrete unit masonry and reacts chemically with the byproducts of cement hydration in the presence of water to develop crystalline growth within substrate capillaries to produce an impervious, dense, waterproof substrate; that has VOC content complying with limits of authorities having jurisdiction; with properties meeting or exceeding the criteria specified below.

a. Water Permeability: Maximum zero for water at 30 feet (9 m) when tested according to CE CRD-C 48.
b. Compressive Strength: Minimum 4000 psi (27.6 MPa) at 28 days when tested according to ASTM C 109/C 109M.

B. Accessory Materials
1. Patching Compound: Factory-premixed cementitious repair mortar, crack filler, or sealant recommended by waterproofing manufacturer for filling and patching tie holes, honeycombs, reveals, and other imperfections; compatible with substrate and other materials indicated; and VOC content complying with limits of authorities having jurisdiction.
2. Plugging Compound: Factory-premixed cementitious compound with hydrophobic properties and recommended by waterproofing manufacturer; resistant to water and moisture but vapor permeable for all standard applications (vertical, overhead, and horizontal surfaces not exposed to vehicular traffic); compatible with substrate and other materials indicated; and VOC content complying with limits of authorities having jurisdiction.
3. Portland Cement: ASTM C 150, Type I.
4. Sand: ASTM C 144.
5. Polymer Admixture for Protective Topping: Polymer bonding agent and admixture designed to improve adhesion to prepared substrates and not to create a vapor barrier.
6. Water: Potable.

C. Mixes
1. Crystalline Waterproofing: Add prepackaged dry ingredients to water according to manufacturer's written instructions. Mix together with mechanical mixer or by hand to required consistency.
2. Protective Topping: Measure, batch, and mix portland cement and sand in the proportion of 1:3 and water gaged with a polymer admixture. Blend together with mechanical mixer to required consistency.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Applicator present, for suitable conditions where waterproofing is to be applied.
2. Proceed with application only after unsatisfactory conditions have been corrected.
3. Notify the Owner in writing of active leaks or defects that would affect system performance.

B. Preparation
1. Protect other work from damage caused by cleaning, preparation, and application of waterproofing. Provide temporary enclosure to confine spraying operation and to ensure adequate ambient temperatures and ventilation conditions for application.
2. Do not allow waterproofing, patching, and plugging materials to enter reveals or annular spaces intended for resilient sealants or gaskets, such as joint spaces between pipes and pipe sleeves.
3. Stop active water leaks with plugging compound according to waterproofing manufacturer's written instructions.
4. Repair damaged or unsatisfactory substrate with patching compound according to manufacturer's written instructions.
   a. At holes and cracks in substrate, remove loosened chips and cut reveal with sides perpendicular to surface, not tapered, and approximately 1 inch (25.4 mm) deep. Fill reveal with patching compound flush with surface.
5. Surface Preparation: Comply with waterproofing manufacturer's written instructions to remove efflorescence, chalk, dust, dirt, mortar spatter, grease, oils, paint, curing compounds, and form-release agents to ensure that waterproofing bonds to surfaces.
   a. Clean concrete surfaces according to ASTM D 4258.

1) Scratch- and Float-Finished Concrete: Etch with 10 percent muriatic (hydrochloric) acid solution according to ASTM D 4260.
2) Prepare smooth-formed and trowel-finished concrete by mechanical abrading or abrasive-blast cleaning according to ASTM D 4259.

b. Clean concrete unit masonry surfaces according to ASTM D 4261.
1) Lightweight Concrete Unit Masonry: Etch with 10 percent muriatic (hydrochloric) acid solution or abrade surface by wire brushing. Remove acid residue until pH readings of water after rinse are not more than 1.0 pH lower or 2.0 pH higher than pH of water before rinse.
2) Medium- and Normal-Weight Concrete Unit Masonry: Sandblast or bushhammer to a depth of 1/16 inch (1.6 mm).

c. Concrete Joints: Clean reveals according to waterproofing manufacturer's written instructions.

C. Application
1. General: Comply with waterproofing manufacturer's written instructions for application and curing.
a. Saturate surface with water for several hours prior to application and maintain damp condition until applying waterproofing. Remove standing water.
b. Apply waterproofing to surfaces indicated on Drawings.
c. Number of Coats: Number required for specified water permeability **OR** Two **OR** Three, **as directed**.
d. Application Method: Brush **OR** Spray, **as directed**. Apply to ensure that each coat fills voids and is in full contact with substrate or previous coat.
e. Dampen surface between coats.
2. Final Coat Finish: Smooth **OR** Brushed **OR** Spray Textured, **as directed**.
3. Curing: Moist-cure waterproofing for three, **as directed**, days immediately after final coat has set, followed by air drying, unless otherwise recommended in writing by manufacturer.
4. Waterproofing Treatment Extensions: Extend waterproofing treatment as follows:
a. Onto columns integral with treated walls.
1) Onto interior nontreated walls intersecting exterior treated walls, for a distance of 24 inches (600 mm) for cast-in-place concrete and 48 inches (1200 mm) for masonry.
2) Onto exterior walls and onto both exterior and interior columns, for a height of 12 inches (300 mm), where floors, but not walls, are treated.
3) Onto every substrate in areas indicated for treatment, including pipe trenches, pipe chases, pits, sumps, and similar offsets and features.
5. Protective Topping: Apply 1-inch- (25.4-mm-) thick, protective topping over floor surfaces.

D. Field Quality Control
1. Inspection: Engage manufacturer's representative to inspect completed application and provide a written report that application complies with manufacturer's written instructions.

END OF SECTION 07 16 16 00

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SECTION 07 16 19 00 - METAL-OXIDE WATERPROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for metal-oxide waterproofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes metal-oxide waterproofing for positive or negative-side application to concrete, concrete unit masonry, and clay masonry.

C. Submittals
1. Product Data: For each type of product indicated. Include construction details, material descriptions and installation instructions for metal-oxide waterproofing.
2. Qualification Data: For Applicator.
3. Product Certificates: For waterproofing, patching, and plugging materials, from manufacturer.
4. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for metal-oxide waterproofing.
5. Field quality-control reports.

D. Quality Assurance
1. Applicator Qualifications: A firm experienced in applying metal-oxide waterproofing similar in material, design, and extent to that indicated for this Project, whose work has resulted in applications with a record of successful in-service performance, and that employs workers trained and approved by manufacturer.
2. Preinstallation Conference: Conduct conference at Project site.

E. Project Conditions
1. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit metal-oxide waterproofing to be performed according to manufacturer's written instructions.
2. Proceed with waterproofing work only after pipe sleeves, vents, curbs, inserts, drains, and other projections through the substrate to be waterproofed have been completed. Proceed only after substrate defects, including honeycombs, voids, and cracks, have been repaired to provide a sound substrate free of forming materials, including reveal inserts.
3. Ambient Conditions: Proceed with waterproofing work only if temperature is maintained at 40 deg F (4.4 deg C) or above during work and cure period, and space is well ventilated and kept free of water.

1.2 PRODUCTS

A. Waterproofing Materials
1. Metal-Oxide Waterproofing Compound: A product specifically formulated for waterproofing concrete and masonry substrates; containing pulverized iron and a chemical oxidizing agent to cause the iron particles to rust and grow in size in the presence of water; with VOC content complying with limits of authorities having jurisdiction.

B. Accessory Materials
1. Patching Compound: Factory-premixed cementitious repair mortar, crack filler, or sealant recommended by waterproofing manufacturer for filling and patching tie holes, honeycombs,

reveals, and other imperfections; compatible with substrate and other materials indicated; and VOC content complying with limits of authorities having jurisdiction.
2. Plugging Compound: Factory-premixed cementitious compound with hydrophobic properties and recommended by waterproofing manufacturer; resistant to water and moisture but vapor permeable for all standard applications (vertical, overhead, and horizontal surfaces not exposed to vehicular traffic); compatible with substrate and other materials indicated; and VOC content complying with limits of authorities having jurisdiction.
3. Portland Cement: ASTM C 150, Type I.
4. Sand: ASTM C 144.
5. Water: Potable.

C. Mixes
1. Metal-Oxide Coats: Add metal-oxide waterproofing compound to portland cement, sand, and water according to manufacturer's written instructions. Blend together with mechanical mixer or by hand to required consistency for each coat.
2. Protection Coat: Field mix protection coat consisting of portland cement and sand as recommended by same manufacturer as metal-oxide waterproofing according to manufacturer's written instructions for application over waterproofing. Measure, batch, and mix materials with potable water. Blend together with mechanical mixer to required consistency.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Applicator present, for suitable conditions where waterproofing is to be applied.
2. Proceed with application only after unsatisfactory conditions have been corrected.
3. Notify the Owner in writing of active leaks or defects that would affect system performance.

B. Preparation
1. Protect other work from damage caused by cleaning, preparation, and application of waterproofing. Provide temporary enclosure to confine spraying operation and to ensure adequate ambient temperatures and ventilation conditions for application.
2. Do not allow waterproofing, patching, and plugging materials to enter reveals or annular spaces intended for resilient sealants or gaskets, such as joint spaces between pipes and pipe sleeves.
3. Stop active water leaks with plugging compound according to waterproofing manufacturer's written instructions.
4. Repair damaged or unsatisfactory substrate with patching compound according to manufacturer's written instructions.
   a. At holes and cracks in substrate, remove loosened chips and cut reveal with sides perpendicular to surface, not tapered, and approximately 1 inch (25.4 mm) deep. Fill reveal with patching compound flush with surface.
5. Surface Preparation: Comply with waterproofing manufacturer's written instructions to remove efflorescence, chalk, dust, dirt, mortar spatter, grease, oils, paint, curing compounds, and form-release agents to ensure that waterproofing bonds to surfaces.
   a. Clean concrete surfaces according to ASTM D 4258.
      1) Scratch- and Float-Finished Concrete: Etch with 10 percent muriatic (hydrochloric) acid solution according to ASTM D 4260.
      2) Prepare smooth-formed and trowel-finished concrete by mechanical abrading or abrasive-blast cleaning according to ASTM D 4259.
   b. Clean concrete unit masonry surfaces according to ASTM D 4261.
      1) Lightweight Concrete Unit Masonry: Etch with 10 percent muriatic (hydrochloric) acid solution or abrade surface by wire brushing. Remove acid residue until pH readings of water after rinse are not more than 1.0 pH lower or 2.0 pH higher than pH of water before rinse.

2) Medium- and Normal-Weight Concrete Unit Masonry: Sandblast or bushhammer to a depth of 1/16 inch (1.6 mm).

c. Clean clay masonry surfaces according to ASTM D 5703.

d. Concrete Joints: Clean reveals according to waterproofing manufacturer's written instructions.

C. Application

1. General: Comply with waterproofing manufacturer's written instructions for application and curing.
   a. Saturate surface for several hours prior to application with water and maintain damp condition until applying waterproofing. Remove standing water.
   b. Apply waterproofing to surfaces indicated on Drawings.
   c. Number of Metal-Oxide Coats: Number required for specified water permeability **OR** Two **OR** Three, **as directed**.
   d. Application Method: Brush apply the waterproofing, vigorously working first coat onto the substrate and forcing the material into surface voids. Brush each subsequent coat into full contact with previous coat.
   e. Dampen surface between coats.
   f. Allow each coat to set for 24 hours between coats.
   g. Protection Coat: Apply to a thickness of 1/8 inch (3 mm) **OR** 1/4 inch (6 mm), **as directed**, for walls and 1 inch (25 mm) for floors.
2. Final Coat Finish: Smooth **OR** Brushed **OR** Textured, **as directed**.
3. Curing: Moist-cure waterproofing for three days immediately after final coat has set, followed by air drying prior to being placed in service, unless otherwise recommended in writing by manufacturer.
4. Waterproofing Treatment Extensions: Extend waterproofing treatment as follows:
   a. Onto columns integral with treated walls.
   b. Onto interior nontreated walls intersecting exterior treated walls, for a distance of 24 inches (600 mm) for cast-in-place concrete and 48 inches (1200 mm) for masonry.
   c. Onto exterior walls and onto both exterior and interior columns, for a height of 12 inches (300 mm), where floors, but not walls, are treated.
   d. Onto every substrate in areas indicated for treatment, including pipe trenches, pipe chases, pits, sumps, and similar offsets and features.

D. Field Quality Control

1. Inspection: Engage manufacturer's representative to inspect completed application and provide a written report that application complies with manufacturer's written instructions.

END OF SECTION 07 16 19 00

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SECTION 07 17 13 00 - BENTONITE WATERPROOFING

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for bentonite waterproofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Bentonite waterproofing.
      b. Molded-sheet drainage panels.
      c. Insulation.

C. Submittals
   1. Product Data: For each type of product indicated. Include product specifications and manufacturer's written installation instructions.
   2. Shop Drawings: Show installation details for interface with other work.
   3. Samples: For each of the following products, in sizes indicated:
      a. Waterproofing: 6 inches (150 mm) square.
      b. Drainage Panels: 6 inches (150 mm) square.
      c. Insulation: 6 inches (150 mm) square.
   4. Material Certificates: For each type of bentonite waterproofing, from manufacturer.
   5. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency **OR** a qualified testing agency, **as directed**, for bentonite waterproofing.
   6. Field quality-control reports.
   7. Warranty: Sample of special warranty.

D. Quality Assurance
   1. Source Limitations: Obtain bentonite waterproofing system from single source from single manufacturer. Obtain accessory products used with bentonite waterproofing from sources acceptable to bentonite waterproofing manufacturer.
   2. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
   1. Deliver materials to Project site in manufacturer's original unopened and undamaged containers.
   2. Store materials in a dry, well-ventilated space.
   3. Remove and replace bentonite materials that have been prematurely exposed to moisture.

F. Project Conditions
   1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit bentonite waterproofing to be installed according to manufacturers' written instructions and warranty requirements.
      a. Do not apply waterproofing materials to surfaces where ice or frost is visible. Do not apply bentonite waterproofing materials in areas with standing water.
      b. Placing bentonite clay products in panel or composite form on damp surfaces is allowed if approved in writing by manufacturer.

G. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree(s) to repair or replace components of bentonite waterproofing system that fail in materials or workmanship within specified warranty period.
   a. Warranty Period: Five years from date of Final Completion.

1.2 PRODUCTS

A. Geotextile/Bentonite Sheets
1. Geotextile/Bentonite Waterproofing: Minimum of 1.0 lb/sq. ft. (5 kg/sq. m) of bentonite clay granules between two layers of geotextile polypropylene fabric, one woven and one nonwoven, needle punched and heat fused together.
   a. Grab Tensile Strength: 95 lbf (422 N) according to ASTM D 4632.
2. Contaminant-Resistant Geotextile/Bentonite Waterproofing: Minimum of 1.0 lb/sq. ft. (5 kg/sq. m) of bentonite clay granules specially formulated for use in saltwater or contaminated ground water, between two layers of geotextile polypropylene fabric, one woven and one nonwoven, needle punched and heat fused together.
   a. Grab Tensile Strength: 95 lbf (422 N) according to ASTM D 4632.
3. Geotextile-Geomembrane/Bentonite Waterproofing: Minimum of 1.0 lb/sq. ft. (5 kg/sq. m) of bentonite clay granules between two layers of geotextile polypropylene fabric, one woven and one nonwoven, needle punched and heat fused together; and the woven fabric coated with a low-permeable polypropylene geomembrane.
   a. Grab Tensile Strength: 95 lbf (422 N) according to ASTM D 4632.
4. Composite Geotextile-HDPE/Bentonite Membrane: Minimum of 1.1 lb/sq. ft. (5.4 kg/sq. m) of bentonite clay granules bonded to nonwoven geotextile polypropylene fabric, with HDPE bonded to surface of nonwoven fabric.
   a. Grab Tensile Strength: 120 lbf (534 N) according to ASTM D 4632.
   b. Puncture Resistance: 140 lbf (620 N) according to ASTM D 4833.
   c. Vapor Permeance: 0.03 perms according to ASTM E 96.
5. Contaminant-Resistant Composite Geotextile-HDPE/Bentonite Membrane: Minimum of 1.1 lb/sq. ft. (5.4 kg/sq. m) of bentonite clay granules specially formulated for use in saltwater or contaminated ground water, bonded to nonwoven geotextile polypropylene fabric, with HDPE bonded to surface of nonwoven fabric.
   a. Grab Tensile Strength: 120 lbf (534 N) according to ASTM D 4632.
   b. Puncture Resistance: 140 lbf (620 N) according to ASTM D 4833.
   c. Vapor Permeance: 0.03 perms according to ASTM E 96.

B. Composite HDPE/Bentonite Membrane
1. Composite HDPE/Bentonite Membrane: Minimum 90-mil- (2.3-mm-) thick membrane consisting of a 12-mil- (0.5-mm-) thick, HDPE geomembrane liner bonded to a layer of bentonite clay granules 78 mils (1.9 mm) thick.
   a. Puncture Resistance: 169 lbf (752 N) according to ASTM E 154.
   b. Vapor Permeance: 0.03 perms according to ASTM E 96.
2. Composite HDPE/Bentonite Membrane with Protective Facing: Minimum 170-mil- (4.3-mm-) thick membrane consisting of HDPE geomembrane liner bonded to a layer of bentonite clay granules and with a spun polypropylene facing.
   a. Puncture Resistance: 169 lbf (752 N) according to ASTM E 154.
   b. Vapor Permeance: 0.03 perms according to ASTM E 96.
3. Composite HDPE/Bentonite-Polymer Membrane: Minimum 200-mil- (5-mm-) thick membrane consisting of HDPE geomembrane liner bonded to a layer of bentonite-polymer clay granules.
   a. Puncture Resistance: 75 lbf (334 N) according to ASTM D 4833.
   b. Vapor Permeance: 0.005 perms according to ASTM E 96.
4. Composite Gastight HDPE/Bentonite Membrane: Minimum 150-mil- (3.8-mm-) thick membrane consisting of a 60-mil- (1.5-mm-) thick, HDPE geomembrane liner bonded to a layer of bentonite clay.

a. Puncture Resistance: 169 lbf (752 N) according to ASTM E 154.
b. Vapor Permeance: 0.03 perms according to ASTM E 96.

5. Composite Saline/Alkaline HDPE/Bentonite Membrane: Minimum 150-mil- (3.8-mm-) thick membrane consisting of a 60-mil- (1.5-mm-) thick, HDPE geomembrane liner bonded to a layer of bentonite clay granules.
   a. Puncture Resistance: 169 lbf (752 N) according to ASTM E 154.
   b. Vapor Permeance: 0.03 perms according to ASTM E 96.

C. Composite Geotextile-HDPE/Bentonite Membrane
1. Geotextile/Bentonite-Polymer Waterproofing: Minimum 250-mil- (6.4-mm-) thick membrane of bentonite-polymer clay granules between two layers of geotextile polypropylene fabric, one woven and one nonwoven, needle punched and heat fused together.
   a. Puncture Resistance: 75 lbf (334 N) according to ASTM D 4833.
   b. Vapor Permeance: 0.005 perms according to ASTM E 96.

D. Bentonite Panels
1. Standard Panels: 3/16-inch- (5-mm-) thick, corrugated kraft-paper panels with a minimum of 1.0 lb/sq. ft. (5 kg/sq. m) of bentonite confined in corrugations of boards.
2. Coated Panels: 3/16-inch- (5-mm-) thick, corrugated kraft-paper panels specially coated to resist premature hydration due to incidental moisture; filled with a minimum of 1.0 lb/sq. ft. (5 kg/sq. m) of bentonite.
3. Contaminant-Resistant Panels: 3/16-inch- (5-mm-) thick, corrugated kraft-paper panels with a minimum of 1.0 lb/sq. ft. (5 kg/sq. m) of contaminant-resistant granular bentonite specially formulated for use in contaminated ground-water conditions; confined in corrugations of boards.

E. Installation Accessories
1. Granular Bentonite: Sodium bentonite clay containing a minimum of 90 percent montmorillonite (hydrated aluminum silicate), with a minimum of 90 percent passing a No. 20 (0.85-mm) sieve.
2. Bentonite Mastic: Trowelable consistency, bentonite compound, specifically formulated for application at joints and penetrations.
3. Granular Bentonite Tubes: Manufacturer's standard 2-inch- (50-mm-) diameter, water-soluble tube containing approximately 1.5 lb/ft. (2.2 kg/m) of bentonite; hermetically sealed; designed specifically for placing on wall footings at line of joint with exterior base of wall.
4. Termination Bar: Extruded-aluminum or formed-stainless-steel bars with upper flange to receive sealant.
5. Plastic Protection Sheet: Polyethylene sheeting complying with ASTM D 4397; thickness recommended by waterproofing manufacturer to suit application but at least 6 mils (0.15 mm) thick.
6. Cement Grout Patching Material: Manufacturer's recommended grout mix compatible with substrate being patched.
7. Masonry Fasteners: Case-hardened nails or hardened-steel, powder-actuated fasteners. Depending on manufacturer's written requirements, provide 1/2- or 1-inch- (13- or 25-mm-) diameter washers under fastener heads.
8. Sealants: As recommended in writing by waterproofing manufacturer. Comply with requirements specified in Division 7 Section "Joint Sealants."
9. Tapes: Waterproofing manufacturer's recommended tape for joints between sheets, membranes, or panels.
10. Adhesive: Water-based adhesive used to secure waterproofing to both vertical and horizontal surfaces.
11. Protection Course: ASTM D 6506, semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners, and as follows:
    a. Thickness: 1/8 inch (3 mm), nominal, for vertical applications; 1/4 inch (6 mm), nominal, elsewhere.
12. Geotextile Protection Course: As recommended by waterproofing manufacturer.
13. Molded-Sheet Drainage Panel: Comply with Division 33 Section "Subdrainage".

14. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21-mm) sieve laminated to one side with **OR** without, **as directed**, a polymeric film bonded to the other side of a studded, nonbiodegradable, molded-plastic-sheet drainage core, with a vertical flow rate of 9 to 15 gpm per foot (112 to 188 L/min. per m).
15. Woven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a woven-geotextile facing with an apparent opening size not exceeding No. 40 (0.425-mm) sieve laminated to one side with **OR** without, **as directed**, a polymeric film bonded to the other side of a studded, nonbiodegradable, molded-plastic-sheet drainage core, with a horizontal flow rate not less than 2.8 gpm per foot (35 L/min. per m).
16. Board Insulation: Extruded-polystyrene board insulation complying with ASTM C 578, square **OR** shiplap, **as directed**, edged.
    a. Type VI, 40-psi (276-kPa) minimum compressive strength.
    b. Type VII, 60-psi (414-kPa) minimum compressive strength.
    c. Type V, 100-psi (690-kPa) minimum compressive strength.
17. Unfaced Wall Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type VI, 40-psi (276-kPa) minimum compressive strength; unfaced; fabricated with shiplap or channel edges and with one side having grooved drainage channels.
18. Geotextile-Faced Wall Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type VI, 40-psi (276-kPa) minimum compressive strength; fabricated with tongue-and-groove edges and with one side having grooved drainage channels faced with nonwoven geotextile filter fabric.
19. Unfaced Plaza Deck Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type VI, 40-psi (276-kPa) **OR** Type VII, 60-psi (414-kPa), **as directed**, minimum compressive strength; unfaced; fabricated with shiplapped or channel edges and with one side having ribbed drainage channels.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrate preparations affecting performance of bentonite waterproofing.
2. Verify that substrate is complete and that work that will penetrate waterproofing is complete and rigidly installed.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Coordinate work in the vicinity of waterproofing to ensure proper conditions for installing the waterproofing system and to prevent damage to waterproofing after installation.
2. Formed Concrete Surfaces: Remove fins and projections. Fill voids, rock pockets, form-tie holes, and other defects with bentonite mastic or cement grout patching material according to manufacturer's written instructions.
3. Horizontal Concrete Surfaces: Remove debris, standing water, oily substances, mud, and similar substances that could impair the bonding ability of concrete or the effectiveness of waterproofing. Fill voids, cracks greater than 1/8 inch (3 mm), honeycomb areas, and other defects with bentonite mastic or cement grout patching material according to manufacturer's written instructions.
4. Excavation Support and Protection System: If water is seeping, use plastic protection sheets or other suitable means to prevent wetting the bentonite waterproofing. Fill minor gaps and spaces 1/8 inch (3 mm) wide or wider with wood, metal, concrete, or other appropriate filling material. Cover or fill large voids and crevices with cement mortar according to manufacturer's written instructions.

C. Installation, General
1. Install waterproofing and accessories according to manufacturer's written instructions.
   a. Apply granular bentonite around penetrations in horizontal surfaces and changes in plane according to manufacturer's details in preparation for granular bentonite tubes and mastic.
   b. Apply granular bentonite tubes, bentonite mastic, or both at changes of plane, construction joints in substrate, projections, and penetrations.
2. Apply granular bentonite tubes continuously on footing against base of wall to be waterproofed according to manufacturer's written instructions.
3. Protect waterproofing from damage and wetting before and during subsequent construction operations. Repair punctures, tears, and cuts according to manufacturer's written instructions.
4. Install protection course before backfilling or placing overburden when recommended by waterproofing manufacturer.

D. Geotextile/Bentonite Sheet Installation
1. General: Install a continuous layer of waterproofing sheets directly against concrete to be waterproofed. Lap ends and edges a minimum of 4 inches (100 mm) on horizontal and vertical substrates. Stagger end joints between sheets a minimum of 24 inches (600 mm). Fasten seams by stapling to adjacent sheet or nailing to substrate.
2. Below Structural Slabs-on-Grade: Place waterproofing sheets on compacted substrate with ends and edges lapped and stapled.
   a. Install a layer of waterproofing sheets under footings, grade beams, and pile caps; or continue waterproofing through key joints between footings and foundation walls, and extend a minimum of 8 inches (200 mm) up or beyond perimeter slab forms.
3. Concrete Walls: Starting at bottom of wall, apply waterproofing sheets horizontally with primary backing side against wall. Secure with masonry fasteners spaced according to manufacturer's written instructions. Extend to bottom of footing, grade beam, or wall, and secure.
   a. Termination at Grade: Extend waterproofing sheets to within 2 inches (50 mm) of finish grade unless otherwise indicated. Secure top edge with termination bar. Apply sealant to top edge of termination bar.
      OR
      Termination at Grade: Fasten top edge of waterproofing sheets to wall and protect top edge with sheet metal counterflashing. Cover waterproofing with a lapped course of plastic protection sheets if backfilling does not proceed immediately.
4. Excavation Support and Protection (Permanent Shoring): Encase tieback rods, nuts, and plates, using bentonite mastic and waterproofing sheets, according to waterproofing manufacturer's written instructions for each configuration.
   a. Install a layer of waterproofing sheets, with ends and edges lapped and nailed to shoring. Cover waterproofing with plastic protection sheets if needed for protection from precipitation; remove plastic sheets before placing concrete.
   b. Inspect and repair waterproofing after reinforcing steel has been placed. Coordinate and control concrete placement to avoid damage to waterproofing.

E. Composite HDPE/Bentonite Membrane Installation
1. General: Install a continuous layer of waterproofing membrane with ends and edges lapped a minimum of 3 inches (75 mm). Stagger end joints between membranes. Seal joints with permanent seam tape.
2. Below Structural Slabs-on-Grade: Apply waterproofing membrane with HDPE side down and staple ends and edges.
   a. Install under footings, grade beams, and pile caps; or continue waterproofing through key joints between footings and foundation walls, and extend a minimum of 8 inches (200 mm) up or beyond perimeter slab forms.
   b. Protect waterproofing from damage caused by reinforcing bar supports with sharp edges.
3. Slabs: Starting at lowest point, install a continuous layer of waterproofing membrane, with ends and edges lapped a minimum of 2 inches (50 mm).
4. Vertical Concrete or Masonry Walls: Apply mastic around penetrations and form continuous 2-inch (50-mm) cant at intersection of footings and walls with mastic.

a. Starting at lowest point, install a layer of waterproofing membrane horizontally, extending a minimum of 6 inches (150 mm) onto the footing. Lap membrane ends and edges a minimum of 2 inches (50 mm).
b. Secure membrane to wall with adhesive or washer-headed fasteners, and tape terminations of membrane at grade.

5. Excavation Support and Protection: Cut, clean, and treat tiebacks and similar projections. Encase tieback rods, nuts, and plates. If water is present, cover shoring and lagging with plastic protection sheets.
   a. Starting at lowest point, install a layer of waterproofing membrane, with ends and edges lapped and nailed to shoring.
6. Horizontal Roofs, Plazas, and between Slabs: Starting at lowest point, install a layer of waterproofing membrane, with ends and edges lapped and taped a minimum of 3 inches (75 mm).
   a. Prime concrete substrates. Primer may be omitted on concrete surfaces that comply with requirements for dryness, surface texture, and freedom from imperfections.
   b. Install bentonite side of membrane against the material to be waterproofed.
   c. Terminations at Vertical Surfaces: Provide a fillet or cant at intersection of horizontal and vertical substrates. Extend waterproofing membrane to top of curb or to a minimum of 6 inches (150 mm) above plane of waterproofing; secure with manufacturer's recommended tape.
   d. Cover waterproofing with a plastic slip-sheet.

F. Composite Geotextile-HDPE/Bentonite Membrane Installation
1. General: Install a continuous layer of waterproofing membrane with ends and edges lapped a minimum of 3 inches (75 mm). Stagger end joints between membranes. Seal joints with permanent seam tape.
2. Below Structural Slabs-on-Grade: Apply waterproofing membrane with HDPE side down and staple ends and edges.
   a. Install under footings, grade beams, and pile caps; or continue waterproofing through key joints between footings and foundation walls, and extend a minimum of 8 inches (200 mm) up or beyond perimeter slab forms.
   b. Protect waterproofing from damage caused by reinforcing bar supports with sharp edges.
3. Concrete Walls: Starting at bottom of wall, apply waterproofing membrane with HDPE side facing Installer; overlap sheets 3 inches (75 mm). Secure with powder-actuated fasteners or case-hardened nails. Extend to bottom of footing, grade beam, or wall, and secure.
   a. Termination at Grade: Extend waterproofing membrane to within 2 inches (50 mm) of finish grade unless otherwise indicated. Secure top edge with termination bar. Apply sealant to top edge of termination bar.
4. Excavation Support and Protection (Permanent Shoring): Cut, clean, and treat tiebacks and similar projections. Encase tieback rods, nuts, and plates. If water is present, cover shoring and lagging with plastic protection sheets; remove plastic sheets before placing concrete.
   a. Starting at lowest point, install a layer of waterproofing membrane, with ends and edges lapped and mechanically secured to shoring.
   b. Inspect and repair waterproofing membrane after reinforcing steel has been placed. Coordinate and control concrete placement to avoid damage to waterproofing.
5. Horizontal Slabs, Roofs, and Plazas: Starting at lowest point, install a layer of waterproofing membrane, with ends and edges lapped and taped a minimum of 3 inches (75 mm).
   a. Clean overlap area and apply waterproof tape, rolling the exposed edge to seal to sheet below.
   b. Turn edges up and seal to vertical surfaces.
   c. Cover waterproofing with a plastic slip-sheet.

G. Bentonite Panel Installation

1. General: Install a continuous layer of bentonite waterproofing panels with ends and edges lapped a minimum of 1-1/2 inches (38 mm) unless otherwise indicated. Stagger joints in adjoining panel rows.
    a. Install a double layer of waterproofing panels, with ends and edges butted instead of lapped and with second layer of joints staggered over first. Staple panels together to hold them in place.
2. Concrete Walls: Starting at bottom of wall, apply waterproofing panels with ends and edges lapped and with vertical joints staggered. Secure with fasteners or adhesive recommended in writing by manufacturer. Extend to bottom of footing, grade beam, or wall.
    a. Horizontal-to-Vertical Transitions: Install granular bentonite tubes immediately before backfilling and compact backfill over the joint.
    b. Termination at Grade: Extend waterproofing panels to within 2 inches (50 mm) of finish grade unless otherwise indicated. Secure top edge with termination bar. Apply sealant to top edge of termination bar.
    OR
    Termination at Grade: Fasten top edge of waterproofing panels to wall and protect top edge with sheet metal counterflashing.
    c. Cover waterproofing panels with a lapped course of plastic protection sheets; remove plastic sheets before backfilling.

H. Molded-Sheet Drainage Panel Installation
1. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate. Use adhesives or mechanical fasteners that do not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.
    a. For vertical applications, install board insulation **OR** protection course, **as directed**, before installing drainage panels.

I. Insulation Installation
1. Install one or more layers of board insulation to achieve required thickness and insulation drainage panels over waterproofed surfaces. Cut and fit to within 3/4 inch (19 mm) of projections and penetrations.
2. On vertical surfaces, set insulation units in adhesive or tape applied according to manufacturer's written instructions.
3. On horizontal surfaces, loosely lay insulation units. Stagger end joints and tightly abut insulation units.

J. Field Quality Control
1. Inspection: Arrange for manufacturer's representative to inspect completed waterproofing installation before covering with other construction and provide written report that installation complies with manufacturer's written instructions.
    a. Remove and replace applications of bentonite waterproofing where inspection indicates that it does not comply with specified requirements.
2. Flood Testing: Flood test each deck area for leaks, according to recommendations in ASTM D 5957, after completing waterproofing but before overlaying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.
    a. Flood to an average depth of 2-1/2 inches (64 mm) with a minimum depth of 1 inch (25 mm) but not exceeding a depth of 4 inches (100 mm). Maintain 2 inches (50 mm) of clearance from top of membrane flashings.
    b. Flood each area for 24 **OR** 48, **as directed**, hours.
    c. After flood testing, repair leaks, repeat flood test, and make further repairs until waterproofing installation is watertight.
3. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.

END OF SECTION 07 17 13 00

SECTION 07 19 13 00 - WATER REPELLENTS

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for water repellents. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes penetrating and film-forming water-repellent coatings for the following vertical and horizontal surfaces:
      a. Concrete (unpainted).
      b. Cast stone.
      c. Brick masonry.
      d. Concrete unit masonry (unpainted and unglazed).
      e. Portland cement plaster (stucco).
      f. Stonework.

C. Performance Requirements
   1. Performance Testing: Provide water repellents that comply with test-performance requirements indicated, as evidenced by reports of tests performed by manufacturer **OR** based on Project-specific preconstruction testing, **as directed**, by a qualified independent testing agency on manufacturer's standard products applied to substrates simulating those on Project using same application methods to be used for Project.
      a. Engage testing agency to perform preconstruction tests on laboratory mockups.
      b. Select sizes and configurations of assemblies to adequately demonstrate capability of water repellents to comply with performance requirements.
      c. Notify the Owner seven days in advance of the dates and times when assemblies will be constructed.
   2. Absorption: Minimum 80 **OR** 90, **as directed**, percent reduction of absorption after 24 hours in comparison of treated and untreated specimens.
      a. Brick: ASTM C 67.
      b. Stone: ASTM C 97.
      c. Concrete Unit Masonry: ASTM C 140.
      d. Hardened Concrete: ASTM C 642.
   3. Water-Vapor Transmission: Maximum 10 percent reduction in rate of vapor transmission in comparison of treated and untreated specimens, per ASTM E 96.
   4. Permeability: Minimum 80 percent water-vapor transmission in comparison of treated and untreated specimens, per ASTM D 1653.
   5. Water Penetration and Leakage through Masonry: Maximum 90 percent reduction in leakage rate in comparison of treated and untreated specimens, per ASTM E 514.
   6. Durability: Maximum 5 percent loss of water repellency after 2500 hours of weathering in comparison to specimens before weathering, per ASTM G 154.
      a. Reduction of Water Absorption: 80 percent.
      b. Reduction in Chloride Content: 80 percent.

D. Submittals
   1. Product Data: For each type of product indicated.
   2. Product test reports.

E. Quality Assurance
   1. Installer Qualifications: An employer of workers trained and approved by manufacturer.

F. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer and Applicator agree(s) to repair or replace materials that fail to maintain water repellency specified in Part 1.1 "Performance Requirements" Article within specified warranty period.
   a. Warranty Period: Two **OR** Five, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Penetrating Water Repellents
1. Silane, Penetrating Water Repellent: Clear, monomeric compound containing 20 percent or more solids of alkyltrialkoxysilanes; with alcohol, mineral spirits, water, or other proprietary solvent carrier; and with 3.3 lb/gal. (400 g/L) or less of VOCs.
2. Silane, Penetrating Water Repellent: Clear, monomeric compound containing 20 percent or more solids of alkyltrialkoxysilanes; with alcohol, mineral spirits, water, or other proprietary solvent carrier; and with 5 lb/gal. (600 g/L) or less of VOCs.
3. Silane, Penetrating Water Repellent: Pigmented, monomeric compound containing 20 percent or more solids of alkyltrialkoxysilanes; with alcohol, mineral spirits, water, or other proprietary solvent carrier; and with 5 lb/gal. (600 g/L) or less of VOCs.
4. Silane, Penetrating Water Repellent: Clear, monomeric compound containing 20 percent or more solids of alkyltrialkoxysilanes; with alcohol, mineral spirits, water, or other proprietary solvent carrier; and with more than 5 lb/gal. (600 g/L) of VOCs.
5. Siloxane, Penetrating Water Repellent: Clear, oligomerous alkylalkoxysiloxanes containing 10 percent or more solids; with alcohol, ethanol, mineral spirits, water, or other proprietary solvent carrier; and with 3.3 lb/gal. (400 g/L) or less of VOCs.
6. Siloxane, Penetrating Water Repellent: Clear, oligomerous alkylalkoxysiloxanes containing 10 percent or more solids; with alcohol, ethanol, mineral spirits, water, or other proprietary solvent carrier; and with 5 lb/gal. (600 g/L) or less of VOCs.
7. Siloxane, Penetrating Water Repellent: Clear, oligomerous alkylalkoxysiloxanes containing 10 percent or more solids; with alcohol, ethanol, mineral spirits, water, or other proprietary solvent carrier; and with more than 5 lb/gal. (600 g/L) of VOCs.
8. Silane/Siloxane-Blend, Penetrating Water Repellent: Clear, silane and siloxane blends with 3.3 lb/gal. (400 g/L) or less of VOCs.
9. Silane/Siloxane-Blend, Penetrating Water Repellent: Clear, silane and siloxane blends with 5 lb/gal. (600 g/L) or less of VOCs.
10. Proprietary-Blend, Penetrating Water Repellent: Clear, consisting of 1 or several different resins (silanes or siloxanes), polymers, stearates, or oils plus other compounds or products of components; and with 3.3 lb/gal. (400 g/L) or less of VOCs.
11. Proprietary-Blend, Penetrating Water Repellent: Clear, consisting of 1 or several different resins (silanes or siloxanes), polymers, stearates, or oils plus other compounds or products of components; and with 5 lb/gal. (600 g/L) or less of VOCs.

B. Film-Forming Water Repellents
1. Silicone Sealer, Film-Forming Water Repellent: Clear, polymerized, silicone-resin water repellent for dense substrates; with a solvent- or water-based solution containing not less than 3 and up to 5 percent solids by weight; and with 3.3 lb/gal. (400 g/L) or less of VOCs.
2. Silicone-Sealer, Film-Forming Water Repellent: Clear, polymerized, silicone-resin water repellent for dense substrates; with a solvent- or water-based solution containing not less than 3 and up to 5 percent solids by weight; and with 5 lb/gal. (600 g/L) or less of VOCs.
3. Proprietary-Blend, Film-Forming Water Repellent: Clear, consisting of 1 or several different resins, acrylics, polymers, stearates, or oils plus other compounds or products of components; and with 3.3 lb/gal. (400 g/L) or less of VOCs.
4. Proprietary-Blend, Film-Forming Water Repellent: Clear, consisting of 1 or several different resins, acrylics, polymers, stearates, or oils plus other compounds or products of components; and with 5 lb/gal. (600 g/L) or less of VOCs.

5. Siliconate, Film-Forming Water Repellent: Clear, with 3.3 lb/gal. (400 g/L) or less of VOCs.
6. Acrylic, Film-Forming Water Repellent: Clear **OR** Pigmented, **as directed**, breathing coating of acrylic resins; with a water-based, solvent-based, or acrylic emulsion solution containing less than 15 percent solids by volume; and with 3.3 lb/gal. (400 g/L) or less of VOCs.
   a. Colors: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
7. Acrylic, Film-Forming Water Repellent: Pigmented, with 5 lb/gal. (600 g/L) or less of VOCs.
   a. Colors: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

1.3 EXECUTION

A. Preparation
1. Clean substrate of substances that might interfere with penetration or performance of water repellents. Test for moisture content, according to water-repellent manufacturer's written instructions, to ensure that surface is dry enough.
   a. Cast-in-Place Concrete: Remove oil, curing compounds, laitance, and other substances that could prevent adhesion or penetration of water repellents.
   b. Clay Brick Masonry: Clean clay brick masonry per ASTM D 5703.
2. Test for pH level, according to water-repellent manufacturer's written instructions, to ensure chemical bond to silicate minerals.
3. Protect adjoining work, including sealant bond surfaces, from spillage or blow-over of water repellent. Cover adjoining and nearby surfaces of aluminum and glass if there is the possibility of water repellent being deposited on surfaces. Cover live plants and grass.
4. Coordination with Sealants: Do not apply water repellent until sealants for joints adjacent to surfaces receiving water-repellent treatment have been installed and cured.
   a. Water-repellent work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, water repellent, and sealant materials identical to those used in the work.
5. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Application
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect the substrate before application of water repellent and to instruct Applicator on the product and application method to be used.
2. Apply a heavy-saturation spray coating of water repellent on surfaces indicated for treatment using low-pressure spray equipment. Comply with manufacturer's written instructions for using airless spraying procedure, unless otherwise indicated.
   a. Precast Concrete: At Contractor's option, first application of water repellent on precast concrete units may be completed before installing units. Mask sealant-bond surfaces to prevent water repellent from migrating onto joint surfaces.
3. Apply a second saturation spray coating, as directed, repeating first application. Comply with manufacturer's written instructions for limitations on drying time between coats and after rainstorm wetting of surfaces between coats. Consult manufacturer's technical representative if written instructions are not applicable to Project conditions.

C. Cleaning
1. Immediately clean water repellent from adjoining surfaces and surfaces soiled or damaged by water-repellent application as work progresses. Repair damage caused by water-repellent application. Comply with manufacturer's written cleaning instructions.

END OF SECTION 07 19 13 00

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Task	Specification	Specification Description
07 19 16 00	07 19 13 00	Water Repellents

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SECTION 07 21 13 13 - MODIFIED BITUMOUS PROTECTED MEMBRANE ROOFING

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for modified bituminous protected membrane roofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section includes APP-modified and SBS-modified bituminous protected membrane roofing.

C. Definitions
   1. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.
   2. Hot Roofing Asphalt: Roofing asphalt heated to its equiviscous temperature, the temperature at which its viscosity is 125 centipoise for mop-applied roofing asphalt and 75 centipoise for mechanical spreader-applied roofing asphalt, within a range of plus or minus 25 deg F (14 deg C), measured at the mop cart or mechanical spreader immediately before application.

D. Performance Requirements
   1. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.
   2. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.
   3. Roofing System Design: If membrane roofing system is to be designed to withstand uplift pressure established by ASCE/SEI 7, provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
      a. Corner Uplift Pressure: as directed by the Owner.
      b. Perimeter Uplift Pressure: as directed by the Owner.
      c. Field-of-Roof Uplift Pressure: as directed by the Owner.
   4. FM Approvals Listing: If Project is FM Global insured or if FM Approvals requirements will set a minimum quality standard, provide membrane roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a membrane roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.
      a. Fire/Windstorm Classification: Class 1A-60 **OR** Class 1A-75 **OR** Class 1A-90 **OR** Class 1A-105 **OR** Class 1A-120, **as directed**.
      b. Hail Resistance Rating: MH **OR** SH, **as directed**.
   5. Energy Performance (if required for LEED-NC Credit SS 7.2): Provide roofing system with initial Solar Reflectance Index not less than 78 when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.
      OR
      Energy Performance (for roofs that must comply with the DOE's ENERGY STAR requirements): Provide roofing system that is listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.
      OR

Energy Performance (for roofs that must comply with California Energy Commission's CEC-Title 24): Provide roofing system with initial Solar Reflectance not less than 0.70 and Thermal Emittance not less than 0.75 when tested according to CRRC-1.

E. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Product Test Reports for Credit SS 7.2: For roof materials, indicating that roof materials comply with Solar Reflectance Index requirement.
   b. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.
   a. Base flashings and membrane terminations.
   b. Tapered insulation, including slopes.
   c. Crickets, saddles, and tapered edge strips, including slopes.
4. Samples: For the following products:
   a. Sheet roofing materials, including base sheet, base-ply sheet, roofing membrane sheet, flashing backer sheet, membrane cap sheet and flashing sheet, of color specified.
   b. Roof insulation.
   c. 10 lb (4.5 kg) of aggregate ballast in gradation and color indicated.
   d. Roof paver, full sized, in each color and texture required.
5. Qualification Data: For qualified Installer and manufacturer.
6. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
   a. Submit evidence of compliance with performance requirements.
7. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of membrane roofing system.
8. Research/Evaluation Reports: For components of membrane roofing system, from the ICC-ES or applicable model code organization.
9. Maintenance Data: For roofing system to include in maintenance manuals.
10. Warranties: Sample of special warranties.

F. Quality Assurance
1. Manufacturer Qualifications: A qualified manufacturer that is UL listed **OR** FM Approvals approved, **as directed**, for membrane roofing system identical to that used for this Project.
2. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
3. Source Limitations: Obtain components including roof insulation and fasteners for membrane roofing system from same manufacturer as membrane roofing or approved by membrane roofing manufacturer.
4. Exterior Fire-Test Exposure: ASTM E 108, Class A **OR** Class B **OR** Class C, **as directed**; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.
5. Fire-Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
6. Preinstallation Roofing Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

2. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing manufacturer. Protect stored liquid material from direct sunlight.
   a. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
3. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
4. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

H. Project Conditions
1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

I. Warranty
1. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period.
   a. Special warranty includes membrane roofing, base flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories, roof pavers, and other components of membrane roofing system.
   b. Warranty Period: 10 **OR** 15, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. APP-Modified Asphalt-Sheet Materials
1. Roofing Membrane Sheet: ASTM D 6222, Grade S, Type I or II, APP-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6223, Grade S, Type I or II, APP-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; smooth surfaced; suitable for application method specified.
2. Smooth-Surfaced Roofing Membrane Cap Sheet: ASTM D 6222, Grade S, Type I or II, APP-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6223, Grade S, Type I or II, APP-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; smooth surfaced; suitable for application method specified.
   OR
   Granule-Surfaced Roofing Membrane Cap Sheet: ASTM D 6222, Grade G, Type I or II, APP-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6223, Grade G, Type I or II, APP-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; granular surfaced; suitable for application method specified.

B. SBS-Modified Asphalt-Sheet Materials
1. Roofing Membrane Sheet: ASTM D 6164, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6163, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with glass fibers) **OR** ASTM D 6162, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; smooth surfaced; suitable for application method specified.
2. Smooth-Surfaced Roofing Membrane Cap Sheet: ASTM D 6164, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6163, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with glass fibers) **OR** ASTM D 6162, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; smooth surfaced; suitable for application method specified.
   OR

Granule-Surface Roofing Membrane Cap Sheet: ASTM D 6164, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6163, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with glass fibers) **OR** ASTM D 6162, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; granular surfaced; suitable for application method specified.
OR
Metal-Foil-Surfaced Roofing Membrane Cap Sheet: ASTM D 6298, metal-foil surfaced SBS-modified asphalt sheet (reinforced with glass fibers); suitable for application method specified, and as follows:
a. Foil Surfacing: Aluminum **OR** Copper **OR** Stainless steel, **as directed**.

C. Base-Sheet Materials
1. Base Sheet: ASTM D 4601, Type II, SBS-modified asphalt-impregnated and -coated sheet, with glass-fiber-reinforcing mat, dusted with fine mineral surfacing on both sides.
a. Weight: 25 lb/100 sq. ft. (1.2 kg/sq. m) **OR** 40 lb/100 sq. ft. (1.95 kg/sq. m) **OR** 50 lb/100 sq. ft. (2.4 kg/sq. m) **OR** 60 lb/100 sq. ft. (2.9 kg/sq. m) **OR** 75 lb/100 sq. ft. (3.7 kg/sq. m), **as directed**, minimum.
OR
Base Sheet: ASTM D 4601, Type I **OR** Type II, **as directed**, nonperforated, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.
OR
Base Sheet: ASTM D 4897, Type II, venting, nonperforated, heavyweight, asphalt-impregnated and -coated, glass-fiber base sheet with coarse granular surfacing or embossed venting channels on bottom surface.
OR
Base Sheet: ASTM D 2626, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.

D. Base-Ply Sheet Materials
1. Glass-Fiber Base-Ply Sheet: ASTM D 2178, Type IV **OR** Type VI, **as directed**, asphalt-impregnated, glass-fiber felt.

E. Base Flashing Sheet Materials
1. Backer Sheet: ASTM D 4601, Type I **OR** Type II, **as directed**, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.
OR
Backer Sheet: ASTM D 2626, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.
OR
Backer Sheet: ASTM D 6222, Grade S, Type I or II, APP-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6223, Grade S, Type I or II, APP-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; smooth surfaced; suitable for application method specified.
OR
Backer Sheet: ASTM D 6164, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6163, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with glass fibers) **OR** ASTM D 6162, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; smooth surfaced; suitable for application method specified.
2. Smooth-Surfaced Flashing Sheet: ASTM D 6222, Grade S, Type I or II, APP-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6223, Grade S, Type I or II, APP-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; smooth surfaced; suitable for application method specified.
3. Granule-Surfaced Flashing Sheet (for use with APP-modified roofing membranes): ASTM D 6222, Grade G, Type I or II, APP-modified asphalt sheet (reinforced with polyester

fabric) **OR** ASTM D 6223, Grade G, Type I or II, APP-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; granular surfaced; suitable for application method specified, and as follows:
   a. Granule Color: White **OR** Gray **OR** Tan, **as directed**.
4. Granule-Surfaced Flashing Sheet (for use with SBS-modified roofing membranes): ASTM D 6164, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6163, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with glass fibers) **OR** ASTM D 6162, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; granular surfaced; suitable for application method specified, and as follows:
   a. Granule Color: White **OR** Gray **OR** Tan, **as directed**.
5. Metal-Foil-Surfaced Flashing Sheet: ASTM D 6298, metal-foil surfaced SBS-modified asphalt sheet (reinforced with glass fibers); suitable for application method specified, and as follows:
   a. Foil Surfacing: Aluminum **OR** Copper **OR** Stainless steel **OR** Aluminum, fluoropolymer coated finish, of color and gloss selected from manufacturer's full range, **as directed**.
6. Glass-Fiber Fabric: Woven glass-fiber cloth, treated with asphalt, complying with ASTM D 1668, Type I.

F. Auxiliary Roofing Membrane Materials
1. General: Auxiliary materials recommended by roofing manufacturer for intended use and compatible with roofing membrane.
   a. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
   b. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
      1) Plastic Foam Adhesives: 50 g/L.
      2) Multipurpose Construction Adhesives: 70 g/L.
      3) Fiberglass Adhesives: 80 g/L.
      4) Contact Adhesives: 80 g/L.
      5) Other Adhesives: 250 g/L.
      6) Nonmembrane Roof Sealants: 300 g/L.
      7) Sealant Primers for Nonporous Substrates: 250 g/L.
      8) Sealant Primers for Porous Substrates: 775 g/L.
2. Asphalt Primer: ASTM D 41.
3. Roofing Asphalt: ASTM D 312, Type III **OR** Type IV **OR** Type III or IV as recommended by roofing manufacturer for application, **as directed**.
   OR
   Roofing Asphalt: ASTM D 6152, SEBS modified.
4. Cold-Applied Adhesive: Roofing manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive specially formulated for compatibility and use with roofing membrane and base flashings.
5. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required by roofing manufacturer for application.
6. Mastic Sealant: Polyisobutylene, plain or modified bitumen, nonhardening, nonmigrating, nonskinning, and nondrying.
7. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing membrane components to substrate, tested by manufacturer for required pullout strength, and acceptable to roofing system manufacturer.
8. Insulation Cant Strips: ASTM C 728, perlite insulation board.
   OR
   Insulation Cant Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.
9. Metal Flashing Sheet: As specified in Division 7 Section "Sheet Metal Flashing and Trim."

10. Roofing Granules: Ceramic-coated **OR** Slate, **as directed**, roofing granules, No. 11 screen size with 100 percent passing No. 8 (2.36-mm) sieve and 98 percent of mass retained on No. 40 (0.425-mm) sieve, color to match roofing membrane.
11. Separator Sheet: Polyethylene sheet, 4 mils (0.1 mm) thick, minimum.
12. Miscellaneous Accessories: Provide those recommended by roofing system manufacturer.

G. Coating Materials
1. Roof Coating: ASTM D 1227, Type II, Class 1, mineral-colloid-emulsified, fibered **OR** Class 2, chemically emulsified, filled or fibered, **as directed**, asphalt emulsion, asbestos free.
OR
Roof Coating: ASTM D 1227, Type III, Class 1, mineral-colloid-emulsified **OR** Class 2, chemically emulsified, **as directed**, asphalt emulsion, nonfibered.
OR
Roof Coating: ASTM D 2824, Type I, nonfibered **OR** Type III, fibered, asbestos-free, **as directed**, aluminum-pigmented asphaltic coating.
OR
Roof Coating: Acrylic elastomer emulsion coating, formulated for use on bituminous roof surfaces and complying with ASTM D 6083.
    a. Color: White **OR** Gray **OR** Buff, **as directed**.

H. Roof Insulation
1. General: Preformed roof insulation boards manufactured or approved by roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation, **as directed**.
2. Extruded-Polystyrene Board Insulation: ASTM C 578, Type VI, 1.8 lb/cu. ft. (29 kg/cu. m) **OR** Type VII, 2.2 lb/cu. ft. (35 kg/cu. m), **as directed**, with two or four edges rabbeted.
3. Mortar-Faced, Extruded-Polystyrene Board Insulation: ASTM C 578, Type VI, 1.8-lb/cu. ft. (29-kg/cu. m) minimum density, with tongue-and-groove edges on long dimension, and latex-modified cement mortar topping, 3/8 inch (9 mm) thick, 4.5 lb/sq. ft. (19.5 kg/sq. m) **OR** 15/16 inch (23 mm) thick, 11 lb/sq. ft. (53.7 kg/sq. m), **as directed**.

I. Insulation Accessories
1. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.
2. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric, water permeable and resistant to UV degradation, type and weight as recommended by roofing system manufacturer for application.
3. Metal Securement System: Perimeter securement flashing and strapping fabricated from stainless steel, a minimum of 0.031 inch (0.8 mm) thick. Provide fasteners as recommended by mortar-faced insulation manufacturer.

J. Ballast
1. Aggregate Ballast: Washed, crushed stone or smooth stone that will withstand weather exposure without significant deterioration and will not contribute to membrane degradation; of the following size:
    a. Size: ASTM D 448, Size 5, ranging in size from 1/2 to 1 inch (13 to 25 mm).
    b. Size: ASTM D 448, Size 4, ranging in size from 3/4 to 1-1/2 inches (19 to 38 mm).
    c. Size: ASTM D 448, Size 2, ranging in size from 1-1/2 to 2-1/2 inches (38 to 63 mm).
2. Interlocking Roof Pavers: Interlocking, lightweight concrete units, specially factory cast for use as roof ballast; grooved back, with four-way drainage capability; beveled, doweled, or otherwise profiled. Size and weight shall be as directed.
    a. Compressive Strength: 2500 psi (17 MPa) **OR** 5000 psi (34 MPa), **as directed**, minimum.
    b. Colors and Textures: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

3. Roof Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C 67; and as follows:
   a. Size: 24 by 24 inches (600 by 600 mm). Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch (1.6 mm) in length, height, and thickness.
   b. Weight: Weight shall be as directed.
   c. Compressive Strength: 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, minimum; ASTM C 140.
   d. Colors and Textures: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   e. Paver Supports: Integral corner pedestals.
      OR
      Paver Supports: Paver manufacturer's standard SBR rubber, high-density polyethylene, or polyurethane paver support assembly, including fixed-height **OR** adjustable or stackable, **as directed**, pedestals, shims, and spacer tabs for joint spacing of 1/8 inch (3 mm) **OR** 3/16 inch (5 mm) **OR** 1/8 to 3/16 inch (3 to 5 mm), **as directed**.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
   a. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
   b. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations.
   c. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
   d. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
      1) Test for moisture by pouring 1 pint (0.5 L) of hot roofing asphalt on deck at start of each day's work and at start of each roof area or plane. Do not proceed with roofing work if test sample foams or can be easily and cleanly stripped after cooling.
   e. Verify that concrete curing compounds that will impair adhesion of roofing components to roof deck have been removed.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
2. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
3. Prime surface of concrete deck with asphalt primer at a rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.

C. Roofing Membrane Installation, General
1. If referencing NRCA's roof assembly identification matrix system, install roofing membrane system according to roofing system manufacturer's written instructions and applicable recommendations in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."
   a. Install roofing system MBA **OR** S, **as directed**,-4-C-T **OR** M **OR** L, **as directed**,-P, according to roof assembly identification matrix and roof assembly layout illustrations in NRCA's "The NRCA Roofing and Waterproofing Manual" and requirements in this Section.

2. For roof system that exceeds requirements of NRCA's roof assemblies, install roofing membrane system according to roofing system manufacturer's written instructions and applicable recommendations in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing" and as follows:
   a. Membrane: A (APP) **OR** S (SBS), **as directed**.
   b. Deck Type: C (concrete or nonnailable).
   c. Adhering Method: T (torched) **OR** M (mopped) **OR** L (cold-applied adhesive), **as directed**.
   d. Base Sheet: One.
   e. Number of Glass-Fiber Base-Ply Sheets: One.
   f. Number of Modified Asphalt Sheets: Two.
   g. Surfacing Type: P (protected).
3. Start installation of roofing membrane in presence of roofing system manufacturer's technical personnel.
4. Where roof slope exceeds 1/2 inch per 12 inches (1:24) **OR** 3/4 inch per 12 inches (1:18), **as directed**, install roofing membrane sheets parallel with slope.
   a. Backnail roofing membrane sheets to nailer strips according to roofing system manufacturer's written instructions.
5. Cooperate with testing agencies engaged or required to perform services for installing roofing system.
6. Coordinate installing roofing system so components of the roofing membrane system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.
   a. Provide tie-offs at end of each day's work to cover exposed roofing membrane sheets with a course of coated felt set in roofing cement or hot roofing asphalt with joints and edges sealed.
   b. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
   c. Remove and discard temporary seals before beginning work on adjoining roofing.
7. Asphalt Heating: Do not raise roofing asphalt temperature above equiviscous temperature range more than one hour before time of application. Do not exceed roofing asphalt manufacturer's recommended temperature limits during roofing asphalt heating. Do not heat roofing asphalt within 25 deg F (14 deg C) of flash point. Discard roofing asphalt maintained at a temperature exceeding finished blowing temperature for more than four hours.
   OR
   Asphalt Heating: Heat and apply SEBS-modified roofing asphalt according to roofing system manufacturer's written instructions.
8. Substrate-Joint Penetrations: Prevent roofing asphalt from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

D. Base-Sheet Installation
1. Install lapped base sheet course, extending sheet over and terminating beyond cants. Attach base sheet as follows:
   a. Spot- or strip-mop to substrate with hot roofing asphalt.
   OR
   Adhere to substrate in a solid mopping of hot roofing asphalt **OR** uniform coating of cold-applied adhesive, **as directed**.

E. Base-Ply Sheet Installation
1. Install glass-fiber base-ply sheets according to roofing system manufacturer's written instructions starting at low point of roofing system. Align glass-fiber base-ply sheets without stretching. Extend glass-fiber base-ply sheets over and terminate beyond cants. Embed each glass-fiber base-ply sheet in a continuous void-free mopping of hot roofing asphalt, to form a uniform membrane without glass-fiber base-ply sheets touching.

F. Modified Bituminous Membrane Installation

1. Install modified bituminous roofing membrane sheet and cap sheet according to roofing manufacturer's written instructions, starting at low point of roofing system. Extend roofing membrane sheets over and terminate beyond cants.
   a. Unroll roofing membrane sheets and allow them to relax for minimum time period required by manufacturer.
2. Laps: Accurately align roofing membrane sheets, without stretching, and maintain uniform side and end laps. Stagger end laps. Completely bond and seal laps, leaving no voids.
   a. Repair tears and voids in laps and lapped seams not completely sealed.
   b. Apply roofing granules to cover exuded bead at laps while bead is hot.
3. Install roofing membrane sheets so side and end laps shed water.

G. Flashing And Stripping Installation
1. Install base flashing over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through roof, and secure to substrates according to roofing system manufacturer's written instructions and as follows:
   a. Prime substrates with asphalt primer if required by roofing system manufacturer.
   b. Backer Sheet Application: Mechanically fasten backer sheet to walls or parapets. Adhere backer sheet over roofing membrane at cants in a solid mopping of hot roofing asphalt **OR** cold-applied adhesive, **as directed**.
      OR
      Backer Sheet Application: Adhere backer sheet to substrate in a solid mopping of hot roofing asphalt **OR** cold-applied adhesive at rate required by roofing system manufacturer, **as directed**.
   c. Flashing Sheet Application: Adhere flashing sheet to substrate in cold-applied adhesive at rate required by roofing system manufacturer.
      OR
      Flashing Sheet Application: Adhere flashing sheet to substrate in asphalt roofing cement at rate required by roofing system manufacturer.
      OR
      Flashing Sheet Application: Torch apply flashing sheet to substrate.
      OR
      Flashing Sheet Application: Adhere flashing sheet to substrate in a solid mopping of hot roofing asphalt applied at not less than 425 deg F (218 deg C). Apply hot roofing asphalt to back of flashing sheet if recommended by roofing system manufacturer.
2. Extend base flashing up walls or parapets a minimum of 8 inches (200 mm) above roofing membrane and 4 inches (100 mm) onto field of roofing membrane.
3. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.
   a. Seal top termination of base flashing with a strip of glass-fiber fabric set in asphalt roofing cement, **as directed**.
4. Install roofing membrane cap-sheet stripping where metal flanges and edgings are set on membrane roofing according to roofing system manufacturer's written instructions.
5. Roof Drains: Set 30-by-30-inch (760-by-760-mm) metal flashing in bed of roofing-manufacturer-approved asphaltic adhesive on completed roofing membrane. Cover metal flashing with roofing membrane cap-sheet stripping and extend a minimum of 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, beyond edge of metal flashing onto field of roofing membrane. Clamp roofing membrane, metal flashing, and stripping into roof-drain clamping ring.
   a. Install stripping according to roofing system manufacturer's written instructions.

H. Coating Installation
1. Apply coatings to base flashings according to manufacturer's written instructions, by spray, roller, or other suitable application method.

I. Insulation Installation
1. Loosely lay separator sheet over cooled roofing membrane, with minimum 2-inch (50-mm) side laps and 4-inch (150-mm) end laps.

2. Loosely lay board insulation units over roofing membrane, with long joints of insulation in continuous straight lines and with end joints staggered between rows. Abut edges and ends between units.
3. Install one or more layers of insulation to achieve required thickness over roofing membrane. Cut and fit to within 3/4 inch (19 mm) of projections and penetrations.
   a. Where overall insulation thickness is 2 inches (50 mm) or more, install required thickness in two or more layers with joints of each succeeding layer staggered over joints of previous layer a minimum of 6 inches (150 mm) in each direction.
4. Install geotextile fabric over insulation, overlapping edges and ends at least 12 inches (300 mm). Do not lap ends of fabric sheets within 72 inches (1800 mm) of roof perimeter. Extend fabric 2 to 3 inches (50 to 75 mm) above ballast at perimeter and penetrations. Apply additional layer of fabric around penetrations to prevent aggregate from getting between penetration and insulation. Do not cover drains or restrict water flow to drains.

J. Ballast Installation
1. To roofed area, apply aggregate ballast uniformly over geotextile fabric at rate required by insulation manufacturer, but not less than the following, carefully spreading aggregate to not damage roofing membrane and base flashings. Install roof-paver ballast according to insulation manufacturer's written instructions, **as directed**. Apply ballast as insulation is installed, leaving roofing membrane insulated and ballasted at end of workday.
   a. Ballast (Dow's "Standard Design"): 15 lb/sq. ft. (75 kg/sq. m) **OR** 20 lb/sq. ft. (100 kg/sq. m), **as directed**, Size 5 aggregate within 102 inches (2600 mm) of roof perimeter and corners and 24 inches (600 mm) of roof penetrations; 10 lb/sq. ft. (50 kg/sq. m), Size 5 aggregate elsewhere.
      1) If partially replacing aggregate ballast with roof pavers, install one row of roof pavers in lieu of aggregate ballast at roof perimeter, corners, and penetrations.
   b. Ballast (for Dow's "Design #1"): 15 lb/sq. ft. (75 kg/sq. m) **OR** 20 lb/sq. ft. (100 kg/sq. m), **as directed**, Size 4 aggregate within 102 inches (2600 mm) of roof perimeter and corners and 24 inches (600 mm) of roof penetrations; 12 lb/sq. ft. (60 kg/sq. m), Size 4 aggregate elsewhere.
   c. Ballast (for Dow's "Design #1") (if combining aggregate ballast with roof pavers): 12 lb/sq. ft. (60 kg/sq. m), Size 4 aggregate to field of roof; install two rows of roof pavers at roof perimeter, corners, and penetrations according to insulation manufacturer's written instructions.
   d. Ballast (for Dow's "Design #2") (for aggregate ballast with roof pavers at corners): 15 lb/sq. ft. (75 kg/sq. m) **OR** 20 lb/sq. ft. (100 kg/sq. m), **as directed**, Size 2 aggregate within 102 inches (2600 mm) of roof perimeter and 24 inches (600 mm) of roof penetrations; 13 lb/sq. ft. (65 kg/sq. m), Size 2 aggregate to field of roof; and install three rows of roof pavers at corners of roof according to insulation manufacturer's written instructions. Mechanically fasten securement strapping to center of first perimeter corner row of roof pavers.
   e. Ballast (for Dow's "Design #2") (if combining aggregate ballast with roof pavers at roof perimeters, corners, and penetrations): 13 lb/sq. ft. (65 kg/sq. m), Size 2 aggregate to field of roof and install three rows of concrete pavers at roof perimeter, corners, and penetrations according to insulation manufacturer's written instructions. Mechanically fasten securement strapping to center of first perimeter and perimeter corner row of roof pavers.
   f. Ballast (for Dow's "Design #3"): 15 lb/sq. ft. (75 kg/sq. m) **OR** 20 lb/sq. ft. (100 kg/sq. m), **as directed**, Size 2 aggregate within 24 inches (600 mm) of roof penetrations; 13 lb/sq. ft. (65 kg/sq. m), Size 2 aggregate to field of roof; and install four rows of roof pavers at roof perimeter and corners according to insulation manufacturer's written instructions. Mechanically fasten securement strapping to center of first two perimeter and perimeter corner rows of roof pavers.
2. Walkway Pavers: Install walkways formed from one row **OR** two rows, **as directed**, of roof pavers, loosely laid and butted.

K. Roof-Paver Installation
1. Interlocking Roof Pavers: Install interlocking roof pavers over roofed area according to manufacturer's written instructions.
2. For Dow's Technote 508 "Standard Design" and "Design #1", install roof pavers over roofed area according to insulation manufacturer's written instructions.
3. For Dow's Technote 508 "Standard Design" and "Design #2", install roof pavers over roofed area according to insulation manufacturer's written instructions. Mechanically fasten roof-paver metal straps to center of first perimeter and first perimeter corner row of roof pavers.
4. For Dow's Technote 508 "Standard Design" and "Design #3", install roof pavers over roofed area according to insulation manufacturer's written instructions. Mechanically fasten roof-paver metal straps to center of first two perimeters and first two perimeter corner rows of roof pavers.
5. Install roof pavers on pedestals set according to pedestal manufacturer's written instructions.

L. Mortar-Faced Board Insulation Installation
1. Install mortar-faced board insulation loosely laid, according to manufacturer's written instructions, with tongue-and-groove joints nested. Stagger end joints of adjoining rows and abut insulation.
   a. Mechanically fasten metal securement strapping at penetrations and at perimeter edges of mortar-faced board insulation.
   b. Over mortar-faced board insulation, install roof pavers on roof perimeter and corners according to manufacturer's written instructions.
2. Install one row **OR** two rows, **as directed**, of 24-inch- (600-mm-) wide roof pavers to roof perimeter, corners, and penetrations according to mortar-faced board insulation manufacturer's written instructions.

M. Field Quality Control
1. Testing Agency: Perform tests and inspections and to prepare reports.
2. Test Cuts: Test specimens will be removed to evaluate problems observed during quality-assurance inspections of roofing membrane as follows:
   a. Approximate quantities of components within roofing membrane will be determined according to ASTM D 3617.
   b. Test specimens will be examined for interply voids according to ASTM D 3617 and to comply with criteria established in Appendix 3 in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."
   c. Repair areas where test cuts were made according to roofing system manufacturer's written instructions.
3. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
   a. Notify the Owner and Owner 48 hours in advance of date and time of inspection.
4. Roofing system will be considered defective if it does not pass tests and inspections.
   a. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

N. Protecting And Cleaning
1. Protect roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to the Owner and Owner.
2. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Final Completion and according to warranty requirements.
3. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 21 13 13

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Task	Specification	Specification Description
07 21 13 13	07 51 13 00	Built-Up Asphalt Roofing
07 21 13 13	07 01 50 81	Built-Up Coal-Tar Roofing
07 21 13 13	07 53 16 00	EPDM Membrane Roofing
07 21 13 13	07 05 13 00	CSPE Membrane Roofing
07 21 13 13	07 05 13 00a	APP-Modified Bituminous Membrane Roofing
07 21 13 13	07 05 13 00b	SBS-Modified Bituminous Membrane Roofing
07 21 13 16	07 51 13 00	Built-Up Asphalt Roofing
07 21 13 16	07 01 50 81	Built-Up Coal-Tar Roofing
07 21 13 16	07 53 16 00	EPDM Membrane Roofing
07 21 13 16	07 05 13 00	CSPE Membrane Roofing
07 21 13 16	07 05 13 00a	APP-Modified Bituminous Membrane Roofing
07 21 13 16	07 05 13 00b	SBS-Modified Bituminous Membrane Roofing
07 21 13 19	07 51 13 00	Built-Up Asphalt Roofing
07 21 13 19	07 01 50 81	Built-Up Coal-Tar Roofing
07 21 13 19	07 53 16 00	EPDM Membrane Roofing
07 21 13 19	07 05 13 00	CSPE Membrane Roofing
07 21 13 19	07 05 13 00a	APP-Modified Bituminous Membrane Roofing
07 21 13 19	07 05 13 00b	SBS-Modified Bituminous Membrane Roofing

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SECTION 07 21 16 00 - BUILDING INSULATION

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for building insulation. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Perimeter insulation under slabs-on-grade.
      b. Perimeter wall insulation (supporting backfill).
      c. Cavity-wall insulation.
      d. Concealed building insulation.
      e. Exposed building insulation.
      f. Loose-fill building insulation.
      g. Self-supported, spray-applied cellulosic insulation.
      h. Radiant barriers.
      i. Vapor retarders.
      j. Sound attenuation insulation.

C. Definitions
   1. Mineral-Fiber Insulation: Insulation composed of rock-wool fibers, slag-wool fibers, or glass fibers; produced in boards and blanket with latter formed into batts (flat-cut lengths) or rolls.

D. Performance Requirements
   1. Plenum Rating: Provide glass-fiber **OR** slag-wool-fiber/rock-wool-fiber, **as directed**, insulation where indicated in ceiling plenums whose test performance is rated as follows for use in plenums as determined by testing identical products per "Erosion Test" and "Mold Growth and Humidity Test" described in UL 181, or on comparable tests from another standard acceptable to authorities having jurisdiction.
      a. Erosion Test Results: Insulation shows no visible evidence of cracking, flaking, peeling, or delamination of interior surface of duct assembly, after testing for 4 hours at 2500-fpm (13-m/s) air velocity.
      b. Mold Growth and Humidity Test Results: Insulation shows no evidence of mold growth, delamination, or other deterioration due to the effects of high humidity, after inoculation with Chaetomium globosium on all surfaces and storing for 60 days at 100 percent relative humidity in the dark.

E. Submittals
   1. Product Data: For each type of product indicated.
   2. Samples: Full-size units for each type of exposed insulation indicated.
   3. LEED Submittal:
      a. Product Data for Credit MR 4.1 and MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
         1) Include statement indicating costs for each product having recycled content.
   4. Product test reports.
   5. Research/Evaluation Reports: For foam-plastic insulation.

F. Quality Assurance

1. Fire-Test-Response Characteristics: Provide insulation and related materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
   a. Surface-Burning Characteristics: ASTM E 84.
   b. Fire-Resistance Ratings: ASTM E 119.
   c. Combustion Characteristics: ASTM E 136.

G. Delivery, Storage, And Handling
1. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
2. Protect plastic insulation as follows:
   a. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
   b. Protect against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
   c. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.2 PRODUCTS

A. Foam-Plastic Board Insulation
1. Extruded-Polystyrene Board Insulation: ASTM C 578, of type and density indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively:
   a. Type IV, 1.60 lb/cu. ft. (26 kg/cu. m), unless otherwise indicated.
   b. Type X, 1.30 lb/cu. ft. (21 kg/cu. m).
   c. Type VI, 1.80 lb/cu. ft. (29 kg/cu. m).
   d. Type VII, 2.20 lb/cu. ft. (35 kg/cu. m).
   e. Type V, 3.00 lb/cu. ft. (48 kg/cu. m).
2. Extruded-Polystyrene Drainage Panels: ASTM C 578, of type and density indicated below and fabricated with one side having a matrix of drainage and edge channels.
   a. Type IV, 1.60 lb/cu. ft. (26 kg/cu. m).
   b. Type VI, 1.80 lb/cu. ft. (29 kg/cu. m).
   c. Type VII, 2.20 lb/cu. ft. (35 kg/cu. m).
3. Fabric-Faced, Extruded-Polystyrene Drainage Panels: ASTM C 578, Type VI, with a density of 1.80 lb/cu. ft. (29 kg/cu. m), faced with insulation manufacturer's standard nonwoven filtration fabric and fabricated with 1 side having a matrix of drainage and edge channels.
4. Molded-Polystyrene Board Insulation: ASTM C 578, of type and density indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively:
   a. Type I, 0.90 lb/cu. ft. (15 kg/cu. m).
   b. Type VIII, 1.15 lb/cu. ft. (18 kg/cu. m).
   c. Type II, 1.35 lb/cu. ft. (22 kg/cu. m).
5. Foil-Faced, Polyisocyanurate Board Insulation: ASTM C 1289, Type I, Class 1 **OR** 2, **as directed**, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, based on tests performed on unfaced core on thicknesses up to 4 inches (101 mm).

B. Cellular-Glass Insulation
1. Cellular-Glass Insulation: ASTM C 552 Type I (flat block) **OR** IV (board) faced on both sides with manufacturer's special kraft-paper sheets laminated to glass block with asphalt, **as directed**, with unfaced insulation passing ASTM E 136 for combustion characteristics.

C. Glass-Fiber Board Insulation

1. Unfaced, Flexible Glass-Fiber Board Insulation: ASTM C 612, Type IA; ASTM C 553, Types I, II, and III; or ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, passing ASTM E 136 for combustion characteristics; and of the following nominal density and thermal resistivity:
   a. Nominal density of 1.0 lb/cu. ft. (16 kg/cu. m), thermal resistivity of 3.7 deg F x h x sq. ft./Btu x in. at 75 deg F (25.7 K x m/W at 24 deg C).
   b. Nominal density of not less than 1.5 lb/cu. ft. (24 kg/cu. m) nor more than 1.7 lb/cu. ft. (27 kg/cu. m), thermal resistivity of 4 deg F x h x sq. ft./Btu x in. at 75 deg F (27.7 K x m/W at 24 deg C).
2. Foil-Faced, Flexible Glass-Fiber Board Insulation: ASTM C 612, Type IA or ASTM C 553, Types I, II, and III; faced on 1 side with foil-scrim-kraft vapor retarder; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; and of the following nominal density and thermal resistivity:
   a. Nominal density of 1.0 lb/cu. ft. (16 kg/cu. m), thermal resistivity of 3.7 deg F x h x sq. ft./Btu x in. at 75 deg F (25.7 K x m/W at 24 deg C).
   b. Nominal density of not less than 1.5 lb/cu. ft. (24 kg/cu. m) nor more than 1.7 lb/cu. ft. (27 kg/cu. m), thermal resistivity of 4 deg F x h x sq. ft./Btu x in. at 75 deg F (27.7 K x m/W at 24 deg C).
3. Unfaced, Glass-Fiber Board Insulation: ASTM C 612, Type IA or Types IA and IB; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics; and of the following nominal density and thermal resistivity:
   a. Nominal density of 2.25 lb/cu. ft. (36 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C).
   b. Nominal density of 3 lb/cu. ft. (48 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C).
   c. Nominal density of 4.25 lb/cu. ft. (68 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C).
   d. Nominal density of 6 lb/cu. ft. (96 kg/cu. m), thermal resistivity of 4.4 deg F x h x sq. ft./Btu x in. at 75 deg F (30.5 K x m/W at 24 deg C).
4. Foil-Faced, Glass-Fiber Board Insulation: ASTM C 612, Type IA or Types IA and IB; faced on 1 side with foil-scrim-kraft or foil-scrim-polyethylene vapor retarder, with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; and of the following nominal density and thermal resistivity:
   a. Nominal density of 2.25 lb/cu. ft. (36 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C).
   b. Nominal density of 3 lb/cu. ft. (48 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C).
   c. Nominal density of 4.25 lb/cu. ft. (68 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C).
   d. Nominal density of 6 lb/cu. ft. (96 kg/cu. m), thermal resistivity of not less than 4.34 deg F x h x sq. ft./Btu x in. at 75 deg F (30.1 K x m/W at 24 deg C).
5. Glass-Mat-Faced, Glass-Fiber Board Insulation: ASTM C 612, Type IA or Types IA and IB; faced on 1 side with black glass-fiber mat or black polymer finish; maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; and of the following nominal density and thermal resistivity:
   a. Nominal density of 1.5 lb/cu. ft. (24 kg/cu. m), thermal resistivity of 4.2 deg F x h x sq. ft./Btu x in. at 75 deg F (29.1 K x m/W at 24 deg C).
   b. Nominal density of 2.25 lb/cu. ft. (36 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C).
   c. Nominal density of 3 lb/cu. ft. (48 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C).
   d. Nominal density of 6 lb/cu. ft. (96 kg/cu. m), thermal resistivity of 4.5 deg F x h x sq. ft./Btu x in. at 75 deg F (31.2 K x m/W at 24 deg C).

D. Slag-Wool-Fiber/Rock-Wool-Fiber Board Insulation

1. Unfaced, Slag-Wool-Fiber/Rock-Wool-Fiber Board Insulation: ASTM C 612, maximum flame-spread and smoke-developed indexes of 15 and 0, respectively; passing ASTM E 136 for combustion characteristics; and of the following nominal density and thermal resistivity:
   a. Nominal density of 4 lb/cu. ft. (64 kg/cu. m), Types IA and IB, thermal resistivity of 4 deg F x h x sq. ft./Btu x in. at 75 deg F (27.7 K x m/W at 24 deg C).
   b. Nominal density of 6 lb/cu. ft. (96 kg/cu. m), Type II, thermal resistivity of 4.16 deg F x h x sq. ft./Btu x in. at 75 deg F (28.8 K x m/W at 24 deg C).
   c. Nominal density of 8 lb/cu. ft. (128 kg/cu. m), Type III, thermal resistivity of 4.35 deg F x h x sq. ft./Btu x in. at 75 deg F (30.2 K x m/W at 24 deg C).
   d. Fiber Color: Regular color, unless otherwise indicated.
   e. Fiber Color: Darkened, where indicated.
2. Foil-Faced, Slag-Wool-Fiber/Rock-Wool-Fiber Board Insulation: ASTM C 612; faced on 1 side with foil-scrim or foil-scrim-polyethylene vapor retarder; with maximum flame-spread and smoke-developed indexes of 25 and 5, respectively; and of the following nominal density and thermal resistivity:
   a. Nominal density of 4 lb/cu. ft. (64 kg/cu. m), Types IA and IB, thermal resistivity of 4 deg F x h x sq. ft./Btu x in. at 75 deg F (27.7 K x m/W at 24 deg C).
   b. Nominal density of 6 lb/cu. ft. (96 kg/cu. m), Type II, thermal resistivity of 4.16 deg F x h x sq. ft./Btu x in. at 75 deg F (28.8 K x m/W at 24 deg C).
   c. Nominal density of 8 lb/cu. ft. (128 kg/cu. m), Type III, thermal resistivity of 4.35 deg F x h x sq. ft./Btu x in. at 75 deg F (30.2 K x m/W at 24 deg C).

E. Glass-Fiber Blanket Insulation
1. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
2. Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type III (blankets with reflective membrane facing), Class A (membrane-faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier), faced with foil-scrim-kraft, foil-scrim, or foil-scrim-polyethylene **OR** polypropylene-scrim-kraft, **as directed**, vapor-retarder membrane on 1 face.
3. Where glass-fiber blanket insulation is indicated by the following thicknesses, provide blankets in batt or roll form with thermal resistances indicated:
   a. 3-1/2 inches (89 mm) thick with a thermal resistance of 11 deg F x h x sq. ft./Btu at 75 deg F (1.9 K x sq. m/W at 24 deg C) **OR** 13 deg F x h x sq. ft./Btu at 75 deg F (2.3 K x sq. m/W at 24 deg C), **as directed**.
   b. 3-5/8 inches (92 mm) thick with a thermal resistance of 11 deg F x h x sq. ft./Btu at 75 deg F (1.9 K x sq. m/W at 24 deg C).
   c. 5-1/2 inches (140 mm) thick with a thermal resistance of 19 deg F x h x sq. ft./Btu at 75 deg F (3.3 K x sq. m/W at 24 deg C).
   d. 6-1/2 inches (165 mm) thick with a thermal resistance of 21 deg F x h x sq. ft./Btu at 75 deg F (3.7 K x sq. m/W at 24 deg C).
   e. 9-1/2 inches (241 mm) **OR** 10 inches (254 mm) **OR** 10-1/4 inches (260 mm), **as directed,** thick with a thermal resistance of 30 deg F x h x sq. ft./Btu at 75 deg F (5.2 K x sq. m/W at 24 deg C).

F. Slag-Wool-Fiber/Rock-Wool-Fiber Blanket Insulation
1. Unfaced, Slag-Wool-Fiber/Rock-Wool-Fiber Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
2. Faced, Slag-Wool-Fiber/Rock-Wool-Fiber Blanket Insulation: ASTM C 665, Type III (blankets with reflective membrane facing), Class A (membrane-faced surface with a flame spread of 25 or less); Category 1 (membrane is a vapor barrier), faced with foil-scrim-kraft, foil-scrim, or foil-scrim-polyethylene vapor-retarder membrane on 1 face.

3. Where slag-wool-fiber/rock-wool-fiber blanket insulation is indicated by the following thicknesses, provide blankets in batt form with thermal resistances indicated:
   a. 1-1/2 inches (38 mm) thick with a thermal resistance of 6 deg F x h x sq. ft./Btu at 75 deg F (1 K x sq. m/W at 24 deg C).
   b. 3-1/2 inches (89 mm) thick with a thermal resistance of 13 deg F x h x sq. ft./Btu at 75 deg F (2.3 K x sq. m/W at 24 deg C).
   c. 4 inches (101 mm) thick with a thermal resistance of 16 deg F x h x sq. ft./Btu at 75 deg F (2.8 K x sq. m/W at 24 deg C).
   d. 5-1/4 inches (133 mm) thick with a thermal resistance of 19 deg F x h x sq. ft./Btu at 75 deg F (3.3 K x sq. m/W at 24 deg C).
   e. 6 inches (152 mm) thick with a thermal resistance of 22 deg F x h x sq. ft./Btu at 75 deg F (3.9 K x sq. m/W at 24 deg C).

G. Loose-Fill Insulation
1. Cellulosic-Fiber Loose-Fill Insulation: ASTM C 739, chemically treated for flame-resistance, processing, and handling characteristics.
2. Glass-Fiber Loose-Fill Insulation: ASTM C 764, Type I for pneumatic application or Type II for poured application; with maximum flame-spread and smoke-developed indexes of 5.

H. Spray-Applied Cellulosic Insulation
1. Self-Supported, Spray-Applied Cellulosic Insulation: ASTM C 1149, Type I (materials applied with liquid adhesive; suitable for either exposed or enclosed applications), **OR** Type II (materials containing a dry adhesive activated by water during installation; intended only for enclosed or covered applications), **OR** Type III (materials containing an adhesive mixed with water during application; intended for application on attic floors), **as directed**, chemically treated for flame-resistance, processing, and handling characteristics.

I. Radiant Barriers
1. Interior Radiation Control Coating: ASTM C 1321. Silver-colored, not thickness-dependent, low-emissivity solvent-based **OR** water-based, **as directed**, coating, formulated for adherence to substrates indicated and with a surface emittance value of 0.25 or less as measured per ASTM C 1371.
2. Sheet Radiant Barriers: ASTM C 1313 and as follows:
   a. Sheet Construction: Foil on one side of substrate **OR** Foil on both sides of substrate **OR** Vacuum metallizing on substrate, **as directed**.
   b. Surface-Burning Characteristics: Maximum flame-spread and smoke-developed indexes of 5 and 10, respectively.
   c. Water-Vapor Transmission: 1 perm, maximum **OR** 5 perms or greater, **as directed**.

J. Vapor Retarders
1. Polyethylene Vapor Retarders: ASTM D 4397, 6 mils (0.15 mm) thick, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
2. Reinforced-Polyethylene Vapor Retarders: 2 outer layers of polyethylene film laminated to an inner reinforcing layer consisting of either nylon cord or polyester scrim and weighing not less than 25 lb/1000 sq. ft. (12 kg/100 sq. m), with maximum permeance rating of 0.0507 perm (2.9 ng/Pa x s x sq. m).
3. Fire-Retardant, Reinforced-Polyethylene Vapor Retarders: 2 outer layers of polyethylene film laminated to an inner reinforcing layer consisting of either nonwoven grid of nylon cord or polyester scrim and weighing not less than 22 lb/1000 sq. ft. (10 kg/100 sq. m), with maximum permeance rating of 0.1317 perm (7.56 ng/Pa x s x sq. m) and with flame-spread and smoke-developed indexes of not more than 5 and 60, respectively.
4. Foil-Polyester-Film Vapor Retarders: 2 layers of 0.5-mil- (0.013-mm-) thick polyester film laminated to an inner layer of 1-mil- (0.025-mm-) thick aluminum foil, with maximum water-vapor transmission rate in flat condition of 0.0 g/h x sq. m and with maximum flame-spread and smoke-developed indexes of 5.

5. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
6. Vapor-Retarder Fasteners: Pancake-head, self-tapping steel drill screws; with fender washers.
7. Single-Component Nonsag Urethane Sealant: ASTM C 920, Type I, Grade NS, Class 25, Use NT related to exposure, and Use O related to vapor-barrier-related substrates.
8. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and with demonstrated capability to bond vapor retarders securely to substrates indicated.

K. Auxiliary Insulating Materials
1. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by insulation manufacturers for sealing joints and penetrations in vapor-retarder facings.
2. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates indicated without damaging insulation and substrates.
3. Asphalt Coating for Cellular-Glass Block Insulation: Cutback asphalt or asphalt emulsion of type recommended by manufacturer of cellular-glass block insulation.
4. Eave Ventilation Troughs: Preformed, rigid fiberboard or plastic sheets designed and sized to fit between roof framing members and to provide cross ventilation between insulated attic spaces and vented eaves.

L. Insulation Fasteners
1. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of thickness indicated securely in position indicated with self-locking washer in place; and complying with the following requirements:
   a. Plate: Perforated galvanized carbon-steel sheet, 0.030 inch (0.762 mm) thick by 2 inches (50 mm) square.
   b. Spindle: Copper-coated, low carbon steel; fully annealed; 0.105 inch (2.67 mm) in diameter; length to suit depth of insulation indicated.
2. Adhesively Attached, Angle-Shaped, Spindle-Type Anchors: Angle welded to projecting spindle; capable of holding insulation of thickness indicated securely in position indicated with self-locking washer in place; and complying with the following requirements:
   a. Angle: Formed from 0.030-inch- (0.762-mm-) thick, perforated, galvanized carbon-steel sheet with each leg 2 inches (50 mm) square.
   b. Spindle: Copper-coated, low carbon steel; fully annealed; 0.105 inch (2.67 mm) in diameter; length to suit depth of insulation indicated.
3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick galvanized steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches (38 mm) square or in diameter.
   a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:
      1) Crawlspaces.
      2) Ceiling plenums.
      3) Attic spaces.
      4) Where indicated.
4. Insulation Standoff: Spacer fabricated from galvanized mild-steel sheet for fitting over spindle of insulation anchor to maintain air space of 1 inch (25 mm) **OR** 2 inches (50 mm) **OR** 3 inches (76 mm), **as directed**, between face of insulation and substrate to which anchor is attached.
5. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.

1.3 EXECUTION

A. Preparation
1. Clean substrates of substances harmful to insulation or vapor retarders, including removing projections capable of puncturing vapor retarders or of interfering with insulation attachment.

B. Installation, General
1. Comply with insulation manufacturer's written instructions applicable to products and application indicated.
2. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice, rain, and snow.
3. Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
4. Water-Piping Coordination: If water piping is located within insulated exterior walls, coordinate location of piping to ensure that it is placed on warm side of insulation and insulation encapsulates piping.
5. For preformed insulating units, provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

C. Installation Of Perimeter And Under-Slab Insulation
1. On vertical surfaces, set insulation units in adhesive applied according to manufacturer's written instructions. Use adhesive recommended by insulation manufacturer.
   a. If not otherwise indicated, extend insulation a minimum of 24 inches (610 mm) below exterior grade line.
2. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.
3. Protect below-grade insulation on vertical surfaces from damage during backfilling by applying protection course with joints butted. Set in adhesive according to insulation manufacturer's written instructions.
4. Protect top surface of horizontal insulation from damage during concrete work by applying protection course with joints butted.

D. Installation Of Cavity-Wall Insulation
1. On units of foam-plastic board insulation, install pads of adhesive spaced approximately 24 inches (610 mm) o.c. both ways on inside face, and as recommended by manufacturer. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions. Press units firmly against inside substrates indicated.
   a. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Division 04 Section "Unit Masonry".
2. Install units of cellular-glass insulation with closely fitting joints using method indicated:
   a. Gob Method: Apply 4 gobs of adhesive per unit and set units firmly against inside wythe of masonry or other construction as shown. Apply gobs at each corner; spread gobs to form pads 4 inches (101 mm) in diameter by 1/4 inch (6 mm) thick.
   b. Serrated-Trowel Method: Apply adhesive to entire surface of each cellular-glass insulation unit with serrated trowel complying with insulation manufacturer's written instructions.
   c. Coat edges of insulation units with full bed of adhesive to seal joints between insulation and between insulation and adjoining construction.
   d. Coat exterior face (cold face) of installed cellular-glass block insulation course with asphalt coating.

E. Installation Of General Building Insulation
1. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
2. Seal joints between foam-plastic insulation units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.
3. Set vapor-retarder-faced units with vapor retarder to warm-in-winter side **OR** in location indicated, **as directed**, of construction, unless otherwise indicated.

a. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to surrounding construction to ensure airtight installation.

4. Install mineral-fiber insulation in cavities formed by framing members according to the following requirements:
   a. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill cavity, provide lengths that will produce a snug fit between ends.
   b. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
   c. Maintain 3-inch (76-mm) clearance of insulation around recessed lighting fixtures.
   d. Install eave ventilation troughs between roof framing members in insulated attic spaces at vented eaves.
   e. For metal-framed wall cavities where cavity heights exceed 96 inches (2438 mm), support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
   f. For wood-framed construction, install mineral-fiber blankets according to ASTM C 1320 and as follows:
      1) With faced blankets having stapling flanges, secure insulation by inset, stapling flanges to sides of framing members.
         OR
         With faced blankets having stapling flanges, lap blanket flange over flange of adjacent blanket to maintain continuity of vapor retarder once finish material is installed over it.
5. Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:
   a. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application indicated.
   b. Apply insulation standoffs to each spindle to create cavity width indicated between concrete substrate and insulation.
   c. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation below indicated thickness.
   d. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.
6. Install board insulation in curtain-wall construction where indicated on Drawings according to curtain-wall manufacturer's written instructions.
   a. Retain insulation in place by metal clips and straps or integral pockets within window frames, spaced at intervals recommended in writing by insulation manufacturer to hold insulation securely in place without touching spandrel glass. Maintain cavity width of dimension indicated between insulation and glass.
   b. Install insulation where it contacts perimeter fire-containment system to prevent insulation from bowing under pressure from perimeter fire-containment system.
7. Place loose-fill insulation into spaces indicated, by pouring **OR** by machine blowing, **as directed**, to comply with ASTM C 1015. Level horizontal applications to uniform thickness as indicated, lightly settle to uniform density, but do not compact excessively.
   a. For cellulosic-fiber loose-fill insulation, comply with the Cellulose Insulation Manufacturers Association's Special Report #3, "Standard Practice for Installing Cellulose Insulation."
8. Apply self-supported, spray-applied cellulosic insulation according to manufacturer's written instructions. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked. After insulation is applied, make it flush with face of studs by using method recommended by insulation manufacturer.

9. Stuff glass-fiber loose-fill insulation into miscellaneous voids and cavity spaces where shown. Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft. (40 kg/cu. m).

F. Installation Of Insulation In Ceilings For Sound Attenuation
   1. Install 3-inch- (76-mm-) thick, unfaced glass-fiber **OR** slag-wool-fiber/rock-wool-fiber, **as directed**, blanket insulation over suspended ceilings at partitions in a width that extends insulation 48 inches (1219 mm) on either side of partition.
      OR
      Install 1-1/2-inch- (38-mm-) thick, unfaced glass-fiber **OR** slag-wool-fiber/rock-wool-fiber, **as directed**, blanket insulation over suspended ceilings so that insulation extends over entire ceiling.

G. Installation Of Radiant Barriers
   1. Install interior radiation control coating system according to ASTM C 1321.
   2. Install sheet radiant barriers in locations indicated according to ASTM C 1158.

H. Installation Of Vapor Retarders
   1. General: Extend vapor retarder to extremities of areas to be protected from vapor transmission. Secure in place with adhesives or other anchorage system as indicated. Extend vapor retarder to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.
   2. Seal vertical joints in vapor retarders over framing by lapping not less than two wall studs. Fasten vapor retarders to wood framing at top, end, and bottom edges; at perimeter of wall openings; and at lap joints. Space fasteners 16 inches (400 mm) o.c.
   3. Before installing vapor retarder, apply urethane sealant to flanges of metal framing including runner tracks, metal studs, and framing around door and window openings. Seal overlapping joints in vapor retarders with vapor-retarder tape according to vapor-retarder manufacturer's written instructions. Seal butt joints with vapor-retarder tape. Locate all joints over framing members or other solid substrates.
   4. Firmly attach vapor retarders to metal framing and solid substrates with vapor-retarder fasteners as recommended by vapor-retarder manufacturer.
   5. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarder.
   6. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarder.

I. Protection
   1. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 07 21 16 00

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Task	Specification	Specification Description
07 21 23 00	07 21 16 00	Building Insulation
07 21 26 00	07 21 16 00	Building Insulation
07 21 29 00	07 21 16 00	Building Insulation

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SECTION 07 22 16 00 - ROOF AND DECK INSULATION

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for roof and deck insulation. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Definition
   1. Hot Roofing Asphalt: Roofing asphalt heated to its equiviscous temperature, the temperature at which its viscosity is 125 centipoise for mopping application and 75 centipoise for mechanical application, within a range of plus or minus 25 deg F (14 deg C), measured at the mop cart or mechanical spreader immediately before application.

C. Submittals
   1. Product Data: For each product indicated.
   2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other Work.
   3. Samples: For each product included in roofing system.
   4. Research/evaluation reports.
   5. Maintenance data.

D. Quality Assurance
   1. For all new construction projects and renovation projects that modify the exterior envelope of a building, submit documents and energy analysis that verifies compliance of the project with the State Energy Code. All insulation products shall be Factory Mutual Research Approved.
   2. Installer Qualifications: A qualified installer, approved by manufacturer to install manufacturer's products.
   3. Source Limitations: Obtain components for roofing system from or approved by roofing system manufacturer.
   4. Fire-Test-Response Characteristics: Provide roofing materials with the fire-test-response characteristics indicated as determined by testing identical products per test method below by UL, FMG, or another testing and inspecting agency acceptable to authorities having jurisdiction.
      a. Exterior Fire-Test Exposure: Class A, **unless directed otherwise to be** Class B, **OR** Class C; ASTM E 108, for application and roof slopes indicated.
   5. Preinstallation Conference: Conduct conference at Project site.

E. Performance - In addition to compliance with the State Energy Code, construction assemblies must have the following minimum R-values:
   Built Up Roof: 20

F. Warranty: Manufacturer's standard form, without monetary limitation, in which manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within 20 years, **unless directed otherwise to be** 15 years, **OR** 10 years, from date of Final Completion. Failure includes roof leaks.

1.2 PRODUCTS

A. All insulation products shall be specified to meet the maximum flame spread, maximum smoke spread and combustion criteria of the NiFPA Codes and ASTM standards. Expanded polystyrene board insulation may not be used.

B. Bitumen Materials
1. Asphalt Primer: ASTM D 41.
2. Coal-Tar Primer: ASTM D 43.
3. Coal-Tar Pitch: ASTM D 450, Type I.
4. Roofing Asphalt: ASTM D 312, Type III or IV as recommended by built-up roofing system manufacturer for application.

C. Roof Insulation (select from the following)
1. Extruded-Polystyrene Board Insulation: ASTM C 578
   a. Type IV, 1.6-lb/cu. ft. (26-kg/cu. m) minimum density, square edged.
   b. Type X, 1.3-lb/cu. ft. (21-kg/cu. m) minimum density, square edged.
2. Extruded-Polystyrene Board Insulation: ASTM C 578, for installation above the membrane of a protected membrane roofing system
   a. Type VI, 1.8 lb/cu. ft. (29 kg/cu. m) with 2 or 4 edges rabbeted.
   b. Type VII, 2.2 lb/cu. ft. (35 kg/cu. m) with 2 or 4 edges rabbeted.
3. Mortar-Faced, Extruded-Polystyrene Board Insulation: ASTM C 578, Type VI, 1.8-lb/cu. ft. (29-kg/cu. m) minimum density, with tongue-and-groove edges on long dimension, and latex-modified cement mortar topping.
   a. 3/8 inch (9 mm) thick, 4 lb/sq. ft. (19.5 kg/sq. m)
   b. 15/16 inch (23 mm) thick, 11 lb/sq. ft. (53.7 kg/sq. m).
4. Molded-Polystyrene Board Insulation: ASTM C 578
   a. Type II, 1.35-lb/cu. ft. (22-kg/cu. m) minimum density.
   b. Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) minimum density.
   c. Type IX, 1.8-lb/cu. ft. (29-kg/cu. m) minimum density.
5. Composite Molded-Polystyrene Board Insulation: ASTM C 578 minimum density, with factory-applied facings, of ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick.
   a. Type II, 1.35-lb/cu. ft. (22-kg/cu. m).
   b. Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m).
   c. Type IX, 1.8-lb/cu. ft. (29-kg/cu. m).
6. Polyisocyanurate Board Insulation: ASTM C 1289, Type II.
   a. Type I, Class 1 aluminum foil facer on both major surfaces.
   b. Type II, felt or glass-fiber mat facer on both major surfaces.
7. Composite Polyisocyanurate Board Insulation: ASTM C 1289, faced with insulation board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other.
   a. Type III (perlite-insulation-board facer)
      1) 1/2 inch (13 mm) thick.
      2) 3/4 inch (19 mm) thick.
   b. Type IV (cellulosic-fiber-insulation-board facer), Grade 1, 1/2 inch (13 mm) thick.
8. Perlite Board Insulation: ASTM C 728; composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal-coated.
9. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 1, fibrous-felted wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.
10. Glass-Fiber-Board Insulation: ASTM C 726, combining glass fibers with thermosetting resin binders, faced on one side with asphalt-coated fiberglass scrim and kraft paper.
11. Cellular-Glass Board Insulation: ASTM C 552, Type IV, faced on both sides with manufacturer's standard kraft-paper sheets.
12. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48), unless otherwise indicated.
13. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

D. Insulation Accessories

1. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.
2. Cold Fluid-Applied Adhesive: Manufacturer's standard cold fluid-applied adhesive formulated to adhere roof insulation to substrate.
3. Insulation Cant Strips:
   a. ASTM C 728, perlite insulation board.
   b. ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.
4. Wood Nailer Strips: Comply with requirements in Division 6 Section "Rough Carpentry" **OR** "Miscellaneous Carpentry."
5. Tapered Edge Strips:
   a. ASTM C 728, perlite insulation board.
   b. ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.
   c. ASTM C 726, glass-fiber insulation board.
6. Cover Board:
   a. ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board, 1/2 inch (13 mm) thick.
   b. ASTM C 728, perlite insulation board, 3/4 inch (19 mm) thick, with top surface seal-coated.
   c. ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate.
      1) 1/4 inch (6 mm) thick.
      2) 1/2 inch (13 mm) thick.
   d. ASTM C 726, glass-fiber rigid insulation, faced on one side with asphalt-coated fiberglass scrim and kraft paper, 3/4 inch (19 mm) thick.
7. Substrate Joint Tape: 6- or 8-inch- (150- or 200-mm-) wide, coated, glass-fiber joint tape.
8. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric mat, water permeable and resistant to ultraviolet degradation, type and weight as recommended by roofing system manufacturer for application.
9. Metal Securement System: Perimeter securement flashing and strapping fabricated from stainless steel, a minimum of 0.031 inch (0.8 mm) thick. Provide fasteners as recommended by mortar-faced insulation manufacturer.

E. Protected Membrane Roofing Aggregate Ballast
1. Aggregate Ballast: Provide aggregate ballast that will withstand weather exposure without significant deterioration and not contribute to membrane degradation, of the following type and size:
   a. Aggregate Type: Smooth, washed, riverbed gravel or other acceptable smooth-faced stone or crushed gravel or crushed stone.
   b. Size:
      1) ASTM D 448, Size 4, ranging from 3/4 to 1-1/2 inches (19 to 38 mm).
      2) ASTM D 448, Size 2, ranging from 1-1/2 to 2-1/2 inches (38 to 63 mm).
      3) ASTM D 448, Size 3, ranging from 1 to 2 inches (25 to 50 mm).

F. Protected Membrane Roofing Paver Ballast
1. Lightweight Roof Pavers: Interlocking, lightweight concrete units, specially factory cast for use as roof ballast; grooved back, with four-way drainage capability; beveled, doweled, or otherwise profiled; and as follows:
   a. Size:
      1) 8 by 16 inches (200 by 400 mm).
      2) 12 by 12 inches (300 by 300 mm).
      3) 12 by 16-1/2 inches (300 by 420 mm).
      4) 12 by 18 inches (300 by 450 mm).
   b. Weight: 11 lb/sq. ft. (53.7 kg/sq. m), minimum.
   c. Compressive Strength:
      1) 2500 psi (17 MPa), minimum.
      2) 5000 psi (34 MPa), minimum.
   d. Colors and Textures: As selected from manufacturer's full range.

2. Heavyweight Roof Pavers: Heavyweight, hydraulically pressed, concrete units, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C 67; and as follows:
   a. Shape:
      1) Square edged.
      2) Top edges beveled 3/16 inch (5 mm).
   b. Size: Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch (1.6 mm) in length, height, and thickness.
      1) 24 by 24 inches (600 by 600 mm).
      2) 12 by 12 inches (300 by 300 mm).
      3) 18 by 18 inches (450 by 450 mm).
   c. Weight: ANSI/SPRI RP-4, System 1, all locations, and System 2, field of roof, allow roof pavers weighing 18 lb/sq. ft. (90 kg/sq. m) or more. System 3 requires roof pavers weighing 22 lb/sq. ft. (110 kg/sq. m) or more.
   d. Compressive Strength:
      1) 7500 psi (52 MPa), minimum.
      2) 6500 psi (45 MPa), minimum.
   e. Colors and Textures: As selected from manufacturer's full range.
   f. Paver Supports: Integral corner pedestals.
   g. Paver Supports: Paver manufacturer's standard SBR rubber, high-density polyethylene, or polyurethane paver support assembly, including pedestals, shims, and spacer tabs.
      1) Pedestals:
         a) Fixed-height.
         b) Adjustable or stackable.
      2) Joint spacing of spacer tabs:
         a) 1/8 inch (3 mm).
         b) 3/16 inch (5 mm).
         c) 1/8 to 3/16 inch (3 to 5 mm).

1.3 EXECUTION

A. Preparation
   1. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
   2. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
   3. Prime surface of concrete deck with asphalt or coal-tar, as applicable, primer at a rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
   4. Install acoustical roof deck rib insulation strips, specified in Division 5 Section "Steel Deck," according to acoustical roof deck manufacturer's written instructions.

B. Insulation Installation
   1. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
   2. Comply with roofing system manufacturer's written instructions for installing roof insulation.
   3. If mechanically fastening base sheet to substrate before adhering first layer of insulation, install one lapped course of base sheet and mechanically fasten to substrate according to roofing system manufacturer's written instructions.
   4. Nailer Strips: Mechanically fasten 4-inch nominal- (89-mm actual-) width wood nailer strips of same thickness as insulation perpendicular to sloped roof deck at the following spacing:
      a. 16 feet (4.88 m) apart for roof slopes greater than 1 inch per 12 inches (1:12) but less than 3 inches per 12 inches (3:12).

b. 48 inches (1220 mm) apart for roof slopes greater than 3 inches per 12 inches (3:12).

5. Insulation Cant Strips: Install and secure preformed 45-degree insulation cant strips at junctures of built-up roofing membrane system with vertical surfaces or angle changes greater than 45 degrees.
6. Install tapered insulation under area of roofing to conform to slopes indicated.
7. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
   a. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
8. Install one or more layers of insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 1-1/2 inches (38 mm) for perlite and glass fiber, 2 inches (50 mm) for polyisocyanurate and molded and extruded polystyrene, and 3 inches (75 mm) for cellular glass, install 2 or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.
9. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
10. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.
11. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
    a. Prime surface of concrete deck with asphalt or coal-tar, as applicable, primer at a rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
    b. Set each layer of insulation in a solid mopping of hot roofing asphalt, **unless directed otherwise to be** coal-tar pitch, **OR** in a cold fluid-applied adhesive.
12. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type,
    unless directed otherwise to be
    Mechanically Fastened and Adhered Insulation: Install each layer of insulation and secure first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
    a. Install subsequent layers of insulation in a solid mopping of hot roofing asphalt, **unless directed otherwise to be** coal-tar pitch, **OR** in a cold fluid-applied adhesive.
13. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Stagger joints from joints in insulation below a minimum of 6 inches (150 mm) in each direction. Loosely butt cover boards together and fasten to roof deck. Tape joints if required by roofing system manufacturer.
    a. Fasten to resist uplift pressure at corners, perimeter, and field of roof.
    b. Apply hot roofing asphalt, **unless directed otherwise to be** coal-tar pitch, to underside and immediately bond cover board to substrate.

C. Protected Membrane Roofing Insulation And Ballast Installation

1. Loosely lay separator sheet over cooled roofing membrane, with minimum 2-inch (50-mm) side laps and 4-inch (150-mm) end laps.
2. Insulation: For extruded-polystyrene insulation over membrane, loosely lay board insulation units over roofing membrane, with long joints of insulation in a continuous straight line and with end joints staggered between rows. Abut edges and ends between units. Install to achieve required insulation thickness over roofing membrane. Cut and fit to within 3/4 inch (19 mm) of projections and penetrations.
   a. Where overall insulation thickness is 2 inches (50 mm) or more, install required thickness in 2 or more layers with joints of each succeeding layer staggered over joints of previous layer a minimum of 6 inches (150 mm) in each direction.
   b. Install protection mat over insulation, overlapping edges and ends at least 12 inches (300 mm). Do not lap ends of fabric sheets within 72 inches (1800 mm) of roof perimeter. Extend fabric 2 to 3 inches (50 to 75 mm) above ballast at perimeter and penetrations. Apply additional protection mat layer around penetrations to prevent aggregate from getting between penetrations and insulation. Do not cover drains or restrict water flow to drains.

3. Aggregate Ballast: If using aggregate ballast over protection mat and insulation, apply aggregate ballast uniformly at roofing system manufacturer's recommended rate, but not less than the following, spreading with care to minimize possibility of damage to roofing membrane. Leave roof insulation ballasted at the end of the workday.
    a. Ballast Weight:
        1) Size 4 aggregate, 10 lb/sq. ft. (50 kg/sq. m).
        2) Size 2 aggregate, 13 lb/sq. ft. (65 kg/sq. m), at corners and perimeter; Size 4 aggregate, 10 lb/sq. ft. (50 kg/sq. m), elsewhere.
4. Roof-Paver Ballast: Install lightweight roof-paver ballast according to manufacturer's written instructions.
5. Roof-Paver and Aggregate Ballast: Install heavyweight roof pavers according to manufacturer's written instructions, on roof corners and perimeter as defined by ANSI/SPRI RP-4. Install Size 2 aggregate ballast elsewhere on roofing at a minimum rate of 13 lb/sq. ft. (65 kg/sq. m).
    a. Install roof pavers on pedestals set according to pedestal manufacturer's written instructions.
6. Roof-Paver Walkways: Install heavyweight roof pavers according to manufacturer's written instructions.
7. Mortar-Faced Extruded Insulation: Install mortar-faced extruded insulation loosely laid, according to manufacturer's written instructions, with tongue-and-groove joints nested. Stagger end joints of adjoining rows and abut insulation.
    a. If ANSI/SPRI RP-4, System 1 design is required, install heavyweight roof pavers over mortar-faced extruded insulation to a width not less than 24 inches (600 mm) on roof perimeter as defined by ANSI/SPRI RP-4.
    b. If ANSI/SPRI RP-4, System 2 design is required, install heavyweight roof pavers over mortar-faced extruded insulation on roof corners and perimeter as defined by ANSI/SPRI RP-4.
    c. If perimeter mechanical securement is required, mechanically fasten strapping and perimeter edge securement system over mortar-faced extruded insulation according to manufacturer's written instructions.

D. Self-Adhering Modified Bituminous Membrane Roofing & Hot Fluid-Applied Roofing
1. Ballast Installation
    a. Apply ballast uniformly over fabric mat at rate required by insulation manufacturer, but not less than the following, carefully spreading aggregate to minimize possibility of damage to membrane. Apply ballast as insulation is installed, leaving roofing membrane insulated and ballasted at end of workday.

    NOTE: "Ballast" subparagraphs below are based on Dow Technote 508a. Revise if using SPRI RP-4 as basis of design if requirements vary. First subparagraph corresponds to Dow's standard design.

        1) Ballast: 15 lb/sq. ft. (75 kg/sq. m), Size 5 aggregate within 48 inches (1200 mm) of roof perimeter and 24 inches (600 mm) of roof penetrations; 10 lb/sq. ft. (50 kg/sq. m), Size 5 aggregate elsewhere.
            a) Install one row of roof pavers in lieu of aggregate ballast to roof perimeter and penetrations.
        2) Ballast: 15 lb/sq. ft. (75 kg/sq. m), Size 4 aggregate within 48 inches (1200 mm) of roof perimeter and 24 inches (600 mm) of roof penetrations; 12 lb/sq. ft. (60 kg/sq. m), Size 4 aggregate elsewhere.

        NOTE: Retain subparagraph above or first subparagraph below for Dow's "Design #1." Revise roof perimeter and penetration loads above to 20 lb/sq. ft. (100 kg/sq. m) for insulation 3 inches (75 mm) or thicker. Retain below if combining aggregate ballast with roof pavers, 24 by 24 by 2 inches (600 by 600 by 50 mm), at roof perimeter and penetrations. Coordinate size of roof pavers with "Roof Pavers" Article.

3) Ballast: 12 lb/sq. ft. (60 kg/sq. m), Size 4 aggregate to field of roof; lay 2 rows of roof pavers at roof perimeters and penetrations according to insulation manufacturer's written instructions.
4) Ballast: 15 lb/sq. ft. (75 kg/sq. m), Size 2 aggregate within 48 inches (1200 mm) of roof perimeter and 24 inches (600 mm) of roof penetrations; 13 lb/sq. ft. (65 kg/sq. m), Size 2 aggregate to field of roof; lay 3 rows of roof pavers to corners of roof according to insulation manufacturer's written instructions. Mechanically fasten securement strapping to first row of corner edge roof pavers.

NOTE: Retain subparagraph above or below for Dow's "Design #2." Roof pavers and strapping below are required at corners. Revise roof perimeter and penetration loads to 20 lb/sq. ft. (100 kg/sq. m) for insulation 3 inches (75 mm) or thicker. Retain below if combining aggregate ballast with roof pavers, 24 by 24 by 2 inches (600 by 600 by 50 mm), at roof perimeter, corners, and penetrations. Coordinate size of roof pavers with "Roof Pavers" Article.

5) Ballast: 13 lb/sq. ft. (65 kg/sq. m), Size 2 aggregate to field of roof; lay 3 rows of concrete pavers at roof perimeter, corners, and penetrations according to insulation manufacturer's written instructions. Mechanically fasten securement strapping to first row of perimeter and corner edge roof pavers.

NOTE: Retain subparagraph below for Dow's "Design #3." Revise roof penetration loads to 20 lb/sq. ft. (100 kg/sq. m) for insulation 3 inches (75 mm) or thicker. Retain below if combining aggregate ballast with roof pavers, 24 by 24 by 2 inches (600 by 600 by 50 mm), at roof perimeter, corners, and penetrations. Coordinate size of roof pavers with "Roof Pavers" Article.

6) Ballast: 15 lb/sq. ft. (75 kg/sq. m), Size 2 aggregate within 24 inches (600 mm) of roof penetrations; 13 lb/sq. ft. (65 kg/sq. m), Size 2 aggregate to field of roof; lay 4 rows of roof pavers along roof perimeter and at corners according to insulation manufacturer's written instructions. Mechanically fasten securement strapping to first two rows of perimeter and corner edge roof pavers.
7) Walkway Pavers: Lay roof-paver walkways using roof pavers of size indicated or, if not indicated, of manufacturer's standard size.

2. Roof-Paver Installation
   a. Lay roof-paver ballast according to insulation manufacturer's written instructions (Dow's "Standard Design" and "Design #1").
   b. Lay roof-paver ballast according to insulation manufacturer's written instructions. Mechanically fasten securement strapping to first row of perimeter edge pavers (Dow’s "Design #2").
   c. Lay roof-paver ballast according to insulation manufacturer's written instructions. Mechanically fasten securement strapping to first two rows of perimeter edge pavers (Dow’s "Design #3").
      1) Install roof pavers on pedestals set according to pedestal manufacturer's written instructions.
   d. Over mortar-faced board insulation, lay a 24-inch- (600-mm-) wide ballast strip of roof pavers to roof perimeter. Adhere roof pavers to surface of mortar-faced board insulation according to mortar-faced board insulation manufacturer's written instructions.
   e. Over mortar-faced board insulation, lay roof pavers on roof perimeter and corners. Adhere roof pavers to surface of mortar-faced board insulation according to mortar-faced board insulation manufacturer's written instructions.

END OF SECTION 07 22 16 00

Task	Specification	Specification Description
07 22 16 00	07 51 13 00	Built-Up Asphalt Roofing
07 22 16 00	07 01 50 81	Built-Up Coal-Tar Roofing
07 22 16 00	07 53 16 00	EPDM Membrane Roofing
07 22 16 00	07 05 13 00	CSPE Membrane Roofing
07 22 16 00	07 05 13 00a	APP-Modified Bituminous Membrane Roofing
07 22 16 00	07 05 13 00b	SBS-Modified Bituminous Membrane Roofing

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SECTION 07 24 13 00 - POLYMER-BASED EXTERIOR INSULATION AND FINISH SYSTEM (EIFS)

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for polymer-based exterior insulation and finish systems (EIFS). Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Exterior insulation and finish system (EIFS) applied over concrete, masonry, exterior cement board, gypsum sheathing, and plywood sheathing.
      b. Prefabricated panels consisting of EIFS applied over exterior cement board and gypsum sheathing on metal framing.
   2. Products furnished, but not installed under this Section, include anchors and other attachment devices to be cast in concrete and embedded in masonry assemblies.

C. System Description
   1. Class PB EIFS: A non-load-bearing, exterior wall cladding system that consists of an insulation board attached adhesively, mechanically, or both to the substrate; an integrally reinforced base coat; and a textured protective finish coat.

D. Performance Requirements
   1. EIFS Performance: Comply with the following:
      a. Bond Integrity: Free from bond failure within EIFS components or between system and supporting wall construction, resulting from exposure to fire, wind loads, weather, or other in-service conditions.
      b. Weathertightness: Resistant to water penetration from exterior into EIFS and assemblies behind it or through them into interior of building that results in deterioration of thermal-insulating effectiveness or other degradation of EIFS and assemblies behind it, including substrates, supporting wall construction, and interior finish.
   2. Class PB EIFS: Provide EIFS having physical properties and structural performance that comply with the following:
      a. Abrasion Resistance: Sample consisting of 1-inch- (25.4-mm-) thick EIFS mounted on 1/2-inch- (12.7-mm-) thick gypsum board; cured for a minimum of 28 days; and showing no cracking, checking, or loss of film integrity after exposure to 528 quarts (500 L) of sand when tested per ASTM D 968, Method A.
      b. Absorption-Freeze Resistance: No visible deleterious effects and negligible weight loss after 60 cycles per EIMA 101.01.
      c. Accelerated Weathering: Five samples per ICC-ES AC219 showing no cracking, checking, crazing, erosion, rusting, blistering, peeling, delamination, or other characteristics that might affect performance as a wall cladding after testing for 2000 hours when viewed under 5 times magnification per ASTM G 153 or ASTM G 154 **OR** ASTM G 153 or ASTM G 155, **as directed**.
      d. Freeze-Thaw: No surface changes, cracking, checking, crazing, erosion, rusting, blistering, peeling, or delamination, or indications of delamination between components when viewed under 5 times magnification after 60 cycles per EIMA 101.01 **OR** 10 cycles per ICC-ES AC219, **as directed**.
      e. Mildew Resistance of Finish Coat: Sample applied to 2-by-2-inch (50.8-by-50.8-mm) clean glass substrate, cured for 28 days, and showing no growth when tested per ASTM D 3273 and evaluated according to ASTM D 3274.

f. Salt-Spray Resistance: No deleterious affects when tested according to ICC-ES AC219.
g. Tensile Adhesion: No failure in the EIFS, adhesive, base coat, or finish coat when tested per EIMA 101.03 **OR** ICC-ES AC219, **as directed**.
h. Water Penetration: Sample consisting of 1-inch- (25.4-mm-) thick EIFS mounted on 1/2-inch- (12.7-mm-)thick gypsum board, cured for 28 days, and showing no water penetration into the plane of the base coat to expanded-polystyrene board interface of the test specimen after 15 minutes at 6.24 lbf/sq. ft. (299 Pa) of air pressure difference or 20 percent of positive design wind pressure, whichever is greater, across the specimen during a test period when tested per EIMA 101.02.
i. Water Resistance: Three samples, each consisting of 1-inch- (25.4-mm-) thick EIFS mounted on 1/2-inch- (12.7-mm-) thick gypsum board; cured for 28 days; and showing no cracking, checking, crazing, erosion, rusting, blistering, peeling, or delamination after testing for 14 days per ASTM D 2247.
j. Wind-Driven-Rain Resistance: Resist wind-driven rain according to ICC-ES AC219.
k. Impact Resistance: Sample consisting of 1-inch- (25.4-mm-) thick EIFS when constructed, conditioned, and tested per EIMA 101.86; and meeting or exceeding the following:
   1) Standard Impact Resistance: 25 to 49 inch-lb (2.8 to 5.6 J).
   2) Medium Impact Resistance: 50 to 89 inch-lb (5.7 to 10.1 J).
   3) High Impact Resistance: 90 to 150 inch-lb (10.2 to 17 J).
   4) Ultra-High Impact Resistance: More than 150 inch-lb (17 J).
l. Structural Performance Testing: EIFS assembly and components shall comply with ICC-ES AC219 when tested per ASTM E 330.

3. Performance of Prefabricated Panels: Prefabricated panels shall be designed as follows and withstand the structural performance indicated for Class PB EIFS and thermal movement limits indicated below without failure due to defective manufacture, fabrication, installation, or other defects in construction.
   a. Delegated Design: Design prefabricated panels, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
   b. Structural Performance: EIFS shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to SEI/ASCE 7.
      1) Wind Loads: Uniform pressure as indicated on Drawings.
   c. Deflection Limits: Design prefabricated panels to withstand design loads without deflections greater than 1/240.
   d. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
      1) Temperature Change (Range): 100 deg F (55 deg C).

E. Submittals
1. Product Data: For each type and component of EIFS indicated.
2. LEED Submittal:
   a. Product Data for Credit EQ 4.1: For adhesives and sealants used inside the weatherproofing system, including printed statement of VOC content.
3. Shop Drawings: For EIFS. Include plans, elevations, sections, details of components, details of penetration and termination, flashing details, joint locations and configurations, lifting points for prefabricated panels, fastening and anchorage details including mechanical fasteners, and connections and attachments to other work.
4. Panel Schedule: For prefabricated panel fabrication.
5. Samples: For each exposed product and for each color and texture specified.
6. Delegated-Design Submittal: For prefabricated panels indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
7. Material or product certificates.

8. Product test reports.
9. Compatibility and Adhesion Test Reports: For joint sealants from sealant manufacturer indicating the following:
   a. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
   b. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
10. Field quality-control reports and special inspection reports.
11. Evaluation reports
12. Maintenance data.

F. Quality Assurance
1. Installer Qualifications: An installer who is certified in writing by EIFS manufacturer as qualified to install manufacturer's system using trained workers.
2. Source Limitations: Obtain EIFS from single source from single EIFS manufacturer and from sources approved by EIFS manufacturer as compatible with system components.
3. Fire-Test-Response Characteristics: Provide EIFS and system components with the following fire-test-response characteristics as determined by testing identical EIFS and system components per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.
   a. Fire-Resistance Characteristics: Per ASTM E 119.
   b. Full-Scale Multistory Fire Test: Per IBC Standard.
   c. Full-Scale Diversified Fire Test: Per ASTM E 108 modified for testing vertical walls.
   d. Intermediate-Scale Multistory Fire Test: Per NFPA 285 **OR** IBC Standard, **as directed**.
   e. Radiant Heat Exposure: No ignition of EIFS when tested according to NFPA 268.
   f. Potential Heat: Acceptable level when tested according to NFPA 259.
   g. Surface-Burning Characteristics: Provide insulation board, adhesives, base coats, and finish coats with flame-spread index of 25 or less and smoke-developed index of 450 or less, per ASTM E 84 **OR** IBC Standard, **as directed**.
4. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver materials in original, unopened packages with manufacturers' labels intact and clearly identifying products.
2. Store materials inside and under cover; keep them dry and protected from weather, direct sunlight, surface contamination, aging, corrosion, damaging temperatures, construction traffic, and other causes.
   a. Stack insulation board flat and off the ground.
   b. Protect plastic insulation against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
   c. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

H. Project Conditions
1. Weather Limitations: Maintain ambient temperatures above 40 deg F (4.4 deg C) for a minimum of 24 hours before, during, and after adhesives or coatings are applied. Do not apply EIFS adhesives or coatings during rainfall. Proceed with installation only when existing and forecasted weather conditions and ambient outdoor air, humidity, and substrate temperatures permit EIFS to be applied, dried, and cured according to manufacturers' written instructions and warranty requirements.

1.2 PRODUCTS

A. Materials
1. Compatibility: Provide adhesive, fasteners, board insulation, reinforcing meshes, base- and finish-coat systems, sealants, and accessories that are compatible with one another and with substrates and approved for use by EIFS manufacturer for Project.
2. Prefabricated Panels: Comply with requirements in Division 05 Section "Cold-formed Metal Framing" for metal framing and with requirements in Division 06 Section "Sheathing" for gypsum sheathing and weather-resistant sheathing paper.
3. Exterior Cement Board: Not less than 5/16-inch- (8-mm-) **OR** 7/16-inch- (11-mm-), **as directed**, thick, fiber cement board complying with ASTM C 1186, Type A, for exterior applications.
   a. Fasteners: Wafer-head or flat-head steel drill screws complying with ASTM C 954, with an organic-polymer coating or other corrosion-protective coating having a salt-spray resistance of more than 500 hours per ASTM B 117.
      1) Size and Length: As recommended by sheathing manufacturer for type and thickness of sheathing board to be attached.
4. Primer/Sealer: EIFS manufacturer's standard substrate conditioner with VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), designed to seal substrates from moisture penetration and to improve the bond between substrate of type indicated and adhesive used for application of insulation.
5. Flexible-Membrane Flashing: Cold-applied, fully self-adhering, self-healing, rubberized-asphalt and polyethylene-film composite sheet or tape and primer; EIFS manufacturer's standard or product recommended in writing by EIFS manufacturer.
6. Insulation Adhesive: EIFS manufacturer's standard formulation designed for indicated use; compatible with substrate; with VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24); and complying with one of the following:
   a. Job-mixed formulation of portland cement complying with ASTM C 150, Type I, and polymer-based adhesive specified for base coat.
   b. Factory-blended dry formulation of portland cement, dry polymer admixture, and fillers specified for base coat.
   c. Factory-mixed noncementitious formulation designed for adhesive attachment of insulation to substrates of type indicated, as recommended by EIFS manufacturer.
7. Molded, Rigid Cellular Polystyrene Board Insulation: Comply with ASTM C 578, Type I; EIFS manufacturer's requirements; and EIMA's "EIMA Guideline Specification for Expanded Polystyrene (EPS) Insulation Board" for most stringent requirements for material performance and qualities of insulation, including dimensions and permissible variations, and the following:
   a. Aging: Before cutting and shipping, age insulation in block form by air drying for not less than six weeks or by another method approved by EIMA that produces equivalent results.
   b. Flame-Spread and Smoke-Developed Indexes: 25 and 450 or less, respectively, per ASTM E 84.
   c. Dimensions: Provide insulation boards not more than 24 by 48 inches (610 by 1219 mm) and in thickness indicated, but not more than 4 inches (102 mm) thick or less than thickness allowed by ASTM C 1397.
   d. Foam Shapes: Provide with profiles and dimensions indicated on Drawings.
8. Reinforcing Mesh: Balanced, alkali-resistant, open-weave, glass-fiber mesh treated for compatibility with other EIFS materials, complying with ASTM D 578 and the following:
   a. Standard-Impact Reinforcing Mesh: Not less than 4.0 oz./sq. yd. (136 g/sq. m).
   b. Intermediate-Impact Reinforcing Mesh: Not less than 10 oz./sq. yd. (339 g/sq. m) **OR** 12.0 oz./sq. yd. (407 g/sq. m), **as directed**.
   c. High-Impact Reinforcing Mesh: Not less than 15 oz./sq. yd. (509 g/sq. m).
   d. Heavy-Duty Reinforcing Mesh: Not less than 20 oz./sq. yd. (678 g/sq. m).
   e. Strip Reinforcing Mesh: Not less than 3.75 oz./sq. yd. (127 g/sq. m).
   f. Detail Reinforcing Mesh: Not less than 4.0 oz./sq. yd. (136 g/sq. m).
   g. Corner Reinforcing Mesh: Not less than 7.2 oz./sq. yd. (244 g/sq. m).

9. Base-Coat Materials: EIFS manufacturer's standard mixture complying with one of the following:
   a. Job-mixed formulation of portland cement complying with ASTM C 150, Type I, white or natural color; and manufacturer's standard polymer-emulsion adhesive designed for use with portland cement.
   b. Job-combined formulation of manufacturer's standard polymer-emulsion adhesive and manufacturer's standard dry mix containing portland cement.
   c. Factory-blended dry formulation of portland cement, dry polymer admixture, and inert fillers to which only water is added at Project site.
   d. Factory-mixed noncementitious formulation of polymer-emulsion adhesive and inert fillers that is ready to use without adding other materials.
10. Waterproof Adhesive/Base-Coat Materials: EIFS manufacturer's standard waterproof formulation with VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24) complying with one of the following:
    a. Job-mixed formulation of portland cement complying with ASTM C 150, Type I, white or natural color; and manufacturer's standard polymer-emulsion adhesive designed for use with portland cement.
    b. Job-combined formulation of manufacturer's standard polymer-emulsion adhesive and manufacturer's standard dry mix containing portland cement.
11. Primer: EIFS manufacturer's standard factory-mixed, elastomeric-polymer primer for preparing base-coat surface for application of finish coat.
12. Finish-Coat Materials: EIFS manufacturer's standard acrylic-based coating **OR** standard acrylic-based coating with enhanced mildew resistance **OR** siliconized acrylic-based coating, **as directed**, complying with the following:
    a. Factory-mixed formulation of polymer-emulsion binder, colorfast mineral pigments, sound stone particles, and fillers.
    b. Factory-mixed formulation of polymer-emulsion binder, colorfast mineral pigments, and fillers used with stone particles for embedding in finish coat to produce an applied-aggregate finish.
       1) Aggregate: Marble chips of size and color as selected by the Owner from manufacturer's full range.
    c. Sealer: Manufacturer's waterproof, clear acrylic-based sealer for protecting finish coat.
    d. Colors: As selected by the Owner from manufacturer's full range.
13. Water: Potable.
14. Mechanical Fasteners: EIFS manufacturer's standard corrosion-resistant fasteners consisting of thermal cap, standard washer and shaft attachments, and fastener indicated below; selected for properties of pullout, tensile, and shear strength required to resist design loads of application indicated; capable of pulling fastener head below surface of insulation board; and of the following description:
    a. For attachment to steel studs from 0.033 to 0.112 inch (0.84 to 2.84 mm) in thickness, provide steel drill screws complying with ASTM C 954.
    b. For attachment to light-gage steel framing members not less than 0.0179 inch (0.45 mm) in thickness, provide steel drill screws complying with ASTM C 1002.
    c. For attachment to wood framing members and plywood sheathing, provide steel drill screws complying with ASTM C 1002, Type W.
    d. For attachment to masonry and concrete substrates, provide sheathing dowel in form of a plastic wing-tipped fastener with thermal cap, sized to fit insulation thickness indicated and to penetrate substrate to depth required to secure anchorage.
    e. For attachment, provide manufacturer's standard fasteners suitable for substrate.
15. Trim Accessories: Type as designated or required to suit conditions indicated and to comply with EIFS manufacturer's written instructions; manufactured from UV-stabilized PVC; and complying with ASTM D 1784, manufacturer's standard Cell Class for use intended, and ASTM C 1063.
    a. Casing Bead: Prefabricated, one-piece type for attachment behind insulation, of depth required to suit thickness of coating and insulation, with face leg perforated for bonding to coating and back leg.

b. Drip Screed/Track: Prefabricated, one-piece type for attachment behind insulation with face leg extended to form a drip, of depth required to suit thickness of coating and insulation, with face leg perforated for bonding to coating and back leg.
c. Expansion Joint: Prefabricated, one-piece V profile; designed to relieve stress of movement.
d. Window Sill Flashing: Prefabricated type for both flashing and sloping sill over framing beneath windows; with end and back dams; designed to direct water to exterior.
e. Parapet Cap Flashing: Type for both flashing and covering parapet top with design complying with ASTM C 1397.

B. Elastomeric Sealants
1. Elastomeric Sealant Products: Provide EIFS manufacturer's listed and recommended chemically curing, elastomeric sealant that is compatible with joint fillers, joint substrates, and other related materials, and complies with requirements for products and testing indicated in ASTM C 1481 and with requirements in Division 07 Section "Joint Sealants" for products corresponding to description indicated below:
a. Multicomponent, nonsag urethane sealant.
b. Single-component, nonsag, neutral-curing silicone sealant.
c. Provide sealants, used inside the weatherproofing system, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Preformed Foam Sealant Products: Provide sealant compatible with adjacent materials and complying with requirements in Division 07 Section "Joint Sealants".
3. Sealant Color: As selected by the Owner from manufacturer's full range.

C. Mixing
1. General: Comply with EIFS manufacturer's requirements for combining and mixing materials. Do not introduce admixtures, water, or other materials except as recommended by EIFS manufacturer. Mix materials in clean containers. Use materials within time period specified by EIFS manufacturer or discard.

D. Panel Fabrication
1. Panel Framing: Fabricate panel framing to comply with requirements in Division 05 Section "Cold-formed Metal Framing".
a. Connect panel framing by welding unless otherwise indicated.
b. Connections: Provide connections capable of adjustment, complying with erection tolerance requirements, to anchor panels to structure.
2. Exterior Cement Board: Install on metal framing to comply with requirements in "Exterior Cement-Board Installation" Article.
3. EIFS Application: Apply EIFS to sheathed metal-framed panels to comply with requirements in "Trim Installation," "Insulation Installation," "Base-Coat Installation," and "Finish-Coat Installation" articles and as follows:
a. Wrap base coat and reinforcing mesh at edges of panels and extend coverage not less than 4 inches (100 mm) over backs of panels unless otherwise indicated.
b. Wrap base coat and reinforcing mesh at edges of panels and extend coverage not less than full thickness to cover edges of metal framing unless otherwise indicated.
c. Continue finish coat around corners at edges of panels, unless otherwise indicated, and extend to location indicated for sealant application. Do not extend finish coat over surfaces where sealant will be applied.
d. Continue finish coat around corners at edges of panels and extend over edges to cover base coat unless otherwise indicated.
4. Panel Fabrication Tolerances: Comply with the following:
a. Overall Height and Width: Plus or minus 1/8 inch (3.2 mm).
b. Cumulative Height and Width over Length of Building: Not more than 3/8 inch (9.6 mm).
c. Openings within One Unit: Plus or minus 1/8 inch (3.2 mm) for window and door frames.

d. Out of Square: Plus or minus 1/8 inch (3.2 mm).
e. Locations of Reveals and Architectural Features: Plus or minus 1/8 inch (3.2 mm).
f. Thickness: Plus or minus 1/16 inch (1.6 mm).
g. Flatness: Not more than 1/8 inch in 8 feet (3.2 mm in 2.4 m) across face of panel.

1.3 EXECUTION

A. Preparation
1. Protect contiguous work from moisture deterioration and soiling caused by application of EIFS. Provide temporary covering and other protection needed to prevent spattering of exterior finish coats on other work.
2. Protect EIFS, substrates, and wall construction behind them from inclement weather during installation. Prevent penetration of moisture behind EIFS and deterioration of substrates.
3. Prepare and clean substrates to comply with EIFS manufacturer's written instructions to obtain optimum bond between substrate and adhesive for insulation.
    a. Concrete Substrates: Provide clean, dry, neutral-pH substrate for insulation installation. Verify suitability of substrate by performing bond and moisture tests recommended by EIFS manufacturer.

B. Exterior Cement-Board Installation
1. Exterior Cement Board: Install on metal framing to comply with cement-board manufacturer's written instructions and evaluation report acceptable to authorities having jurisdiction. Install board with steel drill screws spaced no more than 8 inches (203 mm) o.c. along framing with perimeter fasteners at least 3/8 inch (9.6 mm) but less than 5/8 inch (15.9 mm) from edges of boards.

C. EIFS Installation, General
1. Comply with ASTM C 1397 and EIFS manufacturer's written instructions for installation of EIFS as applicable to each type of substrate indicated.

D. Substrate Protection Application
1. Primer/Sealer: Apply over gypsum sheathing substrates to protect substrates from degradation and where required by EIFS manufacturer for improving adhesion of insulation to substrate.
2. Waterproof Adhesive/Base Coat: Apply over sloped surfaces **OR** window sills **OR** parapets **OR** where indicated on Drawings, **as directed**, to protect substrates from degradation.
3. Flexible-Membrane Flashing: Install over weather-resistive barrier, applied and lapped to shed water; seal at openings, penetrations, terminations, and where indicated by EIFS manufacturer's written instructions to protect wall assembly from degradation. Prime substrates, if required, and install flashing to comply with EIFS manufacturer's written instructions and details.

E. Trim Installation
1. Trim: Apply trim accessories at perimeter of EIFS, at expansion joints, at window sills, and elsewhere as indicated, according to EIFS manufacturer's written instructions. Coordinate with installation of insulation.
    a. Drip Screed/Track: Use at bottom edges of EIFS unless otherwise indicated.
    b. Window Sill Flashing: Use at windows unless otherwise indicated.
    c. Expansion Joint: Use where indicated on Drawings.
    d. Casing Bead: Use at other locations.
    e. Parapet Cap Flashing: Use where indicated on Drawings.

F. Insulation Installation
1. Board Insulation: Adhesively **OR** Mechanically **OR** Adhesively and mechanically, **as directed**, attach insulation to substrate in compliance with ASTM C 1397, EIFS manufacturer's written instructions, and the following:

a. Apply adhesive to insulation by notched-trowel method in a manner that results in coating the entire surface of sheathing with adhesive once insulation is adhered to sheathing unless EIFS manufacturer's written instructions specify using primer/sealer with ribbon-and-dab method. Apply adhesive to a thickness of not less than 1/4 inch (6.4 mm) for factory mixed and not less than 3/8 inch (9.6 mm) for field mixed, measured from surface of insulation before placement.
b. Press and slide insulation into place. Apply pressure over the entire surface of insulation to accomplish uniform contact, high initial grab, and overall level surface.
c. Allow adhered insulation to remain undisturbed for period recommended by EIFS manufacturer, but not less than 24 hours, before installing mechanical fasteners, beginning rasping and sanding insulation, or applying base coat and reinforcing mesh.
d. Mechanically attach insulation to substrate by method complying with EIFS manufacturer's written instructions. Install top surface of fastener heads flush with plane of insulation. Install fasteners into or through substrates with the following minimum penetration:
   1) Steel Framing: 5/16 inch (8 mm).
   2) Wood Framing: 1 inch (25 mm).
   3) Concrete and Masonry: 1 inch (25 mm).
e. Apply insulation over dry substrates in courses with long edges of boards oriented horizontally.
f. Begin first course of insulation from a level base line and work upward.
g. Begin first course of insulation from screed/track and work upward. Work from perimeter casing beads toward interior of panels if possible.
h. Stagger vertical joints of insulation boards in successive courses to produce running bond pattern. Locate joints so no piece of insulation is less than 12 inches (300 mm) wide or 6 inches (150 mm) high. Offset joints not less than 6 inches (150 mm) from corners of window and door openings and not less than 4 inches (100 mm) from aesthetic reveals.
   1) Adhesive Attachment: Offset joints of insulation not less than 6 inches (150 mm) from horizontal and 4 inches (100 mm) from vertical joints in sheathing.
   2) Mechanical Attachment: Offset joints of insulation from horizontal joints in sheathing.
i. Interlock ends at internal and external corners.
j. Abut insulation tightly at joints within and between each course to produce flush, continuously even surfaces without gaps or raised edges between boards. If gaps greater than 1/16 inch (1.6 mm) occur, fill with insulation cut to fit gaps exactly; insert insulation without using adhesive or other material.
k. Cut insulation to fit openings, corners, and projections precisely and to produce edges and shapes complying with details indicated.
l. Rasp or sand flush entire surface of insulation to remove irregularities projecting more than 1/32 inch (0.8 mm) **OR** 1/16 inch (1.6 mm), **as directed**, from surface of insulation and to remove yellowed areas due to sun exposure; do not create depressions deeper than 1/16 inch (1.6 mm).
m. Cut aesthetic reveals in outside face of insulation with high-speed router and bit configured to produce grooves, rabbets, and other features that comply with profiles and locations indicated. Do not reduce insulation thickness at aesthetic reveals to less than 3/4 inch (19 mm).
n. Install foam shapes and attach to sheathing **OR** structure, **as directed**.
o. Interrupt insulation for expansion joints where indicated.
p. Form joints for sealant application by leaving gaps between adjoining insulation edges and between insulation edges and dissimilar adjoining surfaces. Make gaps wide enough to produce joint widths indicated after encapsulating joint substrates with base coat and reinforcing mesh.
q. Form joints for sealant application with back-to-back casing beads for joints within EIFS and with perimeter casing beads at dissimilar adjoining surfaces. Make gaps between

casing beads and between perimeter casing beads and adjoining surfaces of width indicated.

r. After installing insulation and before applying reinforcing mesh, fully wrap board edges with strip reinforcing mesh. Cover edges of board and extend encapsulating mesh not less than 2-1/2 inches (64 mm) over front and back face unless otherwise indicated on Drawings.

s. Treat exposed edges of insulation as follows:
   1) Except for edges forming substrates of sealant joints, encapsulate with base coat, reinforcing mesh, and finish coat.
   2) Encapsulate edges forming substrates of sealant joints within EIFS or between EIFS and other work with base coat and reinforcing mesh.
   3) At edges trimmed by accessories, extend base coat, reinforcing mesh, and finish coat over face leg of accessories.

t. Coordinate installation of flashing and insulation to produce wall assembly that does not allow water to penetrate behind flashing and EIFS protective-coating lamina.

2. Expansion Joints: Install at locations indicated, where required by EIFS manufacturer, and as follows:
   a. At expansion joints in substrates behind EIFS.
   b. Where EIFS adjoin dissimilar substrates, materials, and construction, including other EIFS.
   c. At floor lines in multilevel wood-framed construction.
   d. Where wall height or building shape changes.
   e. Where EIFS manufacturer requires joints in long continuous elevations.
   f. Where panels abut one another.

G. Base-Coat Installation

1. Base Coat: Apply to exposed surfaces of insulation and foam shapes in minimum thickness recommended in writing by EIFS manufacturer, but not less than 1/16-inch (1.6-mm) dry-coat thickness.

2. Reinforcing Mesh: Embed type indicated below in wet base coat to produce wrinkle-free installation with mesh continuous at corners and overlapped not less than 2-1/2 inches (64 mm) or otherwise treated at joints to comply with ASTM C 1397 and EIFS manufacturer's written instructions. Do not lap reinforcing mesh within 8 inches (204 mm) of corners. Completely embed mesh, applying additional base-coat material if necessary, so reinforcing-mesh color and pattern are not visible.
   a. Standard-impact reinforcing mesh unless otherwise indicated.
   b. Intermediate-impact reinforcing mesh where indicated.
   c. High-impact reinforcing mesh where indicated.
   d. Heavy-duty reinforcing mesh where indicated.

3. Double-Layer Reinforcing Mesh Application: Where indicated, apply second base coat and second layer of standard-impact **OR** intermediate-impact, **as directed**, reinforcing mesh, overlapped not less than 2-1/2 inches (64 mm) or otherwise treated at joints to comply with ASTM C 1397 and EIFS manufacturer's written instructions in same manner as first application. Do not apply until first base coat has cured.

4. Additional Reinforcing Mesh: Apply strip reinforcing mesh around openings extending 4 inches (100 mm) beyond perimeter. Apply additional 9-by-12-inch (230-by-300-mm) strip reinforcing mesh diagonally at corners of openings (re-entrant corners). Apply 8-inch- (200-mm-) wide strip reinforcing mesh at both inside and outside corners unless base layer of mesh is lapped not less than 4 inches (100 mm) on each side of corners.
   a. At aesthetic reveals, apply strip reinforcing mesh not less than 8 inches (200 mm) wide.
   b. Embed strip reinforcing mesh in base coat before applying first layer of reinforcing mesh.

5. Foam Shapes: Fully embed reinforcing mesh in base coat.

6. Double Base-Coat Application: Where indicated, apply second base coat in same manner and thickness as first application except without reinforcing mesh. Do not apply until first base coat has cured.

H. Finish-Coat Installation
1. Primer: Apply over dry base coat according to EIFS manufacturer's written instructions.
2. Finish Coat: Apply over dry primed base coat, maintaining a wet edge at all times for uniform appearance, in thickness required by EIFS manufacturer to produce a uniform finish of color and texture matching approved sample and free of cold joints, shadow lines, and texture variations.
a. Texture: As selected by the Owner from manufacturer's full range.
b. Embed aggregate in finish coat according to EIFS manufacturer's written instructions to produce a uniform applied-aggregate finish of color and texture matching approved sample.
3. Sealer Coat: Apply over dry finish coat, in number of coats and thickness required by EIFS manufacturer.

I. Installation Of Prefabricated Panels
1. General: Install panels according to Shop Drawings. Install by welding metal framing to structural-steel frame **OR** by welding to steel-weld plates anchored in concrete, **as directed**, to comply with requirements in Division 05 Section "Cold-formed Metal Framing" unless otherwise indicated.
a. Lift panels only as indicated on Shop Drawings.
b. Do not warp or stress panels by forcing alignment.
c. Adjust connections to align panels and maintain correct and uniform joint widths.
d. Install bracing as panels are erected. Weld securely to panel framing and to structure.
2. Erection Tolerances: Install panels level, plumb, and true to line with no variation in plane or alignment exceeding 1/16 inch (1.6 mm) and no variation in position exceeding 1/8 inch (3.2 mm).
a. Maintain clearance between panels required for installing joint sealants.

J. Installation Of Joint Sealants
1. Prepare joints and apply sealants, of type and at locations indicated, to comply with applicable requirements in Division 07 Section "Joint Sealants" and in ASTM C 1481.
a. Apply joint sealants after base coat has cured but before applying finish coat.
b. Clean surfaces to receive sealants to comply with indicated requirements and EIFS manufacturer's written instructions.
c. Apply primer recommended in writing by sealant manufacturer for surfaces to be sealed.
d. Install sealant backing to control depth and configuration of sealant joint and to prevent sealant from adhering to back of joint.
e. Apply masking tape to protect areas adjacent to sealant joints. Remove tape immediately after tooling joints, without disturbing joint seal.
f. Recess sealant sufficiently from surface of EIFS so an additional sealant application, including cylindrical sealant backing, can be installed without protruding beyond EIFS surface.

K. Field Quality Control
1. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
a. According to ICC-ES AC24 **OR** ICC-ES AC219, **as directed**.
2. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
3. EIFS Tests and Inspections: For the following:
a. According to ICC-ES AC24 **OR** ICC-ES AC219, **as directed**.
4. Prefabricated Panels: Test and inspect field welds.
5. Remove and replace EIFS where test results indicate that EIFS do not comply with specified requirements.
6. Prepare test and inspection reports.

L. Cleaning And Protection

1. Remove temporary covering and protection of other work. Promptly remove coating materials from window and door frames and other surfaces outside areas indicated to receive EIFS coatings.

END OF SECTION 07 24 13 00

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SECTION 07 24 13 00a - WATER-DRAINAGE EXTERIOR INSULATION AND FINISH SYSTEM (EIFS)

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for water drainage exterior insulation and finish system (EIFS). Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes water-drainage exterior insulation and finish system (EIFS) applied over water-resistive coating over sheathing, weather-resistant sheathing paper over sheathing, weather-resistant sheathing paper over exterior cement board, and exterior cement board over weather-resistant sheathing paper.

C. System Description
1. Class PB EIFS: A non-load-bearing, exterior wall cladding system that consists of an insulation board attached adhesively, mechanically, or both to the substrate; an integrally reinforced base coat; and a textured protective finish coat.
2. Water-Drainage EIFS: EIFS with a means that allows water entering into an EIFS assembly to drain to the exterior.

D. Performance Requirements
1. EIFS Performance: Comply with the following:
   a. Bond Integrity: Free from bond failure within EIFS components or between system and supporting wall construction, resulting from exposure to fire, wind loads, weather, or other in-service conditions.
   b. Weathertightness: Resistant to water penetration from exterior into water-drainage EIFS and assemblies behind it or through them into interior of building that results in deterioration of thermal-insulating effectiveness or other degradation of EIFS and assemblies behind it, including substrates, supporting wall construction, and interior finish, and including a means that allows water entering into an EIFS assembly to drain to the exterior.
2. Class PB EIFS: Provide EIFS having physical properties and structural performance that comply with the following:
   a. Abrasion Resistance: Sample consisting of 1-inch- (25.4-mm-) thick EIFS mounted on 1/2-inch- (12.7-mm-) thick gypsum board; cured for a minimum of 28 days; and showing no cracking, checking, or loss of film integrity after exposure to 528 quarts (500 L) of sand when tested per ASTM D 968, Method A.
   b. Absorption-Freeze Resistance: No visible deleterious effects and negligible weight loss after 60 cycles per EIMA 101.01.
   c. Accelerated Weathering: Five samples per ICC-ES AC235 showing no cracking, checking, crazing, erosion, rusting, blistering, peeling, delamination, or other characteristics that might affect performance as a wall cladding after testing for 2000 hours when viewed under 5 times magnification per ASTM G 153 or ASTM G 154 **OR** ASTM G 153 or ASTM G 155, **as directed**.
   d. Freeze-Thaw: No surface changes, cracking, checking, crazing, erosion, rusting, blistering, peeling, or delamination, or indications of delamination between components when viewed under 5 times magnification after 60 cycles per EIMA 101.01 **OR** 10 cycles per ICC-ES AC235, **as directed**.

e. Mildew Resistance of Finish Coat: Sample applied to 2-by-2-inch (50.8-by-50.8-mm) clean glass substrate, cured for 28 days, and showing no growth when tested per ASTM D 3273 and evaluated according to ASTM D 3274.
f. Salt-Spray Resistance: No deleterious affects when tested according to ICC-ES AC235.
g. Tensile Adhesion: No failure in the EIFS, adhesive, base coat, or finish coat when tested per EIMA 101.03 **OR** ICC-ES AC235, **as directed**.
h. Water Penetration: Sample consisting of 1-inch- (25.4-mm-) thick EIFS mounted on 1/2-inch- (12.7-mm-) thick gypsum board, cured for 28 days, and showing no water penetration into the plane of the base coat to expanded polystyrene board interface of the test specimen after 15 minutes at 6.24 lbf/sq. ft. (299 Pa) of air pressure difference or 20 percent of positive design wind pressure, whichever is greater, across the specimen during a test period when tested per EIMA 101.02.
i. Water Resistance: Three samples, each consisting of 1-inch- (25.4-mm-) thick EIFS mounted on 1/2-inch- (12.7-mm-) thick gypsum board; cured for 28 days; and showing no cracking, checking, crazing, erosion, rusting, blistering, peeling, or delamination after testing for 14 days per ASTM D 2247.
j. Impact Resistance: Sample consisting of 1-inch- (25.4-mm-) thick EIFS when constructed, conditioned, and tested per EIMA 101.86; and meeting or exceeding the following:
   1) Standard Impact Resistance: 25 to 49 inch-lb (2.8 to 5.6 J).
   2) Medium Impact Resistance: 50 to 89 inch-lb (5.7 to 10.1 J).
   3) High Impact Resistance: 90 to 150 inch-lb (10.2 to 17 J).
   4) Ultra-High Impact Resistance: More than 150 inch-lb (17 J).
k. Drainage: According to ICC-ES AC24 **OR** ICC-ES AC235, **as directed**.
l. Structural Performance Testing: EIFS assembly and components shall comply with ICC-ES AC235 when tested per ASTM E 330.

E. Submittals
1. Product Data: For each type and component of EIFS indicated.
2. LEED Submittal:
   a. Product Data for Credit EQ 4.1: For adhesives and sealants used inside the weatherproofing system, including printed statement of VOC content.
3. Shop Drawings: For EIFS. Include plans, elevations, sections, details of components, details of penetration and termination, flashing details, joint locations and configurations, fastening and anchorage details including mechanical fasteners, and connections and attachments to other work.
4. Samples: For each exposed product and for each color and texture specified.
5. Material or product certificates.
6. Product test reports.
7. Compatibility and Adhesion Test Reports: For joint sealants from sealant manufacturer indicating the following:
   a. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
   b. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
8. Field quality-control reports and special inspection reports.
9. Evaluation reports
10. Maintenance data.

F. Quality Assurance
1. Installer Qualifications: An installer who is certified in writing by EIFS manufacturer as qualified to install manufacturer's system using trained workers.
2. Source Limitations: Obtain EIFS from single source from single EIFS manufacturer and from sources approved by EIFS manufacturer as compatible with system components.

3. Fire-Test-Response Characteristics: Provide EIFS and system components with the following fire-test-response characteristics as determined by testing identical EIFS and system components per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.
   a. Fire-Resistance Characteristics: Per ASTM E 119.
   b. Full-Scale Multistory Fire Test: Per IBC Standard.
   c. Full-Scale Diversified Fire Test: Per ASTM E 108 modified for testing vertical walls.
   d. Intermediate-Scale Multistory Fire Test: Per FPA 285 **OR** IBC Standard, **as directed**.
   e. Radiant Heat Exposure: No ignition of EIFS when tested according to NFPA 268.
   f. Potential Heat: Acceptable level when tested according to NFPA 259.
   g. Surface-Burning Characteristics: Provide insulation board, adhesives, base coats, and finish coats with flame-spread index of 25 or less and smoke-developed index of 450 or less, per ASTM E 84 **OR** IBC Standard, **as directed**.
4. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver materials in original, unopened packages with manufacturers' labels intact and clearly identifying products.
2. Store materials inside and under cover; keep them dry and protected from weather, direct sunlight, surface contamination, aging, corrosion, damaging temperatures, construction traffic, and other causes.
   a. Stack insulation board flat and off the ground.
   b. Protect plastic insulation against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
   c. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

H. Project Conditions
1. Weather Limitations: Maintain ambient temperatures above 40 deg F (4.4 deg C) for a minimum of 24 hours before, during, and after adhesives or coatings are applied. Do not apply EIFS adhesives or coatings during rainfall. Proceed with installation only when existing and forecasted weather conditions and ambient outdoor air, humidity, and substrate temperatures permit EIFS to be applied, dried, and cured according to manufacturers' written instructions and warranty requirements.

1.2 PRODUCTS

A. Materials
1. Compatibility: Provide water-resistive coating, adhesive, fasteners, board insulation, reinforcing meshes, base- and finish-coat systems, sealants, and accessories that are compatible with one another and with substrates and approved for use by EIFS manufacturer for Project.
2. Exterior Cement Board: Not less than 5/16-inch- (8-mm-) **OR** 7/16-inch- (11-mm-), **as directed** thick, fiber cement board complying with ASTM C 1186, Type A, for exterior applications.
   a. Fasteners: Wafer-head or flat-head steel drill screws complying with ASTM C 954, with an organic-polymer coating or other corrosion-protective coating having a salt-spray resistance of more than 500 hours per ASTM B 117.
      1) Size and Length: As recommended by sheathing manufacturer for type and thickness of sheathing board to be attached.
3. Water-Resistive Coatings: EIFS manufacturer's standard formulation and accessories for use as water/weather-resistive barriers, compatible with substrate, and complying with physical and performance criteria of ICC-ES AC209 **OR** ICC-ES AC212, **as directed**.
   a. Sheathing Joint Tape **OR** Compound and Tape, **as directed**: Type recommended by EIFS manufacturer for sealing joints between and penetrations through sheathing.

b. VOC Content of Coatings Used as Insulation Adhesive: 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

4. Primer/Sealer: EIFS manufacturer's standard substrate conditioner with VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), designed to seal substrates from moisture penetration and to improve the bond between substrate of type indicated and adhesive used for application of insulation.
5. Flexible-Membrane Flashing: Cold-applied, fully self-adhering, self-healing, rubberized-asphalt and polyethylene-film composite sheet or tape and primer; EIFS manufacturer's standard or product recommended in writing by EIFS manufacturer.
6. Drainage Mat: Three-dimensional, nonwoven, entangled filament, nylon or plastic **OR** Woven or fused, self-furring, PVC mesh lath, **as directed**, mat designed to drain incidental moisture by gravity; EIFS manufacturer's standard or product recommended in writing by EIFS manufacturer with manufacturer's standard corrosion-resistant mechanical fasteners suitable for intended substrate.
7. Spacers: Closed-cell polyethylene **OR** Woven or fused, self-furring, PVC mesh lath, **as directed** furring strips; EIFS manufacturer's standard or product recommended in writing by EIFS manufacturer with manufacturer's standard corrosion-resistant mechanical fasteners suitable for intended substrate.
8. Insulation Adhesive: EIFS manufacturer's standard formulation designed for indicated use; compatible with substrate; with VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24); and complying with one of the following:
   a. Job-mixed formulation of portland cement complying with ASTM C 150, Type I, and polymer-based adhesive specified for base coat.
   b. Factory-blended dry formulation of portland cement, dry polymer admixture, and fillers specified for base coat.
   c. Factory-mixed noncementitious formulation designed for adhesive attachment of insulation to substrates of type indicated, as recommended by EIFS manufacturer.
9. Molded, Rigid Cellular Polystyrene Board Insulation: Comply with ASTM C 578, Type I; EIFS manufacturer's requirements; and EIMA's "EIMA Guideline Specification for Expanded Polystyrene (EPS) Insulation Board" for most stringent requirements for material performance and qualities of insulation, including dimensions and permissible variations, and the following:
   a. Aging: Before cutting and shipping, age insulation in block form by air drying for not less than six weeks or by another method approved by EIMA that produces equivalent results.
   b. Flame-Spread and Smoke-Developed Indexes: 25 and 450 or less, respectively, per ASTM E 84.
   c. Dimensions: Provide insulation boards not more than 24 by 48 inches (610 by 1219 mm) and in thickness indicated but not more than 4 inches (102 mm) thick or less than thickness allowed by ASTM C 1397.
   d. Channeled Board Insulation: EIFS manufacturer's standard factory-fabricated profile with linear, vertical drainage channels, slots, or waves on the back side of board.
   e. Board Insulation Closure Blocks: EIFS manufacturer's standard density, size, and configuration.
   f. Foam Shapes: Provide with profiles and dimensions indicated on Drawings.
10. Reinforcing Mesh: Balanced, alkali-resistant, open-weave, glass-fiber mesh treated for compatibility with other EIFS materials, made from continuous multiend strands with retained mesh tensile strength of not less than 120 lbf/in. (21 dN/cm) per ASTM E 2098 **OR** EIMA 105.01, **as directed**; complying with ASTM D 578 and the following:
    a. Standard-Impact Reinforcing Mesh: Not less than 4.0 oz./sq. yd. (136 g/sq. m).
    b. Intermediate-Impact Reinforcing Mesh: Not less than 10 oz./sq. yd. (339 g/sq. m) **OR** 12.0 oz./sq. yd. (407 g/sq. m), **as directed**.
    c. High-Impact Reinforcing Mesh: Not less than 15 oz./sq. yd. (509 g/sq. m).
    d. Heavy-Duty Reinforcing Mesh: Not less than 20 oz./sq. yd. (678 g/sq. m).
    e. Strip Reinforcing Mesh: Not less than 3.75 oz./sq. yd. (127 g/sq. m).
    f. Detail Reinforcing Mesh: Not less than 4.0 oz./sq. yd. (136 g/sq. m).

g. Corner Reinforcing Mesh: Not less than 7.2 oz./sq. yd. (244 g/sq. m).

11. Base-Coat Materials: EIFS manufacturer's standard mixture complying with one of the following requirements:
    a. Job-mixed formulation of portland cement complying with ASTM C 150, Type I, white or natural color; and manufacturer's standard polymer-emulsion adhesive designed for use with portland cement.
    b. Job-combined formulation of manufacturer's standard polymer-emulsion adhesive and manufacturer's standard dry mix containing portland cement.
    c. Factory-blended dry formulation of portland cement, dry polymer admixture, and inert fillers to which only water is added at Project site.
    d. Factory-mixed noncementitious formulation of polymer-emulsion adhesive and inert fillers that is ready to use without adding other materials.
12. Waterproof Adhesive/Base-Coat Materials: EIFS manufacturer's standard waterproof formulation with VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), complying with one of the following:
    a. Job-mixed formulation of portland cement complying with ASTM C 150, Type I, white or natural color; and manufacturer's standard polymer-emulsion adhesive designed for use with portland cement.
    b. Job-combined formulation of manufacturer's standard polymer-emulsion adhesive and manufacturer's standard dry mix containing portland cement.
13. Primer: EIFS manufacturer's standard factory-mixed, elastomeric-polymer primer for preparing base-coat surface for application of finish coat.
14. Finish-Coat Materials: EIFS manufacturer's standard acrylic-based coating **OR** standard acrylic-based coating with enhanced mildew resistance **OR** siliconized acrylic-based coating, **as directed**, complying with the following:
    a. Factory-mixed formulation of polymer-emulsion binder, colorfast mineral pigments, sound stone particles, and fillers.
    b. Factory-mixed formulation of polymer-emulsion binder, colorfast mineral pigments, and fillers used with stone particles for embedding in finish coat to produce an applied-aggregate finish.
        1) Aggregate: Marble chips of size and as selected by the Owner from manufacturer's full range.
    c. Sealer: Manufacturer's waterproof, clear acrylic-based sealer for protecting finish coat.
    d. Colors: As selected by the Owner from manufacturer's full range.
15. Water: Potable.
16. Mechanical Fasteners: EIFS manufacturer's standard corrosion-resistant fasteners consisting of thermal cap, standard washer and shaft attachments, and fastener indicated below; selected for properties of pullout, tensile, and shear strength required to resist design loads of application indicated; capable of pulling fastener head below surface of insulation board; and of the following description:
    a. For attachment to steel studs from 0.033 to 0.112 inch (0.84 to 2.84 mm) in thickness, provide steel drill screws complying with ASTM C 954.
    b. For attachment to light-gage steel framing members not less than 0.0179 inch (0.45 mm) in thickness, provide steel drill screws complying with ASTM C 1002.
    c. For attachment to wood framing members and plywood sheathing, provide steel drill screws complying with ASTM C 1002, Type W.
    d. For attachment to masonry and concrete substrates, provide sheathing dowel in form of a plastic wing-tipped fastener with thermal cap, sized to fit insulation thickness indicated and to penetrate substrate to depth required to secure anchorage.
    e. For attachment, provide manufacturer's standard fasteners suitable for substrate.
17. Trim Accessories: Type as designated or required to suit conditions indicated and to comply with EIFS manufacturer's written instructions; manufactured from UV-stabilized PVC; and complying with ASTM D 1784, manufacturer's standard Cell Class for use intended, and ASTM C 1063.

a. Casing Bead: Prefabricated, one-piece type for attachment behind insulation, of depth required to suit thickness of coating and insulation, with face leg perforated for bonding to coating and back leg.
b. Drip Screed/Track: Prefabricated, one-piece type for attachment behind insulation with face leg extended to form a drip, of depth required to suit thickness of coating and insulation, with face leg perforated for bonding to coating and back leg.
c. Weep Screed/Track: Prefabricated, one-piece type for attachment behind insulation with perforated face leg extended to form a drip and weep holes in track bottom, of depth required to suit thickness of coating and insulation, with face leg perforated for bonding to coating and back leg; designed to drain incidental moisture that gets into wall construction to the exterior at terminations of EIFS with drainage.
d. Expansion Joint: Prefabricated, one-piece V profile; designed to relieve stress of movement.
e. Window Sill Flashing: Prefabricated type for both flashing and sloping sill over framing beneath windows; with end and back dams; designed to direct water to exterior.
f. Parapet Cap Flashing: Type for both flashing and covering parapet top with design complying with ASTM C 1397.

B. Elastomeric Sealants
1. Elastomeric Sealant Products: Provide EIFS manufacturer's listed and recommended chemically curing, elastomeric sealant that is compatible with joint fillers, joint substrates, and other related materials, and complies with requirements for products and testing indicated in ASTM C 1481 and with requirements in Division 07 Section "Joint Sealants" for products corresponding to description indicated below:
a. Multicomponent, nonsag urethane sealant.
b. Single-component, nonsag, neutral-curing silicone sealant.
c. Provide sealants, for use inside the weatherproofing system, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Preformed Foam Sealant Products: Provide sealant compatible with adjacent materials and complying with requirements in Division 07 Section "Joint Sealants".
3. Sealant Color: As selected by the Owner from manufacturer's full range.

C. Mixing
1. General: Comply with EIFS manufacturer's requirements for combining and mixing materials. Do not introduce admixtures, water, or other materials except as recommended by EIFS manufacturer. Mix materials in clean containers. Use materials within time period specified by EIFS manufacturer or discard.

1.3 EXECUTION

A. Preparation
1. Protect contiguous work from moisture deterioration and soiling caused by application of EIFS. Provide temporary covering and other protection needed to prevent spattering of exterior finish coats on other work.
2. Protect EIFS, substrates, and wall construction behind them from inclement weather during installation. Prevent penetration of moisture behind drainage plane of EIFS and deterioration of substrates.
3. Prepare and clean substrates to comply with EIFS manufacturer's written instructions to obtain optimum bond between substrate and adhesive for insulation.

B. Exterior Cement-Board Installation
1. Exterior Cement Board: Install on metal framing to comply with cement-board manufacturer's written instructions and evaluation report acceptable to authorities having jurisdiction. Install

board with steel drill screws spaced no more than 8 inches (203 mm) o.c. along framing with perimeter fasteners at least 3/8 inch (9.6 mm) but less than 5/8 inch (15.9 mm) from edges of boards.

C. EIFS Installation, General
1. Comply with EIFS manufacturer's written instructions for installation of EIFS as applicable to each type of substrate indicated.

D. Substrate Protection Application
1. Primer/Sealer: Apply over gypsum sheathing substrates to protect substrates from degradation and where required by EIFS manufacturer for improving adhesion of insulation to substrate.
2. Water-Resistive Coatings: Apply over substrates to protect substrates from degradation and to provide water-/weather-resistive barrier.
   a. Tape and seal joints, exposed edges, terminations, and inside and outside corners of sheathing unless otherwise indicated by EIFS manufacturer's written instructions.
3. Waterproof Adhesive/Base Coat: Apply over sloped surfaces **OR** window sills **OR** parapets **OR** where indicated on Drawings, **as directed**, to protect substrates from degradation.
4. Flexible-Membrane Flashing: Install over weather-resistive barrier, applied and lapped to shed water; seal at openings, penetrations, terminations, and where indicated by EIFS manufacturer's written instructions to protect wall assembly from degradation. Prime substrates, if required, and install flashing to comply with EIFS manufacturer's written instructions and details.

E. Trim Installation
1. Trim: Apply trim accessories at perimeter of EIFS, at expansion joints, at window sills, and elsewhere as indicated, according to EIFS manufacturer's written instructions. Coordinate with installation of insulation.
   a. Weep Screed/Track: Use at bottom termination edges, at window and door heads, and at floor line expansion joints of water-drainage EIFS unless otherwise indicated.
   b. Window Sill Flashing: Use at windows unless otherwise indicated.
   c. Expansion Joint: Use where indicated on Drawings.
   d. Casing Bead: Use at other locations.
   e. Parapet Cap Flashing: Use where indicated on Drawings.

F. Drainage Mat Installation
1. Drainage Mat: Apply wrinkle free, continuously, with edges butted **OR** overlapped, **as directed**, and adhesively secured **OR** mechanically secured with fasteners, **as directed**, over water-/weather-resistive barrier according to manufacturer's written instructions.

G. Insulation Installation
1. Board Insulation: Adhesively **OR** Mechanically **OR** Adhesively and mechanically, **as directed**, attach insulation to substrate in compliance with ASTM C 1397, EIFS manufacturer's written instructions, and the following:
   a. Apply adhesive to insulation by notched-trowel method in a manner that results in coating the entire surface of sheathing with adhesive once insulation is adhered to sheathing unless EIFS manufacturer's written instructions specify using primer/sealer with ribbon-and-dab method. Apply adhesive to a thickness of not less than 1/4 inch (6.4 mm) for factory mixed and not less than 3/8 inch (9.6 mm) for field mixed, measured from surface of insulation before placement.
   b. Apply adhesive to insulation by notched-trowel method in a manner that results in coating the entire surface of drainage mat with adhesive once insulation is adhered to drainage mat.
   c. Apply adhesive to ridges on back of insulation by notched-trowel method in a manner that results in full adhesive contact over the entire surface of ridges, leaving channels free of adhesive once insulation is adhered to substrate.

d. Press and slide insulation into place. Apply pressure over the entire surface of insulation to accomplish uniform contact, high initial grab, and overall level surface.
e. Allow adhered insulation to remain undisturbed for period recommended by EIFS manufacturer, but not less than 24 hours, before installing mechanical fasteners, beginning rasping and sanding insulation, or applying base coat and reinforcing mesh.
f. Mechanically attach insulation to substrate by method complying with EIFS manufacturer's written instructions. Install top surface of fastener heads flush with plane of insulation. Install fasteners into or through substrates with the following minimum penetration:
   1) Steel Framing: 5/16 inch (8 mm).
   2) Wood Framing: 1 inch (25 mm).
   3) Concrete and Masonry: 1 inch (25 mm).
g. Apply insulation over drainage mat and dry substrates in courses with long edges of boards oriented horizontally.
h. Begin first course of insulation from a level base line and work upward.
i. Begin first course of insulation from screed/track and work upward. Work from perimeter casing beads toward interior of panels if possible.
j. Stagger vertical joints of insulation boards in successive courses to produce running bond pattern. Locate joints so no piece of insulation is less than 12 inches (300 mm) wide or 6 inches (150 mm) high. Offset joints not less than 6 inches (150 mm) from corners of window and door openings and not less than 4 inches (100 mm) from aesthetic reveals.
   1) Adhesive Attachment: Offset joints of insulation not less than 6 inches (150 mm) from horizontal and 4 inches (100 mm) from vertical joints in sheathing.
   2) Mechanical Attachment: Offset joints of insulation from horizontal joints in sheathing.
k. Place insulation with adhesive strips and channels, slots, or waves aligned in the vertical position for drainage. Align drainage channels, slots, or waves with channels, slots, or waves in insulation boards above and below.
l. Interlock ends at internal and external corners.
m. Abut insulation tightly at joints within and between each course to produce flush, continuously even surfaces without gaps or raised edges between boards. If gaps greater than 1/16 inch (1.6 mm) occur, fill with insulation cut to fit gaps exactly; insert insulation without using adhesive or other material.
n. Cut insulation to fit openings, corners, and projections precisely and to produce edges and shapes complying with details indicated.
o. Rasp or sand flush entire surface of insulation to remove irregularities projecting more than 1/32 inch (0.8 mm) **OR** 1/16 inch (1.6 mm), **as directed**, from surface of insulation and to remove yellowed areas due to sun exposure; do not create depressions deeper than 1/16 inch (1.6 mm).
p. Cut aesthetic reveals in outside face of insulation with high-speed router and bit configured to produce grooves, rabbets, and other features that comply with profiles and locations indicated. Do not reduce insulation thickness at aesthetic reveals to less than 3/4 inch (19 mm).
q. Install foam shapes and attach to sheathing **OR** structure, **as directed**.
r. Interrupt insulation for expansion joints where indicated.
s. Install insulation closure blocks using ribbon-and-dab method to create air zones where indicated.
t. Form joints for sealant application by leaving gaps between adjoining insulation edges and between insulation edges and dissimilar adjoining surfaces. Make gaps wide enough to produce joint widths indicated after encapsulating joint substrates with base coat and reinforcing mesh.
u. Form joints for sealant application with back-to-back casing beads for joints within EIFS and with perimeter casing beads at dissimilar adjoining surfaces. Make gaps between casing beads and between perimeter casing beads and adjoining surfaces of width indicated.

v. After installing insulation and before applying field-applied reinforcing mesh, fully wrap board edges. Cover edges of board and extend encapsulating mesh not less than 2-1/2 inches (64 mm) over front and back face unless otherwise indicated on Drawings.
w. Treat exposed edges of insulation as follows:
   1) Except for edges forming substrates of sealant joints, encapsulate with base coat, reinforcing mesh, and finish coat.
   2) Encapsulate edges forming substrates of sealant joints within EIFS or between EIFS and other work with base coat and reinforcing mesh.
   3) At edges trimmed by accessories, extend base coat, reinforcing mesh, and finish coat over face leg of accessories.
x. Coordinate installation of flashing and insulation to produce wall assembly that does not allow water to penetrate behind flashing and water-/weather-resistive barrier.

2. Expansion Joints: Install at locations indicated, where required by EIFS manufacturer, and as follows:
   a. At expansion joints in substrates behind EIFS.
   b. Where EIFS adjoin dissimilar substrates, materials, and construction, including other EIFS.
   c. At floor lines in multilevel wood-framed construction.
   d. Where wall height or building shape changes.
   e. Where EIFS manufacturer requires joints in long continuous elevations.

H. Base-Coat Installation
1. Base Coat: Apply to exposed surfaces of insulation and foam shapes in minimum thickness recommended in writing by EIFS manufacturer, but not less than 1/16-inch (1.6-mm) dry-coat thickness.
2. Reinforcing Mesh: Embed type indicated below in wet base coat to produce wrinkle-free installation with mesh continuous at corners and overlapped not less than 2-1/2 inches (64 mm) or otherwise treated at joints to comply with ASTM C 1397 and EIFS manufacturer's written instructions. Do not lap reinforcing mesh within 8 inches (204 mm) of corners. Completely embed mesh, applying additional base-coat material if necessary, so reinforcing-mesh color and pattern are not visible.
   a. Standard-impact reinforcing mesh unless otherwise indicated.
   b. Intermediate-impact reinforcing mesh where indicated.
   c. High-impact reinforcing mesh where indicated.
   d. Heavy-duty reinforcing mesh where indicated.
3. Double-Layer Reinforcing Mesh Application: Where indicated, apply second base coat and second layer of standard-impact **OR** intermediate-impact, **as directed**, reinforcing mesh, overlapped not less than 2-1/2 inches (64 mm) or otherwise treated at joints to comply with ASTM C 1397 and EIFS manufacturer's written instructions in same manner as first application. Do not apply until first base coat has cured.
4. Additional Reinforcing Mesh: Apply strip reinforcing mesh around openings extending 4 inches (100 mm) beyond perimeter. Apply additional 9-by-12-inch (230-by-300-mm) strip reinforcing mesh diagonally at corners of openings (re-entrant corners). Apply 8-inch- (200-mm-) wide strip reinforcing mesh at both inside and outside corners unless base layer of mesh is lapped not less than 4 inches (100 mm) on each side of corners.
   a. At aesthetic reveals, apply strip reinforcing mesh not less than 8 inches (200 mm) wide.
   b. Embed strip reinforcing mesh in base coat before applying first layer of reinforcing mesh.
5. Foam Shapes: Fully embed reinforcing mesh in base coat.
6. Double Base-Coat Application: Where indicated, apply second base coat in same manner and thickness as first application except without reinforcing mesh. Do not apply until first base coat has cured.

I. Finish-Coat Installation
1. Primer: Apply over dry base coat according to EIFS manufacturer's written instructions.

2. Finish Coat: Apply over dry primed base coat, maintaining a wet edge at all times for uniform appearance, in thickness required by EIFS manufacturer to produce a uniform finish of color and texture matching approved sample and free of cold joints, shadow lines, and texture variations.
   a. Texture: As selected by the Owner from manufacturer's full range.
   b. Embed aggregate in finish coat according to EIFS manufacturer's written instructions to produce a uniform applied-aggregate finish of color and texture matching approved sample.
3. Sealer Coat: Apply over dry finish coat, in number of coats and thickness required by EIFS manufacturer.

J. Installation Of Joint Sealants
1. Prepare joints and apply sealants, of type and at locations indicated, to comply with applicable requirements in Division 07 Section "Joint Sealants" and in ASTM C 1481.
   a. Apply joint sealants after base coat has cured but before applying finish coat.
   b. Clean surfaces to receive sealants to comply with indicated requirements and EIFS manufacturer's written instructions.
   c. Apply primer recommended in writing by sealant manufacturer for surfaces to be sealed.
   d. Install sealant backing to control depth and configuration of sealant joint and to prevent sealant from adhering to back of joint.
   e. Apply masking tape to protect areas adjacent to sealant joints. Remove tape immediately after tooling joints, without disturbing joint seal.
   f. Recess sealant sufficiently from surface of EIFS so an additional sealant application, including cylindrical sealant backing, can be installed without protruding beyond EIFS surface.

K. Field Quality Control
1. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
   a. According to ICC-ES AC24 **OR** ICC-ES AC235, **as directed**.
2. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
3. EIFS Tests and Inspections: For the following:
   a. According to ICC-ES AC24 **OR** ICC-ES AC235, **as directed**.
4. Remove and replace EIFS where test results indicate that EIFS do not comply with specified requirements.
5. Prepare test and inspection reports.

L. Cleaning And Protection
1. Remove temporary covering and protection of other work. Promptly remove coating materials from window and door frames and other surfaces outside areas indicated to receive EIFS coatings.

END OF SECTION 07 24 13 00a

Task	Specification	Specification Description
07 26 13 00	06 10 00 00	Rough Carpentry

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SECTION 07 31 13 13 - ASPHALT SHINGLES

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for asphalt shingles. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Asphalt shingles.
b. Underlayment.

C. Definition
1. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

D. Submittals
1. Product Data: For each type of product indicated.
2. Samples: For each exposed product and for each color and blend specified.
3. Product test reports.
4. Research/evaluation reports.
5. Maintenance data.
6. Warranties: Sample of special warranties.

E. Quality Assurance
1. Fire-Resistance Characteristics: Where indicated, provide asphalt shingles and related roofing materials identical to those of assemblies tested for fire resistance per test method below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.
a. Exterior Fire-Test Exposure: Class A **OR** Class C, **as directed**; ASTM E 108 or UL 790, for application and roof slopes indicated.
2. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Store roofing materials in a dry, well-ventilated, weathertight location according to asphalt shingle manufacturer's written instructions. Store underlayment rolls on end on pallets or other raised surfaces. Do not double stack rolls.
a. Handle, store, and place roofing materials in a manner to avoid significant or permanent damage to roof deck or structural supporting members.
2. Protect unused underlayment from weather, sunlight, and moisture when left overnight or when roofing work is not in progress.

G. Warranty
1. Special Warranty: Standard form in which manufacturer agrees to repair or replace asphalt shingles that fail in materials or workmanship within specified warranty period.
a. Material Warranty Period: 25 **OR** 30 **OR** 35 **OR** 40, **as directed**, years from date of Final Completion, prorated, with first three **OR** five **OR** 12, **as directed**, years nonprorated.
b. Wind-Speed Warranty Period: Asphalt shingles will resist blow-off or damage caused by wind speeds up to 60 mph (27 m/s) **OR** 75 mph (33 m/s) **OR** 80 mph (36 m/s) **OR** 100 mph (45 m/s), **as directed**, for five **OR** 10, **as directed**, years from date of Final Completion.

c. Algae-Discoloration Warranty Period: Asphalt shingles will not discolor five **OR** 10, **as directed**, years from date of Final Completion.
d. Workmanship Warranty Period: 10 **OR** 12, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Glass-Fiber-Reinforced Asphalt Shingles
1. Laminated-Strip Asphalt Shingles: ASTM D 3462, laminated, multi-ply overlay construction, glass-fiber reinforced, mineral-granule surfaced, and self-sealing.
   a. Butt Edge: Straight **OR** Notched **OR** Crenelated, **as directed**, cut.
   b. Strip Size: Manufacturer's standard.
   c. Algae Resistance: Granules treated to resist algae discoloration.
   d. Color and Blends: As selected by the Owner from manufacturer's full range.
2. Laminated-Strip, SBS-Modified Asphalt Shingles: ASTM D 3462, laminated, multi-ply overlay construction, glass-fiber reinforced, mineral-granule surfaced, and self-sealing; complying with UL 2218, Class IV.
   a. Butt Edge: Straight **OR** Notched **OR** Crenelated, **as directed**, cut.
   b. Strip Size: Manufacturer's standard.
   c. Algae Resistance: Granules treated to resist algae discoloration.
   d. Color and Blends: As selected by the Owner from manufacturer's full range.
3. Multitab-Strip Asphalt Shingles: ASTM D 3462, glass-fiber reinforced, mineral-granule surfaced, and self-sealing.
   a. Tab Arrangement: Three tabs, regularly spaced **OR** Four tabs, regularly spaced **OR** Five tabs, randomly spaced, **as directed**.
   b. Cutout Shape: Square **OR** Tapered, **as directed**.
   c. Butt Edge: Straight **OR** Stagger, **as directed**, cut.
   d. Strip Size: Manufacturer's standard.
   e. Algae Resistance: Granules treated to resist algae discoloration.
   f. Color and Blends: As selected by the Owner from manufacturer's full range.
4. Three-Tab-Strip, SBS-Modified Asphalt Shingles: ASTM D 3462, glass-fiber reinforced, mineral-granule surfaced, and self-sealing; complying with UL 2218, Class IV.
   a. Strip Size: Manufacturer's standard.
   b. Algae Resistance: Granules treated to resist algae discoloration.
   c. Color and Blends: As selected by the Owner from manufacturer's full range.
5. No-Cutout-Strip Asphalt Shingles: ASTM D 3462, glass-fiber reinforced, mineral-granule surfaced, self-sealing, square, and single tab.
   a. Butt Edge: Stagger **OR** Straight, **as directed**, cut.
   b. Strip Size: Manufacturer's standard.
   c. Algae Resistance: Granules treated to resist algae discoloration.
   d. Color and Blends: As selected by the Owner from manufacturer's full range.
6. Hip and Ridge Shingles: Manufacturer's standard units to match asphalt shingles **OR** Site-fabricated units cut from asphalt shingle strips. Trim each side of lapped portion of unit to taper approximately 1 inch (25 mm), **as directed**.

B. Organic-Felt-Reinforced Asphalt Shingles
1. Laminated-Strip Asphalt Shingles: ASTM D 225, laminated, multi-ply overlay construction, organic-felt reinforced, mineral-granule surfaced, and self-sealing; complying with requirements in ASTM D 3161 for wind resistance.
   a. Butt Edge: Straight **OR** Notched **OR** Crenelated, **as directed**, cut.
   b. Strip Size: Manufacturer's standard.
   c. Algae Resistance: Granules treated to resist algae discoloration.
   d. Color and Blends: As selected by the Owner from manufacturer's full range.

2. Multitab-Strip Asphalt Shingles: ASTM D 225, organic-felt reinforced, mineral-granule surfaced, and self-sealing; complying with requirements in ASTM D 3161 for wind resistance.
   a. Tab Arrangement: Three tabs, regularly spaced **OR** Four tabs, regularly spaced **OR** Six tabs, regularly spaced, scalloped edge, **as directed**.
   b. Strip Size: Manufacturer's standard.
   c. Algae Resistance: Granules treated to resist algae discoloration.
   d. Color and Blends: As selected by the Owner from manufacturer's full range.
3. No-Cutout-Strip Asphalt Shingles: ASTM D 225, organic-felt reinforced, mineral-granule surfaced, self-sealing, square, and single tab; complying with requirements in ASTM D 3161 for wind resistance.
   a. Butt Edge: Stagger **OR** Straight, **as directed**, cut.
   b. Strip Size: Manufacturer's standard.
   c. Color and Blends: As selected by the Owner from manufacturer's full range.
4. Hip and Ridge Shingles: Manufacturer's standard units to match asphalt shingles **OR** Site-fabricated units cut from asphalt shingle strips. Trim each side of lapped portion of unit to taper approximately 1 inch (25 mm), **as directed**.

C. Underlayment Materials
1. Felt: ASTM D 226 **OR** ASTM D 4869, **as directed**, Type I **OR** Type II, **as directed**, asphalt-saturated organic felts, nonperforated.
2. Self-Adhering Sheet Underlayment, Granular Surfaced: ASTM D 1970, minimum of 55-mil- (1.4-mm-) thick sheet; glass-fiber-mat-reinforced, SBS-modified asphalt; mineral-granule surfaced; with release paper backing; cold applied. Provide primer for adjoining concrete or masonry surfaces to receive underlayment.
3. Self-Adhering Sheet Underlayment, Polyethylene Faced: ASTM D 1970, minimum of 40-mil- (1.0-mm-) thick, slip-resisting, polyethylene-film-reinforced top surface laminated to SBS-modified asphalt adhesive, with release paper backing; cold applied. Provide primer for adjoining concrete or masonry surfaces to receive underlayment.
4. Self-Adhering Sheet Underlayment, High Temperature: Minimum of 30- to 40-mil- (0.76- to 1.0-mm-) thick, slip-resisting, polyethylene-film-reinforced top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release paper backing; cold applied. Provide primer for adjoining concrete or masonry surfaces to receive underlayment.
   a. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D 1970.
   b. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (29 deg C); ASTM D 1970.
5. Granular-Surfaced Valley Lining: ASTM D 6380, Class M, organic-felt-based **OR** ASTM D 3909, mineral-granular-surfaced, glass-felt-based, **as directed**, asphalt roll roofing; 36 inches (914 mm) wide.

D. Ridge Vents
1. Rigid Ridge Vent: Manufacturer's standard, rigid section high-density polypropylene or other UV-stabilized plastic ridge vent with nonwoven geotextile filter strips and external deflector baffles; for use under ridge shingles.
2. Flexible Ridge Vent: Manufacturer's standard, compression-resisting, three-dimensional, open-nylon or polyester-mat filter bonded to a nonwoven, nonwicking, geotextile fabric cover.

E. Accessories
1. Asphalt Roofing Cement: ASTM D 4586, Type II, asbestos free.
2. Roofing Nails: ASTM F 1667; aluminum, stainless-steel, copper, or hot-dip galvanized-steel wire shingle nails, minimum 0.120-inch- (3-mm-) diameter, barbed **OR** smooth, **as directed**, shank, sharp-pointed, with a minimum 3/8-inch- (9.5-mm-) diameter flat head and of sufficient length to penetrate 3/4 inch (19 mm) into solid wood decking or extend at least 1/8 inch (3 mm) through OSB or plywood sheathing.
   a. Where nails are in contact with metal flashing, use nails made from same metal as flashing.

3. Felt Underlayment Nails: Aluminum, stainless-steel, or hot-dip galvanized-steel wire with low-profile capped heads or disc caps, 1-inch (25-mm) minimum diameter.

F. Metal Flashing And Trim
1. General: Comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim".
   a. Sheet Metal: Copper **OR** Stainless steel **OR** Zinc-tin alloy-coated stainless steel **OR** Zinc-tin alloy-coated steel **OR** Zinc-tin alloy-coated copper **OR** Anodized aluminum **OR** Aluminum, mill finished, **as directed**.
2. Fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of the item.
   a. Apron Flashings: Fabricate with lower flange a minimum of 4 inches (100 mm) **OR** 5 inches (125 mm), **as directed**, over and 4 inches (100 mm) beyond each side of downslope asphalt shingles and 6 inches (150 mm) up the vertical surface.
   b. Step Flashings: Fabricate with a headlap of 2 inches (50 mm) and a minimum extension of 4 inches (100 mm) **OR** 5 inches (125 mm), **as directed**, over the underlying asphalt shingle and up the vertical surface.
   c. Cricket **OR** Backer, **as directed**, Flashings: Fabricate with concealed flange extending a minimum of 18 inches (450 mm) **OR** 24 inches (600 mm), **as directed**, beneath upslope asphalt shingles and 6 inches (150 mm) beyond each side of chimney **OR** skylight, **as directed**, and 6 inches (150 mm) above the roof plane.
   d. Open-Valley Flashings: Fabricate in lengths not exceeding 10 feet (3 m) with 1-inch- (25-mm-) high, inverted-V profile at center of valley and equal flange widths of 10 inches (250 mm) **OR** 12 inches (300 mm), **as directed**.
   e. Drip Edges: Fabricate in lengths not exceeding 10 feet (3 m) with 2-inch (50-mm) roof-deck flange and 1-1/2-inch (38-mm) fascia flange with 3/8-inch (9.6-mm) drip at lower edge.
3. Vent Pipe Flashings: ASTM B 749, Type L51121, at least 1/16 inch (1.6 mm) thick. Provide lead sleeve sized to slip over and turn down into pipe, soldered to skirt at slope of roof, and extending at least 4 inches (100 mm) from pipe onto roof.

1.3 EXECUTION

A. Underlayment Installation
1. General: Comply with underlayment manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.
2. Single-Layer Felt Underlayment: Install on roof deck parallel with and starting at the eaves. Lap sides a minimum of 2 inches (50 mm) over underlying course. Lap ends a minimum of 4 inches (100 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment **OR** roofing, **as directed**, nails.
   a. Install felt underlayment on roof deck not covered by self-adhering sheet underlayment. Lap sides of felt over self-adhering sheet underlayment not less than 3 inches (75 mm) in direction to shed water. Lap ends of felt not less than 6 inches (150 mm) over self-adhering sheet underlayment.
   b. Install fasteners at no more than 36 inch (900 mm) o.c. where the basic wind speed is equal to or greater than 110 mph (176 km/h).
3. Double-Layer Felt Underlayment: Install on roof deck parallel with and starting at the eaves. Install a 19-inch- (485-mm-) wide starter course at eaves and completely cover with full-width second course. Install succeeding courses lapping previous courses 19 inches (485 mm) in shingle fashion. Lap ends a minimum of 6 inches (150 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment **OR** roofing, **as directed**, nails.

a. Apply a continuous layer of asphalt roofing cement over starter course and on felt underlayment surface to be concealed by succeeding courses as each felt course is installed. Apply over entire roof **OR** at locations indicated on Drawings, **as directed**.
b. Install felt underlayment on roof sheathing not covered by self-adhering sheet underlayment. Lap edges over self-adhering sheet underlayment not less than 3 inches (75 mm) in direction to shed water.
c. Terminate felt underlayment flush **OR** extended up not less than 4 inches (100 mm), **as directed**, against sidewalls, curbs, chimneys, and other roof projections.
d. Install fasteners at no more than 36 inch (900 mm) o.c. where the basic wind speed is equal to or greater than 110 mph (176 km/h).

4. Self-Adhering Sheet Underlayment: Install, wrinkle free, on roof deck. Comply with low-temperature installation restrictions of underlayment manufacturer if applicable. Install at locations indicated below **OR** on Drawings, **as directed**, lapped in direction to shed water. Lap sides not less than 3-1/2 inches (89 mm). Lap ends not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses. Roll laps with roller. Cover underlayment within seven days.
   a. Prime concrete and masonry surfaces to receive self-adhering sheet underlayment.
   b. Eaves: Extend from edges of eaves 24 inches (600 mm) **OR** 36 inches (914 mm), **as directed**, beyond interior face of exterior wall.
   c. Rakes: Extend from edges of rake 24 inches (600 mm) **OR** 36 inches (914 mm), **as directed**, beyond interior face of exterior wall.
   d. Valleys: Extend from lowest to highest point 18 inches (450 mm) on each side.
   e. Hips: Extend 18 inches (450 mm) on each side.
   f. Ridges: Extend 36 inches (914 mm) on each side without obstructing continuous ridge vent slot.
   g. Sidewalls: Extend beyond sidewall 18 inches (450 mm), and return vertically against sidewall not less than 4 inches (100 mm).
   h. Dormers, Chimneys, Skylights, and Other Roof-Penetrating Elements: Extend beyond penetrating element 18 inches (450 mm), and return vertically against penetrating element not less than 4 inches (100 mm).
   i. Roof Slope Transitions: Extend 18 inches (450 mm) on each roof slope.
5. Concealed, Woven **OR** Closed-Cut, **as directed**, Valley Lining: Comply with NRCA's recommendations. Install a 36-inch- (914-mm-) wide felt underlayment centered in valley. Fasten to roof deck with felt underlayment **OR** roofing, **as directed**, nails.
   a. Lap roof-deck felt underlayment over valley felt underlayment at least 6 inches (150 mm).
   b. Install a 36-inch- (914-mm-) wide strip of granular-surfaced valley lining centered in valley, with granular-surface face up. Lap ends of strips at least 12 inches (300 mm) in direction to shed water, and seal with asphalt roofing cement. Fasten to roof deck with roofing nails.
6. Metal-Flashed, Open-Valley Underlayment: Install two layers of 36-inch- (914-mm-) wide felt underlayment centered in valley. Stagger end laps between layers at least 72 inches (1830 mm). Lap ends of each layer at least 12 inches (300 mm) in direction to shed water, and seal with asphalt roofing cement. Fasten each layer to roof deck with felt underlayment **OR** roofing, **as directed**, nails.
   a. Lap roof-deck felt underlayment over first layer of valley felt underlayment at least 6 inches (150 mm).
7. Granular-Surfaced, Open-Valley Lining: Comply with NRCA's recommendations. Install a 36-inch- (914-mm-) wide felt underlayment centered in valley. Fasten to roof deck with felt underlayment **OR** roofing, **as directed**, nails.
   a. Lap roof-deck felt underlayment over valley felt underlayment at least 6 inches (150 mm).
   b. Install an 18-inch- (450-mm-) wide strip of valley lining centered in valley, with granular-surface face down. Install a second 36-inch- (914-mm-) wide strip of valley lining centered in valley, with granular-surface face up. Lap ends of each strip at least 12 inches (300 mm) in direction to shed water, and seal with asphalt roofing cement. Stagger end laps between succeeding strips at least 72 inches (1830 mm). Fasten each strip to roof deck with roofing nails.

B. Metal Flashing Installation
1. General: Install metal flashings and other sheet metal to comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim".
   a. Install metal flashings according to recommendations in ARMA's "Residential Asphalt Roofing Manual" and asphalt shingle recommendations in NRCA's "The NRCA Roofing and Waterproofing Manual."
2. Apron Flashings: Extend lower flange over and beyond each side of downslope asphalt shingles and up the vertical surface.
3. Step Flashings: Install with a headlap of 2 inches (50 mm) and extend over the underlying asphalt shingle and up the vertical surface. Fasten to roof deck only.
4. Cricket **OR** Backer, **as directed**, Flashings: Install against the roof-penetrating element extending concealed flange beneath upslope asphalt shingles and beyond each side.
5. Open-Valley Flashings: Install centered in valleys, lapping ends at least 8 inches (200 mm) in direction to shed water. Fasten upper end of each length to roof deck beneath overlap.
   a. Secure hemmed flange edges into metal cleats spaced 12 inches (300 mm) apart and fastened to roof deck.
   b. Adhere 9-inch- (225-mm-) wide strip of self-adhering sheet to metal flanges and to self-adhering sheet underlayment.
6. Rake Drip Edges: Install rake drip edge flashings over underlayment and fasten to roof deck.
7. Eave Drip Edges: Install eave drip edge flashings below underlayment and fasten to roof sheathing.
8. Pipe Flashings: Form flashing around pipe penetrations and asphalt shingles. Fasten and seal to asphalt shingles as recommended by manufacturer.

C. Asphalt Shingle Installation
1. General: Install asphalt shingles according to manufacturer's written instructions, recommendations in ARMA's "Residential Asphalt Roofing Manual," and asphalt shingle recommendations in NRCA's "The NRCA Roofing and Waterproofing Manual."
2. Install starter strip along lowest roof edge, consisting of an asphalt shingle strip with tabs removed **OR** at least 7 inches (175 mm) wide, **as directed**, with self-sealing strip face up at roof edge.
   a. Extend asphalt shingles 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, over fasciae at eaves and rakes.
   b. Install starter strip along rake edge.
3. For Three-Tab- And Other Multitab-Strip Asphalt Shingles: Install first and remaining courses of asphalt shingles stair-stepping diagonally across roof deck with 4-inch (100-mm) **OR** 5-inch (125-mm) **OR** 6-inch (150-mm) **OR** 1/2-tab **OR** 1/3-tab **OR** manufacturer's recommended, **as directed**, offset pattern at succeeding courses, maintaining uniform exposure.
4. For Laminated-Strip And No-Cutout-Strip Asphalt Shingles: Install first and remaining courses of asphalt shingles stair-stepping diagonally across roof deck with manufacturer's recommended offset pattern at succeeding courses, maintaining uniform exposure.
5. Install asphalt shingles by single-strip column or racking method, maintaining uniform exposure. Install full-length first course followed by cut second course, repeating alternating pattern in succeeding courses.
6. Fasten asphalt shingle strips with a minimum of four **OR** five **OR** six, **as directed**, roofing nails located according to manufacturer's written instructions.
   a. Where roof slope exceeds 20:12, seal asphalt shingles with asphalt roofing cement spots after fastening with additional roofing nails.
   b. Where roof slope is less than 4:12, seal asphalt shingles with asphalt roofing cement spots.
   c. When ambient temperature during installation is below 50 deg F (10 deg C), seal asphalt shingles with asphalt roofing cement spots.
7. Woven Valleys: Extend succeeding asphalt shingle courses from both sides of valley 12 inches (300 mm) beyond center of valley, weaving intersecting shingle-strip courses over each other. Use one-piece shingle strips without joints in valley.

a. Do not nail asphalt shingles within 6 inches (150 mm) of valley center.

8. Closed-Cut Valleys: Extend asphalt shingle strips from one side of valley 12 inches (300 mm) beyond center of valley. Use one-piece shingle strips without joints in valley. Fasten with extra nail in upper end of shingle. Install asphalt shingle courses from other side of valley and cut back to a straight line 2 inches (50 mm) short of valley centerline. Trim upper concealed corners of cut-back shingle strips.
   a. Do not nail asphalt shingles within 6 inches (150 mm) of valley center.
   b. Set trimmed, concealed-corner asphalt shingles in a 3-inch- (75-mm-) wide bed of asphalt roofing cement.
9. Open Valleys: Cut and fit asphalt shingles at open valleys, trimming upper concealed corners of shingle strips. Maintain uniform width of exposed open valley **OR** Widen exposed portion of open valley 1/8 inch in 12 inches (1:96), **as directed**, from highest to lowest point.
   a. Set valley edge of asphalt shingles in a 3-inch- (75-mm-) wide bed of asphalt roofing cement.
   b. Do not nail asphalt shingles to metal open-valley flashings.
10. Ridge Vents: Install continuous ridge vents over asphalt shingles according to manufacturer's written instructions. Fasten with roofing nails of sufficient length to penetrate sheathing.
11. Ridge and Hip Cap Shingles: Maintain same exposure of cap shingles as roofing shingle exposure. Lap cap shingles at ridges to shed water away from direction of prevailing winds. Fasten with roofing nails of sufficient length to penetrate sheathing.
    a. Fasten ridge cap asphalt shingles to cover ridge vent without obstructing airflow.

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SECTION 07 31 16 00 - METAL SHINGLES

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for metal shingles. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Metal-shingle panels.
      b. Individual metal shingles.
      c. Underlayment.
      d. Ridge vents.
      e. Snow guards.

C. Definitions
   1. Roofing Terminology: See ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

D. Performance Requirements
   1. General Performance: Metal shingles shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
   2. Wind-Uplift Resistance: Provide metal-shingle assemblies that comply with the following wind-uplift requirements.
      a. Class: 15 **OR** 30 **OR** 60 **OR** 90, **as directed**, when tested according to UL 580.
      b. Uplift Resistance: 75 lbf/sq. ft. (3.6 kPa) **OR** 120 lbf/sq. ft. (5.75 kPa) **OR** 165 lbf/sq. ft. (7.9 kPa), **as directed**, when tested according to UL 1897.
   3. Impact Resistance: Class 3 **OR** Class 4, **as directed**, when tested according to UL 2218.
   4. Energy Performance, Solar Reflectance (for LEED-NC Credit SS 7.2): Provide shingles with Solar Reflectance Index not less than 29 when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.
   5. Energy Performance, ENERGY STAR: Provide roofing system that is listed on the DOE's "Roof Products Qualified Product List" for steep-slope roof products.
   6. Recycled Content: Provide metal shingles with recycled content so that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 50 percent by weight.

E. Submittals
   1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.
   2. LEED Submittals:
      a. Product Test Reports for Credit SS 7.2: For metal shingles, documentation indicating compliance with Solar Reflectance Index requirement.
      b. Product Data for Credit(s) MR 4.1 and MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.

3. Shop Drawings: For metal shingles. Show roof plans and wall elevations, **as directed**; sections at hips, gables, ridges, valleys, and eaves; details of metal shingles, flashing, trim, and accessories; and attachments to other work.
4. Samples: Full-size components of each type of metal shingle indicated, including visible accessories.
5. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency or performed by a qualified testing agency, for metal shingles, demonstrating compliance with requirements specified in "Performance Requirements" Article.
6. Warranty: Sample of special warranties.

F. Quality Assurance
1. Source Limitations: Obtain metal shingles from single source from single manufacturer.
2. Fire-Test Exposure Rating: Class A **OR** Class B **OR** Class C, **as directed**; for application and roof slopes indicated, as determined by testing identical products per test method UL 790 or ASTM E 108 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
3. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Do not store metal-shingle materials in contact with other materials that might cause staining, denting, or other surface damage. Store metal-shingle materials away from uncured concrete and masonry.
2. Protect strippable protective covering on metal shingles from exposure to sunlight and high humidity, except to the extent necessary for the period of metal-shingle installation.

H. Project Conditions
1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing to be performed according to manufacturer's written instructions and warranty requirements.
   a. Install self-adhering sheet underlayment within the range of ambient and substrate temperatures recommended by manufacturer.

I. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace metal shingles and accessories that fail in materials within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Structural failures including wind uplift.
      2) Water penetration and hail perforation.
      3) Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   b. Materials-Only Warranty Period: 15 **OR** 25 **OR** 50, **as directed**, years from date of Final Completion.
2. Special Project Warranty: Roofing Installer's Warranty, signed by roofing Installer, covering Work of this Section, in which Installer agrees to repair or replace components of roofing that fail in materials or workmanship within the following warranty period:
   a. Warranty Period: Two **OR** Five, **as directed**, years from date of Final Completion.
3. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal shingles that show evidence of deterioration of factory-applied finishes within specified warranty period.
   a. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
      1) Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      2) Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      3) Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   b. Warranty Period: 10 **OR** 20, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Sheet Metal Materials
1. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.
a. Mill Finish: Uncoated aluminum sheet.
b. High-Performance Organic Coating (Coil-Coated Finishes): Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
1) Two-Coat Fluoropolymer: AAMA 620. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
2) Three-Coat Fluoropolymer: AAMA 620. System consisting of primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent PVDF resin by weight.
3) Concealed Surface: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat and with a minimum total dry film thickness of 0.5 mil (0.013 mm).
2. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 37 (Class AZM150 coating designation, Grade 255); structural quality.
a. Mill Finish: Satin-finish, aluminum-zinc alloy-coated steel sheet without additional coating.
b. Granular-Coating Finish: Entire upper surface of shingle, including flange edges, coated with ceramic-colored quartz granules or crushed stone chips bonded to shingle with a resin adhesive and sealed with a clear overglaze.
3. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
a. Mill Finish: Zinc-coated (galvanized) steel sheet without additional coating **OR** with manufacturer's standard mill-phosphatized finish, **as directed**.
b. High-Performance Organic Coating, (Coil-Coated Finishes): Prepainted by the coil-coating process to comply with ASTM A 755/A 755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
1) Two-Coat Fluoropolymer: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
2) Three-Coat Fluoropolymer: AAMA 621. System consisting of primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent PVDF resin by weight.
4. Copper Sheet: ASTM B 370; Temper H00, cold rolled, unless Temper 060 is required for forming.
a. Mill Finish: Nonpatinated and exposed.
b. Pre-Patinated Finish: Dark brown **OR** Verdigris, **as directed**, pre-patinated according to ASTM B 882.
5. Zinc-Alloy Sheet: Alloy of 99.995 percent pure electrolytic high-grade zinc with alloy additives of copper (0.08 to 0.20 percent), titanium (0.07 to 0.12 percent), and aluminum (0.015 percent) **OR** Zinc alloy consisting of 99 percent pure zinc with 0.08 to 1.00 percent copper, 0.06 to 0.20 percent titanium, and up to 0.015 percent aluminum, **as directed**; with manufacturer's standard factory-applied, flexible, protective back coating.
a. Bright-Rolled Finish: Uncoated, bright-rolled zinc-alloy sheet.
b. Preweathered Finish: Factory-applied preweathering to uniform color.

B. Metal Shingles
1. Aluminum Shingles: Factory-formed, interlocking shingle panels **OR** individual shingles, **as directed**.
a. Shingle Panels: Stamped panels resembling multiple shakes **OR** shingles **OR** Spanish tiles **OR** flat tiles **OR** scalloped tiles, **as directed**.

1) Material: Formed aluminum, 0.020 inch (0.51 mm) thick **OR** 0.032 inch (0.81 mm) thick **OR** thickness as needed to meet performance requirements, **as directed**.
2) Reinforcement: Manufacturer's standard insert material in units to increase rigidity.
3) Exposure: 48 by 12 inches (1219 by 305 mm).
4) Finish: Mill **OR** High-performance organic coating.
5) Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

b. Individual Shingles: Rectangular **OR** Diamond, **as directed**, shingle units.
1) Material: Formed aluminum, 0.020 inch (0.51 mm) thick **OR** 0.032 inch (0.81 mm) thick **OR** thickness as needed to meet performance requirements, **as directed**.
2) Reinforcement: Manufacturer's standard insert material in units to increase rigidity.
3) Exposure: 14 by 14 inches (356 by 356 mm).
4) Finish: Mill **OR** High-performance organic coating, **as directed**.
5) Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

2. Steel Shingles: Factory-formed, interlocking shingle panels **OR** individual shingles, **as directed**.
a. Shingle Panels: Stamped panels resembling multiple shakes **OR** shingles **OR** Spanish tiles **OR** flat tiles **OR** scalloped tiles, **as directed**.
1) Material: Aluminum-zinc alloy-coated **OR** Zinc-coated (galvanized), **as directed**, steel sheet, nominal 0.022 inch (0.56 mm) thick **OR** 0.028 inch (0.71 mm) thick **OR** thickness as needed to meet performance requirements, **as directed**.
2) Exposure: 47-1/4 by 15-13/16 inches (1200 by 402 mm).
3) Finish: Mill **OR** Granular coating **OR** High-performance organic coating, **as directed**.
4) Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

b. Individual Shingles: Rectangular shingle units.
1) Material: Aluminum-zinc alloy coated **OR** Zinc-coated (galvanized), **as directed**, steel sheet, nominal 0.022 inch (0.56 mm) thick **OR** 0.028 inch (0.71 mm) thick **OR** thickness as needed to meet performance requirements, **as directed**.
2) Exposure: 9 by 12 inches (229 by 305 mm).
3) Finish: Mill **OR** Granular coating **OR** High-performance organic coating, **as directed**.
4) Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

3. Copper Shingles: Factory-formed, interlocking shingle panels **OR** individual shingles, **as directed**.
a. Shingle Panels: Stamped panels resembling multiple shakes **OR** shingles, **as directed**.
1) Material: Copper sheet, 12 oz./sq. ft. (0.41 mm thick) **OR** 16 oz./sq. ft. (0.55 mm thick) **OR** weight (thickness) as needed to meet performance requirements, **as directed**.
2) Exposure: 33-1/4 by 10 inches (845 by 254 mm).
3) Finish: Mill **OR** Pre-patinated dark brown **OR** Pre-patinated verdigris, **as directed**.

b. Individual Shingles: Rectangular **OR** Diamond, **as directed**, shingle units.
1) Material: Copper sheet, 12 oz./sq. ft. (0.41 mm thick) **OR** 16 oz./sq. ft. (0.55 mm-thick) **OR** weight (thickness) as needed to meet performance requirements, **as directed**.
2) Exposure: 9-1/2 by 7-1/4 inches (241 by 184 mm).
3) Finish: Mill **OR** Pre-patinated dark brown **OR** Pre-patinated verdigris, **as directed**.

4. Zinc Shingles: Factory-formed, interlocking shingle panels **OR** individual shingles, **as directed**.
a. Shingle Panels: Stamped panels resembling multiple shakes **OR** shingles, **as directed**.
1) Material: Zinc-alloy sheet, 0.027 inch (0.70 mm) thick **OR** thickness as needed to meet performance requirements, **as directed**.
2) Exposure: 47-1/4 by 15-13/16 inches (1200 by 402 mm), **as directed**.
3) Finish: Bright rolled **OR** Preweathered gray **OR** Preweathered black, **as directed**.

b. Individual Shingles: Rectangular **OR** Diamond, **as directed**, shingle units.
   1) Material: Zinc-alloy sheet, 0.027 inch (0.70 mm) thick **OR** thickness as needed to meet performance requirements, **as directed**.
   2) Exposure: 14 by 14 inches (356 by 356 mm).
   3) Finish: Bright rolled **OR** Preweathered gray **OR** Preweathered black, **as directed**.

C. Underlayment
1. Felt Underlayment: ASTM D 226 or ASTM D 4869, Type I **OR** Type II, **as directed**, asphalt-saturated organic felt, nonperforated.
2. Self-Adhering Sheet Underlayment, Polyethylene Faced: ASTM D 1970, a minimum of 40-mil- (1.0-mm-) thick, slip-resisting, polyethylene-film-reinforced top surface laminated to SBS-modified asphalt adhesive, with release paper backing; cold applied. Provide primer for adjoining concrete or masonry surfaces to receive underlayment.
3. Self-Adhering Sheet Underlayment, High Temperature: A minimum of 30- to 40-mil- (0.76- to 1.0-mm-) thick, slip-resisting, polyethylene-film-reinforced top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release paper backing; cold applied. Provide primer for adjoining concrete or masonry surfaces to receive underlayment and when recommended by underlayment manufacturer.
   a. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D 1970.
   b. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (29 deg C); ASTM D 1970.
4. Slip Sheet: Building paper, 3-lb/100 sq. ft. (0.16-kg/sq. m) minimum, rosin sized.

D. Accessories
1. General: Provide materials and types of fasteners, protective coatings, separators, sealants, and other accessory items as required for a complete roofing system and as recommended by metal-shingle manufacturer unless otherwise indicated.
2. Sheet Metal Flashing and Trim: Metal-shingle manufacturer's flashing and trim components matching shingle material, color, and finish unless otherwise indicated or recommended in writing by metal-shingle manufacturer. Fabricate to sizes and configurations shown or required. Unless otherwise indicated, fabricate sheet metal flashing and trim to comply with recommendations that apply to design, dimensions, metal, and other characteristics of the item in SMACNA's "Architectural Sheet Metal Manual."
3. Ridge Vents: Metal-shingle manufacturer's continuous vented ridge caps matching material and finish of metal shingles with insect screen or insect-resisting geotextile filter strips and with external deflector baffles; for use with specified metal shingles.
   a. Minimum Net Free Area: As required to satisfy Project requirements.
   b. Accessories: Splices, end caps, and other accessories matching metal and finish.
4. Snow Guards: Stop-type **OR** Bar-type, **as directed**, prefabricated aluminum **OR** copper **OR** cast-bronze **OR** zinc **OR** stainless-steel, **as directed**, units, designed to be installed without penetrating metal shingles.
   a. Attachment: Designed to be attached to surface of metal shingles using construction adhesive, silicone or polyurethane sealant, or adhesive tape **OR** mechanically anchored through predrilled holes concealed by the metal shingles, **as directed**.
   b. Finish: Matching the metal shingles.
5. Wood Battens: Pressure-preservative-treated wood complying with requirements in Division 6 Section "Rough Carpentry" **OR** "Miscellaneous Carpentry", **as directed**.
   a. Contoured Rigid Foam: Manufacturers standard rigid foam formed to match underside contour of metal shingles.
6. Metal Battens: Hat channels formed from zinc-coated (galvanized) steel sheet; ASTM A 653/A 653M, G90 (Z275) coating designation, not less than 0.025-inch (0.64-mm) nominal thickness, and complying with requirements in Division 5 Section Cold-Formed Metal Framing."
7. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.
8. Asphalt Roofing Cement: ASTM D 4586, Type II, asbestos free.

9. Sealant: ASTM C 920, one-part elastomeric polymer joint sealant as recommended by metal-shingle manufacturer for installation indicated; of type, grade, class, and use classifications required to seal joints in metal shingles and remain watertight. Where sealant will be exposed, provide in color matching shingle.
10. Sheet Metal Fasteners: Noncorrosive screws, nails, and anchors designed to withstand design loads as recommended in writing by metal-shingle manufacturer.
    a. Exposed Fasteners: Heads matching color of metal shingles using plastic caps or factory-applied coating. Provide metal-backed neoprene or EPDM washers under heads of exposed fasteners bearing on weather side of shingles.
    b. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
    c. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
    d. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
    e. Fasteners for Aluminum-Zinc Alloy-Coated **OR** Zinc-Coated, **as directed**, Steel Sheet: Hot-dip galvanized steel according to ASTM A 153/A 153M, ASTM F 2329, or Series 300 stainless steel.
    f. Fasteners for Copper Sheet: Copper, hardware bronze, or Series 300 stainless steel.
    g. Fasteners for Zinc Sheet: Hot-dip galvanized steel according to ASTM A 153/A 153M, ASTM F 2329, or Series 300 stainless steel.
11. Felt Underlayment Nails: Aluminum, stainless-steel, or hot-dip galvanized-steel wire with low-profile capped heads or disc caps, 1-inch (25-mm) minimum diameter.
    a. Where nails are in contact with metal shingles or flashing, use nails made from same metal as metal shingles.
12. Wood Batten Nails: ASTM F 1667; common or box, steel wire, flat head, and smooth shank; hot-dip galvanized.

E. General Finish Requirements
1. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
2. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
    a. Examine roof sheathing to verify that sheathing joints are supported by framing and blocking, that tops of fasteners are flush with surface, and that installation is within flatness tolerances.
    b. Verify that substrate is sound, dry to the maximum moisture content recommended by metal-shingle manufacturer, smooth, clean, sloped for drainage, and completely anchored and that provision has been made for flashings and penetrations through metal shingles.
    c. Verify that vent stacks and other penetrations through metal shingles have been installed and are securely fastened.
2. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Underlayment Installation

1. General: Comply with metal-shingle and underlayment manufacturers' written installation instructions applicable to products and applications indicated unless more stringent requirements apply.
2. Single-Layer Felt Underlayment: Install on roof deck parallel with and starting at the eaves. Lap sides a minimum of 2 inches (50 mm) over underlying course. Lap ends a minimum of 4 inches (100 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment nails.
   a. Install felt underlayment on roof deck not covered by self-adhering sheet underlayment. Lap sides of felt over self-adhering sheet underlayment not less than 3 inches (75 mm) in direction to shed water. Lap ends of felt not less than 6 inches (152 mm) over self-adhering sheet underlayment.
3. Double-Layer Felt Underlayment: Install on roof deck parallel with and starting at the eaves. Install a 19-inch- (485-mm-) wide starter course at eaves and completely cover with full-width second course. Install succeeding courses lapping previous courses 19 inches (485 mm) in shingle fashion. Lap ends a minimum of 6 inches (152 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment nails.
   a. Apply a continuous layer of asphalt roofing cement over starter course and on felt underlayment surface to be concealed by succeeding courses as each felt course is installed. Apply over entire roof **OR** at locations indicated on Drawings, **as directed**.
   b. Install felt underlayment on roof sheathing not covered by self-adhering sheet underlayment. Lap edges over self-adhering sheet underlayment not less than 3 inches (75 mm) in direction to shed water.
   c. Terminate felt underlayment flush **OR** extended up not less than 4 inches (100 mm), **as directed**, against sidewalls, curbs, chimneys, and other roof projections.
4. Self-Adhering Sheet Underlayment: Install wrinkle free; comply with low-temperature installation restrictions of underlayment manufacturer if applicable. Install at locations indicated below **OR** on Drawings, **as directed**, lapped in direction to shed water. Lap sides not less than 3-1/2 inches (89 mm). Lap ends not less than 6 inches (152 mm), staggered 24 inches (610 mm) between courses. Roll laps with roller. Cover underlayment within seven days.
   a. Prime concrete and masonry surfaces to receive self-adhering sheet underlayment.
   b. Eaves: Extend from edges of eaves 24 inches (610 mm) **OR** 36 inches (914 mm), **as directed**, beyond interior face of exterior wall.
   c. Rakes: Extend from edges of rakes 24 inches (610 mm) **OR** 36 inches (914 mm), **as directed**, beyond interior face of exterior wall.
   d. Valleys: Extend from lowest to highest point 18 inches (455 mm) on each side.
   e. Hips: Extend 18 inches (455 mm) on each side.
   f. Ridges: Extend 36 inches (914 mm) on each side without obstructing continuous ridge vent slot.
   g. Sidewalls: Extend 18 inches (455 mm) beyond sidewalls and return vertically against sidewalls not less than 4 inches (100 mm).
   h. Dormers, Chimneys, Skylights, and Other Roof-Penetrating Elements: Extend 18 inches (455 mm) beyond penetrating elements and return vertically against penetrating elements not less than 4 inches (100 mm).
   i. Roof-Slope Transitions: Extend 18 inches (455 mm) on each roof slope.
5. Metal-Flashed, Open-Valley Underlayment: Install one layer of 36-inch- (914-mm-) wide felt underlayment or self-adhering sheet underlayment centered in valley and running the full length of valley in addition to the underlayment required for metal shingles. Stagger end laps between layers and lap ends of each layer at least 12 inches (305 mm) in direction to shed water.
   a. Solidly cement valley felt underlayment with asphalt roofing cement to the underlayment required for metal shingles.
6. Apply slip sheet with adhesive or tape before installing metal flashing and shingles.

C. Metal-Shingle Installation
1. General: Install metal shingles according to manufacturer's written instructions applicable to products and applications indicated; install level, plumb, and true to line.

2. Felt Interlayment: Install 18-inch- (455-mm-) wide strip of felt underlayment over top portion of first and each succeeding course. Stagger fasten to roof deck with felt underlayment nails.
3. Maintain uniform exposure and coursing of metal shingles throughout roof.
4. Apply sealant between shingles, flashing, trim, and exposed fasteners to achieve a weathertight system.
5. Interlock and overlap shingles and stagger end joints from **OR** align joints of tile-form, **as directed**, shingle courses above and below.
6. Metal Protection: Where dissimilar metals will contact each other, protect against galvanic action by painting contact surfaces with bituminous coating, by applying self-adhering sheet underlayment to each contact surface, or by other permanent separation as recommended by manufacturer of metal shingles or of the metals in contact.
    a. Do not use graphite pencils to mark metal surfaces.

D. Accessory Installation
1. General: Install accessories according to manufacturers' written instructions unless more stringent requirements are indicated.
2. Metal Flashings and Trim: Install metal flashings and trim according to recommendations in NRCA's "The NRCA Roofing and Waterproofing Manual" unless more stringent requirements are indicated.
3. Ridge Vents: Install ridge vents with end closures at locations indicated.
4. Stop-Type Snow Guards: Install rows of snow guards at locations indicated. Space rows apart horizontally, beginning from gutter. Space snow guards apart in each row, offsetting by half this dimension between succeeding rows.
5. Bar-Type Snow Guards: Install rows of snow guards at locations indicated. Space rows apart horizontally, beginning from gutter.
6. Battens: Install battens according to metal-shingle manufacturer's written instructions and as needed to meet performance requirements.
    a. Wood Battens: Install nominal 2-by-2-inch (38-by-38-mm) wood battens horizontally over installed underlayment with ends separated by 1/2 inch (13 mm), at spacing required by metal-shingle manufacturer, and securely fasten to roof deck with wood batten nails.
    b. Metal Battens: Install 1-1/2-inch (38-mm) metal battens horizontally over installed underlayment with ends separated by 1/2 inch (13 mm), at spacing required by metal-shingle manufacturer, and securely fasten to roof deck with sheet metal fasteners.
    c. Intermediate Battens: Install nominal 1-inch- (19-mm-) thick wood battens with double strip of contoured rigid foam horizontally with ends separated by 1/2 inch (13 mm), at spacing required by metal-shingle manufacturer to uniformly support underside of metal shingles between main battens, and securely fasten to roof deck with wood batten nails.
7. Metal Protection: Where dissimilar metals will contact each other, protect against galvanic action by painting contact surfaces with bituminous coating, by applying self-adhering sheet underlayment to each contact surface, or by other permanent separation as recommended by manufacturer of metal shingles or of the metals in contact.

E. Erection Tolerances
1. Installation Tolerances: Shim and align metal shingles within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.
   OR
   Installation Tolerances: Shim and align metal shingles within installed tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

F. Adjusting And Cleaning
1. Remove and replace damaged or deformed metal shingles or metal shingles that do not comply with specified requirements. Replace shingles with damaged or deteriorated finishes and other components of the Work that cannot be successfully repaired by finish touchup or similar minor repair procedures.

2. Remove temporary protective coverings and strippable films as metal shingles are installed unless otherwise indicated in manufacturer's written installation instructions.
3. On completion of installation, clean exposed surfaces of metal shingles according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Remove excess sealants. Maintain metal shingles in a clean condition during construction.
4. Remove excess metal shingles and debris from Project site.

END OF SECTION 07 31 16 00

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SECTION 07 31 26 00 - SLATE SHINGLES

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for slate shingles. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Slate shingles.
b. Underlayment.
c. Snow guards.

C. Definitions
1. Roofing Terminology: See ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

D. Submittals
1. Product Data: For each type of product indicated.
2. Samples
a. Slate Shingle: Full size, of each color, size, texture, and shape.
b. Ridge Cap **OR** Vent, **as directed**: 12-inch- (305-mm-) long Sample.
c. Fasteners: Three fasteners of each type, length, and finish.
d. Exposed Valley Lining: 12 inches (305 mm) square.
e. Snow Guard: Full-size unit **OR** Base, bracket, and 12-inch- (300-mm-) long rail, **as directed**.
3. Warranty: Sample of special warranty.

E. Quality Assurance
1. Source Limitations: Obtain each color of slate shingle from single quarry capable of producing slate of consistent quality in appearance and physical properties.
2. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Store underlayment rolls on end, on pallets or other raised surfaces. Do not double stack rolls.
a. Handle, store, and place roofing materials in a manner to avoid significant or permanent damage to roof deck or structural supporting members.
2. Protect unused underlayment from weather, sunlight, and moisture when left overnight or when roofing work is not in progress.

G. Warranty
1. Special Warranty: Standard form in which roofing Installer agrees to repair or replace slate roofing that fails in materials or workmanship within two **OR** five, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Slate Shingles
1. Slate Shingles: ASTM C 406, Grade S1 **OR** Grade S2, **as directed**; hard, dense, and sound; chamfered edges, with nail holes machine punched or drilled and countersunk. No broken or

cracked slates, no broken exposed corners, and no broken corners on covered ends that could sacrifice nailing strength or laying of a watertight roof.

a. Thickness: Nominal 3/16 inch (5 mm) **OR** 3/16 to 1/4 inch (5 to 6 mm) **OR** 1/4 to 3/8 inch (6 to 10 mm) **OR** 3/8 to 1/2 inch (10 to 13 mm), **as directed**.
b. Surface Texture: Smooth **OR** Rough, **as directed**.
c. Size: 24 inches (610 mm) long by 14 inches (355 mm) **OR** 12 inches (305 mm) **OR** random widths, but not less than one-half-length, **as directed**, wide.
d. Size: 22 inches (560 mm) long by 14 inches (355 mm) **OR** 12 inches (305 mm) **OR** 11 inches (280 mm) **OR** random widths, but not less than one-half-length, **as directed**, wide.
e. Size: 20 inches (510 mm) long by 14 inches (355 mm) **OR** 12 inches (305 mm) **OR** 11 inches (280 mm) **OR** 10 inches (255 mm) **OR** random widths, but not less than one-half-length, **as directed**, wide.
f. Size: 18 inches (455 mm) long by 14 inches (355 mm) **OR** 12 inches (305 mm) **OR** 11 inches (280 mm) **OR** 10 inches (255 mm) **OR** 9 inches (230 mm) **OR** random widths, but not less than one-half-length, **as directed**, wide.
g. Size: 16 inches (405 mm) long by 14 inches (355 mm) **OR** 12 inches (305 mm) **OR** 11 inches (280 mm) **OR** 10 inches (255 mm) **OR** 9 inches (230 mm) **OR** 8 inches (205 mm) **OR** random widths, but not less than one-half-length, **as directed**, wide.
h. Size: 14 inches (355 mm) long by 12 inches (305 mm) **OR** 11 inches (280 mm) **OR** 10 inches (255 mm) **OR** 9 inches (230 mm) **OR** 8 inches (205 mm) **OR** 7 inches (180 mm) **OR** random widths, but not less than one-half-length, **as directed** wide.
i. Size: 12 inches (305 mm) long by 12 inches (305 mm) **OR** 10 inches (255 mm) **OR** 9 inches (230 mm) **OR** 8 inches (205 mm) **OR** 7 inches (180 mm) **OR** 6 inches (152 mm) **OR** random widths, but not less than one-half-length, **as directed**, wide.
j. Size: 10 inches (255 mm) by 10 inches (255 mm) **OR** 9 inches (230 mm) **OR** 8 inches (205 mm) **OR** 7 inches (180 mm) **OR** 6 inches (152 mm) **OR** random widths, but not less than one-half-length, **as directed**, wide.
k. Nail Holes: Two **OR** Four, **as directed**, per shingle.
l. Butt Shape: Standard square cut.
m. Cut Butt Shape: Standard square cut and pointed **OR** deep bevel **OR** shallow bevel **OR** deep scallop **OR** shallow scallop **OR** round, **as directed**.
n. Color: Black **OR** Gray **OR** Purple **OR** Green **OR** Blue black **OR** Blue gray **OR** Mottled purple and green **OR** Red **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
o. Weather-Exposure Color Change: Unfading **OR** Weathering, **as directed**.

2. Starter Slate: Slate shingles with chamfered nail holes front-side punched.
   a. Length: Exposure of slate shingle plus head lap.
3. Ridge Slate: Slate shingles fabricated with vertical **OR** horizontal, **as directed**, grain orientation.

B. Underlayment Materials
1. Felt Underlayment: ASTM D 226, Type **I OR** Type **II**, **as directed**, asphalt-saturated organic felt, unperforated.
2. Felt Underlayment: ASTM D 2626, asphalt-saturated and -coated organic felt, mineral surfaced, unperforated.
3. Self-Adhering Sheet Underlayment, Granular Surfaced: ASTM D 1970, minimum of 55-mil- (1.4-mm-) thick sheet; glass-fiber-mat-reinforced, SBS-modified asphalt; mineral-granule surfaced; with release paper backing; cold applied. Provide primer for adjoining concrete or masonry surfaces to receive underlayment, **as directed**.
4. Self-Adhering Sheet Underlayment, Polyethylene Faced: ASTM D 1970, minimum of 40-mil- (1.0-mm-) thick, slip-resisting, polyethylene-film-reinforced top surface laminated to SBS-modified asphalt adhesive, with release paper backing; cold applied. Provide primer for adjoining concrete or masonry surfaces to receive underlayment, **as directed**.
5. Self-Adhering Sheet Underlayment, High Temperature: Minimum of 30- to 40-mil- (0.76- to 1.0-mm-) thick, slip-resisting, polyethylene-film-reinforced top surface laminated to layer of butyl or

SBS-modified asphalt adhesive, with release paper backing; cold applied. Provide primer for adjoining concrete or masonry surfaces to receive underlayment, **as directed**.

a. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D 1970.

b. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (29 deg C); ASTM D 1970.

C. Snow Guards

1. Snow-Guard Pads: Fabricated copper **OR** cast-bronze **OR** zinc **OR** stainless-steel **OR** aluminum, **as directed**, units, designed to be installed without penetrating slate shingles, and complete with predrilled holes or hooks for anchoring.

2. Snow-Guard Rails: Units fabricated from metal baseplate anchored to adjustable **OR** fixed, **as directed**, bracket and equipped with two **OR** three, **as directed**, bars.

a. Brackets and Baseplate: Aluminum **OR** Bronze or brass **OR** Stainless steel, **as directed**.

b. Bars: Aluminum, mill finished **OR** Aluminum, clear anodized **OR** Stainless steel, mill finished, **as directed**.

D. Accessories

1. Asphalt Roofing Cement: ASTM D 4586, Type II, asbestos free.

2. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied.

3. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane **OR** polysulfide **OR** silicone, **as directed**, polymer sealant; of type, grade, class, and use classifications required to seal joints in slate-shingle roofing and remain watertight.

4. Slating Nails: ASTM F 1667, copper, **OR** aluminum-alloy, **OR** stainless-steel, **OR** cut-brass, **as directed**, smooth shanked, wire nails; 0.135-inch (3.4-mm) minimum thickness; sharp pointed; with 3/8-inch- (10-mm-) minimum diameter flat head; of sufficient length to penetrate a minimum of 3/4 inch (19 mm) into sheathing.

a. Where nails are in contact with metal flashing, use nails made from same metal as flashing.

5. Felt Underlayment Nails: Aluminum, stainless-steel, or hot-dip galvanized-steel wire nails with low-profile capped heads or disc caps, 1-inch (25-mm) minimum diameter.

6. Wood Nailer Strips and Eave Cants: Comply with requirements in Division 06 Section(s) "Rough Carpentry" OR "Miscellaneous Rough Carpentry", **as directed**.

7. Ridge Cap **OR** Vent, **as directed**: Custom-fabricated metal covers with noncorrosive components complete with internal anchoring lag screws, compression plates, and snap-on caps and slate retention channels, **as directed**.

a. Type: Cap, nonventilating **OR** Vent, with ventilating mesh providing net-free area of 18 sq. in./ft. (380 sq. cm/m) **OR** Vent, with ventilating mesh providing net-free area of 18 sq. in./ft. (380 sq. cm/m) and external baffles, **as directed**.

b. Metal Components: Copper, 20-oz./sq. ft.- (0.7-mm-) thick sheet **OR** Aluminum, 0.050-inch- (1.3-mm-) thick sheet, with manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin on exposed surfaces, **as directed**.

c. Accessories: Splices, end caps, and other accessories of matching metal and finish.

8. Track- and Clip-Attachment System: Custom-fabricated slate-shingle attachment system designed for use with notched-slate shingles consisting of extruded-aluminum, **OR** formed stainless-steel, **as directed**, perforated Z-track, screws, and spring clips for anchoring slate to roof deck.

E. Metal Flashing And Trim

1. General: Comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim".

a. Sheet Metal: Copper **OR** Stainless steel **OR** Zinc-tin alloy-coated stainless steel **OR** Zinc-tin alloy-coated steel **OR** Zinc-tin alloy-coated copper **OR** Anodized aluminum **OR** Aluminum, mill finished, **as directed**.

2. Fabricate sheet metal flashing and trim to comply with recommendations that apply to design, dimensions, metal, and other characteristics of the item in SMACNA's "Architectural Sheet Metal Manual."
   a. Apron Flashings: Fabricate with lower flange extending a minimum of 4 inches (100 mm) **OR** 6 inches (152 mm), **as directed**, over and 4 inches (100 mm) beyond each side of downslope slate shingles and 6 inches (152 mm) up the vertical surface.
   b. Step Flashings: Fabricate with a head lap of 3 inches (75 mm) and a minimum extension of 4 inches (100 mm) **OR** 5 inches (127 mm), **as directed**, both horizontally and vertically.
   c. Cricket **OR** Backer, **as directed**, Flashings: Fabricate with concealed flange extending a minimum of 18 inches (455 mm) **OR** 24 inches (610 mm), **as directed**, beneath upslope slate shingles and 6 inches (152 mm) beyond each side of chimney **OR** skylight, **as directed**, and 6 inches (152 mm) above the roof plane.
   d. Hip Flashings: Fabricate to length of slate shingle and to extend 3 inches (75 mm), **as directed**, beyond joint of hip shingle with adjoining roof shingle.
   e. Open-Valley Flashings: Fabricate in lengths not exceeding 10 feet (3 m) with 1-inch- (25-mm-) high, inverted-V profile at center of valley and equal flange widths of 10 inches (255 mm) **OR** 12 inches (305 mm), **as directed**.
   f. Closed-Valley Flashings: Fabricate in lengths not exceeding 10 feet (3 m) and equal flange widths of 10 inches (255 mm) **OR** 12 inches (305 mm), **as directed**.
   g. Drip Edges: Fabricate in lengths not exceeding 10 feet (3 m) with 2-inch (50-mm) roof-deck flange and 1-1/2-inch (38-mm) fascia flange with 3/8-inch (10-mm) drip at lower edge.
3. Vent-Pipe Flashings: ASTM B 749, Type L51121, at least 1/16 inch (1.6 mm) thick. Provide lead sleeve sized to slip over and turn down into pipe, soldered to skirt at slope of roof and extending at least 4 inches (100 mm) from pipe onto roof.

1.3 EXECUTION

A. Underlayment Installation
1. General: Comply with underlayment manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.
2. Single-Layer Felt Underlayment: Install on roof deck parallel with and starting at the eaves. Lap sides a minimum of 2 inches (50 mm) over underlying course. Lap ends a minimum of 4 inches (100 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment nails.
   a. Install felt underlayment on roof deck not covered by self-adhering sheet underlayment. Lap sides of felt over self-adhering sheet underlayment not less than 3 inches (75 mm) in direction to shed water. Lap ends of felt not less than 6 inches (152 mm) over self-adhering sheet underlayment.
3. Double-Layer Felt Underlayment: Install on roof deck parallel with and starting at the eaves. Install a 19-inch- (485-mm-) wide starter course at eaves and completely cover with full-width second course. Install succeeding courses lapping previous courses 19 inches (485 mm) in shingle fashion. Lap ends a minimum of 6 inches (152 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment nails.
   a. Apply a continuous layer of asphalt roofing cement over starter course and on felt underlayment surface to be concealed by succeeding courses as each felt course is installed. Apply over entire roof **OR** at locations indicated on Drawings, **as directed**.
   b. Install felt underlayment on roof sheathing not covered by self-adhering sheet underlayment. Lap edges over self-adhering sheet underlayment not less than 3 inches (75 mm) in direction to shed water.
   c. Terminate felt underlayment flush **OR** extended up not less than 4 inches (100 mm), **as directed**, against sidewalls, curbs, chimneys, and other roof projections.
4. Self-Adhering Sheet Underlayment: Install, wrinkle free, on roof deck. Comply with low-temperature installation restrictions of underlayment manufacturer if applicable. Install at locations indicated below **OR** on Drawings, **as directed**, lapped in direction to shed water. Lap

sides not less than 3-1/2 inches (89 mm). Lap ends not less than 6 inches (152 mm), staggered 24 inches (600 mm) between courses. Roll laps with roller. Cover underlayment within seven days.

a. Prime concrete and masonry surfaces to receive self-adhering sheet underlayment.
b. Eaves: Extend from edges of eaves 24 inches (610 mm) **OR** 36 inches (914 mm), **as directed**, beyond interior face of exterior wall.
c. Rakes: Extend from edges of rakes 24 inches (610 mm) **OR** 36 inches (914 mm), **as directed**, beyond interior face of exterior wall.
d. Valleys: Extend from lowest to highest point 18 inches (455 mm) on each side.
e. Hips: Extend 18 inches (455 mm) on each side.
f. Ridges: Extend 36 inches (914 mm) on each side without obstructing continuous ridge vent slot, **as directed**.
g. Sidewalls: Extend 18 inches (455 mm) beyond sidewalls and return vertically against sidewalls not less than 4 inches (100 mm).
h. Dormers, Chimneys, Skylights, and Other Roof-Penetrating Elements: Extend 18 inches (455 mm) beyond penetrating elements and return vertically against penetrating elements not less than 4 inches (100 mm).
i. Roof-Slope Transitions: Extend 18 inches (455 mm) on each roof slope.

5. Metal-Flashed, Open-Valley Underlayment: Install two layers of 36-inch- (914-mm-) wide felt underlayment centered in valley. Stagger end laps between layers at least 72 inches (1830 mm). Lap ends of each layer at least 12 inches (305 mm) in direction to shed water, and seal with asphalt roofing cement. Fasten each layer to roof deck with felt underlayment nails.
   a. Lap roof-deck felt underlayment over first layer of valley felt underlayment at least 6 inches (152 mm).

B. Metal Flashing Installation

1. General: Install metal flashings and other sheet metal to comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim".
   a. Install metal flashings according to recommendations in NRCA's "The NRCA Roofing and Waterproofing Manual."
2. Apron Flashings: Extend lower flange over and beyond each side of downslope slate shingles and up the vertical surface.
3. Step Flashings: Install with a head lap of 3 inches (75 mm) and extend both horizontally and vertically. Install with lower edge of flashing just upslope of, and concealed by, butt of overlying slate shingle. Fasten to roof deck only.
4. Cricket **OR** Backer, **as directed**, Flashings: Install against the roof-penetrating element, extending concealed flange beneath upslope slate shingles and beyond each side.
5. Hip Flashings: Install centrally over hip with lower edge of flashing concealed by butt of overlying slate shingle. Fasten to roof deck.
6. Open **OR** Closed, **as directed**,-Valley Flashings: Install centrally in valleys, lapping ends at least 8 inches (205 mm) in direction to shed water. Fasten upper end of each length to roof deck beneath overlap.
   a. Secure hemmed flange edges into metal cleats spaced 12 inches (305 mm) apart and fastened to roof deck.
   b. Adhere 9-inch- (230-mm-) wide strips of self-adhering sheet to metal flanges and to self-adhering sheet underlayment.
7. Rake Drip Edges: Install over underlayment and fasten to roof deck.
8. Eave Drip Edges: Install beneath underlayment and fasten to roof deck.
9. Pipe Flashings: Form flashing around pipe penetrations and slate shingles. Fasten and seal to slate shingles.

C. Slate-Shingle Installation

1. General: Beginning at eaves, install slate shingles according to manufacturer's written instructions and to details and recommendations in NRCA's "The NRCA Roofing and Waterproofing Manual."
   a. Install wood nailer strip cant at eave edges.

b. Install shingle starter course chamfered face down.
2. Install first and succeeding shingle courses with chamfered face up. Install full-width first course at rake edge.
   a. Offset joints of uniform-width slate shingles by half the shingle width in succeeding courses.
   b. Offset joints of random-width slate shingles a minimum of 3 inches (75 mm) in succeeding courses.
3. Maintain a 3-inch- (75-mm-) **OR** 4-inch- (100-mm-), **as directed**, minimum head lap between succeeding shingle courses.
4. Maintain uniform exposure of shingle courses between eaves and ridge **OR** midway between eaves and ridge and increase head lap of succeeding shingle courses to ensure uniform exposure on remaining shingle courses, **as directed**.
5. Extend shingle starter course and first course 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**, over fasciae at eaves.
6. Extend shingle starter course and succeeding courses 1 inch (25 mm) over fasciae at rakes.
7. Cut and fit slate neatly around roof vents, pipes, ventilators, and other projections through roof.
8. Hang slate with two **OR** four, **as directed**, slating nails for each shingle with nail heads lightly touching slate. Do not drive nails home drawing slates downward or leave nail head protruding enough to interfere with overlapping shingle above.
   a. For vented ridge, terminate slate shingles leaving uniform air space on each side of ridge apex.
9. Ridges: Install ridge slate in saddle **OR** strip saddle **OR** combing, **as directed**, configuration.
   a. Install and anchor wood nailer strips of thicknesses to match abutting courses of slate shingles, terminating nailer strip 3 to 4 inches (75 to 100 mm) from the eave. Cover with felt underlayment strip, extending to underlying slate but concealed by ridge slate.
   b. Lay ridge slate in bed of asphalt roofing cement **OR** butyl sealant, **as directed**.
   c. Anchor ridge slate to supporting wood nailer strip with two **OR** four, **as directed**, nails for each slate shingle without nails penetrating underlying slate.
   d. Extend combing slate over leeward ridge slate by 1/8 to 1/4 inch (3 to 6 mm). Seal ridge joint with elastomeric sealant.
   e. Cover heads of exposed nails at final ridge shingle with asphalt roofing cement **OR** butyl sealant, **as directed**.
10. Hips: Install and anchor slate hips in saddle **OR** mitered **OR** fantail, **as diorected**, configuration.
   a. Install and anchor wood nailer strips of thickness to match abutting courses of slate shingles. Cover nailer strip with felt underlayment strip, extending on to underlying slate but concealed by hip slate. Anchor hip slate to nailer strip with two nails located in upper third of hip-slate length.
   b. Notch starter shingle and first shingle course at hip to fit around nailer strips so no wood is exposed at ridge eave.
   c. Lay hip slate in bed of asphalt roofing cement **OR** butyl sealant, **as directed**.
   d. Seal hip centerline joint with elastomeric sealant.
11. Open Valleys: Cut slate shingles to form straight lines at open valleys, trimming upper concealed corners of shingles. Maintain uniform width of exposed open valley **OR** Widen exposed portion of open valley 1/8 inch in 12 inches (1:96), **as directed**, from highest to lowest point.
   a. Do not nail shingles to valley metal flashings.
12. Closed Valleys: Cut slate shingles to form straight lines at closed valleys, trimming upper concealed corners of shingles. Maintain uniform gap at centerline of valley of 1/2 to 3/4 inch (13 to 19 mm) **OR** 3/4 to 1 inch (19 to 25 mm), **as directed**.
   a. Do not nail shingles to valley metal flashings.

D. Snow-Guard Installation
1. Snow-Guard Pads: Install rows of snow-guard pads at locations indicated according to manufacturer's written installation instructions. Space rows apart horizontally, beginning from gutter. Space snow guards apart in each row, offsetting by half this dimension between succeeding rows.

2. Snow-Guard Rails: Install rows of snow-guard rails at locations indicated according to manufacturer's written installation instructions. Space rows apart horizontally, beginning from gutter.

E. Accessories Installation
   1. Ridge Caps **OR** Vents, **as directed**: Install units according to manufacturer's written instructions.
      a. Install slate shingles into retention channels, butting adjacent shingles.

F. Adjusting And Cleaning
   1. Remove and replace damaged or broken slate shingles.
   2. Remove excess slate and debris from Project site.

END OF SECTION 07 31 26 00

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SECTION 07 31 29 00 - WOOD SHINGLES AND SHAKES

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for wood shingles and shakes. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Wood roof shingles and shakes.
      b. Wood wall shingles and shakes.
      c. Wood-shingle-clad panels.
      d. Underlayment.

C. Definitions
   1. CSSB: Cedar Shake & Shingle Bureau.
   2. Roofing Terminology: See ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

D. Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittal:
      a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood shingles and shakes comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating costs for each certified wood product.
   3. Samples: For each type of wood shingle, shake, ridge and hip unit, and ridge vent indicated.
   4. Research/Evaluation Reports: For wood shingles and shakes, from the ICC, **as directed**.
   5. Maintenance Data: For wood shingles and shakes to include in maintenance manuals.
   6. Warranties: Sample of special warranties.

E. Quality Assurance
   1. Grading Agency Qualifications: An independent testing and inspecting agency recognized by authorities having jurisdiction as qualified to label wood shingles and shakes for compliance with referenced grading rules.
   2. Forest Certification: Provide shingles and shakes produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
   3. Fire-Resistance Characteristics: Where indicated, provide wood shingles and shakes and related roofing materials identical to those of assemblies tested for fire resistance per test method below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.
      a. Exterior Fire-Test Exposure: Class B **OR** Class C, **as directed**; UL 790 or ASTM E 108 with ASTM D 2898, for application and roof slopes indicated.
   4. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
   1. Store underlayment rolls on end, on pallets or other raised surfaces. Do not double stack rolls.
      a. Handle, store, and place roofing materials in a manner to avoid significant or permanent damage to roof deck or structural supporting members.

2. Protect unused underlayment from weather, sunlight, and moisture when left overnight or when roofing work is not in progress.

G. Warranty
1. Special Warranty: CSSB's standard form in which CSSB agrees to repair or replace wood shingles and shakes that fail in materials within specified warranty period. Material failures include manufacturing defects that result in leaks.
   a. Materials-Only Warranty Period: 20 **OR** 25, **as directed**, years for shingles and shakes, and 20 years for manufactured ridge and hip units, from date of Final Completion.

1.2 PRODUCTS

A. Roof Shingles
1. Cedar Roof Shingles: Smooth-sawn western red cedar shingles.
   a. Grading Standards: CSSB's "Grading Rules for Certigrade Red Cedar Shingles."
   b. Grade: No. 1, with starter courses of No. 1 **OR** No. 2 **OR** No. 3, **as directed**.
   c. Size: 16 inches (405 mm) long; 0.40 inch (10 mm) thick **OR** 18 inches (455 mm) long; 0.45 inch (11 mm) thick **OR** 24 inches (610 mm) long; 0.50 inch (13 mm) thick, **as directed**, at butt.
2. Ridge and Hip, **as directed**, Units: Manufactured **OR** Site-fabricated, **as directed**, units of same thickness as roof shingle, 7 inches (180 mm) wide; beveled, alternately overlapped, and nailed.
   a. Grade: No. 1.
   b. Length: 16 inches (405 mm) **OR** 18 inches (455 mm), **as directed**.
3. Fancy-Butt Roof Shingles: Clear heartwood red cedar, No. 1 grade, with butt shape indicated.
   a. Butt Shape: Diagonal **OR** Half Cove **OR** Diamond **OR** Round **OR** Hexagonal **OR** Octagonal **OR** Arrow **OR** Square **OR** Fish Scale, **as directed**.
   b. Grading Standards: CSSB's "Grading Rules for Certigrade Red Cedar Shingles."
   c. Size: 16 inches (405 mm) long; 5 inches (127 mm) wide **OR** 18 inches (455 mm) long; 5 inches (127 mm) wide, **as directed**, by manufacturer's standard thickness.

B. Roof Shakes
1. Cedar Roof Shakes: Handsplit and resawn western red cedar shakes; split face and sawn back.
   a. Grading Standard: CSSB's "Grading Rules for Certi-Split Resawn Cedar Shakes."
   b. Grade: Premium, **OR** No. 1, **as directed**, with starter courses of Premium **OR** No. 1, **as directed**.
   c. Length: 18 inches (455 mm), **OR** 24 inches (610 mm), **as directed**, with 15-inch- (380-mm-) long starter course.
   d. Thickness: 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, at butt.
2. Cedar Roof Shakes: Tapersawn western red cedar shakes; sawn both sides.
   a. Grading Standard: CSSB's "Grading Rules for Certi-Sawn Tapersawn Cedar Shakes."
   b. Grade: Premium, **OR** No. 1, **as directed**, with starter courses of Premium **OR** No. 1 **OR** No. 2, **as directed**.
   c. Length: 18 inches (455 mm), **OR** 24 inches (610 mm), **as directed**, with 15-inch- (380-mm-) long starter course.
   d. Thickness: 5/8 inch (16 mm) **OR** 3/4 inch (19 mm), **as directed**, at butt.
3. Cedar Roof Shakes: Tapersplit western red cedar shakes; handsplit.
   a. Grading Standard: CSSB's "Grading Rules for Certi-Split Resawn Cedar Shakes."
   b. Grade: Premium, with premium starter courses.
   c. Length: 24 inches (610 mm), with 15-inch- (380-mm-) long starter course.
   d. Thickness: 1/2 inch (13 mm) at butt.
4. Cedar Roof Shakes: Straightsplit western red cedar shakes; machine split or handsplit.
   a. Grading Standard: CSSB's "Grading Rules for Certi-Split Resawn Cedar Shakes."
   b. Grade: Premium, with premium starter courses.

c. Length: 18 inches (455 mm) **OR** 24 inches (610 mm), **as directed**, with 15-inch- (380-mm-) long starter course.
d. Thickness: 3/8 to 1/2 inch (10 to 13 mm) at butt.

5. Ridge and Hip, **as directed**, Units: Manufactured **OR** Site-fabricated, **as directed**, units of same grade as shake, 9 inches (230 mm) wide; beveled, alternately overlapped, and nailed.
   a. Type: Handsplit and resawn **OR** Tapersawn, **as directed**.
   b. Length: 18 inches (455 mm) **OR** 24 inches (610 mm), **as directed**.
   c. Thickness: 5/8 inch (16 mm) **OR** 3/4 inch (19 mm), **as directed**, at butt.

C. Wall Shingles
1. Cedar Wall Shingles: Smooth-sawn western red cedar shingles.
   a. Grading Standards: CSSB's "Grading Rules for Certigrade Red Cedar Shingles."
   b. Grade: No. 1 **OR** No. 2 **OR** No. 3, **as directed**.
   c. Size: 16 inches (405 mm) long; 0.40 inch (10 mm) thick **OR** 18 inches (455 mm) long; 0.45 inch (11 mm) thick **OR** 24 inches (610 mm) long; 0.50 inch (13 mm) thick, **as directed**, at butt.
   d. Undercourse Shingle Grade: No. 3 **OR** Undercoursing, **as directed**.
   e. Undercourse Shingle Size: 16 inches (405 mm) long; 0.40 inch (10 mm) thick **OR** 18 inches (455 mm) long; 0.45 inch (11 mm) thick, **as directed**, at butt.
2. Cedar Wall Shingles: Rebutted and rejointed, smooth-sawn **OR** sanded, **as directed**, western red cedar shingles.
   a. Grading Standards: CSSB's "Grading Rules for Certigrade Red Cedar Shingles."
   b. Grade: No. 1 **OR** No. 2, **as directed**.
   c. Size: 16 inches (405 mm) long; 0.40 inch (10 mm) thick **OR** 18 inches (455 mm) long; 0.45 inch (11 mm) thick **OR** 24 inches (610 mm) long; 0.50 inch (13 mm) thick, **as directed**, at butt.
   d. Undercourse Shingle Grade: No. 3 **OR** Undercoursing, **as directed**.
   e. Undercourse Shingle Size: 16 inches (405 mm) long; 0.40 inch (10 mm) thick **OR** 18 inches (455 mm) long; 0.45 inch (11 mm) thick, **as directed**, at butt.
3. Cedar Wall Shingles: Rebutted and rejoined, machine-grooved, smooth-sawn western red cedar.
   a. Grading Standards: CSSB's "Grading Rules for Certigrade Red Cedar Shingles."
   b. Grade: No. 1.
   c. Size: 16 inches (405 mm) long; 0.40 inch (10 mm) thick **OR** 18 inches (455 mm) long; 0.45 inch (11 mm) thick **OR** 24 inches (610 mm) long; 0.50 inch (13 mm) thick, **as directed**, at butt.
   d. Undercourse Shingle Grade: No. 3 **OR** Undercoursing, **as directed**.
   e. Undercourse Shingle Size: 16 inches (405 mm) long; 0.40 inch (10 mm) thick **OR** 18 inches (455 mm) long; 0.45 inch (11 mm) thick, **as directed**, at butt.
4. Fancy-Butt Wall Shingles: Clear heartwood red cedar, No. 1 grade, with butt shape indicated.
   a. Butt Shape: Diagonal **OR** Half Cove **OR** Diamond **OR** Round **OR** Hexagonal **OR** Octagonal **OR** Arrow **OR** Square **OR** Fish Scale, **as directed**.
   b. Grading Standards: CSSB's "Grading Rules for Certigrade Red Cedar Shingles."
   c. Size: 16 inches (405 mm) long; 5 inches (127 mm) wide **OR** 18 inches (455 mm) long; 5 inches (127 mm) wide, **as directed**, by manufacturer's standard thickness.
5. Cedar Wall Shingle Finish: Unfinished **OR** Semitransparent penetrating stain, oil based, factory applied **OR** Semisolid penetrating stain, oil based, factory applied **OR** Oil-based primer, stain blocking, factory applied, **as directed**.

D. Wall Shakes
1. Cedar Wall Shakes: Handsplit and resawn western red cedar shakes; split face and sawn back.
   a. Grading Standard: CSSB's "Grading Rules for Certi-Split Resawn Cedar Shakes."
   b. Outer Course Grade: Premium **OR** No. 1, **as directed**.
   c. Starter Course **OR** Undercourse, **as directed**, Grade: No. 1 **OR** Standard, **as directed**.
   d. Length: 18 inches (455 mm) **OR** 24 inches (610 mm), **as directed**.
   e. Thickness: 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, at butt.
2. Cedar Wall Shakes: Tapersawn western red cedar shakes; sawn both sides.

a. Grading Standard: CSSB's "Grading Rules for Certi-Sawn Tapersawn Cedar Shakes."
b. Outer Course Grade: Premium **OR** No. 1 **OR** No. 2, **as directed**.
c. Starter Course **OR** Undercourse, **as directed**, Grade: No. 1 **OR** No. 2 **OR** No. 3, **as directed**.
d. Length: 18 inches (455 mm) **OR** 24 inches (610 mm), **as directed**.
e. Thickness: 5/8 inch (16 mm) **OR** 3/4 inch (19 mm), **as directed**, at butt.

3. Cedar Wall Shakes: Tapersplit western red cedar shakes; handsplit.
   a. Grading Standard: CSSB's "Grading Rules for Certi-Split Resawn Cedar Shakes."
   b. Grade: Premium.
   c. Length: 24 inches (610 mm).
   d. Thickness: 1/2 inch (13 mm) at butt.
   e. Undercourse Shingle Grade: No. 3 **OR** Undercoursing, **as directed**.
   f. Undercourse Shingle Size: 16 inches (405 mm) long; 0.40 inch (10 mm) thick **OR** 18 inches (455 mm) long; 0.45 inch (11 mm) thick, **as directed**, at butt.
4. Cedar Wall Shakes: Straightsplit western red cedar shakes; machine split or handsplit.
   a. Grading Standard: CSSB's "Grading Rules for Certi-Split Resawn Cedar Shakes."
   b. Grade: Premium.
   c. Length: 18 inches (455 mm) **OR** 24 inches (610 mm), **as directed**.
   d. Thickness: 3/8 to 1/2 inch (10 to 13 mm) at butt.
   e. Undercourse Shingle Grade: No. 3 **OR** Undercoursing, **as directed**.
   f. Undercourse Shingle Size: 16 inches (405 mm) long; 0.40 inch (10 mm) thick **OR** 18 inches (455 mm) long; 0.45 inch (11 mm) thick, **as directed**, at butt.
5. Cedar Wall Shake Finish: Unfinished **OR** Semitransparent penetrating stain, oil based, factory applied **OR** Semisolid penetrating stain, oil based, factory applied **OR** Oil-based primer, stain blocking, factory applied, **as directed**.

E. Wood-Shingle-Clad Panels

1. Cedar Shingle Panels: Clear, vertical-grain, western red cedar shingles bonded with exterior-type adhesives to 5/16-inch- (8-mm-) thick, 96-inch- (2400-mm-) long, DOC PS 1 Exterior C-D plywood panels.
   a. Number of Courses per Panel: One **OR** Two **OR** Three **OR** Four, **as directed**.
   b. Butt Style: Straight line **OR** Staggered, **as directed**.
   c. Fancy-Butt Style: Diagonal **OR** Half Cove **OR** Diamond **OR** Round **OR** Hexagonal **OR** Octagonal **OR** Arrow **OR** Square **OR** Fish Scale, **as directed**.
   d. Exposure: 4-1/2 inches (115 mm) **OR** 5 inches (127 mm) **OR** 7 inches (180 mm), **as directed**, per course.
2. Prefabricated Corners: Flush **OR** Flush, with staggered ends **OR** Add-on, **as directed**, type.

F. Wood Treatments

1. Fire-Retardant Treatment: Exterior-type pressure treatment complying with AWPA C1, **as directed**.
2. Pressure-Preservative Treatment: AWPA C34, chromated copper arsenate (CCA) pressure treatment; a minimum of 0.40 lb/cu. ft. (6.4 kg/cu. m).
3. Identification: Attach a label to each bundle of wood shingles or shakes; identify manufacturer, references to model-code approval, type of product, grade, dimensions, and approved grading agency.
   a. Include chemical treatment, method of application, purpose of treatment, and warranties available.

G. Underlayment Materials

1. Felt Underlayment: ASTM D 226 **OR** ASTM D 4869, **as directed**, Type I **OR** Type II, **as directed**, asphalt-saturated organic felt.
2. Felt Interlayment: ASTM D 226 **OR** ASTM D 4869, **as directed**, Type I **OR** Type II, **as directed**, asphalt-saturated organic felt.

3. Self-Adhering Sheet Underlayment, Granular Surfaced: ASTM D 1970, a minimum of 55-mil- (1.4-mm-) thick sheet; glass-fiber-mat-reinforced, SBS-modified asphalt; mineral-granule surfaced; with release paper backing; cold applied. Provide primer for adjoining concrete or masonry surfaces to receive underlayment, **as directed**.
4. Self-Adhering Sheet Underlayment, Polyethylene Faced: ASTM D 1970, a minimum of 40-mil- (1.0-mm-) thick, slip-resisting, polyethylene-film-reinforced top surface laminated to SBS-modified asphalt adhesive, with release paper backing; cold applied. Provide primer for adjoining concrete or masonry surfaces to receive underlayment, **as directed**.

H. Ridge Vents
1. Rigid Ridge Vent: Manufacturer's standard rigid section, high-density polypropylene or other UV-stabilized plastic ridge vent with nonwoven geotextile filter strips and external deflector baffles, **as directed**; for use under ridge shingles and shakes.
2. Flexible Ridge Vent: Manufacturer's standard, compression-resisting, three-dimensional, open-nylon or polyester-mat filter bonded to a nonwoven, nonwicking, geotextile fabric cover, **as directed**; for use under roof shingles and shakes.

I. Accessories
1. Asphalt Roofing Cement: ASTM D 4586, Type II, asbestos free.
2. Drainage Mat: Manufacturer's standard, compression-resisting, three-dimensional, nonwoven, entangled filament, nylon mat designed to permit air movement and drain incidental moisture by gravity.
3. Roofing Nails: ASTM F 1667, aluminum **OR** stainless-steel **OR** hot-dip galvanized-steel, **as directed**, wire nails, sharp pointed, and of sufficient length to penetrate a minimum of 3/4 inch (19 mm) into sheathing.
   a. Use box **OR** shingle, **as directed**,-type nails for wood shingles.
   b. Use box-type nails for wood shakes.
   c. Where nails are in contact with metal flashing, use nails made from same metal as flashing.
4. Roofing Staples: Type 304 or Type 316, stainless-steel staples, 0.05-inch (1.3-mm) thick, with a minimum of 7/16-inch (11-mm) crown width, of sufficient length to penetrate a minimum of 3/4 inch (19 mm) into sheathing.
5. Felt Underlayment and Interlayment, **as directed**, Nails: Aluminum, stainless-steel, or hot-dip galvanized-steel wire nails; with 1-inch- (25-mm-) minimum diameter, low-profile capped heads or disc caps.
6. Wood Lath Strip: Western red cedar, clear heartwood, a minimum of 1-1/2 inches (38 mm) wide.

J. Metal Flashing And Trim
1. General: Comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim"
   a. Sheet Metal: Copper **OR** Stainless steel **OR** Zinc-tin alloy-coated stainless steel **OR** Zinc-tin alloy-coated steel **OR** Zinc-tin alloy-coated copper **OR** Anodized aluminum **OR** Aluminum, mill finished, **as directed**.
2. Fabricate sheet metal flashing and trim to comply with recommendations that apply to design, dimensions, metal, and other characteristics of the item in SMACNA's "Architectural Sheet Metal Manual."
   a. Apron Flashings: Fabricate with lower flange extending a minimum of 4 inches (100 mm) **OR** 6 inches (152 mm), **as directed**, over and 4 inches (100 mm) beyond each side of downslope wood roofing and 6 inches (152 mm) up the vertical surface.
   b. Step Flashings: Fabricate with a head lap of 3 inches (75 mm) and a minimum extension of 4 inches (100 mm) **OR** 5 inches (127 mm), **as directed**, both horizontally and vertically.
   c. Cricket **OR** Backer, **as directed**, Flashings: Fabricate with concealed flange extending a minimum of 18 inches (455 mm) **OR** 24 inches (610 mm), **as directed**, beneath upslope wood roofing and 6 inches (152 mm) beyond each side of chimney **OR** skylight, **as directed**, and 6 inches (152 mm) above the roof plane.

d. Open-Valley Flashings: Fabricate in lengths not exceeding 10 feet (3 m) with 1-inch- (25-mm-) high, inverted-V profile at center of valley and equal flange widths of 10 inches (255 mm) **OR** 12 inches (305 mm), **as directed**.
e. Drip Edges: Fabricate in lengths not exceeding 10 feet (3 m) with 2-inch (50-mm) roof-deck flange and 1-1/2-inch (38-mm) fascia flange with 3/8-inch (10-mm) drip at lower edge.

3. Vent-Pipe Flashings: ASTM B 749, Type L51121, at least 1/16 inch (1.6 mm) thick. Provide lead sleeve sized to slip over and turn down into pipe, soldered to skirt at slope of roof and extending at least 4 inches (100 mm) from pipe onto roof.

1.3 EXECUTION

A. Underlayment Installation
1. General: Comply with underlayment manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.
2. Single-Layer Felt Underlayment: Install on roof deck parallel with and starting at the eaves. Lap sides a minimum of 2 inches (50 mm) over underlying course. Lap ends a minimum of 4 inches (100 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment nails.
   a. Install felt underlayment on roof deck not covered by self-adhering sheet underlayment. Lap sides of felt over self-adhering sheet underlayment not less than 3 inches (75 mm) in direction to shed water. Lap ends of felt not less than 6 inches (152 mm) over self-adhering sheet underlayment.
3. Double-Layer Felt Underlayment: Install on roof deck parallel with and starting at the eaves. Install a 19-inch- (485-mm-) wide starter course at eaves and completely cover with full-width second course. Install succeeding courses lapping previous courses 19 inches (485 mm) in shingle fashion. Lap ends a minimum of 6 inches (152 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment nails.
   a. Apply a continuous layer of asphalt roofing cement over starter course and on felt underlayment surface to be concealed by succeeding courses as each felt course is installed. Apply over entire roof **OR** at locations indicated on Drawings, **as directed**.
   b. Install felt underlayment on roof sheathing not covered by self-adhering sheet underlayment. Lap edges over self-adhering sheet underlayment not less than 3 inches (75 mm) in direction to shed water.
   c. Terminate felt underlayment flush **OR** extended up not less than 4 inches (100 mm), **as directed**, against sidewalls, curbs, chimneys, and other roof projections.
4. Self-Adhering Sheet Underlayment: Install, wrinkle free, on roof deck. Comply with low-temperature installation restrictions of underlayment manufacturer if applicable. Install at locations indicated below **OR** on Drawings, **as directed**, lapped in direction to shed water. Lap sides not less than 3-1/2 inches (89 mm). Lap ends not less than 6 inches (152 mm), staggered 24 inches (610 mm) between courses. Roll laps with roller. Cover underlayment within seven days.
   a. Prime concrete and masonry surfaces to receive self-adhering sheet underlayment.
   b. Eaves: Extend from edges of eaves 24 inches (610 mm) **OR** 36 inches (914 mm), **as directed**, beyond interior face of exterior wall.
   c. Rakes: Extend from edges of rakes 24 inches (610 mm) **OR** 36 inches (914 mm), **as directed**, beyond interior face of exterior wall.
   d. Valleys: Extend from lowest to highest point 18 inches (455 mm) on each side.
   e. Hips: Extend 18 inches (455 mm) on each side.
   f. Ridges: Extend 36 inches (914 mm) on each side without obstructing continuous ridge vent slot, **as directed**.
   g. Sidewalls: Extend 18 inches (455 mm) beyond sidewalls and return vertically against sidewalls not less than 4 inches (100 mm).

h. Dormers, Chimneys, Skylights, and Other Roof-Penetrating Elements: Extend 18 inches (455 mm) beyond penetrating elements and return vertically against penetrating elements not less than 4 inches (100 mm).
i. Roof-Slope Transitions: Extend 18 inches (455 mm) on each roof slope.

5. Metal-Flashed, Open-Valley Underlayment: Install two layers of 36-inch- (914-mm-) wide felt underlayment centered in valley. Stagger end laps between layers at least 72 inches (1830 mm). Lap ends of each layer at least 12 inches (305 mm) in direction to shed water, and seal with asphalt roofing cement. Fasten each layer to roof deck with felt underlayment nails.
   a. Lap roof-deck felt underlayment over first layer of valley felt underlayment at least 6 inches (152 mm).

B. Metal Flashing Installation
1. General: Install metal flashings and other sheet metal to comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim".
   a. Install metal flashings according to recommendations for wood roofing in NRCA's "The NRCA Roofing and Waterproofing Manual."
2. Apron Flashings: Extend lower flange over and beyond each side of downslope wood roofing and up the vertical surface.
3. Step Flashings: Install with a head lap of 3 inches (75 mm) and extend both horizontally and vertically. Install with lower edge of flashing just upslope of, and concealed by, butt of overlying shingle or shake. Fasten to roof deck only.
4. Cricket **OR** Backer, **as directed**, Flashings: Install against the roof-penetrating element, extending concealed flange beneath upslope wood roofing and beyond each side.
5. Open-Valley Flashings: Install centrally in valleys, lapping ends at least 8 inches (205 mm) in direction to shed water. Fasten upper end of each length to roof deck beneath overlap.
   a. Secure hemmed flange edges into metal cleats spaced 12 inches (305 mm) apart and fastened to roof deck.
   b. Adhere 9-inch- (230-mm-) wide strip of self-adhering sheet to metal flanges and to self-adhering sheet underlayment.
6. Rake Drip Edges: Install over underlayment and fasten to roof deck.
7. Eave Drip Edges: Install beneath underlayment and fasten to roof deck.
8. Pipe Flashings: Form flashing around pipe penetrations and wood roofing. Fasten and seal to wood roofing.

C. Roof-Shingle Installation
1. General: Install wood-shingle roofing according to manufacturer's written instructions and to recommendations in CSSB's "New Roof Construction Manual" and NRCA's "The NRCA Roofing and Waterproofing Manual."
2. Install drainage mat perpendicular to roof slope in parallel courses, butting edges and ends to form a continuous layer, and fasten to roof deck.
3. Install single **OR** double, **as directed**,-layer wood-shingle starter course along lowest roof edge. Extend starter course 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, over fascia and 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, over rake edge.
   a. Offset joints of double-layer starter course a minimum of 1-1/2 inches (38 mm).
4. Install first course of wood shingles directly over starter course and in continuous straight-line courses across roof deck. Install second and succeeding courses of wood shingles in continuous straight-line courses across roof deck. Extend 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, over rake edge.
   a. Offset joints between shingles in succeeding courses a minimum of 1-1/2 inches (38 mm). Limit alignment of vertical joints in every third course to not exceed 10 percent of joints.
   b. Space shingles a minimum of 1/4 inch (6 mm) and a maximum of 3/8 inch (10 mm) apart.
   c. Fasten each shingle with two nails **OR** staples, **as directed**, spaced 3/4 to 1 inch (19 to 25 mm) from edge of shingle and 1-1/2 to 2 inches (38 to 50 mm) above butt line of succeeding course. Drive fasteners flush with top surface of shingles without crushing wood.

d. Maintain weather exposure of 5 inches (127 mm) for 16-inch- (405-mm-) **OR** 5-1/2 inches (140 mm) for 18-inch- (455-mm-) **OR** 7-1/2 inches (190 mm) for 24-inch- (610-mm-), **as directed**, long shingles.

5. Open Valleys: Cut and fit wood shingles at open valleys, trimming upper concealed corners of shingles. Maintain uniform width of exposed open valley **OR** Widen exposed portion of open valley 1/8 inch in 12 inches (1:96), **as directed**, from highest to lowest point.
6. Fancy-Butt Shingles: Install one **OR** two **OR** three, **as directed**, courses of fancy-butt shingles in continuous straight-line courses across roof deck. Center each shingle in succeeding courses between the two shingles below it with 1/8-inch (3-mm) space between shingles.
   a. Maintain weather exposure of 5 inches (127 mm).
7. Ridge Vents: Install continuous ridge vents over wood shingles according to manufacturer's written instructions. Fasten with roofing nails of sufficient length to penetrate roof sheathing.
8. Ridge and Hip, **as directed**, Units: Install units over wood shingles trimmed at apex. Maintain same exposure dimension of units as roof-shingle exposure. Lap units at ridges to shed water away from direction of prevailing winds. Alternate overlaps of units and fasten with concealed roofing nails of sufficient length to penetrate sheathing.
   a. Install concealed strip of felt underlayment over apex shingles and fasten with felt underlayment nails.
   b. Fasten ridge units to cover ridge vent without obstructing airflow.

D. Roof-Shake Installation
1. General: Install wood-shake roofing according to manufacturer's written instructions and to recommendations in CSSB's "New Roof Construction Manual" and NRCA's "The NRCA Roofing and Waterproofing Manual."
2. Install drainage mat perpendicular to roof slope in parallel courses, butting edges and ends to form a continuous layer, and fasten to roof deck.
3. Install single **OR** double, **as directed**,-layer wood-shake starter course along lowest roof edge. Extend starter course 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, over fascia and 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, over rake edge.
   a. Offset joints of double-layer starter course a minimum of 1-1/2 inches (38 mm).
4. Install first course of wood shakes directly over starter course and in continuous straight-line courses across roof deck. Install second and succeeding courses of wood shakes in continuous straight-line courses across roof deck. Extend 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, over rake edge.
   a. Install 18-inch- (455-mm-) wide strip of felt interlayment over top portion of first and each succeeding course. Set bottom edge of felt interlayment at a distance of twice the weather-exposure dimension above the shake butt. Stagger fasten to roof deck with felt underlayment nails.
   b. Offset joints between shakes in succeeding courses a minimum of 1-1/2 inches (38 mm).
   c. Space shakes a minimum of 3/8 inch (10 mm) and a maximum of 5/8 inch (16 mm) apart.
   d. Fasten each shake with two nails **OR** staples, **as directed**, spaced 3/4 to 1 inch (19 to 25 mm) from edge of shake and 1-1/2 to 2 inches (38 to 50 mm) above butt line of succeeding course. Drive fasteners flush with top surface of shakes without crushing wood.
   e. Maintain weather exposure of 5-1/2 inches (140 mm) for 18-inch- (455-mm-) **OR** 7-1/2 inches (190 mm) for 18-inch- (455-mm-) **OR** 7-1/2 inches (190 mm) for 24-inch- (610-mm-) **OR** 10 inches (255 mm) for 24-inch- (610-mm-), **as directed**, long shakes.
5. Open Valleys: Cut and fit wood shakes at open valleys, trimming upper concealed corners of shakes. Maintain uniform width of exposed open valley **OR** Widen exposed portion of open valley 1/8 inch in 12 inches (1:96), **as directed**, from highest to lowest point.
6. Ridge Vents: Install continuous ridge vents over wood shakes according to manufacturer's written instructions. Fasten with roofing nails of sufficient length to penetrate sheathing.
7. Ridge and Hip, **as directed**, Units: Install units over wood shakes trimmed at apex. Maintain same exposure dimension of units as roof-shake exposure. Lap units at ridges to shed water away from direction of prevailing winds. Alternate overlaps of units and fasten with concealed roofing nails of sufficient length to penetrate sheathing.

a. Install concealed strip of felt underlayment over apex shakes and fasten with felt underlayment nails.
b. Fasten ridge units to cover ridge vent without obstructing airflow.

E. Wall-Shingle Installation, Single Coursed
1. Install wood wall shingles according to manufacturer's written instructions and recommendations in CSSB's "Exterior and Interior Wall Manual."
2. Install drainage mat horizontally, in parallel courses, over surface to receive wood shingles, butting edges and ends to form a continuous layer; fasten to wall sheathing.
3. Install wood shingles, beginning at base of wall, with a double-layer starter course in a continuous straight line. Offset joints of double-layer starter course a minimum of 1-1/2 inches (38 mm).
   a. Extend starter course 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, below top of foundation wall.
4. Install first course of wood shingles over starter course. Install second and succeeding courses of wood shingles. Offset joints between shingles in succeeding courses a minimum of 1-1/2 inches (38 mm).
   a. Install shingles in continuous straight-line courses.
   OR
   Install shingle courses with butt lines staggered 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, from true butt line.
   b. Install primed shingles with sides abutting **OR** Space shingles 1/8 to 1/4 inch (3 to 6 mm) apart, **as directed**.
   c. Fasten each shingle with two concealed nails **OR** staples driven parallel to butt, **as directed**, spaced 3/4 to 1 inch (19 to 25 mm) from edge of shingle and 1 inch (25 mm) above butt line of succeeding course. For shingles wider than 8 inches (205 mm), add two concealed fasteners, spaced 1 inch (25 mm) apart, to the center of shingle. Drive fasteners flush with top surface of shingles without crushing wood.
   d. Maintain weather exposure of 7-1/2 inches (190 mm) for 16-inch- (405-mm-) **OR** 8-1/2 inches (215 mm) for 18-inch- (455-mm-) **OR** 11-1/2 inches (290 mm) for 24-inch- (610-mm-), **as directed**, long shingles.
   e. Interior Corner Treatment: Butted against wood stop **OR** Laced with flashing behind, **as directed**.
   f. Exterior Corner Treatment: Butted against corner boards **OR** Laced **OR** Mitered, **as directed**.
5. Fancy-Butt Shingles: Install fancy-butt shingles where indicated, in continuous straight-line courses along wall. Center each shingle in succeeding courses between the two shingles below it with primed shingles abutting **OR** 1/8-inch (3-mm) space between shingles, **as directed**.
   a. Maintain weather exposure of 7-1/2 inches (190 mm).
   b. Interior Corner Treatment: Butted against wood stop.
   c. Exterior Corner Treatment: Butted against corner boards **OR** Mitered, **as directed**.

F. Wall-Shingle Installation, Double Coursed
1. Install wood wall shingles in continuous straight-line courses according to manufacturer's written instructions and recommendations in CSSB's "Exterior and Interior Wall Manual."
2. Install drainage mat horizontally, in parallel courses, over surface to receive wood shingles, butting edges and ends to form a continuous layer; fasten to wall sheathing.
3. Install double-layer undercourse of wood shingles beginning at base of wall. Offset joints of each undercourse layer a minimum of 1-1/2 inches (38 mm). Fasten with a single center-and-top nail **OR** staple driven parallel to butt, **as directed**.
   a. Extend undercourse 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, below top of foundation wall.
   b. Fasten two layers of lath wood strips at base of undercourse to match thickness of double-layer undercourse. Extend 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, below top of foundation wall.
4. Install succeeding undercourse layers against wood lath strip, **as directed**. Offset joints between undercourse and outer course a minimum of 1-1/2 inches (38 mm).

a. Fasten with a single center-and-top nail **OR** staple driven parallel to butt, **as directed**.
5. Install single wood lath strip on first and succeeding outer courses to match thickness of undercourse and at height that results in specified outer course weather exposure.
6. Install first and succeeding outer courses of wood shingles directly over undercourses, projecting 1/2 inch (13 mm) below undercourse **OR** lath strips, **as directed**. Offset joints between shingles and undercourse a minimum of 1-1/2 inches (38 mm). Offset joints between shingles in succeeding outer courses a minimum of 1-1/2 inches (38 mm).
   a. Install primed outer shingles with sides abutting **OR** Space outer shingles 1/8 to 1/4 inch (3 to 6 mm) apart, **as directed**.
   b. Fasten each shingle with two exposed nails **OR** staples driven parallel to butt, **as directed**, spaced 3/4 to 1 inch (19 to 25 mm) from edge of shingle and 2 inches (50 mm) above butt line of succeeding course. For outer course shingles wider than 8 inches (205 mm), add two concealed fasteners, spaced 1 inch (25 mm) apart, to the center of shingle. Drive fasteners flush with top surface of shingles without crushing wood.
   c. Maintain weather exposure of 12 inches (305 mm) for 16-inch- (405-mm-) **OR** 14 inches (355 mm) for 18-inch- (455-mm-) **OR** 16 inches (405 mm) for 24-inch- (610-mm-), **as directed**, long shingles.
   d. Interior Corner Treatment: Butted against wood stop **OR** Laced with flashing behind, **as directed**.
   e. Exterior Corner Treatment: Butted against corner boards **OR** Laced **OR** Mitered, **as directed**.

G. Wall-Shake Installation, Single Coursed
1. Install wood wall shakes according to manufacturer's written instructions and recommendations in CSSB's "Exterior and Interior Wall Manual."
2. Install drainage mat horizontally, in parallel courses, over surface to receive wood shakes, butting edges and ends to form a continuous layer; fasten to wall sheathing.
3. Install wood shakes, beginning at base of wall, with a double-layer starter course in a continuous straight line. Offset joints of double-layer starter course a minimum of 1-1/2 inches (38 mm).
   a. Extend starter course 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, below top of foundation wall.
4. Install first course of wood shakes over starter course. Install second and succeeding course of wood shakes. Offset joints between shakes in succeeding courses a minimum of 1-1/2 inches (38 mm).
   a. Install shakes in continuous straight-line courses.
      OR
      Install shake courses with butt lines staggered 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, from true butt line.
   b. Install primed shakes with sides abutting **OR** Space shingles 1/8 to 1/4 inch (3 to 6 mm) apart, **as directed**.
   c. Fasten each shake with two concealed nails **OR** staples driven parallel to butt, **as directed**, spaced 3/4 to 1 inch (19 to 25 mm) from edge of shake and 1 inch (25 mm) above butt line of succeeding course. For shakes wider than 8 inches (205 mm), add two concealed fasteners, spaced 1 inch (25 mm) apart, to the center of shake. Drive fasteners flush with top surface of shakes without crushing wood.
   d. Maintain weather exposure of 7-1/2 inches (190 mm) for 16-inch- (405-mm-) **OR** 8-1/2 inches (215 mm) for 18-inch- (455-mm-) **OR** 11-1/2 inches (290 mm) for 24-inch- (610-mm-), **as directed**, long shakes.
   e. Interior Corner Treatment: Butted against wood stop **OR** Laced with flashing behind, **as directed**.
   f. Exterior Corner Treatment: Butted against corner boards **OR** Laced **OR** Mitered, **as directed**.

H. Wall-Shake Installation, Double Coursed

1. Install wood wall shakes in continuous straight-line courses according to manufacturer's written instructions and recommendations in CSSB's "Exterior and Interior Wall Manual."
2. Install drainage mat horizontally, in parallel courses, over surface to receive wood shakes, butting edges and ends to form a continuous layer; fasten to wall sheathing.
3. Install double-layer undercourse of wood shingles beginning at base of wall. Offset joints of each undercourse layer a minimum of 1-1/2 inches (38 mm). Fasten with a single center-and-top nail **OR** staple driven parallel to butt, **as directed**.
   a. Extend undercourse 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, below top of foundation wall.
   b. Fasten two layers of lath wood strips at base of undercourse to match thickness of double-layer undercourse. Extend 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, below top of foundation wall.
4. Install succeeding undercourse layers against wood lath strip, **as directed**. Offset joints between undercourse and outer course a minimum of 1-1/2 inches (38 mm).
   a. Fasten with a single center-and-top nail **OR** staple driven parallel to butt, **as directed**.
5. Install single wood lath strip on first and succeeding outer courses to match thickness of undercourse and at height that results in specified outer course weather exposure.
6. Install first and succeeding outer courses of wood shakes directly over undercourses, projecting 1/2 inch (13 mm) below undercourse **OR** lath strips, **as directed**. Offset joints between shakes and undercourse shingles a minimum of 1-1/2 inches (38 mm). Offset joints between shakes in succeeding outer courses a minimum of 1-1/2 inches (38 mm).
   a. Install primed outer shakes with sides abutting **OR** Space outer shakes 1/4 to 3/8 inch (6 to 10 mm) apart, **as directed**.
   b. Fasten each shake with two exposed nails **OR** staples driven parallel to butt, **as directed**, spaced 3/4 to 1 inch (19 to 25 mm) from edge of shake and 2 inches (50 mm) above butt line of succeeding course. For shakes wider than 8 inches (205 mm), add two concealed fasteners, spaced 1 inch (25 mm) apart, to the center of shake. Drive fasteners flush with top surface of shake without crushing wood.
   c. Maintain weather exposure of 12 inches (305 mm) for 16-inch- (405-mm-) **OR** 14 inches (355 mm) for 18-inch- (455-mm-) **OR** 18 inches (455 mm) for 24-inch- (610-mm-), **as directed**, long shakes.
   d. Interior Corner Treatment: Butted against wood stop **OR** Laced with flashing behind, **as directed**.
   e. Exterior Corner Treatment: Butted against corner boards **OR** Laced **OR** Mitered, **as directed**.

I. Wood-Shingle-Clad Panel Installation
1. Install wood-shingle-clad panels and corner units, **as directed**, according to manufacturer's written instructions.
2. Install panels level, plumb, true, and aligned with adjacent materials.
3. Install panels working from the lowest level to the top of the wall area.

END OF SECTION 07 31 29 00

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Task	Specification	Specification Description
07 31 29 13	07 31 29 00	Wood Shingles And Shakes
07 31 29 16	07 31 29 00	Wood Shingles And Shakes
07 31 29 19	01 22 16 00	No Specification Required
07 31 29 19	07 31 29 00	Wood Shingles And Shakes

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SECTION 07 31 33 00 - COMPOSITE RUBBER SHINGLES

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for composite rubber shingles. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.
2. Furnish and install this Majestic Slate Tile Roof System in strict accordance with specifications and drawings approved by EcoStar.
3. Metal flashing work is not covered in this specification since EcoStar does **NOT** warrant metal flashing. EcoStar advises that metal flashing and securement of metal should be to industry standards (SMACNA) to prevent the metal from pulling free or buckling. EcoStar also suggests that all flashing metal be copper, stainless steel or an equally long-term material.
4. EcoStar Attic Guard Ridge Ventilation product must be used on those projects that will be using a ridge ventilation system. If a ridge ventilation system is not to be used on the project, another form of ventilation may be used, but will not be covered by any EcoStar warranties. EcoStar advises that a ridge style venting system be utilized to insure the best possible air movement and to provide the best aesthetic appearance to the roofing system.

B. Definitions
1. Roofing Terminology: Refer to ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

C. Submittals
1. Submit an “EcoStar Gold Star Project Survey” to EcoStar Technical Department for approval **PRIOR** to the job start to enable the Technical Department to approve and assign a job number to the project.
2. The “EcoStar Gold Star Project Survey Form” must be filled out completely and accurately to include any prior deviations approved from this specification, including a roof drawing showing all dimensions, all penetrations, and roof slope.
3. When an EcoStar Gold Star Warranty is desired, EcoStar must be contacted **PRIOR** to project bid and installation. Information may be required for wind design and slope requirements.
4. Product Data: For each type of product indicated.
5. Samples: For the following products, of sizes indicated.
   a. Composite Rubber Shingle: Full size, of each color, size, texture, and shape.
   b. Ridge Vent System: 12 inches (300 mm) long.
   c. Fasteners: Three fasteners of each type, length, and finish.
   d. Underlayment: 12 inches (300 mm) square.

D. Quality Assurance
1. To qualify for an EcoStar Gold Star Warranty, an authorized EcoStar Gold Star Applicator must install system.
2. There shall be no deviation made from this specification without written approval from EcoStar prior to the start of the roofing project.
3. For an EcoStar Gold Star Warranty, upon completion of the installation, an inspection must be conducted by a Technical Representative of EcoStar to ascertain that the roofing system has been installed according to EcoStar’s most current published specifications and details. This inspection is not intended to be a Final Inspection for the benefit of the Owner, but for the benefit of EcoStar to determine whether a warranty shall be issued.
4. Class C Testing Requirements:
   a. Fire Resistance - UL 790 Test Standard
   b. Class 4 Impact Resistance - UL 2218 Test Standard

c. 110 mph wind load - PA100-95 Test Standard
d. Wind uplift - 105 lbs / sq ft - UL 1897 Test Standard

5. Class A Testing Requirements:
   a. Fire Resistance - UL 790 Test Standard
   b. Class 4 Impact Resistance - UL 2218 Test Standard

E. Product Delivery, Storage And Handling
1. Deliver materials in original unopened packages.
2. Packages shall be labeled with manufacturer's name, brand name, installation instructions and identification of various items.
3. All tile materials must be stored between 45^{O} F. and 80^{O} F. If exposed to lower temperatures, restore to 45^{O} F minimum temperature before using.
4. Store all materials in a dry protected area. Damaged materials must **NOT** be used. Installed materials found to be damaged shall be replaced at Gold Star Authorized Applicator's expense.

F. Job Conditions (Cautions And Warnings)
1. Contact EcoStar Technical Department for procedures when installing a Majestic Slate Tile Roof System during temperatures less than 45^{O} F.
2. Do not install the Majestic Slate Tile Roof System directly over existing asphalt shingles or existing tile roof systems. All existing roof materials **MUST** be removed prior to installation of the Majestic Slate Tile System.
3. Roofing surface must be free of ice, water, or snow prior to and during the roofing project.

G. Warranty
1. Roofing materials manufacturer will provide the warranty for those materials supplied by the manufacturer when the project is completed by a manufacturer's authorized applicator and all required materials have been utilized within the roof system.
2. Only when a manufacturer's technical representative has inspected and approved the completed installation will a warranty be issued.
3. The warranty is available for all types of buildings and structures.
4. The warranty period is expressed on the warranty certificate, which reflects the inclusive dates of coverage.
5. The warranty does NOT cover the aesthetic appearance of the Majestic Slate - Tiles. Care should be taken by the authorized applicator to ensure that proper blending of the tiles occurs. When improper blending occurs the aesthetic appearance of the roof can be effected negatively. Blending should occur from a minimum of seven bundles from each pallet. It is highly suggested that all material be on site to blend from.
6. Only products supplied by EcoStar, a Division of Carlisle SynTec Incorporated, are included in the warranty unless otherwise specified and approved in writing by EcoStar, a Division of Carlisle SynTec Incorporated.

1.2 PRODUCTS

A. Manufacturer
1. All Components of the Majestic Slate - Tile Roof System are to be products manufactured or supplied by EcoStar, a Division of Carlisle SynTec Incorporated, or approved equivalent.

B. Class C Tile Roofing System
1. Slate Tiles/Shingles: Tiles made of Starloy™, 100% recycled rubber and plastic compound, 12" wide by 18" long with a nominal thickness of 1/4". Weight shall be determined by the following acceptable tile exposures:

7"	241 - 258 lbs per square
6-1/2"	259 - 278 lbs per square
6"	280 - 300 lbs per square

a. Color: As selected from manufacturer's standard colors, unless directed otherwise.

2. Underlayment
   a. AquaGuard - a roofing underlayment recognized for use as an alternative to Type 30 roofing underlayment, consisting of spunbonded polypropylene coated with a layer of U.V. stabilized polypropylene on both sides, meeting requirements of ASTM D2626, referred to as 30 lb and without perforations.
   b. Glacier Guard ice and water underlayment - Granular Surface (55 mil), Smooth Surface (40 mil), or Smooth Surface High Temperature (40 mil), a composite membrane consisting of fiberglass reinforced rubberized asphalt laminated to an impermeable polyethylene film layer (Smooth Surface and Smooth Surface High Temperature) or coated with a granular surface providing maximum skid resistance (Granular Surface).

C. Class A Tile Roofing System
1. Slate Tiles/Shingles: Tiles made of Starloy™, 100% recycled rubber and plastic compound, 12" wide by 18" long with a nominal thickness of 1/4". Weight shall be determined by the following acceptable tile exposures:

7"	258 - 276 lbs per square
6-1/2"	278 - 294 lbs per square
6"	300 - 321 lbs per square

   a. Color: As selected from manufacturer's standard colors, unless directed otherwise.
2. Underlayment
   a. VersaShield - One layer of Elk VersaShield meeting or exceeding the requirements of ASTM D226.
   b. Glacier Guard ice & water underlayment - Granular Surface (55 mil), Smooth Surface (40 mil), or Smooth Surface High Temperature (40 mil), a composite membrane consisting of fiberglass reinforced rubberized asphalt laminated to an impermeable polyethylene film layer (Smooth Surface and Smooth Surface High Temperature) or coated with a granular surface providing maximum skid resistance (Granular Surface).

D. Fasteners
1. AquaGuard/VersaShield
   a. Roofing nails with one inch (1") diameter round or square head, plastic or metal, and 3/4" long shank. Metal parts of fastener are to be corrosion resistant.
2. Tile Fasteners
   a. EcoStar Roofing Nail with a 3/8" diameter head and a minimum of 1-1/2" long shank made from stainless steel. Nails can be supplied either as a hand drive style or in coils for use in pneumatic tools.

1.3 EXECUTION

A. Substrate Criteria
1. The Building owner or the Owner's Representative is responsible for providing and determining that the substrate is suitable to receive the Majestic Slate Tile Roof System and the authorized EcoStar Gold Star Applicator should not proceed until all defects have been corrected.
2. The Majestic Slate Roof System may only be applied over:
   a. Minimum ½" plywood or OSB decking
   b. Minimum 1" tongue and groove wood decking
   c. Approved metal deck systems - for specifics contact roofing materials manufacturer.
3. Minimum slope of substrate for installation of Majestic Slate Roof System shall be a minimum of 3/12 for 6" exposure installation and a minimum of 6/12 for 7" exposure installation. Contact the EcoStar Technical Department for approval of applications on lower slopes or exceptions to this requirement.

B. Substrate Preparation

1. The Building Owner or the Owner's Representative is responsible for ensuring that all wet or damaged substrate has been removed in a re-roofing application.
2. Existing roof material **MUST** be removed and a clean substrate free of foreign material be provided prior to the installation of the Majestic Slate Tile Roof System. Majestic Slate Tiles may **NOT** be installed directly over any existing roof material or system.

C. Installation
1. Flashing and Sheet Metal:
    a. Install sheet metal and flashing metal in all valleys and where required on projections furnish in accordance with Division 07 Section "Sheet Metal Flashing And Trim".
    b. Where required, install metal starter strip at all eaves and roof edges. Furnish metal in accordance with Division 07 Section "Sheet Metal Flashing And Trim".
    c. The roofing materials manufacturer suggests that all metal work be made from copper, stainless steel or an equally long-term material.
2. Underlayment:
    a. AquaGuard:
        1) Apply 41.5" wide sheet over complete deck, lapping the area covered with Glacier Guard ice and water underlayment. Lap end joints 6" and side joints 4" and double through valleys.
        2) Do not leave exposed to weather more than 90 days after beginning of installation without written approval of the Owner.
        3) Do not leave any fastener heads exposed. Nail only in areas to be covered by lapping of underlayment.
    b. VersaShield:
        1) Apply 42" wide sheet over complete deck, covering the entire roof deck **INCLUDING** those areas with Glacier Guard Ice & Water underlayment. Lap end joints 4" and side joints 6".
        2) Lap the VersaShield 6" from both sides over all hips, valleys, and ridges.
        3) Where the roof meets a vertical surface, carry the VersaShield 3" to 4" up the surface.
        4) Do not leave exposed to weather more than **60** days after beginning of installation without written approval of the Owner.
        5) Do not leave any fastener heads exposed. Nail only in areas to be covered by lapping of underlayment.
    c. Glacier Guard Ice and water underlayment:
        1) Lap end joints 6" and side joints 3.5"
        2) Apply continuous 36" wide sheet in valley centered over valley.
        3) Apply rows of 36" wide sheets along all eaves and rakes. Lap end joints 6" and side joints 3.5".
        4) Apply rows of 36" wide sheets along and around all dormers and roof projections. Lap end joints 6" and side joints 3.5".
        5) When applicable install as far as it can be installed on any head walls or vertical walls a minimum of 12".
        6) Do not leave Glacier Guard Granular Surface exposed to weather more than 14 days after beginning of installation. Do not leave Glacier Guard Smooth Surface exposed to weather more than 30 days after beginning of installation. Do not leave Glacier Guard Smooth Surface High Temp exposed to the weather more than 60 days after the beginning of installation.
3. Tile/Shingle Installation
    a. After installing underlayment and before installing the tiles, clean the surface of debris and dirt.
    b. Beginning at the eave, install a layer of tiles gapped a minimum of 3/8" between tiles and any projections, with two roofing fasteners per tile (in location shown on tiles). This layer of tiles will become the starter row. Install another layer of tiles in the same manner as the first with the exception of the second layer having a 1/2 tile offset to the first layer.

c. Continue installing tiles per the chosen exposure.

d. Care must be taken to place tiles so color variations are evenly distributed over the entire roof area. Tiles between bundles and pallets **MUST** be shuffled to insure even distribution of color variations. "Patchy" or "Blotching" in appearance is not acceptable and the applicator will be required to correct. It is recommended that work not begin until all roofing materials have been delivered to the job site.

e. It is the responsibility of the applicator to ensure that all tiles are bent back in a downward curve prior to installation. **Do not install tiles with an upward curve**.

f. Either an open or closed valley design may be used.
   1) With an open valley design leave a minimum of 2" on each side of the center of the valley exposed and uncovered by the roof tiles. A V-Style or W-Style Valley metal may be used.
   2) With a closed valley design cut the tiles in a straight line to fit no closer than 3/8" against tile of adjoining roof slope.

g. Minimum Fastening - No less than 2 approved fasteners per tile, with a minimum length of 1-1/2", shall be used.

h. CAUTION: When using a pneumatic nailer, care shall be taken to ensure that nails are not over driven causing the tiles to curl upward. If tiles have been installed with over-driven nails causing the ends of the tile to curve upward, tiles will never lay flat. Over-driven tiles must be removed and re-nailed properly.

i. Install EcoStar Attic Guard ridge vent system per the manufacturer's application instructions, and then place the Majestic Slate - Universal Hip/Ridge Tile over the ridge vent. A minimum 2.5" stainless steel, hand-driven EcoStar fastener should be used on a ventilated hip/ridge to fasten the hip/ridge tile to the deck. A minimum 2" stainless steel, hand-driven EcoStar fastener should be used on an unventilated hip/ridge to fasten the hip/ridge tile to the deck. Place fasteners in the location marked on the tile. Majestic Slate - Universal Hip/Ridge Tile must be installed with 6" exposure.

j. Tiles may not be installed if the tiles have been stored in temperatures lower than 45^{O} F. If tiles have been stored in temperatures below 45^{O} F., tiles must be brought back to an ambient material temperature of 45^{O} F. As the temperature rises, tiles will expand beyond the designed installation pattern if the product is installed while cold or frozen.

k. Do not install tiles directly adjacent to each other. A minimum gap of 3/8" must be maintained between installed tiles.

l. After the initial row of tiles has been installed, it is recommended that a chalk line be placed parallel to the roof edge and running perpendicular to the first row of tiles. This chalk line will ensure that the tiles stay true and plumb to the roof edge throughout installation.

m. Care must be taken to minimize foot traffic over completed areas of the roof. Tiles will show mud and dirt and cause appearance problems. The removal of dirt and debris is the responsibility of the applicator.

n. Tiles can be slippery when wet, caution should be exhibited with early morning dew and after rain. The tile manufacturer suggests the use of toe boards and OSHA approved harnesses and safety equipment at all time.

o. Upon completion of the roof system installation, inspect and remove all debris from roof, sweep clean and wash with a mild, non-bleaching detergent.

END OF SECTION 07 31 33 00

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Task	Specification	Specification Description
07 31 33 00	01 22 16 00	No Specification Required

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SECTION 07 32 13 00 - CLAY ROOF TILES

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for clay roof tiles. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Clay roof tiles.
      b. Underlayment.
      c. Snow guards.

C. Definitions
   1. Roofing Terminology: See ASTM D 1079, glossaries in TRI/WSRCA's "Concrete and Clay Roof Tile Design Criteria Installation Manual for Moderate Climate Regions," and NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

D. Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittal:
      a. Product Test Reports for Credit SS 7.2: For clay roof tiles, documentation indicating compliance with Solar Reflectance Index requirement.
   3. Samples: For each type of clay roof tile and accessory tile indicated.
   4. Material test reports.
   5. Research/evaluation reports.
   6. Maintenance data.
   7. Warranties: Sample of special warranties.

E. Quality Assurance
   1. Fire-Test-Response Characteristics: Provide clay roof tiles and related roofing materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
      a. Exterior Fire-Test Exposure: Class A **OR** Class B **OR** Class C, **as directed**; UL 790 or ASTM E 108, for application and roof slopes indicated.
   2. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
   1. Store underlayment rolls on end, on pallets or other raised surfaces. Do not double stack rolls.
      a. Handle, store, and place roofing materials in a manner to avoid significant or permanent damage to roof deck or structural supporting members.
   2. Protect unused underlayment from weather, sunlight, and moisture when left overnight or when roofing work is not in progress.

G. Warranty
   1. Special Warranty: Standard form in which manufacturer agrees to repair or replace clay roof tiles that fail in materials within specified warranty period.
      a. Materials-Only Warranty Period: 50 years from date of Final Completion.

1.2 PRODUCTS

A. Clay Roof Tiles
1. Clay Roof Tiles: ASTM C 1167, molded- or extruded-clay roof tile units of shape and configuration indicated, kiln fired to vitrification, and free of surface imperfections. Provide with fastening holes prepunched at factory before firing.
a. Durability: Grade 1 **OR** Grade 2 **OR** Grade 3, **as directed**.
b. High-Profile Shape: Type **I**, Spanish or "S" **OR** Type **I**, tapered mission, two piece **OR** Type **I**, straight mission, two piece **OR** Type **I**, straight barrel mission, two piece **OR** Type **I**, Greek, two piece **OR** Type **I**, Roman, two piece, **as directed**.
c. Low-Profile Shape: Type **II**, French interlocking.
d. Flat Shape: Type **III**, flat shingle **OR** Type **III**, flat interlocking, **as directed**.
1) Provide clay roof tiles of diminishing widths for circular bays or round towers.
e. Solar Reflectance Index: Provide clay roof tile with Solar Reflectance Index not less than 29 when calculated according to ASTM E 1980, based on testing of identical products by a qualified testing agency.
f. Finish and Texture: Matte, smooth **OR** Matte, striated **OR** Glazed, smooth, **as directed**.
g. Color: Terra cotta **OR** Brown **OR** Red **OR** Blended red **OR** Buff, **as directed**.
h. High **OR** Low, **as directed**,-Profile-Shape Accessory Tiles: Ridge, ridge vent, ridge end, hip and hip starter, header course, L-shaped rake edge, roll rake edge, starter, end band, terminal, eave closure, and top fixture, **as directed**, units, in color matching clay roof tiles.
i. Flat-Shape Accessory Tiles: Ridge and closed ridge end, hip and hip starter, header course, L-shaped rake edge, starter, end band, and terminal, **as directed**, units, in color matching clay roof tiles.

B. Accessories
1. Asphalt Roofing Cement: ASTM D 4586, Type **II**, asbestos free.
2. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied.
3. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane **OR** silicone, **as directed**,-based joint sealant; Type M **OR** Type S, **as directed**, Grade NS, Class 25, Use NT related to exposure, and, as applicable to joint substrates indicated, Use O.
4. Roofing Asphalt: ASTM D 312, Type IV.
5. Cold-Applied Adhesive: Manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive specially formulated for compatibility and use with underlayments.
6. Foam Adhesive: Two-component, polyurethane expanding adhesive recommended for application by clay roof tile manufacturer.
OR
Mortar: ASTM C 270, Type M, natural color **OR** with ASTM C 979, pigmented mortar matching the color of clay roof tiles for exposed-to-view mortar, and natural color for concealed-from-view mortar, **as directed**.
7. Eave Closure: Manufacturer's standard EPDM **OR** copper **OR** stainless-steel **OR** galvanized-steel **OR** aluminum, mill finish, **as directed**, eave closure formed to shape of clay roof tile.
8. Wood Nailers, Beveled Cant Strips and Wood Battens: Comply with requirements for pressure-preservative-treated wood in Division 06 Section(s) "Rough Carpentry" OR "Miscellaneous Rough Carpentry", **as directed**.
9. Mesh Fabric: 18-by-14 (1.1-by-1.4-mm) mesh of PVC-coated, glass-fiber thread.

C. Fasteners
1. Roofing Nails: ASTM F 1667, copper, 0.135-inch- (3.4-mm-) **OR** aluminum, 0.1055-inch- (2.7-mm-) **OR** hot-dip galvanized-steel, 0.1055-inch- (2.7-mm-), **as directed**, diameter shank, sharp-pointed, conventional roofing nails with barbed shanks; minimum 3/8-inch- (10-mm-) diameter head; of sufficient length to penetrate 3/4 inch (19 mm) into wood battens **OR** solid wood decking **OR** roof-deck sheathing, **as directed**.

a. Where nails are in contact with metal flashing, use nails made from same metal as flashing.

2. Felt Underlayment Nails: Aluminum, stainless-steel, or hot-dip galvanized-steel wire with low-profile capped heads or disc caps, 1-inch (25-mm) minimum diameter.
3. Wood Batten Nails: ASTM F 1667; common or box, steel wire, flat head, and smooth shank.
4. Wire Ties: Copper **OR** Brass **OR** Stainless steel, **as directed**, 0.083-inch (2.1-mm) minimum diameter.
5. Twisted-Wire-Tie System: Continuously twisted, two-wire unit with loops formed 6 inches (152 mm) apart, minimum 0.1-inch- (2.5-mm-) diameter brass wire and 0.06-inch- (1.5-mm-) diameter brass tie wires **OR** 0.1-inch- (2.5-mm-) diameter copper wire and 0.06-inch- (1.5-mm-) diameter brass tie wires **OR** 0.083-inch- (2.1-mm-) diameter stainless-steel wire and 0.037-inch- (0.94-mm-) diameter stainless-steel tie wires **OR** 0.083-inch- (2.1-mm-) diameter galvanized-steel wire and 0.037-inch- (0.94-mm-) diameter galvanized-steel tie wires, **as directed**, with matching-metal folding clip anchors.
6. Single-Line, Wire-Tie System: Interconnecting eave-to-ridge system, minimum 0.1-inch- (2.5-mm-) diameter brass **OR** 0.09-inch- (2.3-mm-) diameter galvanized-steel, **as directed**, wire, preformed to accommodate clay roof tile type and application indicated.
7. Hook Nails: One-piece wind lock and clay roof tile fastener system, minimum 0.1-inch- (2.5-mm-) diameter brass **OR** 0.09-inch- (2.3-mm-) diameter galvanized-steel, **as directed**, wire, for direct deck nailing.
8. Tile Locks: Brass **OR** Copper **OR** Stainless-steel **OR** Hot-dip galvanized-steel, **as directed**, 0.1-inch- (2.5-mm-) diameter wire device designed to secure butt edges of overlaid clay roof tiles.
9. Storm Clips: Brass **OR** Stainless-steel **OR** Hot-dip galvanized-steel, **as directed**, strap-type, 0.04-by-1/2-inch (1.0-by-13-mm), L-shaped retainer clips designed to secure side edges of clay roof tiles. Provide with two fastener holes in base flange.

D. Underlayment Materials

1. Felt Underlayment: ASTM D 226, Type II, asphalt-saturated organic felt, unperforated.
2. Felt Underlayment: ASTM D 2626, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides, unperforated.
3. Roll Roofing Underlayment: ASTM D 6380, Class M, Type II, asphalt-saturated and -coated organic felt, mineral-granule surfaced.
4. Self-Adhering Sheet Underlayment, Granular Surfaced: ASTM D 1970, a minimum of 55-mil- (1.4-mm-) thick sheet; glass-fiber-mat-reinforced, SBS-modified asphalt; mineral-granule surfaced; with release paper backing; cold applied. Provide primer for adjoining concrete or masonry surfaces to receive underlayment, **as directed**.
5. Self-Adhering Sheet Underlayment, Polyethylene Faced: ASTM D 1970, a minimum of 40-mil- (1.0-mm-) thick, slip-resisting, polyethylene-film-reinforced top surface laminated to SBS-modified asphalt adhesive, with release paper backing; cold applied. Provide primer for adjoining concrete or masonry surfaces to receive underlayment, **as directed**.

E. Snow Guards

1. Snow-Guard Pads: Fabricated copper **OR** cast-bronze **OR** zinc **OR** stainless-steel **OR** aluminum, **as directed**, units, designed to be installed without penetrating roof tiles, and complete with predrilled holes or hooks for anchoring.
2. Snow-Guard Rails: Units fabricated from metal baseplate anchored to adjustable **OR** fixed, **as directed**, bracket and equipped with two **OR** three, **as directed**, bars.
   a. Brackets and Baseplate: Aluminum **OR** Bronze or brass **OR** Stainless steel, **as directed**.
   b. Bars: Aluminum, mill finished **OR** Aluminum, clear anodized **OR** Stainless steel, mill finished, **as directed**.

F. Metal Flashing And Trim

1. General: Comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim".
   a. Sheet Metal: Copper **OR** Stainless steel **OR** Zinc-tin alloy-coated stainless steel **OR** Zinc-tin alloy-coated steel **OR** Zinc-tin alloy-coated copper **OR** Anodized aluminum **OR** Aluminum, mill finished, **as directed**.

2. Fabricate sheet metal flashing and trim to comply with recommendations that apply to design, dimensions, metal, and other characteristics of the item in SMACNA's "Architectural Sheet Metal Manual."
    a. Apron Flashings: Fabricate with lower flange extending a minimum of 4 inches (100 mm) **OR** 6 inches (152 mm), **as directed**, over and 4 inches (100 mm) beyond each side of downslope tile roofing and 6 inches (152 mm) up the vertical surface.
    b. Step Flashings: Fabricate with a head lap of 3 inches (75 mm) and a minimum extension of 4 inches (100 mm) **OR** 5 inches (127 mm), **as directed**, both horizontally and vertically.
    c. Channel Flashings: Fabricate with vertical surface extending a minimum of 4 inches (100 mm) **OR** 5 inches (127 mm), **as directed**, above the clay roof tile and 4 inches (100 mm) **OR** 6 inches (152 mm), **as directed**, beneath the tile roofing, with a 1-inch- (25-mm-) high vertical return to form a runoff channel.
    d. Rake Pan Flashings: Fabricate with vertical surface extending over fasciae and 6 inches (152 mm) beneath the tile roofing, with a 1-inch- (25-mm-) high vertical return to form a runoff channel.
    e. Cricket **OR** Backer, **as directed**, Flashings: Fabricate with concealed flange extending a minimum of 18 inches (455 mm) **OR** 24 inches (610 mm), **as directed**, beneath upslope tile roofing, 6 inches (152 mm) beyond each side of chimney **OR** skylight, **as directed**, and 6 inches (152 mm) above the roof plane.
    f. Closed **OR** Open, **as directed**,-Valley Flashings: Fabricate in lengths not exceeding 10 feet (3 m), with 1-inch- (25-mm-) high, inverted-V profile at center of valley and with equal flange widths of 10 inches (255 mm) **OR** 12 inches (305 mm), **as directed**.
    g. Drip Edges: Fabricate in lengths not exceeding 10 feet (3 m), with 2-inch (50-mm) roof-deck flange and 1-1/2-inch (38-mm) fascia flange with 3/8-inch (10-mm) drip at lower edge.
3. Sheet Metal Ridge Vent: Fabricate from 16-oz./sq. ft.- (0.55-mm-) thick copper sheet, terminating each side in V-shaped external baffles with venting holes producing net-free ventilating area of 2.65 sq. in./ft. (56 sq. cm/m).
4. Vent-Pipe Flashings: ASTM B 749, Type L51121, at least 1/16 inch (1.6 mm) thick. Provide lead sleeve sized to slip over and turn down into pipe, soldered to skirt at slope of roof and extending at least 4 inches (100 mm) from pipe onto roof.

1.3 EXECUTION

A. Underlayment Installation
1. General: Comply with clay roof tile manufacturer's written instructions and recommendations in NRCA's "The NRCA Roofing and Waterproofing Manual."
    a. Cover ridge **OR** hip, **as directed**, wood nailers with underlayment strips.
2. Single-Layer Felt Underlayment: Install on roof deck parallel with and starting at the eaves. Lap sides a minimum of 2 inches (50 mm) over underlying course. Lap ends a minimum of 4 inches (100 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment **OR** roofing, **as directed**, nails.
    a. Install felt underlayment on roof deck not covered by self-adhering sheet underlayment. Lap sides of felt over self-adhering sheet underlayment not less than 3 inches (75 mm) in direction to shed water. Lap ends of felt not less than 6 inches (152 mm) over self-adhering sheet underlayment.
3. Double-Layer Felt Underlayment: Install on roof deck parallel with and starting at the eaves. Install a 19-inch- (485-mm-) wide starter course at eaves and completely cover with full-width second course. Install succeeding courses lapping previous courses 19 inches (485 mm) in shingle fashion. Lap ends a minimum of 6 inches (152 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment **OR** roofing, **as directed**, nails.
    a. Apply a continuous layer of asphalt roofing cement over starter course and on felt underlayment surface to be concealed by succeeding courses as each felt course is installed. Apply over entire roof **OR** at locations indicated on Drawings, **as directed**.

b. Install felt underlayment on roof sheathing not covered by self-adhering sheet underlayment. Lap edges over self-adhering sheet underlayment not less than 3 inches (75 mm) in direction to shed water.

4. Double-Layer Felt/Roll Roofing Underlayment:
   a. Install single layer of felt underlayment on roof deck parallel with and starting at the eaves. Lap sides a minimum of 2 inches (50 mm) over underlying course. Lap ends a minimum of 4 inches (100 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment **OR** roofing, **as directed**, nails.
   b. Install roll roofing underlayment, in parallel courses, in same direction as felt underlayment. Lap ends a minimum of 6 inches (152 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm).
      1) Mechanically fasten over felt underlayment.
      2) Adhere to felt underlayment with solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature **OR** uniform coating of cold-applied adhesive **OR** uniform coating of asphalt roofing cement, **as directed**.
   c. Terminate felt underlayment flush **OR** extended up not less than 4 inches (100 mm), **as directed**, against chimneys, sidewalls, curbs, and other projections.

5. Self-Adhering Sheet Underlayment: Install wrinkle free; comply with low-temperature installation restrictions of underlayment manufacturer if applicable. Install at locations indicated below **OR** on Drawings, **as directed**, lapped in direction to shed water. Lap sides not less than 3-1/2 inches (89 mm). Lap ends not less than 6 inches (152 mm), staggered 24 inches (610 mm) between succeeding courses. Roll laps with roller. Cover underlayment within seven days.
   a. Prime concrete and masonry surfaces to receive self-adhering sheet underlayment.
   b. Extend self-adhering sheet underlayment over entire roof deck.
      OR
      Extend self-adhering sheet underlayment over roof deck as follows:
      1) Eaves: Extend from edges of eaves 24 inches (610 mm) **OR** 36 inches (914 mm), **as directed**, beyond interior face of exterior wall.
      2) Rakes: Extend from edges of rakes 24 inches (610 mm) **OR** 36 inches (914 mm), **as directed**, beyond interior face of exterior wall.
      3) Valleys: Extend from lowest to highest point 18 inches (455 mm) on each side.
      4) Hips: Extend 18 inches (455 mm) on each side.
      5) Ridges: Extend 36 inches (914 mm) on each side without obstructing continuous ridge vent slot, **as directed**.
      6) Sidewalls: Extend 18 inches (455 mm) beyond sidewalls and return vertically against sidewalls not less than 4 inches (100 mm).
      7) Dormers, Chimneys, Skylights, and Other Roof-Penetrating Elements: Extend 18 inches (455 mm) beyond penetrating elements and return vertically against penetrating elements not less than 4 inches (100 mm).
      8) Roof-Slope Transitions: Extend 18 inches (455 mm) on each roof slope.

6. Double-Layer Felt/Self-Adhering Sheet Underlayment:
   a. Install single layer of felt underlayment on roof deck parallel with and starting at the eaves. Lap sides a minimum of 2 inches (50 mm) over underlying course. Lap ends a minimum of 4 inches (100 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment **OR** roofing, **as directed**, nails.
   b. Install self-adhering sheet underlayment, wrinkle free, on felt underlayment. Comply with low-temperature installation restrictions of underlayment manufacturer if applicable. Lap sides not less than 3-1/2 inches (89 mm) in direction to shed water. Lap ends not less than 6 inches (152 mm), staggered 24 inches (610 mm) between succeeding courses. Roll laps with roller. Cover underlayment within seven days.

7. Metal-Flashed, Open-Valley Underlayment: Install two layers of 36-inch- (914-mm-) wide felt underlayment centered in valley. Stagger end laps between layers at least 72 inches (1830 mm). Lap ends of each layer at least 12 inches (305 mm) in direction to shed water, and seal with asphalt roofing cement. Fasten each layer to roof deck with felt underlayment nails.
   a. Lap roof-deck felt underlayment over first layer of valley felt underlayment at least 6 inches (152 mm).

B. Metal Flashing Installation
1. General: Install metal flashings and other sheet metal to comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim".
   a. Install metal flashings according to clay roof tile manufacturer's written instructions and recommendations in NRCA's "The NRCA Roofing and Waterproofing Manual."
2. Apron Flashings: Extend lower flange over and beyond each side of downslope tile roofing and up the vertical surface.
3. Step Flashings: Install with a head lap of 3 inches (75 mm) and extend both horizontally and vertically. Install with lower edge of flashing just upslope of, and concealed by, butt of overlying tile. Fasten to roof deck only.
4. Cricket **OR** Backer, **as directed**, Flashings: Install against roof-penetrating elements, extending concealed flange beneath upslope tile roofing and beyond each side.
5. Open-Valley Flashings: Install centrally in valleys, lapping ends at least 8 inches (205 mm) in direction to shed water. Fasten upper end of each length to roof deck beneath overlap.
   a. Secure hemmed flange edges into metal cleats spaced 12 inches (305 mm) apart and fastened to roof deck.
   b. Adhere 9-inch- (230-mm-) wide strips of self-adhering sheet to metal flanges and to self-adhering sheet underlayment.
6. Channel Flashings: Install over underlayment and fasten to roof deck.
7. Rake Pan Flashings: Install over underlayment and fasten to roof deck.
8. Rake Drip Edges: Install over underlayment and fasten to roof deck.
9. Eave Drip Edges: Install beneath underlayment and fasten to roof deck.
10. Pipe Flashings: Form flashing around pipe penetrations and tile roofing. Fasten and seal to tile roofing.
11. Sheet Metal Ridge Vents: Install centrally, and mechanically fasten to wood ridge. Adhere each side to clay roof tile with elastomeric sealant.
    a. Install fabric mesh over roof-deck air ventilation gaps to prevent insect entry.

C. Wood Nailers And Battens, **as directed**
1. Install wood nailers at ridges **OR** hips **OR** rakes, **as directed**, and securely fasten to roof deck.
2. Install beveled wood cant at eaves and securely fasten to roof deck.
3. Install nominal 1-by-2-inch (25-by-50-mm) wood battens horizontally over 1/2-inch- (13-mm-) high, pressure-preservative-treated wood lath strips **OR** in 48-inch (1200-mm) lengths with ends separated by 1/2 inch (13 mm), **as directed**, at spacing required by clay roof tile manufacturer, and securely fasten to roof deck.
   a. Install nominal 1-by-2-inch (25-by-50-mm) wood counter battens vertically spaced 24 inches (610 mm) apart and securely fasten to roof deck.

D. Clay Roof Tile Installation
1. General: Install clay roof tiles according to manufacturer's written instructions, to recommendations in TRI/WSRCA's "Concrete and Clay Roof Tile Design Criteria Installation Manual for Moderate Climate Regions," and to NRCA's "The NRCA Roofing and Waterproofing Manual."
   a. Maintain uniform exposure and coursing of clay roof tiles throughout roof.
   b. Extend tiles 2 inches (50 mm) over eave fasciae.
   c. Nail Fastening: Drive nails to clear the clay roof tile so the tile hangs from the nail and is not drawn up.
      1) Install wire through nail holes of cut tiles that cannot be nailed directly to roof deck, and fasten to nails driven into deck.
   d. Wire-Tie Fastening: Install wire-tie systems and fasten clay roof tiles according to manufacturer's written instructions.
   e. Foam-Adhesive **OR** Mortar, **as directed**, Setting: Install clay roof tile according to TRI/FRSA's "Concrete and Clay Roof Tile Installation Manual."
   f. Install storm clips to capture edges of longitudinal sides of clay roof tiles and securely fasten to roof deck.

g. Install clay roof tile locks to support and lock overlying tile butts to underlying tiles.
h. Cut and fit clay roof tiles neatly around roof vents, pipes, ventilators, and other projections through roof. Fill voids with mortar.
i. Install clay roof tiles with color blend approved by the Owner.

2. Flat Shingle Clay Roof Tile Installation:
   a. Maintain 2-inch (50-mm) head lap between succeeding courses of clay roof tiles.
   b. Offset joints by half the clay roof tile width in succeeding courses.
   c. Extend clay roof tiles 1 inch (25 mm) over fasciae at rakes.
   d. Install ridge tiles in V-ridge **OR** saddle **OR** mitered, **as directed**, configuration with laps facing away from prevailing wind. Seal laps with asphalt roofing cement **OR** butyl sealant **OR** elastomeric sealant, **as directed**.
      1) Close voids where ridge tiles meet clay roof tiles with ridge closure tiles **OR** mortar struck with face of ridge cover tiles, **as directed**.
   e. Install hip tiles in V-ridge **OR** saddle **OR** mitered, **as directed**, configuration. Seal laps with asphalt roofing cement **OR** butyl sealant **OR** elastomeric sealant, **as directed**.
      1) Fill voids with mortar where hip tiles meet clay roof tiles, and strike mortar flush with face of hip cover tiles.
3. Flat Interlocking Clay Roof Tile Installation:
   a. Provide minimum 3-inch (75-mm) lap between succeeding courses of clay roof tiles.
   b. Offset joints by half the clay roof tile width in succeeding courses.
   c. Install L-shaped rake tiles.
   d. Install ridge tiles in V-ridge **OR** saddle **OR** mitered, **as directed**, configuration with laps facing away from prevailing wind. Seal laps with asphalt roofing cement **OR** butyl sealant **OR** elastomeric sealant, **as directed**.
      1) Close voids where ridge tiles meet clay roof tiles with ridge closure tiles **OR** mortar struck with face of ridge cover tiles, **as directed**.
   e. Install hip tiles in V-ridge **OR** saddle **OR** mitered, **as directed**, configuration. Seal laps with asphalt roofing cement **OR** butyl sealant **OR** elastomeric sealant, **as directed**.
      1) Fill voids with mortar where hip tiles meet clay roof tiles, and strike mortar flush with face of hip cover tiles.
4. Low-Profile, Interlocking Clay Roof Tile Installation:
   a. Provide minimum 3-inch (75-mm) lap between succeeding courses of clay roof tiles.
   b. Install L-shaped rake tiles.
   c. Install ridge tiles with laps facing away from prevailing wind. Seal laps with asphalt roofing cement **OR** butyl sealant **OR** elastomeric sealant, **as directed**.
5. High-Profile Clay Roof Tile Installation:
   a. Install tile **OR** sheet metal **OR** EPDM, **as directed**, eave closure.
   b. Provide minimum 3-inch (75-mm) lap between succeeding courses of clay roof tiles.
   c. Install L-shaped **OR** roll, **as directed**, rake tiles.
   d. Install ridge tiles with laps facing away from prevailing wind. Seal laps with asphalt roofing cement **OR** butyl sealant **OR** elastomeric sealant, **as directed**.
6. Open Valleys: Cut clay roof tiles at open valleys to form straight lines. Maintain uniform width of exposed open valley **OR** Widen exposed portion of open valley 1/8 inch in 12 inches (1:96), **as directed**, from highest to lowest point.
   a. Drill or notch cut valley tiles and wire-tie to fastener placed clear of valley metal flashings.
   b. Do not nail tiles to metal flashings.
7. Closed Valleys: Cut clay roof tiles at closed valleys to form straight lines, trimming upper concealed corners of tiles. Maintain uniform gap at centerline of valley of 1/2 to 3/4 inch (13 to 19 mm) **OR** 3/4 to 1 inch (19 to 25 mm), **as directed**.
   a. Drill or notch cut valley tiles and wire-tie to fastener placed clear of valley metal flashings.
   b. Do not nail tiles to metal flashings.

E. Snow-Guard Installation
   1. Snow-Guard Pads: Install rows of snow-guard pads at locations indicated, according to manufacturer's written installation instructions. Space rows apart horizontally, beginning from

gutter. Space snow guards apart in each row, offsetting by half this dimension between succeeding rows.

2. Snow-Guard Rails: Install rows of snow-guard rails at locations indicated, according to manufacturer's written installation instructions. Space rows apart horizontally, beginning from gutter.

F. Adjusting And Cleaning
   1. Remove and replace damaged or broken clay roof tiles.
   2. Remove excess clay roof tiles and debris from Project site.

END OF SECTION 07 32 13 00

SECTION 07 32 16 00 - CONCRETE ROOF TILES

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for concrete roof tiles. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Concrete roof tiles.
      b. Underlayment.
      c. Snow guards.

C. Definitions
   1. Roofing Terminology: See ASTM D 1079, glossaries in TRI/WSRCA's "Concrete and Clay Roof Tile Design Criteria Installation Manual for Moderate Climate Regions," and NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

D. Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittal:
      a. Product Test Reports for Credit SS 7.2: For concrete roof tiles, documentation indicating compliance with Solar Reflectance Index requirement.
   3. Samples: For each type of concrete roof tile and accessory tile indicated.
   4. Material test reports.
   5. Research/evaluation reports.
   6. Maintenance data.
   7. Warranties: Sample of special warranties.

E. Quality Assurance
   1. Fire-Test-Response Characteristics: Provide concrete roof tiles and related roofing materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
      a. Exterior Fire-Test Exposure: Class A **OR** Class B **OR** Class C, **as directed**; UL 790 or ASTM E 108, for application and roof slopes indicated.
   2. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
   1. Store underlayment rolls on end, on pallets or other raised surfaces. Do not double stack rolls.
      a. Handle, store, and place roofing materials in a manner to avoid significant or permanent damage to roof deck or structural supporting members.
   2. Protect unused underlayment from weather, sunlight, and moisture when left overnight or when roofing work is not in progress.

G. Warranty
   1. Special Warranty: Standard form in which manufacturer agrees to repair or replace concrete roof tiles that fail in materials within specified warranty period.
      a. Materials-Only Warranty Period: 50 years from date of Final Completion.

1.2 PRODUCTS

A. Concrete Roof Tiles
1. Concrete Roof Tiles: ASTM C 1492, molded- or extruded-concrete roof tile units of shape and configuration indicated, with integral color, and free of surface imperfections. Provide with fastening holes prepunched at factory.
   a. Weight: Normal **OR** Medium **OR** Light, **as directed**.
   b. High-Profile Shape: Type I, Spanish or "S".
   c. Medium-Profile Shape: Type II, French interlocking.
   d. Low-Profile Shape: Type III, flat shingle **OR** Type III, flat interlocking, **as directed**.
   e. Side Configuration: Interlocking **OR** Noninterlocking, **as directed**.
   f. Solar Reflectance Index: Provide concrete roof tiles with Solar Reflectance Index not less than 29 when calculated according to ASTM E 1980, based on testing of identical products by a qualified testing agency.
   g. Colors, Blends, and Patterns: As selected from manufacturer's full range.
   h. Finish and Texture: Matte, smooth **OR** Matte, striated **OR** Glazed, smooth, **as directed**.
   i. Color: Brown **OR** White **OR** Red **OR** Pale red **OR** Green **OR** Gray **OR** Buff, **as directed**.
   j. High **OR** Medium, **as directed**,-Profile-Shape Accessory Tiles: Ridge, ridge vent, ridge end, hip and hip starter, header course, L-shaped rake edge, roll rake edge, starter, end band, and terminal, **as directed**, units, in color matching concrete roof tiles.
   k. Low-Profile-Shape Accessory Tiles: Ridge and closed ridge end, hip and hip starter, header course, L-shaped rake edge, starter, end band, and terminal, **as directed**, units, in color matching concrete roof tiles.

B. Accessories
1. Asphalt Roofing Cement: ASTM D 4586, Type II, asbestos free.
2. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied.
3. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane **OR** silicone, **as directed**,-based joint sealant; Type M **OR** Type S, **as directed**, Grade NS, Class 25, Use NT related to exposure, and, as applicable to joint substrates indicated, Use O.
4. Roofing Asphalt: ASTM D 312, Type IV.
5. Cold-Applied Adhesive: Manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive specially formulated for compatibility and use with underlayments.
6. Foam Adhesive: Two-component, polyurethane expanding adhesive recommended for application by concrete roof tile manufacturer.
   OR
   Mortar: ASTM C 270, Type M, natural color **OR** with ASTM C 979, pigmented mortar matching the color of concrete roof tiles for exposed-to-view mortar, and natural color for concealed-from-view mortar, **as directed**.
7. Eave Closure: Manufacturer's standard EPDM **OR** copper **OR** stainless-steel **OR** galvanized-steel **OR** aluminum, mill finish, **as directed**, eave closure formed to shape of concrete roof tiles.
8. Ridge Closure: Manufacturer's standard EPDM ridge closure, formed to shape of concrete roof tiles.
9. Wood Nailers, Beveled Cant Strips and Wood Battens: Comply with requirements for pressure-preservative-treated wood in Division 06 Section(s) "Rough Carpentry" OR "Miscellaneous Rough Carpentry", **as directed**.
10. Mesh Fabric: 18-by-14 (1.1-by-1.4-mm) mesh of PVC-coated, glass-fiber thread.

C. Fasteners
1. Roofing Nails: ASTM F 1667, copper, 0.135-inch- (3.4-mm-) **OR** aluminum, 0.1055-inch- (2.7-mm-) **OR** hot-dip galvanized-steel, 0.1055-inch- (2.7-mm-), **as directed**, diameter shank, sharp-pointed, conventional roofing nails with barbed shanks; minimum 3/8-inch- (10-mm-) diameter head; of sufficient length to penetrate 3/4 inch (19 mm) into wood battens **OR** solid-wood decking **OR** roof-deck sheathing, **as directed**.

a. Where nails are in contact with metal flashing, use nails made from same metal as flashing.
2. Felt Underlayment Nails: Aluminum, stainless-steel, or hot-dip galvanized-steel wire with low-profile capped heads or disc caps, 1-inch (25-mm) minimum diameter.
3. Wood Batten Nails: ASTM F 1667; common or box, steel wire, flat head, and smooth shank.
4. Wire Ties: Copper **OR** Brass **OR** Stainless steel, **as directed**, 0.083-inch (2.1-mm) minimum diameter.
5. Twisted-Wire-Tie System: Continuously twisted, two-wire unit with loops formed 6 inches (152 mm) apart, minimum 0.1-inch- (2.5-mm-) diameter brass wire and 0.06-inch- (1.5-mm-) diameter brass tie wires **OR** 0.1-inch- (2.5-mm-) diameter copper wire and 0.06-inch- (1.5-mm-) diameter brass tie wires **OR** 0.083-inch- (2.1-mm-) diameter stainless-steel wire and 0.037-inch- (0.94-mm-) diameter stainless-steel tie wires **OR** 0.083-inch- (2.1-mm-) diameter galvanized-steel wire and 0.037-inch- (0.94-mm-) diameter galvanized-steel tie wires, **as directed**, with matching-metal folding clip anchors.
6. Hook Nails: One-piece wind lock and concrete roof tile fastener system, minimum 0.1-inch- (2.5-mm-) diameter brass **OR** 0.09-inch- (2.3-mm-) diameter galvanized-steel, **as directed**, wire, for direct deck nailing.
7. Tile Locks: Brass **OR** Copper **OR** Stainless-steel **OR** Hot-dip galvanized-steel, **as directed**, 0.1-inch- (2.5-mm-) diameter wire device designed to secure butt edges of overlaid concrete roof tiles.
8. Storm Clips: Brass **OR** Stainless-steel **OR** Hot-dip galvanized-steel, **as directed**, strap-type, 0.04-by-1/2-inch (1.0-by-13-mm), L-shaped retainer clips designed to secure side edges of concrete roof tiles. Provide with two fastener holes in base flange.

D. Underlayment Materials
1. Felt Underlayment: ASTM D 226, Type II, asphalt-saturated organic felt, unperforated.
2. Felt Underlayment: ASTM D 2626, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides, unperforated.
3. Roll Roofing Underlayment: ASTM D 6380, Class M, Type II, asphalt-saturated and -coated organic felt, mineral-granule surfaced.
4. Self-Adhering Sheet Underlayment, Granular Surfaced: ASTM D 1970, a minimum of 55-mil- (1.4-mm-) thick sheet; glass-fiber-mat-reinforced, SBS-modified asphalt; mineral-granule surfaced; with release paper backing; cold applied. Provide primer for adjoining concrete or masonry surfaces to receive underlayment, **as directed**.
5. Self-Adhering Sheet Underlayment, Polyethylene Faced: ASTM D 1970, minimum of 40-mil- (1.0-mm-) thick, slip-resisting, polyethylene-film-reinforced top surface laminated to SBS-modified asphalt adhesive, with release paper backing; cold applied. Provide primer for adjoining concrete or masonry surfaces to receive underlayment, **as directed**.

E. Snow Guards
1. Snow-Guard Pads: Fabricated copper **OR** cast-bronze **OR** zinc **OR** stainless-steel **OR** aluminum, **as directed**, units, designed to be installed without penetrating roof tiles, and complete with predrilled holes or hooks for anchoring.
2. Snow-Guard Rails: Units fabricated from metal baseplate anchored to adjustable **OR** fixed, **as directed**, bracket and equipped with two **OR** three, **as directed**, bars.
   a. Brackets and Baseplate: Aluminum **OR** Bronze or brass **OR** Stainless steel, **as directed**.
   b. Bars: Aluminum, mill finished **OR** Aluminum, clear anodized **OR** Stainless steel, mill finished, **as directed**.

F. Metal Flashing And Trim
1. General: Comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim".
   a. Sheet Metal: Copper **OR** Stainless steel **OR** Zinc-tin alloy-coated stainless steel **OR** Zinc-tin alloy-coated steel **OR** Zinc-tin alloy-coated copper **OR** Anodized aluminum **OR** Aluminum, mill finished, **as directed**.

2. Fabricate sheet metal flashing and trim to comply with recommendations that apply to design, dimensions, metal, and other characteristics of the item in SMACNA's "Architectural Sheet Metal Manual."
    a. Apron Flashings: Fabricate with lower flange extending a minimum of 4 inches (100 mm) **OR** 6 inches (152 mm), **as directed**, over and 4 inches (100 mm) beyond each side of downslope tile roofing and 6 inches (152 mm) up the vertical surface.
    b. Step Flashings: Fabricate with a head lap of 3 inches (75 mm) and a minimum extension of 4 inches (100 mm) **OR** 5 inches (127 mm), **as directed**, both horizontally and vertically.
    c. Channel Flashings: Fabricate with vertical surface extending a minimum of 4 inches (100 mm) **OR** 5 inches (127 mm), **as directed**, above the concrete roof tile and 4 inches (100 mm) **OR** 6 inches (152 mm), **as directed**, beneath the tile roofing, with a 1-inch- (25-mm-) high vertical return to form a runoff channel.
    d. Rake Pan Flashings: Fabricate with vertical surface extending over fasciae and 6 inches (152 mm) beneath the tile roofing, with a 1-inch- (25-mm-) high vertical return to form a runoff channel.
    e. Cricket **OR** Backer, **as directed**, Flashings: Fabricate with concealed flange extending a minimum of 18 inches (455 mm) **OR** 24 inches (610 mm), **as directed**, beneath upslope tile roofing, 6 inches (152 mm) beyond each side of chimney **OR** skylight, **as directed**, and 6 inches (152 mm) above the roof plane.
    f. Closed **OR** Open, **as directed**,-Valley Flashings: Fabricate in lengths not exceeding 10 feet (3 m), with 1-inch- (25-mm-) high, inverted-V profile at center of valley and with equal flange widths of 10 inches (255 mm) **OR** 12 inches (305 mm), **as directed**.
    g. Drip Edges: Fabricate in lengths not exceeding 10 feet (3 m), with 2-inch (50-mm) roof-deck flange and 1-1/2-inch (38-mm) fascia flange with 3/8-inch (10-mm) drip at lower edge.
3. Vent-Pipe Flashings: ASTM B 749, Type L51121, at least 1/16 inch (1.6 mm) thick. Provide lead sleeve sized to slip over and turn down into pipe, soldered to skirt at slope of roof and extending at least 4 inches (100 mm) from pipe onto roof.

1.3 EXECUTION

A. Underlayment Installation
1. General: Comply with concrete roof tile manufacturer's written instructions and recommendations in NRCA's "The NRCA Roofing and Waterproofing Manual."
    a. Cover ridge **OR** hip, **as directed**, wood nailers with underlayment strips.
2. Single-Layer Felt Underlayment: Install on roof deck parallel with and starting at the eaves. Lap sides a minimum of 2 inches (50 mm) over underlying course. Lap ends a minimum of 4 inches (100 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment **OR** roofing, **as directed**, nails.
    a. Install felt underlayment on roof deck not covered by self-adhering sheet underlayment. Lap sides of felt over self-adhering sheet underlayment not less than 3 inches (75 mm) in direction to shed water. Lap ends of felt not less than 6 inches (152 mm) over self-adhering sheet underlayment.
3. Double-Layer Felt Underlayment: Install on roof deck parallel with and starting at the eaves. Install a 19-inch- (485-mm-) wide starter course at eaves and completely cover with full-width second course. Install succeeding courses lapping previous courses 19 inches (485 mm) in shingle fashion. Lap ends a minimum of 6 inches (152 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment **OR** roofing, **as directed**, nails.
    a. Apply a continuous layer of asphalt roofing cement over starter course and on felt underlayment surface to be concealed by succeeding courses as each felt course is installed. Apply over entire roof **OR** at locations indicated on Drawings, **as directed**.
    b. Install felt underlayment on roof sheathing not covered by self-adhering sheet underlayment. Lap edges over self-adhering sheet underlayment not less than 3 inches (75 mm) in direction to shed water.

4. Double-Layer Felt/Roll Roofing Underlayment:
   a. Install single layer of felt underlayment on roof deck parallel with and starting at the eaves. Lap sides a minimum of 2 inches (50 mm) over underlying course. Lap ends a minimum of 4 inches (100 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment **OR** roofing, **as directed**, nails.
   b. Install roll roofing underlayment, in parallel courses, in same direction as felt underlayment. Lap ends a minimum of 6 inches (152 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm).
      1) Mechanically fasten over felt underlayment.
      2) Adhere to felt underlayment with solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature **OR** uniform coating of cold-applied adhesive **OR** uniform coating of asphalt roofing cement, **as directed**.
   c. Terminate felt underlayment flush **OR** extended up not less than 4 inches (100 mm), **as directed**, against chimneys, sidewalls, curbs, and other projections.
5. Self-Adhering Sheet Underlayment: Install wrinkle free; comply with low-temperature installation restrictions of underlayment manufacturer if applicable. Install at locations indicated below **OR** on Drawings, **as directed**, lapped in direction to shed water. Lap sides not less than 3-1/2 inches (89 mm). Lap ends not less than 6 inches (152 mm), staggered 24 inches (610 mm) between succeeding courses. Roll laps with roller. Cover underlayment within seven days.
   a. Prime concrete and masonry surfaces to receive self-adhering sheet underlayment.
   b. Extend self-adhering sheet underlayment over entire roof deck.
      OR
      Extend self-adhering sheet underlayment over roof deck as follows:
      1) Eaves: Extend from edges of eaves 24 inches (610 mm) **OR** 36 inches (914 mm), **as directed**, beyond interior face of exterior wall.
      2) Rakes: Extend from edges of rakes 24 inches (610 mm) **OR** 36 inches (914 mm), **as directed**, beyond interior face of exterior wall.
      3) Valleys: Extend from lowest to highest point 18 inches (455 mm) on each side.
      4) Hips: Extend 18 inches (455 mm) on each side.
      5) Ridges: Extend 36 inches (914 mm) on each side without obstructing continuous ridge vent slot, **as directed**.
      6) Sidewalls: Extend 18 inches (455 mm) beyond sidewalls and return vertically against sidewalls not less than 4 inches (100 mm).
      7) Dormers, Chimneys, Skylights, and Other Roof-Penetrating Elements: Extend 18 inches (455 mm) beyond penetrating elements and return vertically against penetrating elements not less than 4 inches (100 mm).
      8) Roof-Slope Transitions: Extend 18 inches (455 mm) on each roof slope.
6. Double-Layer Felt/Self-Adhering Sheet Underlayment:
   a. Install single layer of felt underlayment on roof deck parallel with and starting at the eaves. Lap sides a minimum of 2 inches (50 mm) over underlying course. Lap ends a minimum of 4 inches (100 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment **OR** roofing, **as directed**, nails.
   b. Install self-adhering sheet underlayment, wrinkle free, on felt underlayment. Comply with low-temperature installation restrictions of underlayment manufacturer if applicable. Lap sides not less than 3-1/2 inches (89 mm) in direction to shed water. Lap ends not less than 6 inches (152 mm), staggered 24 inches (610 mm) between succeeding courses. Roll laps with roller. Cover underlayment within seven days.
7. Metal-Flashed, Open-Valley Underlayment: Install two layers of 36-inch- (914-mm-) wide felt underlayment centered in valley. Stagger end laps between layers at least 72 inches (1830 mm). Lap ends of each layer at least 12 inches (305 mm) in direction to shed water, and seal with asphalt roofing cement. Fasten each layer to roof deck with felt underlayment nails.
   a. Lap roof-deck felt underlayment over first layer of valley felt underlayment at least 6 inches (152 mm).

B. Metal Flashing Installation

1. General: Install metal flashings and other sheet metal to comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim".
   a. Install metal flashings according to concrete roof tile manufacturer's written instructions and recommendations in NRCA's "The NRCA Roofing and Waterproofing Manual."
2. Apron Flashings: Extend lower flange over and beyond each side of downslope tile roofing and up the vertical surface.
3. Step Flashings: Install with a head lap of 3 inches (75 mm) and extend both horizontally and vertically. Install with lower edge of flashing just upslope of, and concealed by, butt of overlying tile. Fasten to roof deck only.
4. Cricket **OR** Backer, **as directed**, Flashings: Install against roof-penetrating elements, extending concealed flange beneath upslope tile roofing and beyond each side.
5. Open-Valley Flashings: Install centrally in valleys, lapping ends at least 8 inches (205 mm) in direction to shed water. Fasten upper end of each length to roof deck beneath overlap.
   a. Secure hemmed flange edges into metal cleats spaced 12 inches (305 mm) apart and fastened to roof deck.
   b. Adhere 9-inch- (230-mm-) wide strips of self-adhering sheet to metal flanges and to self-adhering sheet underlayment.
6. Channel Flashings: Install over underlayment and fasten to roof deck.
7. Rake Pan Flashings: Install over underlayment and fasten to roof deck.
8. Rake Drip Edges: Install over underlayment and fasten to roof deck.
9. Eave Drip Edges: Install beneath underlayment and fasten to roof deck.
10. Pipe Flashings: Form flashing around pipe penetrations and tile roofing. Fasten and seal to tile roofing.
11. Sheet Metal Ridge Vents: Install centrally, and mechanically fasten to wood ridge. Adhere each side to concrete roof tile with elastomeric sealant.
    a. Install fabric mesh over roof-deck air ventilation gaps to prevent insect entry.

C. Wood Nailers And Battens, **as directed**
1. Install wood nailers at ridges **OR** hips **OR** rakes, **as directed**, and securely fasten to roof deck.
2. Install beveled wood cant at eaves and securely fasten to roof deck.
3. Install nominal 1-by-2-inch (25-by-50-mm) wood battens horizontally over 1/2-inch- (13-mm-) high, pressure-preservative-treated wood lath strips **OR** in 48-inch (1200-mm) lengths with ends separated by 1/2 inch (13 mm), **as directed**, at spacing required by concrete roof tile manufacturer, and securely fasten to roof deck.
   a. Install nominal 1-by-2-inch (25-by-50-mm) wood counter battens vertically spaced 24 inches (610 mm) apart and securely fasten to roof deck.

D. Concrete Roof Tile Installation
1. General: Install concrete roof tiles according to manufacturer's written instructions, to recommendations in TRI/WSRCA's "Concrete and Clay Roof Tile Design Criteria Installation Manual for Moderate Climate Regions," and to NRCA's "The NRCA Roofing and Waterproofing Manual."
   a. Maintain uniform exposure and coursing of concrete roof tiles throughout roof.
   b. Extend tiles 2 inches (50 mm) over eave fasciae.
   c. Nail Fastening: Drive nails to clear the concrete roof tile so the tile hangs from the nail and is not drawn up.
      1) Install wire through nail holes of cut tiles that cannot be nailed directly to roof deck, and fasten to nails driven into deck.
   d. Wire-Tie Fastening: Install wire-tie systems and fasten concrete roof tiles according to manufacturer's written instructions.
   e. Foam-Adhesive **OR** Mortar, **as directed**, Setting: Install concrete roof tiles according to TRI/FRSA's "Concrete and Clay Roof Tile Installation Manual."
   f. Install storm clips to capture edges of longitudinal sides of concrete roof tiles and securely fasten to roof deck.
   g. Install concrete roof tile locks to support and lock overlying tile butts to underlying tiles.

h. Cut and fit concrete roof tiles neatly around roof vents, pipes, ventilators, and other projections through roof. Fill voids with mortar.
i. Install concrete roof tiles with color blend approved by the Owner.

2. Flat Shingle Concrete Roof Tile Installation:
   a. Maintain 2-inch (50-mm) head lap between succeeding courses of concrete roof tiles.
   b. Offset joints by half the concrete roof tile width in succeeding courses.
   c. Extend concrete roof tiles 1 inch (25 mm) over fasciae at rakes.
   d. Install ridge tiles in V-ridge **OR** saddle **OR** mitered, **as directed**, configuration with laps facing away from prevailing wind. Seal laps with asphalt roofing cement **OR** butyl sealant **OR** elastomeric sealant, **as directed**.
      1) Close voids where ridge tiles meet concrete roof tiles with ridge closure tiles **OR** mortar struck with face of ridge cover tiles, **as directed**.
   e. Install hip tiles in V-ridge **OR** saddle **OR** mitered, **as directed**, configuration. Seal laps with asphalt roofing cement **OR** butyl sealant **OR** elastomeric sealant, **as directed**.
      1) Fill voids with mortar where hip tiles meet concrete roof tiles, and strike mortar flush with face of hip cover tiles.
3. Flat Interlocking Concrete Roof Tile Installation:
   a. Provide minimum 3-inch (75-mm) lap between succeeding courses of concrete roof tiles.
   b. Offset joints by half the concrete roof tile width in succeeding courses.
   c. Install L-shaped rake tiles.
   d. Install ridge tiles in V-ridge **OR** saddle **OR** mitered, **as directed**, configuration with laps facing away from prevailing wind. Seal laps with asphalt roofing cement **OR** butyl sealant **OR** elastomeric sealant, **as directed**.
      1) Close voids where ridge tiles meet concrete roof tiles with ridge closure tiles **OR** mortar struck with face of ridge cover tiles, **as directed**.
   e. Install hip tiles in V-ridge **OR** saddle **OR** mitered, **as directed**, configuration. Seal laps with asphalt roofing cement **OR** butyl sealant **OR** elastomeric sealant, **as directed**.
      1) Fill voids with mortar where hip tiles meets concrete roof tiles, and strike mortar flush with face of hip cover tiles.
4. Low-Profile, Interlocking Concrete Roof Tile Installation:
   a. Provide minimum 3-inch (75-mm) lap between succeeding courses of concrete roof tiles.
   b. Install L-shaped rake tiles.
   c. Install ridge tiles with laps facing away from prevailing wind. Seal laps with asphalt roofing cement **OR** butyl sealant **OR** elastomeric sealant, **as directed**.
5. High-Profile Concrete Roof Tile Installation:
   a. Install tile **OR** sheet metal **OR** EPDM, **as directed**, eave closure.
   b. Provide minimum 3-inch (75-mm) lap between succeeding courses of concrete roof tiles.
   c. Install L-shaped **OR** roll, **as directed**, rake tiles.
   d. Install ridge tiles with laps facing away from prevailing wind. Seal laps with asphalt roofing cement **OR** butyl sealant **OR** elastomeric sealant, **as directed**.
6. Open Valleys: Cut concrete roof tiles at open valleys to form straight lines. Maintain uniform width of exposed open valley **OR** Widen exposed portion of open valley 1/8 inch in 12 inches (1:96), **as directed**, from highest to lowest point.
   a. Drill or notch cut valley tiles and wire-tie to fastener placed clear of valley metal flashings.
   b. Do not nail tiles to metal flashings.
7. Closed Valleys: Cut concrete roof tiles at closed valleys to form straight lines, trimming upper concealed corners of tiles. Maintain uniform gap at centerline of valley of 1/2 to 3/4 inch (13 to 19 mm) **OR** 3/4 to 1 inch (19 to 25 mm), **as directed**.
   a. Drill or notch cut valley tiles and wire-tie to fastener placed clear of valley metal flashings.
   b. Do not nail tiles to metal flashings.

E. Snow-Guard Installation
1. Snow-Guard Pads: Install rows of snow-guard pads at locations indicated, according to manufacturer's written installation instructions. Space rows apart horizontally, beginning from gutter. Space snow guards apart in each row, offsetting by half this dimension between succeeding rows.

2. Snow-Guard Rails: Install rows of snow-guard rails at locations indicated, according to manufacturer's written installation instructions. Space rows apart horizontally, beginning from gutter.

F. Adjusting And Cleaning
1. Remove and replace damaged or broken concrete roof tiles.
2. Remove excess concrete roof tiles and debris from Project site.

END OF SECTION 07 32 16 00

Task	Specification	Specification Description
07 34 00 00	07 31 13 13	Asphalt Shingles
07 34 00 00	07 31 16 00	Metal Shingles
07 34 00 00	07 31 26 00	Slate Shingles
07 34 00 00	07 31 29 00	Wood Shingles And Shakes
07 34 00 00	07 32 13 00	Clay Roof Tiles

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SECTION 07 41 13 00 - METAL ROOF PANELS

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for metal roof panels. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Exposed-fastener, lap-seam metal roof panels.
      b. Concealed-fastener, lap-seam metal roof panels.
      c. Standing-seam metal roof panels.
      d. Batten-seam metal roof panels.
      e. Horizontal-seam (Bermuda-type) metal roof panels.
      f. Foamed-insulation-core metal roof panels.
      g. Metal soffit panels.

C. Definitions
   1. Metal Roof Panel Assembly: Metal roof panels, attachment system components, miscellaneous metal framing, thermal insulation, and accessories necessary for a complete weathertight roofing system.

D. Performance Requirements
   1. General Performance: Metal roof panels shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.
   2. Delegated Design: Design metal roof panel assembly, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
   3. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) of roof area when tested according to ASTM E 1680 at the following test-pressure difference:
      a. Test-Pressure Difference (for roofs with slopes of 30 degrees or less): Negative 1.57 lbf/sq. ft. (75 Pa).
      b. Test-Pressure Difference (for roofs with slopes steeper than 30 degrees): Positive and negative 1.57 lbf/sq. ft. (75 Pa).
      c. Positive Preload Test-Pressure Difference: Greater than or equal to 15.0 lbf/sq. ft. (720 Pa) and the greater of 75 percent of building live load or 50 percent of building design positive wind-pressure difference.
      d. Negative Preload Test-Pressure Difference: 50 percent of design wind-uplift-pressure difference.
   4. Water Penetration: No water penetration when tested according to ASTM E 1646 at the following test-pressure difference:
      a. Test-Pressure Difference (for roofs with slopes of 30 degrees or less): 2.86 lbf/sq. ft. (137 Pa).
      b. Test-Pressure Difference (for roofs with slopes steeper than 30 degrees): 20 percent of positive design wind pressure, but not less than 6.24 lbf/sq. ft. (300 Pa) and not more than 12.0 lbf/sq. ft. (575 Pa).
      c. Positive Preload Test-Pressure Difference: Greater than or equal to 15.0 lbf/sq. ft. (720 Pa) and the greater of 75 percent of building live load or 50 percent of building design positive wind-pressure difference.
      d. Negative Preload Test-Pressure Difference: 50 percent of design wind-uplift-pressure difference.

5. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E 2140.
6. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
   a. Uplift Rating: UL 30 **OR** UL 60 **OR** UL 90, **as directed**.
7. FMG Listing: Provide metal roof panels and component materials that comply with requirements in FMG 4471 as part of a panel roofing system and that are listed in FMG's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FMG markings.
   a. Fire/Windstorm Classification: Class 1A-60 **OR** Class 1A-75 **OR** Class 1A-90 **OR** Class 1A-105 **OR** Class 1A-120, **as directed**.
   b. Hail Resistance: MH **OR** SH, **as directed**.
8. Structural Performance: Provide metal roof panel assemblies capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 1592:
   a. Wind Loads: Determine loads based on the following minimum design wind pressures:
      1) Uniform pressure of 20 lbf/sq. ft. (957 Pa) **OR** 30 lbf/sq. ft. (1436 Pa), **as directed**, acting inward or outward.
         OR
         Uniform pressure as indicated on Drawings.
   b. Snow Loads: 25 lbf/sq. ft. (1197 Pa) **OR** 30 lbf/sq. ft. (1436 Pa) **OR** 35 lbf/sq. ft. (1676 Pa), **as directed**.
   c. Deflection Limits: Metal roof panel assemblies shall withstand wind and snow loads with vertical deflections no greater than 1/180 **OR** 1/240, **as directed**, of the span.
9. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
10. Thermal Performance: Provide insulated metal roof panel assemblies with thermal-resistance value (R-value) indicated when tested according to ASTM C 518.
11. Energy Performance
   a. Provide roof panels with solar reflectance index not less than 78 **OR** 29, **as directed**, when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.
      OR
      Energy Performance: Provide roof panels that are listed on the U.S. Department of Energy's ENERGY STAR Roof Products Qualified Product List for low-slope **OR** steep-slope, **as directed**, roof products.
      OR
      Energy Performance: Provide roof panels with initial solar reflectance not less than 0.70 and emissivity not less than 0.75 when tested according to CRRC-1.

E. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Product Test Reports for Credit SS 7.2: For roof panels, indicating that panels comply with solar reflectance index requirement.
   b. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: Indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content.
      1) Include statement indicating costs for each product having recycled content.
3. Shop Drawings: Show fabrication and installation layouts of metal roof panels; details of edge conditions, side-seam and endlap joints, panel profiles, corners, anchorages, trim, flashings, closures, and accessories; and special details. Distinguish between factory- and field-assembled work.
4. Samples: For each type of exposed finish required.

5. Delegated-Design Submittal: For metal roof panel assembly indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   a. Snow Retention System Calculations: Include calculation of number and location of snow guards based on snow load, roof slope, panel length and finish, and seam type and spacing.
6. Coordination Drawings: Roof plans, drawn to scale, based on input from installers of the items involved.
7. Manufacturer Certificates: Signed by manufacturer certifying that roof panels comply with energy performance requirements specified in "Performance Requirements" Article.
   a. Submit evidence of meeting performance requirements.
8. Product test reports.
9. Field quality-control reports.
10. Maintenance data.
11. Warranties: Samples of special warranties.

F. Quality Assurance
1. Installer Qualifications: An employer of workers trained and approved by manufacturer.
2. Surface-Burning Characteristics: Provide metal roof panels having insulation core material with the following surface-burning characteristics as determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   a. Flame-Spread Index: 25 or less.
   b. Smoke-Developed Index: 450 or less.
3. Fire-Resistance Ratings: Where indicated, provide metal roof panels identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   a. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
   b. Combustion Characteristics: ASTM E 136.
4. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver components, sheets, metal roof panels, and other manufactured items so as not to be damaged or deformed. Package metal roof panels for protection during transportation and handling.
2. Unload, store, and erect metal roof panels in a manner to prevent bending, warping, twisting, and surface damage.
3. Stack metal roof panels on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal roof panels to ensure dryness. Do not store metal roof panels in contact with other materials that might cause staining, denting, or other surface damage.
4. Protect strippable protective covering on metal roof panels from exposure to sunlight and high humidity, except to extent necessary for period of metal roof panel installation.
5. Protect foam-plastic insulation as follows:
   a. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
   b. Protect against ignition at all times. Do not deliver foam-plastic insulation materials to Project site before installation time.
   c. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

H. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace metal roof panel assemblies that fail in materials or workmanship within two years from date of Final Completion.

2. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal roof panels that show evidence of deterioration of factory-applied finishes within 10 **OR** 20, **as directed**, years from date of Final Completion.
3. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace metal roof panel assemblies that fail to remain weathertight, including leaks, within five **OR** 10, **as directed**, years from date of Final Completion.
4. Special Weathertightness Warranty for Standing-Seam Metal Roof Panels: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within 20 years from date of Final Completion.

1.2 PRODUCTS

A. Panel Materials
1. Metallic-Coated Steel Sheet: Restricted flatness steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
   a. Recycled Content: Provide steel sheet with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
   b. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
   c. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40 (Class AZM150 coating designation, Grade 275); structural quality.
   d. Surface: Smooth, flat **OR** Embossed, **as directed**, finish.
   e. Exposed Coil-Coated Finish:
      1) 2-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      2) 3-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      3) 4-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat and clear coats. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      4) Mica Fluoropolymer: AAMA 621. 2-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      5) Metallic Fluoropolymer: AAMA 621. 3-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      6) FEVE Fluoropolymer: AAMA 621. 2-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      7) Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
      8) Plastisol: Epoxy primer and vinyl plastisol topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 3.8 mil (0.97 mm) for topcoat.

f. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

2. Aluminum Sheet: Coil-coated sheet, ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.
   a. Surface: Smooth, flat **OR** Embossed, **as directed**, finish.
   b. Exposed Coil-Coated Finish:
      1) 2-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      2) 3-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      3) 4-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat and clear coats. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      4) Mica Fluoropolymer: AAMA 620. 2-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      5) Metallic Fluoropolymer: AAMA 620. 3-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      6) FEVE Fluoropolymer: AAMA 620. 2-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      7) Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
      8) Plastisol: Epoxy primer and vinyl plastisol topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 3.8 mil (0.97 mm) for topcoat.
   c. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

3. Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 temper.
   a. Exposed Finish: Apply the following finish, as specified or indicated on Drawings:
      1) Natural finish.
      2) Brushed Satin: CDA M32-06x (Mechanical Finish: directionally textured, medium satin; Coating: clear organic, air drying, as specified below):
      3) Mirror Polished: CDA M22-06x (Mechanical Finish: buffed, specular; Coating: clear organic, air drying, as specified below):
         a) Clear, Organic Coating: Clear, air-drying, acrylic lacquer specially developed for coating copper-alloy products, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
      4) Pre-patinated: ASTM B 882. Copper sheets artificially aged by chemical reaction to convert surface to inorganic crystalline structure with color range and durability of naturally formed patina.

4. Panel Sealants:

a. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
b. Joint Sealant: ASTM C 920; elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal roof panels and remain weathertight; and as recommended in writing by metal roof panel manufacturer.
c. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

B. Field-Installed Thermal Insulation
1. Polyethylene Vapor Retarders: ASTM D 4397, 6 mils (0.15 mm) thick, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
2. Unfaced, Polyisocyanurate Board Insulation: ASTM C 591, Type II, compressive strength of 35 psi (240 kPa), with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, based on tests performed.
3. Faced, Polyisocyanurate Board Insulation: ASTM C 1289, Type I, Class 1 aluminum foil **OR** Type II, Class 1 or 2 felt or glass-fiber mat, Grade 3 **OR** Type V, oriented-strand-board facing, **as directed**, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, based on tests performed on unfaced core.
4. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.60-lb/cu. ft. (26-kg/cu. m) minimum density unless otherwise indicated; with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively.
5. Molded-Polystyrene Board Insulation: ASTM C 578, Type I, 0.9 lb/cu. ft. (15 kg/cu. m) **OR** Type II, 1.35 lb/cu. ft. (22 kg/cu. m), **as directed**, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively.
6. Unfaced, Glass-Fiber Board Insulation: ASTM C 612, Type IA or Types IA and IB; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; and with a nominal density of 3 lb/cu. ft. (48 kg/cu. m).
7. Mineral-Fiber-Blanket Insulation: ASTM C 665, type indicated below; consisting of fibers manufactured from glass, slag wool, or rock wool.
   a. Type I (blankets without membrane covering), passing ASTM E 136 for combustion characteristics.
   b. Type II (blankets with nonreflective membrane covering), Category 1 (membrane is a vapor retarder), Class A (membrane-faced surface with a flame-spread index of 25 or less).
   c. Type III (blankets with reflective membrane covering), Category 1 (membrane is a vapor retarder), Class A (membrane-faced surface with a flame-spread index of 25 or less).
8. Metal Building Insulation: ASTM C 991, Type I, or NAIMA 202 **OR** ASTM C 991, Type II, **as directed**, glass-fiber-blanket insulation; 0.5-lb/cu. ft. (8-kg/cu. m) density; 2-inch- (50-mm-) wide, continuous, vapor-tight edge tabs; and with a flame-spread index of 25 or less.
   a. Vapor-Retarder Facing: ASTM C 1136, with permeance not greater than 0.02 perm (1.15 ng/Pa x s x sq. m) when tested according to ASTM E 96, Desiccant Method:
      1) Composition: Polypropylene faced, scrim reinforced, and kraft-paper backing **OR** Foil faced, scrim reinforced, and kraft-paper backing with vapor-retarder coating **OR** Polypropylene faced, scrim reinforced, and foil backing **OR** Vinyl faced, scrim reinforced, and foil backing **OR** Vinyl faced, scrim reinforced, and polyester backing, **as directed**.
   b. Insulation Retainer Strips: 0.019-inch- (0.48-mm-) thick, formed, galvanized-steel or PVC retainer clips colored to match insulation facing.
   c. Thermal Spacer Blocks: Fabricated from extruded polystyrene, 1 inch (25 mm) thick.

C. Underlayment Materials
1. Self-Adhering, High-Temperature Sheet: 30 to 40 mils (0.76 to 1.0 mm) thick minimum, consisting of slip-resisting, polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
   a. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D 1970.

b. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (29 deg C); ASTM D 1970.
2. Felts: ASTM D 226, Type II (No. 30) **OR** Type I (No. 15), **as directed**, asphalt-saturated organic felts.
3. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

D. Substrate Boards
1. Gypsum Board: Type X, of thickness indicated, with water-resistant-treated core and with water-repellent paper bonded to core's face, back, and long edges. ASTM C 1396/C 1396M.
2. Glass-Mat Gypsum Sheathing Board: ASTM C 1177/C 1177M; Regular, 1/2 inch (13 mm) **OR** Type X, 5/8 inch (16 mm), **as directed**.
3. Perlite Board: ASTM C 728, 1 inch (25 mm) thick.
4. Substrate-Board Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FMG 4470, designed for fastening substrate board to substrate.

E. Miscellaneous Metal Framing
1. Miscellaneous Metal Framing, General: ASTM C 645, cold-formed metallic-coated steel sheet, ASTM A 653/A 653M, G40 (Z120) hot-dip galvanized **OR** ASTM A 653/A 653M, G60 (Z180) hot-dip galvanized, **as directed**, or coating with equivalent corrosion resistance unless otherwise indicated.
2. Hat-Shaped, Rigid Furring Channels:
   a. Nominal Thickness: As indicated **OR** As required to meet performance requirements **OR** 0.025 inch (0.64 mm) **OR** 0.040 inch (1.02 mm), **as directed**.
   b. Depth: As indicated **OR** 7/8 inch (22 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
3. Cold-Rolled Furring Channels: Minimum 1/2-inch- (13-mm-) wide flange.
   a. Nominal Thickness: As indicated **OR** As required to meet performance requirements **OR** 0.064 inch (1.63 mm), **as directed**.
   b. Depth: As indicated **OR** 3/4 inch (19 mm), **as directed**.
   c. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with nominal thickness of 0.040 inch (1.02 mm).
   d. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.57-mm-) diameter wire, or double strand of 0.048-inch- (1.22-mm-) diameter wire.
4. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (32 mm), wall attachment flange of 7/8 inch (22 mm), and depth required to fit insulation thickness indicated.
   a. Nominal Thickness: As indicated **OR** As required to meet performance requirements **OR** 0.025 inch (0.64 mm), **as directed**.
5. Fasteners for Miscellaneous Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten miscellaneous metal framing members to substrates.

F. Miscellaneous Materials
1. Panel Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal roof panels by means of plastic caps or factory-applied coating. Provide EPDM, PVC, or neoprene sealing washers.
2. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

G. Exposed-Fastener, Lap-Seam Metal Roof Panels
1. General: Provide factory-formed metal roof panels designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps. Include accessories required for weathertight installation.
2. Corrugated-Profile, Exposed-Fastener Metal Roof Panels: Formed with alternating curved ribs spaced at 2.67 inches (68 mm) o.c. across width of panel.

a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
 1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
 2) Color: As selected by the Owner from manufacturer's full range.

b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
 1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
 2) Color: As selected by Architect from manufacturer's full range.

c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
 1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
 2) Color: As selected by Architect from manufacturer's full range.

d. Panel Coverage: 21.3 inches (541 mm) **OR** 29.3 inches (744 mm) **OR** 34.67 inches (881 mm) **OR** 37.3 inches (947 mm) **OR** 42.67 inches (1084 mm) **OR** 45.3 inches (1151 mm), **as directed**.

e. Panel Height: 0.5 inch (13 mm) **OR** 0.875 inch (22 mm), **as directed**.

3. Tapered-Rib-Profile, Exposed-Fastener Metal Roof Panels: Formed with raised, trapezoidal major ribs and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between major ribs.

a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
 1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
 2) Color: As selected by the Owner from manufacturer's full range.

b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
 1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
 2) Color: As selected by the Owner from manufacturer's full range.

c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
 1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
 2) Color: As selected by the Owner from manufacturer's full range.

d. Material: Copper sheet, 16-oz./sq. ft. weight (0.55-mm thickness) **OR** 20-oz./sq. ft. weight (0.68-mm thickness), **as directed**.
 1) Exterior Finish: Brushed satin (lacquered) **OR** Mirror polished, **as directed**.

e. Major-Rib Spacing: 6 inches (152 mm) **OR** 8 inches (203 mm) **OR** 9 inches (229 mm) **OR** 12 inches (305 mm), **as directed**, o.c.

f. Panel Coverage: 24 inches (610 mm) **OR** 36 inches (914 mm), **as directed**.

g. Panel Height: 0.625 inch (16 mm) **OR** 0.75 inch (19 mm) **OR** 1.0 inch (25 mm) **OR** 1.25 inches (32 mm) **OR** 1.5 inches (38 mm), **as directed**.

4. Vee-Rib-Profile, Exposed-Fastener Metal Roof Panels: Formed with raised, V-shaped ribs and recesses that are approximately same size, evenly spaced across panel width, and with rib/recess sides angled at approximately 45 degrees.
   a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm) **OR** 0.064-inch (1.63-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm) **OR** 0.064-inch (1.63-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm), **as directed**, thick.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   d. Rib Spacing: 5.3 inches (135 mm) **OR** 7.2 inches (183 mm) **OR** 12 inches (305 mm), **as directed**, o.c.
   e. Panel Coverage: 30 inches (762 mm) **OR** 32 inches (813 mm) **OR** 36 inches (914 mm) **OR** 40 inches (1016 mm), **as directed**.
   f. Panel Height: 1.375 inches (35 mm) **OR** 1.5 inches (38 mm) **OR** 1.75 inches (44 mm) **OR** 2.0 inches (51 mm) **OR** 3.0 inches (76 mm), **as directed**.
5. Box-Rib-Profile, Exposed-Fastener Metal Roof Panels: Formed with raised, box-shaped ribs that are wider than recesses, evenly spaced across panel width, and with rib/recess sides angled 60 degrees or more.
   a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   d. Rib Spacing: 2.67 inches (68 mm) **OR** 4.0 inches (102 mm) **OR** 5.3 inches (135 mm) **OR** 6.0 inches (152 mm), **as directed**, o.c.
   e. Panel Coverage: 24 inches (610 mm) **OR** 28 inches (711 mm) **OR** 30 inches (762 mm) **OR** 32 inches (813 mm) **OR** 36 inches (914 mm), **as directed**.

f. Panel Height: 0.625 inch (16 mm) **OR** 1.0 inch (25 mm) **OR** 1.5 inches (38 mm) **OR** 2.0 inches (51 mm), **as directed**.

6. Deep-Box-Rib-Profile, Exposed-Fastener Metal Roof Panels: Formed with raised, box-shaped ribs that are wider than recesses, evenly spaced across panel width, and with rib/recess sides angled more than 60 degrees.
   a. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm) **OR** 0.064-inch (1.63-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   b. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm) **OR** 0.064-inch (1.63-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm), **as directed**, thick.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   d. Rib Spacing: 12 inches (305 mm), **as directed**, o.c.
   e. Panel Coverage: 24 inches (610 mm), **as directed**.
   f. Panel Height: 3 inches (76 mm) **OR** 4 inches (102 mm).**as directed**.

H. Concealed-Fastener, Lap-Seam Metal Roof Panels

1. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps. Include accessories required for weathertight installation.
2. Tapered-Rib-Profile, Concealed-Fastener Metal Roof Panels: Formed with raised, trapezoidal major rib at panel edge and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between major rib and panel edge.
   a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.

d. Panel Coverage: 12 inches (305 mm) **OR** 16 inches (406 mm) **OR** 18 inches (457 mm), **as directed**.
e. Panel Height: 1.0 inch (25 mm) **OR** 1.5 inches (38 mm) **OR** 1.75 inches (44 mm), **as directed**.

3. Standing-Seam-Profile, Concealed-Fastener Metal Roof Panels: Formed with raised, curved-top, standing-seam-shaped major rib at panel edge and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between major rib and panel edge.
   a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   d. Material: Copper sheet, 16-oz./sq. ft. weight (0.55-mm thickness) **OR** 20-oz./sq. ft. weight (0.68-mm thickness), **as directed**.
      1) Exterior Finish: Brushed satin (lacquered) **OR** Mirror polished, **as directed**.
   e. Panel Coverage: 10 inches (254 mm) **OR** 12 inches (305 mm) **OR** 16 inches (406 mm) **OR** 18 inches (457 mm), **as directed**.
   f. Panel Height: 1.0 inch (25 mm) **OR** 1.25 inches (32 mm) **OR** 1.5 inches (38 mm), **as directed**.

4. Batten-Seam-Profile, Concealed-Fastener Metal Roof Panels: Formed with raised, batten-seam-shaped major rib at panel edge and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between major rib and panel edge.
   a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   d. Panel Coverage: 10 inches (254 mm) **OR** 12 inches (305 mm) **OR** 14 inches (356 mm) **OR** 15 inches (381 mm) **OR** 18 inches (457 mm) **OR** 24 inches (610 mm) **OR** 36 inches (914 mm), **as directed**.

e. Panel Height: 0.75 inch (19 mm) **OR** 1.25 inches (32 mm) **OR** 1.5 inches (38 mm), **as directed**.
f. Batten Width: 1.5 inches (38 mm) **OR** 2.0 inches (51 mm), **as directed**.

I. Standing-Seam Metal Roof Panels
1. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
a. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1514.
b. Aluminum Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1637.
2. Vertical-Rib, Snap-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels, and snapping panels together.
a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As selected by the Owner from manufacturer's full range.
b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As selected by the Owner from manufacturer's full range.
c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As selected by the Owner from manufacturer's full range.
d. Material: Copper sheet, 16-oz./sq. ft. weight (0.55-mm thickness) **OR** 20-oz./sq. ft. weight (0.68-mm thickness), **as directed**,.
1) Exterior Finish: Brushed satin (lacquered) **OR** Mirror polished, **as directed**.
e. Batten: Same material, finish, and color as roof panels.
f. Clips: Fixed **OR** Floating to accommodate thermal movement, **as directed**.
1) Material: 0.028-inch- (0.71-mm-) **OR** 0.064-inch- (1.63-mm-), **as directed**, nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
2) Material: 0.025-inch- (0.64-mm-) **OR** 0.062-inch- (1.59-mm-), **as directed**, thick, stainless-steel sheet.
g. Panel Coverage: 10 inches (254 mm) **OR** 12 inches (305 mm) **OR** 14 inches (356 mm) **OR** 16 inches (406 mm) **OR** 18 inches (457 mm) **OR** 24 inches (610 mm), **as directed**.
h. Panel Height: 1.0 inch (25 mm) **OR** 1.5 inches (38 mm) **OR** 1.75 inches (44 mm), **as directed**.
3. Vertical-Rib, Seamed-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels, and mechanically seaming panels together.

a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As selected by the Owner from manufacturer's full range.
b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As selected by the Owner from manufacturer's full range.
c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As selected by the Owner from manufacturer's full range.
d. Material: Copper sheet, 16-oz./sq. ft. weight (0.55-mm thickness) **OR** 20-oz./sq. ft. weight (0.68-mm thickness), **as directed**.
   1) Exterior Finish: Brushed satin (lacquered) **OR** Mirror polished, **as directed**.
e. Batten: Same material, finish, and color as roof panels.
f. Clips: Fixed **OR** Floating to accommodate thermal movement, **as directed**.
   1) Material: 0.028-inch- (0.71-mm-) **OR** 0.064-inch- (1.63-mm-), **as directed**, nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
   2) Material: 0.025-inch- (0.64-mm-) **OR** 0.062-inch- (1.59-mm-), **as directed**, thick, stainless-steel sheet.
g. Joint Type: Single folded **OR** Double folded **OR** As standard with manufacturer, **as directed**.
h. Panel Coverage: 12 inches (305 mm) **OR** 14 inches (356 mm) **OR** 16 inches (406 mm) **OR** 18 inches (457 mm) **OR** 20 inches (508 mm) **OR** 24 inches (610 mm), **as directed**.
i. Panel Height: 1.5 inches (38 mm) **OR** 2.0 inches (51 mm) **OR** 2.5 inches (64 mm), **as directed**.

4. Trapezoidal-Rib, Snap-Joint, Standing-Seam Metal Roof Panels: Formed with raised trapezoidal ribs at panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels, and snapping panels together.
   a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 28-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   c. Clips: Fixed **OR** Floating to accommodate thermal movement, **as directed**.
      1) Material: 0.028-inch- (0.71-mm-) **OR** 0.064-inch- (1.63-mm-), **as directed**, nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.

d. Panel Coverage: 12 inches (305 mm) **OR** 18 inches (457 mm) **OR** 24 inches (610 mm), **as directed**.
e. Panel Height: 3 inches (76 mm).

5. Trapezoidal-Rib, Seamed-Joint, Standing-Seam Metal Roof Panels: Formed with raised trapezoidal ribs at panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels, and mechanically seaming panels together.
   a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   c. Clips: Fixed **OR** Floating to accommodate thermal movement, **as directed**.
      1) Material: 0.028-inch- (0.71-mm-) **OR** 0.064-inch- (1.63-mm-), **as directed**, nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
   d. Joint Type: Single folded **OR** Double folded **OR** As standard with manufacturer, **as directed**.
   e. Panel Coverage: 12 inches (305 mm) **OR** 18 inches (457 mm) **OR** 24 inches (610 mm), **as directed**.
   f. Panel Height: 2.7 inches (69 mm) **OR** 3.0 inches (76 mm), **as directed**.

6. Integral-Standing-Seam Metal Roof Panels: Formed with integral ribs at panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and lapping and interconnecting side edges of adjacent panels.
   a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   d. Material: Copper sheet, 16-oz./sq. ft. weight (0.55-mm thickness) **OR** 20-oz./sq. ft. weight (0.68-mm thickness), **as directed**.
      1) Exterior Finish: Brushed satin (lacquered) **OR** Mirror polished, **as directed**.
   e. Clips: Fixed **OR** Floating to accommodate thermal movement, **as directed**.

1) Material: 0.028-inch- (0.71-mm-) **OR** 0.064-inch- (1.63-mm-), **as directed**, nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
2) Material: 0.025-inch- (0.64-mm-) **OR** 0.062-inch- (1.59-mm-), **as directed**, thick, stainless-steel sheet.

f. Panel Coverage: 12 inches (305 mm) **OR** 16 inches (406 mm) **OR** 18 inches (457 mm), **as directed**.

g. Panel Height: 1.0 inch (25 mm) **OR** 1.5 inches (38 mm) **OR** 2.0 inches (51 mm), **as directed**.

J. Batten-Seam Metal Roof Panels

1. General: Provide factory-formed metal roof panel assembly designed to be installed by covering vertical side edges of adjacent panels with battens and mechanically attaching panels to supports using concealed clips. Include battens and accessories required for weathertight installation.
2. Narrow-Profile, Snap-on-Batten-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between ribs; designed for independent installation by mechanically attaching panels to supports using concealed clips located under 1 side of panels and engaging opposite edge of adjacent panels, and installation of 3/8-to-1/2-inch- (10-to-13-mm-) wide, snap-on battens over panel joints.

a. Panel Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As selected by the Owner from manufacturer's full range.

b. Panel Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As selected by the Owner from manufacturer's full range.

c. Panel Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As selected by the Owner from manufacturer's full range.

d. Panel Material: Copper sheet, 16-oz./sq. ft. weight (0.55-mm thickness) **OR** 20-oz./sq. ft. weight (0.68-mm thickness), **as directed**.
1) Exterior Finish: Brushed satin (lacquered) **OR** Mirror polished, **as directed**.

e. Batten Material: Same material, finish, and color as roof panels.

f. Clips: One **OR** Two, **as directed**, piece.
1) Material: 0.028-inch- (0.71-mm-) **OR** 0.064-inch- (1.63-mm-), **as directed,** nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
2) Material: 0.025-inch- (0.64-mm-) **OR** 0.062-inch- (1.59-mm-), **as directed**, thick, stainless-steel sheet.

g. Sealant: Factory applied in top **OR** on each side, **as directed**, of battens.

h. Panel Coverage: 12 inches (305 mm) **OR** 14 inches (356 mm) **OR** 16 inches (406 mm) **OR** 18 inches (457 mm) **OR** 20 inches (508 mm), **as directed**.

i. Batten Height: 1.0 inch (25 mm) **OR** 1.25 inches (32 mm) **OR** 1.5 inches (38 mm) **OR** 1.75 inches (44 mm) **OR** 2.0 inches (51 mm), **as directed**.

3. Wide-Profile, Snap-on-Batten-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between ribs; designed for independent installation by mechanically attaching panels to supports using concealed clips located between and engaging edges of adjacent panels, and installing snap-on battens over panel joints.

a. Panel Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As selected by the Owner from manufacturer's full range.
b. Panel Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As selected by the Owner from manufacturer's full range.
c. Panel Material: Aluminum sheet, 0.024 inch (0.061 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm), **as directed**, thick.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As selected by the Owner from manufacturer's full range.
d. Panel Material: Copper sheet, 16-oz./sq. ft. weight (0.55-mm thickness) **OR** 20-oz./sq. ft. weight (0.68-mm thickness), **as directed**.
   1) Exterior Finish: Brushed satin (lacquered) **OR** Mirror polished, **as directed**.
e. Batten Material: Same material, finish, and color as roof panels.
f. Clips: One piece.
   1) Material: 0.028-inch- (0.71-mm-) **OR** 0.064-inch- (1.63-mm-), **as directed**, nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
   2) Material: 0.025-inch- (0.64-mm-) **OR** 0.062-inch- (1.59-mm-), **as directed**, thick, stainless-steel sheet.
g. Sealant: Factory applied on each side of battens.
h. Panel Coverage: 12 inches (305 mm) **OR** 14 inches (356 mm) **OR** 16 inches (406 mm) **OR** 18 inches (457 mm) **OR** 22 inches (559 mm) **OR** 24 inches (610 mm), **as directed**.
i. Batten Height: 1.0 inch (25 mm) **OR** 1.5 inches (38 mm) **OR** 1.75 inches (44 mm) **OR** 1.88 inches (48 mm) **OR** 2.0 inches (51 mm), **as directed**.

4. Seamed-Batten Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced **OR** smooth, flat pan, **as directed**, between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels, and installing mechanically seamed battens over panel joints.
   a. Panel Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   b. Panel Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   c. Panel Material: Aluminum sheet, 0.024 inch (0.061 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm), **as directed**, thick.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.

d. Panel Material: Copper sheet, 16-oz./sq. ft. weight (0.55-mm thickness) **OR** 20-oz./sq. ft. weight (0.68-mm thickness), **as directed**.
   1) Exterior Finish: Brushed satin (lacquered) **OR** Mirror polished, **as directed**.
e. Batten Material: Same material, finish, and color as roof panels.
f. Clips: One **OR** Two, **as directed**, piece.
   1) Material: 0.028-inch- (0.71-mm-) **OR** 0.064-inch- (1.63-mm-), **as directed**, nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
   2) Material: 0.025-inch- (0.64-mm-) **OR** 0.062-inch- (1.59-mm-), **as directed**, thick, stainless-steel sheet.
g. Sealant: Factory applied on each side of clips under battens.
h. Panel Coverage: 12 inches (305 mm) **OR** 16 inches (406 mm) **OR** 18 inches (457 mm), **as directed**.
i. Batten Height: 2.0 inches (51 mm) **OR** 2.375 inches (60 mm) **OR** 3.0 inches (76 mm), **as directed**.

K. Horizontal-Seam (Bermuda-Type) Metal Roof Panels
1. Horizontal-Seam (Bermuda-Type) Metal Roof Panels: Formed with horizontal seam at panel edges and smooth, flat pan; designed to be installed in sequential installation by engaging lower edge of each panel to upper edge of panel below and mechanically attaching panels to supports using concealed clips located under upper edge of panels.
   a. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   b. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   c. Material: Aluminum sheet, 0.032 inch (0.81 mm) thick.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   d. Material: Copper sheet, 16-oz./sq. ft. weight (0.55-mm thickness) **OR** 20-oz./sq. ft. weight (0.68-mm thickness), **as directed**.
      1) Exterior Finish: Brushed satin (lacquered) **OR** Mirror polished, **as directed**.
   e. Clips: One piece.
      1) Material: 0.028-inch- (0.71-mm-) nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
      2) Material: 0.025-inch- (0.64-mm-) thick, stainless-steel sheet.
   f. Seal: Factory-applied sealant or vinyl weatherseal in seam.
   g. Exposure: 9.5 inches (241 mm) **OR** 11 inches (279 mm), **as directed**, nominal.
   h. Seam Height: 1.0 inch (25 mm) **OR** 1.5 inches (38 mm), **as directed**.

L. Foamed-Insulation-Core Metal Roof Panels
1. General: Provide factory-formed and -assembled metal roof panels fabricated from two sheets of metal with insulation core foamed-in-place during fabrication with joints between panels designed to form weathertight seals. Include accessories required for weathertight installation.
   a. Panel Performance:
      1) Flatwise Tensile Strength: 30 psi (200 kPa) when tested according to ASTM C 297/C 297M.

2) Humid Aging: Volume increase not greater than 6.0 percent and no delamination or metal corrosion when tested for 7 days at 140 deg F (60 deg C) and 100 percent relative humidity according to ASTM D 2126.
3) Heat Aging: Volume increase not greater than 2.0 percent and no delamination, surface blistering, or permanent bowing when tested for 7 days at 200 deg F (93 deg C) according to ASTM D 2126.
4) Cold Aging: Volume decrease not more than 1.0 percent and no delamination, surface blistering, or permanent bowing when tested for 7 days at minus 20 deg F (29 deg C) according to ASTM D 2126.
5) Fatigue: No evidence of delamination, core cracking, or permanent bowing when tested to a 20-lbf/sq. ft. (958-kPa) positive and negative wind load and with deflection of L/180 for 2 million cycles.
6) Autoclave: No delamination when exposed to 2-psi (13.8-kPa) pressure at a temperature of 212 deg F (100 deg C) for 2-1/2 hours.
7) Fire-Test-Response Characteristics: Class A according to ASTM E 108.

b. Insulation Core: Modified isocyanurate or polyurethane foam using a non-CFC blowing agent, with maximum flame-spread and smoke-developed indexes of 25 and 450, respectively.
1) Closed-Cell Content: 90 percent when tested according to ASTM D 2856.
2) Density: 2.0 to 2.6 lb/cu. ft. (32 to 42 kg/cu. m) when tested according to ASTM D 1622.
3) Compressive Strength: Minimum 20 psi (140 kPa) when tested according to ASTM D 1621.
4) Shear Strength: 26 psi (179 kPa) when tested according to ASTM C 273.

2. Lap-Seam-Profile, Foamed-Insulation-Core Metal Roof Panels: Formed for lapping side edges of adjacent panels and mechanically attaching to supports using exposed fasteners in side laps.

a. Facings: Fabricate panel with exterior and interior facings of same material and thickness.
1) Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
2) Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
3) Exterior Facing Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
a) Color: As selected by the Owner from manufacturer's full range.
4) Interior Facing Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
a) Color: As selected by the Owner from manufacturer's full range.

b. Batten: Same material, finish, and color as exterior facings of roof panels.

c. Panel Coverage: 24 inches (610 mm) **OR** 30 inches (762 mm) **OR** 36 inches (914 mm) **OR** 39.6 inches (1000 mm) **OR** 40 inches (1016 mm) **OR** 44.5 inches (1130 mm), **as directed**.

d. Panel Thickness: 1.0 inch (25 mm) **OR** 1.5 inches (38 mm) **OR** 2.0 inches (51 mm) **OR** 2.5 inches (64 mm) **OR** 3.0 inches (76 mm) **OR** 4.0 inches (102 mm) **OR** 5.0 inches (127 mm) **OR** 6.0 inches (152 mm), **as directed**.

3. Standing-Seam-Profile, Foamed-Insulation-Core Metal Roof Panels: Formed with vertical tongue-and-groove ribs at panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between ribs; designed for sequential installation by interlocking tongue-and-groove panel edges and mechanically attaching panels to supports using concealed clips located between and engaging edges of adjacent panels, and mechanically seaming panels together.

a. Facings: Fabricate panel with exterior and interior facings of same material and thickness.
1) Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.

2) Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
3) Exterior Facing Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
a) Color: As selected by the Owner from manufacturer's full range.
4) Interior Facing Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
a) Color: As selected by the Owner from manufacturer's full range.
b. Joint Type: Single folded **OR** Double folded **OR** As standard with manufacturer, **as directed**.
c. Panel Coverage: 36 inches (914 mm) **OR** 42 inches (1067 mm), **as directed**.
d. Panel Thickness: 2.0 inches (51 mm) **OR** 2.5 inches (64 mm) **OR** 3.0 inches (76 mm) **OR** 4.0 inches (102 mm) **OR** 5.0 inches (127 mm) **OR** 6.0 inches (152 mm), **as directed**.
4. Batten-Seam-Profile, Foamed-Insulation-Core Metal Roof Panels: Formed with vertical or tapered tongue-and-groove ribs at panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between ribs; designed for sequential installation by interlocking tongue-and-groove panel edges and mechanically attaching panels to supports using concealed clips located between and engaging edges of adjacent panels, and installing snap-on battens over panel joints.
a. Facings: Fabricate panel with exterior and interior facings of same material and thickness.
1) Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) nominal thickness.
2) Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) nominal thickness.
3) Exterior Facing Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
a) Color: As selected by the Owner from manufacturer's full range.
4) Interior Facing Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
a) Color: As selected by the Owner from manufacturer's full range.
b. Batten: Same material, finish, and color as exterior facings of roof panels.
c. Clips: One piece; 0.064-inch- (1.63-mm-) **OR** 0.097-inch- (2.50-mm-), **as directed**, nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
d. Panel Coverage: 36 inches (914 mm) **OR** 39.6 inches (1000 mm), **as directed**.
e. Panel Thickness: 1.75 inches (44 mm) **OR** 2.0 inches (51 mm) **OR** 2.5 inches (64 mm) **OR** 3.0 inches (76 mm) **OR** 4.0 inches (102 mm) **OR** 5.0 inches (127 mm) **OR** 6.0 inches (152 mm), **as directed**.

M. Metal Soffit Panels
1. General: Provide factory-formed metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps. Include accessories required for weathertight installation.
2. Metal Soffit Panels: Match profile and material of metal roof panels.
a. Finish: Match finish and color of metal roof panels **OR** Match finish and color of metal wall panels **OR** As indicated on Drawings, **as directed**.
b. Sealant: Factory applied within interlocking joint.
3. Flush-Profile Metal Soffit Panels: Solid **OR** Perforated, **as directed**, panels formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between panel edges; with flush joint between panels.
a. Material: Same material, finish, and color as metal roof panels.

b. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: Match finish and color of metal roof panels **OR** Match finish and color of metal wall panels **OR** As selected by the Owner from manufacturer's full range, **as directed**.

c. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: Match finish and color of metal roof panels **OR** Match finish and color of metal wall panels **OR** As selected by the Owner from manufacturer's full range, **as directed**.

d. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: Match finish and color of metal roof panels **OR** Match finish and color of metal wall panels **OR** As selected by the Owner from manufacturer's full range, **as directed**.

e. Material: Copper sheet, 16-oz./sq. ft. weight (0.55-mm thickness) **OR** 20-oz./sq. ft. weight (0.68-mm thickness), **as directed**.
   1) Exterior Finish: Brushed satin (lacquered) **OR** Mirror polished, **as directed**.

f. Panel Coverage: 8 inches (203 mm) **OR** 12 inches (305 mm) **OR** 16 inches (406 mm) **OR** 20 inches (508 mm), **as directed**.

g. Panel Height: 0.875 inch (22 mm) **OR** 1.0 inch (25 mm) **OR** 1.5 inches (38 mm) **OR** 3.0 inches (76 mm), **as directed**.

h. Sealant: Factory applied within interlocking joint.

4. Reveal-Joint-Profile Metal Soffit Panels: Solid **OR** Perforated, **as directed**, panels formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between panel edges; with recessed reveal joint between panels.

a. Material: Same material, finish, and color as metal roof panels.

b. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: Match finish and color of metal roof panels **OR** Match finish and color of metal wall panels **OR** As selected by the Owner from manufacturer's full range, **as directed**.

c. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: Match finish and color of metal roof panels **OR** Match finish and color of metal wall panels **OR** As selected by the Owner from manufacturer's full range, **as directed**.

d. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: Match finish and color of metal roof panels **OR** Match finish and color of metal wall panels **OR** As selected by the Owner from manufacturer's full range, **as directed**.

e. Material: Copper sheet, 16-oz./sq. ft. weight (0.55-mm thickness) **OR** 20-oz./sq. ft. weight (0.68-mm thickness), **as directed**.
   1) Exterior Finish: Brushed satin (lacquered) **OR** Mirror polished, **as directed**.

f. Panel Coverage: 8 inches (203 mm) **OR** 12 inches (305 mm) **OR** 16 inches (406 mm) **OR** 20 inches (508 mm), **as directed**.

g. Panel Height: 0.75 inch (19 mm) **OR** 1.0 inch (25 mm) **OR** 1.5 inches (38 mm), **as directed**.

5. V-Groove-Profile Metal Soffit Panels: Solid **OR** Perforated, **as directed**, panels formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm),flat pan, **as directed**, between panel edges; with V-groove joint between panels.
   a. Material: Same material, finish, and color as metal roof panels.
   b. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: Match finish and color of metal roof panels **OR** Match finish and color of metal wall panels **OR** As selected by the Owner from manufacturer's full range, **as directed**.
   c. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: Match finish and color of metal roof panels **OR** Match finish and color of metal wall panels **OR** As selected by the Owner from manufacturer's full range, **as directed**.
   d. Material: Aluminum sheet, 0.024 inch (0.65 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: Match finish and color of metal roof panels **OR** Match finish and color of metal wall panels **OR** As selected by the Owner from manufacturer's full range, **as directed**.
   e. Panel Coverage: 6 inches (152 mm) **OR** 12 inches (305 mm) **OR** 14 inches (356 mm), **as directed**.
   f. Panel Height: 0.375 inch (10 mm) **OR** 0.44 inch (11 mm) **OR** 0.50 inch (13 mm) **OR** 0.625 inch (16 mm), **as directed**.

N. Accessories
1. Roof Panel Accessories: Provide components approved by roof panel manufacturer and as required for a complete metal roof panel assembly including trim, copings, fasciae, corner units, ridge closures, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels unless otherwise indicated.
   a. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal roof panels.

b. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

c. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.

2. Flashing and Trim: Formed from same material as roof panels, prepainted with coil coating, minimum 0.018 inch (0.45 mm) thick. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal roof panels.

3. Gutters: Formed from same material roof panels. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- (2400-mm-) long sections, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Furnish gutter supports spaced a maximum of 36 inches (900 mm) o.c., fabricated from same metal as gutters. Provide wire ball strainers of compatible metal at outlets. Finish gutters to match metal roof panels **OR** roof fascia and rake trim, **as directed**.

4. Downspouts: Formed from same material as roof panels. Fabricate in 10-foot- (3-m-) long sections, complete with formed elbows and offsets, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual". Finish downspouts to match gutters.

5. Roof Curbs: Fabricated from same material as roof panels, minimum 0.048 inch (1.2 mm) thick; with bottom of skirt profiled to match roof panel profiles, and welded top box and integral full-length cricket. Fabricate curb subframing of minimum 0.0598-inch- (1.5-mm-) thick, angle-, C-, or Z-shaped steel sheet. Fabricate curb and subframing to withstand indicated loads, of size and height indicated. Finish roof curbs to match metal roof panels.

   a. Insulate roof curb with 1-inch- (25-mm-) thick, rigid insulation.

O. Snow Guards

1. Snow Guards: Prefabricated, noncorrosive units designed to be installed without penetrating metal roof panels, and complete with predrilled holes, clamps, or hooks for anchoring.

   a. Surface-Mounted, Plastic, Stop-Type Snow Guards: Clear **OR** Integral color, **as directed**, polycarbonate stops designed for attachment to pan surface of metal roof panels using construction adhesive, silicone or polyurethane sealant, or adhesive tape.

   b. Surface-Mounted, Metal, Stop-Type Snow Guards: Cast-aluminum stops designed for attachment to pan surface of metal roof panel using construction adhesive, silicone or polyurethane sealant, or adhesive tape.

   c. Surface-Mounted, Copper, Stop-Type Snow Guards: Bronze-alloy stops designed for attachment to pan surface of copper roof panel using solder.

   d. Seam-Mounted, Stop-Type Snow Guards: Cast-aluminum **OR** Malleable-iron **OR** Clear polycarbonate **OR** Colored polycarbonate, **as directed**, stops designed for attachment to vertical ribs of standing-seam metal roof panels with stainless-steel set screws.

   e. Seam-Mounted, Bar-Type Snow Guards: Aluminum **OR** stainless-steel, **as directed**, rods or bars held in place by stainless-steel clamps attached to vertical ribs of standing-seam metal roof panels.

      1) Aluminum Finish: Mill **OR** Clear anodized, **as directed**.

      2) Stainless-Steel Finish: Mill **OR** No. 2B **OR** No. 4, **as directed**.

P. Fabrication

1. Fabricate and finish metal roof panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes and as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.

2. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

3. Fabricate metal roof panel side laps with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will seal weathertight and minimize noise from movements within panel assembly.
4. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.
   a. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
   b. End Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
   c. End Seams for Other Than Aluminum: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
   d. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
   e. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
   f. Fabricate cleats and attachment devices of size and metal thickness recommended by SMACNA's "Architectural Sheet Metal Manual" or by metal roof panel manufacturer for application, but not less than thickness of metal being secured.

Q. Finishes
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

1.3 EXECUTION

A. Preparation
1. Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment.
2. Substrate Board: Install substrate boards over roof deck **OR** sheathing, **as directed**, on entire roof surface. Attach with substrate-board fasteners.
   a. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
   b. Comply with UL **OR** FMG, **as directed**, requirements for fire-rated construction.
3. Miscellaneous Framing: Install subpurlins, eave angles, furring, and other miscellaneous roof panel support members and anchorage according to metal roof panel manufacturer's written instructions.
   a. Soffit Framing: Wire tie or clip furring channels to supports, as required to comply with requirements for assemblies indicated.

B. Underlayment Installation
1. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated below **OR** on Drawings, a**s directed**, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Extend underlayment into gutter trough. Roll laps with roller. Cover underlayment within 14 days.
   a. Roof perimeter for a distance up from eaves of 24 inches (600 mm) **OR** 36 inches (914 mm), **as directed**, beyond interior wall line.

b. Valleys, from lowest point to highest point, for a distance on each side of 18 inches (460 mm), **as directed**. Overlap ends of sheets not less than 6 inches (150 mm).
c. Rake edges for a distance of 18 inches (460 mm).
d. Hips and ridges for a distance on each side of 12 inches (300 mm).
e. Roof to wall intersections for a distance from wall of 18 inches (460 mm).
f. Around dormers, chimneys, skylights, and other penetrating elements for a distance from element of 18 inches (460 mm).

2. Felt Underlayment: Apply at locations indicated below **OR** on Drawings, **as directed**, in shingle fashion to shed water, and with lapped joints of not less than 2 inches (50 mm).
   a. Apply over entire roof surface.
   b. Apply on roof not covered by self-adhering sheet underlayment. Lap over edges of self-adhering sheet underlayment not less than 3 inches (75 mm), in shingle fashion to shed water.
3. Apply slip sheet over underlayment before installing metal roof panels.
4. Install flashings to cover underlayment to comply with requirements specified in Division 07 Section "Sheet Metal Flashing And Trim".

C. Thermal Insulation Installation
1. Polyethylene Vapor Retarder: Extend vapor retarder to extremities of areas to be protected from vapor transmission. Repair tears or punctures immediately before concealment by other work.
2. Board Insulation: Extend insulation in thickness indicated to cover entire roof. Comply with installation requirements in Division 07 Section "Thermal Insulation".
   a. Erect insulation and hold in place with Z-shaped furring members spaced 24 inches (610 mm) **OR** 600 mm, **as directed**, o.c. Securely attach narrow flanges of furring members to roof deck with screws spaced 24 inches (600 mm) o.c.
3. Blanket Insulation: Install insulation concurrently with metal roof panel installation, in thickness indicated to cover entire roof, according to manufacturer's written instructions and as follows:
   a. Set vapor-retarder-faced units with vapor retarder to warm side **OR** in location indicated, **as directed**, of construction unless otherwise indicated. Do not obstruct ventilation spaces.
   b. Tape joints and ruptures in vapor retarder and seal each continuous area of insulation to surrounding construction to ensure airtight installation.
   c. Install blankets straight and true in one-piece lengths with both sets of facing tabs sealed. Comply with the following installation method:
      1) Over-Framing Installation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing members. Hold in place by panels fastened to secondary framing.
      2) Between-Purlin Installation: Extend insulation and vapor retarder between purlins. Carry vapor-retarder facing tabs up and over purlin, overlapping adjoining facing of next insulation course maintaining continuity of retarder. Hold in place with bands and crossbands below insulation.
      3) Over-Purlin-with-Spacer-Block Installation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing members. Install layer of filler insulation over first layer to fill space formed by roof panel standoffs. Hold in place by panels fastened to standoffs.
      4) Two-Layers-between-Purlin-with-Spacer-Block Installation: Extend insulation and vapor retarder between purlins. Carry vapor-retarder facing tabs up and over purlins, overlapping adjoining facing of next insulation course maintaining continuity of retarder. Install layer of filler insulation over first layer to fill space between purlins formed by thermal spacer blocks. Hold in place with bands and crossbands below insulation.
   d. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.
   e. Thermal Spacer Blocks: Where metal roof panels attach directly to purlins, install thermal spacer blocks.

D. Metal Roof Panel Installation, General
1. Provide metal roof panels of full length from eave to ridge unless otherwise indicated or restricted by shipping limitations.
2. Thermal Movement. Rigidly fasten metal roof panels to structure at one and only one location for each panel. Allow remainder of panel to move freely for thermal expansion and contraction. Predrill panels for fasteners.
a. Point of Fixity: Fasten each panel along a single line of fixing located at eave **OR** ridge **OR** center of panel length **OR** locations indicated on Drawings, **as directed**.
b. Avoid attaching accessories through roof panels in a manner that will inhibit thermal movement.
3. Install metal roof panels as follows:
a. Commence metal roof panel installation and install minimum of 300 sq. ft. (27.8 sq. m.) in presence of factory-authorized representative.
b. Field cutting of metal panels by torch is not permitted.
c. Install panels perpendicular to purlins.
d. Locate and space fastenings in uniform vertical and horizontal alignment.
e. Provide metal closures at rake edges **OR** rake walls, **as directed**, and each side of ridge **OR** ridge and hip, **as directed**, caps.
f. Flash and seal metal roof panels with weather closures at eaves, rakes, and perimeter of all openings.
g. Install ridge **OR** ridge and hip, **as directed**, caps as metal roof panel work proceeds.
h. End Splices: Locate panel end splices over, but not attached to, structural supports. Stagger panel end splices to avoid a four-panel splice condition.
i. Install metal flashing to allow moisture to run over and off metal roof panels.
4. Fasteners:
a. Steel Roof Panels: Use stainless-steel fasteners for surfaces exposed to the exterior and galvanized-steel fasteners for surfaces exposed to the interior.
b. Aluminum Roof Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior and aluminum or galvanized-steel fasteners for surfaces exposed to the interior.
c. Copper Roof Panels: Use copper, stainless-steel, or hardware-bronze fasteners.
5. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.
6. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.
a. Coat back side of roof panels with bituminous coating where roof panels will contact wood, ferrous metal, or cementitious construction.
7. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal roof panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal roof panel manufacturer.
a. Seal metal roof panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal roof panel manufacturer.
b. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants".

E. Metal Roof Panel Installation
1. Lap-Seam Metal Roof Panels: Fasten metal roof panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.
a. Apply panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.
b. Lap ribbed or fluted sheets one full rib corrugation.
c. Provide metal-backed neoprene or EPDM washers under heads of exposed fasteners bearing on weather side of metal roof panels.

d. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
e. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.
f. Provide sealant tape at lapped joints of metal roof panels and between panels and protruding equipment, vents, and accessories.
g. Apply a continuous ribbon of sealant tape to weather-side surface of fastenings on end laps, and on side laps of nesting-type panels; on side laps of corrugated nesting-type, ribbed, or fluted panels; and elsewhere as needed to make panels weatherproof to driving rains.
h. At panel end splices, nest panels with minimum 6-inch (150-mm) end lap, sealed with butyl-rubber sealant and fastened together by interlocking clamping plates.

2. Standing-Seam Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended by manufacturer.
   a. Install clips to supports with self-tapping fasteners.
   b. Install pressure plates at locations indicated in manufacturer's written installation instructions.
   c. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
   d. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.
3. Batten-Seam Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each batten-seam joint at location, spacing, and with fasteners recommended by manufacturer.
   a. Install clips to supports with self-drilling fasteners.
   b. Apply battens to metal roof panel seams, fully engaged to provide weathertight joints.
4. Horizontal-Seam (Bermuda-Type) Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each horizontal-seam joint at location, spacing, and with fasteners recommended by manufacturer. Start at eave and work upward toward ridge.
   a. Install clips to supports with self-drilling fasteners.

F. Foamed-Insulation-Core Metal Roof Panel Installation
1. General: Apply continuous ribbon of sealant to panel joint on concealed side of insulated metal roof panels as vapor seal; apply sealant to panel joint on exposed side of panels for weather seal.
2. Lap-Seam, Foamed-Insulation-Core Metal Roof Panels: Fasten insulated metal roof panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.
   a. Lap ribbed or fluted sheets one full rib corrugation. Apply panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.
   b. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of insulated metal roof panels.
   c. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
   d. Provide sealant tape at lapped joints of insulated metal roof panels and between panels and protruding equipment, vents, and accessories.
   e. Apply a continuous ribbon of sealant tape to panel side laps and elsewhere as needed to make panels weatherproof to driving rains.
   f. Apply snap-on battens to insulated metal roof panel seams to conceal fasteners.
3. Standing-Seam, Foamed-Insulation-Core Metal Roof Panels: Fasten insulated metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended by manufacturer.
   a. Install clips to supports with self-tapping fasteners.

b. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so cleat, insulated metal roof panel, and factory-applied side-lap sealant are completely engaged.

4. Batten-Seam, Foamed-Insulation-Core Metal Roof Panels: Fasten insulated metal roof panels to supports with concealed clips at each batten-seam joint at location, spacing, and with fasteners recommended by manufacturer.
   a. Apply battens to insulated metal roof panel seams, fully engaged to provide weathertight joints.

G. Metal Soffit Panel Installation
1. In addition to complying with requirements in "Metal Roof Panel Installation, General" Article, install metal soffit panels to comply with requirements in this article.
2. Metal Soffit Panels: Provide metal soffit panels full width of soffits. Install panels perpendicular to support framing.
   a. Flash and seal panels with weather closures where metal soffit panels meet walls and at perimeter of all openings.
3. Metal Fascia Panels: Align bottom of panels and fasten with blind rivets, bolts, or self-tapping screws. Flash and seal panels with weather closures where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.

H. Accessory Installation
1. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
   a. Install components required for a complete metal roof panel assembly including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
2. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
   a. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
   b. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).
3. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 36 inches (914 mm) o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.
4. Downspouts: Join sections with telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1500 mm) o.c. in between.
   a. Provide elbows at base of downspouts to direct water away from building.
   b. Connect downspouts to underground drainage system indicated.
5. Roof Curbs: Install curbs at locations indicated on Drawings. Install flashing around bases where they meet metal roof panels.
6. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

I. Snow Guard Installation

1. Stop-Type Snow Guards: Attach snow guards to metal roof panels with adhesive, sealant, or adhesive tape, as recommended by manufacturer. Do not use fasteners that will penetrate metal roof panels.
    a. Provide rows of snow guards, at locations indicated on Drawings, spaced apart, beginning from gutter, with each snow guard centered between panel ribs.
2. Bar-Type Snow Guards: Attach bar supports to vertical ribs of standing-seam metal roof panels with clamps or set screws. Do not use fasteners that will penetrate metal roof panels.
    a. Provide rows of snow guards, at locations indicated on Drawings, spaced apart, beginning from gutter.

J. Erection Tolerances
1. Installation Tolerances: Shim and align metal roof panel units within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

K. Field Quality Control
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect metal roof panel installation, including accessories. Report results in writing.
2. Remove and replace applications of metal roof panels where inspections indicate that they do not comply with specified requirements.
3. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

L. Cleaning
1. Remove temporary protective coverings and strippable films, if any, as metal roof panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal roof panel installation, clean finished surfaces as recommended by metal roof panel manufacturer. Maintain in a clean condition during construction.
2. Replace metal roof panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 41 13 00

SECTION 07 41 13 00a - SHEET METAL ROOFING

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for sheet metal roofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Flat-seam metal roofing, custom fabricated.
      b. Standing-seam metal roofing, custom fabricated **OR** on-site, roll formed, **as directed**.
      c. Batten-seam metal roofing, custom fabricated **OR** on-site, roll formed, **as directed**.
      d. Horizontal-seam (Bermuda-type) metal roofing, custom fabricated.

C. Performance Requirements
   1. General Performance: Sheet metal roofing system including, but not limited to, metal roof panels, cleats, clips, anchors and fasteners, sheet metal flashing integral with sheet metal roofing, fascia panels, trim, battens, **as directed**, underlayment, and accessories shall comply with requirements indicated without failure due to defective manufacture, fabrication, installation, or other defects in construction. Sheet metal roofing shall remain watertight.
   2. Thermal Movements: Provide sheet metal roofing that allows for thermal movements from ambient and surface temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
      a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
   3. Energy Performance: Provide metal roofing with solar reflectance index not less than 78 **OR** 29, **as directed**, when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.

D. Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittal:
      a. Product Test Reports for Credit SS 7.2: For roof panels, indicating that panels comply with Solar Reflectance Index requirement.
   3. Shop Drawings: Show fabrication and installation layouts of sheet metal roofing, including plans, elevations, expansion joint locations, and keyed details. Distinguish between shop- and field-assembled work.
      a. Include details for forming, joining, and securing sheet metal roofing, including pattern of seams, termination points, fixed points, expansion joints, roof penetrations, edge conditions, special conditions, connections to adjoining work, and details of accessory items.
   4. Samples: For each exposed product and for each finish specified.
   5. Coordination Drawings: Roof plans drawn to scale with coordinated details for penetrations and roof-mounted items.
   6. Portable Roll-Forming Equipment Certificate: Issued by UL for equipment manufacturer's portable roll-forming equipment capable of producing panels that comply with UL requirements.
   7. Product test reports.
   8. Maintenance data.
   9. Warranties: Sample of special warranties.

E. Quality Assurance

1. Roll-Formed Sheet Metal Roofing Fabricator Qualifications: Fabricator authorized by portable roll-forming equipment manufacturer to fabricate and install sheet metal roofing units required for this Project, and who maintains current UL certification of its portable roll-forming equipment.
2. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing roofing panels for sheet metal roofing assemblies that comply with UL 580 for Class 30 **OR** Class 60 **OR** Class 90, **as directed**, wind-uplift resistance. Maintain UL certification of portable roll-forming equipment for duration of sheet metal roofing work.
3. Sheet Metal Roofing Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.
4. Copper Roofing Standard: Comply with CDA's "Copper in Architecture Handbook." Conform to dimensions and profiles shown unless more stringent requirements are indicated.
5. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Do not store sheet metal roofing materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal roofing materials away from uncured concrete and masonry.
2. Protect strippable protective covering on sheet metal roofing from exposure to sunlight and high humidity, except to the extent necessary for the period of sheet metal roofing installation.

G. Warranty
1. Special Warranty: Warranty form at the end of this Section in which Installer agrees to repair or replace components of sheet metal roofing that fail in materials or workmanship within two years from date of Final Completion.
2. Special Warranty on Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace sheet metal roofing that shows evidence of deterioration of factory-applied finishes within 20 **OR** 10, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Roofing Sheet Metals
1. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.
2. Metallic-Coated Steel Sheet: Restricted flatness steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
   a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
   b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40 (Class AZM150 coating designation, Grade 275); structural quality.
   c. Thickness: Nominal 0.022 inch (0.56 mm) **OR** 0.028 inch (0.71 mm), **as directed**, unless otherwise indicated.
      1) Batten Caps: Nominal 0.028 inch (0.71 mm) thick.
   d. Surface: Smooth, flat **OR** Embossed, **as directed**.
   e. Exposed Coil-Coated Finish:
      1) Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      2) Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      3) Four-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat and clear coats. Prepare, pretreat,

and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

4) Mica Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
5) Metallic Fluoropolymer: AAMA 621. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
6) FEVE Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
7) Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
8) Plastisol: Epoxy primer and vinyl plastisol topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 3.8 mils (0.97 mm) for topcoat.

f. Color: As selected from manufacturer's full range.
g. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

3. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required.
   a. Thickness: 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, unless otherwise indicated.
      1) Batten Caps: 0.050 inch (1.27 mm) thick.
   b. As-Milled Finish: Mill **OR** One-side bright mill **OR** Standard one-side bright **OR** Standard two-side bright, **as directed**, finish.
   c. Alclad Finish: Metallurgically bonded surfacing to both sides, forming a composite aluminum sheet with reflective luster.
   d. Surface: Smooth, flat **OR** Embossed, **as directed**.
   e. Factory Prime Coating: Where painting after installation is indicated, pretreat with white or light-colored, factory-applied, baked-on epoxy primer coat; minimum dry film thickness of 0.2 mil (0.005 mm).
   f. Exposed Coil-Coated Finish:
      1) Two-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      2) Three-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      3) Four-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat and clear coats. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      4) Mica Fluoropolymer: AAMA 620. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      5) Metallic Fluoropolymer: AAMA 620. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight

in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

6) FEVE Fluoropolymer: AAMA 620. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
7) Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
8) Plastisol: Epoxy primer and vinyl plastisol topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 3.8 mil (0.97 mm) for topcoat.

g. Color: As selected from manufacturer's full range.
h. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

4. Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 temper, 16 oz./sq. ft. (0.55 mm thick) **OR** 20 oz./sq. ft. (0.70 mm thick), **as directed**, unless otherwise indicated.
   a. Batten Caps: 20 oz./sq. ft. (0.70 mm thick).
   b. Non-Patinated Exposed Finish: Mill
   c. Non-Patinated Exposed, Lacquered Finish: Finish designations for copper alloys comply with the system defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."
      1) Brushed Satin (Lacquered): M32-06x (Mechanical Finish: directionally textured, medium satin; with clear organic coating); coating of "Incralac" waterborne **OR** solvent-borne, **as directed**, methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats per manufacturer's written instructions to a total thickness of 1 mil (0.025 mm).
      2) Mirror Polished (Lacquered): M22-06x (Mechanical Finish: buffed, specular; with clear organic coating); coating of "Incralac" waterborne **OR** solvent-borne, **as directed**, air-drying, methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats per manufacturer's written instructions to a total thickness of 1 mil (0.025 mm).
   d. Pre-Patinated Copper-Sheet Finish: Dark brown **OR** Verdigris, **as directed**, pre-patinated according to ASTM B 882.
5. Zinc-Tin Alloy-Coated Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 temper, coated on both sides with a zinc-tin alloy (50 percent zinc, 50 percent tin).
   a. Weight (Thickness): 16-oz./sq. ft. (0.55-mm) **OR** 20-oz./sq. ft. (0.70-mm), **as directed**, uncoated weight (thickness), with 0.787-mil (0.020-mm) coating thickness applied to each side.
      1) Batten Caps: 20-oz./sq. ft. (0.70-mm) uncoated weight (thickness), with 0.787-mil (0.020-mm) coating thickness applied to each side unless otherwise indicated.
6. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304, dead soft, fully annealed.
   a. Thickness: 0.016 inch (0.40 mm) **OR** 0.019 inch (0.48 mm), **as directed**, unless otherwise indicated.
      1) Batten Caps: 0.019 inch (0.48 mm) thick.
   b. Surface: Smooth, flat **OR** Embossed, **as directed**.
   c. Finish: 2D (dull, cold rolled) **OR** 2B (bright, cold rolled) **OR** 3 (coarse, polished directional satin) **OR** 4 (polished directional satin), **as directed**.
      1) Remove tool and die marks and stretch lines or blend into finish.
      2) Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
      3) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

7. Zinc-Tin Alloy-Coated Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, dead-soft, fully annealed stainless-steel sheet, coated on both sides with a zinc-tin alloy (50 percent zinc, 50 percent tin), with factory-applied gray preweathering.
   a. Thickness: 0.015-inch (0.38-mm) **OR** 0.018-inch (0.46-mm) **OR** 0.024-inch (0.61-mm), **as directed**, minimum uncoated thickness, with 0.787-mil (0.020-mm) coating thickness applied to each side.
      1) Batten Caps: 0.018-inch- (0.46-mm-) minimum uncoated thickness, with 0.787-mil (0.020-mm) coating thickness applied to each side unless otherwise indicated.
8. Zinc-Tin Alloy-Coated Steel Sheet: ASTM A 625/A 625M; single-reduced, black-steel sheet, coated on both sides with a zinc-tin alloy (50 percent zinc, 50 percent tin), with factory-applied shop coat, **as directed**.
   a. Thickness: 0.012-inch (0.31-mm) **OR** 0.014-inch (0.36-mm), **as directed**, uncoated thickness, with 0.787-mil (0.020-mm) coating thickness applied to each side.
      1) Batten Caps: 0.014-inch (0.36-mm) uncoated thickness, with 0.787-mil (0.020-mm) coating thickness applied to each side unless otherwise indicated.
   b. Exposed Coil-Coated Finish: Manufacturer's standard two-coat fluoropolymer complying with performance requirements in AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      1) Color: As selected from manufacturer's full range.
   c. Field-Applied Finish: Manufacturer's standard waterborne acrylic emulsion paint primer and finish coat.
      1) Color: As selected from manufacturer's full range.
9. Zinc Sheet: Zinc, 99 percent pure, alloyed with a maximum of 1 percent copper and titanium; with manufacturer's standard factory-applied, flexible, protective back coating.
   a. Thickness: 0.027 inch (0.70 mm) **OR** 0.032 inch (0.80 mm), **as directed**, unless otherwise indicated.
      1) Batten Caps: 0.032 inch (0.80 mm) thick.
   b. Finish: Bright rolled **OR** Preweathered gray **OR** Preweathered black, **as directed**.
10. Titanium Sheet: ASTM B 265, Grade 1.
   a. Thickness: 0.015 inch (0.38 mm) **OR** 0.020 inch (0.51 mm), **as directed**, unless otherwise indicated.
      1) Batten Caps: 0.020 inch (0.51 mm) thick.
   b. Surface: Smooth, flat **OR** Embossed, **as directed**.
   c. Finish: Low **OR** Medium, **as directed**, matte.
   d. Color Anodic Finish (Light-Interference Phenomenon): Silver **OR** Gold **OR** Purple **OR** Blue **OR** Match sample **OR** As selected from manufacturer's full range of colors and color densities, **as directed**.

B. Underlayment Materials
1. Polyethylene Sheet: 6-mil- (0.15-mm-) thick polyethylene sheet complying with ASTM D 4397.
2. Felts: ASTM D 226, Type II (No. 30) **OR** Type I (No. 15), **as directed**, asphalt-saturated organic felts.
3. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
   a. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F (116 deg C).
   b. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F (29 deg C).
4. Slip Sheet: Building paper, 3-lb/100 sq. ft. (0.16-kg/sq. m) minimum, rosin sized.

C. Miscellaneous Materials

1. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for a complete roofing system and as recommended by fabricator for sheet metal roofing.
2. Wood Battens: Lumber complying with requirements in Division 05 Section(s) "Maintenance Of Decorative Metal" OR Division 06 Section(s) "Miscellaneous Rough Carpentry", **as directed**, and treated with exterior-type fire retardant.
3. Snap-On Seams: Provide snap-on seams integrated with panel-edge profile as recommended by portable roll-forming equipment manufacturer to produce sheet metal roofing assemblies that comply with UL 580 for wind-uplift resistance classification specified in "Quality Assurance" Article.
4. Snap-on Batten Caps: Provide batten clips integrated with snap-on caps as recommended by portable roll-forming equipment manufacturer to produce sheet metal roofing assemblies that comply with UL 580 for wind-uplift resistance classification specified in "Quality Assurance" Article.
5. Fasteners: Wood screws, annular-threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads.
    a. General:
        1) Exposed Fasteners: Heads matching color of sheet metal roofing using plastic caps or factory-applied coating.
        2) Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
        3) Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
    b. Fasteners for Zinc-Coated **OR** Aluminum-Zinc Alloy-Coated, a**s directed**, Steel Sheet: Hot-dip galvanized steel according to ASTM A 153/A 153M, ASTM F 2329, or Series 300 stainless steel.
    c. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
    d. Fasteners for Copper **OR** Zinc-Tin Alloy-Coated Copper, **as directed**, Sheet: Copper, hardware bronze, or Series 300 stainless steel.
    e. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
    f. Fasteners for Zinc-Tin Alloy-Coated Steel **OR** Stainless-Steel, **as directed**, Sheet: Series 300 stainless steel.
    g. Fasteners for Zinc Sheet: Hot-dip galvanized steel according to ASTM A 153/A 153M, ASTM F 2329, or Series 300 stainless steel.
    h. Fasteners for Titanium Sheet: Titanium or Series 300 stainless steel.
6. Solder:
    a. For Zinc-Coated (Galvanized) Steel: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead.
    b. For Copper: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.
    c. For Stainless Steel: ASTM B 32, Grade Sn60, with an acid flux of type recommended by stainless-steel sheet manufacturer.
    d. For Zinc-Tin Alloy-Coated Steel **OR** Stainless Steel **OR** Copper, **as directed**: ASTM B 32, 100 percent tin.
    e. For Zinc: ASTM B 32, 40 percent tin and 60 percent lead with low antimony, as recommended by manufacturer.
7. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
8. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane **OR** polysulfide **OR** silicone, **as directed**, polymer sealant as recommended by portable roll-forming equipment manufacturer for installation indicated, **as directed**; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal roofing and remain watertight.
9. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

10. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

D. Accessories
1. Sheet Metal Accessories: Provide components required for a complete sheet metal roofing assembly including trim, copings, fasciae, corner units, clips, flashings, sealants, gaskets, fillers, metal closures, closure strips, and similar items. Match material and finish of sheet metal roofing unless otherwise indicated.
   a. Provide accessories as recommended by portable roll-forming equipment manufacturer to produce sheet metal roofing assemblies that comply with UL 580 for wind-uplift resistance classification specified in "Quality Assurance" Article.
   b. Cleats: For mechanically seaming into joints and formed from the following materials:
      1) Metallic-Coated Steel **OR** Aluminum, **as directed**, Roofing: 0.0250-inch- (0.64-mm-), **as directed**, thick stainless steel.
      2) Copper **OR** Zinc-Tin Alloy-Coated Copper, **as directed**, Roofing: 16-oz./sq. ft. (0.55-mm), **as directed**, copper sheet.
      3) Stainless-Steel **OR** Titanium, **as directed**, Roofing: 0.0250-inch- (0.64-mm-), **as directed**, thick stainless steel.
      4) Zinc-Tin Alloy-Coated Stainless-Steel **OR** Zinc-Tin Alloy-Coated Steel, **as directed**, Roofing: Manufacturer's preformed cleats or cleats fabricated from manufacturer's thickest flat-stock sheet.
      5) Zinc Roofing: Manufacturer's preformed stainless-steel cleats.
   c. Clips: Minimum 0.0625-inch- (1.6-mm-) thick, stainless-steel panel clips designed to withstand negative-load requirements.
   d. Backing Plates: Plates at roofing splices, fabricated from material recommended by SMACNA.
   e. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible-closure strips; cut or premolded to match sheet metal roofing profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
   f. Flashing and Trim: Formed from same material and with same finish as sheet metal roofing, minimum 0.018 inch (0.46 mm) thick.
2. Pipe Flashing: Premolded, EPDM pipe collar with flexible aluminum ring bonded to base.
3. Roof Curbs: Fabricated from same material and finish as sheet metal roofing, minimum thickness matching the sheet metal roofing; with bottom of skirt profiled to match roof panel profiles; with weatherproof top box and integral full-length cricket. Fabricate curb subframing of nominal 0.062-inch- (1.59-mm-) thick, angle-, C-, or Z-shaped galvanized steel or stainless-steel sheet. Fabricate curb and subframing to withstand indicated loads of size and height indicated. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.
   a. Insulate curbs with 1-inch- (25-mm-) thick, rigid insulation.
   b. Install wood nailers at tops of curbs.

E. Snow Guards
1. Snow Guards, General: Prefabricated, noncorrosive units designed to be installed without penetrating sheet metal roofing; complete with predrilled holes, clamps, or hooks for anchoring.
2. Surface-Mounted, Plastic, Stop-Type Snow Guards: Clear **OR** Integral-color, **as directed**, polycarbonate stops designed for attachment to panel surface of sheet metal roofing using construction adhesive, silicone or polyurethane sealant, or adhesive tape.
3. Surface-Mounted, Metal, Stop-Type Snow Guards: Cast-aluminum stops designed for attachment to panel surface of sheet metal roofing using construction adhesive, silicone or polyurethane sealant, or adhesive tape.
4. Surface-Mounted, Copper, Stop-Type Snow Guards: Bronze-alloy stops designed for attachment to panel surface of copper roofing using solder.
5. Seam-Mounted, Stop-Type Snow Guards: Cast-aluminum **OR** Malleable-iron **OR** Clear polycarbonate **OR** Colored polycarbonate, **as directed**, stops designed for attachment to vertical ribs of standing-seam sheet metal roofing with stainless-steel set screws.

6. Seam-Mounted, Bar-Type Snow Guards: Rail- or fence-type assembly consisting of aluminum or stainless-steel rods, bars, or pipe held in place by stainless-steel clamps attached to vertical ribs of standing-seam sheet metal roofing.
   a. Aluminum Finish: Mill **OR** Clear anodized, **as directed**.
   b. Stainless-Steel Finish: Mill **OR** Enamel, **as directed**.

F. Fabrication
1. General: Custom fabricate sheet metal roofing to comply with details shown and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions (panel width and seam height), geometry, metal thickness, and other characteristics of installation indicated. Fabricate sheet metal roofing and accessories at the shop to greatest extent possible.
   a. Flat-Seam Roofing: Form flat-seam panels from metal sheets 20 by 28 inches (510 by 710 mm) with 1/2-inch (13-mm) notched and folded edges.
   b. Standing-Seam Roofing: Form standing-seam panels with finished seam height of 1 inch (25 mm) **OR** of 1-1/2 inches (38 mm) **OR** as indicated, **as directed**.
   c. Batten-Seam Roofing: Form batten-seam panels with sides turned up 2-1/8 inches (54 mm) **OR** as indicated, **as directed**, with 1/2-inch (13-mm) flange turned toward center of pan.
   d. Horizontal-Seam (Bermuda-Type) Roofing: Form horizontal-seam (Bermuda-type) panels with upper edges turned up and extending above batten 1/2 inch (13 mm).
2. General: Fabricate roll-formed sheet metal roofing panels with UL-certified, portable roll-forming equipment capable of producing roofing panels for sheet metal roofing assemblies that comply with UL 580 for wind-uplift resistance classification specified in "Quality Assurance" Article. Fabricate roll-formed sheet metal according to equipment manufacturer's written instructions and to comply with details shown.
3. Fabrication Tolerances: Fabricate sheet metal roofing that is capable of installation to a tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.
4. Fabrication Tolerances: Fabricate sheet metal roofing that is capable of installation to tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."
5. Form exposed sheet metal work to fit substrates without excessive oil canning, buckling, and tool marks; true to line and levels indicated; and with exposed edges folded back to form hems.
   a. Lay out sheet metal roofing so transverse seams, if required, are made in direction of flow with higher panels overlapping lower panels.
   b. Offset transverse seams from each other 12 inches (300 mm) minimum.
   c. Fold and cleat eaves and transverse seams in the shop.
   d. Form and fabricate sheets, seams, strips, cleats, valleys, ridges, edge treatments, integral flashings, and other components of metal roofing to profiles, patterns, and drainage arrangements shown on Drawings and as required for leakproof construction.
6. Expansion Provisions: Fabricate sheet metal roofing to allow for expansion in running work sufficient to prevent leakage, damage, and deterioration of the Work. Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with butyl sealant concealed within joints.
7. Sealant Joints: Where movable, nonexpansion-type joints are indicated or required to produce weathertight seams, form metal to provide for proper installation of elastomeric sealant in compliance with SMACNA standards.
8. Metal Protection: Where dissimilar metals will contact each other, protect against galvanic action by painting contact surfaces with bituminous coating, by applying self-adhering sheet underlayment to each contact surface, or by other permanent separation as recommended by fabricator of sheet metal roofing or manufacturers of the metals in contact.
9. Sheet Metal Accessories: Custom fabricate flashings and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated. Obtain field measurements for accurate fit before shop fabrication.

a. Form exposed sheet metal accessories without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.

b. Seams:

1) Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
OR
Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength, **as directed**.

c. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant.

d. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

e. Fabricate cleats and attachment devices of sizes as recommended by SMACNA's "Architectural Sheet Metal Manual" for application, but not less than thickness of metal being secured.

10. Do not use graphite pencils to mark metal surfaces.

1.3 EXECUTION

A. Preparation

1. Lay out and nail battens to wood sheathing **OR** screw battens to wood sheathing **OR** screw battens to metal deck, **as directed**, before installation of sheet metal roofing.
   a. Space fasteners not more than 18 inches (457 mm) o.c.
   b. Space fasteners as required by portable roll-forming equipment manufacturer for specified UL classification for wind-uplift resistance.
2. Zinc-Tin Alloy-Coated Steel Roofing: For roofing with 3:12 slopes or less, paint underside of shop-coated, zinc-tin alloy-coated steel, before installation, with zinc-tin alloy-coated steel primer, applied at a dry film thickness of not less than 2.5 mils (0.06 mm). Comply with manufacturer's written instructions. This is in addition to the shop coating.

B. Underlayment Installation

1. Polyethylene Sheet: Install polyethylene sheet on roof sheathing under sheet metal roofing. Use adhesive for anchorage to minimize use of mechanical fasteners under sheet metal roofing. Apply at locations indicated on Drawings, in shingle fashion to shed water, with lapped and taped joints of not less than 2 inches (50 mm).
2. Felt Underlayment: Install felt underlayment on roof sheathing under sheet metal roofing. Use adhesive for temporary anchorage to minimize use of mechanical fasteners under sheet metal roofing. Apply at locations indicated, in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm).
   a. Apply from eave to ridge.
   OR
   Apply on roof not covered by self-adhering sheet underlayment. Lap edges of self-adhering sheet underlayment not less than 3 inches (75 mm), in shingle fashion to shed water.
3. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free, on roof sheathing under sheet metal roofing. Apply primer if required by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply over entire roof **OR** at locations indicated, **as directed**, in shingle fashion to shed water, with end laps of not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps with roller. Cover underlayment within 14 days.
   a. Roof perimeter for a distance up from eaves of 24 inches (600 mm) **OR** 36 inches (900 mm), **as directed**, beyond interior wall line.

b. Valleys, from lowest to highest point, for a distance on each side of 18 inches (460 mm). Overlap ends of sheets not less than 6 inches (150 mm).
c. Rake edges for a distance of 18 inches (460 mm).
d. Hips and ridges for a distance on each side of 12 inches (300 mm).
e. Roof to wall intersections for a distance from wall of 18 inches (460 mm).
f. Around dormers, chimneys, skylights, and other penetrating elements for a distance from element of 18 inches (460 mm).

4. Install flashings to cover underlayment to comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim".
5. Apply slip sheet before installing sheet metal roofing.

C. Installation, General
1. General: Anchor sheet metal roofing and other components of the Work securely in place, with provisions for thermal and structural movement. Install fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for a complete roofing system and as recommended by fabricator for sheet metal roofing.
   a. Field cutting of sheet metal roofing by torch is not permitted.
   b. Provide metal closures at peaks, rake edges, rake walls, eaves, and each side of ridge and hip caps, **as directed**.
   c. Flash and seal sheet metal roofing with closure strips at eaves, rakes, and perimeter of all openings. Fasten with self-tapping screws.
   d. Locate and space fastenings in uniform vertical and horizontal alignment. Predrill panels for fasteners.
   e. Install ridge **OR** ridge and hip, **as directed**, caps as sheet metal roofing work proceeds.
   f. Locate roofing splices over, but not attached to, structural supports. Stagger roofing splices and end laps to avoid a four-panel lap splice condition. Install backing plates at roofing splices.
   g. Install sealant tape where indicated.
   h. Lap metal flashing over sheet metal roofing to allow moisture to run over and off the material.
   i. Do not use graphite pencils to mark metal surfaces.
2. Thermal Movement. Rigidly fasten metal roof panels to structure at only one location for each panel. Allow remainder of panel to move freely for thermal expansion and contraction.
   a. Point of Fixity: Fasten each panel along a single line of fixing located at eave **OR** ridge **OR** center of panel length **OR** locations indicated on Drawings, **as directed**.
   b. Avoid attaching accessories through roof panels in a manner that will inhibit thermal movement.
3. Fasteners: Use fasteners of sizes that will penetrate wood sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws **OR** metal decking not less than recommended by fastener manufacturer to achieve maximum pull-out resistance, **as directed**.
4. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying self-adhering sheet underlayment to each contact surface, or by other permanent separation as recommended by SMACNA.
   a. Coat back side of uncoated aluminum and stainless-steel sheet metal roofing with bituminous coating where roofing will contact wood, ferrous metal, or cementitious construction.
5. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
6. Fasciae: Align bottom of sheet metal roofing and fasten with blind rivets, bolts, or self-tapping screws. Flash and seal sheet metal roofing with closure strips where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.

D. Custom-Fabricated Sheet Metal Roofing Installation
1. Fabricate and install work with lines and corners of exposed units true and accurate. Form exposed faces flat and free of buckles, excessive waves, and avoidable tool marks, considering temper and reflectivity of metal. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant. Fold back sheet metal to form a hem on concealed side of exposed edges unless otherwise indicated.
   a. Install cleats to hold sheet metal panels in position. Attach each cleat with two fasteners to prevent rotation.
   b. Fasten cleats not more than 12 inches (300 mm) o.c. Bend tabs over fastener head.
   c. Provide expansion-type cleats and clips for roof panels that exceed 30 feet (9.1 m) in length.
2. Seal joints as shown and as required for watertight construction. For roofing with 3:12 slopes or less, use cleats at transverse seams.
   a. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F (4 deg C).
   b. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants".
3. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches (38 mm), except reduce pre-tinning where pre-tinned surface would show in completed Work.
   a. Do not solder metallic-coated steel **OR** aluminum **OR** titanium sheet.
   b. Do not pre-tin zinc-tin alloy-coated stainless steel **OR** zinc-tin alloy-coated copper.
   c. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.
   d. Stainless-Steel Roofing: Tin edges of uncoated sheets, using solder for stainless steel and acid flux. Promptly remove acid flux residue from metal after tinning and soldering. Comply with solder manufacturer's recommended methods for cleaning and neutralization.
   e. Copper Roofing: Tin edges of uncoated copper sheets, using solder for copper.
4. Rivets: Rivet joints in uncoated aluminum **OR** zinc, **as directed**, where indicated and where necessary for strength.
5. Flat-Seam Roofing: Attach flat-seam metal panels to substrate with cleats, starting at eave and working upward toward ridge. After panels are in place, mallet seams and solder.
   a. Attach roofing panels with cleats spaced not more than 24 inches (610 mm) o.c.. Lock and solder panels to base flashing.
   b. Attach edge flashing to face of roof edge with continuous cleat fastened to roof substrate at 12 inches (305 mm) o.c. Lock panels to edge flashing and solder **OR** apply sealant, **as directed**.
6. Standing-Seam Roofing: Attach standing-seam metal panels to substrate with cleats, double fastened at 12 inches (305 mm) o.c. Install panels reaching from eave to ridge before moving to adjacent panels. Before panels are interlocked, apply continuous bead of sealant to top of flange of lower panel. Lock standing seams by folding over twice so cleat and panel edges are completely engaged.
   a. Lock each panel to panel below with soldered **OR** sealed, **as directed**, transverse seam.
   b. Loose-lock panels at eave edges to continuous cleats and flanges at roof edge at gutters.
      OR
      Loose-lock panels at eave edges to continuous edge flashing exposed 24 inches (610 mm) from roof edge. Attach edge flashing to face of roof edge with continuous cleat fastened to roof substrate at 12 inches (305 mm) o.c. Lock panels to edge flashing.
   c. Leave seams upright **OR** Fold over seams, **as directed**, after locking at ridges and hips.
7. Batten-Seam Roofing: Attach batten-seam metal panels to substrate with cleats, starting at eave and working upward toward ridge. Hold cleats in place with battens and fold edges of cleats over to hold panels. After panels are in place and before batten cap is installed, apply continuous

bead of sealant to top of flanges of each panel. Install batten cap covering batten and panel edges and fold batten cap and panel together so batten cap and panel edges are completely engaged.

a. Hook each panel to panel below with soldered **OR** sealed, **as directed**, transverse seam.
b. Splay upturned edges of panels away from base of battens to provide expansion capability.
c. Close batten ends with metal closures. Fold together with panel edges and end of batten cap.
d. Loose-lock panels at eave edges to continuous cleats and flanges at roof edge at gutters.
OR
Loose-lock panels at eave edges to continuous edge flashing exposed 24 inches (610 mm) from roof edge. Attach edge flashing to face of roof edge with continuous cleat fastened to roof substrate at 12 inches (305 mm) o.c. Lock panels to edge flashing.

8. Horizontal-Seam (Bermuda-Type) Roofing: Attach horizontal-seam metal panels to substrate with cleats, starting at eave and working upward toward ridge. Attach cleats to battens, spaced at 8 inches (203 mm) o.c. Lock lower edge of each panel to upper edge of panel below, folding seam over to engage cleat and panel edges. After first fold, mallet seams against batten, leaving joint slightly angled to form drip.
   a. Hook end of each panel to adjacent panel with soldered **OR** sealed, **as directed**, cross seam.
   b. Hook panel at eave edge to continuous cleat.
   c. Join ridges and hips with a standing seam and leave seams upright **OR** fold over seams, **as directed**, after locking.
9. Field Painting: Paint exposed surfaces of zinc-tin alloy-coated steel with one coat of zinc-tin alloy-coated steel primer and one coat of zinc-tin alloy-coated steel finish coat as soon as possible after installation; apply each coat at a dry film thickness of not less than 2.5 mils (0.06 mm). Comply with manufacturer's written instructions.

E. On-Site, Roll-Formed Sheet Metal Roofing Installation
1. General: Install on-site, roll-formed sheet metal roofing fabricated from UL-certified equipment to comply with equipment manufacturer's written instructions for UL wind-uplift resistance class indicated. Provide sheet metal roofing of full length from eave to ridge unless otherwise restricted by on-site or shipping limitations.
2. Standing-Seam Sheet Metal Roofing: Fasten sheet metal roofing to supports with concealed clips at each standing-seam joint at location, at spacing, and with fasteners recommended by manufacturer of portable roll-forming equipment.
   a. Install clips to substrate with self-tapping fasteners.
   b. Install pressure plates at locations indicated in equipment manufacturer's written installation instructions.
   c. Before panels are joined, apply continuous bead of sealant to top of flange of lower panel.
   d. Snap-On Seam: Nest standing seams and fasten together by interlocking and completely engaging field-applied sealant.
   OR
   Seamed Joint: Crimp standing seams with manufacturer-approved motorized seamer tool so cleat, sheet metal roofing, and field-applied sealant are completely engaged.
3. Batten-Seam Sheet Metal Roofing: Fasten sheet metal roofing to supports with concealed clips at each batten-seam joint at location, at spacing, and with fasteners recommended by manufacturer of portable roll-forming equipment.
   a. Install clips to substrate with self-drilling fasteners.
   b. After panels are in place and before batten cap is installed, apply continuous bead of sealant to top of flange of each panel.
   c. Apply snap-on batten caps to sheet metal roofing seams, fully engaged to provide weathertight joints.
4. Seal joints as shown and as required for watertight construction. For roofing with 3:12 slopes or less, use cleats at transverse seams.

a. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement either way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F (4 deg C).
b. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants".

F. Accessory Installation
1. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
a. Install components required for a complete sheet metal roofing assembly including trim, copings, seam covers, flashings, sealants, gaskets, fillers, metal closures, closure strips, and similar items.
b. Install accessories integral to sheet metal roofing that are specified in Division 07 Section "Sheet Metal Flashing And Trim" to comply with that Section's requirements.
2. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
a. Install flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers.
b. Install continuous strip of self-adhering underlayment at edge of continuous flashing overlapping self-adhering underlayment, where "continuous seal strip" is indicated in SMACNA's "Architectural Sheet Metal Manual," and where indicated on Drawings.
c. Install exposed flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
d. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, and filled with butyl sealant concealed within joints.
3. Pipe Flashing: Form flashing around pipe penetration and sheet metal roofing. Fasten and seal to sheet metal roofing as recommended by SMACNA.
4. Roof Curbs: Install curbs at locations indicated on Drawings. Install flashing around bases where they meet sheet metal roofing.
5. Stop-Type Snow Guards: Attach snow guards to sheet metal roofing with adhesive or adhesive tape, as recommended by manufacturer. Do not use fasteners that will penetrate sheet metal roofing.
a. Provide rows of snow guards, at locations indicated on Drawings, spaced apart, beginning up from roof edge at gutter, with each snow guard centered between sheet metal roofing ribs, **as directed**.
6. Bar-Type Snow Guards: Attach bar supports to vertical ribs of standing-seam sheet metal roofing with clamps or set screws. Do not use fasteners that will penetrate sheet metal roofing.
a. Provide rows of snow guards, at locations indicated on Drawings, spaced apart, beginning up from roof edge at gutter.

G. Erection Tolerances
1. Installation Tolerances: Shim and align sheet metal roofing within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

OR

Installation Tolerances: Shim and align sheet metal roofing within installed tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

H. Cleaning And Protection
1. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
2. Clean and neutralize flux materials. Clean off excess solder.
3. Clean off excess sealants.
4. Remove temporary protective coverings and strippable films as sheet metal roofing is installed unless otherwise indicated in manufacturer's written installation instructions. On completion of sheet metal roofing installation, clean finished surfaces as recommended by sheet metal roofing manufacturer. Maintain sheet metal roofing in a clean condition during construction.
5. Replace sheet metal roofing components that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 41 13 00a

Task	Specification	Specification Description
07 41 33 00	07 41 13 00	Metal Roof Panels
07 42 13 00	07 41 13 00	Metal Roof Panels

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SECTION 07 42 13 19 - GLAZING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for glazing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
a. Windows.
b. Doors.
c. Glazed curtain walls.
d. Storefront framing.
e. Glazed entrances.
f. Sloped glazing.
g. Skylights.
h. Interior borrowed lites.

C. Definitions
1. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
2. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.
3. Interspace: Space between lites of an insulating-glass unit.

D. Performance Requirements
1. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
2. Delegated Design: Design glass, including comprehensive engineering analysis according to ASTM E 1300 **OR** ICC's 2003 International Building Code, **as directed**, by a qualified professional engineer, using the following design criteria:
a. Design Wind Pressures: As indicated on Drawings.
OR
Design Wind Pressures: Determine design wind pressures applicable to Project according to ASCE/SEI 7, based on heights above grade indicated on Drawings.
1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s) **OR** 100 mph (44 m/s) **OR** 110 mph (49 m/s), **as directed**.
2) Importance Factor.
3) Exposure Category: B **OR** C **OR** D, **as directed**.
b. Design Snow Loads: As indicated on Drawings, **as directed**.
c. Vertical Glazing: For glass surfaces sloped 15 degrees or less from vertical, design glass to resist design wind pressure based on glass type factors for short-duration load.
d. Sloped Glazing: For glass surfaces sloped more than 15 degrees from vertical, design glass to resist each of the following combinations of loads:
1) Outward design wind pressure minus the weight of the glass. Base design on glass type factors for short-duration load.
2) Inward design wind pressure plus the weight of the glass plus half of the design snow load. Base design on glass type factors for short-duration load.

3) Half of the inward design wind pressure plus the weight of the glass plus the design snow load. Base design on glass type factors for long-duration load.

e. Glass Type Factors for Wired, Patterned, and Sandblasted Glass:
1) Short-Duration Glass Type Factor for Wired Glass: 0.5.
2) Long-Duration Glass Type Factor for Wired Glass: 0.3.
3) Short-Duration Glass Type Factor for Patterned Glass: 1.0.
4) Long-Duration Glass Type Factor for Patterned Glass: 0.6.
5) Short-Duration Glass Type Factor for Sandblasted Glass: 0.5.

f. Thickness of Patterned Glass: Base design of patterned glass on thickness at thinnest part of the glass.

g. Probability of Breakage for Sloped Glazing: For glass surfaces sloped more than 15 degrees from vertical, design glass for a probability of breakage not greater than 0.001.

h. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch (25 mm), whichever is less.

i. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.

3. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
   a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

E. Preconstruction Testing
1. Preconstruction Adhesion and Compatibility Testing: Test each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.
   a. Testing will not be required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
   b. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
   c. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
   d. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
   e. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.

F. Submittals
1. Product Data: For each glass product and glazing material indicated.
2. LEED Submittals:
   a. Product Data for Credit EQ 4.1: For glazing sealants used inside of the weatherproofing system, including printed statement of VOC content.
3. Glass Samples: For each type of glass product other than clear monolithic vision glass **OR** the following products, **as directed**; 12 inches (300 mm) square.
   a. Tinted glass.
   b. Patterned glass.
   c. Coated glass.
   d. Wired glass.
   e. Fire-resistive glazing products.
   f. Laminated glass with colored interlayer.
   g. Insulating glass.
4. Glazing Accessory Samples: For gaskets, sealants and colored spacers, in 12-inch (300-mm) lengths. Install sealant Samples between two strips of material representative in color of the adjoining framing system, **as directed**.

5. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.
6. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
7. Qualification Data: For installers, manufacturers of insulating-glass units with sputter-coated, low-e coatings, glass testing agency and sealant testing agency.
8. Product Certificates: For glass and glazing products, from manufacturer.
9. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for tinted glass, coated glass, insulating glass, glazing sealants and glazing gaskets.
   a. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.
10. Preconstruction adhesion and compatibility test report.
11. Warranties: Sample of special warranties.

G. Quality Assurance
1. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved and certified, **as directed**, by coated-glass manufacturer.
2. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
3. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.
4. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
5. Source Limitations for Glass: Obtain ultraclear float glass, tinted float glass, coated float glass, laminated glass and insulating glass from single source from single manufacturer for each glass type.
6. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.
7. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
   a. GANA Publications: GANA's "Laminated Glazing Reference Manual" and GANA's "Glazing Manual."
   b. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR-A7, "Sloped Glazing Guidelines."
   c. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."
   d. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
8. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of the SGCC **OR** the SGCC or another certification agency acceptable to authorities having jurisdiction **OR** the manufacturer, **as directed**. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
9. Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, test standard, whether glazing is for use in fire doors or other openings, whether or not glazing passes hose-stream test, whether or not glazing has a temperature rise rating of 450 deg F (250 deg C), and the fire-resistance rating in minutes.
10. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
11. Preinstallation Conference: Conduct conference at Project site.

H. Delivery, Storage, And Handling

1. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
2. Comply with insulating-glass manufacturer's written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

I. Project Conditions
1. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
   a. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below 40 deg F (4.4 deg C).

J. Warranty
1. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form in which coated-glass manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
   a. Warranty Period: 10 years from date of Final Completion.
2. Manufacturer's Special Warranty on Laminated Glass: Manufacturer's standard form in which laminated-glass manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
   a. Warranty Period: Five **OR** 10, **as directed**, years from date of Final Completion.
3. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form in which insulating-glass manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
   a. Warranty Period: 10 years from date of Final Completion.

1.2 PRODUCTS

A. Glass Products, General
1. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.
   a. Minimum Glass Thickness for Exterior Lites: Not less than 6.0 mm.
   b. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.
2. Strength: Where float glass is indicated, provide annealed float glass, Kind HS heat-treated float glass, or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article, **as directed**. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article, **as directed**. Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.
3. Windborne-Debris-Impact Resistance: Provide exterior glazing that passes basic **OR** enhanced, **as directed**,-protection testing requirements in ASTM E 1996 for Wind Zone 1 **OR** Wind Zone 2 **OR** Wind Zone 3 **OR** Wind Zone 4, **as directed**, when tested according to ASTM E 1886. Test

specimens shall be no smaller in width and length than glazing indicated for use on the Project and shall be installed in same manner as glazing indicated for use on the Project.

a. Large-Missile Test: For glazing located within 30 feet (9.1 m) of grade.

b. Small-Missile Test: For glazing located more than 30 feet (9.1 m) above grade.
OR
Large-Missile Test: For all glazing, regardless of height above grade.

4. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
   a. For monolithic-glass lites, properties are based on units with lites 6.0 mm thick **OR** of thickness indicated, **as directed**.
   b. For laminated-glass lites, properties are based on products of construction indicated.
   c. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
   d. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
   e. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
   f. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

B. Glass Products

1. Float Glass: ASTM C 1036, Type **I**, Quality-Q3, Class **I** (clear) unless otherwise indicated.
2. Ultraclear Float Glass: ASTM C 1036, Type **I**, Quality-Q3, Class **I**, complying with other requirements specified and with visible light transmission not less than 91 percent and solar heat gain coefficient not less than 0.87, **as directed**.
3. Heat-Treated Float Glass: ASTM C 1048; Type **I**; Quality-Q3; Class **I** (clear) unless otherwise indicated; of kind and condition indicated.
   a. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
   b. For uncoated glass, comply with requirements for Condition A.
   c. For coated vision glass, comply with requirements for Condition C (other coated glass).
4. Pyrolytic-Coated, Self-Cleaning, Low-Maintenance Glass: Clear float glass with a coating on first surface having both photocatalytic and hydrophilic properties that act to loosen dirt and to cause water to sheet evenly over the glass instead of beading.
5. Uncoated Tinted Float Glass: Class 2, complying with other requirements specified.
   a. Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
   b. Visible Light Transmittance: as directed by the Owner.
6. Polished Wired Glass: ASTM C 1036, Type **II**, Class 1 (clear), Form 1, Quality-Q6, complying with ANSI Z97.1, Class C.
   a. Mesh: M1 (diamond) **OR** M2 (square), **as directed**.
7. Film-Faced Polished Wired Glass: ASTM C 1036, Type **II**, Class 1 (clear), Form 1, Quality-Q6 and complying with testing requirements in 16 CFR 1201 for Category **II** materials.
   a. Mesh: M1 (diamond) **OR** M2 (square), **as directed**.
8. Patterned Glass: ASTM C 1036, Type **II**, Class 1 (clear), Form 3; Quality-Q6, Finish F1 (patterned one side) **OR** Finish F2 (patterned both sides), **as directed**, Pattern P1 (linear) **OR** Pattern P2 (geometric) **OR** Pattern P3 (random) **OR** Pattern P4 (special), **as directed**.
9. Tempered Patterned Glass: ASTM C 1048, Kind FT (fully tempered), Type **II**, Class 1 (clear), Form 3; Quality-Q6, Finish F1 (patterned one side) **OR** Finish F2 (patterned both sides), **as directed**, Pattern P1 (linear) **OR** Pattern P2 (geometric) **OR** Pattern P3 (random) **OR** Pattern P4 (special), **as directed**.
10. Patterned Wired Glass: ASTM C 1036, Type **II**, Class 1 (clear), Form 2, Quality-Q6, Finish F1 (patterned one side) **OR** Finish F2 (patterned both sides), **as directed**, Mesh M1 (diamond), Pattern P1 (linear) **OR** Pattern P2 (geometric) **OR** Pattern P3 (random) **OR** Pattern P4 (special), **as directed**.

11. Ceramic-Coated Vision Glass: Heat-treated float glass, Condition C; with ceramic enamel applied by silk-screened process; complying with Specification No. 95-1-31 in GANA's Tempering Division's "Engineering Standards Manual" and with other requirements specified.
    a. Glass: Clear float **OR** Ultraclear float **OR** Tinted float, **as directed**.
    b. Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
    c. Ceramic Coating Color and Pattern: As selected from manufacturer's full range.
12. Reflective-Coated Vision Glass: ASTM C 1376, coated by pyrolytic process **OR** vacuum deposition (sputter-coating) process, **as directed**, and complying with other requirements specified.
    a. Kind: Kind CV (coated vision glass), except that Kind CO (coated overhead glass) may be used where the lower edge of the glass is more than 6 feet (1.8 m) above the adjacent floor level or cannot be approached closer than 10 feet (3.0 m).
    b. Coating Color: Gold **OR** Pewter **OR** Silver, **as directed**.
    c. Glass: Clear float **OR** Tinted float, **as directed**.
    d. Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
    e. Visible Light Transmittance:
    f. Outdoor Visible Reflectance: as directed by the Owner.
    g. Self-Cleaning, Low-Maintenance Coating: Pyrolytic coating on first surface.
13. Ceramic-Coated Spandrel Glass: ASTM C 1048, Condition B, Type I, Quality-Q3, and complying with other requirements specified.
    a. Glass: Clear float **OR** Ultraclear float **OR** Tinted float, **as directed**.
    b. Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
    c. Ceramic Coating Color: As selected from manufacturer's full range.
14. Silicone-Coated Spandrel Glass: ASTM C 1048, Condition C, Type I, Quality-Q3, and complying with other requirements specified.
    a. Glass: Clear float **OR** Ultraclear float **OR** Tinted float, **as directed**.
    b. Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
    c. Silicone Coating Color: As selected from manufacturer's full range.
15. Reflective-Coated Spandrel Glass: ASTM C 1376, Kind CS; coated by pyrolytic process **OR** vacuum deposition (sputter-coating) process, **as directed**, and complying with other requirements specified.
    a. Coating Color: Gold **OR** Pewter **OR** Silver, **as directed**.
    b. Glass: Clear float **OR** Ultraclear float **OR** Tinted float, **as directed**.
    c. Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
    d. Visible Light Transmittance: as directed by the Owner.
    e. Outdoor Visible Reflectance: as directed by the Owner.

C. Laminated Glass
1. Laminated Glass: ASTM C 1172, and complying with testing requirements in 16 CFR 1201 for Category II materials, and with other requirements specified. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
    a. Construction: Laminate glass with polyvinyl butyral interlayer or cast-in-place and cured-transparent-resin interlayer to comply with interlayer manufacturer's written recommendations.
    b. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
    c. Interlayer Color: Clear unless otherwise indicated.
2. Windborne-Debris-Impact-Resistant Laminated Glass: ASTM C 1172, and complying with testing requirements in 16 CFR 1201 for Category II materials, with "Windborne-Debris-Impact Resistance" Paragraph in "Glass Products, General" Article, and with other requirements specified. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
    a. Construction: Laminate glass with one of the following to comply with interlayer manufacturer's written recommendations:

1) Polyvinyl butyral interlayer.
2) Polyvinyl butyral interlayers reinforced with polyethylene terephthalate film.
3) Ionoplast interlayer.
4) Cast-in-place and cured-transparent-resin interlayer.
5) Cast-in-place and cured-transparent-resin interlayer reinforced with polyethylene terephthalate film.

b. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
c. Interlayer Color: Clear unless otherwise indicated.

3. Glass: Comply with applicable requirements in "Glass Products" Article as indicated by designations in "Laminated-Glass Types" Article.

D. Insulating Glass

1. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190, and complying with other requirements specified.
   a. Sealing System: Dual seal, with manufacturer's standard **OR** polyisobutylene and polysulfide **OR** polyisobutylene and silicone **OR** polyisobutylene and hot-melt butyl **OR** polyisobutylene and polyurethane, **as directed**, primary and secondary.
   b. Spacer: Manufacturer's standard spacer material and construction **OR** Aluminum with mill or clear anodic finish **OR** Aluminum with black, color anodic finish **OR** Aluminum with bronze, color anodic finish **OR** Aluminum with powdered metal paint finish in color selected **OR** Galvanized steel **OR** Stainless steel **OR** Polypropylene covered stainless steel in color selected **OR** Thermally broken aluminum **OR** Nonmetallic laminate **OR** Nonmetallic tube, **as directed**.
   c. Desiccant: Molecular sieve or silica gel, or blend of both.
2. Glass: Comply with applicable requirements in "Glass Products" Article and in "Laminated Glass" Article, **as directed**, as indicated by designations in "Insulating-Glass Types" Article and in "Insulating-Laminated-Glass Types" Article, **as directed**.

E. Fire-Protection-Rated Glazing

1. Fire-Protection-Rated Glazing, General: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252 for door assemblies and NFPA 257 for window assemblies.
2. Monolithic Ceramic Glazing: Clear, ceramic flat glass; 3/16-inch (5-mm) nominal thickness.
3. Film-Faced Ceramic Glazing: Clear, ceramic flat glass; 3/16-inch (5-mm) nominal thickness; faced on one surface with a clear glazing film; complying with testing requirements in 16 CFR 1201 for Category II materials.
4. Laminated Ceramic Glazing: Laminated glass made from 2 plies of clear, ceramic flat glass; 5/16-inch (8-mm) total nominal thickness; complying with testing requirements in 16 CFR 1201 for Category II materials.
5. Fire-Protection-Rated Tempered Glass: 1/4-inch- (6.4-mm-) **OR** 3/8-inch- (9.5-mm-) **OR** 1/2-inch- (12.7-mm-), **as directed**, thick, fire-protection-rated tempered glass, complying with testing requirements in 16 CFR 1201 for Category II materials.
6. Fire-Protection-Rated Laminated Glass: 5/16-inch- (8-mm-) thick, fire-protection-rated laminated glass, complying with testing requirements in 16 CFR 1201 for Category II materials.
7. Laminated Glass with Intumescent Interlayers: Laminated glass made from multiple plies of uncoated, clear float glass; with intumescent interlayers; complying with testing requirements in 16 CFR 1201 for Category II materials.
8. Gel-Filled, Double Glazing Units: Double glazing units made from two lites of uncoated, clear, fully tempered float glass; with a perimeter metal spacer separating lites and dual-edge seal enclosing a cavity filled with clear, fully transparent, heat-absorbing gel; complying with testing requirements in 16 CFR 1201 for Category II materials.

F. Glazing Gaskets

1. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:
   a. Neoprene complying with ASTM C 864.
   b. EPDM complying with ASTM C 864.
   c. Silicone complying with ASTM C 1115.
   d. Thermoplastic polyolefin rubber complying with ASTM C 1115.
2. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned neoprene, EPDM, silicone or thermoplastic polyolefin rubber gaskets complying with ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.
   a. Application: Use where soft compression gaskets will be compressed by inserting dense compression gaskets on opposite side of glazing or pressure applied by means of pressure-glazing stops on opposite side of glazing.
3. Lock-Strip Gaskets: Neoprene extrusions in size and shape indicated, fabricated into frames with molded corner units and zipper lock-strips, complying with ASTM C 542, black.

G. Glazing Sealants
1. General:
   a. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
   b. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
   c. VOC Content: For sealants used inside of the weatherproofing system, not more than 250 g/L when calculated according to 40 CFR 59, Subpart D.
   d. Colors of Exposed Glazing Sealants: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
2. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.
3. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT.
4. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT.
5. Glazing Sealant: Acid-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT.
6. Glazing Sealants for Fire-Rated Glazing Products: Products that are approved by testing agencies that listed and labeled fire-resistant glazing products with which they are used for applications and fire-protection ratings indicated.

H. Glazing Tapes
1. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
   a. AAMA 804.3 tape, where indicated.
   b. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
   c. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
2. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
   a. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
   b. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

I. Miscellaneous Glazing Materials
   1. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
   2. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
   3. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
   4. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
   5. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
   6. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.
   7. Perimeter Insulation for Fire-Resistive Glazing: Product that is approved by testing agency that listed and labeled fire-resistant glazing product with which it is used for application and fire-protection rating indicated.

J. Fabrication Of Glazing Units
   1. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
   2. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.
   3. Grind smooth and polish exposed glass edges and corners.

K. Monolithic-Glass Types
   1. Glass Type: Clear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
      a. Thickness: 6.0 mm.
      b. Provide safety glazing labeling.
   2. Glass Type: Ultraclear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
      a. Thickness: 6.0 mm.
      b. Provide safety glazing labeling.
   3. Glass Type: Pyrolytic-coated, self-cleaning, low-maintenance, clear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
      a. Thickness: 6.0 mm.
      b. Provide safety glazing labeling.
   4. Glass Type: Tinted float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
      a. Thickness: 6.0 mm.
      b. Winter Nighttime U-Factor: as directed by the Owner.
      c. Summer Daytime U-Factor: as directed by the Owner.
      d. Solar Heat Gain Coefficient: as directed by the Owner.
      e. Provide safety glazing labeling.
   5. Glass Type: Polished wired glass.
      a. Thickness: 6.0 mm.
   6. Glass Type: Patterned glass.
      a. Thickness: 4.0 **OR** 5.0 **OR** 6.0, **as directed**, mm.
   7. Glass Type: Tempered patterned glass.
      a. Thickness: 4.0 **OR** 5.0 **OR** 6.0, **as directed**, mm.
      b. Provide safety glazing labeling.
   8. Glass Type: Patterned wired glass.
      a. Thickness: 6.0 mm.

9. Glass Type: Ceramic-coated vision glass, heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
    a. Thickness: 6.0 mm.
    b. Coating Location: Second surface.
    c. Winter Nighttime U-Factor: as directed by the Owner.
    d. Summer Daytime U-Factor: as directed by the Owner.
    e. Solar Heat Gain Coefficient: as directed by the Owner.
    f. Provide safety glazing labeling.
10. Glass Type: Reflective-coated vision glass, float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
    a. Thickness: 6.0 mm.
    b. Coating Location: First **OR** Second, **as directed**, surface.
    c. Winter Nighttime U-Factor: as directed by the Owner.
    d. Summer Daytime U-Factor: as directed by the Owner.
    e. Solar Heat Gain Coefficient: as directed by the Owner.
    f. Provide safety glazing labeling.
11. Glass Type: Ceramic-coated spandrel glass, heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
    a. Thickness: 6.0 mm.
    b. Coating Location: Second surface.
    c. Winter Nighttime U-Factor: as directed by the Owner.
    d. Summer Daytime U-Factor: as directed by the Owner.
    e. Fallout Resistance: Passes fallout-resistance test in ASTM C 1048 for an assembly of glass and adhered reinforcing material.
12. Glass Type: Silicone-coated spandrel glass, heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
    a. Thickness: 6.0 mm.
    b. Coating Location: Second surface.
    c. Winter Nighttime U-Factor: as directed by the Owner.
    d. Summer Daytime U-Factor: as directed by the Owner.
    e. Fallout Resistance: Passes fallout-resistance test in ASTM C 1048 for an assembly of glass and adhered reinforcing material.
13. Glass Type: Reflective-coated spandrel glass, heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
    a. Thickness: 6.0 mm.
    b. Coating Location: First **OR** Second, **as directed**, surface.
    c. Winter Nighttime U-Factor: as directed by the Owner.
    d. Summer Daytime U-Factor: as directed by the Owner.
    e. Fallout Resistance: Passes fallout-resistance test in ASTM C 1048 for an assembly of glass and adhered reinforcing material.
    f. Factory apply manufacturer's standard opacifier of the following material to coated second surface of lites, with resulting products complying with Specification No. 89-1-6 in GANA's Tempering Division's "Engineering Standards Manual":
        1) Manufacturer's standard opacifier material.
        OR
        Polyester film laminated to glass with solvent-based adhesive.

L. Laminated-Glass Types
1. Glass Type: Clear laminated glass with two plies of float glass **OR** heat-strengthened float glass **OR** fully tempered float glass **OR** ultraclear float glass **OR** ultraclear heat-strengthened float glass **OR** ultraclear fully tempered float glass, **as directed**.
    a. Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
    b. Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **as directed**.

c. Provide safety glazing labeling.

2. Glass Type: Antireflective-coated clear laminated glass with two plies of float glass **OR** heat-strengthened float glass **OR** fully tempered float glass **OR** ultraclear float glass **OR** ultraclear heat-strengthened float glass **OR** ultraclear fully tempered float glass, **as directed**.
   a. Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.
   b. Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **as directed**.
   c. Visible Reflectance: Less than 2 percent.
   d. Winter Nighttime U-Factor: as directed by the Owner.
   e. Summer Daytime U-Factor: as directed by the Owner.
   f.
   g. Solar Heat Gain Coefficient: as directed by the Owner.
   h.
   i. Provide safety glazing labeling.
3. Glass Type: Tinted laminated glass with two plies of float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**, with outer ply Class 2 (tinted) and inner ply Class 1 (clear).
   a. Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
   b. Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **as directed**.
   c. Winter Nighttime U-Factor: as directed by the Owner.
   d.
   e. Summer Daytime U-Factor: as directed by the Owner.
   f.
   g. Solar Heat Gain Coefficient: as directed by the Owner.
   h.
   i. Provide safety glazing labeling.
4. Glass Type: Tinted laminated glass with two plies of clear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**, and tinted interlayer.
   a. Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
   b. Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **as directed**.
   c. Interlayer Color: Blue-green **OR** Bronze light **OR** Gray, **as directed**.
   d. Winter Nighttime U-Factor: as directed by the Owner.
   e.
   f. Summer Daytime U-Factor: as directed by the Owner.
   g.
   h. Solar Heat Gain Coefficient: as directed by the Owner.
   i. Provide safety glazing labeling.
5. Glass Type: Ceramic-coated, laminated vision glass with two plies of heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   a. Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
   b. Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **as directed**.
   c. Coating Location: Second **OR** Third **OR** Fourth, **as directed**, surface.
   d. Winter Nighttime U-Factor: as directed by the Owner.
   e.
   f. Summer Daytime U-Factor: as directed by the Owner.
   g.
   h. Solar Heat Gain Coefficient: as directed by the Owner.
   i.
   j. Provide safety glazing labeling.

6. Glass Type: Reflective-coated, laminated vision glass with two plies of heat-strengthened float glass **OR** fully tempered float glass, **as directed**, with inner ply Class 1 (clear).
   a. Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
   b. Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **as directed**.
   c. Coating Location: First **OR** Second **OR** Third, **as directed**, surface.
   d. Winter Nighttime U-Factor: as directed by the Owner.
   e.
   f. Summer Daytime U-Factor: as directed by the Owner.
   g.
   h. Solar Heat Gain Coefficient: as directed by the Owner.
   i. Provide safety glazing labeling.
7. Glass Type: Low-e-coated, laminated vision glass with two plies of clear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   a. Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
   b. Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **as directedf**.
   c. Low-E Coating: Pyrolytic on second **OR** Pyrolytic on third **OR** Sputtered on second **OR** Sputtered on third **OR** Pyrolytic or sputtered on second or third, **as directed**, surface.
   d. Visible Light Transmittance: as directed by the Owner.
   e.
   f. Winter Nighttime U-Factor: as directed by the Owner.
   g.
   h. Summer Daytime U-Factor: as directed by the Owner.
   i.
   j. Solar Heat Gain Coefficient: as directed by the Owner.
   k.
   l. Provide safety glazing labeling.
8. Glass Type: Reflective-coated, laminated spandrel glass with two plies of heat-strengthened float glass **OR** fully tempered float glass, **as directed**, with inner ply Class 1 (clear).
   a. Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
   b. Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **as directed**.
   c. Coating Location: First **OR** Second **OR** Third, **as directed**, surface.
   d. Winter Nighttime U-Factor: as directed by the Owner.
   e.
   f. Summer Daytime U-Factor: as directed by the Owner.
   g.

M. Insulating-Glass Types
1. Glass Type: Clear insulating glass.
   a. Overall Unit Thickness: 1 inch (25 mm) **OR** 5/8 inch (16 mm), **as directed**.
   b. Thickness of Each Glass Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.
   c. Outdoor Lite: Float glass **OR** Heat-strengthened float glass **OR** Fully tempered float glass, **as directed**.
   d. Interspace Content: Air **OR** Argon, **as directed**.
   e. Indoor Lite: Float glass **OR** Heat-strengthened float glass **OR** Fully tempered float glass, **as directed**.
   f. Winter Nighttime U-Factor: as directed by the Owner.
   g.
   h. Summer Daytime U-Factor: as directed by the Owner.
   i. Provide safety glazing labeling.

2. Glass Type: Ultraclear insulating glass.
   a. Overall Unit Thickness: 1 inch (25 mm) **OR** 5/8 inch (16 mm), **as directed**.
   b. Thickness of Each Glass Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.
   c. Outdoor Lite: Ultraclear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   d. Interspace Content: Air **OR** Argon, **as directed**.
   e. Indoor Lite: Ultraclear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   f. Winter Nighttime U-Factor: as directed by the Owner.
   g.
   h. Summer Daytime U-Factor: as directed by the Owner.
   i.
   j. Provide safety glazing labeling.
3. Glass Type: Pyrolytic-coated, self-cleaning, low-maintenance, clear insulating glass.
   a. Overall Unit Thickness: 1 inch (25 mm) **OR** 5/8 inch (16 mm), **as directed**.
   b. Thickness of Each Glass Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.
   c. Outdoor Lite: Pyrolytic-coated, self-cleaning, low-maintenance, clear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   d. Interspace Content: Air **OR** Argon, **as directed**.
   e. Indoor Lite: Float glass **OR** Heat-strengthened float glass **OR** Fully tempered float glass, **as directed**.
   f. Winter Nighttime U-Factor: as directed by the Owner.
   g. Summer Daytime U-Factor: as directed by the Owner.
   h. Provide safety glazing labeling.
4. Glass Type: Low-e-coated, clear insulating glass.
   a. Overall Unit Thickness: 1 inch (25 mm) **OR** 5/8 inch (16 mm), **as directed**.
   b. Thickness of Each Glass Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.
   c. Outdoor Lite: Float glass **OR** Heat-strengthened float glass **OR** Fully tempered float glass **OR** Ultraclear float glass **OR** Ultraclear heat-strengthened float glass **OR** Ultraclear fully tempered float glass, **as directed**.
   d. Interspace Content: Air **OR** Argon, **as directed**.
   e. Indoor Lite: Float glass **OR** Heat-strengthened float glass **OR** Fully tempered float glass **OR** Ultraclear float glass **OR** Ultraclear heat-strengthened float glass **OR** Ultraclear fully tempered float glass, **as directed**.
   f. Low-E Coating: Pyrolytic on second **OR** Pyrolytic on third **OR** Sputtered on second **OR** Sputtered on third **OR** Pyrolytic or sputtered on second or third, **as directed**, surface.
   g. Visible Light Transmittance: as directed by the Owner.
   h. Winter Nighttime U-Factor: as directed by the Owner.
   i. Summer Daytime U-Factor: as directed by the Owner.
   j. Solar Heat Gain Coefficient: as directed by the Owner.
   k. Provide safety glazing labeling.
5. Glass Type: Tinted insulating glass.
   a. Overall Unit Thickness: 1 inch (25 mm) **OR** 5/8 inch (16 mm), **as directed**.
   b. Thickness of Each Glass Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.
   c. Outdoor Lite: Tinted float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   d. Interspace Content: Air **OR** Argon, **as directed**.
   e. Indoor Lite: Clear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   f. Winter Nighttime U-Factor: as directed by the Owner.
   g. Summer Daytime U-Factor: as directed by the Owner.
   h. Solar Heat Gain Coefficient: as directed by the Owner.
   i. Provide safety glazing labeling.
6. Glass Type: Low-e-coated, tinted insulating glass.
   a. Overall Unit Thickness: 1 inch (25 mm) **OR** 5/8 inch (16 mm), **as directed**.
   b. Thickness of Each Glass Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.

c. Outdoor Lite: Tinted float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
d. Interspace Content: Air **OR** Argon, **as directed**.
e. Indoor Lite: Clear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
f. Low-E Coating: Pyrolytic on second **OR** Pyrolytic on third **OR** Sputtered on second **OR** Sputtered on third **OR** Pyrolytic or sputtered on second or third, **as directed**, surface.
g. Visible Light Transmittance: as directed by the Owner.
h. Winter Nighttime U-Factor: as directed by the Owner.
i. Summer Daytime U-Factor: as directed by the Owner.
j. Solar Heat Gain Coefficient: as directed by the Owner.
k. Provide safety glazing labeling.

7. Glass Type: Ceramic-coated, insulating vision glass.
   a. Overall Unit Thickness: 1 inch (25 mm) **OR** 5/8 inch (16 mm), **as directed**.
   b. Thickness of Each Glass Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.
   c. Outdoor Lite: Heat-strengthened float glass **OR** Fully tempered float glass **OR** Ultraclear heat-strengthened float glass **OR** Ultraclear fully tempered float glass, **as directed**.
   d. Interspace Content: Air **OR** Argon, **as directed**.
   e. Indoor Lite: Float glass **OR** Heat-strengthened float glass **OR** Fully tempered float glass **OR** Ultraclear float glass **OR** Ultraclear heat-strengthened float glass **OR** Ultraclear fully tempered float glass, **as directed**.
   f. Coating Location: Second **OR** Third **OR** Fourth, **as directed**, surface.
   g. Winter Nighttime U-Factor: as directed by the Owner.
   h. Summer Daytime U-Factor: as directed by the Owner.
   i. Solar Heat Gain Coefficient: as directed by the Owner.
   j. Provide safety glazing labeling.
8. Glass Type: Reflective-coated, clear insulating glass.
   a. Overall Unit Thickness: 1 inch (25 mm) **OR** 5/8 inch (16 mm), **as directed**.
   b. Thickness of Each Glass Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.
   c. Outdoor Lite: Clear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   d. Interspace Content: Air **OR** Argon, **as directed**.
   e. Indoor Lite: Clear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   f. Coating Location: First **OR** Second **OR** Third, **as directed**, surface.
   g. Winter Nighttime U-Factor: as directed by the Owner.
   h. Summer Daytime U-Factor: as directed by the Owner.
   i. Solar Heat Gain Coefficient: as directed by the Owner.
   j. Provide safety glazing labeling.
9. Glass Type: Reflective-coated, tinted insulating glass.
   a. Overall Unit Thickness: 1 inch (25 mm) **OR** 5/8 inch (16 mm), **as directed**.
   b. Thickness of Each Glass Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.
   c. Outdoor Lite: Tinted float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   d. Interspace Content: Air **OR** Argon, **as directed**.
   e. Indoor Lite: Clear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   f. Coating Location: First **OR** Second **OR** Third, **as directed**, surface.
   g. Winter Nighttime U-Factor: as directed by the Owner.
   h. Summer Daytime U-Factor: as directed by the Owner.
   i. Solar Heat Gain Coefficient: as directed by the Owner.
   j. Provide safety glazing labeling.
10. Glass Type: Ceramic-coated **OR** Silicone-coated, **as directed**, insulating spandrel glass.
   a. Overall Unit Thickness: 1 inch (25 mm).
   b. Thickness of Each Glass Lite: 5.0 mm **OR** 6.0 mm, **as directed**.

c. Outdoor Lite: Float glass **OR** Heat-strengthened float glass **OR** Fully tempered float glass **OR** Ultraclear float glass **OR** Ultraclear heat-strengthened float glass **OR** Ultraclear fully tempered float glass, **as directed**.
d. Interspace Content: Air **OR** Argon, **as directed**.
e. Indoor Lite: Float glass **OR** Heat-strengthened float glass **OR** Fully tempered float glass **OR** Ultraclear float glass **OR** Ultraclear heat-strengthened float glass **OR** Ultraclear fully tempered float glass, **as directed**.
f. Coating Location: Fourth surface.
g. Winter Nighttime U-Factor: as directed by the Owner.
h. Summer Daytime U-Factor: as directed by the Owner.

11. Glass Type: Ceramic-coated **OR** Silicone-coated, **as directed**, low-e, insulating spandrel glass.
    a. Overall Unit Thickness: 1 inch (25 mm).
    b. Thickness of Each Glass Lite: 5.0 mm **OR** 6.0 mm, **as directed**.
    c. Outdoor Lite: Float glass **OR** Heat-strengthened float glass **OR** Fully tempered float glass **OR** Ultraclear float glass **OR** Ultraclear heat-strengthened float glass **OR** Ultraclear fully tempered float glass, **as directed**.
    d. Interspace Content: Air **OR** Argon, **as directed**.
    e. Indoor Lite: Float glass **OR** Heat-strengthened float glass **OR** Fully tempered float glass **OR** Ultraclear float glass **OR** Ultraclear heat-strengthened float glass **OR** Ultraclear fully tempered float glass, **as directed**.
    f. Low-E Coating: Pyrolytic on second **OR** Pyrolytic on third **OR** Sputtered on second **OR** Sputtered on third **OR** Pyrolytic or sputtered on second or third, **as directed**, surface.
    g. Opaque Coating Location: Fourth surface.
    h. Winter Nighttime U-Factor: as directed by the Owner.
    i. Summer Daytime U-Factor: as directed by the Owner.
12. Glass Type: Ceramic-coated **OR** Silicone-coated, **as directed**, tinted, insulating spandrel glass.
    a. Overall Unit Thickness: 1 inch (25 mm).
    b. Thickness of Each Glass Lite: 5.0 mm **OR** 6.0 mm.
    c. Outdoor Lite: Tinted float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
    d. Interspace Content: Air **OR** Argon, **as directed**.
    e. Indoor Lite: Clear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
    f. Coating Location: Fourth surface.
    g. Winter Nighttime U-Factor: as directed by the Owner.
    h. Summer Daytime U-Factor: as directed by the Owner.

N. Insulating-Laminated-Glass Types

1. Glass Type: Clear insulating laminated glass.
    a. Overall Unit Thickness: 1-3/16 inch (30 mm) **OR** 1 inch (25 mm) **OR** 3/4 inch (19 mm), **as directed**.
    b. Thickness of Outdoor Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.
    c. Outdoor Lite: Heat-strengthened float glass **OR** Fully tempered float glass, **as directed**.
    d. Interspace Content: Air **OR** Argon, **as directed**.
    e. Indoor Lite: Clear laminated glass with two plies of float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
        1) Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
        2) Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **as directed**.
    f. Winter Nighttime U-Factor: as directed by the Owner.
    g. Summer Daytime U-Factor: as directed by the Owner.
    h. Solar Heat Gain Coefficient: as directed by the Owner.
    i. Provide safety glazing labeling.
2. Glass Type: Low-e-coated, clear insulating laminated glass.

a. Overall Unit Thickness: 1-3/16 inch (30 mm) **OR** 1 inch (25 mm) **OR** 3/4 inch (19 mm), **as directed**.
b. Thickness of Outdoor Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.
c. Outdoor Lite: Heat-strengthened float glass **OR** Fully tempered float glass, **as directed**.
d. Interspace Content: Air **OR** Argon, **as directed**.
e. Indoor Lite: Clear laminated glass with two plies of float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   1) Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
   2) Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **as directed**.
f. Low-E Coating: Pyrolytic on second **OR** Pyrolytic on third **OR** Sputtered on second **OR** Sputtered on third **OR** Pyrolytic or sputtered on second or third, **as directed**, surface.
g. Visible Light Transmittance: as directed by the Owner.
h. Winter Nighttime U-Factor: as directed by the Owner.
i. Summer Daytime U-Factor: as directed by the Owner.
j. Solar Heat Gain Coefficient: as directed by the Owner.
k. Provide safety glazing labeling.

3. Glass Type: Tinted, insulating laminated glass.
   a. Overall Unit Thickness: 1-3/16 inch (30 mm) **OR** 1 inch (25 mm) **OR** 3/4 inch (19 mm), **as directed**.
   b. Thickness of Outdoor Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.
   c. Outdoor Lite: Tinted heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   d. Interspace Content: Air **OR** Argon, **as directed**.
   e. Indoor Lite: Clear laminated glass with two plies of float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
      1) Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
      2) Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **as directed**.
   f. Winter Nighttime U-Factor: as directed by the Owner.
   g. Summer Daytime U-Factor: as directed by the Owner.
   h. Solar Heat Gain Coefficient: as directed by the Owner.
   i. Provide safety glazing labeling.

4. Glass Type: Low-e-coated, tinted, insulating laminated glass.
   a. Overall Unit Thickness: 1-3/16 inch (30 mm) **OR** 1 inch (25 mm) **OR** 3/4 inch (19 mm), **as directed**.
   b. Thickness of Outdoor Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.
   c. Outdoor Lite: Tinted heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   d. Interspace Content: Air **OR** Argon, **as directed**.
   e. Indoor Lite: Clear laminated glass with two plies of float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
      1) Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
      2) Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **as directed**.
   f. Low-E Coating: Pyrolytic on second **OR** Pyrolytic on third **OR** Sputtered on second **OR** Sputtered on third **OR** Pyrolytic or sputtered on second or third, **as directed**, surface.
   g. Visible Light Transmittance: as directed by the Owner.
   h. Winter Nighttime U-Factor: as directed by the Owner.
   i. Summer Daytime U-Factor: as directed by the Owner.
   j. Solar Heat Gain Coefficient: as directed by the Owner.
   k. Provide safety glazing labeling.

5. Glass Type: Reflective-coated, clear, insulating laminated glass.
   a. Overall Unit Thickness: 1-3/16 inch (30 mm) **OR** 1 inch (25 mm), **as directed**.
   b. Thickness of Outdoor Lite: 6.0 mm.
   c. Outdoor Lite: Clear heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   d. Interspace Content: Air **OR** Argon, **as directed**.
   e. Indoor Lite: Clear laminated glass with two plies of float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
      1) Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
      2) Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **as directed**.
   f. Coating Location: First **OR** Second **OR** Third, **as directed**, surface.
   g. Winter Nighttime U-Factor: as directed by the Owner.
   h. Summer Daytime U-Factor: as directed by the Owner.
   i. Solar Heat Gain Coefficient: as directed by the Owner.
   j. Provide safety glazing labeling.
6. Glass Type: Reflective-coated, tinted, insulating laminated glass.
   a. Overall Unit Thickness: 1-3/16 inch (30 mm) **OR** 1 inch (25 mm), **as directed**.
   b. Thickness of Outdoor Lite: 6.0 mm.
   c. Outdoor Lite: Tinted heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   d. Interspace Content: Air **OR** Argon, **as directed**.
   e. Indoor Lite: Clear laminated glass with two plies of float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
      1) Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
      2) Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **asdrected**.
   f. Coating Location: First **OR** Second **OR** Third, **as directed**, surface.
   g. Winter Nighttime U-Factor: as directed by the Owner.
   h. Summer Daytime U-Factor: as directed by the Owner.
   i. Solar Heat Gain Coefficient: as directed by the Owner.
   j. Provide safety glazing labeling.

O. Fire-Protection-Rated Glazing Types
1. Glass Type: 20-minute fire-rated glazing without hose-stream test; monolithic ceramic glazing **OR** film-faced ceramic glazing **OR** laminated ceramic glazing **OR** fire-protection-rated tempered glass **OR** fire-protection-rated laminated glass **OR** gel-filled, double glazing units, **as directed**.
   a. Provide safety glazing labeling.
2. Glass Type: 20-minute fire-rated glazing with hose-stream test; monolithic ceramic glazing **OR** film-faced ceramic glazing **OR** laminated ceramic glazing **OR** gel-filled, double glazing units, **as directd**.
   a. Provide safety glazing labeling.
3. Glass Type: 45-minute **OR** 60-minute **OR** 90-minute **OR** 120-minute, **as directed**, fire-rated glazing; monolithic ceramic glazing **OR** film-faced ceramic glazing **OR** laminated ceramic glazing **OR** laminated glass with intumescent interlayers **OR** gel-filled, double glazing units, **as directed**.
   a. Provide safety glazing labeling.
4. Glass Type: 45-minute **OR** 60-minute **OR** 90-minute **OR** 120-minute, **as directed**, fire-rated glazing with 450 deg F (250 deg C) temperature rise limitation; laminated glass with intumescent interlayers **OR** gel-filled, double glazing units, **as directed**.
   a. Provide safety glazing labeling.

1.3 EXECUTION

A. Examination
1. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
   a. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
   b. Presence and functioning of weep systems.
   c. Minimum required face and edge clearances.
   d. Effective sealing between joints of glass-framing members.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
2. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that will leave visible marks in the completed work.

C. Glazing, General
1. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
2. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.
3. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
4. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
5. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
6. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
7. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).
   a. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
   b. Provide 1/8-inch (3-mm) minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
8. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
9. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
10. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
11. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
12. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

D. Tape Glazing
1. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
2. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
3. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
4. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
5. Do not remove release paper from tape until right before each glazing unit is installed.
6. Apply heel bead of elastomeric sealant.
7. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
8. Apply cap bead of elastomeric sealant over exposed edge of tape.

E. Gasket Glazing (Dry)
1. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
2. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
3. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
4. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
5. Install gaskets so they protrude past face of glazing stops.

F. Sealant Glazing (Wet)
1. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
2. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
3. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

G. Lock-Strip Gasket Glazing
1. Comply with ASTM C 716 and gasket manufacturer's written instructions. Provide supplementary wet seal and weep system unless otherwise indicated.

H. Cleaning And Protection
1. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.
2. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.

3. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.
4. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.
5. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Final Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION 07 42 13 19

Task	Specification	Specification Description
07 42 63 00	01 22 16 00	No Specification Required

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SECTION 07 42 93 00 - SIDING

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for siding. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Aluminum, Fiber-cement, and Vinyl siding.
      b. Aluminum, Fiber-cement, and Vinyl soffit.

C. Submittals
   1. Product Data: For each type of product indicated.
      a. For vinyl siding, include VSI's official certification logo printed on product data.
   2. Samples: For siding and soffit including related accessories.
   3. Qualification Data: For qualified vinyl siding Installer.
   4. Product certificates.
   5. Product test reports.
   6. Research/evaluation reports
   7. Maintenance data.
   8. Warranty: Sample of special warranty.

D. Quality Assurance
   1. Labeling: Provide fiber-cement siding that is tested and labeled according to ASTM C 1186 by a qualified testing agency acceptable to authorities having jurisdiction.
   2. Vinyl Siding Installer Qualifications: A qualified installer who employs a VSI-Certified Installer on Project.
   3. Vinyl Siding Certification Program: Provide vinyl siding products that are listed in VSI's list of certified products.
   4. Source Limitations: Obtain each type, color, texture, and pattern of siding and soffit, including related accessories, from single source from single manufacturer.
   5. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
   1. Store materials in a dry, well-ventilated, weathertight place.

F. Warranty
   1. Special Warranty: Standard form in which manufacturer agrees to repair or replace siding and/or soffit that fail(s) in materials or workmanship within 10 **OR** 25 **OR** 50, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Aluminum Siding
   1. General: Formed and coated aluminum siding complying with AAMA 1402.
   2. Horizontal Pattern: 8-inch (203-mm) exposure in plain, single-board **OR** beaded-edge, single-board **OR** plain, double-board, 4-inch (102-mm), **as directed**, style.
   3. Horizontal Pattern: 10-inch (254-mm) exposure in plain, **OR** Dutch-lap, **as directed**, double, 5-inch (127-mm) board style.

4. Vertical Pattern: 12-inch (300-mm) exposure in board-and-batten, single-board style.
5. Vertical Pattern: 16-inch (400-mm) exposure in V-grooved, triple, 5-1/3-inch (135-mm) board style.
6. Texture: Smooth **OR** Wood grain, **as directed**.
7. Nominal Thickness: 0.019 inch (0.5 mm) **OR** 0.024 inch (0.6 mm), **as directed**.
8. Insulation: Manufacturer's standard integral insulation panels.
9. Finish: Manufacturer's standard three-coat PVDF **OR** primer and baked-on acrylic **OR** primer and baked-on polyester, **as directed**.
   a. Colors: As selected by the Owner from manufacturer's full range of industry colors.

B. Fiber-Cement Siding
1. General: ASTM C 1186, Type A, Grade II, fiber-cement board, noncombustible when tested according to ASTM E 136; with a flame-spread index of 25 or less when tested according to ASTM E 84.
   a. Horizontal Pattern: Boards 5-1/4 inches (133 mm) **OR** 6-1/4 to 6-1/2 inches (159 to 165 mm) **OR** 7-1/4 to 7-1/2 inches (184 to 190 mm) **OR** 8-1/4 to 8-1/2 inches (210 to 216 mm) **OR** 9-1/4 to 9-1/2 inches (235 to 241 mm), **as directed**, wide in plain **OR** beaded-edge, **as directed**, style.
      1) Texture: Smooth **OR** Rough sawn **OR** Wood grain, **as directed**.
   b. Vertical Pattern: 48-inch- (1200-mm-) wide sheets with wood-grain texture and grooves 8 inches (203 mm) **OR** 12 inches (300 mm), **as directed**, o.c.
   c. Shingle Pattern: 48-inch- (1200-mm-) wide, straight-edge notched **OR** staggered-edge notched, **as directed**, sheets with wood-grain texture.
   d. Panel Texture: 48-inch- (1200-mm-) wide sheets with smooth **OR** stucco **OR** wood-grain, **as directed**, texture.
   e. Factory Priming: Manufacturer's standard acrylic primer.

C. Vinyl Siding
1. General: Integrally colored vinyl siding complying with ASTM D 3679.
2. Horizontal Pattern: 6-1/2- or 7-inch (165- or 178-mm) exposure in beaded-edge, single-board style.
3. Horizontal Pattern: 8-inch (203-mm) exposure in plain, single-board **OR** double board, 4-inch (102-mm) **OR** triple board, 2-2/3-inch (68-mm), **as directed**, style.
4. Horizontal Pattern: 8-inch (203-mm) exposure in Dutch-lap, double, 4-inch (102-mm) board style.
5. Horizontal Pattern: 9-inch (229-mm) exposure in plain, double board, 4-1/2-inch (114-mm) **OR** triple board, 3-inch (76-mm), **as directed**, style.
6. Horizontal Pattern: 9-inch (229-mm) exposure in Dutch-lap, double, 4-1/2-inch (114-mm) board style.
7. Horizontal Pattern: 10-inch (254-mm) exposure in plain, **OR** Dutch-lap, **as directed**, double, 5-inch (127-mm) board style.
8. Vertical Pattern: 6-inch (152-mm) exposure in V-grooved, single-board style.
9. Vertical Pattern: 8-inch (203-mm) exposure in beaded-edge, double, 4-inch (102-mm) board style.
10. Vertical Pattern: 10-inch (254-mm) exposure in V-grooved, double, 5-inch (127-mm) board style.
11. Vertical Pattern: 12-inch (300-mm) exposure in V-grooved, double board, 6-inch (152-mm) **OR** triple board, 4-inch (102-mm), **as directed**, style.
12. Shingle Pattern: 48-inch- (1200-mm-) wide, straight-edge notched **OR** staggered-edge notched **OR** half-round edge **OR** octagon edge, **as directed**, sheets with wood-grain texture.
13. Texture: Smooth **OR** Wood grain, **as directed**.
14. Nominal Thickness: 0.040 inch (1.0 mm) **OR** 0.044 inch (1.1 mm), **as directed**.
15. Minimum Profile Depth (Butt Thickness): 1/2 inch (13 mm) **OR** 5/8 inch (16 mm) **OR** 3/4 inch (19 mm), **as directed**.
16. Nailing Hem: Double thickness.
17. Finish: Wood-grain print with clear protective coating containing not less than 70 percent PVDF.
   a. Colors: As selected by the Owner from manufacturer's full range of industry colors.

D. Aluminum Soffit
1. General: Formed and coated aluminum soffit complying with AAMA 1402.
2. Pattern: 6-inch (152-mm) exposure in V-grooved, single-board style.
3. Pattern: 10-inch (254-mm) exposure in V-grooved, double, 5-inch (127-mm) board style.
4. Pattern: 12-inch (300-mm) exposure in V-grooved, double, 6-inch (152-mm) board style.
5. Pattern: 16-inch (400-mm) exposure in V-grooved, triple board, 5-1/3-inch (135-mm) **OR** quadruple board, 4-inch (102-mm), **as directed**, style.
6. Texture: Smooth **OR** Wood grain, **as directed**.
7. Ventilation: Provide perforated **OR** unperforated, **as directed**, soffit unless otherwise indicated.
8. Nominal Thickness: 0.019 inch (0.5 mm) **OR** 0.024 inch (0.6 mm), **as directed**.
9. Finish: Manufacturer's standard three-coat PVDF **OR** primer and baked-on acrylic **OR** primer and baked-on polyester, **as directed**.
   a. Colors: As selected by the Owner from manufacturer's full range of industry colors **OR** Match adjacent siding, **as directed**.

E. Fiber-Cement Soffit
1. General: ASTM C 1186, Type A, Grade II, fiber-cement board, noncombustible when tested according to ASTM E 136; with a flame-spread index of 25 or less when tested according to ASTM E 84.
2. Pattern: 12-inch- (300-mm-) **OR** 16-inch- (400-mm-) **OR** 24-inch- (600-mm-), **as directed**, wide sheets with smooth **OR** wood-grain, **as directed**, texture.
3. Ventilation: Provide perforated **OR** unperforated, **as directed**, soffit unless otherwise indicated.
4. Factory Priming: Manufacturer's standard acrylic primer.

F. Vinyl Soffit
1. General: Integrally colored vinyl soffit complying with ASTM D 4477.
2. Pattern: 6-inch (152-mm) exposure in V-grooved, single-board **OR** beaded-edge, triple board, 2-inch (51-mm), **as directed**, style.
3. Pattern: 8-inch (203-mm) exposure in V-grooved, double, 4-inch (102-mm) board style.
4. Pattern: 10-inch (254-mm) exposure in V-grooved, double, 5-inch (127-mm) board style.
5. Pattern: 12-inch (300-mm) exposure in V-grooved, double board, 6-inch (152-mm) **OR** triple board, 4-inch (102-mm), **as directed**, style.
6. Texture: Smooth **OR** Wood grain, **as directed**.
7. Ventilation: Provide perforated **OR** unperforated, **as directed**, soffit unless otherwise indicated.
8. Nominal Thickness: 0.035 inch (0.9 mm) **OR** 0.040 inch (1.0 mm) **OR** 0.044 inch (1.1 mm), **as directed**.
9. Minimum Profile Depth: 1/2 inch (13 mm) **OR** 5/8 inch (16 mm) **OR** 3/4 inch (19 mm), **as directed**.
10. Colors: As selected by the Owner from manufacturer's full range of industry colors **OR** Match adjacent siding, **as directed**.

G. Accessories
1. Siding Accessories, General: Provide starter strips, edge trim, outside and inside corner caps, and other items as recommended by siding manufacturer for building configuration.
   a. Provide accessories made from same material as **OR** matching color and texture of, **as directed**, adjacent siding unless otherwise indicated.
2. Aluminum Accessories: Where aluminum accessories are indicated, provide accessories complying with AAMA 1402.
   a. Texture: Smooth **OR** Wood grain, **as directed**.
   b. Nominal Thickness: 0.019 inch (0.5 mm) **OR** 0.024 inch (0.6 mm), **as directed**.
   c. Finish: Manufacturer's standard three-coat PVDF **OR** primer and baked-on acrylic **OR** primer and baked-on polyester, **as directed**.
3. Vinyl Accessories: Integrally colored vinyl accessories complying with ASTM D 3679 except for wind-load resistance.
   a. Texture: Smooth **OR** Wood grain, **as directed**.

4. Decorative Accessories: Provide the following aluminum **OR** fiber-cement **OR** vinyl, **as directed**, decorative accessories as indicated:
   a. Corner posts with fluted faces, **as directed**.
   b. Door and window casings with fluted faces, **as directed**, and corner rosettes, **as directed**.
   c. Entrance and window head pediments.
   d. Pilasters with fluted faces, **as directed**.
   e. Shutters with paneled **OR** louvered, **as directed**, faces.
   f. Louvers.
   g. Lattice.
   h. Fasciae.
   i. Moldings and trim.
5. Colors for Decorative Accessories: As selected by the Owner from manufacturer's full range of industry colors **OR** Match adjacent siding, **as directed**.
6. Flashing: Provide aluminum **OR** stainless-steel, **as directed**, flashing complying with Division 07 Section "Sheet Metal Flashing And Trim" at window and door heads and where indicated.
   a. Finish for Aluminum Flashing: Same as aluminum siding **OR** Siliconized polyester coating, same color as siding **OR** High-performance organic finish, same color as siding **OR** Factory-prime coating, **as directed**.
7. Fasteners:
   a. For fastening to wood, use siding nails **OR** ribbed bugle-head screws, **as directed**, of sufficient length to penetrate a minimum of 1 inch (25 mm) into substrate.
   b. For fastening to metal, use ribbed bugle-head screws of sufficient length to penetrate a minimum of 1/4 inch (6 mm), or three screw-threads, into substrate.
   c. For fastening aluminum, use aluminum fasteners. Where fasteners will be exposed to view, use prefinished aluminum fasteners in color to match item being fastened.
   d. For fastening fiber cement, use hot-dip galvanized **OR** stainless-steel, **as directed**, fasteners.
   e. For fastening vinyl, use aluminum **OR** hot-dip galvanized **OR** stainless-steel, **as directed**, fasteners. Where fasteners will be exposed to view, use prefinished aluminum fasteners in color to match item being fastened.
8. Insect Screening for Soffit Vents: Aluminum, 18-by-16 (1.4-by-1.6-mm) mesh **OR** PVC-coated, glass-fiber fabric, 18-by-14 or 18-by-16 (1.4-by-1.8- or 1.4-by-1.6-mm) mesh **OR** Stainless steel, 18-by-18 (1.4-by-1.4-mm) mesh, **as directed**.
9. Continuous Soffit Vents: Aluminum, hat-channel shape, with stamped louvers **OR** perforations, **as directed**; 2 inches (51 mm) wide and not less than 96 inches (2438 mm) long.
   a. Net-Free Area: 4 sq. in./linear ft. (280 sq. cm/m) **OR** 6 sq. in./linear ft. (420 sq. cm/m) **OR** 8 sq. in./linear ft. (560 sq. cm/m), **as directed**.
   b. Finish: Mill finish **OR** White paint **OR** Brown paint, **as directed**.
10. Round Soffit Vents: Stamped aluminum louvered vents, 2 inches (51 mm) **OR** 2-1/2 inches (64 mm) **OR** 3 inches (76 mm) **OR** 4 inches (102 mm), **as directed**, in diameter, made to be inserted into round holes cut into soffit.
    a. Finish: Mill finish **OR** White paint **OR** Brown paint, **as directed**.

1.3 EXECUTION

A. Preparation
   1. Clean substrates of projections and substances detrimental to application.

B. Installation
   1. General: Comply with siding and soffit manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.
      a. Do not install damaged components.
      b. Center nails in elongated nailing slots without binding siding to allow for thermal movement.

2. Install aluminum siding and soffit and related accessories according to AAMA 1402.
   a. Install fasteners no more than 24 inches (600 mm) o.c.
3. Install fiber-cement siding and soffit and related accessories.
   a. Install fasteners no more than 24 inches (600 mm) o.c.
4. Install vinyl siding and soffit and related accessories according to ASTM D 4756.
   a. Install fasteners for horizontal vinyl siding no more than 16 inches (400 mm) o.c.
   b. Install fasteners for vertical vinyl siding no more than 12 inches (300 mm) o.c.
5. Install joint sealants as specified in Division 07 Section "Joint Sealants" and to produce a weathertight installation.
6. Where aluminum siding will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape or installing nonconductive spacers as recommended by manufacturer for this purpose.

C. Adjusting And Cleaning
1. Remove damaged, improperly installed, or otherwise defective materials and replace with new materials complying with specified requirements.
2. Clean finished surfaces according to manufacturer's written instructions and maintain in a clean condition during construction.

END OF SECTION 07 42 93 00

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SECTION 07 46 16 00 - METAL WALL PANELS

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for metal wall panels. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Exposed-fastener, lap-seam metal wall panels.
      b. Concealed-fastener, lap-seam metal wall panels.
      c. Metal liner panels.
      d. Metal soffit panels.

C. Definition
   1. Metal Wall Panel Assembly: Metal wall panels, attachment system components, miscellaneous metal framing, thermal insulation, and accessories necessary for a complete weathertight wall system.

D. Performance Requirements
   1. General Performance: Metal wall panel assemblies shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.
   2. Delegated Design: Design metal wall panel assembly, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
   3. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) of wall area when tested according to ASTM E 283 at the following test-pressure difference:
      a. Test-Pressure Difference: 1.57 lbf/sq. ft. (75 Pa).
   4. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:
      a. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa) which is equivalent to a 50-mph (80-km/h) wind.
   5. Water Penetration under Dynamic Pressure: No evidence of water leakage when tested according to AAMA 501.1 under dynamic pressure equal to 20 percent of inward-acting, wind-load design pressure of not less than 6.24 lbf/sq. ft. (300 Pa) (which is equivalent to a 50-mph (80-km/h) wind) and not more than 12 lbf/sq. ft. (575 Pa).
      a. Water Leakage: As defined according to AAMA 501.1.
         OR
         Water Leakage: Uncontrolled water infiltrating the system or appearing on system's normally exposed interior surfaces from sources other than condensation. Water controlled by flashing and gutters that is drained back to the exterior and cannot damage adjacent materials or finishes is not water leakage.
   6. Structural Performance: Provide metal wall panel assemblies capable of withstanding the effects the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 1592:
      a. Wind Loads: Determine loads based on the following minimum design wind pressures:
         1) Uniform pressure of 20 lbf/sq. ft. (957 Pa) **OR** 30 lbf/sq. ft. (1436 Pa), **as directed**, acting inward or outward.
            OR
            Uniform pressure as indicated on Drawings.

b. Deflection Limits: Metal wall panel assemblies shall withstand wind loads with horizontal deflections no greater than 1/180 **OR** 1/240, **as directed**, of the span.

7. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

E. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Show fabrication and installation layouts of metal wall panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details. Distinguish between factory-, shop- and field-assembled work.
3. Samples: For each type of exposed finish required.
4. Delegated-Design Submittal: For metal wall panel assembly indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
5. Coordination Drawings: Exterior elevations drawn to scale and coordinating penetrations and wall-mounted items.
6. Product Test Reports.
7. Field quality-control reports.
8. Maintenance Data.
9. Warranties: Sample of special warranties.

F. Quality Assurance
1. Installer Qualifications: An employer of workers trained and approved by manufacturer.
2. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
3. Fire-Resistance Ratings: Where indicated, provide metal wall panels identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
4. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver components, sheets, metal wall panels, and other manufactured items so as not to be damaged or deformed. Package metal wall panels for protection during transportation and handling.
2. Unload, store, and erect metal wall panels in a manner to prevent bending, warping, twisting, and surface damage.
3. Stack metal wall panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal wall panels to ensure dryness, with positive slope for drainage of water. Do not store metal wall panels in contact with other materials that might cause staining, denting, or other surface damage.
4. Retain strippable protective covering on metal wall panel for period of metal wall panel installation.
5. Protect foam-plastic insulation as follows:
   a. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
   b. Protect against ignition at all times. Do not deliver foam-plastic insulation materials to Project site before installation time.
   c. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

H. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal wall panel assemblies that fail in materials or workmanship within specified warranty period.
   a. Warranty Period: Two years from date of Final Completion.
2. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal wall panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
   a. Finish Warranty Period:
      1) 20 years from date of Final Completion for fluoropolymer finish.
      2) 10 years from date of Final Completion for siliconized polyester.

1.2 PRODUCTS

A. Panel Materials
1. Metallic-Coated Steel Sheet: Restricted flatness steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
   a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
   b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40 (Class AZM150 coating designation, Grade 275); structural quality.
   c. Surface: Smooth, flat **OR** Embossed, **as directed**, finish.
   d. Exposed Coil-Coated Finish:
      1) 2-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      2) 3-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      3) 4-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat and clear coats. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      4) Mica Fluoropolymer: AAMA 621. 2-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      5) Metallic Fluoropolymer: AAMA 621. 3-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      6) FEVE Fluoropolymer: AAMA 621. 2-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      7) Siliconized-Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
      8) Plastisol: Epoxy primer and vinyl plastisol topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 3.8 mil (0.97 mm) for topcoat.
   e. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

2. Aluminum Sheet: Coil-coated sheet, ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.
   a. Surface: Smooth, flat **OR** Embossed, **as directed**, finish.
   b. Exposed Coil-Coated Finish:
      1) 2-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      2) 3-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      3) 4-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat and clear coats. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      4) Mica Fluoropolymer: AAMA 620. 2-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      5) Metallic Fluoropolymer: AAMA 620. 3-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      6) FEVE Fluoropolymer: AAMA 620. 2-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      7) Siliconized-Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
      8) Plastisol: Epoxy primer and vinyl plastisol topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 3.8 mil (0.97 mm) for topcoat.
   c. Exposed Anodized Finish:
      1) Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
      2) Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
   d. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).
3. Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 temper.
   a. Exposed Finish: Apply the following finish, as specified or indicated on Drawings.
      1) Natural finish.
      2) Brushed Satin: CDA M32-06x (Mechanical Finish: directionally textured, medium satin; Coating: clear organic, air drying, as specified below):
         a) Clear, Organic Coating: Clear, air-drying, acrylic lacquer specially developed for coating copper-alloy products, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
      3) Mirror Polished: CDA M22-06x (Mechanical Finish: buffed, specular; Coating: clear organic, air drying, as specified below):
         a) Clear, Organic Coating: Clear, air-drying, acrylic lacquer specially developed for coating copper-alloy products, applied by air spray in two coats per

manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).

4) Pre-patinated: ASTM B 882. Copper sheets artificially aged by chemical reaction to convert surface to inorganic crystalline structure with color range and durability of naturally-formed patina.

4. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304 **OR** 316, **as directed**, fully annealed.
   a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
   b. Polished Finish: Grind and polish surfaces to produce uniform finish, free of cross scratches.
      1) Run grain of directional finishes with long dimension of each piece.
      2) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
      3) Directional Satin Finish: No. 4.
   c. Bright, Cold-Rolled, Unpolished Finish: No. 2B.
5. Panel Sealants:
   a. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
   b. Joint Sealant: ASTM C 920; elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal wall panels and remain weathertight; and as recommended in writing by metal wall panel manufacturer.
   c. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

B. Field-Installed Thermal Insulation
1. Unfaced, Polyisocyanurate Board Insulation: ASTM C 591, Type II, compressive strength of 35 psi (241 kPa), with maximum flame-spread index of 75 and smoke-developed index of 450.
2. Faced, Polyisocyanurate Board Insulation: ASTM C 1289, Type I (foil facing), Class 1 or 2 **OR** Type II (asphalt felt or glass-fiber mat facing), Class 2 or 3, Grade 3, **as directed**, with maximum flame-spread index of 75 and smoke-developed index of 450, based on tests performed on unfaced core.
3. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.60-lb/cu. ft. (26-kg/cu. m), with maximum flame-spread index of 75 and smoke-developed index of 450.
4. Molded-Polystyrene Board Insulation: ASTM C 578, Type I, 0.9 lb/cu. ft. (15 kg/cu. m) **OR** Type II, 1.35 lb/cu. ft. (22 kg/cu. m), **as directed**, with maximum flame-spread index of 75 and smoke-developed index of 450.
5. Unfaced, Glass-Fiber Board Insulation: ASTM C 612, Type IA or Types IA and IB; with maximum flame-spread index of 25 and smoke-developed index of 50, and with a nominal density of 3 lb/cu. ft. (48 kg/cu. m).
6. Mineral-Fiber-Blanket Insulation: ASTM C 665, type indicated below; consisting of fibers manufactured from glass **OR** slag or rock wool, **as directed**.
   a. Type I (blankets without membrane covering), passing ASTM E 136 for combustion characteristics.
   b. Type II (blankets with nonreflective membrane covering), Category 1 (membrane is a vapor retarder), Class A (membrane-faced surface with a flame-spread index of 25 or less).
   c. Type III (blankets with reflective membrane covering), Category 1 (membrane is a vapor retarder), Class A (membrane-faced surface with a flame-spread index of 25 or less).
7. Metal Building Insulation: ASTM C 991, Type I; or NAIMA 202 **OR** ASTM C 991, Type II, **as directed**, glass-fiber-blanket insulation; 0.5-lb/cu. ft. (8-kg/cu. m) density; 2-inch- (50-mm-) wide, continuous, vapor-tight edge tabs; and with a flame-spread index of 25 or less.
   a. Vapor-Retarder Facing: ASTM C 1136, with permeance not greater than 0.02 perm (1.15 ng/Pa x s x sq. m) when tested according to ASTM E 96, Desiccant Method:
      1) Composition: Polypropylene faced, scrim reinforced, and kraft-paper backing **OR** Foil faced, scrim reinforced, and kraft-paper backing with vapor-retarder coating **OR** Polypropylene faced, scrim reinforced, and foil backing **OR** Vinyl faced, scrim reinforced, and foil backing **OR** Vinyl faced, scrim reinforced, and polyester backing, **as directed**.

b. Insulation Retainer Strips: 0.019-inch- (0.48-mm-) thick, formed galvanized steel or PVC retainer clips colored to match insulation facing.

C. Miscellaneous Metal Framing
1. Miscellaneous Metal Framing, General: ASTM C 645, cold-formed metallic-coated steel sheet, ASTM A 653/A 653M, G40 (Z120) hot-dip galvanized **OR** ASTM A 653/A 653M, G60 (Z180) hot-dip galvanized, **as directed**, or coating with equivalent corrosion resistance unless otherwise indicated.
2. Subgirts: Manufacturer's standard C- or Z-shaped sections, 0.064-inch (1.63-mm) nominal thickness.
3. Zee Clips: 0.079-inch (2.01-mm) nominal thickness.
4. Base or Sill Angles **OR** Channels, **as directed**: 0.079-inch (2.01-mm) nominal thickness.
5. Hat-Shaped, Rigid Furring Channels:
   a. Nominal Thickness: As indicated **OR** As required to meet performance requirements **OR** 0.025 inch (0.64 mm) **OR** 0.040 inch (1.02 mm), **as directed**.
   b. Depth: As indicated **OR** 7/8 inch (22 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
6. Cold-Rolled Furring Channels: Minimum 1/2-inch- (13-mm-) wide flange.
   a. Nominal Thickness: As indicated **OR** As required to meet performance requirements **OR** 0.064 inch (1.63 mm), **as directed**.
   b. Depth: As indicated **OR** 3/4 inch (19 mm), **as directed**.
   c. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with 0.040-inch (1.02-mm) nominal thickness.
   d. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.57-mm-) diameter wire, or double strand of 0.048-inch- (1.22-mm-) diameter wire.
7. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (32 mm), wall attachment flange of 7/8 inch (22 mm), and depth required to fit insulation thickness indicated.
   a. Nominal Thickness: As indicated **OR** As required to meet performance requirements **OR** 0.025 inch (0.64 mm), **as directed**.
8. Fasteners for Miscellaneous Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten miscellaneous metal framing members to substrates.

D. Miscellaneous Materials
1. Panel Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal wall panels by means of plastic caps or factory-applied coating. Provide EPDM, PVC, or neoprene sealing washers.

E. Exposed-Fastener, Lap-Seam Metal Wall Panels
1. General: Provide factory-formed metal wall panels designed to be field assembled by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps. Include accessories required for weathertight installation.
2. Corrugated-Profile, Exposed-Fastener Metal Wall Panels: Formed with alternating curved ribs spaced at 2.67 inches (68 mm) o.c. across width of panel.
   a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
   b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.

1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm)**, as directed,** thick.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

d. Panel Coverage: 21.3 inches (541 mm) **OR** 29.3 inches (744 mm) **OR** 34.6 inches (881 mm) **OR** 37.3 inches (947 mm) **OR** 42.6 inches (1084 mm) **OR** 45.3 inches (1151 mm), **as directed**.

e. Panel Height: 0.5 inch (13 mm) **OR** 0.875 inch (22 mm), **as directed**.

3. Tapered-Rib-Profile, Exposed-Fastener Metal Wall Panels: Formed with raised, trapezoidal major ribs and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between major ribs.

a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

d. Major-Rib Spacing: 6 inches (152 mm) **OR** 8 inches (203 mm) **OR** 9 inches (229 mm) **OR** 12 inches (305 mm), **as directed**, o.c.

e. Panel Coverage: 24 inches (610 mm) **OR** 36 inches (914 mm), **as directed**.

f. Panel Height: 0.625 inch (16 mm) **OR** 0.75 inch (19 mm) **OR** 1.0 inch (25 mm) **OR** 1.25 inches (32 mm) **OR** 1.5 inches (38 mm), **as directed**.

4. Reverse-Rib-Profile, Exposed-Fastener Metal Wall Panels: Formed with recessed, trapezoidal major valleys and intermediate stiffening valleys symmetrically spaced **OR** flat pan, **as directed**, between major valleys.

a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.

1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

c. Major-Rib Spacing: 12 inches (305 mm) o.c.
d. Panel Coverage: 36 inches (914 mm).
e. Panel Height: 1.25 inches (32 mm).

5. Vee-Rib-Profile, Exposed-Fastener Metal Wall Panels: Formed with raised, V-shaped ribs and recesses that are approximately same size, evenly spaced across panel width, and with rib/recess sides angled at approximately 45 degrees.

a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm) **OR** 0.064-inch (1.63-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm) **OR** 0.064-inch (1.63-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm), **as directed**, thick.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

d. Rib Spacing: 5.3 inches (135 mm) **OR** 7.2 inches (183 mm) **OR** 12 inches (305 mm), **as directed**, o.c.
e. Panel Coverage: 30 inches (762 mm) **OR** 32 inches (813 mm) **OR** 36 inches (914 mm) **OR** 40 inches (1016 mm), **as directed**.
f. Panel Height: 1.375 inches (35 mm) **OR** 1.5 inches (38 mm) **OR** 1.75 inches (44 mm) **OR** 2.0 inches (51 mm) **OR** 3.0 inches (76 mm), **as directed**.

6. Box-Rib-Profile, Exposed-Fastener Metal Wall Panels: Formed with raised, box-shaped ribs, evenly spaced across panel width, and with rib/recess sides angled 60 degrees or more.

a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.

1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

d. Rib Spacing: 2.67 inches (68 mm) **OR** 4.0 inches (102 mm) **OR** 5.3 inches (135 mm) **OR** 6.0 inches (152 mm), **as directed**, o.c.

e. Panel Coverage: 24 inches (610 mm) **OR** 28 inches (711 mm) **OR** 30 inches (762 mm) **OR** 32 inches (813 mm) **OR** 36 inches (914 mm), **as directed**.

f. Panel Height: 0.625 inch (16 mm) **OR** 1.0 inch (25 mm) **OR** 1.5 inches (38 mm) **OR** 2.0 inches (51 mm), **as directed**.

7. Deep-Box-Rib-Profile, Exposed-Fastener Metal Wall Panels: Formed with raised, box-shaped ribs, evenly spaced across panel width, and with rib/recess sides angled more than 60 degrees.

a. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm) **OR** 0.064-inch (1.63-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

b. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm) **OR** 0.064-inch (1.63-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm), **as directed**, thick.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

d. Rib Spacing: 12 inches (305 mm) o.c.

e. Panel Coverage: 24 inches (610 mm).

f. Panel Height: 3.0 inches (76 mm) **OR** 4.0 inches (102 mm), **as directed**.

F. Concealed-Fastener, Lap-Seam Metal Wall Panels
1. General: Provide factory-formed metal wall panels designed to be field assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps. Include accessories required for weathertight installation.
2. Flush-Profile, Concealed-Fastener Metal Wall Panels: Formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between panel edges; with flush joint between panels.
   a. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
   b. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
   c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm), **as directed**, thick.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
      2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
   d. Panel Coverage: 12 inches (305 mm), **as directed**.
   e. Panel Height: 1.0 inch (25 mm) **OR** 1.5 inches (38 mm), **as directed**.
3. Reveal-Joint, Concealed-Fastener Metal Wall Panels: Formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between panel edges; with narrow reveal joint between panels.
   a. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
   b. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
   c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm), **as directed**, thick.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE

fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
d. Panel Coverage: 12 inches (305 mm).
e. Panel Height: 1.0 inch (25 mm) **OR** 1.5 inches (38 mm), **as directed**.
4. Wide-Reveal-Joint, Concealed-Fastener Metal Wall Panels: Formed with vertical panel edges and stepped profile between panel edges resulting in wide reveal joint between panels.
a. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
b. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm), **as directed**, thick.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
d. Panel Coverage: 12 inches (305 mm).
e. Panel Height: 1.5 inches (38 mm).
5. V-Groove-Profile, Concealed-Fastener Metal Wall Panels: Formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between panel edges.
a. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
b. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
c. Panel Coverage: 6 inches (152 mm) **OR** 8 inches (203 mm) **OR** 12 inches (305 mm), **as directed**.
d. Panel Height: 0.625 inch (16 mm) **OR** 1.25 inches (32 mm), **as directed**.
6. Tapered-Rib-Profile, Concealed-Fastener Metal Wall Panels: Formed with raised, trapezoidal major ribs and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between major ribs.

a. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

b. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

c. Panel Coverage: 12 inches (305 mm) **OR** 14 inches (356 mm), **as directed**.

d. Panel Height: 1.0 inch (25 mm) **OR** 1.5 inches (38 mm), **as directed**.

7. Curved-Rib-Profile, Concealed-Fastener Metal Wall Panels: Formed with raised, curved-side major ribs and flat pan between major ribs; with reveal joint between panels.

a. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

b. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As indicated by manufacturer's designations **OR** Match samplesAs selected from manufacturer's full range, **as directed**.

c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm), **as directed**, thick.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
   2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

d. Panel Coverage: 12 inches (305 mm).

e. Panel Height: 0.875 inch (22 mm) **OR** 1.5 inches (38 mm), **as directed**.

8. Creased-Profile, Concealed-Fastener Metal Wall Panels: Formed with vertical panel edges and center-creased pan between panel edges; with flush joint between panels.

a. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

b. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.

1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

d. Panel Coverage: 12 inches (305 mm).
e. Panel Height: 1.5 inches (38 mm).

9. Creased-Rib-Profile, Concealed-Fastener Metal Wall Panels: Formed with raised, center-creased, trapezoidal major ribs; with reveal joint between panels.
a. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

b. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

d. Panel Coverage: 12 inches (305 mm).
e. Panel Height: 0.875 inch (22 mm) **OR** 1.5 inches (38 mm), **as directed**.

G. Metal Liner Panels

1. General: Provide factory-formed metal liner panels designed for interior side of metal wall panel assemblies and field assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps. Include accessories required for a complete installation.
2. Flush-Profile Metal Liner Panels: Solid **OR** Perforated, **as directed**, panels formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between panel edges; with flush joint between panels.
a. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.

2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

b. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.

1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.

2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.

1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.

2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

d. Panel Coverage: 12 inches (305 mm) **OR** 16 inches (406 mm) **OR** 24 inches (610 mm) **OR** 36 inches (914 mm), **as directed**.

e. Panel Height: 1.5 inches (38 mm) **OR** 2.0 inches (51 mm) **OR** 3.0 inches (76 mm), **as directed**.

f. Acoustical Performance: Where sound-absorption requirement is indicated, fabricate interior liner panels with 1/8-inch- (3-mm-) diameter holes uniformly spaced approximately 1000 holes/sq. ft. (10 750 holes/sq. m).

1) NRC of not less than 0.65 **OR** 0.85 **OR** 1.00, **as directed**, when tested according to ASTM C 423.

H. Metal Soffit Panels

1. General: Provide factory-formed metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps. Include accessories required for weathertight installation.

2. Metal Soffit Panels: Match profile and material of metal wall panels.

a. Finish: Match finish and color of metal wall panels **OR** As indicated on Drawings, **as directed**.

b. Sealant: Factory applied within interlocking joint.

3. Flush-Profile Metal Soffit Panels: Solid **OR** Perforated, **as directed**, panels formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between panel edges; with flush joint between panels.

a. Material: Same material, finish, and color as metal wall panels.

b. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.

1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.

2) Color: Match finish and color of metal wall panels **OR** As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

c. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.

1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: Match finish and color of metal wall panels **OR** As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

d. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed.**
2) Color: Match finish and color of metal wall panels **OR** As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

e. Material: Copper sheet, 16-oz./sq. ft. weight (0.55-mm thickness) **OR** 20-oz./sq. ft. weight (0.68-mm thickness), **as directed**.
1) Exterior Finish: Brushed satin (lacquered) **OR** Mirror polished, **as directed**.

f. Panel Coverage: 8 inches (203 mm) **OR** 12 inches (305 mm) **OR** 16 inches (406 mm) **OR** 20 inches (508 mm), **as directed**.

g. Panel Height: 0.875 inch (22 mm) **OR** 1.0 inch (25 mm) **OR** 1.5 inches (38 mm) **OR** 3.0 inches (76 mm), **as directed**.

h. Sealant: Factory applied within interlocking joint.

4. Reveal-Joint-Profile Metal Soffit Panels: Solid **OR** Perforated, **as directed**, panels formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between panel edges; with recessed reveal joint between panels.

a. Material: Same material, finish, and color as metal wall panels.

b. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: Match finish and color of metal wall panels **OR** As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

c. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: Match finish and color of metal wall panels **OR** As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

d. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed.**
2) Color: Match finish and color of metal wall panels **OR** As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

e. Panel Coverage: 8 inches (203 mm) **OR** 12 inches (305 mm) **OR** 16 inches (406 mm) **OR** 20 inches (508 mm), **as directed**.

f. Panel Height: 0.75 inch (19 mm) **OR** 1.0 inch (25 mm) **OR** 1.5 inches (38 mm), **as directed**.

5. V-Groove-Profile Metal Soffit Panels: Solid **OR** Perforated, **as directed**, panels formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between panel edges; with V-groove joint between panels.
   a. Material: Same material, finish, and color as metal wall panels.
   b. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: Match finish and color of metal wall panels **OR** As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
   c. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: Match finish and color of metal wall panels **OR** As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
   d. Material: Aluminum sheet, 0.024 inch (0.65 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**
      2) Color: Match finish and color of metal wall panels **OR** As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
   e. Panel Coverage: 6 inches (152 mm) **OR** 12 inches (305 mm) **OR** 14 inches (356 mm), **as directed**.
   f. Panel Height: 0.375 inch (10 mm) **OR** 0.44 inch (11 mm) **OR** 0.50 inch (13 mm) **OR** 0.625 inch (16 mm), **as directed**.

I. Accessories
1. Wall Panel Accessories: Provide components required for a complete metal wall panel assembly including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels, unless otherwise indicated.
   a. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal wall panels.
   b. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
   c. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal wall panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
2. Flashing and Trim: Formed from 0.018-inch (0.46-mm) minimum thickness, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal wall panels.

J. Fabrication
1. General: Fabricate and finish metal wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
2. Fabricate metal wall panels in a manner that eliminates condensation on interior side of panel and with joints between panels designed to form weathertight seals.
3. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
4. Fabricate metal wall panel joints with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, and that will minimize noise from movements within panel assembly.
5. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.
   a. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
   b. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
   c. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
   d. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
   e. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
   f. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal wall panel manufacturer.
      1) Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

K. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

1.3 EXECUTION

A. Preparation
1. Miscellaneous Framing: Install subgirts, base angles, sills, furring, and other miscellaneous wall panel support members and anchorages according to ASTM C 754 and metal wall panel manufacturer's written recommendations.
   a. Soffit Framing: Wire-tie or clip furring channels to supports, as required to comply with requirements for assemblies indicated.

B. Thermal Insulation Installation
1. Board Insulation: Extend insulation in thickness indicated to cover entire wall. Comply with installation requirements in Division 07 Section "Thermal Insulation".

a. Erect insulation horizontally and hold in place with Z-shaped furring members spaced 24 inches (610 mm) o.c. Attach furring members to substrate with screws spaced 24 inches (610 mm) o.c.

b. Retain insulation in place by metal clips and straps or integral pockets within panels, spaced at intervals according to insulation manufacturer's instructions. Maintain cavity width between insulation and metal liner panel of dimension indicated.

2. Blanket Insulation: Install insulation concurrently with metal wall panel installation, in thickness indicated to cover entire wall, according to manufacturer's written instructions and as follows:

a. Set vapor-retarder-faced insulation with vapor-retarder facing building exterior **OR** building interior **OR** as indicated on Drawings, **as directed**. Do not obstruct ventilation spaces, except for firestopping.

b. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to surrounding construction to ensure airtight installation.

c. Install insulation straight and true in one-piece lengths. Comply with the following installation method:

1) Over-Framing Installation: Extend insulation over and perpendicular to top flange of framing members.

d. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with framing to hold insulation in place.

C. Metal Wall Panel Installation

1. General: Install metal wall panels according to manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts and subgirts unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.

a. Commence metal wall panel installation and install minimum of 300 sq. ft. (27.8 sq. m.) in presence of factory-authorized representative.

b. Shim or otherwise plumb substrates receiving metal wall panels.

c. Flash and seal metal wall panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until weather barrier and flashings that will be concealed by metal wall panels are installed.

d. Install screw fasteners in predrilled holes.

e. Locate and space fastenings in uniform vertical and horizontal alignment.

f. Install flashing and trim as metal wall panel work proceeds.

g. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.

h. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete and elsewhere as indicated or, if not indicated, as necessary for waterproofing.

i. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.

j. Provide weathertight escutcheons for pipe and conduit penetrating exterior walls.

2. Fasteners:

a. Steel Wall Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized steel fasteners for surfaces exposed to the interior.

b. Aluminum Wall Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized steel fasteners for surfaces exposed to the interior.

c. Copper Wall Panels: Use copper, stainless-steel or hardware-bronze fasteners.

d. Stainless-Steel Wall Panels: Use stainless-steel fasteners.

3. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action as recommended by metal wall panel manufacturer.

4. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weathertight performance of metal wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal wall panel manufacturer.

a. Seal metal wall panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal wall panel manufacturer.
b. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants".
5. Lap-Seam Metal Wall Panels: Fasten metal wall panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.
a. Lap ribbed or fluted sheets one full rib corrugation. Apply panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.
b. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal wall panels.
c. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
d. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.
e. Provide sealant tape at lapped joints of metal wall panels and between panels and protruding equipment, vents, and accessories.
f. Apply a continuous ribbon of sealant tape to weather-side surface of fastenings on end laps; on side laps of nesting-type panels; on side laps of corrugated nesting-type, ribbed, or fluted panels; and elsewhere as needed to make panels weathertight.
g. At panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with butyl-rubber sealant and fastened together by interlocking clamping plates.
6. Zee Clips: Provide Zee clips of size indicated or, if not indicated, as required to act as standoff from subgirts for thickness of insulation indicated. Attach to subgirts with fasteners.
7. Metal Liner Panels: Install panels on exterior side of girts with girts exposed to the interior **OR** interior side of girts with flush appearance on the inside **OR** girts as indicated on Drawings, **as directed**.
8. Fire-Rated Metal Wall Panel Assemblies: Install metal liner panels on exterior side of girts, fastening through faces of panels, with girts exposed to the interior. Install subgirts horizontally, fastened to legs of metal liner panels. Install substrate board as indicated in Division 06 Section "Sheathing", in number of layers required for fire rating, over subgirts, attached with board fasteners. Install second set of subgirts horizontally, fastened through substrate board into first set of subgirts. Install exterior metal wall panels, fastened to second set of subgirts.
a. Comply with UL **OR** FMG, **as directed**, requirements for fire-rated construction.

D. Metal Soffit Panel Installation
1. In addition to complying with requirements of "Metal Wall Panel Installation, General" Article, install metal soffit panels to comply with the requirements of this article.
2. Metal Soffit Panels: Provide metal soffit panels full width of soffits. Install panels perpendicular to support framing.
a. Flash and seal panels with weather closures where metal soffit panels meet walls and at perimeter of all openings.

E. Accessory Installation
1. General: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
a. Install components required for a complete metal wall panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
2. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
a. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form

hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.

b. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (605 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

F. Field Quality Control

1. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports, **as directed by the Owner**.
2. Water Penetration: Test areas of installed system indicated on Drawings for compliance with system performance requirements according to ASTM E 1105 at minimum differential pressure of 20 percent of inward-acting, wind-load design pressure as defined by SEI/ASCE 7, but not less than 6.24 lbf/sq. ft. (300 Pa).
3. Water-Spray Test: After completing the installation of 75-foot- (23-m-) by-2-story minimum area of metal wall panel assembly, test assembly for water penetration according to AAMA 501.2 in a 2-bay area directed by the Owner.
4. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect and test completed metal wall panel installation, including accessories.
5. Remove and replace metal wall panels where tests and inspections indicate that they do not comply with specified requirements.
6. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

G. Cleaning And Protection

1. Remove temporary protective coverings and strippable films, if any, as metal wall panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal wall panel installation, clean finished surfaces as recommended by metal wall panel manufacturer. Maintain in a clean condition during construction.
2. After metal wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
3. Replace metal wall panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 46 16 00

SECTION 07 46 16 00a - METAL PLATE WALL PANELS

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for metal plate wall panels. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section includes metal plate wall panels.

C. Definition
   1. Metal Plate Wall Panel Assembly: Metal plate wall panels, attachment system components, miscellaneous metal framing, and accessories necessary for a complete weathertight wall system.

D. Performance Requirements
   1. General Performance: Metal plate wall panel assemblies shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.
   2. Delegated Design: Design metal plate wall panel assembly, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
   3. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) of wall area when tested according to ASTM E 283 at the following test-pressure difference:
      a. Test-Pressure Difference: 1.57 lbf/sq. ft. (75 Pa) which is equivalent to a 25-mph (40-km/h) wind.
   4. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:
      a. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa) which is equivalent to a 50-mph (80-km/h) wind.
   5. Water Penetration under Dynamic Pressure: No evidence of water leakage when tested according to AAMA 501.1 under dynamic pressure equal to 20 percent of inward-acting, wind-load design pressure of not less than 6.24 lbf/sq. ft. (300 Pa) {which is equivalent to a 50-mph (80-km/h) wind} and not more than 12 lbf/sq. ft. (575 Pa).
      a. Water Leakage: As defined according to AAMA 501.1.
         OR
         Water Leakage: Uncontrolled water infiltrating the system or appearing on system's normally exposed interior surfaces from sources other than condensation. Water controlled by flashing and gutters that is drained back to the exterior and cannot damage adjacent materials or finishes is not water leakage.
   6. Structural Performance: Provide metal plate wall panel assemblies capable of withstanding the effects of the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 330:
      a. Wind Loads: Determine loads based on the following minimum design wind pressures:
         1) Uniform pressure of 20 lbf/sq. ft. (957 Pa) **OR** 30 lbf/sq. ft. (1436 Pa), **as directed**, acting inward or outward.
            OR
            Uniform pressure as indicated on Drawings.
      b. Deflection Limits: Metal plate wall panel assemblies shall withstand wind loads with horizontal deflections no greater than 1/180 **OR** 1/240, **as directed**, of the span.

7. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

E. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Show fabrication and installation layouts of metal plate wall panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details. Distinguish among factory-, shop-, and field-assembled work.
3. Samples: For each type of exposed finish required.
4. Delegated-Design Submittal: For metal plate wall panel assembly indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
5. Coordination Drawings: Exterior elevations, drawn to scale and coordinating penetrations and wall-mounted items.
6. Product Test Reports.
7. Field quality-control reports.
8. Maintenance Data.
9. Warranties: Sample of special warranties.

F. Quality Assurance
1. Installer Qualifications: An employer of workers trained and approved by manufacturer.
2. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
3. Fire-Resistance Ratings: Where indicated, provide metal plate wall panels identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
4. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver components, metal plate wall panels, and other manufactured items so as not to be damaged or deformed. Package panels for protection during transportation and handling.
2. Unload, store, and erect metal plate wall panels in a manner to prevent bending, warping, twisting, and surface damage.
3. Stack metal plate wall panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store panels to ensure dryness, with positive slope for drainage of water. Do not store panels in contact with other materials that might cause staining, denting, or other surface damage.
4. Retain strippable protective covering on metal plate wall panel for period of installation.
5. Protect foam-plastic insulation as follows:
   a. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
   b. Protect against ignition at all times. Do not deliver foam-plastic insulation materials to Project site before installation time.
   c. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

H. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal plate wall panel assemblies that fail in materials or workmanship within specified warranty period.
   a. Warranty Period: Two years from date of Final Completion.

2. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal plate wall panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
    a. Finish Warranty Period:
        1) 20 years from date of Final Completion for fluoropolymer finish.
        2) 10 years from date of Final Completion for siliconized polyester.

1.2 PRODUCTS

A. Panel Materials
1. Aluminum Plate: ASTM B 209 (ASTM B 209M). Alloy and temper as recommended by manufacturer for application.
2. Copper Plate: ASTM B 152/B 152M, solid copper alloy.
3. Panel Sealant: ASTM C 920; elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal plate wall panels and remain weathertight; and as recommended in writing by panel manufacturer.

B. Miscellaneous Metal Framing
1. Miscellaneous Metal Framing, General: ASTM C 645, cold-formed metallic-coated steel sheet, ASTM A 653/A 653M, G40 (Z120) hot-dip galvanized **OR** ASTM A 653/A 653M, G60 (Z180) hot-dip galvanized, **as directed**, or coating with equivalent corrosion resistance unless otherwise indicated.
2. Subgirts: Manufacturer's standard C- or Z-shaped sections, 0.064-inch (1.63-mm) nominal thickness.
3. Zee Clips: 0.079-inch (2.01-mm) nominal thickness.
4. Base or Sill Angles **OR** Channels, **as directed**: 0.079-inch (2.01-mm) nominal thickness.
5. Hat-Shaped, Rigid Furring Channels:
    a. Nominal Thickness: As indicated **OR** As required to meet performance requirements **OR** 0.025 inch (0.64 mm) **OR** 0.040 inch (1.02 mm), **as directed**.
    b. Depth: As indicated **OR** 7/8 inch (22 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
6. Cold-Rolled Furring Channels: Minimum 1/2-inch- (13-mm-) wide flange.
    a. Nominal Thickness: As indicated **OR** As required to meet performance requirements **OR** 0.064 inch (1.63 mm), **as directed**.
    b. Depth: As indicated **OR** 3/4 inch (19 mm), **as directed**.
    c. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with nominal thickness of 0.040 inch (1.02 mm).
    d. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.57-mm-) diameter wire, or double strand of 0.048-inch- (1.22-mm-) diameter wire.
7. Fasteners for Miscellaneous Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten miscellaneous metal framing members to substrates.

C. Miscellaneous Materials
1. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy and temper recommended by manufacturer for type of use and finish indicated.
2. Panel Fasteners: Self-tapping screws; bolts and nuts; self-locking rivets and bolts; end-welded studs; and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal wall panels by means of plastic caps or factory-applied coating. Provide EPDM, PVC, or neoprene sealing washers.

D. Metal Plate Wall Panels
1. Metal Plate Wall Panels: Provide factory-formed, metal plate wall panels fabricated from single sheets of metal formed into profile for installation method indicated. Include attachment system components, panel stiffeners, and accessories required for weathertight system.

a. Material: Tension-leveled, smooth aluminum sheet, ASTM B 209 (ASTM B 209M), 0.120 inch (3.05 mm) **OR** 0.125 inch (3.18 mm) **OR** 0.1875 inch (4.76 mm) **OR** 0.190 inch (4.82 mm), **as directed**, thick.
b. Panel Depth: 2 inches (51 mm) **OR** As indicated on Drawings, **as directed**.
c. Exterior Finish: Two-coat fluoropolymer **OR** Three-coat fluoropolymer **OR** Four-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Clear anodized **OR** Color anodized, **as directed**.
   1) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

2. Attachment System Components: Formed from extruded aluminum.
   a. Provide internal drainage system that allows individual panels to be installed and removed without disturbing adjacent panels.
   b. Include manufacturer's standard subgirts, perimeter extrusions, tracks, and drainage channels, panel stiffeners, panel clips and anchor channels, **as applicable**.
   c. Alignment Pins: Stainless steel.

E. Accessories
1. Metal Plate Wall Panel Accessories: Provide components required for a complete metal plate wall panel assembly including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of panels unless otherwise indicated.
2. Flashing and Trim: Same material, finish, and color as adjacent metal plate wall panels, minimum 0.030 inch (0.76 mm) thick unless otherwise indicated.

F. Fabrication
1. General: Fabricate and finish metal plate wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
2. Fabricate metal plate wall panels in a manner that eliminates condensation on interior side of panel and with joints between panels designed to form weathertight seals.
3. Metal Plate Wall Panels: Fabricate panels with panel stiffeners as required to comply with deflection limits. Weld and grind panel corners smooth. Fabricate panels to the following dimensional tolerances:
   a. Length and Width: Plus or minus 0.032 inch (0.81 mm) up to 48 inches (1219 mm); 0.064 inch (1.63 mm) more than 48 inches (1219 mm).
   b. Diagonal: Plus or minus 0.1875 inch (4.76 mm).
   c. Panel Bow: Not more than 0.2 percent of panel width or length up to 0.1875 inch (4.76 mm) maximum.
   d. Thickness: Plus or minus 0.008 inch (0.2 mm).
   e. Squareness: 0.1875-inch (4.76-mm) difference between diagonal measurements.
   f. Camber: 0.032 inch (0.81 mm).
4. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
   a. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
   b. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
   c. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
   d. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.

e. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

f. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal plate wall panel manufacturer.

1) Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal plate wall panel manufacturer for application, but not less than thickness of metal being secured.

G. General Finish Requirements

1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

H. Aluminum Finishes

1. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
3. Four-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat and clear coats. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
4. Mica Fluoropolymer: AAMA 2605. 2-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
5. Metallic Fluoropolymer: AAMA 2605. 3-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
6. FEVE Fluoropolymer: AAMA 2605. 2-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
7. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
8. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
9. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

I. Copper-Alloy Finishes

1. Exposed Finish: Mill.
2. Exposed Finish: Finish designations prefixed by CDA comply with the system established by the Copper Development Association for designating copper-alloy finish systems.

a. Brushed Satin: CDA M32-06x (Mechanical Finish: directionally textured, medium satin; Coating: clear organic, air drying, as specified below):

1) Clear, Organic Coating: Clear, air-drying, acrylic lacquer specially developed for coating copper-alloy products, applied by air spray in 2 coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).

b. Mirror Polished: CDA M22-06x (Mechanical Finish: buffed, specular; Coating: clear organic, air drying, as specified below):

1) Clear, Organic Coating: Clear, air-drying, acrylic lacquer specially developed for coating copper-alloy products, applied by air spray in 2 coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).

1.3 EXECUTION

A. Preparation

1. Miscellaneous Framing: Install subgirts, base angles, sills, furring, and other miscellaneous metal plate wall panel support members and anchorage according to ASTM C 754 and panel manufacturer's written instructions.

B. Metal Plate Wall Panel Installation

1. General: Install metal plate wall panels according to manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts and subgirts unless otherwise indicated. Anchor panels and other components of the Work securely in place, with provisions for thermal and structural movement.
   a. Commence metal plate wall panel installation and install minimum of 300 sq. ft. (27.8 sq. m) in presence of factory-authorized representative.
   b. Shim or otherwise plumb substrates receiving metal plate wall panels.
   c. Flash and seal metal plate wall panels with weather closures at perimeter of all openings. Do not begin installation until weather barrier and flashings that will be concealed by panels are installed.
   d. Install flashing and trim as metal plate wall panel work proceeds.
   e. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated or, if not indicated, as necessary for waterproofing.
   f. Provide weathertight escutcheons for pipe and conduit penetrating exterior walls.
2. Fasteners:
   a. Aluminum Plate Wall Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior and aluminum or galvanized-steel fasteners for surfaces exposed to the interior.
   b. Copper Plate Wall Panels: Use copper, stainless-steel, or hardware-bronze fasteners.
3. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action as recommended by metal plate wall panel manufacturer.
4. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weathertight performance of metal wall plate panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by panel manufacturer.
   a. Seal metal plate wall panel end laps with double beads of sealant, full width of panel. Seal side joints where recommended by panel manufacturer.
   b. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants".
5. Attachment System, General: Install attachment system required to support metal plate wall panels and to provide a complete weathertight wall system, including subgirts, perimeter extrusions, tracks, drainage channels, panel clips, and anchor channels.
   a. Include attachment to supports, panel-to-panel joinery, panel-to-dissimilar-material joinery, and panel-system joint seals.
6. Flange-Attachment Installation: Attach metal plate wall panels, formed with extended perimeter flanges, to supports at locations, spacings, and with fasteners recommended by manufacturer.

a. Seal horizontal and vertical joints between adjacent panels with sealant backing and sealant. Install sealant backing and sealant according to requirements specified in Division 07 Section "Joint Sealants".
b. Seal horizontal and vertical joints between adjacent panels with manufacturer's standard gaskets.

7. Clip Installation: Attach panel clips to supports at locations, spacings, and with fasteners recommended by manufacturer. Attach flanges of metal plate wall panels to panel clips with fasteners **OR** by welding, **as directed**, as recommended by manufacturer.
   a. Seal horizontal and vertical joints between adjacent metal plate wall panels with sealant backing and sealant. Install sealant backing and sealant according to requirements specified in Division 07 Section "Joint Sealants".
   b. Seal horizontal and vertical joints between adjacent metal plate wall panels with manufacturer's standard gaskets.
8. Subgirt-and-Spline Installation: Provide manufacturer's standard subgirts and splines that provide support and complete secondary drainage system, draining to the exterior at horizontal joints. Install support system at locations, spacings, and with fasteners recommended by manufacturer. Attach metal plate wall panels by interlocking perimeter extrusions attached to panels with subgirts and splines. Fully engage integral subgirt-and-spline gaskets and leave horizontal and vertical joints with open reveal. Terminate edge of panels flush with perimeter extrusions.
   a. Install metal plate wall panels to allow individual panels to be installed and removed without disturbing adjacent panels.
   b. Do not apply sealants to joints unless otherwise indicated on Drawings.
9. Track-Support Installation: Provide manufacturer's standard horizontal tracks and vertical tracks **OR** drain channels, **as directed**, that provide support and complete secondary drainage system, draining to the exterior at horizontal joints through drain tube. Install support system at locations, spacings, and with fasteners recommended by manufacturer. Attach metal plate wall panels to tracks by interlocking panel edges with manufacturer's standard "T" clips.
   a. Install metal plate wall panels to allow individual panels to be installed and removed without disturbing adjacent panels.
   b. Seal horizontal and vertical joints between adjacent metal plate wall panels with sealant backing and sealant. Install sealant backing and sealant according to requirements specified in Division 07 Section "Joint Sealants".
10. Rail-Support Installation: Provide manufacturer's standard interlocking rails that provide support and complete secondary drainage system, draining to the exterior at horizontal joints. Install rails at locations, spacings, and with fasteners recommended by manufacturer. Attach metal plate wall panels by overlapping and interlocking support rails with perimeter rails attached to panels. Apply sealant, foam sealant, and tape sealant at locations recommended by manufacturer. Leave horizontal and vertical joints with open reveal.
    a. Install metal plate wall panels to allow individual panels to be installed and removed without disturbing adjacent panels.
    b. Install backer plates before installing support rails.
    c. Do not apply sealants to joints unless otherwise indicated on Drawings.
11. Rainscreen-Principle Installation: Provide manufacturer's standard pressure-equalized, rainscreen-principle system with vertical channel that provides support and complete secondary drainage system, draining at base of wall. Notch vertical channel to receive support pins. Install vertical channels supported by channel brackets or adjuster angles and at locations, spacings, and with fasteners recommended by manufacturer. Attach metal plate wall panels by engaging horizontal support pins into notches in vertical channels and into flanges of panels. Leave horizontal and vertical joints with open reveal.
    a. Install metal plate wall panels to allow individual panels to be installed and removed without disturbing adjacent panels.
    b. Do not apply sealants to joints unless otherwise indicated on Drawings.

C. Accessory Installation

1. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
   a. Install components required for a complete metal plate wall panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
2. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
   a. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
   b. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

D. Erection Tolerances
1. Installation Tolerances: Shim and align metal plate wall panel units within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m), nonaccumulative, on level, plumb, and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

E. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Water Penetration: Test areas of installed system indicated on Drawings for compliance with system performance requirements according to ASTM E 1105 at minimum differential pressure of 20 percent of inward-acting, wind-load design pressure as defined by SEI/ASCE 7, but not less than 6.24 lbf/sq. ft. (300 Pa).
3. Water-Spray Test: After completing the installation of 75-foot- (23-m-) by-2-story minimum area of metal plate wall panel assembly, test assembly for water penetration according to AAMA 501.2 in a 2-bay area directed by the Owner.
4. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust completed metal plate wall panel installation, including accessories.
5. Metal plate wall panels will be considered defective if they do not pass tests and inspections.
6. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
7. Prepare test and inspection reports.

F. Cleaning
1. Remove temporary protective coverings and strippable films, if any, as metal plate wall panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal plate wall panel installation, clean finished surfaces as recommended by panel manufacturer. Maintain in a clean condition during construction.
2. After metal plate wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
3. Replace metal plate wall panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 46 16 00a

Task	Specification	Specification Description
07 46 16 00	07 41 13 00	Metal Roof Panels
07 46 16 00	07 42 93 00	Siding
07 46 19 00	07 41 13 00	Metal Roof Panels
07 46 19 00	07 46 16 00	Metal Wall Panels
07 46 19 00	07 46 16 00a	Metal Plate Wall Panels
07 46 19 00	07 42 93 00	Siding
07 46 23 00	06 10 00 00	Rough Carpentry
07 46 23 00	06 05 23 00a	Miscellaneous Carpentry
07 46 23 00	06 16 23 00	Sheathing
07 46 29 00	06 10 00 00	Rough Carpentry
07 46 29 00	06 05 23 00a	Miscellaneous Carpentry
07 46 29 00	06 16 23 00	Sheathing
07 46 33 00	07 42 93 00	Siding
07 46 46 00	01 22 16 00	No Specification Required
07 46 46 00	06 46 29 00	Exterior Architectural Woodwork
07 46 46 00	06 41 13 00	Interior Architectural Woodwork
07 46 46 00	07 42 93 00	Siding

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SECTION 07 46 63 00 - INSULATED-CORE METAL WALL PANELS

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for insulated-core metal wall panels. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Foamed-insulation-core metal wall panels.
      b. Laminated-insulation-core metal wall panels.
      c. Honeycomb-core metal wall panels.

C. Definitions
   1. Metal Wall Panel Assembly: Insulated-core metal wall panels, attachment system components, miscellaneous metal framing, and accessories necessary for a complete weathertight wall system.

D. Performance Requirements
   1. General Performance: Metal wall panel assemblies shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.
   2. Delegated Design: Design metal wall panel assembly, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
   3. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) of wall area when tested according to ASTM E 283 at the following test-pressure difference:
      a. Test-Pressure Difference: 1.57 lbf/sq. ft. (75 Pa) which is equivalent to a 25-mph (40-km/h) wind.
   4. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:
      a. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa) which is equivalent to a 50-mph (80-km/h) wind.
   5. Water Penetration under Dynamic Pressure: No evidence of water leakage when tested according to AAMA 501.1 under dynamic pressure equal to 20 percent of inward-acting, wind-load design pressure of not less than 6.24 lbf/sq. ft. (299 Pa) and not more than 12 lbf/sq. ft. (575 Pa).
      a. Water Leakage: As defined according to AAMA 501.1.
         OR
         Water Leakage: Uncontrolled water infiltrating the system or appearing on system's normally exposed interior surfaces from sources other than condensation. Water controlled by flashing and gutters that is drained back to the exterior and cannot damage adjacent materials or finishes is not water leakage.
   6. Structural Performance: Metal wall panel assemblies shall withstand the effects the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 330:
      a. Wind Loads: Determine loads based on the following minimum design wind pressures:
         1) Uniform pressure of 20 lbf/sq. ft. (958 Pa) **OR** 30 lbf/sq. ft. (1436 Pa), **as directed**, acting inward or outward.
            OR
            Uniform pressure as indicated on Drawings.

b. Deflection Limits: Metal wall panel assemblies shall withstand wind loads with horizontal deflections no greater than 1/180 **OR** 1/240, **as directed**, of the span.

7. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
8. Thermal Performance: Provide insulated metal wall panel assemblies with thermal-resistance value (R-value) indicated when tested according to ASTM C 518.

E. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Show fabrication and installation layouts of metal wall panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details. Distinguish between factory-, shop-, and field-assembled work.
3. Samples: For each type of exposed finish required.
4. Delegated-Design Submittal: For metal wall panel assembly indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
5. Coordination Drawings: Exterior elevations, drawn to scale, and coordinating penetrations and wall-mounted items.
6. Product Test Reports.
7. Field quality-control reports.
8. Maintenance Data.
9. Warranties: Sample of special warranties.

F. Quality Assurance
1. Installer Qualifications: An employer of workers trained and approved by manufacturer.
2. Fire-Test-Response Characteristics: Provide metal wall panels and system components with the following fire-test-response characteristics as determined by testing identical panels and system components per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.
   a. Fire-Resistance Characteristics: Provide materials and construction tested for fire resistance per ASTM E 119.
   b. Intermediate-Scale Multistory Fire Test: Tested mockup, representative of completed multistory wall assembly of which wall panel is a part, complies with NFPA 285 for test method and required fire-test-response characteristics of exterior non-load-bearing wall panel assemblies.
   c. Radiant Heat Exposure: No ignition when tested according to NFPA 268.
   d. Potential Heat: Acceptable level when tested according to NFPA 259.
   e. Surface-Burning Characteristics: Provide wall panels with flame-spread index of 25 or less and smoke-developed index of 450 or less, per ASTM E 84.
3. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver components, sheets, metal wall panels, and other manufactured items so as not to be damaged or deformed. Package metal wall panels for protection during transportation and handling.
2. Unload, store, and erect metal wall panels in a manner to prevent bending, warping, twisting, and surface damage.
3. Stack metal wall panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal wall panels to ensure dryness, with positive slope for

drainage of water. Do not store metal wall panels in contact with other materials that might cause staining, denting, or other surface damage.

4. Retain strippable protective covering on metal wall panels for period of metal wall panel installation.

H. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal wall panel assemblies that fail in materials or workmanship within specified warranty period.
    a. Warranty Period: Two years from date of Final Completion.
2. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal wall panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
    a. Finish Warranty Period:
        1) 20 years from date of Final Completion for fluoropolymer finish.
        2) 10 years from date of Final Completion for siliconized polyester.

1.2 PRODUCTS

A. Panel Materials

1. Metallic-Coated Steel Sheet: Restricted flatness steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
    a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
    b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40 (Class AZM150 coating designation, Grade 275); structural quality.
    c. Surface: Smooth, flat **OR** Embossed, **as directed**, finish.
    d. Exposed Coil-Coated Finish:
        1) Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
        2) Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
        3) Four-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat and clear coats. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
        4) Mica Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
        5) Metallic Fluoropolymer: AAMA 621. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
        6) FEVE Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

7) Siliconized-Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
8) Plastisol: Epoxy primer and vinyl plastisol topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 3.8 mil (0.097 mm) for topcoat.

e. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

2. Aluminum Sheet: Coil-coated sheet, ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.
a. Surface: Smooth, flat **OR** Embossed, **as directed**, finish.
b. Exposed Coil-Coated Finishes:
1) Two-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2) Three-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
3) Four-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat and clear coats. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
4) Mica Fluoropolymer: AAMA 620. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
5) Metallic Fluoropolymer: AAMA 620. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
6) FEVE Fluoropolymer: AAMA 620. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
7) Siliconized-Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
8) Plastisol: Epoxy primer and vinyl plastisol topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 3.8 mil (0.097 mm) for topcoat.

c. Exposed Anodized Finish:
1) Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
2) Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.

d. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

3. Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 temper.
a. Exposed Finish: Apply the following finish, as specified or indicated on Drawings.
1) Natural finish.

2) Brushed Satin: CDA M32-06x (Mechanical Finish: directionally textured, medium satin; Coating: clear organic, air drying, as specified below):
   a) Clear, Organic Coating: Clear, air-drying, acrylic lacquer specially developed for coating copper-alloy products, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
3) Mirror Polished: CDA M22-06x (Mechanical Finish: buffed, specular; Coating: clear organic, air drying, as specified below):
   a) Clear, Organic Coating: Clear, air-drying, acrylic lacquer specially developed for coating copper-alloy products, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
4) Pre-patinated: ASTM B 882. Copper sheets artificially aged by chemical reaction to convert surface to inorganic crystalline structure with color range and durability of naturally-formed patina.

4. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304 **OR** 316, **as directed**, fully annealed.
   a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
   b. Polished Finish: Grind and polish surfaces to produce uniform finish, free of cross scratches.
      1) Run grain of directional finishes with long dimension of each piece.
      2) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
      3) Directional Satin Finish: No. 4.
   c. Bright, Cold-Rolled, Unpolished Finish: No. 2B.
5. Panel Sealants:
   a. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
   b. Joint Sealant: ASTM C 920; elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal wall panels and remain weathertight; and as recommended in writing by metal wall panel manufacturer.
   c. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

B. Insulation For Panel Cores
1. Polyisocyanurate Insulation: Closed cell, modified polyisocyanurate foam using a non-CFC blowing agent, foamed-in-place **OR** board, **as directed**, type, with maximum flame-spread index of 25 and smoke-developed index of 450.
   a. Closed-Cell Content: 90 percent when tested according to ASTM D 2856.
2. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.60-lb/cu. ft. (26-kg/cu. m) minimum density, unless otherwise indicated; with maximum flame-spread index of 25 and smoke-developed index of 450.
3. Molded-Polystyrene Board Insulation: ASTM C 578, Type I, 0.9 lb/cu. ft. (14 kg/cu. m) **OR** Type II, 1.35 lb/cu. ft. (22 kg/cu. m), Class 2 or 3, Grade 3, **as directed**, with maximum flame-spread index of 25 and smoke-developed index of 450.

C. Miscellaneous Metal Framing
1. Miscellaneous Metal Framing, General: ASTM C 645, cold-formed metallic-coated steel sheet, ASTM A 653/A 653M, G40 (Z120) hot-dip galvanized **OR** ASTM A 653/A 653M, G60 (Z180) hot-dip galvanized, **as directed**, or coating with equivalent corrosion resistance unless otherwise indicated.
2. Subgirts: Manufacturer's standard C- or Z-shaped sections, 0.064-inch (1.63-mm) nominal thickness.
3. Zee Clips: 0.079-inch (2.01-mm) nominal thickness.
4. Base or Sill Angles **OR** Channels, **as directed**: 0.079-inch (2.01-mm) nominal thickness.
5. Hat-Shaped, Rigid Furring Channels:

a. Nominal Thickness: As indicated **OR** As required to meet performance requirements **OR** 0.025 inch (0.64 mm) **OR** 0.040 inch (1.02 mm), **as directed**.

b. Depth: As indicated **OR** 7/8 inch (21 mm) **OR** 1-1/2 inches (38 mm), **as directed**.

6. Cold-Rolled Furring Channels: Minimum 1/2-inch- (13-mm-) wide flange.

a. Nominal Thickness: As indicated **OR** As required to meet performance requirements **OR** 0.064 inch (1.63 mm), **as directed**.

b. Depth: As indicated **OR** 3/4 inch (19 mm), **as directed**.

c. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with 0.040-inch (1.02-mm) nominal thickness.

7. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.52-mm-) diameter wire, or double strand of 0.048-inch- (1.22-mm-) diameter wire.

8. Fasteners for Miscellaneous Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten miscellaneous metal framing members to substrates.

D. Miscellaneous Materials

1. Panel Fasteners: Self-tapping screws; bolts and nuts; self-locking rivets and bolts; end-welded studs; and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal wall panels by means of plastic caps or factory-applied coating. Provide EPDM, PVC, or neoprene sealing washers.

2. Backer Board: Hardboard complying with AHA A135.4, Class 1 tempered, 1/8 inch (3 mm) **OR** 1/4 inch (6 mm), **as directed**, thick unless otherwise indicated.

E. Foamed-Insulation-Core Metal Wall Panels

1. General: Provide factory-formed and -assembled metal wall panels fabricated from two metal facing sheets and insulation core foamed in place during fabrication, and with joints between panels designed to form weathertight seals. Include accessories required for weathertight installation.

a. Panel Performance:

1) Flatwise Tensile Strength: 30 psi (207 kPa) when tested according to ASTM C 297.

2) Humid Aging: Volume increase not greater than 6.0 percent and no delamination or metal corrosion when tested for 7 days at 140 deg F (60 deg C) and 100 percent relative humidity according to ASTM D 2126.

3) Heat Aging: Volume increase not greater than 2.0 percent and no delamination, surface blistering, or permanent bowing when tested for 7 days at 200 deg F (93 deg C) according to ASTM D 2126.

4) Cold Aging: Volume decrease not more than 1.0 percent and no delamination, surface blistering, or permanent bowing when tested for 7 days at minus 20 deg F (29 deg C) according to ASTM D 2126.

5) Fatigue: No evidence of delamination, core cracking, or permanent bowing when tested to a 20-lbf/sq. ft. (958-kPa) positive and negative wind load and with deflection of L/180 for 2 million cycles.

6) Autoclave: No delamination when exposed to 2-psi (13.8-kPa) pressure at a temperature of 212 deg F (100 deg C) for 2-1/2 hours.

b. Polyisocyanurate Insulation-Core Performance:

1) Density: 2.0 to 2.6 lb/cu. ft. (32 to 42 kg/cu. m) when tested according to ASTM D 1622.

2) Compressive Strength: Minimum 20 psi (138 kPa) when tested according to ASTM D 1621.

3) Shear Strength: 26 psi (179 kPa) when tested according to ASTM C 273.

2. Exposed-Fastener, Foamed-Insulation-Core Metal Wall Panels: Formed with raised, trapezoidal major rib at panel edge and two intermediate stiffening ribs symmetrically spaced between major rib and panel edge; designed for lapping side edges of adjacent panels and mechanically attaching to supports using exposed fasteners in side laps.

a. Facings: Fabricate panel with exterior and interior facings of same material and thickness.

1) Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
2) Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
3) Backer Board: On back side of exterior facing.
4) Exterior Facing Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   a) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
5) Interior Facing Finish: Manufacturer's standard white polyester.

b. Snap-On Batten: Same material, finish, and color as exterior facings of wall panels.
c. Panel Coverage: 36 inches (914 mm) **OR** 40 inches (1016 mm), **as directed**, nominal.
d. Panel Thickness: 1.0 inch (25 mm) **OR** 1.5 inches (38 mm) **OR** 2.0 inches (51 mm) **OR** 2.5 inches (64 mm) **OR** 3.0 inches (76 mm) **OR** 4.0 inches (102 mm) **OR** 5.0 inches (127 mm), **as directed**.
e. Thermal-Resistance Value (R-Value): as directed by the Owner.

3. Concealed-Fastener, Foamed-Insulation-Core Metal Wall Panels: Formed with tongue-and-groove panel edges; designed for sequential installation by interlocking panel edges and mechanically attaching panels to supports using concealed clips or fasteners.
   a. Facings: Fabricate panel with exterior and interior facings of same material and thickness.
      1) Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      2) Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      3) Material: Stainless-steel sheet, 0.031 inch (0.79 mm) **OR** 0.038 inch (0.97 mm), **as directed**, thick with No. 4 **OR** 2B, **as directed**, finish.
      4) Backer Board: On back side of exterior facing.
      5) Exterior Facing Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
         a) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
      6) Interior Facing Finish: Manufacturer's standard siliconized polyester.
      7) Exterior Surface: Smooth, flat **OR** Striated **OR** Shallow ribs **OR** Shallow V grooves, **as directed**.
   b. Panel Coverage: 24 inches (610 mm) **OR** 30 inches (762 mm) **OR** 36 inches (914 mm) **OR** 39.37 inches (1000 mm) **OR** 42 inches (1067 mm), **as directed**, nominal.
   c. Panel Thickness: 2.0 inches (51 mm) **OR** 2.5 inches (64 mm) **OR** 3.0 inches (76 mm) **OR** 4.0 inches (102 mm) **OR** 5.0 inches (127 mm) **OR** 6.0 inches (152 mm), **as directed**.
   d. Thermal-Resistance Value (R-Value): as directed by the Owner.

F. Laminated-Insulation-Core Metal Wall Panels

1. General: Provide factory-formed and -assembled metal wall panels fabricated from two metal facing sheets and core material laminated or otherwise securely bonded to facing sheets during fabrication without use of contact adhesives, and with joints between panels designed to form weathertight seals. Include accessories required for weathertight installation.
   a. Panel Performance:
      1) Flatwise Tensile Strength: 27 psi (186 kPa) when tested according to ASTM C 297.
      2) Humid Aging: Volume increase not greater than 6.0 percent and no delamination or metal corrosion when tested for 7 days at 140 deg F (60 deg C) and 100 percent relative humidity according to ASTM D 2126.
      3) Heat Aging: Volume increase not greater than 2.0 percent and no delamination, surface blistering, or permanent bowing when tested for 7 days at 200 deg F (93 deg C) according to ASTM D 2126.

4) Cold Aging: Volume decrease not more than 1.0 percent and no delamination, surface blistering, or permanent bowing when tested for 7 days at minus 20 deg F (29 deg C) according to ASTM D 2126.
5) Fatigue: No evidence of delamination, core cracking, or permanent bowing when tested to a 20-lbf/sq. ft. (958-kPa) positive and negative wind load and with deflection of L/180 for 2 million cycles.
6) Autoclave: No delamination when exposed to 2-psi (13.8-kPa) pressure at a temperature of 212 deg F (100 deg C) for 2-1/2 hours.

b. Polyisocyanurate Insulation-Core Performance:
1) Density: 1.8 to 2.3 lb/cu. ft. (29 to 37 kg/cu. m) when tested according to ASTM D 1622.
2) Compressive Strength: Minimum 20 psi (138 kPa) when tested according to ASTM D 1621.
3) Shear Strength: 24 psi (164 kPa) when tested according to ASTM C 273.

2. Wrapped-Edge, Laminated-Insulation-Core Metal Wall Panels: Formed with flush exterior panel facing wrapped over panel edges; designed for independent installation by mechanically attaching panels to supports using staggered, concealed side clips engaging panel edges **OR** through extended panel edges to supports using concealed fasteners, **as directed**; with sealant **OR** gasketed, **as directed**, joints.

a. Exterior Facing:
1) Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
2) Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
3) Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm) **OR** 0.063 inch (1.60 mm) **OR** 0.080 inch (2.03 mm), **as directed**, thick.
4) Surface: Smooth, flat **OR** Embossed, **as directed**.
5) Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
a) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

b. Interior Facing:
1) Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
2) Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
3) Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm), **as directed**, thick.
4) Finish: Manufacturer's standard primer or white polyester.

c. Core Material: Polyisocyanurate **OR** Extruded-polystyrene **OR** Expanded-polystyrene, **as directed**, board insulation.
1) Backer Board: 0.125-inch- (3-mm-) **OR** 0.250-inch- (6-mm-), **as directed**, thick hardboard behind exterior facing for increased impact resistance.

d. Clips: Manufacturer's standard one piece, formed from zinc-coated (galvanized) steel **OR** aluminum-zinc alloy-coated steel **OR** stainless steel, **as directed**.
e. Gaskets: Extruded, dry seal silicone.
f. Sealant: Manufacturer's standard silicone.
g. Panel Thickness: 1.0 inch (25 mm) **OR** 2.0 inches (51 mm) **OR** 3.0 inches (76 mm) **OR** 4.0 inches (102 mm) **OR** 5.0 inches (127 mm) **OR** 6.0 inches (152 mm), **as directed**.
h. Thermal-Resistance Value (R-Value): as directed by the Owner.

3. Shiplap-Edge, Laminated-Insulation-Core Metal Wall Panels: Formed with flush exterior panel facing and with shiplap edges; designed for sequential installation by mechanically attaching panels to supports using concealed clips and fasteners; with factory-applied sealant **OR** gaskets, **as directed**, in side laps.
   a. Exterior Facing:
      1) Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
      2) Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
      3) Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm) **OR** 0.063 inch (1.60 mm), **as directed**, thick.
      4) Surface: Smooth, flat **OR** Embossed, **as directed**.
      5) Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
         a) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
   b. Interior Facing:
      1) Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
      2) Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
      3) Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
      4) Finish: Manufacturer's standard primer or white polyester.
   c. Core Material: Polyisocyanurate **OR** Extruded-polystyrene **OR** Expanded-polystyrene, **as directed**, board insulation.
      1) Backer Board: 0.125-inch- (3-mm-) **OR** 0.250-inch- (6-mm-), **as directed**, thick hardboard behind exterior facing for increased impact resistance.
   d. Clips: Manufacturer's standard one piece, formed from zinc-coated (galvanized) steel **OR** aluminum-zinc alloy-coated steel **OR** stainless steel, **as directed**.
   e. Gaskets: Extruded, dry seal silicone.
   f. Sealant: Manufacturer's standard silicone.
   g. Panel Thickness: 1.0 inch (25 mm) **OR** 2.0 inches (51 mm) **OR** 3.0 inches (76 mm) **OR** 4.0 inches (102 mm) **OR** 5.0 inches (127 mm) **OR** 6.0 inches (152 mm), **as directed**.
   h. Thermal-Resistance Value (R-Value): as directed by the Owner.
4. Framed-Edge, Laminated-Insulation-Core Metal Wall Panels: Formed with flush exterior panel facing and integral, extruded edge members; designed for independent installation by mechanically attaching panels to supports through edge framing using concealed fasteners; with gasketed joints.
   a. Exterior Facing:
      1) Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
      2) Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0-71 mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
      3) Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm) **OR** 0.063 inch (1.60 mm) **OR** 0.080 inch (2.03 mm), **as directed**, thick.
      4) Surface: Smooth, flat **OR** Embossed, **as directed**.
      5) Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
         a) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

b. Interior Facing:
   1) Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
   2) Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
   3) Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
   4) Finish: Manufacturer's standard primer or white polyester.
c. Core Material: Polyisocyanurate **OR** Extruded-polystyrene **OR** Expanded-polystyrene, **as directed**, board insulation.
   1) Backer Board: 0.125-inch- (3.18-mm-) **OR** 0.250-inch- (6-mm-), **as directed**, thick hardboard behind exterior facing for increased impact resistance.
d. Edge Members: Extruded aluminum, not less than 0.063-inch (1.60-mm) wall thickness.
e. Gaskets: Extruded, dry seal silicone.
f. Panel Thickness: 1.0 inch (25 mm) **OR** 2.0 inches (51 mm) **OR** 3.0 inches (76 mm) **OR** 4.0 inches (102 mm) **OR** 5.0 inches (127 mm) **OR** 6.0 inches (152 mm), **as directed**.
g. Thermal-Resistance Value (R-Value): as directed by the Owner.

G. Honeycomb-Core Metal Wall Panels
1. General: Provide factory-formed and -assembled metal wall panels fabricated from two metal facing sheets and honeycomb-core material laminated or otherwise securely bonded to facing sheets during fabrication without use of contact adhesives or pinch rollers, and with joints between panels designed to form weathertight seals. Include accessories required for weathertight installation.
   a. Panel Performance:
      1) Fatigue: No evidence of delamination, core cracking, or permanent bowing when tested to a 20-lbf/sq. ft. (958-kPa) positive and negative wind load and with deflection of L/180 for 2 million cycles.
      2) Autoclave: No delamination when exposed to 2-psi (13.8-kPa) pressure at a temperature of 212 deg F (100 deg C) for 2-1/2 hours.
2. Wrapped-Edge, Honeycomb-Core Metal Wall Panels: Formed with flush exterior panel facing wrapped over panel edges; designed for independent installation by mechanically attaching panels to supports using staggered, concealed side clips engaging panel edges **OR** through extended panel edges to supports using concealed fasteners, **as directed**; with sealant **OR** gasketed, **as directed**, joints.
   a. Facings: Fabricate panel with exterior and interior facings of same material and thickness.
      1) Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
      2) Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
      3) Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm) **OR** 0.063 inch (1.60 mm), **as directed**, thick.
      4) Exterior Facing Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
         a) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
      5) Interior Facing Finish: Manufacturer's standard primer or polyester.
   b. Kraft-Paper Honeycomb Core: Manufacturer's standard phenolic-resin impregnated paper, with not less than 15 percent resin content by weight and chemically treated for fire resistance; with maximum 1/2-inch (13-mm) cell size.
   c. Aluminum Honeycomb Core: Manufacturer's standard 0.003-inch- (0.08-mm-) thick, commercial grade aluminum with maximum 3/4-inch (19-mm) cell size.

d. Clips: Manufacturer's standard one piece, formed from zinc-coated (galvanized) steel **OR** aluminum-zinc alloy-coated steel **OR** stainless steel, **as directed**.
e. Gaskets: Extruded, dry seal silicone.
f. Sealant: Manufacturer's standard silicone.
g. Panel Thickness: 0.25 inch (6 mm) **OR** 1.0 inch (25 mm) **OR** 2.0 inches (51 mm) **OR** 3.0 inches (76 mm) **OR** 4.0 inches (102 mm), **as directed**.

3. Shiplap-Edge, Honeycomb-Core Metal Wall Panels: Formed with flush exterior panel facing and with shiplap edges; designed for sequential installation by mechanically attaching panels to supports using concealed clips and fasteners; with factory-applied sealant **OR** gaskets, **as directed**, in side laps.
    a. Facings: Fabricate panel with exterior and interior facings of same material and thickness.
        1) Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
        2) Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
        3) Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm) **OR** 0.063 inch (1.60 mm), **as directed**, thick.
        4) Exterior Facing Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
            a) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
        5) Interior Facing Finish: Manufacturer's standard primer or polyester.
    b. Kraft-Paper Honeycomb Core: Manufacturer's standard phenolic-resin-impregnated paper, with not less than 15 percent resin content by weight and chemically treated for fire resistance; with maximum 1/2-inch (13-mm) cell size.
    c. Aluminum Honeycomb Core: Manufacturer's standard 0.003-inch- (0.08-mm-) thick, commercial grade aluminum with maximum 3/4-inch (19-mm) cell size.
    d. Clips: Manufacturer's standard one piece, formed from zinc-coated (galvanized) steel **OR** aluminum-zinc alloy-coated steel **OR** stainless steel, **as directed**.
    e. Gaskets: Extruded, dry seal silicone.
    f. Sealant: Manufacturer's standard silicone.
    g. Panel Thickness: 1.0 inch (25 mm) **OR** 1.25 inches (32 mm) **OR** 2.0 inches (51 mm), **as directed**.

4. Framed-Edge, Honeycomb-Core Metal Wall Panels: Formed with flush exterior panel facing and integral, extruded edge members; designed for independent installation by mechanically attaching panels to supports through edge framing using concealed fasteners; with gasketed joints.
    a. Facings: Fabricate panel with exterior and interior facings of same material and thickness.
        1) Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) nominal thickness.
        2) Material: Aluminum sheet, 0.040 inch (1.02 mm) **OR** 0.063 inch (1.60 mm), **as directed**, thick.
        3) Exterior Facing Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
            a) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
        4) Interior Facing Finish: Manufacturer's standard primer or polyester.
    b. Kraft-Paper Honeycomb Core: Manufacturer's standard phenolic-resin-impregnated paper, with not less than 15 percent resin content by weight and chemically treated for fire resistance; with maximum 1/2-inch (13-mm) cell size.
    c. Aluminum Honeycomb Core: Manufacturer's standard 0.003-inch- (0.08-mm-) thick, commercial grade aluminum with maximum 3/4-inch (19-mm) cell size.

d. Edge Members: Extruded aluminum, not less than 0.063-inch (1.6-mm) wall thickness.
e. Gaskets: Extruded, dry seal silicone.
f. Panel Thickness: 1.0 inch (25 mm) **OR** 2.0 inches (51 mm) **OR** 3.0 inches (76 mm), **as directed**.

H. Accessories
1. Wall Panel Accessories: Provide components required for a complete metal wall panel assembly including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels unless otherwise indicated.
a. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal wall panels.
b. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
c. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal wall panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
2. Flashing and Trim: Formed from 0.018-inch- (0.46-mm-) minimum thickness, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal wall panels.

I. Fabrication
1. General: Fabricate and finish metal wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
2. Fabricate metal wall panels in a manner that eliminates condensation on interior side of panel and with joints between panels designed to form weathertight seals.
3. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
4. Fabricate metal wall panel joints with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will minimize noise from movements within panel assembly.
5. Honeycomb-Core Metal Wall Panels: Fabricate panels using manufacturer's standard thermosetting structural adhesive in a lamination process that bonds panel under minimum 10-psi (69-kPa) pressure. Use of contact adhesives with pinch-roll process is not acceptable.
a. Panel Bow Tolerance: Not more than 0.5 percent of panel width or length.
6. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.
a. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
b. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
c. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
d. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
e. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

f. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal wall panel manufacturer.
1) Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

J. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

1.3 EXECUTION

A. Preparation
1. Miscellaneous Framing: Install subgirts, base angles, sills, furring, and other miscellaneous wall panel support members and anchorages according to ASTM C 754 and metal wall panel manufacturer's written recommendations.

B. Metal Wall Panel Installation, General
1. General: Install metal wall panels according to manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts and subgirts unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.
a. Commence metal wall panel installation and install minimum of 300 sq. ft. (27.9 sq. m.) in presence of factory-authorized representative.
b. Shim or otherwise plumb substrates receiving metal wall panels.
c. Flash and seal metal wall panels with weather closures at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until weather barrier and flashings that will be concealed by metal wall panels are installed.
d. Install screw fasteners in predrilled holes.
e. Locate and space fastenings in uniform vertical and horizontal alignment.
f. Install flashing and trim as metal wall panel work proceeds.
g. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
h. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated or, if not indicated, as necessary for waterproofing.
i. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
j. Provide weathertight escutcheons for pipe and conduit penetrating exterior walls.
2. Fasteners:
a. Steel Wall Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized steel fasteners for surfaces exposed to the interior.
b. Aluminum Wall Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized steel fasteners for surfaces exposed to the interior.
c. Copper Wall Panels: Use copper, stainless-steel, or hardware-bronze fasteners.
d. Stainless-Steel Wall Panels: Use stainless-steel fasteners.
3. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action as recommended by metal wall panel manufacturer.

4. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weathertight performance of metal wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal wall panel manufacturer.
   a. Seal metal wall panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal wall panel manufacturer.
   b. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants".

C. Insulated-Core Metal Wall Panel Installation
1. General: Apply continuous ribbon of sealant to panel joint on concealed side of insulated-core metal wall panels as vapor seal; apply sealant to panel joint on exposed side of panels for weather seal.
   a. Fasten insulated-core metal wall panels to supports with fasteners at each lapped joint at location and spacing and with fasteners recommended by manufacturer.
   b. Lap ribbed or fluted sheets one full rib corrugation. Apply panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.
   c. Provide metal-backed washers under heads of exposed fasteners on weather side of insulated metal wall panels.
   d. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
   e. Provide sealant tape at lapped joints of insulated metal wall panels and between panels and protruding equipment, vents, and accessories.
   f. Apply a continuous ribbon of sealant tape to panel side laps and elsewhere as needed to make panels weathertight.
   g. Apply snap-on battens to exposed-fastener, insulated-core metal wall panel seams to conceal fasteners.
2. Foamed-Insulation-Core Metal Wall Panels: Fasten metal wall panels to supports with concealed clips at each joint at location and spacing and with fasteners recommended by manufacturer. Fully engage tongue and groove of adjacent panels.
   a. Install clips to supports with self-tapping fasteners.
3. Laminated-Insulation-Core Metal Wall Panels:
   a. Wrapped-Edge Panels: Mechanically attach wall panels to supports using staggered, concealed side clips engaging wrapped panel edges. Install clips to supports with self-tapping fasteners. Seal joints with backer rod and sealant **OR** manufacturer's standard gaskets, **as directed**.
   b. Wrapped-Edge Panels: Mechanically attach wall panels through extended edge of panels to supports using self-tapping fasteners. Seal joints with backer rod and sealant **OR** manufacturer's standard gaskets, **as directed**.
   c. Shiplap-Edge Panels: Mechanically attach wall panels to supports using staggered, concealed side clips engaging tongue-and-groove panel edges. Install clips to supports with self-tapping fasteners.
      1) Horizontal Joints: Maintain reveal joint of consistent width **OR** Seal joints with backer rod and sealant **OR** Seal joints with manufacturer's standard gaskets, **as directed**.
      2) Vertical Joints: Maintain reveal joint of consistent width **OR** Seal joints with backer rod and sealant **OR** Seal joints with manufacturer's standard gaskets, **as directed**.
   d. Framed-Edge Panels: Mechanically attach wall panels through integral, extruded edge members to supports using self-tapping fasteners. Seal joints with manufacturer's standard gaskets.
4. Honeycomb-Core Metal Wall Panels:
   a. Wrapped-Edge Panels: Mechanically attach wall panels to supports using staggered, concealed side clips engaging wrapped panel edges. Install clips to supports with self-tapping fasteners. Seal joints with backer rod and sealant **OR** manufacturer's standard gaskets, **as directed**.

b. Wrapped-Edge Panels: Mechanically attach wall panels through extended edge of panels to supports using self-tapping fasteners. Seal joints with backer rod and sealant **OR** manufacturer's standard gaskets, **as directed**.

c. Shiplap-Edge Panels: Mechanically attach wall panels to supports using staggered, concealed side clips engaging tongue-and-groove panel edges. Install clips to supports with self-tapping fasteners.

1) Horizontal Joints: Maintain reveal joint of consistent width **OR** Seal joints with backer rod and sealant **OR** Seal joints with manufacturer's standard gaskets, **as directed**.

2) Vertical Joints: Maintain reveal joint of consistent width **OR** Seal joints with backer rod and sealant **OR** Seal joints with manufacturer's standard gaskets, **as directed**.

d. Framed-Edge Panels: Mechanically attach wall panels through integral, extruded edge members to supports using self-tapping fasteners. Seal joints with manufacturer's standard gaskets.

D. Accessory Installation

1. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

a. Install components required for a complete metal wall panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

2. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

a. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.

b. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (605 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

E. Field Quality Control

1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

2. Water Penetration: Test areas of installed system indicated on Drawings for compliance with system performance requirements according to ASTM E 1105 at minimum differential pressure of 20 percent of inward-acting, wind-load design pressure as defined by SEI/ASCE 7, but not less than 6.24 lbf/sq. ft. (299 Pa).

3. Water-Spray Test: After completing the installation of 75-foot- (23-m-) by-2-story minimum area of metal wall panel assembly, test assembly for water penetration according to AAMA 501.2 in a 2-bay area directed by the Owner.

4. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect and test completed metal wall panel installation, including accessories.

5. Remove and replace metal wall panels where tests and inspections indicate that they do not comply with specified requirements.

6. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

F. Cleaning And Protection

1. Remove temporary protective coverings and strippable films, if any, as metal wall panels are installed unless otherwise indicated in manufacturer's written installation instructions. On

completion of metal wall panel installation, clean finished surfaces as recommended by metal wall panel manufacturer. Maintain in a clean condition during construction.

2. After metal wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
3. Replace metal wall panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 46 63 00

Task	Specification	Specification Description
07 46 63 00	07 46 16 00	Metal Wall Panels

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SECTION 07 51 13 00 - BUILT-UP ASPHALT ROOFING

1.1 GENERAL

A. Description Of Work:

1. This specification covers the furnishing and installation of materials for built-up asphalt roofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Built-up asphalt roofing.
   b. Vapor retarder.
   c. Roof insulation.
2. Section includes the installation of insulation strips in ribs of acoustical roof deck. Insulation strips are furnished under Division 5 Section "Steel Deck."

C. Definitions

1. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to built-up roofing.
2. Hot Roofing Asphalt: Roofing asphalt heated to its equiviscous temperature, the temperature at which its viscosity is 125 centipoise for mop-applied roofing asphalt and 75 centipoise for mechanical spreader-applied roofing asphalt, within a range of plus or minus 25 deg F (14 deg C), measured at the mop cart or mechanical spreader immediately before application.

D. Performance Requirements

1. General Performance: Installed built-up roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Built-up roofing and base flashings shall remain watertight.
2. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by built-up roofing manufacturer based on testing and field experience.
3. Roofing System Design: Provide built-up roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
4. FM Approvals Listing: Provide built-up roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a built-up roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.
   a. Fire/Windstorm Classification: Class 1A-60 **OR** Class 1A-75 **OR** Class 1A-90 **OR** Class 1A-105 **OR** Class 1A-120, **as directed**.
   b. Hail Resistance Rating: MH **OR** SH, **as directed**.
5. Energy Performance (for LEED-NC Credit SS 7.2): Provide roofing system with initial Solar Reflectance Index not less than 78 when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.
6. Energy Performance: Provide roofing system that is listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.
7. Energy Performance (for roofs that must comply with California Energy Commission's CEC-Title 24): Provide roofing system with initial solar reflectance not less than 0.70 and emissivity not less than 0.75 when tested according to CRRC-1.

E. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittals:
    a. Product Test Reports for Credit SS 7.2: For roof materials, indicating that roof materials comply with Solar Reflectance Index requirement.
    b. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: For built-up roofing. Include plans, elevations, sections, details, and attachments to other work.
    a. Base flashings and built-up terminations.
    b. Tapered insulation, including slopes.
    c. Crickets, saddles, and tapered edge strips, including slopes.
    d. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
4. Samples: For the following products:
    a. Built-up roofing materials, including base sheet, ply sheet, cap sheet, and flashing sheet, of color specified.
    b. Roof insulation.
    c. 3 lb (1.5 kg) of aggregate surfacing material in gradation and color indicated.
    d. Roof paver, full sized, in each color and texture required.
    e. Walkway pads.
    f. Six insulation fasteners of each type, length, and finish.
5. Qualification Data: For qualified Installer and manufacturer.
6. Manufacturer Certificates: Signed by roofing manufacturer certifying that built-up roofing complies with requirements specified in "Performance Requirements" Article.
    a. Submit evidence of compliance with performance requirements.
7. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of built-up roofing.
8. Research/Evaluation Reports: For components of built-up roofing, from the ICC-ES.
9. Maintenance Data: For built-up roofing to include in maintenance manuals.
10. Warranties: Sample of special warranties.

F. Quality Assurance
1. Manufacturer Qualifications: A qualified manufacturer that is UL listed **OR** FM Approvals approved, **as directed**, for built-up roofing identical to that used for this Project.
2. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by built-up roofing manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
3. Source Limitations: Obtain components including roof insulation and fasteners for built-up roofing from same manufacturer as built-up roofing or approved by built-up roofing manufacturer.
4. Exterior Fire-Test Exposure: ASTM E 108, Class A **OR** Class B **OR** Class C, **as directed**; for application and roof slopes indicated, as determined by testing identical built-up roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.
5. Fire-Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
6. Preinstallation Roofing Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
2. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing manufacturer. Protect stored liquid material from direct sunlight.

a. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

3. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
4. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

H. Project Conditions

1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing to be installed according to manufacturer's written instructions and warranty requirements.

I. Warranty

1. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of built-up roofing that fail in materials or workmanship within specified warranty period.
   a. Special warranty includes built-up roofing membrane, base flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories, roof pavers, and other components of built-up roofing.
   b. Warranty Period: 10 **OR** 15 **OR** 20 **OR** 25 **OR** 30, **as directed**, years from date of Final Completion.
2. Special Project Warranty: Submit roofing Installer's warranty, signed by Installer, covering the Work of this Section, including all components of built-up roofing such as built-up roofing membrane, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, roof pavers, and walkway products, for the following warranty period:
   a. Warranty Period: Two years from date of Final Completion.

1.2 PRODUCTS

A. Built-Up Roofing Manufacturers

B. Base-Sheet Materials

1. Sheathing Paper: Red-rosin type, minimum 3 lb/100 sq. ft. (0.16 kg/sq. m).
2. Base Sheet: ASTM D 4601, Type II, SBS-modified, asphalt-impregnated and -coated sheet, with glass-fiber-reinforcing mat, dusted with fine mineral surfacing on both sides.
   a. Weight: 25 lb/100 sq. ft. (1.2 kg/sq. m) **OR** 40 lb/100 sq. ft. (1.95 kg/sq. m) **OR** 50 lb/100 sq. ft. (2.4 kg/sq. m) **OR** 60 lb/100 sq. ft. (3.0 kg/sq. m) **OR** 75 lb/100 sq. ft. (3.7 kg/sq. m), **as directed**, minimum.

   OR

   Base Sheet: ASTM D 4601, Type I **OR** II, **as directed**, nonperforated, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.

   OR

   Base Sheet: ASTM D 4897, Type II, venting, nonperforated, heavyweight, asphalt-impregnated and -coated, glass-fiber base sheet with coarse granular surfacing or embossed venting channels on bottom surface.

   OR

   Base Sheet: ASTM D 2626, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.

C. Roofing Membrane Plies

1. Ply Sheet: ASTM D 2178, Type IV **OR** VI, **as directed**, asphalt-impregnated, glass-fiber felt.
2. Cap Sheet: ASTM D 3909, asphalt-impregnated and -coated, glass-fiber cap sheet, with white coarse mineral-granule top surfacing and fine mineral surfacing on bottom surface.

D. Base Flashing Sheet Materials
1. Backer Sheet: ASTM D 2178, Type IV **OR** VI, **as directed**, asphalt-impregnated, glass-fiber felt.
OR
Backer Sheet: ASTM D 4601, Type I **OR** II, **as directed**, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.
OR
Backer Sheet: ASTM D 2626, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.
2. Granule-Surfaced Flashing Sheet: ASTM D 6164, Grade G, Type I or II, polyester-reinforced **OR** ASTM D 6163, Grade G, Type I or II, glass-fiber-reinforced **OR** ASTM D 6162, Grade G, Type I or II, composite polyester-reinforced and glass-fiber-reinforced, **as directed**, SBS-modified asphalt sheet; granular surfaced; suitable for application method specified, and as follows:
a. Granule Color: White **OR** Gray **OR** Tan, **as directed**.
3. Metal-Foil-Surfaced Flashing Sheet: ASTM D 6298, glass-fiber-reinforced, SBS-modified asphalt sheet; metal-foil surfaced; suitable for application method specified, and as follows:
a. Foil Surfacing: Aluminum **OR** Copper **OR** Stainless steel **OR** Aluminum, fluoropolymer coated finish, of color and gloss selected from manufacturer's full range, **as directed**.
4. Smooth-Surfaced Flashing Sheet: ASTM D 6222, Grade S, Type I or II, polyester-reinforced **OR** ASTM D 6223, Grade S, Type I or II, composite polyester-reinforced and glass-fiber-reinforced, **as directed**, APP-modified asphalt sheet; smooth surfaced; suitable for application method specified.
OR
Granule-Surfaced Flashing Sheet: ASTM D 6222, Grade G, Type I or II, polyester-reinforced **OR** ASTM D 6223, Grade G, Type I or II, composite polyester-reinforced and glass-fiber-reinforced, **as directed**, APP-modified asphalt sheet; granular surfaced; suitable for application method specified, and as follows:
a. Granule Color: White **OR** Gray **OR** Tan, **as directed**.
5. Glass-Fiber Fabric: Woven glass-fiber cloth, treated with asphalt, complying with ASTM D 1668, Type I.

E. Asphalt Materials
1. Asphalt Primer: ASTM D 41.
2. Roofing Asphalt: ASTM D 312, Type III **OR** IV **OR** III or IV as recommended by built-up roofing manufacturer for application, **as directed**.
3. Roofing Asphalt: ASTM D 6152, SEBS modified.

F. Auxiliary Built-Up Roofing Materials
1. General: Auxiliary materials recommended by roofing manufacturer for intended use and compatible with built-up roofing.
a. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
b. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
1) Plastic Foam Adhesives: 50 g/L.
2) Gypsum Board and Panel Adhesives: 50 g/L.
3) Multipurpose Construction Adhesives: 70 g/L.
4) Fiberglass Adhesives: 80 g/L.
5) Contact Adhesives: 80 g/L.
6) Other Adhesives: 250 g/L.
7) Nonmembrane Roof Sealants: 300 g/L.
8) Sealant Primers for Nonporous Substrates: 250 g/L.
9) Sealant Primers for Porous Substrates: 775 g/L.

2. Cold-Applied Adhesive: Roofing manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive specially formulated for compatibility and use with built-up base flashings.
3. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required by roofing manufacturer for application.
4. Mastic Sealant: Polyisobutylene, plain or modified bitumen, nonhardening, nonmigrating, nonskinning, and nondrying.
5. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening built-up roofing components to substrate, tested by manufacturer for required pullout strength, and acceptable to roofing manufacturer.
6. Metal Flashing Sheet: Metal flashing sheet is specified in Division 7 Section "Sheet Metal Flashing and Trim."
7. Aggregate Surfacing: ASTM D 1863, No. 6 or No. 67, clean, dry, opaque, water-worn gravel or crushed stone, free of sharp edges **OR** crushed slag, free of sharp edges, **as directed**.
8. Miscellaneous Accessories: Provide miscellaneous accessories recommended by built-up roofing manufacturer.

G. Substrate Boards

1. Substrate Board: ASTM C 1396/C 1396M, Type X gypsum board, 5/8 inch (16 mm) thick.
   OR
   Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** Type X, 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.
   OR
   Substrate Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
   OR
   Substrate Board: ASTM C 728, perlite board, 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick, seal coated.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

H. Vapor Retarder

1. Polyethylene Film: ASTM D 4397, 6 mils (0.15 mm) thick, minimum, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
   a. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
      OR
      Adhesive: Manufacturer's standard lap adhesive, FM Approvals approved for vapor-retarder application.
2. Laminated Sheet: Kraft paper/polyethylene laminate, two layers, reinforced with woven fiberglass yarn, laminated and edge reinforced, with maximum permeance rating of 0.50 perm (29 ng/Pa x s x sq. m) and with manufacturer's standard adhesive, **as directed**.
3. Self-Adhering Sheet Vapor Retarder: ASTM D 1970, minimum of 40-mil- (1.0-mm-) thick, polyethylene film laminated to layer of rubberized asphalt adhesive; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold-applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.
   OR
   Self-Adhering Sheet Vapor Retarder: 30- to 40-mil- (0.76- to 1.0-mm-) thick, polyethylene film laminated to layer of butyl rubber adhesive; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold-applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.
4. Glass-Fiber Felts: ASTM D 2178, Type IV, asphalt impregnated.

I. Roof Insulation
1. General: Preformed roof insulation boards manufactured or approved by roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation, **as directed**.
2. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.6-lb/cu. ft. (26-kg/cu. m) **OR** X, 1.3-lb/cu. ft. (21-kg/cu. m), **as directed**, minimum density, square edged.
3. Molded-Polystyrene Board Insulation: ASTM C 578 Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density.
4. Composite Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density, with factory-applied facings, as follows:
   a. Facer: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick.
      OR
      Facer: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
5. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2 **OR** Type II, Class I, Grade 3, **as directed**, felt or glass-fiber mat facer on both major surfaces.
6. Composite Polyisocyanurate Board Insulation: ASTM C 1289, with factory-applied facing board on one major surface as indicated below by type, and felt or glass-fiber mat facer on the other surface.
   a. Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick.
   b. Type V, OSB facer, 7/16 inch (11 mm) thick.
   c. Type VII, glass mat faced gypsum board facer, 1/4 inch (6 mm) thick.
7. Perlite Board Insulation: ASTM C 728, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.
8. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.
9. Cellular-Glass Board Insulation: ASTM C 552, Type IV, rigid, cellular-glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.
10. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48) unless otherwise indicated.
11. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

J. Insulation Accessories
1. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatible with built-up roofing.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate and acceptable to roofing manufacturer.
3. Modified Asphaltic Insulation Adhesive: Insulation manufacturer's recommended modified asphaltic, asbestos-free, cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.
   OR
   Bead-Applied Insulation Adhesive: Insulation manufacturer's recommended bead-applied, low-rise, one- or multicomponent urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
   OR
   Full-Spread Applied Insulation Adhesive: Insulation manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
4. Insulation Cant Strips: ASTM C 728, perlite insulation board.
5. Insulation Cant Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.

6. Wood Nailer Strips: Comply with requirements in Division 6 Section "Rough Carpentry" **OR** "Miscellaneous Carpentry", **as directed**.
7. Tapered Edge Strips: ASTM C 728, perlite insulation board.
   OR
   Tapered Edge Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.
8. Cover Board: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, 1/2 inch (13 mm) thick.
   OR
   Cover Board: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
   OR
   Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.
   OR
   Cover Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
9. Substrate Joint Tape: 6- or 8-inch- (150- or 200-mm-) wide, coated, glass fiber.

K. Coating Materials
1. Roof Coating: ASTM D 1227, Type II, Class 1, mineral-colloid-emulsified, fibered **OR** 2, chemically emulsified, filled or fibered, **as directed**, asphalt emulsion, asbestos free.
   OR
   Roof Coating: ASTM D 1227, Type III, Class 1, mineral-colloid-emulsified **OR** 2, chemically emulsified, **as directed**, asphalt emulsion, nonfibered.
   OR
   Roof Coating: ASTM D 2824, Type I, nonfibered **OR** III, fibered, asbestos-free, **as directed**, aluminum-pigmented asphaltic coating.
   OR
   Roof Coating: Acrylic elastomer emulsion coating, formulated for use on bituminous roof surfaces and complying with ASTM D 6083 **OR** the following, **as directed**:
   a. Initial Percent Elongation (Break): Not less than 60 percent at 0 deg F (-18 deg C) and 200 percent at 73 deg F (23 deg C) when tested according to ASTM D 2370.
   b. Initial Tensile Strength (Maximum Stress): Not less than 100 psi (1.38 MPa) at 73 deg F (23 deg C) and 200 psi (2.76 MPa) at 0 deg F (-18 deg C) when tested according to ASTM D 2370.
   c. Final Percent Elongation (Break) after Accelerated Weathering 1000 hrs.: Not less than 40 percent at 0 deg F (-18 deg C) and 100 percent at 73 deg F (23 deg C) when tested according to ASTM D 2370.
   d. Permeance: Not more than 50 perms when measured according to ASTM D 1653.
   e. Accelerated Weathering 1000 hrs.: No cracking or checking when tested according to ASTM D 4798.
   f. Color: White **OR** Gray **OR** Buff, **as directed**.

L. Walkways
1. Walkway Pads: Mineral-granule-surfaced, reinforced asphaltic composition **OR** Polymer-modified, reconstituted solid-rubber, surface-textured, **as directed**, slip-resisting pads, manufactured as a traffic pad for foot traffic and acceptable to roofing manufacturer, 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, thick, minimum.
2. Walkway Cap Sheet Strips: ASTM D 6164, Grade G, Type I or II, polyester-reinforced **OR** ASTM D 6163, Grade G, Type I or II, glass-fiber-reinforced **OR** ASTM D 6162, Grade G, Type I or II, composite polyester-reinforced and glass-fiber-reinforced, **as directed**, SBS-modified asphalt sheet; granular surfaced; suitable for application method specified, and as follows:
   a. Granule Color: White **OR** Gray **OR** Tan, **as directed**.
3. Roof Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, factory cast for use as roof pavers; absorption not

greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C 67; and as follows:

a. Size: 24 by 24 inches (600 by 600 mm). Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch (1.6 mm) in length, height, and thickness.
b. Compressive Strength: 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, minimum; ASTM C 140.
c. Colors and Textures: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

1.3 EXECUTION

A. Examination

1. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
   a. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
   b. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
   c. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 05 Section "Steel Decking".
   d. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of 1/16 inch (1.6 mm) out of plane relative to adjoining deck.
   e. Verify that minimum concrete drying period recommended by roofing manufacturer has passed.
   f. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
      1) Test for moisture by pouring 1 pint (0.5 L) of hot roofing asphalt on deck at start of each day's work and at start of each roof area or plane. Do not proceed with roofing work if test sample foams or can be easily and cleanly stripped after cooling.
   g. Verify that concrete curing compounds that will impair adhesion of roofing components to roof deck have been removed.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation

1. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing manufacturer's written instructions. Remove sharp projections.
2. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
3. Prime surface of concrete deck with asphalt primer at a rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
4. Install insulation strips in ribs of acoustical roof decks according to acoustical roof deck manufacturer's written instructions.

C. Substrate Board Installation

1. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
   a. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' "RoofNav" and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.
      OR
      Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to built-up roofing manufacturer's written instructions.

D. Vapor-Retarder Installation
1. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
   a. Continuously seal side and end laps with tape **OR** adhesive, **as directed**.

   OR

   Laminate Sheet: Install laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively. Bond vapor retarder to substrate as follows:
   a. Apply adhesive at rate recommended by vapor-retarder manufacturer. Seal laps with adhesive.

      OR

      Apply ribbons of hot roofing asphalt at spacing, temperature, and rate recommended by vapor-retarder manufacturer. Seal laps with hot roofing asphalt.

   OR

   Self-Adhering Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 inches (90 mm) and 6 inches (150 mm), respectively. Seal laps by rolling.

   OR

   Built-up Vapor Retarder: Install two glass-fiber felt plies lapping each felt 19 inches (483 mm) over preceding felt. Embed each felt in a solid mopping of hot roofing asphalt. Glaze-coat completed surface with hot roofing asphalt. Apply hot roofing asphalt within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
2. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into built-up roofing.

E. Insulation Installation
1. Comply with built-up roofing manufacturer's written instructions for installing roof insulation.
2. Install one lapped base sheet course and mechanically fasten to substrate according to built-up roofing manufacturer's written instructions.
3. Nailer Strips: Mechanically fasten 4-inch nominal- (89-mm actual-) width wood nailer strips of same thickness as insulation perpendicular to sloped roof deck at the following spacing:
   a. 16 feet (4.88 m) apart for roof slopes greater than 1 inch per 12 inches (1:12) but less than 3 inches per 12 inches (3:12).
   b. 48 inches (1220 mm) apart for roof slopes greater 3 inches per 12 inches (3:12).
4. Insulation Cant Strips: Install and secure preformed 45-degree insulation cant strips at junctures of built-up roofing with vertical surfaces or angle changes greater than 45 degrees.
5. Install tapered insulation under area of roofing to conform to slopes indicated.
6. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
   a. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
7. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.
   a. Where installing composite and noncomposite board insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
8. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
9. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.
10. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
   a. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.

b. Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
c. Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
OR
Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

11. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
a. If Project is FM Global insured or if FM Approvals requirements are proposed as a performance standard, fasten insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
b. If number of fasteners will be based on ASCE/SEI 7's uplift pressure, fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.

12. Mechanically Fastened and Adhered Insulation: Install first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
a. If Project is FM Global insured or if FM Approvals requirements are proposed as a performance standard, fasten first layer of insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
b. If number of fasteners will be based on ASCE/SEI 7's uplift pressure, fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
c. Set each subsequent layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
OR
Set each subsequent layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
OR
Set each subsequent layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

13. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction. Loosely butt cover boards together and fasten to roof deck, **as directed**. Tape joints if required by roofing manufacturer.
a. Fasten cover boards according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
b. Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.
c. Apply hot roofing asphalt to underside and immediately bond cover board to substrate.

F. Built-Up Roofing Installation, General
1. Install roofing membrane according to roofing manufacturer's written instructions and applicable recommendations of ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing."
a. Install roofing system BU-3 **OR** 4 **OR** 5, **as directed**,-N **OR** I **OR** C, **as directed**,-A-A **OR** S **OR** M, **as directed**, according to roof assembly identification matrix and roof assembly layout illustrations in NRCA's "The NRCA Roofing and Waterproofing Manual" and requirements in this Section.

OR
Install roofing membrane according to roofing manufacturer's written instructions and applicable recommendations of ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing" and as follows:
a. Deck Type: N (nailable) **OR** I (insulated) **OR** C (concrete or nonnailable), **as directed**.
b. Base Sheet: 1 **OR** 1, installed over sheathing paper, **as directed**.
c. Number of Ply Sheets: 2 **OR** 3 **OR** 4, **as directed**.

d. Surfacing Type: A (aggregate) **OR** S (asphalt surfacing or coating) **OR** M (mineral-granule-surfaced cap sheet), **as directed**.
   1) Mineral-granule-surfaced cap sheet is in addition to number of ply sheets specified.

2. Start installation of built-up roofing in presence of manufacturer's technical personnel.
3. Where roof slope exceeds 1/2 inch per 12 inches (1:24) **OR** 3/4 inch per 12 inches (1:18), **as directed**, install built-up roofing sheets parallel with slope.
   a. Backnail built-up roofing sheets to nailer strips **OR** substrate, **as directed**, according to roofing manufacturer's written instructions.
4. Cooperate with testing agencies engaged or required to perform services for installing roofing.
5. Coordinate installation of roofing so insulation and other components of built-up roofing not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.
   a. Provide tie-offs at end of each day's work to cover exposed built-up roofing sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt with joints and edges sealed.
   b. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing.
   c. Remove and discard temporary seals before beginning work on adjoining roofing.
6. Asphalt Heating: Do not raise roofing asphalt temperature above equiviscous temperature range more than one hour before time of application. Do not exceed roofing asphalt manufacturer's recommended temperature limits during roofing asphalt heating. Do not heat roofing asphalt within 25 deg F (14 deg C) of flash point. Discard roofing asphalt maintained at a temperature exceeding finished blowing temperature for more than 4 hours.
   OR
   Asphalt Heating: Heat and apply SEBS-modified roofing asphalt according to roofing manufacturer's written instructions.
7. Substrate-Joint Penetrations: Prevent roofing asphalt and adhesives from penetrating substrate joints, entering building, or damaging built-up roofing components or adjacent building construction.

G. Roofing Membrane Installation
1. Loosely lay one course of sheathing paper, lapping edges and ends a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
2. Install lapped base sheet course, extending sheet over and terminating beyond cants. Attach base sheet as follows:
   a. Mechanically fasten to substrate.
      OR
      Spot- or strip-mop to substrate with hot roofing asphalt.
      OR
      Adhere to substrate in a solid mopping of hot roofing asphalt, **as directed**.
3. Install two **OR** three **OR** four, **as directed**, ply sheets starting at low point of roofing. Align ply sheets without stretching. Shingle side laps of ply sheets uniformly to achieve required number of plies throughout thickness of roofing membrane. Shingle in direction to shed water. Extend ply sheets over and terminate beyond cants.
   a. Embed each ply sheet in a solid mopping of hot roofing asphalt applied at rate required by roofing manufacturer, to form a uniform membrane without ply sheets touching.
4. Cap Sheet: Install lapped granulated cap sheet starting at low point of roofing. Offset laps from laps of preceding ply sheets and align cap sheet without stretching. Lap in direction to shed water. Extend cap sheet over and terminate beyond cants.
   a. Embed cap sheet in a solid mopping of hot roofing asphalt applied at rate required by built-up roofing manufacturer.
5. Aggregate Surfacing: Promptly after installing and testing roofing membrane, base flashing, and stripping, flood-coat roof surface with 60 lb/100 sq. ft. (3.0 kg/sq. m) of hot roofing asphalt. While flood coat is hot and fluid, cast the following average weight of aggregate in a uniform course:
   a. Aggregate Weight: 400 lb/100 sq. ft. (20 kg/sq. m) **OR** 300 lb/100 sq. ft. (15 kg/sq. m), **as directed**.

b. If aggregate surfacing is delayed, promptly apply glaze coat of hot roofing asphalt at a rate of 10 lb/100 sq. ft. (0.5 kg/sq. m).

6. Glaze-coat roofing membrane surface with hot roofing asphalt applied at a rate of 10 to 15 lb/100 sq. ft. (0.5 to 0.75 kg/sq. m).

H. Flashing And Stripping Installation

1. Install base flashing over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through roof, and secure to substrates according to built-up roofing manufacturer's written instructions and as follows:
   a. Prime substrates with asphalt primer if required by built-up roofing manufacturer.
   b. Backer Sheet Application: Mechanically fasten backer sheet to walls or parapets. Adhere backer sheet over built-up roofing at cants in a solid mopping of hot roofing asphalt **OR** cold-applied adhesive, **as directed**.
      OR
      Backer Sheet Application: Adhere backer sheet to substrate in a solid mopping of hot roofing asphalt **OR** cold-applied adhesive, **as directed**.
   c. Flashing Sheet Application: Adhere flashing sheet to substrate in a solid mopping of hot roofing asphalt applied at not less than 425 deg F (218 deg C). Apply hot roofing asphalt to back of flashing sheet if recommended by roofing manufacturer.
      OR
      Flashing Sheet Application: Adhere flashing sheet to substrate in cold-applied adhesive at rate required by roofing manufacturer.
      OR
      Flashing Sheet Application: Adhere flashing sheet to substrate in asphalt roofing cement at rate required by roofing manufacturer.
      OR
      Flashing Sheet Application: Torch apply flashing sheet to substrate.
2. Extend base flashing up walls or parapets a minimum of 8 inches (200 mm) above built-up roofing and 4 inches (100 mm) onto field of built-up roofing.
3. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.
   a. Seal top termination of base flashing with a strip of glass-fiber fabric set in asphalt roofing cement.
4. Install stripping, according to roofing manufacturer's written instructions, where metal flanges and edgings are set on built-up roofing.
   a. Flashing-Sheet Stripping: Install flashing-sheet stripping in a continuous coating of asphalt roofing cement or in a solid mopping of hot roofing asphalt applied at not less than 425 deg F (218 deg C), and extend onto roofing membrane.
      OR
      Flashing-Sheet Stripping: Install flashing-sheet stripping by heat welding and extend onto roofing membrane.
      OR
      Built-up Stripping: Install stripping of not less than two roofing membrane ply sheets, setting each ply in a continuous coating of asphalt roofing cement or in a solid mopping of hot roofing asphalt, and extend onto roofing membrane 4 inches (100 mm) and 6 inches (150 mm), respectively.
5. Roof Drains: Set 30-by-30-inch (760-by-760-mm) metal flashing in bed of asphalt roofing cement on completed built-up roofing. Cover metal flashing with built-up roofing cap-sheet stripping and extend a minimum of 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, beyond edge of metal flashing onto field of built-up roofing. Clamp built-up roofing, metal flashing, and stripping into roof-drain clamping ring.
   a. Install stripping according to roofing manufacturer's written instructions.

I. Coating Installation

1. Apply coating to built-up roofing and base flashings according to manufacturer's written instructions, by spray, roller, or other suitable application method to provide a dry film thickness of not less than 20 mils (0.5 mm).

J. Walkway Installation
   1. Walkway Pads: Install walkway pads using units of size indicated or, if not indicated, of manufacturer's standard size, according to walkway pad manufacturer's written instructions.
      a. Set walkway pads in additional pour coat of hot roofing asphalt after sweeping away loose aggregate surfacing.
   2. Walkway Cap Sheet Strips: Install walkway cap sheet strips, approximately 36 inches (900 mm) wide and in lengths not exceeding 10 feet (3 m), leaving a space of 6 inches (150 mm) between strips, over built-up roofing. Adhere in hot roofing asphalt.
   3. Roof-Paver Walkways: Install walkway roof pavers according to roofing manufacturer's written instructions in locations indicated, to form walkways. Leave 3 inches (75 mm) of space between adjacent roof pavers.

K. Field Quality Control
   1. Testing Agency: Perform roof tests and inspections and to prepare test reports.
   2. Test Cuts: Test specimens will be removed to evaluate problems observed during quality-assurance inspections of built-up roofing as follows:
      a. Approximate quantities of components within built-up roofing will be determined according to ASTM D 3617.
      b. Test specimens will be examined for interply voids according to ASTM D 3617 and to comply with criteria established in Appendix 3 of ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing."
      c. Repair areas where test cuts were made according to roofing manufacturer's written instructions.
   3. Repair or remove and replace components of built-up roofing where test results or inspections indicate that they do not comply with specified requirements.
      a. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

L. Protecting And Cleaning
   1. Protect built-up roofing from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and the Owner.
   2. Correct deficiencies in or remove built-up roofing that does not comply with requirements, repair substrates, and repair or reinstall roofing to a condition free of damage and deterioration at time of Final Completion and according to warranty requirements.
   3. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 51 13 00

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Task	Specification	Specification Description
07 51 13 00	06 05 23 00a	Miscellaneous Carpentry
07 51 13 00	07 01 50 81	Built-Up Coal-Tar Roofing
07 51 13 00	07 53 16 00	EPDM Membrane Roofing
07 51 13 00	07 05 13 00a	APP-Modified Bituminous Membrane Roofing
07 51 13 00	07 05 13 00b	SBS-Modified Bituminous Membrane Roofing
07 51 13 00	07 01 50 81a	Preparation for Re-Roofing
07 52 13 00	07 05 13 00a	APP-Modified Bituminous Membrane Roofing
07 52 13 00	07 01 50 81a	Preparation for Re-Roofing
07 52 16 00	07 05 13 00b	SBS-Modified Bituminous Membrane Roofing
07 52 16 00	07 01 50 81a	Preparation for Re-Roofing

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SECTION 07 53 16 00 - EPDM MEMBRANE ROOFING

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for ethylene-propylene-diene-monomer (EPDM) roofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Adhered EPDM membrane roofing system.
      b. Mechanically fastened EPDM membrane roofing system.
      c. Loosely laid and ballasted EPDM membrane roofing system.
      d. Vapor retarder.
      e. Roof insulation.
   2. Section includes the installation of acoustical roof deck rib insulation strips furnished under Division 05 Section "Steel Decking".

C. Definitions
   1. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

D. Performance Requirements
   1. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.
   2. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.
   3. Roofing System Design: Provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
   4. FM Approvals Listing: Provide membrane roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a membrane roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals' markings.
      a. Fire/Windstorm Classification: Class 1A-60 **OR** Class 1A-75 **OR** Class 1A-90 **OR** Class 1A-105 **OR** Class 1A-120 **OR** Class 1A-135 **OR** Class 1A-150 **OR** Class 1A-165, **as directed**.
      b. Hail Resistance: MH **OR** SH, **as directed**.
   5. Energy Performance (for “cool-roof” performance): Provide roofing system with initial Solar Reflectance Index not less than 78 **OR** 29, **as directed**, when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency, **as directed**.
   6. Energy Performance: Provide roofing system that is listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low **OR** steep, **as directed**,-slope roof products, **as directed**.
   7. Energy Performance: Provide roofing system with initial solar reflectance not less than 0.70 and emissivity not less than 0.75 when tested according to CRRC-1.

E. Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittals:

a. Product Test Reports for Credit SS 7.2: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirement.
b. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.
4. Samples: For each product included in the roofing system.
5. Manufacturer Certificate: Signed by roofing manufacturer certifying that membrane roofing system complies with requirements specified in "Performance Requirements" Article.
   a. Submit evidence of complying with performance requirements.
6. Research/evaluation reports.
7. Field quality-control reports.
8. Maintenance data.
9. Warranties: Sample of special warranties.

F. Quality Assurance
1. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
2. Source Limitations: Obtain components for membrane roofing system from same manufacturer as membrane roofing or approved by membrane roofing manufacturer.
3. Exterior Fire-Test Exposure: ASTM E 108, Class A **OR** Class B **OR** Class C, **as directed**; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.
4. Fire-Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
5. Preinstallation Roofing Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
2. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
   a. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
3. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
4. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

H. Project Conditions
1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

I. Warranty
1. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within 10 **OR** 15 **OR** 20, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. EPDM Membrane Roofing
1. EPDM: ASTM D 4637, Type I, non-reinforced, **OR** Type II, scrim or fabric internally reinforced, **as directed**, uniform, flexible EPDM sheet.
   a. Thickness: 45 mils (1.1 mm) **OR** 60 mils (1.5 mm) **OR** 75 mils (1.9 mm) **OR** 90 mils (2.2 mm), **as directed**, nominal.
   b. Exposed Face Color: Black **OR** White on black, **as directed**.
2. Fabric-Backed EPDM: ASTM D 4637, Type III, non-reinforced, uniform, flexible EPDM sheet, laminated to a nonwoven polyester fabric backing except at selvages.
   a. Composite Thickness: 90 mils (2.3 mm) **OR** 100 mils (2.5 mm) **OR** 105 mils (2.7 mm) **OR** 115 mils (2.9 mm), **as directed**, nominal.
   b. Exposed Face Color: Black **OR** White on black, **as directed**.

B. Auxiliary Membrane Roofing Materials
1. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.
   a. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
   b. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
      1) Plastic Foam Adhesives: 50 g/L.
      2) Gypsum Board and Panel Adhesives: 50 g/L.
      3) Multipurpose Construction Adhesives: 70 g/L.
      4) Fiberglass Adhesives: 80 g/L.
      5) Contact Adhesive: 80 g/L.
      6) Single-Ply Roof Membrane Sealants: 450 g/L.
      7) Nonmembrane Roof Sealants: 300 g/L.
      8) Sealant Primers for Nonporous Substrates: 250 g/L.
      9) Sealant Primers for Porous Substrates: 775 g/L.
      10) Other Adhesives and Sealants: 250 g/L.
2. Sheet Flashing: 60-mil- (1.5-mm-) thick EPDM, partially cured or cured, according to application.
3. Protection Sheet: Epichlorohydrin or neoprene non-reinforced flexible sheet, 55- to 60-mil- (1.4- to 1.5-mm-) thick, recommended by EPDM manufacturer for resistance to hydrocarbons, non-aromatic solvents, grease, and oil.
4. Bonding Adhesive: Manufacturer's standard, water based, **as directed**.
5. Modified Asphaltic Fabric-Backed Membrane Adhesive: Roofing system manufacturer's standard modified asphalt, asbestos-free, cold-applied adhesive formulated for compatibility and use with fabric-backed membrane roofing.
6. Water-Based, Fabric-Backed Membrane Adhesive: Roofing system manufacturer's standard water-based, cold-applied adhesive formulated for compatibility and use with fabric-backed membrane roofing.
7. Low-Rise, Urethane, Fabric-Backed Membrane Adhesive: Roof system manufacturer's standard spray-applied, low-rise, two-component urethane adhesive formulated for compatibility and use with fabric-backed membrane roofing.
8. Seaming Material: Single-component, butyl splicing adhesive and splice cleaner **OR** Manufacturer's standard, synthetic-rubber polymer primer and 3-inch- (75-mm-) wide minimum, butyl splice tape with release film, **as directed**.
9. Lap Sealant: Manufacturer's standard, single-component sealant, colored to match membrane roofing, **as directed**.
10. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.
11. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.
12. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick (25 mm wide by 1.3 mm thick), prepunched.

13. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening membrane to substrate, and acceptable to roofing system manufacturer.
14. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, reinforced EPDM securement strips, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.
15. Liquid coating, specifically formulated for coating EPDM membrane roofing, as follows:
    a. Type: Acrylic emulsion **OR** Hypalon, **as directed**.
    b. Color: White **OR** Gray **OR** Tan **OR** As selected from manufacturer's full range, **as directed**.

C. Substrate Boards

1. Substrate Board: ASTM C 1396/C 1396M, Type X gypsum board, 5/8 inch (16 mm) thick.
   OR
   Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** Type X, 5/8 inch (16 mm), **as directed**, thick.
   OR
   Substrate Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
   OR
   Substrate Board: ASTM C 728, perlite board, 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick, seal coated.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate panel to roof deck.

D. Vapor Retarder

1. Polyethylene Film: ASTM D 4397, 6 mils (0.15 mm) thick, minimum, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
   a. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
   b. Adhesive: Manufacturer's standard lap adhesive, FM Approvals approved for vapor-retarder application.
2. Laminated Sheet: Kraft paper, two layers, laminated with asphalt and edge reinforced with woven fiberglass yarn with maximum permeance rating of 0.50 perm (29 ng/Pa x s x sq. m) and with manufacturer's standard adhesive, **as directed**.
3. Glass-Fiber Felts: ASTM D 2178, Type IV, asphalt impregnated.

E. Roof Insulation

1. General: Preformed roof insulation boards manufactured or approved by EPDM membrane roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation, **as directed**.
2. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.6-lb/cu. ft. (26-kg/cu. m) **OR** Type X, 1.3-lb/cu. ft. (21-kg/cu. m), **as directed**, minimum density, square edged.
3. Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density.
4. Composite Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density, with factory-applied facings, as follows:
   a. Facer: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick.
      OR
      Facer: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.

5. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2 **OR** Type II, Class I, Grade 3, **as directed**, felt or glass-fiber mat facer on both major surfaces.
6. Composite Polyisocyanurate Board Insulation: ASTM C 1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other.
   a. Type IV, cellulosic-fiber-insulation-board facer, Grade 2, 1/2 inch (13 mm) thick.
   b. Type V, OSB facer, 7/16 inch (11 mm) thick.
   c. Type VII, glass mat faced gypsum board facer, 1/4 inch (6 mm) thick.
7. Perlite Board Insulation: ASTM C 728, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.
8. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.
9. Cellular-Glass Board Insulation: ASTM C 552, Type IV, rigid, cellular-glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.
10. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48) unless otherwise indicated.
11. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

F. Insulation Accessories
1. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards, **as directed**, to substrate, and acceptable to roofing system manufacturer.
3. Modified Asphaltic Insulation Adhesive: Insulation manufacturer's recommended modified asphalt, asbestos-free, cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.
4. Bead-Applied Insulation Adhesive: Insulation manufacturer's recommended bead-applied, low-rise, one- or multicomponent urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
5. Full-Spread Applied Insulation Adhesive: Insulation manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
6. Cover Board: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, 1/2 inch (13 mm) thick.
   OR
   Cover Board: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
   OR
   Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.
   OR
   Cover Board: ASTM C 1278/C 1278M, cellulosic-fiber reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
7. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric, water permeable and resistant to UV degradation, type and weight as recommended by roofing system manufacturer for application.

G. Asphalt Materials
1. Roofing Asphalt: ASTM D 312, Type III or Type IV **OR** ASTM D 6152, SEBS modified, **as directed**.
2. Asphalt Primer: ASTM D 41.

H. Aggregate Ballast (for loosely laid and aggregate-ballasted installations)

1. Aggregate Ballast: Provide aggregate ballast that will withstand weather exposure without significant deterioration and will not contribute to membrane degradation, of the following type and size:
   a. Aggregate Type: Smooth, washed, riverbed gravel or other acceptable smooth-faced stone **OR** Crushed gravel or crushed stone, **as directed**.
   b. Size: ASTM D 448, Size 4, ranging in size from 3/4 to 1-1/2 inches (19 to 38 mm).
      OR
      Size: ASTM D 448, Size 2, ranging in size from 1-1/2 to 2-1/2 inches (38 to 63 mm).
      OR
      Size: ASTM D 448, Size 3, ranging in size from 1 to 2 inches (25 to 50 mm).

I. Roof Pavers
1. Lightweight Roof Pavers: Interlocking, lightweight concrete units, specially factory cast for use as roof ballast; grooved back, with four-way drainage capability; beveled, doweled, or otherwise profiled; and as follows:
   a. Size: 8 by 16 inches (200 by 400 mm) **OR** 12 by 12 inches (300 by 300 mm) **OR** 12 by 16-1/2 inches (300 by 420 mm) **OR** 12 by 18 inches (300 by 450 mm), **as directed**.
   b. Weight: At least 10 lb/sq. ft. (50 kg/sq. m) but not exceeding 18 lb/sq. ft. (90 kg/sq. m).
   c. Compressive Strength: 2500 psi (17 MPa) **OR** 5000 psi (34 MPa), **as directed**, minimum.
   d. Colors and Textures: As selected from manufacturer's full range.
2. Rubber Roof Pavers: Interlocking, lightweight rubber units, 24 by 24 by 2-1/4 inches (600 by 600 by 57 mm), 6 lb/sq. ft. (30 kg/sq. m) specially manufactured for use as roof ballast; with grooved back for four-way drainage, beveled and doweled; and as follows:
   a. Perimeter Securement Strip: Manufacturer's standard coated steel sheet channel **OR** aluminum sheet channel **OR** mill-finish aluminum sheet hold down **OR** coated aluminum sheet hold down, color as selected, **as directed**, and fasteners.
   b. Color: Black **OR** Gray **OR** Terra cotta, **as directed**.
3. Heavyweight Roof Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C 67; and as follows:
   a. Size: 12 by 12 inches (300 by 300 mm) **OR** 18 by 18 inches (450 by 450 mm) **OR** 24 by 24 inches (600 by 600 mm), **as directed**. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch (1.6 mm) in length, height, and thickness.
   b. Weight: 18 lb/sq. ft. (90 kg/sq. m) **OR** 22 lb/sq. ft. (110 kg/sq. m), **as directed**.
   c. Compressive Strength: 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, minimum.
   d. Colors and Textures: As selected from manufacturer's full range.

J. Walkways
1. Flexible Walkways: Factory-formed, nonporous, heavy-duty, solid-rubber, slip-resisting, surface-textured walkway pads **OR** rolls, **as directed**, approximately 3/16 inch (5 mm) thick, and acceptable to membrane roofing system manufacturer.
2. Walkway Roof Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C 67; and as follows:
   a. Size: 12 by 12 inches (300 by 300 mm) **OR** 18 by 18 inches (450 by 450 mm) **OR** 24 by 24 inches (600 by 600 mm), **as directed**. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch (1.6 mm) in length, height, and thickness.
   b. Weight: 18 lb/sq. ft. (90 kg/sq. m) **OR** 22 lb/sq. ft. (110 kg/sq. m), **as directed**.
   c. Compressive Strength: 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, minimum.
   d. Colors and Textures: As selected from manufacturer's full range.

1.3 EXECUTION

A. Preparation
1. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
2. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
3. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.
4. Install acoustical roof deck rib insulation strips, specified in Division 05 Section "Steel Decking", according to acoustical roof deck manufacturer's written instructions, immediately before installation of overlying construction and to remain dry.

B. Substrate Board
1. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
   a. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' "RoofNav" and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.
   OR
   Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to membrane roofing system manufacturers' written instructions.

C. Vapor-Retarder Installation
1. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
   a. Continuously seal side and end laps with tape **OR** adhesive, **as directed**.
2. Laminate Sheet: Install laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively. Bond vapor retarder to substrate as follows:
   a. Apply adhesive at rate recommended by vapor-retarder manufacturer. Seal laps with adhesive.
   OR
   Apply ribbons of hot roofing asphalt at spacing, temperature, and rate recommended by vapor-retarder manufacturer. Seal laps with hot roofing asphalt.
3. Built-Up Vapor Retarder: Install two glass-fiber felt plies lapping each felt 19 inches (483 mm) over preceding felt. Embed each felt in a solid mopping of hot roofing asphalt. Glaze-coat completed surface with hot roofing asphalt. Apply hot roofing asphalt within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
4. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into membrane roofing system.

D. Insulation Installation
1. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
2. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.
3. Install tapered insulation under area of roofing to conform to slopes indicated.
4. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.

a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.

5. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
6. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
   a. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
7. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
   a. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
   b. Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
   c. Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
      OR
      Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
8. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
   a. Fasten insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
      OR
      Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.
9. Mechanically Fastened and Adhered Insulation: Install first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
   a. Fasten first layer of insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
      OR
      Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
   b. Set each subsequent layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
      OR
      Set each subsequent layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
      OR
      Set each subsequent layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
10. Loosely Laid Insulation: Loosely lay insulation units over substrate.
11. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction. Loosely butt cover boards together and fasten to roof deck, **as directed**.
    a. Fasten cover boards according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
       OR
       Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.

E. Adhered Membrane Roofing Installation
1. Adhere membrane **OR** fabric-backed membrane, **as directed**, roofing over area to receive roofing according to membrane roofing system manufacturer's written instructions. Unroll membrane roofing and allow to relax before installing.

2. Start installation of membrane roofing in presence of membrane roofing system manufacturer's technical personnel.
3. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
4. Bonding Adhesive: Apply to substrate and underside of membrane roofing at rate required by manufacturer and allow to partially dry before installing membrane roofing. Do not apply to splice area of membrane roofing.
5. Hot Roofing Asphalt: Apply a solid mopping of hot roofing asphalt to substrate at temperature and rate required by manufacturer and install fabric-backed membrane roofing. Do not apply to splice area of membrane roofing.
   OR
   Fabric-Backed Membrane Adhesive: Apply to substrate at rate required by manufacturer and install fabric-backed membrane roofing.
6. In addition to adhering, mechanically fasten membrane roofing securely at terminations, penetrations, and perimeters.
7. Apply membrane roofing with side laps shingled with slope of roof deck where possible.
8. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping membrane roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of membrane roofing terminations.
   a. Apply a continuous bead of in-seam sealant before closing splice if required by membrane roofing system manufacturer.
9. Tape Seam Installation: Clean and prime both faces of splice areas, apply splice tape, and firmly roll side and end laps of overlapping membrane roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of membrane roofing terminations.
10. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
11. Spread sealant or mastic bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
12. Install membrane roofing and auxiliary materials to tie in to existing membrane roofing to maintain weather-tightness of transition and to not void warranty for existing membrane roofing system.
13. Adhere protection sheet over membrane roofing at locations indicated.

F. Mechanically Fastened Membrane Roofing Installation
1. Mechanically fasten membrane roofing over area to receive roofing according to roofing system manufacturer's written instructions. Unroll membrane roofing and allow to relax before installing.
   a. For in-splice attachment, install membrane roofing with long dimension perpendicular to steel roof deck flutes.
2. Start installation of membrane roofing in presence of roofing system manufacturer's technical personnel.
3. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
4. Mechanically fasten or adhere membrane roofing securely at terminations, penetrations, and perimeter of roofing.
5. Apply membrane roofing with side laps shingled with slope of roof deck where possible.
6. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping membrane roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of membrane roofing terminations.
   a. Apply a continuous bead of in-seam sealant before closing splice if required by membrane roofing system manufacturer.
7. Tape Seam Installation: Clean and prime both faces of splice areas, apply splice tape, and firmly roll side and end laps of overlapping membrane roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of membrane roofing terminations.
8. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.

9. Spread sealant or mastic bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
10. In-Splice Attachment: Secure one edge of membrane roofing using fastening plates or metal battens centered within membrane splice and mechanically fasten membrane roofing to roof deck. Field splice seam.
    OR
    Through-Membrane Attachment: Secure membrane roofing using fastening plates or metal battens and mechanically fasten membrane roofing to roof deck. Cover battens and fasteners with a continuous cover strip.
11. Install membrane roofing and auxiliary materials to tie in to existing roofing to maintain weather-tightness of transition and to not void warranty for existing membrane roofing system.
12. Adhere protection sheet over membrane roofing at locations indicated.

G. Loosely Laid And Ballasted Membrane Roofing Installation
1. Loosely lay membrane roofing over area to receive roofing according to roofing system manufacturer's written instructions. Unroll membrane roofing and allow to relax before installing.
    a. Comply with requirements in SPRI RP-4 for System 1 **OR** System 2 **OR** System 3, **as directed**.
2. Start installation of membrane roofing in presence of roofing system manufacturer's technical personnel.
3. Accurately align membrane roofing, without stretching, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
4. Mechanically fasten or adhere perimeter of membrane roofing according to requirements in SPRI RP-4.
    OR
    Mechanically fasten or adhere membrane roofing at corners, perimeters, and transitions according to requirements in SPRI RP-4.
    a. At corners and perimeters, omit aggregate ballast leaving membrane roofing exposed.
    b. At corners and perimeters, adhere a second layer of membrane roofing
5. Apply membrane roofing with side laps shingled with slope of deck where possible.
6. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping membrane roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of membrane roofing terminations.
    a. Apply a continuous bead of in-seam sealant before closing splice if required by membrane roofing system manufacturer.
7. Tape Seam Installation: Clean and prime both faces of splice areas, apply splice tape, and firmly roll side and end laps of overlapping membrane roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of membrane roofing terminations.
8. Leave seams uncovered until inspected by membrane roofing system manufacturer **OR** testing agency, **as directed**.
9. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
10. Spread sealant or mastic bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
11. Install membrane roofing and auxiliary materials to tie in to existing roofing to maintain weather-tightness of transition and to not void warranty for existing membrane roofing system.
12. Adhere protection sheet over membrane roofing at locations indicated.
13. Install protection mat over membrane roofing, overlapping a minimum of 6 inches (150 mm). Install an additional protection mat layer at projections, pipes, vents, and drains, overlapping a minimum of 12 inches (300 mm).
14. Aggregate Ballast, **as directed**: Apply uniformly over membrane roofing at the rate required by membrane roofing system manufacturer, but not less than the following, spreading with care to minimize possibility of damage to membrane roofing system. Lay ballast as membrane roofing is installed, leaving membrane roofing ballasted at the end of the workday.

a. Ballast Weight: Size 4 aggregate, 10 lb/sq. ft. (50 kg/sq. m).
OR
Ballast Weight: Size 2 aggregate, 13 lb/sq. ft. (65 kg/sq. m), at corners and perimeter; Size 4 aggregate, 10 lb/sq. ft. (50 kg/sq. m), elsewhere.
OR
Ballast Weight: Size 2 aggregate, 13 lb/sq. ft. (65 kg/sq. m).

15. Roof-Paver Ballast: Install lightweight **OR** heavyweight, **as directed**, roof-paver ballast according to manufacturer's written instructions.
OR
Roof-Paver Ballast: Install rubber roof-paver ballast according to manufacturer's written instructions, in locations indicated.
a. Install perimeter paver edge securement.
OR
Roof-Paver and Aggregate Ballast: Install heavyweight roof pavers according to manufacturer's written instructions on roof corners and perimeter.
b. Install Size 4 aggregate ballast elsewhere on roofing at a minimum rate of 10 lb/sq. ft. (50 kg/sq. m).
OR
Install Size 2 aggregate ballast elsewhere on roofing at a minimum rate of 13 lb/sq. ft. (65 kg/sq. m).

H. Base Flashing Installation
1. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.
2. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.
3. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
4. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.
5. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars, **as directed**.

I. Coating Installation
1. Apply coatings to membrane roofing **OR** base flashings, **as directed**, according to manufacturer's written recommendations, by spray, roller, or other suitable application method.

J. Walkway Installation
1. Flexible Walkways: Install walkway products in locations indicated. Adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.
2. Roof-Paver Walkways: Install walkway roof pavers according to manufacturer's written instructions in locations indicated, to form walkways. Leave 3 inches (75 mm) of space between adjacent roof pavers.

K. Field Quality Control
1. Testing Agency: Engage a qualified independent testing agency to perform inspections.
2. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
3. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.
4. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

L. Protecting And Cleaning

1. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to the Owner.
2. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Final Completion and according to warranty requirements.
3. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 53 16 00

Task	Specification	Specification Description
07 53 16 00	07 51 13 00	Built-Up Asphalt Roofing
07 53 16 00	07 01 50 81	Built-Up Coal-Tar Roofing
07 53 16 00	07 05 13 00	CSPE Membrane Roofing
07 53 16 00	07 01 50 81a	Preparation for Re-Roofing
07 53 23 00	07 51 13 00	Built-Up Asphalt Roofing
07 53 23 00	07 01 50 81	Built-Up Coal-Tar Roofing
07 53 23 00	07 53 16 00	EPDM Membrane Roofing
07 53 23 00	07 01 50 81a	Preparation for Re-Roofing
07 53 29 00	07 51 13 00	Built-Up Asphalt Roofing
07 53 29 00	07 01 50 81	Built-Up Coal-Tar Roofing
07 53 29 00	07 53 16 00	EPDM Membrane Roofing
07 53 29 00	07 01 50 81a	Preparation for Re-Roofing

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SECTION 07 54 19 00 - POLYVINYL-CHLORIDE (PVC) ROOFING

1.1 GENERAL

A. Description Of Work:

1. This specification covers the furnishing and installation of materials for polyvinyl-chloride (PVC) roofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
    a. Adhered PVC membrane roofing system.
    b. Mechanically fastened PVC membrane roofing system.
    c. Loosely laid and ballasted PVC membrane roofing system.
    d. Vapor retarder.
    e. Roof insulation.
2. Section includes the installation of acoustical roof deck rib insulation strips furnished under Division 05 Section "Steel Decking".

C. Definitions

1. Roofing Terminology: See ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.

D. Performance Requirements

1. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.
2. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.
3. Roofing System Design: Provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
4. FM Approvals Listing, **as directed**: Provide membrane roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a membrane roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.
    a. Fire/Windstorm Classification: Class 1A-60 **OR** Class 1A-75 **OR** Class 1A-90 **OR** Class 1A-105 **OR** Class 1A-120 **OR** Class 1A-135 **OR** Class 1A-150 **OR** Class 1A-165, **as directed**.
    b. Hail Resistance: MH **OR** SH, **as directed**.
5. Energy Performance: Provide roofing system with initial Solar Reflectance Index not less than 78 **OR** 29, **as directed**, when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.
6. Energy Performance: Provide roofing system that is listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low **OR** steep, **as directed**,-slope roof products.
7. Energy Performance(for roofs that must comply with California Energy Commission's CEC-Title 24): Provide roofing system with initial solar reflectance not less than 0.70 and emissivity not less than 0.75 when tested according to CRRC-1.

E. Submittals

1. Product Data: For each type of product indicated.

2. LEED Submittals:
    a. Product Data for Credit SS 7.2: For roof materials, indicating that roof materials comply with Solar Reflectance Index requirement.
    b. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.
4. Samples: For each product included in the roofing system.
5. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
    a. Submit evidence of compliance with performance requirements.
6. Research/evaluation reports.
7. Field quality-control reports.
8. Maintenance data.
9. Warranties: Sample of special warranties.

F. Quality Assurance
1. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
2. Source Limitations: Obtain components for membrane roofing system from same manufacturer as membrane roofing or approved by membrane roofing manufacturer.
3. Exterior Fire-Test Exposure: ASTM E 108, Class A **OR** Class B **OR** Class C, **as directed**; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.
4. Fire-Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
5. Preinstallation Roofing Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
2. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
    a. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
3. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
4. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

H. Project Conditions
1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

I. Warranty
1. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within 10 **OR** 15, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. PVC Membrane Roofing
1. PVC Sheet: ASTM D 4434, Type II, Grade I, glass fiber reinforced, felt backed.
    a. Thickness: 48 mils (1.2 mm), minimum **OR** 60 mils (1.5 mm), nominal **OR** 72 mils (1.8 mm) **OR** 80 mils (2.0 mm) **OR** 96 mils (2.4 mm), **as directed**.
    b. Exposed Face Color: Gray.

OR

PVC Sheet: ASTM D 4434, Type III, fabric reinforced and fabric backed, **as directed**.
    a. Thickness: 45 mils (1.1 mm), minimum **OR** 48 mils (1.2 mm) **OR** 50 mils (1.27 mm) **OR** 60 mils (1.5 mm), nominal **OR** 72 mils (1.8 mm) **OR** 80 mils (2.0 mm) **OR** 100 mils (2.5 mm), **as directed**.
    b. Exposed Face Color: White **OR** Gray, **as directed**.

OR

PVC Sheet: ASTM D 4434, Type IV, fabric reinforced and fabric backed, **as directed**.
    a. Thickness: 36 mils (0.9 mm), minimum **OR** 40 mils (1.0 mm), nominal **OR** 50 mils (1.27 mm) **OR** 60 mils (1.5 mm), nominal **OR** 72 mils (1.8 mm) **OR** 80 mils (2.0 mm) **OR** 100 mils (2.5 mm), **as directed**.
    b. Exposed Face Color: White **OR** Gray, **as directed**.

B. Auxiliary Membrane Roofing Materials
1. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use, and compatible with membrane roofing.
    a. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
    b. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
        1) Plastic Foam Adhesives: 50 g/L.
        2) Gypsum Board and Panel Adhesives: 50 g/L.
        3) Multipurpose Construction Adhesives: 70 g/L.
        4) Fiberglass Adhesives: 80 g/L.
        5) Contact Adhesive: 80 g/L.
        6) Other Adhesives: 250 g/L.
        7) PVC Welding Compounds: 510 g/L.
        8) Adhesive Primer for Plastic: 650 g/L
        9) Single-Ply Roof Membrane Sealants: 450 g/L.
        10) Nonmembrane Roof Sealants: 300 g/L.
        11) Sealant Primers for Nonporous Substrates: 250 g/L.
        12) Sealant Primers for Porous Substrates: 775 g/L.
2. Sheet Flashing: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as PVC sheet membrane.
3. Bonding Adhesive: Manufacturer's standard, water based, **as directed**.
4. Slip Sheet: Manufacturer's standard, of thickness required for application.
5. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.
6. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch (25 mm wide by 1.3 mm) thick, prepunched.
7. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.
8. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

C. Substrate Boards

1. Substrate Board: ASTM C 1396/C 1396M, Type X gypsum board, 5/8 inch (16 mm) thick.
   OR
   Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** Type X, 5/8 inch (16 mm), **as directed**, thick.
   OR
   Substrate Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
   OR
   Substrate Board: ASTM C 728, perlite board, 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick, seal coated.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

D. Vapor Retarder
1. Polyethylene Film: ASTM D 4397, 6 mils (0.15 mm) thick, minimum, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
   a. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
      OR
      Adhesive: Manufacturer's standard lap adhesive, FM Approvals approved for vapor-retarder application.
2. Laminated Sheet: Kraft paper, two layers, laminated with asphalt and edge reinforced with woven fiberglass yarn with maximum permeance rating of 0.50 perm (29 ng/Pa x s x sq. m) and with manufacturer's standard adhesive, **as directed**.
3. Glass-Fiber Felts: ASTM D 2178, Type IV, asphalt impregnated.

E. Roof Insulation
1. General: Preformed roof insulation boards manufactured or approved by PVC membrane roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation, **as directed**.
2. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.6-lb/cu. ft. (26-kg/cu. m) **OR** Type X, 1.3-lb/cu. ft. (21-kg/cu. m), **as directed**, minimum density, square edged.
3. Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density.
4. Composite Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density, with factory-applied facings, as follows:
   a. Facer: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick.
      OR
      Facer: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
5. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2 **OR** Type II, Class I, Grade 3, **as directed**, felt or glass-fiber mat facer on both major surfaces.
6. Composite Polyisocyanurate Board Insulation: ASTM C 1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other.
   a. Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick.
   b. Type V, OSB facer, 7/16 inch (11 mm) thick.
   c. Type VII, glass mat faced gypsum board facer, 1/4 inch (6 mm) thick.
7. Perlite Board Insulation: ASTM C 728, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.

8. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.
9. Cellular-Glass Board Insulation: ASTM C 552, Type IV, rigid, cellular-glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.
10. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48), **as directed**, unless otherwise indicated.
11. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

F. Insulation Accessories
1. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards, **as directed**, to substrate, and acceptable to roofing system manufacturer.
3. Modified Asphaltic Insulation Adhesive: Insulation manufacturer's recommended modified asphalt, asbestos-free, cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.
4. Bead-Applied Insulation Adhesive: Insulation manufacturer's recommended bead-applied, low-rise, one- or multicomponent urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
5. Full-Spread Applied Insulation Adhesive: Insulation manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
6. Cover Board: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, 1/2 inch (13 mm) thick.
   OR
   Cover Board: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
   OR
   Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.
   OR
   Cover Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
7. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric, water permeable and resistant to UV degradation, type and weight as recommended by roofing system manufacturer for application.

G. Asphalt Materials
1. Roofing Asphalt: ASTM D 312, Type III or Type IV **OR** ASTM D 6152, SEBS modified, **as directed**.
2. Asphalt Primer: ASTM D 41.

H. Aggregate Ballast (for loosely laid and aggregate-ballasted installations)
1. Aggregate Ballast: Provide aggregate ballast that will withstand weather exposure without significant deterioration and will not contribute to membrane degradation, of the following type and size:
   a. Aggregate Type: Smooth, washed, riverbed gravel or other acceptable smooth-faced stone **OR** Crushed gravel or crushed stone, **as directed**.
   b. Size: ASTM D 448, Size 4, ranging in size from 3/4 to 1-1/2 inches (19 to 38 mm).
      OR
      Size: ASTM D 448, Size 2, ranging in size from 1-1/2 to 2-1/2 inches (38 to 63 mm).
      OR
      Size: ASTM D 448, Size 3, ranging in size from 1 to 2 inches (25 to 50 mm).

I. Roof Pavers
1. Lightweight Roof Pavers: Interlocking, lightweight concrete units, specially factory cast for use as roof ballast; grooved back, with four-way drainage capability; beveled, doweled, or otherwise profiled; and as follows:
   a. Size: 8 by 16 inches (200 by 400 mm) **OR** 12 by 12 inches (300 by 300 mm) **OR** 12 by 16-1/2 inches (300 by 420 mm) **OR** 12 by 18 inches (300 by 450 mm), **as directed**.
   b. Weight: At least 10 lb/sq. ft. (50 kg/sq. m) but not exceeding 18 lb/sq. ft. (90 kg/sq. m).
   c. Compressive Strength: 2500 psi (17 MPa) **OR** 5000 psi (34 MPa), **as directed**, minimum.
   d. Colors and Textures: As selected from manufacturer's full range.
2. Heavyweight Roof Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C 67; and as follows:
   a. Size: 12 by 12 inches (300 by 300 mm) **OR** 18 by 18 inches (450 by 450 mm) **OR** 24 by 24 inches (600 by 600 mm), **as directed**. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch (1.6 mm) in length, height, and thickness.
   b. Weight: 18 lb/sq. ft. (90 kg/sq. m) **OR** 22 lb/sq. ft. (110 kg/sq. m), **as directed**.
   c. Compressive Strength: 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, minimum.
   d. Colors and Textures: As selected from manufacturer's full range.

J. Walkways
1. Flexible Walkways: Factory-formed, nonporous, heavy-duty, solid-rubber, slip-resisting, surface-textured walkway pads **OR** rolls, **as directed**, approximately 3/16 inch (5 mm) thick, and acceptable to membrane roofing system manufacturer.
2. Walkway Roof Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C 67; and as follows:
   a. Size: 12 by 12 inches (300 by 300 mm) **OR** 18 by 18 inches (450 by 450 mm) **OR** 24 by 24 inches (600 by 600 mm), **as directed**. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch (1.6 mm) in length, height, and thickness.
   b. Weight: 18 lb/sq. ft. (90 kg/sq. m) **OR** 22 lb/sq. ft. (110 kg/sq. m), **as directed**.
   c. Compressive Strength: 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, minimum.
   d. Colors and Textures: As selected from manufacturer's full range.

1.3 EXECUTION

A. Preparation
1. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
2. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
3. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.
4. Install acoustical roof deck rib insulation strips, specified in Division 05 Section "Steel Decking", according to acoustical roof deck manufacturer's written instructions, immediately before installation of overlying construction and to remain dry.

B. Substrate Board
1. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.

a. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' "RoofNav" and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.
OR
Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to membrane roofing system manufacturers' written instructions.

C. Vapor-Retarder Installation
1. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
   a. Continuously seal side and end laps with tape **OR** adhesive, **as directed**.
2. Laminate Sheet: Install laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively. Bond vapor retarder to substrate as follows:
   a. Apply adhesive at rate recommended by vapor-retarder manufacturer. Seal laps with adhesive.
   OR
   Apply ribbons of hot roofing asphalt at spacing, temperature, and rate recommended by vapor-retarder manufacturer. Seal laps with hot roofing asphalt.
3. Built-up Vapor Retarder: Install two glass-fiber felt plies lapping each felt 19 inches (483 mm) over preceding felt. Embed each felt in a solid mopping of hot roofing asphalt. Glaze-coat completed surface with hot roofing asphalt. Apply hot roofing asphalt within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
4. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into membrane roofing system.

D. Insulation Installation
1. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
2. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.
3. Install tapered insulation under area of roofing to conform to slopes indicated.
4. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.
   a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
5. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
6. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
   a. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
7. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
   a. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
   b. Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
   c. Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
   d. Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

8. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
   a. Fasten insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
      OR
      Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.
9. Mechanically Fastened and Adhered Insulation: Install each layer of insulation and secure first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
   a. Fasten first layer of insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
      OR
      Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
   b. Set each subsequent layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
      OR
      Set each subsequent layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
      OR
      Set each subsequent layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
10. Loosely Laid Insulation: Loosely lay insulation units over substrate.
11. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction. Loosely butt cover boards together and fasten to roof deck, **as directed**.
    a. Fasten cover boards according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
       OR
       Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.
12. Install slip sheet over insulation **OR** cover board, **as directed**, and immediately beneath membrane roofing.

E. Adhered Membrane Roofing Installation
1. Adhere membrane roofing over area to receive roofing and install according to membrane roofing system manufacturer's written instructions.
   a. Install sheet according to ASTM D 5036.
2. Start installation of membrane roofing in presence of membrane roofing system manufacturer's technical personnel.
3. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
4. Bonding Adhesive: Apply to substrate and underside of membrane roofing at rate required by manufacturer and allow to partially dry before installing membrane roofing. Do not apply to splice area of membrane roofing.
5. In addition to adhering, mechanically fasten membrane roofing securely at terminations, penetrations, and perimeter of roofing.
6. Apply membrane roofing with side laps shingled with slope of roof deck where possible.
7. Seams: Clean seam areas, overlap membrane roofing, and hot-air weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation.
   a. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
   b. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
   c. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.

8. Spread sealant bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
9. Install membrane roofing and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition and to not void warranty for existing membrane roofing system.

F. Mechanically Fastened Membrane Roofing Installation
1. Mechanically fasten membrane roofing over area to receive roofing and install according to roofing system manufacturer's written instructions.
   a. Install sheet according to ASTM D 5082.
   b. For in-splice attachment, install membranes roofing with long dimension perpendicular to steel roof deck flutes.
2. Start installation of membrane roofing in presence of roofing system manufacturer's technical personnel.
3. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
4. Mechanically fasten or adhere membrane roofing securely at terminations, penetrations, and perimeter of roofing.
5. Apply membrane roofing with side laps shingled with slope of roof deck where possible.
6. In-Seam Attachment: Secure one edge of PVC sheet using fastening plates or metal battens centered within membrane seam and mechanically fasten PVC sheet to roof deck.
7. Seams: Clean seam areas, overlap membrane roofing, and hot-air weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation.
   a. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
   b. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
   c. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
8. Spread sealant bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
9. Install membrane roofing and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition and to not void warranty for existing membrane roofing system.

G. Loosely Laid And Ballasted Membrane Roofing Installation
1. Loosely lay membrane roofing over area to receive roofing and install according to roofing system manufacturer's written instructions.
   a. Comply with requirements in SPRI RP-4 for System 1 **OR** System 2 **OR** System 3, **as directed**.
2. Start installation of membrane roofing in presence of roofing system manufacturer's technical personnel.
3. Accurately align membrane roofing, without stretching, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
4. Mechanically fasten or adhere perimeter of membrane roofing according to requirements in SPRI RP-4.
   OR
   Mechanically fasten **OR** adhere, **as directed**, membrane roofing at corners, perimeters, and transitions according to requirements in SPRI RP-4.
   a. At corners and perimeters, omit aggregate ballast leaving membrane roofing exposed.
      OR
      At corners and perimeters, adhere a second layer of membrane roofing.
5. Apply membrane roofing with side laps shingled with slope of deck where possible.
6. Seams: Clean seam areas, overlap membrane roofing, and hot-air weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation.
   a. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
   b. Verify field strength of seams a minimum of twice daily and repair seam sample areas.

c. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
7. Spread sealant bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
8. Install membrane roofing and auxiliary materials to tie in to existing roofing.
9. Install protection mat over membrane roofing, overlapping a minimum of 6 inches (150 mm). Install an additional protection mat layer at projections, pipes, vents, and drains, overlapping a minimum of 12 inches (300 mm).
10. Aggregate Ballast: Apply uniformly over membrane roofing at the rate required by membrane roofing system manufacturer, but not less than the following, spreading with care to minimize possibility of damage to membrane roofing system. Lay ballast as membrane roofing is installed, leaving membrane roofing ballasted at the end of the workday.
    a. Ballast Weight: Size 4 aggregate, 10 lb/sq. ft. (50 kg/sq. m).
       OR
       Ballast Weight: Size 2 aggregate, 13 lb/sq. ft. (65 kg/sq. m), at corners and perimeter; Size 4 aggregate, 10 lb/sq. ft. (50 kg/sq. m), elsewhere.
       OR
       Ballast Weight: Size 2 aggregate, 13 lb/sq. ft. (65 kg/sq. m).
11. Roof-Paver Ballast: Install lightweight **OR** heavyweight, **as directed**, roof-paver ballast according to manufacturer's written instructions.
    OR
    Roof-Paver and Aggregate Ballast: Install heavyweight roof pavers according to manufacturer's written instructions on roof corners and perimeter.
    a. Install Size 4 aggregate ballast elsewhere on roofing at a minimum rate of 10 lb/sq. ft. (50 kg/sq. m).
       OR
       Install Size 2 aggregate ballast elsewhere on roofing at a minimum rate of 13 lb/sq. ft. (65 kg/sq. m).

H. Base Flashing Installation
1. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.
2. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.
3. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
4. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.
5. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars, **as directed**.

I. Walkway Installation
1. Flexible Walkways: Install walkway products in locations indicated. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.
2. Roof-Paver Walkways: Install walkway roof pavers according to manufacturer's written instructions in locations indicated, to form walkways. Leave 3 inches (75 mm) of space between adjacent roof pavers.

J. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
3. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.

4. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

K. Protecting And Cleaning
1. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to the Owner.
2. Correct deficiencies in or remove membrane roofing system that does not comply with requirements; repair substrates; and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Final Completion and according to warranty requirements.
3. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

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Task	Specification	Specification Description
07 54 19 00	07 01 50 81a	Preparation for Re-Roofing

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SECTION 07 54 23 00 - THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for thermoplastic polyolefin (TPO) roofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Adhered TPO membrane roofing system.
   b. Mechanically fastened TPO membrane roofing system.
   c. Loosely laid and ballasted TPO membrane roofing system.
   d. Vapor retarder.
   e. Roof insulation.
2. Section includes the installation of acoustical roof deck rib insulation strips furnished under Division 05 Section "Steel Decking".

C. Definitions
1. TPO: Thermoplastic polyolefin.
2. Roofing Terminology: See ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

D. Performance Requirements
1. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.
2. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.
3. Roofing System Design: Provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
4. FM Approvals Listing, **as directed**: Provide membrane roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a membrane roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.
   a. Fire/Windstorm Classification: Class 1A-60 **OR** Class 1A-75 **OR** Class 1A-90 **OR** Class 1A-105 **OR** Class 1A-120 **OR** Class 1A-135 **OR** Class 1A-150 **OR** Class 1A-165, **as directed**.
   b. Hail Resistance: MH **OR** SH, **as directed**.
5. Energy Performance: Provide roofing system with initial Solar Reflectance Index not less than 78 **OR** 29, **as directed**, when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.
6. Energy Performance: Provide roofing system that is listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low **OR** steep, **as directed**,-slope roof products.
7. Energy Performance (for roofs that must comply with California Energy Commission's CEC-Title 24): Provide roofing system with initial solar reflectance not less than 0.70 and emissivity not less than 0.75 when tested according to CRRC-1.

E. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Product Data for Credit SS 7.2: For roof materials, indicating that roof materials comply with Solar Reflectance Index requirement.
   b. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.
4. Samples: For each product included in the roofing system.
5. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
   a. Submit evidence of compliance with performance requirements.
6. Research/evaluation reports.
7. Field quality-control reports.
8. Maintenance data.
9. Warranties: Sample of special warranties.

F. Quality Assurance
1. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
2. Source Limitations: Obtain components for membrane roofing system from same manufacturer as membrane roofing or approved by membrane roofing manufacturer.
3. Exterior Fire-Test Exposure: ASTM E 108, Class A **OR** Class B **OR** Class C, **as directed**; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.
4. Fire-Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
5. Preinstallation Roofing Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
2. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
   a. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
3. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
4. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

H. Project Conditions
1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

I. Warranty

1. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within 10 **OR** 15, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. TPO Membrane Roofing
   1. Fabric-Reinforced Thermoplastic Polyolefin Sheet: ASTM D 6878, internally fabric or scrim reinforced, uniform, flexible fabric backed, **as directed**, TPO sheet.
      a. Thickness: 45 mils (1.1 mm) **OR** 60 mils (1.5 mm), **as directed**, nominal.
      b. Exposed Face Color: Black **OR** Gray **OR** Tan **OR** White, **as directed**.

B. Auxiliary Membrane Roofing Materials
   1. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use, and compatible with membrane roofing.
      a. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
      b. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
         1) Plastic Foam Adhesives: 50 g/L.
         2) Gypsum Board and Panel Adhesives: 50 g/L.
         3) Multipurpose Construction Adhesives: 70 g/L.
         4) Fiberglass Adhesives: 80 g/L.
         5) Contact Adhesive: 80 g/L.
         6) Other Adhesives: 250 g/L.
         7) Single-Ply Roof Membrane Sealants: 450 g/L.
         8) Nonmembrane Roof Sealants: 300 g/L.
         9) Sealant Primers for Nonporous Substrates: 250 g/L.
         10) Sealant Primers for Porous Substrates: 775 g/L.
   2. Sheet Flashing: Manufacturer's standard unreinforced thermoplastic polyolefin sheet flashing, 55 mils (1.4 mm) thick, minimum, of same color as sheet membrane.
   3. Bonding Adhesive: Manufacturer's standard, water based, **as directed**.
   4. Slip Sheet: Manufacturer's standard, of thickness required for application.
   5. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.
   6. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick (25 mm wide by 1.3 mm thick), prepunched.
   7. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.
   8. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

C. Substrate Boards
   1. Substrate Board: ASTM C 1396/C 1396M, Type X gypsum board, 5/8 inch (16 mm) thick.
      OR
      Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** Type X, 5/8 inch (16 mm), **as directed**, thick.
      OR
      Substrate Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
      OR

Substrate Board: ASTM C 728, perlite board, 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick, seal coated.

2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

D. Vapor Retarder
1. Polyethylene Film: ASTM D 4397, 6 mils (0.15 mm) thick, minimum, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
   a. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
   OR
   Adhesive: Manufacturer's standard lap adhesive, FM Approvals approved for vapor-retarder application.
2. Laminated Sheet: Kraft paper, two layers, laminated with asphalt and edge reinforced with woven fiberglass yarn with maximum permeance rating of 0.50 perm (29 ng/Pa x s x sq. m) and with manufacturer's standard adhesive, **as directed**.
3. Glass-Fiber Felts: ASTM D 2178, Type IV, asphalt impregnated.

E. Roof Insulation
1. General: Preformed roof insulation boards manufactured or approved by TPO membrane roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation, **as directed**.
2. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.6-lb/cu. ft. (26-kg/cu. m) **OR** Type X, 1.3-lb/cu. ft. (21-kg/cu. m), **as directed**, minimum density, square edged.
3. Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density.
4. Composite Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density, with factory-applied facings, as follows:
   a. Facer: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick.
   OR
   Facer: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
5. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2 **OR** Type II, Class I, Grade 3, **as directed**, felt or glass-fiber mat facer on both major surfaces.
6. Composite Polyisocyanurate Board Insulation: ASTM C 1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other.
   a. Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick.
   b. Type V, OSB facer, 7/16 inch (11 mm) thick.
   c. Type VII, glass mat faced gypsum board facer, 1/4 inch (6 mm) thick.
7. Perlite Board Insulation: ASTM C 728, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.
8. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.
9. Cellular-Glass Board Insulation: ASTM C 552, Type IV, rigid, cellular-glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.
10. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48) unless otherwise indicated.
11. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

F. Insulation Accessories

1. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards, **as directed**, to substrate, and acceptable to roofing system manufacturer.
3. Modified Asphaltic Insulation Adhesive: Insulation manufacturer's recommended modified asphalt, asbestos-free, cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.
4. Bead-Applied Insulation Adhesive: Insulation manufacturer's recommended bead-applied, low-rise, one- or multicomponent urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
5. Full-Spread Applied Insulation Adhesive: Insulation manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
6. Cover Board: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, 1/2 inch (13 mm) thick.
   OR
   Cover Board: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
   OR
   Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.
   OR
   Cover Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
7. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric, water permeable and resistant to UV degradation, type and weight as recommended by roofing system manufacturer for application.

G. Asphalt Materials
1. Roofing Asphalt: ASTM D 312, Type III or Type IV **OR** ASTM D 6152, SEBS modified, **as directed**.
2. Asphalt Primer: ASTM D 41.

H. Aggregate Ballast (for loosely laid and aggregate-ballasted installations)
1. Aggregate Ballast: Provide aggregate ballast that will withstand weather exposure without significant deterioration and will not contribute to membrane degradation, of the following type and size:
   a. Aggregate Type: Smooth, washed, riverbed gravel or other acceptable smooth-faced stone **OR** Crushed gravel or crushed stone, **as directed**.
   b. Size: ASTM D 448, Size 4, ranging in size from 3/4 to 1-1/2 inches (19 to 38 mm).
      OR
      Size: ASTM D 448, Size 2, ranging in size from 1-1/2 to 2-1/2 inches (38 to 63 mm).
      OR
      Size: ASTM D 448, Size 3, ranging in size from 1 to 2 inches (25 to 50 mm).

I. Roof Pavers
1. Lightweight Roof Pavers: Interlocking, lightweight concrete units, specially factory cast for use as roof ballast; grooved back, with four-way drainage capability; beveled, doweled, or otherwise profiled; and as follows:
   a. Size: 8 by 16 inches (200 by 400 mm) **OR** 12 by 12 inches (300 by 300 mm) **OR** 12 by 16-1/2 inches (300 by 420 mm) **OR** 12 by 18 inches (300 by 450 mm), **as directed**.
   b. Weight: At least 10 lb/sq. ft. (50 kg/sq. m) but not exceeding 18 lb/sq. ft. (90 kg/sq. m).
   c. Compressive Strength: 2500 psi (17 MPa) **OR** 5000 psi (34 MPa), **as directed**, minimum.
   d. Colors and Textures: As selected from manufacturer's full range.

2. Heavyweight Roof Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C 67; and as follows:
   a. Size: 12 by 12 inches (300 by 300 mm) **OR** 18 by 18 inches (450 by 450 mm) **OR** 24 by 24 inches (600 by 600 mm), **as directed**. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch (1.6 mm) in length, height, and thickness.
   b. Weight: 18 lb/sq. ft. (90 kg/sq. m) **OR** 22 lb/sq. ft. (110 kg/sq. m), **as directed**.
   c. Compressive Strength: 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, minimum.
   d. Colors and Textures: As selected from manufacturer's full range.

J. Walkways
1. Flexible Walkways: Factory-formed, nonporous, heavy-duty, solid-rubber, slip-resisting, surface-textured walkway pads **OR** rolls, **as directed**, approximately 3/16 inch (5 mm) thick, and acceptable to membrane roofing system manufacturer.
2. Walkway Roof Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C 67; and as follows:
   a. Size: 12 by 12 inches (300 by 300 mm) **OR** 18 by 18 inches (450 by 450 mm) **OR** 24 by 24 inches (600 by 600 mm), **as directed**. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch (1.6 mm) in length, height, and thickness.
   b. Weight: 18 lb/sq. ft. (90 kg/sq. m) **OR** 22 lb/sq. ft. (110 kg/sq. m), **as directed**.
   c. Compressive Strength: 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, minimum.
   d. Colors and Textures: As selected from manufacturer's full range.

1.3 EXECUTION

A. Preparation
1. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
2. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
3. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.
4. Install acoustical roof deck rib insulation strips, specified in Division 05 Section "Steel Decking", according to acoustical roof deck manufacturer's written instructions, immediately before installation of overlying construction and to remain dry.

B. Substrate Board
1. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
   a. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' "RoofNav" and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.
      OR
      Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to membrane roofing system manufacturers' written instructions.

C. Vapor-Retarder Installation

1. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
   a. Continuously seal side and end laps with tape **OR** adhesive, **as directed**.
2. Laminate Sheet: Install laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively. Bond vapor retarder to substrate as follows:
   a. Apply adhesive at rate recommended by vapor-retarder manufacturer. Seal laps with adhesive.
      OR
      Apply ribbons of hot roofing asphalt at spacing, temperature, and rate recommended by vapor-retarder manufacturer. Seal laps with hot roofing asphalt.
3. Built-up Vapor Retarder: Install two glass-fiber felt plies lapping each felt 19 inches (483 mm) over preceding felt. Embed each felt in a solid mopping of hot roofing asphalt. Glaze-coat completed surface with hot roofing asphalt. Apply hot roofing asphalt within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
4. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into membrane roofing system.

D. Insulation Installation
1. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
2. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.
3. Install tapered insulation under area of roofing to conform to slopes indicated.
4. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.
   a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
5. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
6. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
   a. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
7. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
   a. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
   b. Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
   c. Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
   d. Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
8. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
   a. Fasten insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
      OR
      Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.

9. Mechanically Fastened and Adhered Insulation: Install each layer of insulation and secure first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
    a. Fasten first layer of insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
       OR
       Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
    b. Set each subsequent layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
       OR
       Set each subsequent layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
       OR
       Set each subsequent layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
10. Loosely Laid Insulation: Loosely lay insulation units over substrate.
11. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction. Loosely butt cover boards together and fasten to roof deck, **as directed**.
    a. Fasten cover boards according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
       OR
       Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.
12. Install slip sheet over insulation **OR** cover board, **as directed**, and immediately beneath membrane roofing.

E. Adhered Membrane Roofing Installation
1. Adhere membrane roofing over area to receive roofing and install according to membrane roofing system manufacturer's written instructions.
2. Start installation of membrane roofing in presence of membrane roofing system manufacturer's technical personnel.
3. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
4. Bonding Adhesive: Apply to substrate and underside of membrane roofing at rate required by manufacturer and allow to partially dry before installing membrane roofing. Do not apply to splice area of membrane roofing.
5. In addition to adhering, mechanically fasten membrane roofing securely at terminations, penetrations, and perimeter of roofing.
6. Apply membrane roofing with side laps shingled with slope of roof deck where possible.
7. Seams: Clean seam areas, overlap membrane roofing, and hot-air weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation.
    a. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
    b. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
    c. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
8. Spread sealant bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
9. Install membrane roofing and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition and to not void warranty for existing membrane roofing system, **as directed**.

F. Mechanically Fastened Membrane Roofing Installation

1. Mechanically fasten membrane roofing over area to receive roofing and install according to roofing system manufacturer's written instructions.
   a. For in-splice attachment, install membranes roofing with long dimension perpendicular to steel roof deck flutes.
2. Start installation of membrane roofing in presence of roofing system manufacturer's technical personnel.
3. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
4. Mechanically fasten or adhere membrane roofing securely at terminations, penetrations, and perimeter of roofing.
5. Apply membrane roofing with side laps shingled with slope of roof deck where possible.
6. In-Seam Attachment: Secure one edge of TPO sheet using fastening plates or metal battens centered within membrane seam and mechanically fasten TPO sheet to roof deck.
7. Seams: Clean seam areas, overlap membrane roofing, and hot-air weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation.
   a. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
   b. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
   c. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
8. Spread sealant bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
9. Install membrane roofing and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition and to not void warranty for existing membrane roofing system.

G. Loosely Laid And Ballasted Membrane Roofing Installation
1. Loosely lay membrane roofing over area to receive roofing and install according to roofing system manufacturer's written instructions.
   a. Comply with requirements in SPRI RP-4 for System 1 **OR** System 2 **OR** System 3, **as directed**.
2. Start installation of membrane roofing in presence of roofing system manufacturer's technical personnel.
3. Accurately align membrane roofing, without stretching, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
4. Mechanically fasten or adhere perimeter of membrane roofing according to requirements in SPRI RP-4.
   OR
   Mechanically fasten **OR** adhere, **as directed**, membrane roofing at corners, perimeters, and transitions according to requirements in SPRI RP-4.
   a. At corners and perimeters, omit aggregate ballast leaving membrane roofing exposed.
      OR
      At corners and perimeters, adhere a second layer of membrane roofing.
5. Apply membrane roofing with side laps shingled with slope of deck where possible.
6. Seams: Clean seam areas, overlap membrane roofing, and hot-air weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation.
   a. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
   b. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
   c. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
7. Spread sealant bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
8. Install membrane roofing and auxiliary materials to tie in to existing roofing.
9. Install protection mat over membrane roofing, overlapping a minimum of 6 inches (150 mm). Install an additional protection mat layer at projections, pipes, vents, and drains, overlapping a minimum of 12 inches (300 mm).

10. Aggregate Ballast: Apply uniformly over membrane roofing at the rate required by membrane roofing system manufacturer, but not less than the following, spreading with care to minimize possibility of damage to membrane roofing system. Lay ballast as membrane roofing is installed, leaving membrane roofing ballasted at the end of the workday.
    a. Ballast Weight: Size 4 aggregate, 10 lb/sq. ft. (50 kg/sq. m).
       OR
       Ballast Weight: Size 2 aggregate, 13 lb/sq. ft. (65 kg/sq. m), at corners and perimeter; Size 4 aggregate, 10 lb/sq. ft. (50 kg/sq. m), elsewhere.
       OR
       Ballast Weight: Size 2 aggregate, 13 lb/sq. ft. (65 kg/sq. m).
11. Roof-Paver Ballast: Install lightweight **OR** heavyweight, **as directed**, roof-paver ballast according to manufacturer's written instructions.
    OR
    Roof-Paver and Aggregate Ballast: Install heavyweight roof pavers according to manufacturer's written instructions on roof corners and perimeter.
    a. Install Size 4 aggregate ballast elsewhere on roofing at a minimum rate of 10 lb/sq. ft. (50 kg/sq. m).
       OR
       Install Size 2 aggregate ballast elsewhere on roofing at a minimum rate of 13 lb/sq. ft. (65 kg/sq. m).

H. Base Flashing Installation
1. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.
2. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.
3. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
4. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.
5. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars, **as directed**.

I. Walkway Installation
1. Flexible Walkways: Install walkway products in locations indicated. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.
2. Roof-Paver Walkways: Install walkway roof pavers according to manufacturer's written instructions in locations indicated, to form walkways. Leave 3 inches (75 mm) of space between adjacent roof pavers.

J. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
3. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.
4. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

K. Protecting And Cleaning
1. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to the Owner.

2. Correct deficiencies in or remove membrane roofing system that does not comply with requirements; repair substrates; and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Final Completion and according to warranty requirements.
3. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 54 23 00

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Task	Specification	Specification Description
07 54 23 00	07 01 50 81a	Preparation for Re-Roofing

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SECTION 07 56 00 00 - COATED FOAMED ROOFING

1.1 GENERAL

A. Description Of Work:

1. This specification covers the furnishing and installation of materials for coated foamed roofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Spray-applied, polyurethane foam insulation.
   b. Elastomeric roof coatings.
   c. Mineral granules.
   d. Aggregate.
   e. Walkways.

C. Performance Requirements

1. Watertightness: Provide coated foamed roofing that is watertight and will not permit the passage of water.
2. Material Compatibility: Provide polyurethane foam, elastomeric coatings, and miscellaneous roofing materials that are compatible with one another and able to bond to substrate under conditions of service and application required, as demonstrated by coated foamed roofing manufacturer based on testing and field experience.
3. Roofing System Design: Provide a coated foamed roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to SEI/ASCE 7.
4. FMG Listing: Provide roofing system and component materials that comply with requirements in FMG 4450 for steel roof decks and FMG 4470 for roof covers as part of a foamed roofing system and that are listed in FMG's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FMG markings.
   a. Fire/Windstorm Classification: Class 1A-60 **OR** 75 **OR** 90 **OR** 105 **OR** 120, **as directed**.
   b. Hail-Resistance Classification: MH **OR** SH, **as directed**.
5. Energy Performance: Provide roofing system with Solar Reflectance Index not less than 78 **OR** 29, **as directed**, when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.

D. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittal:
   a. Product Test Reports for Credit SS 7.2: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirement.
3. Samples: For each exposed product and for each color and texture specified.
4. Research/evaluation reports.
5. Maintenance data.
6. Warranty: Sample of special warranty.
7. Warranty: Sample of special warranty.

E. Quality Assurance

1. Installer Qualifications: A qualified installer who is approved, authorized, or licensed by roof coating manufacturer for installation of manufacturer's product over polyurethane foam.

a. Engage an installer who participates in and who has fulfilled requirements of the SPFA Accreditation Program for company accreditation and individual applicator accreditation for personnel assigned to work on Project.
2. Source Limitations: Obtain polyurethane foam materials from single source or producer and coating products from single, coated foamed roofing manufacturer.
3. Fire-Test-Response Characteristics: Provide coated foamed roofing systems with the fire-test-response characteristics indicated, as determined by testing identical systems per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
   a. Surface-Burning Characteristics: Maximum flame-spread and smoke-developed indexes of 75 and 450, respectively; ASTM E 84.
   b. Exterior Fire-Test Exposure: ASTM E 108; Class A.
   c. Fire-Resistance Ratings: ASTM E 119, determined for coated polyurethane foam roofing as part of a roof assembly.
4. Comply with recommendations in NRCA's "Quality Control Guidelines for the Application of Spray Polyurethane Foam Roofing."
5. Comply with recommendations in SPFA AY 104, "Spray Polyurethane Foam Systems for New and Remedial Roofing."
6. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Deliver materials to Project site in original containers with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, shelf life, and directions for storing and mixing with other components.
2. Store materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by manufacturer. Protect stored materials from direct sunlight.
3. Remove and replace material that cannot be applied within its stated shelf life.

G. Warranty
1. Special Warranty: Coated foamed roofing manufacturer's standard form in which manufacturer agrees to repair or replace coated foamed roofing that does not comply with requirements or that does not remain watertight within five **OR** 10, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Polyurethane Foam
1. Polyurethane Foam: Rigid cellular polyurethane, spray applied, produced by the catalyzed chemical reaction of polyisocyanates with polyhydroxyls, with stabilizers, fire retardants, and blowing agents added; and complying with ASTM C 1029, Type III, as certified by a qualified independent testing agency.
   a. In-Place Density: 2.8 to 3.0 lb/cu. ft. (44.9 to 48.1 kg/cu. m); ASTM D 1622.
   b. Surface-Burning Characteristic: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
      1) Flame-Spread Index: 75 or less.

B. Urethane Coatings
1. Urethane Coatings: Liquid urethane elastomeric coating system, specifically formulated for coating spray polyurethane roofing, of the following composition, coat type, and topcoat color and complying with specified performance and physical requirements.
   a. Base-Coat Composition and Type: One-component **OR** Two-component, **as directed**, aromatic urethane.

b. Topcoat Composition and Type: One-component **OR** Two-component, **as directed**, aromatic **OR** aliphatic, **as directed**, urethane.
c. Topcoat Color: White **OR** Gray **OR** Tan **OR** Copper **OR** Black, **as directed**.
d. Topcoat Color at Walkways: White **OR** Gray **OR** Tan **OR** Copper **OR** Black, **as directed**.
e. Tensile Strength: 400 psi (2.8 MPa) per ASTM D 412.
f. Elongation: 300 percent at 75 deg F (24 deg C) per ASTM D 412.
g. Permanent Set at Break: 30 percent maximum per ASTM D 412.
h. Tear Resistance: 100 lbf/inch (17.5 kN/m) per ASTM D 1004.
i. Water Absorption: 3 percent maximum by weight, 168 hours at 75 deg F (24 deg C) per ASTM D 471.
j. Permeance:
   1) Minimum 0.7 perms (40.2 ng/Pa x s x sq. m) at 20 mils (0.5 mm) thick per ASTM E 96.
      OR
      Minimum 5.0 perms (286 ng/Pa x s x sq. m) at 20 mils (0.5 mm) thick per ASTM E 96.

C. Silicone Coatings
1. Silicone Coatings: Liquid silicone elastomeric coating system, complying with ASTM D 6694 and specifically formulated for coating spray polyurethane roofing.
   a. Base-Coat and Topcoat Composition: One-component **OR** Two-component, **as directed**, silicone.
   b. Topcoat Color: White **OR** Gray,**as directed** .
   c. Topcoat Color at Walkways: White **OR** Gray, **as directed**.
   d. Permeance: Minimum 5.0 perms (286 ng/Pa x s x sq. m) at 20 mils (0.5 mm) thick per ASTM E 96.

D. Acrylic Coatings
1. Acrylic Coatings: Liquid acrylic elastomeric emulsion coating system, complying with ASTM D 6083 and specifically formulated for coating spray polyurethane roofing.
   a. Topcoat Color: White **OR** Gray **OR** Buff, **as directed**.
   b. Topcoat Color at Walkways: White **OR** Gray **OR** Buff, **as directed**.
   c. Permeance: Minimum 5.0 perms (286 ng/Pa x s x sq. m) at 20 mils (0.5 mm) thick per ASTM E 96.

E. Substrate Board
1. Thermal Barrier:
   a. Glass-mat, water-resistant gypsum board, ASTM C 1177/C 1177M, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), Type X, **as directed**.
   b. ASTM C 36/C 36M, 5/8-inch (16-mm) gypsum board base, Type X.
2. Recovery Board and Fasteners: As recommended by polyurethane foam manufacturer, and meeting the requirements of Division 07 Section "Preparation For Re-roofing".
3. Thermal-Barrier Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FMG 4470, and designed and sized for fastening thermal barrier to substrate.

F. Auxiliary Materials
1. Primer: Polyurethane foam manufacturer's standard factory-formulated primer.
2. Vapor Retarder: Fluid applied **OR** Bituminous membrane **OR** As recommended by coated foamed roofing manufacturer, **as directed**.
3. Mineral Granules: Ceramic-coated roofing granules, No. 11 screen size with 100 percent passing No. 8 (2.36-mm) sieve and 98 percent of mass retained by No. 40 (0.42-mm) sieve.
   a. Color: Buff white **OR** Gray **OR** Green **OR** Red, **as directed**.
4. Aggregate: Coarse mineral aggregate, 3/4 inch (19 mm) maximum, ASTM D 1863, No. 7 or No. 67 gradation.

5. Reinforcement: Flexible polyester or fiberglass mat of weight, type, and composition recommended by roof coating manufacturer for embedment in liquid coating.
6. Walkway Pads: Factory formed of nonwoven PVC strands, porous, UV stabilized, of 5/16-inch (8-mm) nominal thickness, and approved by roof coating manufacturer. Provide pad sizes indicated.
   a. Color: Yellow **OR** Gray **OR** Blue **OR** Orange **OR** Green, **as directed**.
7. Sealant: ASTM C 920, Class 25, Use NT, Grade NS, Type M, multicomponent urethane **OR** Type S, one-component, neutral- or acid-curing silicone, **as directed**, and as recommended by coated foamed roofing manufacturer for substrate and joint conditions and for compatibility with roofing materials.
8. Sheet Flashing and Accessories: Types recommended by coated foamed roofing manufacturer, provided at locations indicated and as recommended by coated foamed roofing manufacturer.

1.3 EXECUTION

A. Substrate Board
1. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
   a. Fasten thermal barrier to top flanges of steel deck according to recommendations in FMG's "Approval Guide" for specified Windstorm Resistance Classification.
   b. Fasten thermal barrier to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to coated foamed roofing manufacturer's written instructions.
   c. Install recovery board according to coated foamed roofing manufacturer's written instructions and the requirements of Division 07 Section "Preparation For Re-roofing". Fasten through existing roofing to roof structure as indicated. Space fasteners for wind-uplift conditions at Project site **OR** as indicated, **as directed**.

B. Surface Preparation
1. Clean and prepare substrate according to coated foamed roofing manufacturer's written instructions. Provide clean, dust-free, dew-free, and dry substrate for coated foamed roofing application.
2. Remove grease, oil, form-release agents, curing compounds, and other contaminants from substrate.
3. Prepare substrate for recovering according toDivision 07 Section "Preparation For Re-roofing" and to coated foamed roofing manufacturer's written instructions.
4. Cover and mask adjoining surfaces not receiving coated foamed roofing to prevent overspray or spillage affecting other construction. Close off roof drains, removing roof-drain plugs when no work is being done or when rain is forecast.
   a. Remove masking after polyurethane foam application and remask adjoining substrates before coating.
5. Prime substrate if recommended by coated foamed roofing manufacturer.
6. Fill, cover, or tape joints and cracks in substrate that exceed a width of 1/4 inch (6 mm). Remove dust and dirt from joints and cracks before applying polyurethane foam.
7. Install vapor retarder according to coated foamed roofing manufacturer's written instructions.

C. Polyurethane Foam Application
1. General: Mix and apply polyurethane foam according to ASTM D 5469 and coated foamed roofing manufacturer's written instructions.
   a. Fill irregularities and areas of ponding.
   b. Apply the required full thickness of polyurethane foam in any specific area on same day.
   c. Apply only the area of polyurethane foam that can be covered on same day with required base coating.
   d. Apply polyurethane foam to avoid overspray beyond immediate area of work.

2. Apply polyurethane foam in lift thicknesses not less than 1/2 inch (13 mm) and not more than 1-1/2 inches (38 mm).
3. Uniformly apply total thickness of polyurethane foam indicated, but not less than 1 inch (25 mm), to a surface tolerance of plus 1/4 inch (6 mm) and no minus.
4. Apply polyurethane foam to roof penetrations, terminations, and vertical surfaces as indicated. Unless otherwise indicated, extend polyurethane foam at least 4 inches (100 mm) above elevation of adjacent roof field.
5. Surface Finish: Provide finished surface of polyurethane foam within the following range of surface textures as defined by ASTM D 5469:
   a. Texture: Smooth to orange peel **OR** coarse orange peel **OR** rippling verge of popcorn, **as directed**.
6. Remove and replace polyurethane foam not complying with minimum surface-texture limitations. Remove defective thickness and prepare and reapply polyurethane foam with acceptable, uniform results.

D. Coating Application
1. Allow polyurethane foam substrate to cure for a minimum of two hours and remove dust, dirt, water, and other contaminants before applying coating.
2. Apply coating system to polyurethane foam, in two or more coats and according to roof coating manufacturer's written instructions, by spray, roller, or other suitable application method.
3. Apply base coat and one or more topcoats to obtain a uniform, seamless membrane free of blisters and pinholes. Apply each coat at right angles to preceding coat, using contrasting colors for successive coats.
   a. Apply base coat on same day as polyurethane foam is applied and allow it to cure.
   b. Apply topcoat(s) after removing dust, dirt, water, and other contaminants from base coat.
   c. Urethane Coating: Apply base coat and topcoat to a minimum dry film thickness recommend by coated foamed roofing manufacturer **OR** of 25 mils (0.64 mm) **OR** of 30 mils (0.76 mm) **OR** of 35 mils (0.89 mm), **as directed**.
   d. Silicone Coating: Apply base coat and topcoat to a minimum dry film thickness recommend by coated foamed roofing manufacturer **OR** of 20 mils (0.50 mm) **OR** of 22 mils (0.56 mm) **OR** of 26 mils (0.66 mm) **OR** of 30 mils (0.76 mm), **as directed**.
   e. Acrylic Coating: Apply base coat and topcoat to a minimum dry film thickness recommend by coated foamed roofing manufacturer **OR** of 25 mils (0.64 mm) **OR** of 28 mils (0.71 mm) **OR** of 32 mils (0.81 mm), **as directed**.
4. Apply coating system at wall terminations and vertical surfaces to extend beyond polyurethane foam by 4 inches (100 mm), minimum.
5. Mineral Granules: Apply mineral granules over wet topcoat using pressure equipment at the rate of 0.5 lb/sq. ft. (2.45 kg/sq. m). Remove excess granules after topcoat has cured.
6. Sealant: Apply sealant to perimeter and other terminations where indicated or required by coated foamed roofing manufacturer.
7. Walkways: Install roof walkways in pattern and locations indicated. Mask off completed roof coating adjacent to walkways and apply one or two additional topcoats to achieve a minimum dry film thickness recommended by coated foamed roofing manufacturer. Spread mineral granules uniformly at a rate of 0.5 lb/sq. ft. (2.45 kg/sq. m) into final wet coating. Remove masking and excess granules after topcoat has cured.
8. Walkways: Install roof walkways in pattern and locations indicated. Mask off completed roof coating adjacent to walkways and apply one additional topcoat to achieve a minimum dry film thickness recommended by coated foamed roofing manufacturer. Lay reinforcing fabric into wet coating and apply another topcoat, completely filling fabric. Spread mineral granules uniformly at a rate of 0.5 lb/sq. ft. (2.45 kg/sq. m) into final wet coating. Remove masking and excess granules after topcoat has cured.
9. Walkways: Install walkway pads in pattern and locations indicated. Adhere walkway pads to substrate with compatible adhesive according to coated foamed roofing manufacturer's written instructions.
10. Aggregate: Apply aggregate uniformly over coated polyurethane foam at coated foamed roofing manufacturer's recommended rate, but not less than 6 lb/sq. ft. (29 kg/sq. m) and a minimum

thickness of 3/4 inch (19 mm). Spread with care to prevent puncturing coating and to minimize damage to substrate foam.

E. Field Quality Control
1. Correct deficiencies in, or remove, foam or coatings that do not comply with requirements; fill and repair substrates and reapply materials.
2. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with requirements.
3. Refill cores, repair slits, and recoat test areas.

F. Repair And Recoating
1. Repair and recoat coated foamed roofing according to ASTM D 6705 and coated foamed roofing manufacturer's written instructions.

G. Curing, Protecting, And Cleaning
1. Cure coatings according to coated foamed roofing manufacturer's written instructions, taking care to prevent contamination and damage during application stages and curing. Do not permit traffic on uncured coatings.
2. Protect coated foamed roofing from damage and wear during remainder of construction period.
3. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 56 00 00

Task	Specification	Specification Description
07 56 00 00	07 51 13 00	Built-Up Asphalt Roofing
07 56 00 00	07 01 50 81	Built-Up Coal-Tar Roofing
07 56 00 00	07 53 16 00	EPDM Membrane Roofing
07 57 13 00	07 56 00 00	Coated Foamed Roofing
07 58 00 00	07 51 13 00	Built-Up Asphalt Roofing
07 62 13 00	04 05 23 16	Sheet Metal Flashing And Trim

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SECTION 07 63 00 00 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for common work results for fire suppression. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes the following:
   a. Piping materials and installation instructions common to most piping systems.
   b. Mechanical sleeve seals.
   c. Sleeves.
   d. Escutcheons.
   e. Grout.
   f. Fire-suppression equipment and piping demolition.
   g. Equipment installation requirements common to equipment sections.
   h. Painting and finishing.
   i. Concrete bases.
   j. Supports and anchorages.

C. Definitions

1. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
2. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
3. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
4. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
5. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
6. The following are industry abbreviations for plastic materials:
   a. CPVC: Chlorinated polyvinyl chloride plastic.
7. The following are industry abbreviations for rubber materials:
   a. EPDM: Ethylene-propylene-diene terpolymer rubber.
   b. NBR: Acrylonitrile-butadiene rubber.

D. Submittals

1. Welding certificates.

E. Quality Assurance

1. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
2. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   a. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   b. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

3. Electrical Characteristics for Fire-Suppression Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

F. Delivery, Storage, And Handling
1. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
2. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.2 PRODUCTS

A. Pipe, Tube, And Fittings
1. Refer to individual Division 28 for pipe, tube, and fitting materials and joining methods.
2. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

B. Joining Materials
1. Refer to individual Division 28 for special joining materials not listed below.
2. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   a. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
      1) Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      2) Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   b. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
3. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
4. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
5. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
6. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
7. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
8. Solvent Cements for Joining CPVC Plastic Piping: ASTM F 493.

C. Mechanical Sleeve Seals
1. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   a. Sealing Elements: EPDM **OR** NBR, **as directed**, interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   b. Pressure Plates: Plastic **OR** Carbon steel **OR** Stainless steel, **as directed**. Include two for each sealing element.
   c. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating **OR** Stainless steel, **as directed**, of length required to secure pressure plates to sealing elements. Include one for each sealing element.

D. Sleeves
1. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
2. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

3. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
4. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   a. Underdeck Clamp: Clamping ring with set screws.
5. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
6. PVC Pipe: ASTM D 1785, Schedule 40.
7. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

E. Escutcheons
1. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
2. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
3. One-Piece, Cast-Brass Type: With set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass **OR** Polished chrome-plated and rough brass, **as directed**.
4. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass **OR** Polished chrome-plated and rough brass, **as directed**.
5. One-Piece, Stamped-Steel Type: With set screw **OR** spring clips, **as directed**, and chrome-plated finish.
6. Split-Plate, Stamped-Steel Type: With concealed **OR** exposed-rivet, **as directed**, hinge, set screw **OR** spring clips, **as directed**, and chrome-plated finish.
7. One-Piece, Floor-Plate Type: Cast-iron floor plate.
8. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

F. Grout
1. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   a. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   b. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
   c. Packaging: Premixed and factory packaged.

1.3 EXECUTION

A. Fire-Suppression Demolition
1. Refer to Division 01 Section(s) "Cutting And Patching" AND Division 02 Section(s) "Selective Structure Demolition" for general demolition requirements and procedures.
2. Disconnect, demolish, and remove fire-suppression systems, equipment, and components indicated to be removed.
   a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
   c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
   e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to the Owner.
3. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

B. Piping Systems - Common Requirements
1. Install piping according to the following requirements and Division 28 specifying piping systems.
2. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
3. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
4. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
6. Install piping to permit valve servicing.
7. Install piping at indicated slopes.
8. Install piping free of sags and bends.
9. Install fittings for changes in direction and branch connections.
10. Install piping to allow application of insulation.
11. Select system components with pressure rating equal to or greater than system operating pressure.
12. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
    a. New Piping:
        1) Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
        2) Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
        3) Insulated Piping: One-piece, stamped-steel type with spring clips.
        4) Bare Piping at Wall and Floor Penetrations in Finished Spaces:
            a) One-piece, cast-brass type with polished chrome-plated finish.
               OR
               One-piece, stamped-steel type.
        5) Bare Piping at Ceiling Penetrations in Finished Spaces:
            a) One-piece **OR** Split-casting, **as directed**, cast-brass type with polished chrome-plated finish.
               OR
               One-piece, stamped-steel type **OR** Split-plate, stamped-steel type with concealed hinge, **as directed**, and set screw.
        6) Bare Piping in Unfinished Service Spaces:
            a) One-piece, cast-brass type with polished chrome-plated **OR** rough-brass, **as directed**, finish.
               OR
               One-piece, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and set screw **OR** spring clips, **as directed**.
        7) Bare Piping in Equipment Rooms:
            a) One-piece, cast-brass type.

               One-piece, stamped-steel type with set screw **OR** spring clips, **as directed**.
        8) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
    b. Existing Piping: Use the following:

    c. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
    d. Insulated Piping: Split-plate, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and spring clips.
    e. Bare Piping at Wall and Floor Penetrations in Finished Spaces:
        1) Split-casting, cast-brass type with chrome-plated finish.
           OR
           Split-plate, stamped-steel type with concealed hinge and spring clips.

f. Bare Piping at Ceiling Penetrations in Finished Spaces:
    1) Split-casting, cast-brass type with chrome-plated finish.
    OR
    Split-plate, stamped-steel type with concealed hinge and set screw.
g. Bare Piping in Unfinished Service Spaces:
    1) Split-casting, cast-brass type with polished chrome-plated **OR** rough-brass, **as directed**, finish.
    OR
    Split-plate, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and set screw or spring clips.
h. Bare Piping in Equipment Rooms:
    1) Split-casting, cast-brass type.
    OR
    Split-plate, stamped-steel type with set screw or spring clips.
i. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

13. Sleeves are not required for core-drilled holes.
14. Permanent sleeves are not required for holes formed by removable PE sleeves.
15. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
16. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
    a. Cut sleeves to length for mounting flush with both surfaces.
        1) Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
    b. Install sleeves in new walls and slabs as new walls and slabs are constructed.
    c. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
        1) PVC **OR** Steel, **as directed**, Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
        2) Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
        3) Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing And Trim" for flashing.
            a) Seal space outside of sleeve fittings with grout.
    d. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
17. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
    a. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
    b. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
    c. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
18. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
    a. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

19. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
20. Verify final equipment locations for roughing-in.
21. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

C. Piping Joint Construction
1. Join pipe and fittings according to the following requirements and Division 28 specifying piping systems.
2. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
3. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
4. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
5. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
6. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
7. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Para. 1.1 "Quality Assurance" Article.
8. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
9. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   b. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
10. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

D. Painting
1. Painting of fire-suppression systems, equipment, and components is specified in Division 09 Section(s) "Exterior Painting" AND "Interior Painting".
2. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

E. Concrete Bases
1. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
   a. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
   b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
   c. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   d. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   e. Install anchor bolts to elevations required for proper attachment to supported equipment.
   f. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

g. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-place Concrete".

F. Erection Of Metal Supports And Anchorages
1. Refer to Division 05 Section "Metal Fabrications" for structural steel.
2. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire-suppression materials and equipment.
3. Field Welding: Comply with AWS D1.1.

G. Erection Of Wood Supports And Anchorages
1. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor fire-suppression materials and equipment.
2. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
3. Attach to substrates as required to support applied loads.

H. Grouting
1. Mix and install grout for fire-suppression equipment base bearing surfaces, pump and other equipment base plates, and anchors.
2. Clean surfaces that will come into contact with grout.
3. Provide forms as required for placement of grout.
4. Avoid air entrapment during placement of grout.
5. Place grout, completely filling equipment bases.
6. Place grout on concrete bases and provide smooth bearing surface for equipment.
7. Place grout around anchors.
8. Cure placed grout.

END OF SECTION 07 63 00 00

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SECTION 07 63 00 00a - COMMON WORK RESULTS FOR PLUMBING

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for common work results for plumbing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes the following:
   a. Piping materials and installation instructions common to most piping systems.
   b. Transition fittings.
   c. Dielectric fittings.
   d. Mechanical sleeve seals.
   e. Sleeves.
   f. Escutcheons.
   g. Grout.
   h. Plumbing demolition.
   i. Equipment installation requirements common to equipment sections.
   j. Painting and finishing.
   k. Concrete bases.
   l. Supports and anchorages.

C. Definitions

1. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
2. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
3. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
4. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
5. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
6. The following are industry abbreviations for plastic materials:
   a. ABS: Acrylonitrile-butadiene-styrene plastic.
   b. CPVC: Chlorinated polyvinyl chloride plastic.
   c. PE: Polyethylene plastic.
   d. PVC: Polyvinyl chloride plastic.
7. The following are industry abbreviations for rubber materials:
   a. EPDM: Ethylene-propylene-diene terpolymer rubber.
   b. NBR: Acrylonitrile-butadiene rubber.

D. Submittals

1. Welding certificates.

E. Quality Assurance

1. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

2. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   a. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   b. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
3. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

F. Delivery, Storage, And Handling
1. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
2. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.2 PRODUCTS

A. Pipe, Tube, And Fittings
1. Refer to individual Division 14 for pipe, tube, and fitting materials and joining methods.
2. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

B. Joining Materials
1. Refer to individual Division 14 for special joining materials not listed below.
2. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   a. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
      1) Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      2) Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   b. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
3. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
4. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
5. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
6. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
7. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
8. Solvent Cements for Joining Plastic Piping:
   a. ABS Piping: ASTM D 2235.
   b. CPVC Piping: ASTM F 493.
   c. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
   d. PVC to ABS Piping Transition: ASTM D 3138.
9. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

C. Transition Fittings
1. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
   a. Underground Piping NPS 1-1/2 (DN 40) and Smaller: Manufactured fitting or coupling.

b. Underground Piping NPS 2 (DN 50) and Larger: AWWA C219, metal sleeve-type coupling.
c. Aboveground Pressure Piping: Pipe fitting.

2. Plastic-to-Metal Transition Fittings: CPVC **OR** PVC, **as directed**, one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
3. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
4. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC **OR** PVC, **as directed**, four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
5. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

D. Dielectric Fittings
1. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
2. Insulating Material: Suitable for system fluid, pressure, and temperature.
3. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
4. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
5. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   a. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.
6. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
7. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

E. Mechanical Sleeve Seals
1. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   a. Sealing Elements: EPDM **OR** NBR, **as directed**, interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   b. Pressure Plates: Plastic **OR** Carbon steel **OR** Stainless steel, **as directed**. Include two for each sealing element.
   c. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating **OR** Stainless steel, **as directed**, of length required to secure pressure plates to sealing elements. Include one for each sealing element.

F. Sleeves
1. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
2. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
3. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
4. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   a. Underdeck Clamp: Clamping ring with set screws.
5. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
6. PVC Pipe: ASTM D 1785, Schedule 40.

7. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

G. Escutcheons
1. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
2. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
3. One-Piece, Cast-Brass Type: With set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass **OR** Polished chrome-plated and rough brass, **as directed**.
4. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass **OR** Polished chrome-plated and rough brass, **as directed**.
5. One-Piece, Stamped-Steel Type: With set screw **OR** spring clips, **as directed**, and chrome-plated finish.
6. Split-Plate, Stamped-Steel Type: With concealed **OR** exposed-rivet, **as directed**, hinge, set screw **OR** spring clips, **as directed**, and chrome-plated finish.
7. One-Piece, Floor-Plate Type: Cast-iron floor plate.
8. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

H. Grout
1. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   a. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   b. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
   c. Packaging: Premixed and factory packaged.

1.3 EXECUTION

A. Plumbing Demolition
1. Refer to Division 01 Section(s) "Cutting And Patching" AND Division 02 Section(s) "Selective Structure Demolition" for general demolition requirements and procedures.
2. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.
   a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
   c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
   e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to the Owner.
3. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

B. Piping Systems - Common Requirements
1. Install piping according to the following requirements and Division 14 specifying piping systems.
2. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

3. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
4. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
6. Install piping to permit valve servicing.
7. Install piping at indicated slopes.
8. Install piping free of sags and bends.
9. Install fittings for changes in direction and branch connections.
10. Install piping to allow application of insulation.
11. Select system components with pressure rating equal to or greater than system operating pressure.
12. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
    a. New Piping:
        1) Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
        2) Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
        3) Insulated Piping: One-piece, stamped-steel type with spring clips.
        4) Bare Piping at Wall and Floor Penetrations in Finished Spaces:
            a) One-piece, cast-brass type with polished chrome-plated finish.
               OR
               One-piece, stamped-steel type.
        5) Bare Piping at Ceiling Penetrations in Finished Spaces:
            a) One-piece **OR** Split-casting, **as directed**, cast-brass type with polished chrome-plated finish.
               OR
               One-piece, stamped-steel type **OR** Split-plate, stamped-steel type with concealed hinge, **as directed**, and set screw.
        6) Bare Piping in Unfinished Service Spaces:
            a) One-piece, cast-brass type with polished chrome-plated **OR** rough-brass, **as directed**, finish.
               OR
               One-piece, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and set screw **OR** spring clips, **as directed**.
        7) Bare Piping in Equipment Rooms:
            a) One-piece, cast-brass type.
               OR
               One-piece, stamped-steel type with set screw **OR** spring clips, **as directed**.
        8) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
    b. Existing Piping: Use the following:
        1) Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
        2) Insulated Piping: Split-plate, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and spring clips.
        3) Bare Piping at Wall and Floor Penetrations in Finished Spaces:
            a) Split-casting, cast-brass type with chrome-plated finish.
               OR
               Split-plate, stamped-steel type with concealed hinge and spring clips.
        4) Bare Piping at Ceiling Penetrations in Finished Spaces:
            a) Split-casting, cast-brass type with chrome-plated finish.
               OR
               Split-plate, stamped-steel type with concealed hinge and set screw.
        5) Bare Piping in Unfinished Service Spaces:
            a) Split-casting, cast-brass type with polished chrome-plated **OR** rough-brass, **as directed**, finish.
               OR

Split-plate, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and set screw or spring clips.
6) Bare Piping in Equipment Rooms:
a) Split-casting, cast-brass type.
OR
Split-plate, stamped-steel type with set screw or spring clips.
7) Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.
13. Sleeves are not required for core-drilled holes.
14. Permanent sleeves are not required for holes formed by removable PE sleeves.
15. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
16. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
a. Cut sleeves to length for mounting flush with both surfaces.
1) Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
b. Install sleeves in new walls and slabs as new walls and slabs are constructed.
c. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
1) PVC **OR** Steel, **as directed**, Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
2) Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
3) Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing And Trim" for flashing.
a) Seal space outside of sleeve fittings with grout.
d. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
17. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
a. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
b. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
c. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
18. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
a. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
19. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
20. Verify final equipment locations for roughing-in.
21. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

C. Piping Joint Construction
1. Join pipe and fittings according to the following requirements and Division 14 specifying piping systems.
2. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
3. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
4. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
5. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
6. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
    a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
    b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
7. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Para. 1.1 "Quality Assurance" Article.
8. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
9. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
    a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
    b. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
    c. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
    d. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
    e. PVC Nonpressure Piping: Join according to ASTM D 2855.
    f. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
10. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
11. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
12. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
    a. Plain-End Pipe and Fittings: Use butt fusion.
    b. Plain-End Pipe and Socket Fittings: Use socket fusion.
13. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

D. Piping Connections
1. Make connections according to the following, unless otherwise indicated:
    a. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
    b. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
    c. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
    d. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

E. Equipment Installation - Common Requirements
1. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

2. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
3. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
4. Install equipment to allow right of way for piping installed at required slope.

F. Painting
1. Painting of plumbing systems, equipment, and components is specified in Division 09 Section(s) "Exterior Painting" AND "Interior Painting".
2. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

G. Concrete Bases
1. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
   a. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
   b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
   c. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   d. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   e. Install anchor bolts to elevations required for proper attachment to supported equipment.
   f. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   g. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-place Concrete".

H. Erection Of Metal Supports And Anchorages
1. Refer to Division 05 Section "Metal Fabrications" for structural steel.
2. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
3. Field Welding: Comply with AWS D1.1.

I. Erection Of Wood Supports And Anchorages
1. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.
2. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
3. Attach to substrates as required to support applied loads.

J. Grouting
1. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
2. Clean surfaces that will come into contact with grout.
3. Provide forms as required for placement of grout.
4. Avoid air entrapment during placement of grout.
5. Place grout, completely filling equipment bases.
6. Place grout on concrete bases and provide smooth bearing surface for equipment.
7. Place grout around anchors.
8. Cure placed grout.

END OF SECTION 07 63 00 00a

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SECTION 07 63 00 00b - COMMON WORK RESULTS FOR HVAC

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for common work results for HVAC. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Piping materials and installation instructions common to most piping systems.
      b. Transition fittings.
      c. Dielectric fittings.
      d. Mechanical sleeve seals.
      e. Sleeves.
      f. Escutcheons.
      g. Grout.
      h. HVAC demolition.
      i. Equipment installation requirements common to equipment sections.
      j. Painting and finishing.
      k. Concrete bases.
      l. Supports and anchorages.

C. Definitions
   1. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
   2. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
   3. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
   4. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
   5. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
   6. The following are industry abbreviations for plastic materials:
      a. CPVC: Chlorinated polyvinyl chloride plastic.
      b. PE: Polyethylene plastic.
      c. PVC: Polyvinyl chloride plastic.
   7. The following are industry abbreviations for rubber materials:
      a. EPDM: Ethylene-propylene-diene terpolymer rubber.
      b. NBR: Acrylonitrile-butadiene rubber.

D. Submittals
   1. Welding certificates.

E. Quality Assurance
   1. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
   2. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

a. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
b. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
3. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

F. Delivery, Storage, And Handling
1. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
2. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.2 PRODUCTS

A. Pipe, Tube, And Fittings
1. Refer to individual Division 21 for pipe, tube, and fitting materials and joining methods.
2. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

B. Joining Materials
1. Refer to individual Division 21 for special joining materials not listed below.
2. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
a. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
1) Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
2) Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
b. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
3. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
4. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
5. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
6. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
7. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
8. Solvent Cements for Joining Plastic Piping:
a. CPVC Piping: ASTM F 493.
b. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
9. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

C. Transition Fittings
1. Plastic-to-Metal Transition Fittings: CPVC **OR** PVC, **as directed**, one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
2. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
3. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC **OR** PVC, **as directed**, four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

D. Dielectric Fittings
1. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
2. Insulating Material: Suitable for system fluid, pressure, and temperature.
3. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
4. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
5. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   a. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.
6. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
7. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

E. Mechanical Sleeve Seals
1. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   a. Sealing Elements: EPDM **OR** NBR, **as directed**, interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   b. Pressure Plates: Plastic **OR** Carbon steel **OR** Stainless steel, **as directed**. Include two for each sealing element.
   c. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating **OR** Stainless steel, **as directed**, of length required to secure pressure plates to sealing elements. Include one for each sealing element.

F. Sleeves
1. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
2. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
3. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
4. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   a. Underdeck Clamp: Clamping ring with set screws.
5. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
6. PVC Pipe: ASTM D 1785, Schedule 40.
7. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

G. Escutcheons
1. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
2. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
3. One-Piece, Cast-Brass Type: With set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass **OR** Polished chrome-plated and rough brass, **as directed**.
4. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass **OR** Polished chrome-plated and rough brass, **as directed**.

5. One-Piece, Stamped-Steel Type: With set screw **OR** spring clips, **as directed**, and chrome-plated finish.
6. Split-Plate, Stamped-Steel Type: With concealed **OR** exposed-rivet, **as directed**, hinge, set screw **OR** spring clips, **as directed**, and chrome-plated finish.
7. One-Piece, Floor-Plate Type: Cast-iron floor plate.
8. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

H. Grout
1. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   a. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   b. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
   c. Packaging: Premixed and factory packaged.

1.3 EXECUTION

A. HVAC Demolition
1. Refer to Division 01 Section(s) "Cutting And Patching" AND Division 02 Section(s) "Selective Structure Demolition" for general demolition requirements and procedures.
2. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
   a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
   c. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
   d. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
   e. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   f. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
   g. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to the Owner.
3. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

B. Piping Systems - Common Requirements
1. Install piping according to the following requirements and Division 21 specifying piping systems.
2. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
3. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
4. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
6. Install piping to permit valve servicing.
7. Install piping at indicated slopes.
8. Install piping free of sags and bends.
9. Install fittings for changes in direction and branch connections.

10. Install piping to allow application of insulation.
11. Select system components with pressure rating equal to or greater than system operating pressure.
12. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
    a. New Piping:
        1) Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
        2) Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
        3) Insulated Piping: One-piece, stamped-steel type with spring clips.
        4) Bare Piping at Wall and Floor Penetrations in Finished Spaces:
            a) One-piece, cast-brass type with polished chrome-plated finish.
               OR
               One-piece, stamped-steel type.
        5) Bare Piping at Ceiling Penetrations in Finished Spaces:
            a) One-piece **OR** Split-casting, **as directed**, cast-brass type with polished chrome-plated finish.
               OR
               One-piece, stamped-steel type **OR** Split-plate, stamped-steel type with concealed hinge, **as directed**, and set screw.
        6) Bare Piping in Unfinished Service Spaces:
            a) One-piece, cast-brass type with polished chrome-plated **OR** rough-brass, **as directed**, finish.
               OR
               One-piece, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and set screw **OR** spring clips, **as directed**.
        7) Bare Piping in Equipment Rooms:
            a) One-piece, cast-brass type.
               OR
               One-piece, stamped-steel type with set screw **OR** spring clips, **as directed**.
        8) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
    b. Existing Piping: Use the following:
        1) Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
        2) Insulated Piping: Split-plate, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and spring clips.
        3) Bare Piping at Wall and Floor Penetrations in Finished Spaces:
            a) Split-casting, cast-brass type with chrome-plated finish.
               OR
               Split-plate, stamped-steel type with concealed hinge and spring clips.
        4) Bare Piping at Ceiling Penetrations in Finished Spaces:
            a) Split-casting, cast-brass type with chrome-plated finish.
               OR
               Split-plate, stamped-steel type with concealed hinge and set screw.
        5) Bare Piping in Unfinished Service Spaces:
            a) Split-casting, cast-brass type with polished chrome-plated **OR** rough-brass, **as directed**, finish.
               OR
               Split-plate, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and set screw or spring clips.
        6) Bare Piping in Equipment Rooms:
            a) Split-casting, cast-brass type.
               OR
               Split-plate, stamped-steel type with set screw or spring clips.
        7) Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.
13. Sleeves are not required for core-drilled holes.
14. Permanent sleeves are not required for holes formed by removable PE sleeves.

15. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
16. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
    a. Cut sleeves to length for mounting flush with both surfaces.
        1) Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
    b. Install sleeves in new walls and slabs as new walls and slabs are constructed.
    c. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
        1) PVC **OR** Steel, **as directed**, Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
        2) Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
        3) Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing And Trim" for flashing.
            a) Seal space outside of sleeve fittings with grout.
    d. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
17. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
    a. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
    b. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
    c. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
18. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
    a. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
19. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
20. Verify final equipment locations for roughing-in.
21. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

C. Piping Joint Construction
1. Join pipe and fittings according to the following requirements and Division 21 specifying piping systems.
2. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
3. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
4. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
5. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

6. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
7. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Para. 1.1 "Quality Assurance" Article.
8. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
9. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   b. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
   c. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
   d. PVC Nonpressure Piping: Join according to ASTM D 2855.
10. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
11. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
12. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
   a. Plain-End Pipe and Fittings: Use butt fusion.
   b. Plain-End Pipe and Socket Fittings: Use socket fusion.
13. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

D. Piping Connections
1. Make connections according to the following, unless otherwise indicated:
   a. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
   b. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   c. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
   d. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

E. Equipment Installation - Common Requirements
1. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
2. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
3. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
4. Install equipment to allow right of way for piping installed at required slope.

F. Painting
1. Painting of HVAC systems, equipment, and components is specified in Division 09 Section(s) "Exterior Painting" AND "Interior Painting".
2. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

G. Concrete Bases
1. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
    a. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
    b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
    c. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
    d. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    e. Install anchor bolts to elevations required for proper attachment to supported equipment.
    f. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
    g. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-place Concrete".

H. Erection Of Metal Supports And Anchorages
1. Refer to Division 05 Section "Metal Fabrications" for structural steel.
2. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
3. Field Welding: Comply with AWS D1.1.

I. Erection Of Wood Supports And Anchorages
1. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.
2. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
3. Attach to substrates as required to support applied loads.

J. Grouting
1. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
2. Clean surfaces that will come into contact with grout.
3. Provide forms as required for placement of grout.
4. Avoid air entrapment during placement of grout.
5. Place grout, completely filling equipment bases.
6. Place grout on concrete bases and provide smooth bearing surface for equipment.
7. Place grout around anchors.
8. Cure placed grout.

END OF SECTION 07 63 00 00b

Task	Specification	Specification Description
07 63 00 00	04 05 23 16	Sheet Metal Flashing And Trim
07 65 16 00	07 51 13 00	Built-Up Asphalt Roofing
07 65 16 00	07 01 50 81	Built-Up Coal-Tar Roofing
07 65 16 00	07 53 16 00	EPDM Membrane Roofing
07 65 16 00	07 56 00 00	Coated Foamed Roofing
07 71 13 00	04 05 23 16	Sheet Metal Flashing And Trim

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SECTION 07 71 23 00 - MANUFACTURED ROOF SPECIALTIES

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for manufactured roof specialties. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Copings.
      b. Roof-edge flashings.
      c. Roof-edge drainage systems.
      d. Reglets and counterflashings.

C. Performance Requirements
   1. General Performance: Roof specialties shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
   2. FM Approvals' Listing (if Project is FM Global insured or if FM Approvals' requirements set a minimum quality standard): Manufacture and install copings and roof-edge flashings that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, Class 1-60 **OR** Class 1-75 **OR** Class 1-90 **OR** Class 1-105 **OR** Class 1-120, **as directed**. Identify materials with FM Approvals' markings.
   3. SPRI Wind Design Standard (if Project is governed by the IBC or if SPRI ES-1 sets a minimum quality standard): Manufacture and install copings and roof-edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressures:
      a. Design Pressure: As indicated on Drawings **OR** As directed.
   4. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
      a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

D. Submittals
   1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Shop Drawings: For roof specialties. Include plans, elevations, expansion-joint locations, keyed details, and attachments to other work. Distinguish between plant- and field-assembled work. Include the following:
      a. Details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.
      b. Pattern of seams and layout of fasteners, cleats, clips, and other attachments.
      c. Details of termination points and assemblies, including fixed points.
      d. Details of special conditions.
   3. Samples: For copings **OR** roof-edge flashings **OR** roof-edge drainage systems **OR** reglets and counterflashings, **as directed**, made from 12-inch (300-mm) lengths of full-size components including fasteners, cover joints, accessories, and attachments.
   4. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for copings and roof-edge flashings.

5. Maintenance Data: For roofing specialties to include in maintenance manuals.
6. Warranty: Sample of special warranty.

E. Quality Assurance
1. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.
2. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof specialties installation.

G. Warranty
1. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.
   a. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
      1) Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      2) Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      3) Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   b. Finish Warranty Period: 20 **OR** 10, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Exposed Metals
1. Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 or H01 temper.
   a. Non-Patinated Exposed Finish: Mill.
   b. Pre-Patinated Copper-Sheet Finish: Pre-patinated according to ASTM B 882.
2. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.
   a. Surface: Smooth, flat **OR** Embossed, **as directed**, finish.
   b. Mill Finish: As manufactured.
   c. Exposed Coil-Coated Finishes: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      1) Two-Coat Fluoropolymer: AAMA 620. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
      2) Three-Coat Fluoropolymer: AAMA 620. System consisting of primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent PVDF resin by weight.
      3) Concealed Surface: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).
   d. Clear Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
   e. Color Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
3. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy and temper recommended by manufacturer for type of use and finish indicated, finished as follows:
   a. Exposed High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1) Two-Coat Fluoropolymer: AAMA 2604 **OR** AAMA 2605, **as directed**. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
2) Three-Coat Fluoropolymer: AAMA 2605. System consisting of primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent PVDF resin by weight.

b. Clear Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
c. Color Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

4. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304.
5. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation.
   a. Surface: Smooth, flat **OR** Embossed, **as directed**, finish.
   b. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
   c. Exposed Coil-Coated Finishes: Prepainted by the coil-coating process to comply with ASTM A 755/A 755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      1) Two-Coat Fluoropolymer: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
      2) Three-Coat Fluoropolymer: AAMA 621. System consisting of primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent PVDF resin by weight.

B. Concealed Metals
1. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy and temper recommended by manufacturer for type of use and structural performance indicated, mill finished.
2. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy and temper recommended by manufacturer for type of use and structural performance indicated, mill finished.
3. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304.
4. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation.

C. Underlayment Materials
1. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
2. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
   a. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F (116 deg C).
   b. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F (29 deg C).
3. Polyethylene Sheet: 6-mil- (0.15-mm-) thick polyethylene sheet complying with ASTM D 4397.
4. Slip Sheet: Building paper, 3-lb/100 sq. ft. (0.16-kg/sq. m) minimum, rosin sized.

D. Miscellaneous Materials
1. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
2. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:
   a. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.
   b. Fasteners for Copper Sheet: Copper, hardware bronze, or passivated Series 300 stainless steel.
   c. Fasteners for Aluminum: Aluminum or Series 300 stainless steel.
   d. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.

e. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A 153/A 153M or ASTM F 2329.

3. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane **OR** silicone, **as directed**, polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.
4. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
5. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.
6. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.
7. Solder for Copper: ASTM B 32, lead-free solder **OR** Grade Sn50, 50 percent tin and 50 percent lead, **as directed**.

E. Copings

1. Copings: Manufactured coping system consisting of formed-metal coping cap in section lengths not exceeding 12 feet (3.6 m), concealed anchorage; corner units, end cap units, and concealed splice plates with same finish as coping caps.
   a. Coping-Cap Material: Copper, 20 oz./sq. ft. (0.68 mm thick) **OR** weight (thickness) as required to meet performance requirements, **as directed**.
      1) Finish: Non-patinated, mill **OR** Pre-patinated dark brown **OR** Pre-patinated verdigris, **as directed**.

   OR

   Coping-Cap Material: Formed **OR** Extruded, **as directed**, aluminum, 0.040 inch (1.02 mm) thick **OR** 0.050 inch (1.27 mm) thick **OR** 0.063 inch (1.60 mm) thick **OR** 0.080 inch (2.03 mm) thick **OR** 0.125 inch (3.18 mm) thick **OR** thickness as required to meet performance requirements, **as directed**.
      1) Finish: Mill **OR** Two-coat fluoropolymer **OR** Three-coat fluoropolymer **OR** Clear anodic **OR** Color anodic, **as directed**.
      2) Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

   OR

   Coping-Cap Material: Zinc-coated steel, nominal 0.028-inch (0.71-mm) thickness **OR** 0.034-inch (0.86-mm) thickness **OR** thickness as required to meet performance requirements, **as directed**.
      1) Finish: Mill phosphatized for field painting **OR** Two-coat fluoropolymer **OR** Three-coat fluoropolymer, **as directed**.
      2) Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   b. Corners: Factory mitered and soldered **OR** continuously welded **OR** mechanically clinched and sealed watertight, **as directed**.
   c. Special Fabrications: Radiussed sections **OR** Arched sections **OR** Bullnose face leg **OR** Two-way sloped coping cap, **as directed**.
   d. Coping-Cap Attachment Method: Snap-on **OR** Face leg hooked to continuous cleat with back leg fastener exposed, **as directed**, fabricated from coping-cap material.
   e. Snap-on-Coping Anchor Plates: Concealed, galvanized-steel sheet, 12 inches (300 mm) wide, with integral cleats.

   OR

   Face Leg Cleats: Concealed, continuous galvanized-steel sheet **OR** stainless steel, **as directed**.

F. Roof-Edge Flashings

1. Canted Roof-Edge and Fascia **OR** Fascia and Gravel Stop, **as directed**: Manufactured, two-piece, roof-edge fascia consisting of snap-on **OR** compression-clamped, **as directed**, metal fascia cover in section lengths not exceeding 12 feet (3.6 m) and a continuous formed

galvanized-steel sheet cant, 0.028 inch (0.71 mm) thick, minimum, with extended vertical leg terminating in a drip-edge cleat. Provide matching corner units.

a. Fascia Cover: Fabricated from the following exposed metal:
   1) Formed Aluminum: 0.040 inch (1.02 mm) thick **OR** 0.050 inch (1.27 mm) thick **OR** 0.063 inch (1.60 mm) thick **OR** Thickness as required to meet performance requirements, **as directed**.
   2) Extruded Aluminum: 0.080 inch (2.03 mm) thick **OR** Thickness as required to meet performance requirements, **as directed**.
   3) Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) thickness **OR** 0.034-inch (0.86-mm) thickness **OR** thickness as required to meet performance requirements, **as directed**.
b. Corners: Factory mitered and soldered **OR** continuously welded **OR** mechanically clinched and sealed watertight, **as directed**.
c. Splice Plates: Concealed **OR** Exposed, **as directed**, of same material, finish, and shape as fascia cover.
d. Special Fabrications: Radiussed sections **OR** Arched sections **OR** Bullnose fascia cover **OR** Cornice fascia cover **OR** Cove fascia cover, **as directed**.
e. Fascia Accessories: Fascia extenders with continuous hold-down cleats **OR** Wall cap **OR** Soffit trim **OR** Overflow scuppers **OR** Overflow scuppers with perforated screens **OR** Spillout scuppers **OR** Downspout scuppers with integral conductor head and downspout adapters **OR** Downspout scuppers with integral conductor head and downspout adapters and perforated screens, **as directed**.

2. Roof-Edge Fascia: Manufactured, two-piece, roof-edge fascia consisting of snap-on metal fascia cover in section lengths not exceeding 12 feet (3.6 m) and a continuous formed- or extruded-aluminum anchor bar with integral drip-edge cleat to engage fascia cover. Provide matching corner units.
   a. Fascia Cover: Fabricated from the following exposed metal:
      1) Formed Aluminum: 0.032 inch (0.81 mm) thick **OR** 0.040 inch (1.02 mm) thick **OR** 0.050 inch (1.27 mm) thick **OR** 0.063 inch (1.60 mm) thick **OR** Thickness as required to meet performance requirements, **as directed**.
      2) Zinc-Coated Steel: Nominal 0.028 inch (0.71 mm) thick **OR** 0.034 inch (0.86 mm) thick **OR** thickness as required to meet performance requirements, **as directed**.
   b. Corners: Factory mitered and soldered **OR** continuously welded **OR** mechanically clinched and sealed watertight, **as directed**.
   c. Splice Plates: Concealed **OR** Exposed, **as directed**, of same material, finish, and shape as fascia cover.
   d. Special Fabrications: Radiussed sections **OR** Arched sections **OR** Bullnose fascia cover **OR** Cornice fascia cover **OR** Cove fascia cover, **as directed**.
   e. Fascia Accessories: Fascia extenders with continuous hold-down cleats **OR** Wall cap **OR** Soffit trim **OR** Overflow scuppers **OR** Overflow scuppers with perforated screens **OR** Spillout scuppers **OR** Downspout scuppers with integral conductor head and downspout adapters **OR** Downspout scuppers with integral conductor head and downspout adapters and perforated screens, **as directed**.
3. One-Piece Gravel Stops: Manufactured, one-piece, metal gravel stop in section lengths not exceeding 12 feet (3.6 m), with a horizontal flange and vertical leg, drain-through, **as directed**, fascia terminating in a drip edge, **as directed**, and concealed splice plates of same material, finish, and shape as gravel stop. Provide matching corner units.
   a. Fabricate from the following exposed metal:
      1) Copper: 16 oz./sq. ft. (0.55 mm thick) **OR** Weight (thickness) as required to meet performance requirements, **as directed**.
      2) Formed Aluminum: 0.032 inch (0.81 mm) thick **OR** 0.040 inch (1.02 mm) thick **OR** 0.050 inch (1.27 mm) thick **OR** Thickness as required to meet performance requirements, **as directed**.
      3) Extruded Aluminum: 0.080 inch (2.03 mm) thick **OR** Thickness as required to meet performance requirements, **as directed**.

4) Stainless Steel: 0.025 inch (0.64 mm) thick **OR** Thickness as required to meet performance requirements, **as directed**.
5) Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) thickness **OR** 0.034-inch (0.86-mm) thickness **OR** thickness as required to meet performance requirements, **as directed**.

b. Corners: Factory mitered and soldered **OR** continuously welded **OR** mechanically clinched and sealed watertight, **as directed**.
c. Accessories: Fascia extenders with continuous hold-down cleats **OR** Wall cap **OR** Soffit trim, **as directed**.

4. Copper Finish: Non-patinated, mill **OR** Pre-patinated dark brown **OR** Pre-patinated verdigris, **as directed**.
5. Aluminum Finish: Mill **OR** Two-coat fluoropolymer **OR** Three-coat fluoropolymer **OR** Clear anodic **OR** Color anodic, **as directed**.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
6. Stainless-Steel Finish: No. 2B (bright, cold rolled) **OR** No. 3 (coarse, polished directional satin) **OR** No. 4 (bright, polished directional satin), **as directed**.
7. Zinc-Coated Steel Finish: Mill phosphatized for field painting **OR** Two-coat fluoropolymer **OR** Three-coat fluoropolymer, **as directed**.
   a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

G. Roof-Edge Drainage Systems

1. Gutters: Manufactured in uniform section lengths not exceeding 12 feet (3.6 m), with matching corner units, ends, outlet tubes, and other accessories. Elevate back edge at least 1 inch (25 mm) above front edge. Furnish flat-stock gutter straps, gutter brackets, expansion joints, and expansion-joint covers fabricated from same metal as gutters.
   a. Fabricate from the following exposed metal:
      1) Copper: 16 oz./sq. ft. (0.55 mm thick) **OR** 20 oz./sq. ft. (0.68 mm thick), **as directed**.
      2) Formed Aluminum: 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm) **OR** 0.063 inch (1.60 mm), **as directed**, thick.
      3) Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, thickness.
   b. Gutter Profile: Style A **OR** Style B **OR** Style F **OR** Style G **OR** Style H **OR** Style I **OR** Style K **OR** Style K highback **OR** Half-round single bead **OR** Half-round highback **OR** Quarter round **OR** Ogee **OR** As indicated, **as directed**, according to SMACNA's "Architectural Sheet Metal Manual."
   c. Embossed Surface: Embossed with design as indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   d. Applied Fascia Cover (Concealed Gutter): Exposed, formed copper, 16 oz./sq. ft. (0.55 mm thick) **OR** aluminum, 0.040 inch (1.02 mm) thick, **as directed**, with factory-mitered corners, ends, and concealed splice joints.
   e. Corners: Factory mitered and soldered **OR** continuously welded **OR** mechanically clinched and sealed watertight, **as directed**.
   f. Gutter Supports: Gutter brackets **OR** Straps **OR** Spikes and ferrules **OR** Manufacturer's standard supports as selected by the Owner, **as directed**, with finish matching the gutters.
   g. Special Fabrications: Radiussed sections.
   h. Gutter Accessories: Continuous screened leaf guard with sheet metal frame **OR** Continuous hinged leaf guard of solid metal designed to shed leaves **OR** Continuous snap-in plastic leaf guard **OR** Bronze wire ball downspout strainer **OR** Wire ball downspout strainer **OR** Flat ends **OR** Bullnose ends for half-round gutter, **as directed**.
2. Downspouts: Plain round **OR** Corrugated round **OR** Plain rectangular **OR** Corrugated rectangular **OR** Open-face rectangular, **as directed**, complete with machine-crimped **OR** mitered **OR**

smooth-curve, **as directed**, elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.
a. Copper: 16 oz./sq. ft. (0.55 mm thick).
b. Formed Aluminum: 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm) **OR** 0.063 inch (1.60 mm), **as directed**, thick.
c. Extruded Aluminum: 0.125 inch (3.18 mm) thick.
d. Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, thickness.

3. Parapet Scuppers: Manufactured with closure flange trim to exterior, 4-inch- (100-mm-) wide wall flanges to interior, and base extending 4 inches (100 mm) beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scuppers, **as directed**.
   a. Fabricate from the following exposed metal:
      1) Copper: 16 oz./sq. ft. (0.55 mm thick).
      2) Formed Aluminum: 0.032 inch (0.81 mm) thick.
      3) Stainless Steel: 0.019 inch (0.48 mm) thick.
      4) Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) thickness.
4. Conductor Heads: Manufactured conductor heads, each with flanged back and stiffened top edge and of dimensions and shape indicated, complete with outlet tube that nests into upper end of downspout, exterior flange trim, **as directed**, and built-in overflow, **as directed**.
   a. Fabricate from the following exposed metal:
      1) Copper: 16 oz./sq. ft. (0.55 mm thick).
      2) Formed Aluminum: 0.032 inch (0.81 mm) thick.
      3) Stainless Steel: 0.016 inch (0.40 mm) thick.
      4) Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) thickness.
5. Splash Pans: Fabricate from the following exposed metal:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Formed Aluminum: 0.040 inch (1.02 mm) thick.
   c. Stainless Steel: 0.019 inch (0.48 mm) thick.
   d. Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) thickness.
6. Copper Finish: Non-patinated, mill **OR** Pre-patinated dark brown **OR** Pre-patinated verdigris, **as directed**.
7. Aluminum Finish: Mill **OR** Two-coat fluoropolymer **OR** Three-coat fluoropolymer **OR** Clear anodic **OR** Color anodic, **as directed**.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As indicated by manufacturer's designations **OR** As selected from manufacturer's full rang, **as directed**.
8. Stainless-Steel Finish: No. 2B (bright, cold rolled, unpolished) **OR** No. 3 (coarse, polished directional satin) **OR** No. 4 (bright, polished directional satin), **as directed**.
9. Zinc-Coated Steel Finish: Mill phosphatized for field painting **OR** Two-coat fluoropolymer **OR** Three-coat fluoropolymer, **as directed**.
   a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

H. Reglets And Counterflashings
1. Reglets: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces, from the following exposed metal:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Formed Aluminum: 0.024 inch (0.61 mm) **OR** 0.050 inch (1.27 mm), **as directed**, thick.
   c. Stainless Steel: 0.019 inch (0.48 mm) **OR** 0.025 inch (0.64 mm), **as directed**, thick.
   d. Zinc-Coated Steel: Nominal 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm), **as directed**, thickness.
   e. Corners: Factory mitered and soldered **OR** continuously welded **OR** mechanically clinched and sealed watertight, **as directed**.
   f. Surface-Mounted Type: Provide reglets with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.

g. Stucco Type, Embedded: Provide reglets with upturned fastening flange and extension leg of length to match thickness of applied finish materials.
h. Concrete Type, Embedded: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
i. Masonry Type, Embedded: Provide reglets with offset top flange for embedment in masonry mortar joint.
j. Multiuse Type, Embedded: For multiuse embedment in cast-in-place concrete **OR** masonry mortar joints, **as directed**.

2. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by 4 inches (100 mm) and in lengths not exceeding 12 feet (3.6 m) designed to snap into reglets or through-wall-flashing receiver and compress against base flashings with joints lapped, from the following exposed metal:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Formed Aluminum: 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
   c. Stainless Steel: 0.019 inch (0.48 mm) **OR** 0.025 inch (0.64 mm), **as directed**, thick.
   d. Zinc-Coated Steel: Nominal 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm), **as directed**, thickness.
3. Accessories:
   a. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where reglet is provided separate from metal counterflashing.
   b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.
4. Copper Finish: Non-patinated, mill **OR** Pre-patinated dark brown **OR** Pre-patinated verdigris, **as directed**.
5. Aluminum Finish: Mill **OR** Two-coat fluoropolymer **OR** Three-coat fluoropolymer **OR** Clear anodic **OR** Color anodic, **as directed**.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
6. Stainless-Steel Finish: No. 2B (bright, cold rolled, unpolished) **OR** No. 3 (coarse, polished directional satin) **OR** No. 4 (bright, polished directional satin), **as directed**.
7. Zinc-Coated Steel Finish: Mill phosphatized for field painting **OR** Two-coat fluoropolymer **OR** Three-coat fluoropolymer, **as directed**.
   a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

I. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
2. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.
3. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
4. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Underlayment Installation
1. Felt Underlayment: Install with adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm).
2. Self-Adhering Sheet Underlayment: Install wrinkle free. Apply primer if required by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply in shingle fashion to shed water. Overlap edges not less than 3-1/2 inches (90 mm). Roll laps with roller. Cover underlayment within 14 days.
3. Polyethylene Sheet: Install with adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped and taped joints of not less than 2 inches (50 mm).
4. Slip Sheet: Install with tape or adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm).

C. Installation, General
1. General: Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete roof-specialty systems.
   a. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
   b. Provide uniform, neat seams with minimum exposure of solder and sealant.
   c. Install roof specialties to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
   d. Torch cutting of roof specialties is not permitted.
   e. Do not use graphite pencils to mark metal surfaces.
2. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
   a. Coat concealed side of uncoated aluminum and stainless-steel roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
   b. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet **OR** self-adhering, high-temperature sheet underlayment **OR** polyethylene sheet, **as directed**.
   c. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.
3. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.
   a. Space movement joints at a maximum of 12 feet (3.6 m) with no joints within 18 inches (450 mm) of corners or intersections unless otherwise shown on Drawings.
   b. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.
4. Fastener Sizes: Use fasteners of sizes that will penetrate wood blocking or sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws **OR** substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance, **as directed**.
5. Seal joints with elastomeric **OR** butyl, **as directed**, sealant as required by roofing-specialty manufacturer.
6. Seal joints as required for watertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F (4 deg C).
7. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches (38 mm) except reduce pre-tinning where pre-tinned surface would show in completed Work. Tin edges of uncoated copper sheets using solder for copper. Do not use torches for soldering. Heat surfaces to receive solder and flow

solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

D. Coping Installation
1. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.
2. Anchor copings to meet performance requirements.
   a. Interlock face and back leg drip edges of snap-on coping cap into cleated anchor plates anchored to substrate at 30-inch (760-mm) centers **OR** 40-inch (1015-mm) centers **OR** manufacturer's required spacing that meets performance requirements, **as directed**.
   b. Interlock face leg drip edge into continuous cleat anchored to substrate at 24-inch (600-mm) centers **OR** 16-inch (400-mm) centers **OR** manufacturer's required spacing that meets performance requirements, **as directed**. Anchor back leg of coping with screw fasteners and elastomeric washers at 24-inch (600-mm) centers **OR** 16-inch (400-mm) centers **OR** manufacturer's required spacing that meets performance requirements, **as directed**.

E. Roof-Edge Flashing Installation
1. Install cleats, cants, and other anchoring and attachment accessories and devices with concealed fasteners.
2. Anchor roof edgings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

F. Roof-Edge Drainage-System Installation
1. General: Install components to produce a complete roof-edge drainage system according to manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.
2. Gutters: Join and seal gutter lengths. Allow for thermal expansion. Attach gutters to firmly anchored gutter supports spaced not more than 12 inches (305 mm) **OR** 24 inches (610 mm) **OR** 30 inches (762 mm), **as directed**, apart. Attach ends with rivets and seal with sealant **OR** solder, **as directed**, to make watertight. Slope to downspouts.
   a. Install gutter with expansion joints at locations indicated but not exceeding 50 feet (15.2 m) apart. Install expansion joint caps.
   b. Install continuous leaf guards on gutters with noncorrosive fasteners, removable **OR** hinged to swing open, **as directed**, for cleaning gutters.
3. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1500 mm) o.c.
   a. Provide elbows at base of downspout to direct water away from building.
      OR
      Connect downspouts to underground drainage system indicated.
4. Splash Pans: Install where downspouts discharge on low-slope roofs. Set in asphalt roofing cement **OR** elastomeric sealant, **as directed**.
5. Parapet Scuppers: Install scuppers through parapet where indicated. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
   a. Anchor scupper closure trim flange to exterior wall and seal or solder to scupper.
   b. Loosely lock front edge of scupper with conductor head.
   c. Seal or solder exterior wall scupper flanges into back of conductor head.
6. Conductor Heads: Anchor securely to wall with elevation of conductor top edge 1 inch (25 mm) below scupper **OR** gutter, **as directed**, discharge.

G. Reglet And Counterflashing Installation
1. General: Coordinate installation of reglets and counterflashings with installation of base flashings.

2. Embedded Reglets: See Division 03 Section "Cast-in-place Concrete" and Division 04 Section "Unit Masonry" for installation of reglets.
3. Surface-Mounted Reglets: Install reglets to receive flashings where flashing without embedded reglets is indicated on Drawings. Install at height so that inserted counterflashings overlap 4 inches (100 mm) over top edge of base flashings.
4. Counterflashings: Insert counterflashings into reglets or other indicated receivers; ensure that counterflashings overlap 4 inches (100 mm) over top edge of base flashings. Lap counterflashing joints a minimum of 4 inches (100 mm) and bed with elastomeric **OR** butyl, **as directed**, sealant. Fit counterflashings tightly to base flashings.

H. Cleaning And Protection
1. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
2. Clean and neutralize flux materials. Clean off excess solder and sealants.
3. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.
4. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 07 71 23 00

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Task	Specification	Specification Description
07 71 23 00	01 22 16 00	No Specification Required
07 71 23 00	05 73 23 00	Miscellaneous Ornamental Metals
07 71 23 00	04 05 23 16	Sheet Metal Flashing And Trim
07 71 26 00	04 05 23 16	Sheet Metal Flashing And Trim

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SECTION 07 72 13 00 - PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for packaged, outdoor, central-station air-handling units. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:
   a. Direct-expansion cooling.
   b. Heat-pump refrigeration components.
   c. Hot-gas reheat.
   d. Electric-heating coils.
   e. Gas furnace.
   f. Economizer outdoor- and return-air damper section.
   g. Integral, space temperature controls.
   h. Roof curbs.

C. Definitions

1. DDC: Direct-digital controls.
2. ECM: Electrically commutated motor.
3. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
4. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
5. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.
6. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
7. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
8. VVT: Variable-air volume and temperature.

D. Performance Requirements

1. Delegated Design: Design RTU supports to comply with wind and seismic, **as directed**, performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Wind-Restraint Performance:
   a. Basic Wind Speed: <**Insert value**>.
   b. Building Classification Category: I **OR** II **OR** III **OR** IV, **as directed**.
   c. Minimum 10 lb/sq. ft (48.8 kg/sq. m) multiplied by the maximum area of the mechanical component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.
3. Seismic Performance: RTUs shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

E. Submittals
1. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
2. LEED Submittals:
   a. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.
   b. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
3. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   a. Wiring Diagrams: Power, signal, and control wiring.
4. Delegated-Design Submittal: For RTU supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints, **as directed**, and for designing vibration isolation bases.
   b. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
   c. Wind- and Seismic-Restraint Details, **as directed**: Detail fabrication and attachment of wind and seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
5. Manufacturer Wind Loading Qualification Certification: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
   b. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
   c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
6. Manufacturer Seismic Qualification Certification: Submit certification that RTUs, accessories, and components will withstand seismic forces defined in "Performance Requirements" Article and in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
7. Field quality-control test reports.
8. Operation and maintenance data.
9. Warranty: Special warranty specified in this Section.

F. Quality Assurance
1. ARI Compliance:
   a. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.
   b. Comply with ARI 270 for testing and rating sound performance for RTUs.
2. ASHRAE Compliance:
   a. Comply with ASHRAE 15 for refrigeration system safety.
   b. Comply with ASHRAE 33 for methods of testing cooling and heating coils.

c. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
3. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
4. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
5. UL Compliance: Comply with UL 1995.
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.
a. Warranty Period for Compressors: Manufacturer's standard, but not less than five **OR** 10, **as directed**, years from date of Final Completion.
b. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than five **OR** 10 **OR** 15 **OR** 20, **as directed**, years from date of Final Completion.
c. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Final Completion.
d. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Final Completion.

1.2 PRODUCTS

A. Casing
1. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
2. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
a. Exterior Casing Thickness: 0.052 inch (1.3 mm) **OR** 0.0626 inch (1.6 mm) **OR** 0.079 inch (2.0 mm), **as directed**, thick.
3. Inner Casing Fabrication Requirements:
a. Inside Casing: Galvanized steel, 0.034 inch (0.86 mm) **OR** 0.028 inch (0.7 mm), **as directed**, thick, perforated 40 percent free area, **as directed**.
4. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
a. Materials: ASTM C 1071, Type I.
b. Thickness: 1/2 inch (13 mm) **OR** 1 inch (25 mm), **as directed**.
c. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
d. Liner Adhesive: Comply with ASTM C 916, Type I.
5. Condensate Drain Pans: Formed sections of galvanized-steel **OR** stainless-steel, **as directed**, sheet, a minimum of 2 inches (50 mm) deep, and complying with ASHRAE 62.1, **as directed**.
a. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
b. Drain Connections: Threaded nipple both sides of drain pan, **as directed**.
c. Pan-Top Surface Coating: Corrosion-resistant compound for galvanized-steel drain pans.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

B. Fans
1. Direct-Driven Supply-Air Fans: Double width, forward curved **OR** backward inclined, **as directed**, centrifugal; with permanently lubricated, multispeed **OR** ECM, **as directed**, motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

OR
Belt-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

2. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.
3. Relief-Air Fan: Propeller **OR** Forward curved **OR** Backward inclined, **as directed**, shaft mounted on permanently lubricated motor.
4. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment" when fan-mounted frame and RTU-mounted frame are anchored to building structure.
5. Fan Motor: Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".

C. Coils
1. Supply-Air Refrigerant Coil:
    a. Aluminum-plate **OR** Copper-plate, **as directed**, fin and seamless internally grooved, **as directed**, copper tube in steel casing with equalizing-type vertical distributor.
    b. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
    c. Coil Split: Interlaced.
    d. Baked phenolic **OR** Cathodic epoxy, **as directed**, coating.
    e. Condensate Drain Pan: Galvanized steel with corrosion-resistant coating **OR** Stainless steel, **as directed**, formed with pitch and drain connections complying with ASHRAE 62.1, **as directed**.
2. Outdoor-Air Refrigerant Coil:
    a. Aluminum-plate **OR** Copper-plate, **as directed**, fin and seamless internally grooved, **as directed**, copper tube in steel casing with equalizing-type vertical distributor.
    b. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
    c. Baked phenolic **OR** Cathodic epoxy, **as directed**, coating.
3. Hot-Gas Reheat Refrigerant Coil:
    a. Aluminum-plate **OR** Copper-plate, **as directed**, fin and seamless internally grooved, **as directed**, copper tube in steel casing with equalizing-type vertical distributor.
    b. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
    c. Baked phenolic **OR** Cathodic epoxy, **as directed**, coating.
4. Electric-Resistance Heating:
    a. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
    b. Overtemperature Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box.
    c. Overcurrent Protection: Manual-reset thermal cutouts, factory wired in each heater stage.
    d. Control Panel: Unit mounted with disconnecting means and overcurrent protection. Include the following controls:
        1) Magnetic **OR** Mercury, **as directed**, contactors.
        2) Step Controller: Pilot lights and override toggle switch for each step.
        3) SCR Controller: Pilot lights operate on load ratio, a minimum of five steps.
        4) Time-delay relay.
        5) Airflow proving switch.

D. Refrigerant Circuit Components
1. Number of Refrigerant Circuits: One **OR** Two, **as directed**.
2. Compressor: Hermetic, reciprocating **OR** Semihermetic, reciprocating **OR** Hermetic, scroll, **as directed**, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater, **as directed**.
3. Refrigeration Specialties:
a. Refrigerant: R-407C **OR** R-410A, **as directed**.
b. Expansion valve with replaceable thermostatic element.
c. Refrigerant filter/dryer.
d. Manual-reset high-pressure safety switch.
e. Automatic-reset low-pressure safety switch.
f. Minimum off-time relay.
g. Automatic-reset compressor motor thermal overload.
h. Brass service valves installed in compressor suction and liquid lines.
i. Low-ambient kit high-pressure sensor.
j. Hot-gas reheat solenoid valve with a replaceable magnetic coil.
k. Hot-gas bypass solenoid valve with a replaceable magnetic coil.
l. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

E. Air Filtration
1. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
a. Glass Fiber: Minimum 80 percent arrestance, and MERV 5.
b. Pleated: Minimum 90 percent arrestance, and MERV 7.

F. Gas Furnace
1. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.
a. CSA Approval: Designed and certified by and bearing label of CSA.
2. Burners: Stainless steel.
a. Fuel: Natural **OR** Propane, **as directed**, gas.
b. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
c. High-Altitude Model **OR** Kit, **as directed**: For Project elevations more than 2000 feet (610 m) above sea level.
3. Heat-Exchanger and Drain Pan: Stainless steel.
4. Venting: Gravity vented with vertical extension, **as directed**.
OR
Power Vent: Integral, motorized centrifugal fan interlocked with gas valve with vertical extension, **as directed**.
5. Safety Controls:
a. Gas Control Valve: Single stage **OR** Two stage **OR** Modulating, **as directed**.
b. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

G. Dampers
1. Outdoor-Air Damper: Linked damper blades, for 0 to 25 percent outdoor air, with manual **OR** motorized, **as directed**, damper filter.
2. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
a. Damper Motor: Modulating with adjustable minimum position.
b. Relief-Air Damper: Gravity actuated or motorized, as required by ASHRAE/IESNA 90.1, with bird screen and hood.

H. Electrical Power Connection

1. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit, **as directed**, and control-circuit transformer with built-in overcurrent protection.

I. Controls
1. Control equipment and sequence of operation are specified in Division 23 Section "Instrumentation And Control For Hvac".
2. Basic Unit Controls:
   a. Control-voltage transformer.
   b. Wall-mounted thermostat or sensor with the following features:
      1) Heat-cool-off switch.
      2) Fan on-auto switch.
      3) Fan-speed switch.
      4) Manual **OR** Automatic, **as directed**, changeover.
      5) Adjustable deadband.
      6) Concealed **OR** Exposed, **as directed**, set point.
      7) Concealed **OR** Exposed, **as directed**, indication.
      8) Degree F **OR** Degree C, **as directed**, indication.
      9) Unoccupied-period-override push button.
      10) Data entry and access port to input temperature and humidity, **as directed**, set points, occupied and unoccupied periods, and output room temperature and humidity, **as directed**, supply-air temperature, operating mode, and status.
   c. Wall-mounted humidistat or sensor with the following features:
      1) Concealed **OR** Exposed, **as directed**, set point.
      2) Concealed **OR** Exposed, **as directed**, indication.
   d. Remote Wall **OR** Unit, **as directed**,-Mounted Annunciator Panel for Each Unit:
      1) Lights to indicate power on, cooling, heating, fan running, filter dirty, and unit alarm or failure.
      2) DDC controller or programmable timer and interface with HVAC instrumentation and control system.
      3) Digital display of outdoor-air temperature, supply-air temperature, return-air temperature, economizer damper position, indoor-air quality, and control parameters.
3. Electronic **OR** DDC, **as directed**, Controller:
   a. Controller shall have volatile-memory backup.
   b. Safety Control Operation:
      1) Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.
      2) Firestats: Stop fan and close outdoor-air damper if air greater than 130 deg F (54 deg C) enters unit. Provide additional contacts for alarm interface to fire alarm control panel.
      3) Fire Alarm Control Panel Interface: Provide control interface to coordinate with operating sequence described in Division 28 Section(s) "Digital, Addressable Fire-alarm System" OR "Zoned (dc Loop) Fire-alarm System", **as directed.**
      4) Low-Discharge Temperature: Stop fan and close outdoor-air damper if supply air temperature is less than 40 deg F (4 deg C).
      5) Defrost Control for Condenser Coil: Pressure differential switch to initiate defrost sequence.
   c. Scheduled Operation: Occupied and unoccupied periods on seven-day **OR** 365-day, **as directed**, clock with a minimum of two **OR** four, **as directed**, programmable periods per day.
   d. Unoccupied Period:
      1) Heating Setback: 10 deg F (5.6 deg C).
      2) Cooling Setback: System off.
      3) Override Operation: Two hours.
   e. Supply Fan Operation:

1) Occupied Periods: Run fan continuously.
2) Unoccupied Periods: Cycle fan to maintain setback temperature.

f. Refrigerant Circuit Operation:
1) Occupied Periods: Cycle or stage compressors, and operate hot-gas bypass, **as directed**, to match compressor output to cooling load to maintain room **OR** discharge, **as directed**, temperature and humidity, **as directed**. Cycle condenser fans to maintain maximum hot-gas pressure. Operate low-ambient control kit to maintain minimum hot-gas pressure.
2) Unoccupied Periods: Compressors off **OR** Cycle compressors and condenser fans for heating to maintain setback temperature, **as directed**.
3) Switch reversing valve for heating or cooling mode on air-to-air heat pump.

g. Hot-Gas Reheat-Coil Operation:
1) Occupied Periods: Humidistat opens hot-gas valve to provide hot-gas reheat, and cycles compressor.
2) Unoccupied Periods: Reheat not required.

h. Gas Furnace Operation:
1) Occupied Periods: Cycle **OR** Stage **OR** Modulate, **as directed**, burner to maintain room **OR** discharge, **as directed**, temperature.
2) Unoccupied Periods: Cycle burner to maintain setback temperature.

i. Electric-Heating-Coil Operation:
1) Occupied Periods: Cycle **OR** Stage **OR** Modulate, **as directed**, coil to maintain room **OR** discharge, **as directed**, temperature.
2) Unoccupied Periods: Energize coil to maintain setback temperature.
3) Operate supplemental electric heating coil with compressor for heating with outdoor temperature below 25 deg F (minus 4 deg C).

j. Fixed Minimum Outdoor-Air Damper Operation:
1) Occupied Periods: Open to 25 percent.
2) Unoccupied Periods: Close the outdoor-air damper.

k. Economizer Outdoor-Air Damper Operation:
1) Occupied Periods: Open to 10 **OR** 25, **as directed**, percent fixed minimum intake, and maximum 100 percent of the fan capacity to comply with ASHRAE Cycle II. Controller shall permit air-side economizer operation when outdoor air is less than 60 deg F (15 deg C). Use outdoor-air temperature **OR** mixed-air and outdoor-air temperature **OR** outdoor-air enthalpy **OR** mixed-air temperature and select between outdoor-air and return-air enthalpy, **as directed**, to adjust mixing dampers. Start relief-air fan with end switch on outdoor-air damper, **as directed**. During economizer cycle operation, lock out cooling.
2) Unoccupied Periods: Close outdoor-air damper and open return-air damper.
3) Outdoor-Airflow Monitor: Accuracy maximum plus or minus 5 percent within 15 and 100 percent of total outdoor air. Monitor microprocessor shall adjust for temperature, and output shall range from 2- to 10-V dc **OR** 4 to 20 mA, **as directed**.

l. Carbon Dioxide Sensor Operation:
1) Occupied Periods: Reset minimum outdoor-air ratio down to minimum 10 percent to maintain maximum 1000-ppm concentration.
2) Unoccupied Periods: Close outdoor-air damper and open return-air damper.

m. VVT Relays:
1) Provide heating- and cooling-mode changeover relays compatible with VVT terminal control system required in Division 23 Section(s) "Air Terminal Units" AND "Instrumentation And Control For Hvac".

4. Interface Requirements for HVAC Instrumentation and Control System:
a. Interface relay for scheduled operation.
b. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
c. Provide BACnet **OR** LonWorks, **as directed**, compatible interface for central HVAC control workstation for the following:
1) Adjusting set points.

2) Monitoring supply fan start, stop, and operation.
3) Inquiring data to include outdoor-air damper position, **as directed**, supply- and room-air temperature and humidity, **as directed**.
4) Monitoring occupied and unoccupied operations.
5) Monitoring constant and variable motor loads.
6) Monitoring variable-frequency drive operation.
7) Monitoring cooling load.
8) Monitoring economizer cycles.
9) Monitoring air-distribution static pressure and ventilation air volume.

J. Accessories
1. Electric heater with integral thermostat maintains minimum 50 deg F (10 deg C) temperature in gas burner compartment.
2. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open, **as directed**.
3. Low-ambient kit using staged **OR** damper on **OR** variable-speed, **as directed**, condenser fans for operation down to 35 deg F (1.7 deg C).
4. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
5. Coil guards of painted, galvanized-steel wire.
6. Hail guards of galvanized steel, painted to match casing.
7. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.

K. Roof Curbs
1. Roof curbs with vibration isolators and wind or seismic restraints are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
OR
Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
a. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
1) Materials: ASTM C 1071, Type I or II.
2) Thickness: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**.
b. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
1) Liner Adhesive: Comply with ASTM C 916, Type I.
2) Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
3) Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
4) Liner Adhesive: Comply with ASTM C 916, Type I.
2. Curb Height: 14 inches (355 mm) **OR** 24 inches (610 mm) **OR** 36 inches (910 mm), **as directed**.
3. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment" for wind-load requirements.

1.3 EXECUTION

A. Installation

1. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
   a. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger than supported equipment and minimum 6 inches (150 mm) above finished ground elevation.
   b. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   c. Install anchor bolts to elevations required for proper attachment to supported equipment.
   d. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   e. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-place Concrete".
2. Equipment Mounting: Install RTUs on concrete base using elastomeric pads **OR** elastomeric mounts **OR** restrained spring isolators, **as directed**. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-place Concrete".
   a. Minimum Deflection: 1/4 inch (6 mm) **OR** 1 inch (25 mm), **as directed**.

   OR

   Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts" **OR** ARI Guideline B, **as directed**. Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 07 Section "Roof Accessories". Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.
3. Unit Support: Install unit level on structural curbs **OR** pilings, **as directed**. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.
4. Install wind and seismic restraints according to manufacturer's written instructions. Wind and seismically restrained vibration isolation roof-curb rails are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".

B. Connections
1. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.
2. Install piping adjacent to RTUs to allow service and maintenance.
   a. Gas Piping: Comply with applicable requirements in Division 23 Section(s) "Facility Natural-gas Piping" OR "Facility Liquefied-petroleum Gas Piping", **as directed**. Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.
3. Duct installation requirements are specified in other Division 21. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
   a. Install ducts to termination at top of roof curb.
   b. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
   c. Connect supply ducts to RTUs with flexible duct connectors specified in Division 23 Section "Air Duct Accessories".
   d. Install return-air duct continuously through roof structure.
   e. Install normal-weight, 3000-psi (20.7-MPa), compressive strength (28-day) concrete mix inside roof curb, 4 inches (100 mm) thick. Concrete, formwork, and reinforcement are specified in Division 31.

C. Field Quality Control
1. Perform tests and inspections and prepare test reports.
2. Tests and Inspections:
   a. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
   b. Inspect for and remove shipping bolts, blocks, and tie-down straps.

c. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Remove and replace malfunctioning units and retest as specified above.

D. Startup Service
1. Engage a factory-authorized service representative to perform startup service.
2. Complete installation and startup checks according to manufacturer's written instructions and do the following:
a. Inspect for visible damage to unit casing.
b. Inspect for visible damage to furnace combustion chamber.
c. Inspect for visible damage to compressor, coils, and fans.
d. Inspect internal insulation.
e. Verify that labels are clearly visible.
f. Verify that clearances have been provided for servicing.
g. Verify that controls are connected and operable.
h. Verify that filters are installed.
i. Clean condenser coil and inspect for construction debris.
j. Clean furnace flue and inspect for construction debris.
k. Connect and purge gas line.
l. Remove packing from vibration isolators.
m. Inspect operation of barometric relief dampers.
n. Verify lubrication on fan and motor bearings.
o. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
p. Adjust fan belts to proper alignment and tension.
q. Start unit according to manufacturer's written instructions.
1) Start refrigeration system.
2) Do not operate below recommended low-ambient temperature.
3) Complete startup sheets and attach copy with Contractor's startup report.
r. Inspect and record performance of interlocks and protective devices; verify sequences.
s. Operate unit for an initial period as recommended or required by manufacturer.
t. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.
1) Measure gas pressure on manifold.
2) Inspect operation of power vents.
3) Measure combustion-air temperature at inlet to combustion chamber.
4) Measure flue-gas temperature at furnace discharge.
5) Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
6) Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
u. Calibrate thermostats.
v. Adjust and inspect high-temperature limits.
w. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
x. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F (8 deg C) above return-air temperature:
1) Coil leaving-air, dry- and wet-bulb temperatures.
2) Coil entering-air, dry- and wet-bulb temperatures.
3) Outdoor-air, dry-bulb temperature.
4) Outdoor-air-coil, discharge-air, dry-bulb temperature.
y. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
z. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.

1) Supply-air volume.
2) Return-air volume.
3) Relief-air volume.
4) Outdoor-air intake volume.

aa. Simulate maximum cooling demand and inspect the following:
1) Compressor refrigerant suction and hot-gas pressures.
2) Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.

bb. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
1) High-temperature limit on gas-fired heat exchanger.
2) Low-temperature safety operation.
3) Filter high-pressure differential alarm.
4) Economizer to minimum outdoor-air changeover.
5) Relief-air fan operation.
6) Smoke and firestat alarms.

cc. After startup and performance testing and prior to Final Completion, replace existing filters with new filters.

E. Cleaning And Adjusting
1. Occupancy Adjustments: When requested within 12 months of date of Final Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site during other-than-normal occupancy hours for this purpose.
2. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

F. Demonstration

G. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs.

END OF SECTION 07 72 13 00

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SECTION 07 72 13 00a - INTAKE AND RELIEF VENTILATORS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for intake and relief ventilators. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Louvered-penthouse ventilators.
      b. Roof hoods.
      c. Goosenecks.

C. Performance Requirements
   1. Delegated Design: Design ventilators, including comprehensive engineering analysis by a qualified professional engineer, using structural and seismic performance requirements and design criteria indicated.
   2. Structural Performance: Ventilators shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of ventilator components, noise or metal fatigue caused by ventilator blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
      a. Wind Loads: Determine loads based on pressures as indicated on Drawings.
         OR
         Wind Loads: Determine loads based on a uniform pressure of 20 lbf/sq. ft. (960 Pa) **OR** 30 lbf/sq. ft. (1440 Pa), **as directed**, acting inward or outward.
         OR
         Wind Loads: Determine loads based on pressures indicated below:
         1) Corner Zone: Within <**Insert distance**> of building corners, uniform pressure of <**Insert design wind pressure**>, acting inward, and <**Insert design wind pressure**>, acting outward.
         2) Other Than Corner Zone: Uniform pressure of <**Insert design wind pressure**>, acting inward, and <**Insert design wind pressure**>, acting outward.
   3. Seismic Performance: Ventilators, including attachments to other construction, shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   4. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.
      a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
   5. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1.

D. Submittals
   1. Product Data: For each type of product indicated. For louvered-penthouse ventilators specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
   2. LEED Submittal:

a. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62., Section 5 - "Systems and Equipment."

3. Shop Drawings: For gravity ventilators. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.
   a. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
4. Samples: For each exposed product and for each color and texture specified.
5. Delegated-Design Submittal: For shop-fabricated ventilators indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   a. Detail fabrication and assembly of shop-fabricated ventilators.
6. Coordination Drawings: Roof framing plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   a. Structural members to which roof curbs and ventilators will be attached.
   b. Sizes and locations of roof openings.
7. Seismic Qualification Certificates: For ventilators, accessories, and components, from manufacturer.
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
8. Welding certificates.

E. Quality Assurance
1. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   b. AWS D1.3, "Structural Welding Code - Sheet Steel."

F. Coordination
1. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.2 PRODUCTS

A. Materials
1. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T5 or T-52.
2. Aluminum Sheet: ASTM B 209 (ASTM B 209M), Alloy 3003 or 5005 with temper as required for forming or as otherwise recommended by metal producer for required finish.
3. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 (Z275) zinc coating, mill phosphatized.
4. Stainless-Steel Sheet: ASTM A 666, Type 304, with No. 4 **OR** 6, **as directed**, finish.
5. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.
   a. Use types and sizes to suit unit installation conditions.
   b. Use Phillips flat **OR** hex-head or Phillips pan, **as directed**,-head screws for exposed fasteners unless otherwise indicated.
6. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors made from stainless-steel components, with capability to sustain without failure a load equal to 4 times the loads imposed for concrete, or 6 times the load imposed for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
7. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

B. Fabrication, General
1. Factory or shop fabricate gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.
2. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
3. Fabricate units with closely fitted joints and exposed connections accurately located and secured.
4. Fabricate supports, anchorages, and accessories required for complete assembly.
5. Perform shop welding by AWS-certified procedures and personnel.

C. Louvered-Penthouse Ventilators
1. Construction: All-welded assembly with 4-inch (100-mm) **OR** 6-inch (150-mm), **as directed**,-deep louvers, mitered corners, and aluminum **OR** galvanized-steel **OR** stainless-steel, **as directed**, sheet roof with mineral-fiber insulation and vapor barrier, **as directed**.
2. Frame and Blade Material and Nominal Thickness: Extruded aluminum, of thickness required to comply with structural performance requirements, but not less than 0.080 inch (2.0 mm) for frames and 0.080 inch (2.0 mm) **OR** 0.060 inch (1.5 mm), **as directed**, for blades with condensate deflectors, **as directed**.
   a. AMCA Seal: Mark units with the AMCA Certified Ratings Seal.
   b. Exterior Corners: Prefabricated corner units with mitered and welded blades **OR** mitered blades with concealed close-fitting splices, **as directed**, and with fully recessed **OR** semirecessed, **as directed**, mullions at corners.
3. Frame and Blade Material and Nominal Thickness: Galvanized-steel sheet, of thickness required to comply with structural performance requirements, but not less than 0.052 inch (1.3 mm) for frames and 0.040 inch (1.0 mm) **OR** 0.052 inch (1.3 mm) **OR** 0.064 inch (1.6 mm), **as directed**, for blades with condensate deflectors, **as directed**.
   a. AMCA Seal: Mark units with the AMCA Certified Ratings Seal.
   b. Exterior Corners: Prefabricated corner units with mitered and welded blades **OR** mitered blades with concealed close-fitting splices, **as directed**, and with fully recessed **OR** semirecessed, **as directed**, mullions at corners.
4. Frame and Blade Material and Nominal Thickness: Stainless-steel sheet, of thickness required to comply with structural performance requirements, but not less than 0.050 inch (1.27 mm) **OR** 0.062 inch (1.57 mm), **as directed**, with grain running parallel **OR** perpendicular, **as directed**, to length of blades and frame members with condensate deflectors, **as directed**.
   a. AMCA Seal: Mark units with the AMCA Certified Ratings Seal.
   b. Exterior Corners: Prefabricated corner units with mitered and welded blades **OR** mitered blades with concealed close-fitting splices, **as directed**, and with fully recessed **OR** semirecessed, **as directed**, mullions at corners.
5. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch- (40-mm-) thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to fit roof opening and ventilator base.
   a. Configuration: Self-flashing without a cant strip, with **OR** Built-in cant and **OR** Built-in raised cant and, **as directed**, mounting flange.
   b. Overall Height: 8 inches (200 mm) **OR** 9-1/2 inches (240 mm) **OR** 12 inches (300 mm) **OR** 16 inches (400 mm) **OR** 18 inches (450 mm), **as directed**.
6. Bird Screening: Galvanized-steel, 1/2-inch- (12.7-mm-) square mesh, 0.041-inch (1.04-mm) wire **OR** Aluminum, 1/2-inch- (12.7-mm-) square mesh, 0.063-inch (1.6-mm) wire **OR** Flattened, expanded aluminum, 3/4 by 0.050 inch (19 by 1.27 mm) thick **OR** Stainless-steel, 1/2-inch- (12.7-mm-) square mesh, 0.047-inch (1.19-mm) wire, **as directed**.
   OR
   Insect Screening: Aluminum, 18-by-16 (1.4-by-1.6-mm) mesh, 0.012-inch (0.30-mm) **OR** Stainless-steel, 18-by-18 (1.4-by-1.4-mm) mesh, 0.009-inch (0.23-mm), **as directed**, wire.
7. Galvanized-Steel Sheet Finish:
   a. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to

ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.

b. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.

c. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat and an overall minimum dry film thickness of 2 mils (0.05 mm).

1) Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

8. Accessories:

a. Dampers:

1) Location: Penthouse neck **OR** Inside louver face, **as directed**.

2) Control: Manual **OR** Motorized, **as directed**.

D. Roof Hoods

1. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figures 5-6 and 5-7.

2. Materials: Galvanized-steel sheet, minimum 0.064-inch- (1.62-mm-) thick base and 0.040-inch- (1.0-mm-) thick hood **OR** Aluminum sheet, minimum 0.063-inch- (1.6-mm-) thick base and 0.050-inch- (1.27-mm-) thick hood, **as directed**; suitably reinforced.

3. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch- (40-mm-) thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to fit roof opening and ventilator base.

a. Configuration: Self-flashing without a cant strip, with **OR** Built-in cant and **OR** Built-in raised cant and, **as directed**, mounting flange.

b. Overall Height: 8 inches (200 mm) **OR** 9-1/2 inches (240 mm) **OR** 12 inches (300 mm) **OR** 16 inches (400 mm) **OR** 18 inches (450 mm), **as directed**.

4. Bird Screening: Galvanized-steel, 1/2-inch- (12.7-mm-) square mesh, 0.041-inch (1.04-mm) wire **OR** Aluminum, 1/2-inch- (12.7-mm-) square mesh, 0.063-inch (1.6-mm) wire **OR** Flattened, expanded aluminum, 3/4 by 0.050 inch (19 by 1.27 mm) thick **OR** Stainless-steel, 1/2-inch- (12.7-mm-) square mesh, 0.047-inch (1.19-mm) wire, **as directed**.

OR

Insect Screening: Aluminum, 18-by-16 (1.4-by-1.6-mm) mesh, 0.012-inch (0.30-mm) **OR** Stainless-steel, 18-by-18 (1.4-by-1.4-mm) mesh, 0.009-inch (0.23-mm), **as directed**, wire.

5. Galvanized-Steel Sheet Finish:

a. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.

b. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.

c. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat and an overall minimum dry film thickness of 2 mils (0.05 mm).

1) Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

E. Goosenecks

1. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 5-5; with a minimum of 0.052-inch- (1.3-mm-) thick, galvanized-steel sheet.

2. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch- (40-mm-) thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to fit roof opening and ventilator base.

a. Configuration: Self-flashing without a cant strip, with **OR** Built-in cant and **OR** Built-in raised cant and, **as directed**, mounting flange.

b. Overall Height: 8 inches (200 mm) **OR** 9-1/2 inches (240 mm) **OR** 12 inches (300 mm) **OR** 16 inches (400 mm) **OR** 18 inches (450 mm), **as directed**.

3. Bird Screening: Galvanized-steel, 1/2-inch- (12.7-mm-) square mesh, 0.041-inch (1.04-mm) wire **OR** Aluminum, 1/2-inch- (12.7-mm-) square mesh, 0.063-inch (1.6-mm) wire **OR** Flattened, expanded aluminum, 3/4 by 0.050 inch (19 by 1.27 mm) thick **OR** Stainless-steel, 1/2-inch- (12.7-mm-) square mesh, 0.047-inch (1.19-mm) wire, **as directed**.
OR
Insect Screening: Aluminum, 18-by-16 (1.4-by-1.6-mm) mesh, 0.012-inch (0.30-mm) **OR** Stainless-steel, 18-by-18 (1.4-by-1.4-mm) mesh, 0.009-inch (0.23-mm), **as directed**, wire.

4. Galvanized-Steel Sheet Finish:

a. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.

b. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.

c. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat and an overall minimum dry film thickness of 2 mils (0.05 mm).

1) Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

1.3 EXECUTION

A. Installation

1. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.
2. Install goosenecks on curb base where throat size exceeds 9 by 9 inches (230 by 230 mm).
3. Install gravity ventilators with clearances for service and maintenance.
4. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
5. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Division 07 Section "Joint Sealants" for sealants applied during installation.
6. Label gravity ventilators according to requirements specified in Division 23 Section "Identification For Hvac Piping And Equipment".
7. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
8. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

B. Connections

1. Duct installation and connection requirements are specified in other Division 21. Drawings indicate general arrangement of ducts and duct accessories.

C. Adjusting

1. Adjust damper linkages for proper damper operation.

END OF SECTION 07 72 13 00a

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SECTION 07 72 23 00 - ROOF ACCESSORIES

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for roof accessories. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Roof curbs.
      b. Equipment supports.
      c. Roof hatches.
      d. Dropout-type heat and smoke vents.
      e. Hatch-type heat and smoke vents.
      f. Gravity ventilators.
      g. Roof supports.
      h. Roof walkways.
      i. Preformed flashings.

C. Submittals
   1. Product Data: For each type of roof accessory indicated.
   2. Shop Drawings: Show fabrication and installation details for roof accessories.
   3. Samples: For each type of exposed factory-applied color finish required and for each type of roof accessory indicated, prepared on Samples of size to adequately show color.

D. Quality Assurance
   1. Sheet Metal Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" details for fabrication of units, including flanges and cap flashing to coordinate with type of roofing indicated.

E. Delivery, Storage, And Handling
   1. Pack, handle, and ship roof accessories properly labeled in heavy-duty packaging to prevent damage.

F. Warranty
   1. Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace roof accessories that show evidence of deterioration of factory-applied finishes within 20 years from date of Final Completion.

1.2 PRODUCTS

A. Metal Materials
   1. Galvanized Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coated and mill phosphatized for field painting.
   2. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, AZ50 (AZM150) coated.
   3. Prepainted, Metallic-Coated Steel Sheet: Steel sheet metallic coated by hot-dip process and prepainted by coil-coating process to comply with ASTM A 755/A 755M.
      a. Galvanized Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coated.
      b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 (Class AZM150) coated.

c. Exposed Finishes: Manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight.

4. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy and temper recommended by manufacturer for type of use and mill finish. Coil-coat finish as follows:
   a. Factory-Prime Coating: Where painting after installation is indicated, provide pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat; with a minimum dry film thickness of 0.2 mil (0.005 mm).
   b. Clear **OR** Color, **as directed**, Anodic Finish: Architectural Class II, complying with AAMA 611.
      1) Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** Champagne, **as directed**.
   c. Baked-Enamel Finish: Organic Coating: Thermosetting, modified-acrylic enamel primer/topcoat system complying with AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm), medium gloss.
      1) Color and Gloss: As selected from manufacturer's full range.
   d. High-Performance Organic Finish: Manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight.
      1) Color and Gloss: As selected from manufacturer's full range.
   e. Powder-Coat Finish: Immediately after cleaning and pretreating, electrostatically apply manufacturer's standard baked-polymer thermosetting powder finish.
      1) Color and Gloss: As selected from manufacturer's full range.
5. Stainless-Steel Shapes or Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304 or Type 316, No. 2D finish.
6. Aluminum Extrusions and Tubes: ASTM B 221 (ASTM B 221M), alloy and temper recommended by manufacturer for type of use, mill finished.
7. Steel Shapes: ASTM A 36/A 36M, hot-dip galvanized to comply with ASTM A 123/A 123M, unless otherwise indicated.
8. Steel Tube: ASTM A 500, round tube, baked-enamel finished.
9. Galvanized Steel Tube: ASTM A 500, round tube, hot-dip galvanized to comply with ASTM A 123/A 123M.
10. Galvanized Steel Pipe: ASTM A 53/A 53M.

B. Miscellaneous Materials
1. Acrylic Glazing: ASTM D 4802, thermoformable, monolithic sheet, category as standard with manufacturer, Type UVA (formulated with UV absorber), Finish 1 (smooth or polished).
2. Polycarbonate Glazing: Thermoformable, monolithic polycarbonate sheets manufactured by extrusion process, burglar-resistance rated per UL 972 with an average impact strength of 12 to 16 ft-lbf/in. (640 to 854 J/m) of width when tested according to ASTM D 256, Method A (Izod).
3. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 1, 1 inch (25 mm) thick.
4. Glass-Fiber Board Insulation: ASTM C 726, 1 inch (25 mm) thick.
5. Polyisocyanurate Board Insulation: ASTM C 1289, 1 inch (25 mm) thick.
6. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, complying with AWPA C2; not less than 1-1/2 inches (38 mm) thick.
7. Security Grilles: 3/4-inch- (19-mm-) diameter, ASTM A 1011/A 1011M steel bars spaced 6 inches (150 mm) o.c. in 1 direction and 12 inches (300 mm) o.c. in the other; factory primed.
   a. Factory Finish:
      1) Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
      2) Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment.
      3) Shop Primer: Manufacturer's or fabricator's standard, fast-curing, lead- and chromate-free, universal primer; selected for resistance to normal atmospheric

corrosion, for compatibility with substrate and field-applied finish paint system indicated, and for capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.

8. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
9. Polyethylene Sheet: 6-mil- (0.15-mm-) thick, polyethylene sheet complying with ASTM D 4397.
10. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
    a. Slip Sheet: Rosin-sized paper, minimum 3 lb/100 sq. ft. (0.16 kg/sq. m).
11. Fasteners: Same metal as metals being fastened, or nonmagnetic stainless steel or other noncorrosive metal as recommended by roof accessory manufacturer. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners.
12. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, or PVC; or flat design of foam rubber, sponge neoprene, or cork.
13. Elastomeric Sealant: ASTM C 920, polyurethane **OR** polysulfide **OR** silicone, **as directed**, sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
14. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant, polyisobutylene plasticized, and heavy bodied for hooked-type expansion joints with limited movement.
15. Roofing Cement: ASTM D 4586, nonasbestos, fibrated asphalt cement designed for trowel application or other adhesive compatible with roofing system.

C. Roof Curbs
1. Roof Curbs: Provide metal roof curbs, internally reinforced and capable of supporting superimposed live and dead loads, including equipment loads and other construction to be supported on roof curbs. Fabricate with welded or sealed mechanical corner joints, with integral metal cant, **OR** stepped integral metal cant raised the thickness of roof insulation, **as directed**, and integral formed mounting flange at perimeter bottom. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.
    a. Load Requirements: As required to satisfy local code requirements.
    b. Material:
        1) Galvanized **OR** Aluminum-zinc alloy-coated, **as directed**, steel sheet, 0.052 inch (1.32 mm) **OR** 0.079 inch (2.0 mm), **as directed**, thick.
        2) Aluminum sheet, 0.090 inch (2.28 mm) thick.
        3) Stainless-steel sheet, 0.078 inch (1.98 mm) thick.
    c. Finish:
        1) Prime painted **OR** Baked enamel **OR** High-performance organic coating **OR** Powder coat, **as directed**.
        2) Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
    d. Liner: Same material as curb, of manufacturer's standard thickness and finish.
    e. Factory install wood nailers at tops of curbs.
    f. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
    g. Factory insulate curbs with 1-1/2-inch- (38-mm-) thick, cellulosic-fiber **OR** glass-fiber, **as directed**, board insulation.
    h. Curb height may be determined by adding thickness of roof insulation and minimum base flashing height recommended by roofing membrane manufacturer. Fabricate units to minimum height of 12 inches (300 mm), unless otherwise indicated.
    i. Sloping Roofs: Where slope of roof deck exceeds 1:48, fabricate curb units with water diverter or cricket and with height tapered to match slope to level tops of units.

D. Equipment Supports
1. Equipment Supports: Provide metal equipment supports, internally reinforced and capable of supporting superimposed live and dead loads, including equipment loads and other construction to be supported. Fabricate with welded or sealed mechanical corner joints, with integral metal

cant **OR** stepped integral metal cant raised the thickness of roof insulation, **as directed**, and integral formed mounting flange at perimeter bottom. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

a. Load Requirements: As required to satisfy local code requirements.
b. Material:
   1) Galvanized **OR** Aluminum-zinc alloy-coated, **as directed**, steel sheet, 0.052 inch (1.32 mm) **OR** 0.079 inch (2.0 mm), **as directed**, thick.
   2) Aluminum sheet, 0.090 inch (2.28 mm) thick.
   3) Stainless-steel sheet, 0.078 inch (1.98 mm) thick.
c. Finish:
   1) Prime painted **OR** Baked enamel **OR** High-performance organic coating **OR** Powder coat, **as directed**.
   2) Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
d. Factory-install continuous wood nailers 3-1/2 inches (90 mm) **OR** 5-1/2 inches (140 mm), **as directed**, wide at tops of equipment supports.
e. Metal Counterflashing: Manufacturer's standard removable counterflashing, fabricated of same metal and finish as equipment support.
f. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
g. Fabricate units to minimum height of 12 inches (300 mm), unless otherwise indicated.
h. Sloping Roofs: Where slope of roof deck exceeds 1:48, fabricate curb units with water diverter or cricket and with height tapered to match slope to level tops of units.

E. Roof Hatches

1. Roof Hatches: Fabricate roof hatches with insulated double-wall lids and insulated single-wall **OR** double-wall, **as directed**, curb frame with integral deck mounting flange and lid frame counterflashing. Fabricate with welded or mechanically fastened and sealed corner joints. Provide continuous weathertight perimeter gasketing and equip with corrosion-resistant or hot-dip galvanized hardware.
   a. Loads: Fabricate roof hatches to withstand 40-lbf/sq. ft. (1.9-kPa) external and 20-lbf/sq. ft. (0.95-kPa) internal loads.
   b. Type and Size: Single-leaf lid, 30 by 36 inches (750 by 900 mm) **OR** 30 by 54 inches (750 by 1370 mm) **OR** 30 by 96 inches (750 by 2440 mm), **as directed**.
   c. Type and Size: Double-leaf lid, 72 by 96 inches (1830 by 2440 mm).
   d. Curb and Lid Material:
      1) Galvanized **OR** Aluminum-zinc alloy-coated, **as directed**, steel sheet, 0.079 inch (2.0 mm) thick.
      2) Aluminum sheet, 0.090 inch (2.28 mm) thick.
      3) Stainless-steel sheet, 0.078 inch (1.98 mm) thick.
   e. Finish:
      1) Prime painted **OR** Baked enamel **OR** High-performance organic coating **OR** Powder coat, **as directed**.
      2) Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
   f. Insulation: Cellulosic-fiber **OR** Glass-fiber **OR** Polyisocyanurate, **as directed**, board.
   g. Interior Lid Liner: Manufacturer's standard metal liner of same material and finish as outer metal lid.
   h. Exterior Curb Liner: Manufacturer's standard metal liner of same material and finish as metal curb.
   i. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
   j. Fabricate units to minimum height of 12 inches (300 mm), unless otherwise indicated.
   k. Sloping Roofs: Where slope or roof deck exceeds 1:48, fabricate hatch curbs with height constant **OR** tapered to match slope to level tops of units, **as directed**.
   l. Hardware: Galvanized steel **OR** Stainless-steel, **as directed**, spring latch with turn handles, butt- or pintle-type hinge system, and padlock hasps inside and outside.
      1) Provide 2-point latch on covers larger than 84 inches (2130 mm).
      2) Provide remote-control operation.

m. Ladder Safety Post: Manufacturer's standard ladder safety post. Post to lock in place on full extension. Provide release mechanism to return post to closed position.
n. Safety Railing System: Manufacturer's standard complete system including rails, clamps, fasteners, safety barrier at railing opening, and all accessories required for a complete installation.

F. Heat And Smoke Vents
1. Dropout-Type Heat and Smoke Vents: Manufacturer's standard gravity-operated, automatic smoke and heat vents with integral double-wall insulated curbs and frame with welded or sealed mechanical corner joints, integral condensation gutter, cap flashing, and heat-sensitive dome glazing that will deform and drop out of vent opening within 5 minutes of exposure to a simulated fire represented by a time-temperature gradient that reaches an air temperature of 500 deg F (260 deg C) within 5 minutes.
   a. Loads: Fabricate heat and smoke vents to withstand a minimum 40-lbf/sq. ft. (1.9-kPa) external live load and 30-lbf/sq. ft. (1.4-kPa) uplift.
      1) Dome glazing shall have a thickness capable of resisting 40-lbf/sq. ft. (1.9-kPa) external and 20-lbf/sq. ft. (0.95-kPa) internal loads.
   b. Regulatory Requirements: Comply with UL 793 and NFPA 204.
   c. Heat and Smoke Vent Compliance: Provide units that have been tested and UL listed **OR** FMG approved, **as directed**.
   d. Integral Curb and Framing Material:
      1) Galvanized **OR** Aluminum-zinc alloy-coated, **as directed**, steel sheet, 0.079 inch (2.0 mm) thick.
      2) Aluminum sheet, 0.090 inch (2.28 mm) thick.
      3) Stainless-steel sheet, 0.078 inch (1.98 mm) thick.
   e. Finish:
      1) Prime painted **OR** Baked enamel **OR** High-performance organic coating **OR** Powder coat, **as directed**.
      2) Finish: Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
   f. Insulation: Cellulosic-fiber **OR** Glass-fiber **OR** Polyisocyanurate, **as directed**, board.
   g. Exterior Curb Liner: Manufacturer's standard metal liner of same material and finish as metal curb.
   h. Fabricate integral curbs to minimum height of 12 inches (300 mm), unless otherwise indicated.
   i. Sloping Roofs: Where slope of roof deck exceeds 1:48, fabricate curbs with height constant **OR** tapered to match slope to level tops of units, **as directed**.
   j. Dome Glazing: Single **OR** Double, **as directed,** acrylic **OR** polycarbonate, **as directed**, glazing.
      1) Single-Dome Color: Colorless, transparent **OR** White, translucent **OR** Gray tinted, transparent **OR** Bronze tinted, transparent, **as directed**.
      2) Outer Double-Dome Color: Colorless, transparent **OR** White, translucent **OR** Gray tinted, transparent **OR** Bronze tinted, transparent, **as directed**.
      3) Inner Double-Dome Color: Colorless, transparent **OR** White, translucent **OR** Gray tinted, transparent **OR** Bronze tinted, transparent, **as directed**.
2. Hatch-Type Heat and Smoke Vents: Manufacturer's standard single-leaf **OR** double-leaf, **as directed**, hatch-type heat and smoke vents with integral double-wall insulated curbs and frame, with welded or sealed mechanical corner joints, integral condensation gutter, and cap flashing. Fabricate with insulated double-wall lid, continuous weathertight perimeter lid gaskets, and equip with automatic self-lifting mechanisms, UL-listed fusible links rated at 165 deg F (74 deg C) **OR** fire-suppression system **OR** smoke-detection system, **as directed**, and corrosion-resistant or hot-dip galvanized hardware including hinges, hold-open devices, and independent manual-release devices for inside and outside operation of lids.
   a. Loads: Fabricate heat and smoke vent to withstand a minimum 40-lbf/sq. ft. (1.9-kPa) external live load and 30-lbf/sq. ft. (1.4-kPa) uplift.
      1) When release is actuated, lid shall open against 10-lbf/sq. ft. (0.5-kPa) snow or wind load and lock in position.

b. Regulatory Requirements: UL 793 and NFPA 204.
c. Heat and Smoke Vent Compliance: Provide units that have been tested and UL listed **OR** FMG approved, **as directed**.
d. Fire Resistance of Lids: UL Class A rating.
e. Integral Curb, Framing, and Lid Material:
   1) Galvanized **OR** Aluminum-zinc alloy-coated, **as directed**, steel sheet, 0.079 inch (2.0 mm) thick.
   2) Aluminum sheet, 0.090 inch (2.28 mm) thick.
   3) Stainless-steel sheet, 0.078 inch (1.98 mm) thick.
f. Finish:
   1) Prime painted **OR** Baked enamel **OR** High-performance organic coating **OR** Powder coat, **as directed**.
   2) Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
g. Insulation: Cellulosic-fiber **OR** Glass-fiber **OR** Polyisocyanurate, **as directed**, board.
h. Fabricate integral curbs to minimum height of 12 inches (300 mm), unless otherwise indicated.
i. Sloping Roofs: Where slope of roof deck exceeds 1:48, fabricate curbs with height constant **OR** tapered to match slope to level tops of units, **as directed**.

G. Gravity Ventilators
1. Low-Profile, Cylindrical-Style Gravity Ventilators: Manufacturer's standard unit fabricated from the following materials, with manufacturer's standard welded or sealed mechanical joints:
   a. Provide integral base flange, vent cylinder, cylinder bird screen, and rain cap **OR** hood, **as directed**.
   b. Dimensions: As indicated.
   c. Style: As indicated.
   d. Bird Screens: Manufacturer's standard mesh with rewireable frame.
   e. Insect Screens: Manufacturer's standard mesh with rewireable frame.
   f. Vent Cylinder, Base Flange, and Rain-Cap **OR** Hood, **as directed** Material: Galvanized steel **OR** Aluminum **OR** Stainless-steel, **as directed**, sheet, of manufacturer's standard thickness.
   g. Finish:
      1) Prime painted **OR** Baked enamel **OR** High-performance organic coating **OR** Powder coat, **as directed**.
      2) Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
2. Low-Profile, Louvered Penthouse-Style Gravity Ventilators: Manufacturer's standard unit fabricated from the following materials, with manufacturer's standard welded or sealed mechanical joints:
   a. Provide integral frame with base flange, weathertight cap, louver bird screen, and weatherproof sidewall louvers.
   b. Dimensions: As indicated.
   c. Style: As indicated.
   d. Bird Screens: Manufacturer's standard mesh with rewireable frame.
   e. Insect Screens: Manufacturer's standard mesh with rewireable frame.
   f. Integral Frame, Base Flange, Weathertight Cap, and Louver Material: Galvanized steel **OR** Aluminum **OR** Stainless-steel, **as directed**, sheet, of manufacturer's standard thickness.
   g. Finish:
      1) Prime painted **OR** Baked enamel **OR** High-performance organic coating **OR** Powder coat, **as directed**.
      2) Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
3. Directional Louvered Pedestal-Style Gravity Ventilators: Manufacturer's standard unit fabricated from the following materials, with manufacturer's standard welded or sealed mechanical joints:
   a. Provide integral weathertight base cap, integral outlet duct, weathertight sidewalls, bird screen, and weatherproof sidewall louver.

b. Dimensions: As indicated.
c. Style: As indicated.
d. Bird Screens: Manufacturer's standard mesh with rewireable frame.
e. Insect Screens: Manufacturer's standard mesh with rewireable frame.
f. Weathertight Base Cap, Outlet Duct, Sidewall, and Louver Material: Galvanized steel **OR** Aluminum **OR** Stainless-steel, **as directed**, sheet, of manufacturer's standard thickness.
g. Finish:
1) Prime painted **OR** Baked enamel **OR** High-performance organic coating **OR** Powder coat, **as directed**.
2) Mill **OR** Clear anodic **OR** Color anodic, **as directed**.

4. Turbine-Style Gravity Ventilators: Manufacturer's standard unit fabricated from the following materials, with manufacturer's standard welded or sealed mechanical joints:
a. Provide integral weathertight base cap, outlet duct, and rotating louvered turbine.
b. Dimensions: As indicated.
c. Style: As indicated.
d. Bird Screens: Manufacturer's standard mesh with rewireable frame.
e. Insect Screens: Manufacturer's standard mesh with rewireable frame.
f. Weathertight Base Cap, Outlet Duct, and Turbine Material: Galvanized steel **OR** Aluminum, **as directed**, sheet, of manufacturer's standard thickness.
g. Finish:
1) Prime painted **OR** Baked enamel **OR** High-performance organic coating **OR** Powder coat, **as directed**.
2) Mill **OR** Clear anodic **OR** Color anodic, **as directed**.

H. Roof Supports

1. Pipe Roof Supports: Adjustable height, extruded-aluminum tube, urethane insulation filled, 2 inches (50 mm) in diameter, with aluminum base plates and manufacturer's recommended hardware for mounting to structure **OR** structural roof deck, **as directed**, and extruded-aluminum carrier assemblies, suitable for quantity of pipe runs and sizes, with EPDM end caps. Include manufacturer's standard hardware for mounting to structure or structural roof deck.
a. Pipe Support Height: As indicated.
b. Pipe Roller Assembly: Stainless-steel roller assembly sized for supported pipes with extruded aluminum.
c. Pipe Support Flashing: Insulated **OR** Uninsulated, **as directed**, sleeve flashings with integral base flange, and EPDM grommetted top seal and base seals.
1) Metal: Aluminum sheet, 0.064 inch (1.6 mm) thick **OR** Copper sheet, 16 oz. (0.55 mm) thick, **as directed**.

2. Terrace Lighting Roof Supports: Epoxy-coated hollow structural section steel pipe support, urethane insulation filled, with epoxy-coated steel base plates and manufacturer's recommended hardware for mounting to structure **OR** structural roof deck, **as directed**, 14 inches (356 mm) **OR** 18 inches (457 mm), **as directed**, high, with galvanized threaded cap.
a. Lighting Pole Mounting: Stainless-steel lighting pole adapter **OR** Epoxy-coated steel plate with stainless-steel studs, **as directed**.
b. Pipe Support Flashing: Insulated **OR** Uninsulated, , metal sleeve flashings with integral base flange, and EPDM grommetted top seal and base seals.
1) Metal: Aluminum sheet, 0.064 inch (1.6 mm) thick **OR** Copper sheet, 16 oz. (0.55 mm) thick, **as directed**.

3. Light-Duty Pipe Roof Supports: Extruded-aluminum base assembly and Type 304 stainless-steel roller assembly for pipe sizes indicated, including manufacturer's standard hardware for mounting to structure or structural roof deck.
4. Duct Roof Supports: 2-inch- (50-mm-) diameter, extruded-aluminum, urethane-insulated supports, including manufacturer's standard hardware for mounting to structure or structural roof deck.

I. Roof Walkways

1. Roof Walkway: Multiple C-shaped-channel formed-metal planks, as follows, with upper surface punched in serrated diamond or rectangular shapes to produce raised slip-resistant surface and drainage holes. Provide support framing, brackets, connectors, nosings, and other accessories and components needed for complete installation. Include step units for changes in elevation.
   a. Plank Width: 4-3/4 inches (121 mm) **OR** 7 inches (178 mm) **OR** 9-1/2 inches (241 mm) **OR** 11-3/4 inches (298 mm) **OR** 18-3/4 inches (476 mm) **OR** 24 inches (610 mm) **OR** As indicated, **as directed**.
   b. Walkway Width: As indicated.
   c. Channel Depth: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 2-1/2 inches (64 mm) **OR** 3 inches (76 mm) **OR** As indicated., **as directed**
   d. Metal Material: -0.079-inch- (2.0-mm-) thick, hot-dip galvanized steel sheet **OR** 0.108-inch- (2.8-mm-) thick, hot-dip galvanized steel sheet **OR** 0.062-inch- (1.6-mm-) thick, stainless-steel sheet **OR** 0.078-inch- (1.98-mm-) thick, stainless-steel sheet **OR** 0.080-inch- (2.03-mm-) thick, mill-finished aluminum sheet **OR** 0.100-inch- (2.5-mm-) thick, mill-finished aluminum sheet, **as directed**.
   e. Provide isolation pads attached to supports so supports are completely isolated from roof membrane surface.

J. Preformed Flashings
1. Exhaust Vent Flashings: Double-wall metal flashing sleeve, urethane insulation filled, with integral deck flange, 12 inches (300 mm) high, with removable metal hood and slotted **OR** perforated, **as directed**, metal collar, and as follows:
   a. Metal: Aluminum sheet, 0.064 inch (1.6 mm) thick, mill finished **OR** Copper sheet, 16 oz. (0.55 mm thick), **as directed**.
   b. Diameter: As indicated.
2. Vent Stack Flashing: Metal flashing sleeve, with integral deck flange, uninsulated, and as follows:
   a. Metal: Aluminum sheet, 0.064 inch (1.6 mm) thick, mill finished **OR** Copper sheet, 16 oz. (0.55 mm thick), **as directed**.
   b. Height: As indicated..
   c. Diameter: As indicated.

1.3 EXECUTION

A. Installation
1. General: Install roof accessories according to manufacturer's written instructions. Anchor roof accessories securely in place and capable of resisting forces specified. Use fasteners, separators, sealants, and other miscellaneous items as required for completing roof accessory installation. Install roof accessories to resist exposure to weather without failing, rattling, leaking, and fastener disengagement.
2. Install roof accessories to fit substrates and to result in watertight performance.
3. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
   a. Coat concealed side of uncoated aluminum **OR** stainless-steel, **as directed**, roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
   b. Underlayment: Where installing exposed-to-view components of roof accessories directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet, or install a course of polyethylene underlayment.
   c. Bed flanges in thick coat of asphalt roofing cement where required by roof accessory manufacturers for waterproof performance.
4. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.

5. Seal joints with elastomeric **OR** butyl, **as directed**, sealant as required by manufacturer of roof accessories.

END OF SECTION 07 72 23 00

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Task	Specification	Specification Description
07 72 26 00	07 72 23 00	Roof Accessories
07 72 33 00	07 72 23 00	Roof Accessories
07 72 36 00	07 72 23 00	Roof Accessories
07 72 63 00	01 22 16 00	No Specification Required
07 73 00 00	07 51 13 00	Built-Up Asphalt Roofing
07 73 00 00	07 01 50 81	Built-Up Coal-Tar Roofing
07 73 00 00	07 53 16 00	EPDM Membrane Roofing
07 73 00 00	07 05 13 00	CSPE Membrane Roofing
07 73 00 00	07 05 13 00a	APP-Modified Bituminous Membrane Roofing
07 73 00 00	07 05 13 00b	SBS-Modified Bituminous Membrane Roofing
07 76 16 00	01 22 16 00	No Specification Required

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SECTION 07 81 16 00 - SPRAYED FIRE-RESISTIVE MATERIALS

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for sprayed fire-resistive materials. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Concealed SFRM.
      b. Exposed SFRM.
      c. Exposed intumescent mastic fire-resistive coatings.

C. Definitions
   1. SFRM: Sprayed fire-resistive material.
   2. Concealed: Fire-resistive materials applied to surfaces that are concealed from view behind other construction when the Work is completed and have not been defined as exposed, **as directed**.
   3. Exposed: Fire-resistive materials applied to surfaces that are exposed to view when the Work is completed, that are accessible through suspended ceilings **OR** that are in elevator shafts and machine rooms **OR** that are in mechanical rooms **OR** that are in air-handling plenums **OR** and that are identified as exposed on Drawings, **as directed**.

D. Submittals
   1. Product Data: For each type of product indicated.
   2. Shop Drawings: Show extent of sprayed fire-resistive material for each construction and fire-resistance rating, applicable fire-resistive design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction, and minimum thicknesses.
   3. Product certificates **OR** test reports, **as directed**.
   4. Compatibility and adhesion test reports.
   5. Research/evaluation reports.
   6. Field quality-control test and special inspection, **as directed**, reports.

E. Quality Assurance
   1. Installer Qualifications: A qualified installer approved by SFRM manufacturer to install manufacturer's products. A manufacturer's willingness to sell its SFRM to Contractor or to an installer engaged by Contractor does not in itself confer qualification on the buyer.
   2. SFRM Testing: By a qualified testing and inspecting agency engaged by Contractor or manufacturer to test for compliance with specified requirements for performance and test methods.
      a. SFRMs are randomly selected for testing from bags bearing the applicable classification marking of UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
      b. Testing is performed on specimens of SFRMs that comply with laboratory testing requirements specified in Part 2 and are otherwise identical to installed fire-resistive materials, including application of accelerant, sealers, topcoats, tamping, troweling, rolling, and water overspray, if any of these are used in final application.
      c. Testing is performed on specimens whose application the independent testing and inspecting agency witnessed during preparation and conditioning. Include in test reports a full description of preparation and conditioning of laboratory test specimens.

3. Compatibility and Adhesion Testing: Engage a qualified testing and inspecting agency to test for compliance with requirements for specified performance and test methods.
   a. Test for bond per ASTM E 736 and requirements in UL's "Fire Resistance Directory" for coating materials. Provide bond strength indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
   b. Verify that manufacturer, through its own laboratory testing or field experience, has not found primers or coatings to be incompatible with SFRM.
4. Fire-Test-Response Characteristics: Where indicated, provide products identical to those tested for fire resistance per ASTM E 119 by a testing agency acceptable to authorities having jurisdiction.
   a. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
   b. Identify products with appropriate markings of applicable testing and inspecting agency.
5. Provide products containing no detectable asbestos as determined according to the method specified in 40 CFR 763, Subpart E, Appendix E, Section 1, "Polarized Light Microscopy."
6. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
   1. Deliver products to Project site in original, unopened packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, shelf life if applicable, and fire-resistance ratings applicable to Project.
   2. Use materials with limited shelf life within period indicated. Remove from Project site and discard materials whose shelf life has expired.
   3. Store materials inside, under cover, and aboveground; keep dry until ready for use. Remove from Project site and discard wet or deteriorated materials.

G. Project Conditions
   1. Environmental Limitations: Do not apply SFRM when ambient or substrate temperature is 40 deg F (4 deg C) or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.
   2. Ventilation: Ventilate building spaces during and after application of SFRM. Use natural means or, if they are inadequate, forced-air circulation until fire-resistive material dries thoroughly.

H. Warranty
   1. Special Warranty: Manufacturer's standard form, signed by Contractor and by Installer, in which manufacturer agrees to repair or replace SFRMs that fail in materials or workmanship within two years from date of Final Completion.

1.2 PRODUCTS

A. Concealed SFRM
   1. Material Composition: Manufacturer's standard product, as follows **OR** either of the following, **as directed**:
      a. Concealed Cementitious SFRM: Factory-mixed, dry formulation of gypsum or portland cement binders, additives, and lightweight mineral or synthetic aggregates mixed with water at Project site to form a slurry or mortar for conveyance and application.
      b. Concealed Sprayed-Fiber Fire-Resistive Material: Factory-mixed, dry formulation of inorganic binders, mineral fibers, fillers, and additives conveyed in a dry state by pneumatic equipment and mixed with water at spray nozzle to form a damp, as-applied product.
   2. Physical Properties: Minimum values, unless otherwise indicated, or higher values required to attain designated fire-resistance ratings, measured per standard test methods referenced with each property as follows:

a. Dry Density: 15 lb/cu. ft. (240 kg/cu. m) for average and individual densities, or greater if required to attain fire-resistance ratings indicated, per ASTM E 605 or AWCI Technical Manual 12-A, Section 5.4.5, "Displacement Method."

b. Thickness: Minimum average thickness required for fire-resistance design indicated according to the following criteria, but not less than 0.375 inch (9 mm), per ASTM E 605:

1) Where the referenced fire-resistance design lists a thickness of 1 inch (25 mm) or more, the minimum allowable individual thickness of SFRM is the design thickness minus 0.25 inch (6 mm).

2) Where the referenced fire-resistance design lists a thickness of less than 1 inch (25 mm) but more than 0.375 inch (9 mm), the minimum allowable individual thickness of SFRM is the greater of 0.375 inch (9 mm) or 75 percent of the design thickness.

3) No reduction in average thickness is permitted for those fire-resistance designs whose fire-resistance ratings were established at densities of less than 15 lb/cu. ft. (240 kg/cu. m).

c. Bond Strength: 150 lbf/sq. ft. (7.2 kPa) minimum per ASTM E 736 based on laboratory testing of 0.75-inch (19-mm) minimum thickness of SFRM.

d. Compressive Strength: 5.21 lbf/sq. in. (35.9 kPa) minimum per ASTM E 761. Minimum thickness of SFRM tested shall be 0.75 inch (19 mm) and minimum dry density shall be as specified but not less than 15 lb/cu. ft. (240 kg/cu. m).

e. Corrosion Resistance: No evidence of corrosion per ASTM E 937.

f. Deflection: No cracking, spalling, or delamination per ASTM E 759.

g. Effect of Impact on Bonding: No cracking, spalling, or delamination per ASTM E 760.

h. Air Erosion: Maximum weight loss of 0.025 g/sq. ft. (0.270 g/sq. m) in 24 hours per ASTM E 859. For laboratory tests, minimum thickness of SFRM is 0.75 inch (19 mm), maximum dry density is 15 lb/cu. ft. (240 kg/cu. m), test specimens are not prepurged by mechanically induced air velocities, and tests are terminated after 24 hours.

i. Fire-Test-Response Characteristics: Provide SFRM with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1) Flame-Spread Index: 10 or less.

2) Smoke-Developed Index: 0.

j. Fungal Resistance: No observed growth on specimens per ASTM G 21.

B. Exposed SFRM

1. Material Composition: Manufacturer's standard product, as follows:

a. Exposed Cementitious SFRM: Factory-mixed, dry, cement aggregate formulation; or chloride-free formulation of gypsum or portland cement binders, additives, and inorganic aggregates mixed with water at Project site to form a slurry or mortar for conveyance and application.

b. Exposed Sprayed-Fiber Fire-Resistive Material: Factory-mixed, dry formulation of inorganic binders, mineral fibers, fillers, and additives conveyed in a dry state by pneumatic equipment and mixed with water at spray nozzle to form a damp, as-applied product.

2. Physical Properties: Minimum values, unless otherwise indicated, or higher values required to attain designated fire-resistance ratings, measured per standard test methods referenced with each property as follows:

a. Dry Density: Values for average and individual densities as required for fire-resistance ratings indicated, per ASTM E 605 or AWCI Technical Manual 12-A, Section 5.4.5, "Displacement Method," but with an average density of not less than 22 lb/cu. ft. (352 kg/cu. m).

b. Bond Strength: 434 lbf/sq. ft. (21 kPa) minimum per ASTM E 736.

c. Compressive Strength: 51 lbf/sq. in. (351 kPa) minimum per ASTM E 761.

d. Dry Density: Values for average and individual densities as required for fire-resistance ratings indicated, per ASTM E 605 or AWCI Technical Manual 12-A, Section 5.4.5, "Displacement Method," but with an average density of not less than 39 lb/cu. ft. (625 kg/cu. m).

e. Bond Strength: 1000 lbf/sq. ft. (48 kPa) minimum per ASTM E 736.

f. Compressive Strength: 300 lbf/sq. in. (2067 kPa) minimum per ASTM E 761.
g. Corrosion Resistance: No evidence of corrosion per ASTM E 937.
h. Deflection: No cracking, spalling, or delamination per ASTM E 759.
i. Effect of Impact on Bonding: No cracking, spalling, or delamination per ASTM E 760.
j. Air Erosion: Maximum weight loss of 0.025 g/sq. ft. (0.270 g/sq. m) per ASTM E 859.
k. Combustion Characteristics: Passes ASTM E 136.
l. Fire-Test-Response Characteristics: Provide SFRM with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
   1) Flame-Spread Index: 10 or less.
   2) Smoke-Developed Index: 0.
m. Fungal Resistance: No observed growth on specimens per ASTM G 21.
n. For exterior applications of SFRM, provide formulation listed and labeled by testing and inspecting agency acceptable to authorities having jurisdiction for surfaces exposed to exterior.

C. Exposed Intumescent Mastic Fire-Resistive Coatings
1. Fire-Resistive, Intumescent Mastic Coating: Factory-mixed formulation.
   a. Water-Based Formulation: Approved by manufacturer and authorities having jurisdiction and investigated for Interior General **OR** Conditioned Interior Space, **as directed**, Purpose by UL.
   b. Non-Water-Based Formulation: Approved by manufacturer and UL or another testing and inspecting agency acceptable to authorities having jurisdiction and investigated for Interior General Purpose by UL **OR** investigated for Interior General Purpose and Exterior Use by UL **OR** tested per ASTM E 1529 **OR** tested per UL 1709, **as directed**.
   c. Multicomponent system consisting of intumescent base coat and topcoat.
2. Color and Gloss: As selected from manufacturer's full range.

D. Auxiliary Fire-Resistive Materials
1. General: Provide auxiliary fire-resistive materials that are compatible with SFRM and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.
2. Substrate Primers: For use on each substrate and with each sprayed fire-resistive product, provide primer that complies with one or more of the following requirements:
   a. Primer's bond strength complies with requirements specified in UL's "Fire Resistance Directory" for coating materials based on a series of bond tests per ASTM E 736.
   b. Primer is identical to those used in assemblies tested for fire-test-response characteristics of SFRM per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
3. Adhesive for Bonding Fire-Resistive Material: Product approved by manufacturer of SFRM.
4. Metal Lath: Expanded metal lath fabricated from material of weight, configuration, and finish required to comply with fire-resistance designs indicated and fire-resistive material manufacturer's written recommendations. Include clips, lathing accessories, corner beads, and other anchorage devices required to attach lath to substrates and to receive SFRM.
5. Reinforcing Fabric: Glass- or carbon-fiber fabric of type, weight, and form required to comply with fire-resistance designs indicated; approved and provided by manufacturer of SFRM.
6. Reinforcing Mesh: Metallic mesh reinforcement of type, weight, and form required to comply with fire-resistance designs indicated; approved and provided by manufacturer of intumescent mastic coating fire-resistive material. Include pins and attachment.
7. Sealer for Sprayed-Fiber Fire-Resistive Material: Transparent-drying, water-dispersible, tinted protective coating recommended in writing by manufacturer of sprayed-fiber fire-resistive material.
8. Topcoat: Type recommended in writing by manufacturer of each SFRM for application over concealed **OR** exposed, **as directed**, SFRM.

9. Cement-Based Topcoat: Factory-mixed, cementitious hardcoat formulation recommended in writing by manufacturer of SFRM for trowel or spray application over concealed **OR** exposed, **as directed**, SFRM.
10. Veneer-Plaster Topcoat: Factory-mixed formulation of a latex-modified, portland cement-based veneer plaster recommended in writing by manufacturer of SFRM for trowel or spray application over concealed **OR** exposed, **as directed**, SFRM.
11. Water-Based Permeable Topcoat: Factory-mixed formulation recommended in writing by manufacturer of SFRM for brush, roller, or spray application over concealed **OR** exposed, **as directed**, SFRM. Provide application at a rate of 120 sq. ft./gal. (3 sq. m/L) **OR** 60 sq. ft./gal. (1.5 sq. m/L) **OR** 30 sq. ft./gal. (0.75 sq. m/L), **as directed**.

1.3 EXECUTION

A. Preparation
1. Cover other work subject to damage from fallout or overspray of fire-resistive materials during application.
2. Clean substrates of substances that could impair bond of fire-resistive material, including dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, and incompatible primers, paints, and encapsulants.
3. Prime substrates where recommended in writing by SFRM manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive SFRM.
4. For exposed applications, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of SFRM. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.

B. Application, General
1. Comply with fire-resistive material manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and spray on fire-resistive material, as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.
2. Apply SFRM that is identical to products tested as specified in Part 1.1 "Quality Assurance" Article and substantiated by test reports, with respect to rate of application, accelerator use, sealers, topcoats, tamping, troweling, water overspray, or other materials and procedures affecting test results.
3. Install metal lath and reinforcing fabric, as required, to comply with fire-resistance ratings and fire-resistive material manufacturer's written recommendations for conditions of exposure and intended use. Securely attach lath and fabric, as required, to substrate in position required for support and reinforcement of fire-resistive material. Use anchorage devices of type recommended in writing by SFRM manufacturer. Attach accessories where indicated or required for secure attachment of lath and fabric, as required, to substrate.
4. Coat substrates with bonding adhesive before applying fire-resistive material where required to achieve fire-resistance rating or as recommended in writing by SFRM manufacturer for material and application indicated.
5. Extend fire-resistive material in full thickness over entire area of each substrate to be protected. Unless otherwise recommended in writing by SFRM manufacturer, install body of fire-resistive covering in a single course.
6. Spray apply fire-resistive materials to maximum extent possible. Following the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by SFRM manufacturer.
7. For applications over encapsulant materials, including lockdown (post-removal) encapsulants, apply SFRM that differs in color from that of encapsulant over which it is applied.
8. Where sealers are used, apply products that are tinted to differentiate them from SFRM over which they are applied.

C. Application, Concealed SFRM

1. Apply concealed SFRM in thicknesses and densities not less than those required to achieve fire-resistance ratings designated for each condition, but apply in greater thicknesses and densities if specified in Part 1.2 "Concealed SFRM" Article.
2. Apply water overspray to concealed sprayed-fiber fire-resistive material as required to obtain designated fire-resistance rating and where indicated.
3. Cure concealed SFRM according to product manufacturer's written recommendations.
4. Apply sealer to concealed SFRM where indicated.
5. Apply topcoat to concealed SFRM where indicated.

D. Application, Exposed SFRM
1. Apply exposed SFRM in thicknesses and densities not less than those required to achieve fire-resistance ratings designated for each condition, but apply in greater thicknesses and densities if indicated.
   a. For steel beams and bracing, provide a thickness of not less than 1 inch (25 mm).
   b. For metal floor or roof decks, provide a thickness of not less than 1/2 inch (13 mm).
2. Provide a uniform finish complying with description indicated for each type of material and matching the Owner's sample or, if none, finish approved for field-erected mockup.
3. Apply exposed cementitious SFRM to produce the following finish:
   a. Spray-textured finish with no further treatment.
   b. Even, spray-textured finish, produced by rolling flat surfaces of fire-protected members with a damp paint roller to remove drippings and excessive roughness.
   c. Skip-troweled finish with leveled surface, smoothed-out texture, and neat edges.
   d. Smooth, troweled finish with surface markings eliminated and edges squared.
4. Apply exposed sprayed-fiber fire-resistive material to produce the following finish:
   a. Spray-textured finish.
   b. Sealer where indicated.
   c. Topcoat where indicated\.
5. Cure exposed SFRM according to product manufacturer's written recommendations.

E. Application, Exposed Intumescent Mastic Fire-Resistive Coatings
1. Apply exposed intumescent mastic fire-resistive coatings in thicknesses and densities not less than those required to achieve fire-resistance ratings designated for each condition.
2. Apply intumescent mastic fire-resistive coating as follows:
   a. Install reinforcing fabric as required to obtain designated fire-resistance rating and where indicated.
   b. Finish: Spray-textured finish with no further treatment.
   c. Finish: Even, spray-textured finish produced by lightly rolling flat surfaces of fire-protected members before fire-resistive material dries, to smooth out surface irregularities and to seal in surface fibers.

F. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
   a. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.
2. Tests and Inspections: Testing and inspecting of completed applications of SFRM shall take place in successive stages, in areas of extent and using methods as follows. Do not proceed with application of SFRM for the next area until test results for previously completed applications of SFRM show compliance with requirements. Tested values must equal or exceed values indicated and required for approved fire-resistance design.
   a. Thickness for Floor, Roof, and Wall Assemblies: For each 1000-sq. ft. (93-sq. m) area, or partial area, on each floor, from the average of 4 measurements from a 144-sq. in. (0.093-sq. m) sample area, with sample width of not less than 6 inches (152 mm) per ASTM E 605.

b. Thickness for Structural Frame Members: From a sample of 25 percent of structural members per floor, taking 9 measurements at a single cross section for structural frame beams or girders, 7 measurements of a single cross section for joists and trusses, and 12 measurements of a single cross section for columns per ASTM E 605.

c. Density for Floors, Roofs, Walls, and Structural Frame Members: At frequency and from sample size indicated for determining thickness of each type of construction and structural framing member, per ASTM E 605 or AWCI Technical Manual 12-A, Section 5.4.5, "Displacement Method."

d. Bond Strength for Floors, Roofs, Walls, and Structural Framing Members: For each 10,000-sq. ft. (929 sq. m) area, or partial area, on each floor, cohesion and adhesion from one sample of size indicated for determining thickness of each type of construction and structural framing member, per ASTM E 736.

1) Field test SFRM that is applied to flanges of wide-flange, structural-steel members on surfaces matching those that will exist for remainder of steel receiving fire-resistive material.

2) If surfaces of structural steel receiving SFRM are primed or otherwise painted for coating materials, perform series of bond tests specified in UL's "Fire Resistance Directory." Provide bond strength indicated in referenced UL fire-resistance criteria, but not less than 150 lbf/sq. ft. (7.2 kPa) minimum per ASTM E 736.

e. If testing finds applications of SFRM are not in compliance with requirements, testing and inspecting agency will perform additional random testing to determine extent of noncompliance.

3. Remove and replace applications of SFRM that do not pass tests and inspections for cohesion and adhesion, for density, or for both and retest as specified above.

4. Apply additional SFRM, per manufacturer's written instructions, where test results indicate that thickness does not comply with specified requirements, and retest as specified above.

G. Cleaning, Protecting, And Repair

1. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

2. Protect SFRM, according to advice of product manufacturer and Installer, from damage resulting from construction operations or other causes so fire protection will be without damage or deterioration at time of Final Completion.

3. Coordinate application of SFRM with other construction to minimize need to cut or remove fire protection. As installation of other construction proceeds, inspect SFRM and patch any damaged or removed areas.

4. Repair or replace work that has not successfully protected steel.

END OF SECTION 07 81 16 00

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Task	Specification	Specification Description
07 81 23 00	07 81 16 00	Sprayed Fire-Resistive Materials
07 81 33 00	07 81 16 00	Sprayed Fire-Resistive Materials

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SECTION 07 84 13 16 - THROUGH-PENETRATION FIRESTOP SYSTEMS

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for through-penetration firestop systems. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes through-penetration firestop systems for penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items.

C. Performance Requirements
   1. General: For penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
   2. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per ASTM E 814 or UL 1479:
      a. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
      b. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings, where systems protect penetrating items exposed to potential contact with adjacent materials in occupiable floor areas:
         1) Penetrations located outside wall cavities.
         2) Penetrations located outside fire-resistance-rated shaft enclosures.
      c. L-Rated Systems: Where through-penetration firestop systems are indicated in smoke barriers, provide **OR** Provide, **as directed**, through-penetration firestop systems with L-ratings indicated **OR** of not more than, **as directed**, 3.0 cfm/sq. ft (0.01524cu. m/s x sq. m) at both ambient temperatures and 400 deg F (204 deg C).
   3. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
      a. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
      b. For floor penetrations with annular spaces exceeding 4 inches (100 mm) in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved, either by installing floor plates or by other means.
      c. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.
   4. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

D. Submittals
   1. Product Data: For each type of product indicated.
   2. Shop Drawings: For each through-penetration firestop system, submit documentation, including illustrations, from a qualified testing and inspecting agency, showing each type of construction condition penetrated, relationships to adjoining construction, and type of penetrating item.

a. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular through-penetration firestop condition, submit illustration, with modifications marked, approved by through-penetration firestop system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

E. Quality Assurance

1. Installation Responsibility: Assign installation of through-penetration firestop systems and fire-resistive joint systems in Project to a single qualified installer.
2. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in Part 1.1 "Performance Requirements" Article:
   a. Firestopping tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL **OR** OPL **OR** ITS, **as directed**, or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.
   b. Through-penetration firestop systems are identical to those tested per testing standard referenced in "Part 1.1 Performance Requirements" Article. Provide rated systems bearing classification marking of qualified testing and inspecting agency.
3. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
4. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until each installation has been examined by the Owner's inspecting agency and building inspector, if required by authorities having jurisdiction.

F. Delivery, Storage, And Handling

1. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life if applicable, qualified testing and inspecting agency's classification marking applicable to Project, curing time, and mixing instructions for multicomponent materials.
2. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.2 PRODUCTS

A. Firestopping

1. Compatibility: Provide through-penetration firestop systems that are compatible with one another; with the substrates forming openings; and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.
2. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with Part 1.1 "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:
   a. Permanent forming/damming/backing materials, including the following:
      1) Slag-/rock-wool-fiber insulation.
      2) Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
      3) Fire-rated form board.
      4) Fillers for sealants.
   b. Temporary forming materials.
   c. Substrate primers.

d. Collars.
e. Steel sleeves.

B. Fill Materials
1. General: Provide through-penetration firestop systems containing the types of fill materials indicated in the Through-Penetration Firestop System Schedule at the end of Part 1.3 by referencing the types of materials described in this Article. Fill materials are those referred to in directories of referenced testing and inspecting agencies as "fill," "void," or "cavity" materials.
2. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
3. Latex Sealants: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.
4. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
5. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized steel sheet.
6. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.
7. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
8. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
9. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives.
10. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
11. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:
    a. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and other surfaces requiring a nonslumping, gunnable sealant, unless indicated firestop system limits use to nonsag grade for both opening conditions.
    b. Grade for Horizontal Surfaces: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces.
    c. Grade for Vertical Surfaces: Nonsag formulation for openings in vertical and other surfaces.

C. Mixing: For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

1.3 EXECUTION

A. Through-Penetration Firestop System Installation
1. General: Install through-penetration firestop systems to comply with Part 1.1 "Performance Requirements" Article and with firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.

2. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
   a. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.
3. Install fill materials for firestop systems by proven techniques to produce the following results:
   a. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
   b. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
   c. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.
4. Identification: Identify through-penetration firestop systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of edge of the firestop systems so that labels will be visible to anyone seeking to remove penetrating items or firestop systems. Use mechanical fasteners for metal labels. Include the following information on labels:
   a. The words "Warning - Through-Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
   b. Contractor's name, address, and phone number.
   c. Through-penetration firestop system designation of applicable testing and inspecting agency.
   d. Date of installation.
   e. Through-penetration firestop system manufacturer's name.
   f. Installer's name.

B. Field Quality Control
1. Inspecting Agency: Engage an independent inspecting agency to inspect through-penetration firestops. Independent inspecting agency shall comply with ASTM E 2174 requirements including those related to qualifications, conducting inspections, and preparing test reports.
2. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.
3. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued and firestop installations comply with requirements.

C. Cleaning And Protecting
1. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.
2. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Final Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

D. Through-Penetration Firestop System Schedule
1. Choices in the following paragraphs which are contained within brackets shall be as required to satisfy building and local code requirements.
2. Where UL-classified systems are indicated, they refer to alpha-alpha-numeric designations listed in UL's "Fire Resistance Directory" under product Category XHEZ.
3. Where OPL-classified systems are indicated, they refer to alpha-numeric design numbers in OPL's "Directory of Listed Building Products, Materials, & Assemblies."
4. Where ITS-listed systems are indicated, they refer to design numbers listed in ITS's "Directory of Listed Products," "Firestop Systems" Section.

5. Firestop Systems with No Penetrating Items:
   a. UL-Classified Systems: [C-AJ-] [C-BJ-] [F-A-] [W-J-] [W-L-] <Insert one or more four-digit numbers> [0001-0999].
   b. OPL-Classified Systems: FS <Insert one or more OPL design numbers> [F] [W], Penetrating Item Type G.
   c. ITS-Listed Systems: <Insert ITS design number(s).>
   d. Type of Fill Materials: One or more of the following:
      1) Latex sealant.
      2) Silicone sealant.
      3) Intumescent putty.
      4) Mortar.
6. Firestop Systems for Metallic Pipes, Conduit, or Tubing:
   a. UL-Classified Systems: [C-AJ-] [C-BJ-] [C-BK-] [F-A-] [F-B-] [F-C-] [W-J-] [W-K-] [W-L-] <Insert one or more four-digit numbers> [1001-1999].
   b. OPL-Classified Systems: FS <Insert one or more OPL design numbers> [F] [W], Penetrating Item Type A.
   c. ITS-Listed Systems: <Insert ITS design number(s).>
   d. Type of Fill Materials: One or more of the following:
      1) Latex sealant.
      2) Silicone sealant.
      3) Intumescent putty.
      4) Mortar.
7. Firestop Systems for Nonmetallic Pipe, Conduit, or Tubing:
   a. UL-Classified Systems: [C-AJ-] [C-BJ-] [F-A-] [F-B-] [F-C-] [W-J-] [W-L-] <Insert one or more four-digit numbers> [2001-2999].
   b. OPL-Classified Systems: FS <Insert one or more OPL design numbers> [F] [W], Penetrating Item Type B.
   c. ITS-Listed Systems: <Insert ITS design number(s).>
   d. Type of Fill Materials: One or more of the following:
      1) Latex sealant.
      2) Silicone sealant.
      3) Intumescent putty.
      4) Intumescent wrap strips.
      5) Firestop device.
8. Firestop Systems for Electrical Cables:
   a. UL-Classified Systems: [C-AJ-] [C-BJ-] [F-A-] [F-B-] [F-C-] [W-J-] [W-L-] <Insert one or more four-digit numbers> [3001-3999].
   b. OPL-Classified Systems: FS <Insert one or more OPL design numbers> [F] [W], Penetrating Item Type D.
   c. ITS-Listed Systems: <Insert ITS design number(s).>
   d. Type of Fill Materials: One or more of the following:
      1) Latex sealant.
      2) Silicone sealant.
      3) Intumescent putty.
      4) Silicone foam.
      5) Pillows/bags.
9. Firestop Systems for Cable Trays:
   a. UL-Classified Systems: [C-AJ-] [C-BJ-] [F-A-] [F-B-] [F-C-] [W-J-] [W-K-] [W-L-] <Insert one or more four-digit numbers> [4001-4999].
   b. OPL-Classified Systems: FS <Insert one or more OPL design numbers> [F] [W], Penetrating Item Type D.
   c. ITS-Listed Systems: <Insert ITS design number(s).>
   d. Type of Fill Materials: One or more of the following:
      1) Latex sealant.
      2) Intumescent putty.
      3) Silicone foam.

        4) Pillows/bags.
        5) Mortar.
10. Firestop Systems for Insulated Pipes:
    a. UL-Classified Systems: [C-AJ-] [C-BJ-] [F-A-] [F-C-] [W-J-] [W-L-] <Insert one or more four-digit numbers> [5001-5999].
    b. OPL-Classified Systems: FS <Insert one or more OPL design numbers> [F] [W], Penetrating Item Type C.
    c. ITS-Listed Systems: <Insert ITS design number(s).>
    d. Type of Fill Materials: One or more of the following:
        1) Latex sealant.
        2) Intumescent putty.
        3) Silicone foam.
        4) Intumescent wrap strips.
11. Firestop Systems for Miscellaneous Electrical Penetrants:
    a. UL-Classified Systems: [C-AJ-] [F-A-] [W-L-] <Insert one or more four-digit numbers> [6001-6999].
    b. OPL-Classified Systems: FS <Insert one or more OPL design numbers> [F] [W], Penetrating Item Type E.
    c. ITS-Listed Systems: <Insert ITS design number(s).>
    d. Type of Fill Materials: One or more of the following:
        1) Latex sealant.
        2) Intumescent putty.
        3) Mortar.
12. Firestop Systems for Miscellaneous Mechanical Penetrants:
    a. UL-Classified Systems: [C-AJ-] [F-C-] [W-J-] [W-L-] <Insert one or more four-digit numbers> [7001-7999].
    b. ITS-Listed Systems: <Insert ITS design number(s).>
    c. Type of Fill Materials: One or both of the following:
        1) Latex sealant.
        2) Mortar.
13. Firestop Systems for Groupings of Penetrants:
    a. UL-Classified Systems: [C-AJ-] [C-BJ-] [F-A-] [F-C-] [W-J-] [W-L-] <Insert one or more four-digit numbers> [8001-8999].
    b. ITS-Listed Systems: <Insert ITS design number(s).>
    c. Type of Fill Materials: One or more of the following:
        1) Latex sealant.
        2) Mortar.
        3) Intumescent wrap strips.
        4) Firestop device.
        5) Intumescent composite sheet.

END OF SECTION 07 84 13 16

SECTION 07 84 13 16a - FIRE-RESISTIVE JOINT SYSTEMS

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for fire-resistive joint systems. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes fire-resistive joint systems for the following:
   a. Floor-to-floor joints.
   b. Floor-to-wall joints.
   c. Head-of-wall joints.
   d. Wall-to-wall joints.
   e. Perimeter fire-resistive joint systems consisting of floor-to-wall joints between perimeter edge of fire-resistance-rated floor assemblies and exterior curtain walls.

C. Performance Requirements
1. General: Provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assembly in which fire-resistive joint systems are installed.
2. Joint Systems in and between Fire-Resistance-Rated Constructions: Provide systems with assembly ratings equaling or exceeding the fire-resistance ratings of construction that they join, and with movement capabilities and L-ratings indicated as determined by UL 2079.
   a. Load-bearing capabilities as determined by evaluation during the time of test.
3. Perimeter Fire-Resistive Joint Systems: For joints between edges of fire-resistance-rated floor assemblies and exterior curtain walls, provide systems of type and with ratings indicated below and those indicated in the Fire-Resistive Joint System Schedule at the end of Part 1.3, as determined by IBC Standard **OR** NFPA 285, **as directed,** and UL 2079.
   a. UL-Listed, Perimeter Fire-Containment Systems: Integrity ratings equaling or exceeding fire-resistance ratings of floor or floor/ceiling assembly forming one side of joint.
   b. OPL-Listed, Perimeter Fire-Barrier Systems: F-ratings equaling or exceeding fire-resistance ratings of floor or floor/ceiling assembly forming one side of joint.
4. For fire-resistive systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

D. Submittals
1. Product Data: For each product indicated.
2. Shop Drawings: For each fire-resistive joint system.
3. Qualification Data: For Installer.
4. Field quality-control test reports.
5. Evaluation Reports: Evidence of fire-resistive joint systems' compliance with ICBO ES AC30, from the ICBO Evaluation Service.
6. Research/Evaluation Reports: For each type of fire-resistive joint system.

E. Quality Assurance
1. Installer Qualifications: A firm that has been approved by FMG according to FMG 4991, "Approval of Firestop Contractors."
2. Installation Responsibility: Assign installation of through-penetration firestop systems and fire-resistive joint systems in Project to a single qualified installer.
3. Fire-Test-Response Characteristics: Provide fire-resistive joint systems that comply with the following requirements and those specified in Part 1 "Performance Requirements" Article:

a. Fire-resistance tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL **OR** OPL, **as directed**, or another agency performing testing and follow-up inspection services for fire-resistive joint systems acceptable to authorities having jurisdiction.

b. Fire-resistive joint systems are identical to those tested per methods indicated in Part 1 "Performance Requirements" Article and comply with the following:

1) Fire-resistive joint system products bear classification marking of qualified testing and inspecting agency.

2) Fire-resistive joint systems correspond to those indicated by referencing system designations of the qualified testing and inspecting agency.

4. Coordinate construction of joints to ensure that fire-resistive joint systems are installed according to specified requirements.

5. Do not cover up fire-resistive joint system installations that will become concealed behind other construction until inspecting agency and building inspector of authorities having jurisdiction have examined each installation.

F. Delivery, Storage, And Handling

1. Deliver fire-resistive joint system products to Project site in original, unopened containers or packages with qualified testing and inspecting agency's classification marking applicable to Project and with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life, curing time, and mixing instructions for multicomponent materials.

2. Store and handle materials for fire-resistive joint systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.2 PRODUCTS

A. Fire-Resistive Joint Systems

1. Compatibility: Provide fire-resistive joint systems that are compatible with joint substrates, under conditions of service and application, as demonstrated by fire-resistive joint system manufacturer based on testing and field experience.

2. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing and inspecting agency for systems indicated.

1.3 EXECUTION

A. Installation

1. Install fire-resistive joint systems to comply with Part 1.1 "Performance Requirements" Article and fire-resistive joint system manufacturer's written installation instructions for products and applications indicated.

2. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

B. Field Quality Control

1. Inspecting Agency: Engage a qualified independent inspecting agency to inspect fire-resistive joint systems and prepare inspection reports.

2. Testing Services: Inspecting of completed installations of fire-resistive joint systems shall take place in successive stages as installation of fire-resistive joint systems proceeds. Do not proceed with installation of joint systems for the next area until inspecting agency determines completed work shows compliance with requirements.

a. Inspecting agency shall state in each report whether inspected fire-resistive joint systems comply with or deviate from requirements.

3. Remove and replace fire-resistive joint systems where inspections indicate that they do not comply with specified requirements.
4. Proceed with enclosing fire-resistive joint systems with other construction only after inspection reports are issued and fire-resistive joint systems comply with requirements.

C. Fire-Resistive Joint System Schedule
1. Designation System for Joints in or between Fire-Resistance-Rated Constructions: Alphanumeric systems listed in UL's "Fire Resistance Directory" under Product Category XHBN.
2. Designation System for Joints at the Intersection of Fire-Resistance-Rated Floor or Floor/Ceiling Assembly and an Exterior Curtain-Wall Assembly: Alphanumeric systems listed in UL's "Fire Resistance Directory" under Product Category XHDG **OR** OPL's "Directory of Listed Building Products, Materials, & Assemblies" as perimeter fire-barrier systems, **as directed**.

END OF SECTION 07 84 13 16a

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SECTION 07 84 13 16b - FIRESTOPPING

1.1 DESCRIPTION OF WORK

A. This specification covers the furnishing and installation of materials for firestopping. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 GENERAL

A. System Description
  1. Performance Requirements: Comply with following:
    a. Firestopping: Consist of material or combination of materials to form effective barrier against spread of flame, smoke, and gases, and maintain integrity of fire-resistance rated walls, partitions, floors, and ceiling-floor assemblies at penetrations.
      1) Penetrations: Include annular space around pipes, ducts, chimneys, tubes, conduit, wires, cables, and vents.

B. Submittals
  1. Product Data:
    a. Composition and performance characteristics.
    b. List of FM, UL, or WH classification number of systems installed.
  2. Quality Assurance/Control Submittals:
    a. Test Reports: If not FM, UL, or WH listed, submit certified test results for ASTM E 814 tests by UL, FM, WH, or other accredited independent laboratory demonstrating compliance of firestopping with specified requirements.
    b. Manufacturers installation instructions.

C. Quality Assurance
  1. Regulatory Requirements: Comply with applicable building-code requirements for firestopping.

D. Delivery, Storage, And Handling
  1. Packing, Shipping, Handling, and Unloading: Deliver in original, unopened containers with manufacturer's labels.
    a. Products: FM, UL, or WH labeled and FM, UL, or WHI listed.
  2. Storage and Protection: Store firestopping materials in accordance with manufacturer's recommendations.

1.3 PRODUCTS

A. Fire-Rated Penetration Sealant Systems
  1. Firestopping Materials: Commercially manufactured asbestos-free products complying with following minimum requirements:
    a. Material:
      1) Flame Spread: ASTM E 84 or UL 723, 25 or less.
      2) Smoke Developed Rating: ASTM E 84 or UL 723, 50 or less.
      3) Material: Approved firestopping material as listed in UL 05, FM P7825, or WH Certified Listing.
    b. Material Properties:

1) Contain no flammable or toxic solvents and have no dangerous or flammable outgassing during the drying or curing of products.
2) Non-toxic to human beings at all stages of application and during fire conditions.
3) Water-resistant after drying or curing and unaffected by high humidity, condensation, or transient water exposure.

c. Devices and systems requiring heat activation to seal opening created by burning or melting of penetrant shall exhibit demonstrated ability to function as required for floors and walls of construction and thickness similar to those to be firestopped.

2. Firestopping System Requirements: Materials from single manufacturer capable of maintaining effective barrier against flame, smoke, and gases in accordance with ASTM E 814 and UL 1479.
   a. Fire-Resistance Rating: Equal or greater than fire-resistance rating of assembly in which it is being placed.
   b. F Ratings: Equal to or greater than fire-resistance rating of assembly penetrated.
   c. T Ratings: Equal to or greater than fire-resistance rating of assembly penetrated at following locations:
      1) Penetrations located outside of wall cavities.
      2) Penetrations located outside of fire-resistive shaft enclosures.
      3) Penetrations located in enclosures with doors required to have temperature-rise rating.
      4) Penetrations with penetrating hems larger than 100 mm (4 inch) diameter nominal pipe or 10 320 sq. mm (16 square inches) in cross-sectional area.
   d. System: Listed in UL 05, FM 7825, or WH Certified Listing, or tested by approved laboratory in accordance with ASTM E 814.
   e. System: Suitable for firestopping of penetrations made by steel, glass, plastic. and insulated pipe.
   f. Penetration by Insulated Pipe: Does not require removal of insulation.

1.4 EXECUTION

A. Examination
1. Verification of Conditions:
   a. Existing Conditions: Examine penetrations before beginning installation.
   b. Do not proceed with installation until conditions are satisfactory.

B. Installation
1. Fire-Rated Penetration Sealant Systems: Install in accordance with UL 05, FM P7825, or WH systems and manufacturers recommendations to maintain required fire-separation rating.
   a. Preparation: Clean surfaces in contact with firestopping materials that may affect proper fitting or required fire rating. Prime if required. Dam void if required.
   b. Penetrations: Completely fill void with sealant materials to smooth surface, flush with adjacent surfaces and in contact with surfaces formed by openings and penetrating items ensuring adhesion. Provide sealant in thickness to achieve required fire rating and smoke barrier.
   c. Firestopping at Voids 100 mm (4 inches) or More in Any Direction: Capable of supporting same load as floor is designed to support or protected by permanent barrier.
   d. Remove any excess sealant from adjacent surfaces.
2. Firestopping: Provide at following locations:
   a. Penetrations of duct, chimney, conduit, tubing, cable, and pipe through floors and through fire-resistance rated walls, partitions, and ceiling-floor assemblies.
   b. Penetrations of vertical shafts such as pipe chases, elevator shafts, and utility chutes.
   c. Gaps at intersection of fire-rated floor stabs and walls.
   d. Gaps at perimeter of fire-rated walls and partitions, such as between top of walls and bottom of floor or roof decks.
   e. Construction joints in fire-rated floors, walls, and partitions.

f. Other locations where required to maintain fire-resistance rating of the construction.
g. Other locations as indicated on Drawings (if any).

C. Field Quality Control
1. Inspection: Examine areas to be firestopped prior to concealing or enclosing to ensure proper installation.
a. Keep areas of firestopping work accessible until inspection by authorities having jurisdiction over work.

END OF SECTION 07 84 13 16b

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Task	Specification	Specification Description
07 84 13 19	07 84 13 16	Through-Penetration Firestop Systems
07 84 13 19	07 84 13 16a	Fire-Resistive Joint Systems
07 84 13 19	07 84 13 16b	Firestopping
07 84 16 00	03 05 13 00	Cast-In-Place Concrete
07 84 43 00	07 84 13 16	Through-Penetration Firestop Systems
07 84 43 00	07 84 13 16a	Fire-Resistive Joint Systems
07 84 43 00	07 84 13 16b	Firestopping

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SECTION 07 84 56 13 - BOARD FIRE PROTECTION

1.1 GENERAL

A. Description Of Work:

1. This specification covers the furnishing and installation of materials for board fire protection. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Calcium silicate board fire protection.
   b. Mineral-fiber board fire protection.

C. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings: Structural framing plans indicating the following:
   a. Locations and types of surface preparations required before applying board fire protection.
   b. Extent of board fire protection for each construction and fire-resistance rating, including the following:
      1) Applicable fire-resistance design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.
         a) For steel joist assemblies, include applicable fire-resistance design designations, with each steel joist tested with same maximum tensile stress as each steel joist indicated on Drawings **OR** in a schedule, **as directed**. Design designations with steel joists tested at lower maximum tensile stress than those indicated are not permitted.
      2) Minimum thicknesses needed to achieve required fire-resistance ratings of structural components and assemblies.
      3) Treatment of sprayed fire-resistive material after application.
3. Product Certificates: For each type of board fire protection, from manufacturer.
4. Research/Evaluation Reports: For board fire protection.

D. Quality Assurance

1. Source Limitations: Obtain board fire-protection materials from single source from single manufacturer.
2. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" **OR** UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency, **as directed**, acceptable to authorities having jurisdiction, for board fireproofing serving as direct-applied protection tested per ASTM E 119.

E. Coordination

1. Coordinate installation of board fire protection with other construction specified in other Sections.
   a. Do not install board fire protection on structural members until piping and other construction behind fire-resistive materials have been completed, uninterrupted coverage of fire-resistive materials can be provided, and the need for subsequent cutting and patching of fire-resistive materials has been eliminated.
   b. Do not install enclosing or concealing construction until after board fire protection has been applied and inspected by authorities having jurisdiction.

1.2 PRODUCTS

A. Board Fire Protection
1. Calcium Silicate Board: Rigid board containing no asbestos and consisting primarily of lime, silica, inert fillers, and cellulosic reinforcing fibers; of thickness required to produce fire-resistance rating indicated; with flame-spread and smoke-developed indexes of zero per ASTM E 84; passing ASTM E 136 for combustion characteristics.
a. Finish: Sanded finish on both sides **OR** one side, **as directed**.
2. Mineral-Fiber Board: Unfaced **OR** Foil-faced **OR** Fiberglass mat-faced, **as directed**, rigid board produced by combining slag-wool-/rock-wool fibers with thermosetting resin binders passing ASTM E 136 for combustion characteristics; of thickness required to produce fire-resistance rating indicated.
a. Maximum Density: 8 lb/cu. ft. (128 kg/cu. m) **OR** 10 lb/cu. ft. (160 kg/cu. m) **OR** 12 lb/cu. ft. (192 kg/cu. m), **as directed**, per ASTM C 612.
b. Surface-Burning Characteristics: Flame-spread and smoke-developed indexes of 15 **OR** zero, **as directed**, and 5 **OR** zero, **as directed**, respectively, per ASTM E 84.

B. Accessories
1. Anchorage Accessories: Provide manufacturer's standard board-anchorage components complying with related design of UL or of another testing and inspecting agency acceptable to authorities having jurisdiction.
2. Joint Treatment and Finishing Materials: For exposed calcium silicate board applications, provide joint treatment tape and joint compounds recommended in writing by board manufacturer for finishing surfaces.

1.3 EXECUTION

A. Preparation
1. Remove rust and scale from steel substrates at welded steel stud anchorage locations.

B. Installation
1. Install board fire protection according to manufacturer's written instructions.
2. Install board fire protection to comply with requirements for layer thicknesses and number, construction of joints and corners, and anchorage methods applicable to fire-resistance-rated assemblies indicated.
3. Finish exposed calcium silicate board to comply with board manufacturer's written instructions and as follows:
a. At joints in calcium silicate board, embed tape in joint compound and apply first, fill, and finish coats of joint compounds over tape, fastener heads, and accessories.
b. Apply a thin, uniform skim coat of joint compound over entire surface.
c. Touch up and sand between coats and after last coat as needed to produce a surface free of visual defects, tool marks, and ridges.

C. Protection
1. Replace or repair board fire protection that has been cut away to facilitate other construction. Maintain complete coverage of full thickness on members and substrates protected by board fire protection.
a. Provide final protection and maintain conditions in a manner acceptable to Installer, manufacturer, and authorities having jurisdiction to ensure that board fire protection is without damage or deterioration at time of Final Completion.

END OF SECTION 07 84 56 13

Task	Specification	Specification Description
07 84 56 13	07 81 16 00	Sprayed Fire-Resistive Materials

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SECTION 07 91 23 00 - JOINT SEALANTS

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for joint sealants. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Silicone joint sealants.
      b. Urethane joint sealants.
      c. Polysulfide joint sealants.
      d. Latex joint sealants.
      e. Solvent-release-curing joint sealants.
      f. Preformed joint sealants.
      g. Acoustical joint sealants.

C. Preconstruction Testing
   1. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
      a. Use ASTM C 1087 **OR** manufacturer's standard test method, **as directed**, to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
      b. Submit not fewer than eight pieces of each kind of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
      c. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
      d. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
      e. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.
   2. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
      a. Locate test joints where indicated on Project or, if not indicated, as directed by the Owner.
      b. Conduct field tests for each application indicated below:
         1) Each kind of sealant and joint substrate indicated.
      c. Notify the Owner seven days in advance of dates and times when test joints will be erected.
      d. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
         1) Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
            a) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
      e. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
      f. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with

requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

D. Submittals
1. Product Data: For each joint-sealant product indicated.
2. LEED Submittal:
   a. Product Data for Credit EQ 4.1: For sealants and sealant primers used inside the weatherproofing system, including printed statement of VOC content.
3. Samples: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
4. Joint-Sealant Schedule: Include the following information:
   a. Joint-sealant application, joint location, and designation.
   b. Joint-sealant manufacturer and product name.
   c. Joint-sealant formulation.
   d. Joint-sealant color.
5. Qualification Data: For qualified Installer and testing agency.
6. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.
7. Sealant, Waterproofing, and Restoration Institute (SWRI) Validation Certificate: For each sealant specified to be validated by SWRI's Sealant Validation Program.
8. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.
9. Preconstruction Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
   a. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
   b. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
10. Preconstruction Field-Adhesion Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
11. Field-Adhesion Test Reports: For each sealant application tested.
12. Warranties: Sample of special warranties.

E. Quality Assurance
1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.
3. Product Testing: Test joint sealants using a qualified testing agency.
   a. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
   b. Test according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C 920 for adhesion and cohesion under cyclic movement, adhesion-in-peel, and indentation hardness.
4. Preinstallation Conference: Conduct conference at Project site.

F. Project Conditions
1. Do not proceed with installation of joint sealants under the following conditions:
   a. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C, **as directed**.
   b. When joint substrates are wet.
   c. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.

d. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

G. Warranty

1. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   a. Warranty Period: Two years from date of Final Completion.
2. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
   a. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
   b. Disintegration of joint substrates from natural causes exceeding design specifications.
   c. Mechanical damage caused by individuals, tools, or other outside agents.
   d. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

1.2 PRODUCTS

A. Materials, General

1. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
2. VOC Content of Interior Sealants: Provide sealants and sealant primers for use inside the weatherproofing system that comply with the following limits for VOC content when calculated according to 40 CFR 59, Part 59, Subpart D (EPA Method 24):
   a. Architectural Sealants: 250 g/L.
   b. Sealant Primers for Nonporous Substrates: 250 g/L.
   c. Sealant Primers for Porous Substrates: 775 g/L.
3. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
   a. Suitability for Immersion in Liquids. Where sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247. Liquid used for testing sealants is deionized water, unless otherwise indicated.
4. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
5. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.
6. Colors of Exposed Joint Sealants: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

B. Silicone Joint Sealants

1. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use NT.
2. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.
3. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
4. Single-Component, Nonsag, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.

5. Single-Component, Nonsag, Traffic-Grade, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use T.
6. Single-Component, Pourable, Traffic-Grade, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade P, Class 100/50, for Use T.
7. Multicomponent, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type M, Grade NS, Class 50, for Use NT.
8. Multicomponent, Pourable, Traffic-Grade, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type M, Grade P, Class 100/50, for Use T.
9. Mildew-Resistant, Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
10. Mildew-Resistant, Single-Component, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.

C. Urethane Joint Sealants
1. Single-Component, Nonsag, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use NT.
2. Single-Component, Nonsag, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.
3. Single-Component, Nonsag, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
4. Single-Component, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920. Type S, Grade NS, Class 25, for Use T.
5. Single-Component, Pourable, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type S, Grade P, Class 25, for Use T.
6. Multicomponent, Nonsag, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 50, for Use NT.
7. Multicomponent, Nonsag, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use NT.
8. Multicomponent, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 50, for Use T.
9. Multicomponent, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use T.
10. Immersible, Single-Component, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Uses T and I.
11. Immersible, Single-Component, Pourable, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type S, Grade P, Class 25, for Uses T and I.
12. Immersible Multicomponent, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Uses T and I.
13. Immersible Multicomponent, Pourable, Traffic-Grade, Urethane Joint Sealant: ASTM C 920. Type M, Grade P, Class 25, for Use T and I.

D. Polysulfide Joint Sealants
1. Single-Component, Nonsag, Polysulfide Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
2. Multicomponent, Nonsag, Polysulfide Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use NT.
3. Multicomponent, Nonsag, Traffic-Grade, Polysulfide Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use T.
4. Multicomponent, Pourable, Traffic-Grade, Polysulfide Joint Sealant: ASTM C 920, Type M, Grade P, Class 25, for Use T.
5. Immersible, Multicomponent Nonsag, Traffic-Grade, Polysulfide Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use T and Use I.

E. Latex Joint Sealants
1. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

F. Solvent-Release-Curing Joint Sealants
   1. Acrylic-Based Joint Sealant: ASTM C 1311.
   2. Butyl-Rubber-Based Joint Sealant: ASTM C 1311.

G. Preformed Joint Sealants
   1. Preformed Silicone Joint Sealants: Manufacturer's standard sealant consisting of precured low-modulus silicone extrusion, in sizes to fit joint widths indicated, combined with a neutral-curing silicone sealant for bonding extrusions to substrates.
   2. Preformed Foam Joint Sealant: Manufacturer's standard preformed, precompressed, open-cell foam sealant manufactured from urethane foam with minimum density of 10 lb/cu. ft. (160 kg/cu. m) and impregnated with a nondrying, water-repellent agent. Factory produce in precompressed sizes in roll or stick form to fit joint widths indicated; coated on one side with a pressure-sensitive adhesive and covered with protective wrapping.

H. Acoustical Joint Sealants
   1. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

I. Joint Sealant Backing
   1. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
   2. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin) **OR** Type O (open-cell material) **OR** Type B (bicellular material with a surface skin) **OR** or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, **as directed**, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
   3. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

J. Miscellaneous Materials
   1. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
   2. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
   3. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

1.3 EXECUTION

A. Examination
   1. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
   2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
   1. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

a. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

b. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
   1) Concrete.
   2) Masonry.
   3) Unglazed surfaces of ceramic tile.
   4) Exterior insulation and finish systems.

c. Remove laitance and form-release agents from concrete.

d. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
   1) Metal.
   2) Glass.
   3) Porcelain enamel.
   4) Glazed surfaces of ceramic tile.

2. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

C. Installation Of Joint Sealants

1. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

2. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

3. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   a. Do not leave gaps between ends of sealant backings.
   b. Do not stretch, twist, puncture, or tear sealant backings.
   c. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

4. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

5. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
   a. Place sealants so they directly contact and fully wet joint substrates.
   b. Completely fill recesses in each joint configuration.
   c. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

6. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
   a. Remove excess sealant from surfaces adjacent to joints.

b. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
c. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.
d. Provide flush joint profile where indicated per Figure 8B in ASTM C 1193.
e. Provide recessed joint configuration of recess depth and at locations indicated per Figure 8C in ASTM C 1193.
   1) Use masking tape to protect surfaces adjacent to recessed tooled joints.

7. Installation of Preformed Silicone-Sealant System: Comply with the following requirements:
   a. Apply masking tape to each side of joint, outside of area to be covered by sealant system.
   b. Apply silicone sealant to each side of joint to produce a bead of size complying with preformed silicone-sealant system manufacturer's written instructions and covering a bonding area of not less than 3/8 inch (10 mm). Hold edge of sealant bead 1/4 inch (6 mm) inside masking tape.
   c. Within 10 minutes of sealant application, press silicone extrusion into sealant to wet extrusion and substrate. Use a roller to apply consistent pressure and ensure uniform contact between sealant and both extrusion and substrate.
   d. Complete installation of sealant system in horizontal joints before installing in vertical joints. Lap vertical joints over horizontal joints. At ends of joints, cut silicone extrusion with a razor knife.
8. Installation of Preformed Foam Sealants: Install each length of sealant immediately after removing protective wrapping. Do not pull or stretch material. Produce seal continuity at ends, turns, and intersections of joints. For applications at low ambient temperatures, apply heat to sealant in compliance with sealant manufacturer's written instructions.
9. Acoustical Sealant Installation: At sound-rated assemblies and elsewhere as indicated, seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations.

D. Field Quality Control
1. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
   a. Extent of Testing: Test completed and cured sealant joints as follows:
      1) Perform 10 tests for the first 1000 feet (300 m) of joint length for each kind of sealant and joint substrate.
      2) Perform 1 test for each 1000 feet (300 m) of joint length thereafter or 1 test per each floor per elevation.
   b. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
      1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
   c. Inspect tested joints and report on the following:
      1) Whether sealants filled joint cavities and are free of voids.
      2) Whether sealant dimensions and configurations comply with specified requirements.
      3) Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
   d. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
   e. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

2. Evaluation of Field-Adhesion Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

E. Cleaning
1. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

F. Protection
1. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Final Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

G. Joint-Sealant Schedule
1. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.
   a. Joint Locations:
      1) Control and expansion joints in brick pavers.
      2) Isolation and contraction joints in cast-in-place concrete slabs.
      3) Joints between plant-precast architectural concrete paving units.
      4) Joints in stone paving units, including steps.
      5) Tile control and expansion joints.
      6) Joints between different materials listed above.
      7) Other joints as indicated.
   b. Silicone Joint Sealant: Single component, nonsag, traffic grade, neutral curing **OR** Single component, pourable, traffic grade, neutral curing **OR** Multicomponent, pourable, traffic grade, neutral curing, **as directed**.
   c. Urethane Joint Sealant: Single component, nonsag, traffic grade **OR** Single component, pourable, traffic grade **OR** Multicomponent, nonsag, traffic grade, Class 50 **OR** Multicomponent, nonsag, traffic grade, Class 25, **as directed**.
   d. Polysulfide Joint Sealant: Multicomponent, nonsag, traffic grade **OR** Multicomponent, pourable, traffic grade, **as directed**.
   e. Preformed Joint Sealant: Preformed foam sealant.
   f. Joint-Sealant Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range of colors, **as directed**.
2. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces subject to water immersion.
   a. Joint Locations:
      1) Joints in pedestrian plazas.
      2) Joints in swimming pool decks.
      3) Other joints as indicated.
   b. Urethane Joint Sealant: Immersible, single component, nonsag, traffic grade **OR** Immersible, single component, pourable, traffic grade **OR** Immersible, multicomponent, nonsag, traffic grade **OR** Immersible, multicomponent, pourable, traffic grade, **as directed**.
   c. Polysulfide Joint Sealant: Immersible, multicomponent, nonsag, traffic grade.
   d. Joint-Sealant Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range of colors, **as directed**.
3. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
   a. Joint Locations:
      1) Construction joints in cast-in-place concrete.
      2) Joints between plant-precast architectural concrete units.
      3) Control and expansion joints in unit masonry.
      4) Joints in dimension stone cladding.

5) Joints in glass unit masonry assemblies.
6) Joints in exterior insulation and finish systems.
7) Joints between metal panels.
8) Joints between different materials listed above.
9) Perimeter joints between materials listed above and frames of doors, windows and louvers.
10) Control and expansion joints in ceilings and other overhead surfaces.
11) Other joints as indicated.

b. Silicone Joint Sealant: Single component, nonsag, neutral curing, Class 100/50 **OR** Single component, nonsag, neutral curing, Class 50 **OR** Single component, nonsag, neutral curing, Class 25 **OR** Single component, nonsag, acid curing **OR** Multicomponent, nonsag, neutral curing, **as directed**.

c. Urethane Joint Sealant: Single component, nonsag, Class 100/50 **OR** Single component, nonsag, Class 50 **OR** Single component, nonsag, Class 25 **OR** Multicomponent, nonsag,, Class 50 **OR** Multicomponent, nonsag,, Class 25, **as directed**.

d. Polysulfide Joint Sealant: Single component, nonsag **OR** Multicomponent, nonsag, **as directed**.

e. Preformed Joint Sealant: Preformed silicone **OR** Preformed foam, **as directed**.

f. Joint-Sealant Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range of colors, **as directed**.

4. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.

a. Joint Locations:
1) Isolation joints in cast-in-place concrete slabs.
2) Control and expansion joints in stone flooring.
3) Control and expansion joints in brick flooring.
4) Control and expansion joints in tile flooring.
5) Other joints as indicated.

b. Silicone Joint Sealant: Single component, nonsag, traffic grade, neutral curing **OR** Single component, pourable, traffic grade, neutral curing **OR** Multicomponent, pourable, traffic grade, neutral curing, **as directed**.

c. Urethane Joint Sealant: Single component, nonsag, traffic grade **OR** Single component, pourable, traffic grade **OR** Multicomponent, nonsag, traffic grade, Class 50 **OR** Multicomponent, nonsag, traffic grade, Class 25, **as directed**.

d. Polysulfide Joint Sealant: Multicomponent, nonsag, traffic grade **OR** Multicomponent, pourable, traffic grade, **as directed**.

e. Preformed Joint Sealant: Preformed foam.

f. Joint-Sealant Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range of colors, **as directed**.

5. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.

a. Joint Locations:
1) Control and expansion joints on exposed interior surfaces of exterior walls.
2) Perimeter joints of exterior openings where indicated.
3) Tile control and expansion joints.
4) Vertical joints on exposed surfaces of interior unit masonry and concrete walls and partitions.
5) Joints on underside of plant-precast structural concrete beams and planks.
6) Perimeter joints between interior wall surfaces and frames of interior doors, windows and elevator entrances.
7) Other joints as indicated.

b. Joint Sealant: Latex **OR** Acrylic based **OR** Butyl rubber based, **as directed**.

c. Joint-Sealant Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range of colors, **as directed**.

6. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.

a. Joint Sealant Location:
1) Joints between plumbing fixtures and adjoining walls, floors, and counters.

2) Tile control and expansion joints where indicated.
3) Other joints as indicated.

b. Joint Sealant: Mildew resistant, single component, nonsag, neutral curing, Silicone **OR** Single component, nonsag, mildew resistant, acid curing, **as directed**.

c. Joint-Sealant Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range of colors, **as directed**.

7. Joint-Sealant Application: Interior acoustical joints in vertical surfaces and horizontal nontraffic surfaces.

a. Joint Location:
1) Acoustical joints where indicated.
2) Other joints as indicated.

b. Joint Sealant: Acoustical.

c. Joint-Sealant Color: As selected from manufacturer's full range.

END OF SECTION 07 91 23 00

Task	Specification	Specification Description
07 91 26 00	07 91 23 00	Joint Sealants
07 92 13 00	07 91 23 00	Joint Sealants
07 92 19 00	07 91 23 00	Joint Sealants

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SECTION 07 95 13 13 - ARCHITECTURAL JOINT SYSTEMS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for architectural joint systems. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.
2. See Division 03 Section "Cast-in-place Concrete" for cast-in architectural-joint-system frames furnished, but not installed, in this Section.

B. Definitions
1. Maximum Joint Width: Widest linear gap a joint system tolerates and in which it performs its designed function without damaging its functional capabilities.
2. Minimum Joint Width: Narrowest linear gap a joint system tolerates and in which it performs its designed function without damaging its functional capabilities.
3. Movement Capability: Value obtained from the difference between widest and narrowest widths of a joint opening typically expressed in numerical values (mm or inches) or a percentage (plus or minus) of nominal value of joint width.
4. Nominal Joint Width: The width of the linear opening specified in practice and in which the joint system is installed.

C. Submittals
1. Shop Drawings: Provide placement drawings, including line diagrams and details, and a tabular schedule of architectural joint systems.

D. Quality Assurance
1. Accessibility Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines (ADAAG)" and ICC A117.1.
2. Fire-Test-Response Characteristics: Where indicated, provide architectural joint system and fire-barrier assemblies identical to those of assemblies tested for fire resistance per UL 2079 or ASTM E 1966 by a testing and inspecting agency acceptable to authorities having jurisdiction.
   a. Hose Stream Test: Wall-to-wall and wall-to-ceiling assemblies shall be subjected to hose stream testing.

1.2 PRODUCTS

A. Materials
1. Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6063-T5 for extrusions; ASTM B 209 (ASTM B 209M), Alloy 6061-T6 for sheet and plate.
   a. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.
   b. Mill Finish.
   c. Clear Anodic Finish: Class II, clear anodic coating **OR** Class I, clear anodic coating, **as directed**, complying with AAMA 611.
   d. Color Anodic Finish: Class II, color anodic coating **OR** Class I, color anodic coating, **as directed**, complying with AAMA 611.
   e. High-Performance Organic Finish (Two-Coat Fluoropolymer): Comply with AAMA 2604 and with coating and resin manufacturers' written instructions.
2. Stainless Steel: ASTM A 666, Type 304 for plates, sheet, and strips.
3. Brass: ASTM B 36/B 36M, UNS Alloy C26000 for half hard sheet and coil.

4. Bronze: ASTM B 455, Alloy C38500 for extrusions; Alloy C23000 red brass for plates.
5. Moisture Barrier: PVC , minimum 30 mils thick **OR** EPDM, minimum 45 mils thick **OR** Santoprene, **as directed**.
6. Elastomeric Seals: Preformed elastomeric membranes or extrusions to be installed in metal frames.
7. Compression Seals: ASTM E 1612; preformed rectangular elastomeric extrusions having internal baffle system and designed to function under compression.
8. Strip Seals: ASTM E 1783; preformed elastomeric membrane or tubular extrusions having an internal baffle system and secured in or over a joint by a metal locking rail.
9. Cellular Foam Seals: Extruded, compressible foam designed to function under compression.
10. Elastomeric Concrete: Modified epoxy or polyurethane extended into a prepackaged aggregate blend, specifically designed for bonding to concrete substrates.
11. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint and to meet performance criteria for required rating period.
12. Accessories: Manufacturer's standard anchors, fasteners, and other accessories as required for complete installations.

B. Architectural Joint Systems, General
1. General: Provide joint systems of design indicated.
    a. Furnish in longest practicable lengths to minimize splicing. Install with hairline mitered corners where joint changes direction.
    b. Include factory-fabricated closure materials and transition pieces to provide continuous joint systems.
2. Design architectural joint systems for the following size and movement characteristics:
    a. Nominal Joint Width: As indicated on Drawings **OR** As scheduled, **as directed**.
    b. Movement Capability: Plus or minus 25 percent **OR** Plus or minus 50 percent **OR** Plus or minus 100 percent **OR** As indicated on Drawings **OR** As scheduled, **as directed**.
    c. Type of Movement: As indicated on Drawings **OR** As scheduled **OR** Thermal **OR** Seismic **OR** Wind sway, **as directed**.

C. Architectural Joint Systems For Building Interiors
1. Floor-to-Floor and Floor-to-Wall Joint Systems:
    a. Type: Cover plate **OR** Center plate **OR** Glide plate **OR** Hidden sightline **OR** Pan **OR** Surface mounted, **as directed**.
        1) Exposed Metal: Aluminum **OR** Stainless steel **OR** Bronze **OR** Brass, **as directed**.
            a) Finish: Manufacturer's standard finish **OR** Mill **OR** Class I, clear anodic **OR** Class II, clear anodic **OR** No. 2B **OR** No, 4, **as directed**.
            b) Color: As selected from manufacturer's full range.
    b. Type: Elastomeric **OR** Dual elastomeric, **as directed**, seal.
        1) Exposed Metal: Aluminum **OR** Stainless steel **OR** Bronze **OR** Brass, **as directed**.
            a) Finish: Manufacturer's standard finish **OR** Mill **OR** Class I, clear anodic **OR** Class II, clear anodic **OR** No. 2B **OR** No, 4, **as directed**.
            b) Color: As selected from manufacturer's full range.
        2) Seal Material: Santoprene.
            a) Color: As selected from manufacturer's full range.
    c. Cover-Plate Design:
        1) Plain **OR** Serrated **OR** Abrasive filled, **as directed**.
        2) Recessed to accept field-applied finish materials.
            a) Recess Depth: To accommodate adjacent flooring.
    d. Attachment Method: Mechanical anchors **OR** Cast in, **as directed**.
    e. Load Capacity: Standard **OR** Heavy **OR** Extra heavy, **as directed**, duty.
    f. Fire-Resistance Rating: Match adjacent construction.
    g. Moisture Barrier: Manufacturer's standard.
2. Wall-to-Wall and Wall Corner Joint Systems:

a. Type: Vertical cover plate **OR** Glide plate **OR** Hidden sightline **OR** Snap-on cover **OR** Clip-in cover, **as directed**.
1) Exposed Metal: Aluminum **OR** Stainless steel **OR** Bronze **OR** Brass, **as directed**.
a) Finish: Manufacturer's standard finish **OR** Mill **OR** Class I, clear anodic **OR** Class II, clear anodic **OR** No. 2B **OR** No, 4, **as directed**.
b) Color: As selected from manufacturer's full range.
b. Type: Elastomeric seal **OR** Dual elastomeric seal **OR** Accordion, **as directed**.
1) Exposed Metal: Aluminum **OR** Stainless steel **OR** Bronze **OR** Brass, **as directed**.
a) Finish: Manufacturer's standard finish **OR** Mill **OR** Class I, clear anodic **OR** Class II, clear anodic **OR** No. 2B **OR** No, 4, **as directed**.
b) Color: As selected from manufacturer's full range.
2) Seal Material: Santoprene **OR** PVC, **as directed**.
a) Color: As selected from manufacturer's full range.
c. Type: Flat seal.
1) Seal Material: Santoprene.
a) Color: As selected from manufacturer's full range.
d. Fire-Resistance Rating: Match adjacent construction.
e. Moisture Barrier: Manufacturer's standard.
3. Wall-to-Ceiling and Ceiling-to-Ceiling Joint Systems:
a. Type: Cover plate **OR** Glide plate **OR** Snap-on cover **OR** Clip-in cover, **as directed**.
1) Exposed Metal: Aluminum **OR** Stainless steel **OR** Bronze **OR** Brass, **as directed**.
a) Finish: Manufacturer's standard finish **OR** Mill **OR** Class I, clear anodic **OR** Class II, clear anodic **OR** No. 2B **OR** No, 4, **as directed**.
b) Color: As selected from manufacturer's full range.
b. Type: Elastomeric seal **OR** Dual elastomeric seal **OR** Accordion, **as directed**.
1) Exposed Metal: Aluminum **OR** Stainless steel **OR** Bronze **OR** Brass, **as directed**.
a) Finish: Manufacturer's standard finish **OR** Mill **OR** Class I, clear Color: As selected from manufacturer's full range.
b) Seal Material: Santoprene **OR** PVC, **as directed**.
c) Color: As selected from manufacturer's full range.
c. Type: Flat seal.
1) Seal Material: Santoprene.
a) Color: As selected from manufacturer's full range.
d. Fire-Resistance Rating: Match adjacent construction.
e. Moisture Barrier: Manufacturer's standard.

D. Architectural Joint Systems For Building Exteriors
1. Architectural Joint Systems for Exterior Walls and Soffits:
a. Type: Vertical cover-plate.
1) Exposed Metal: Aluminum **OR** Stainless steel, **as directed**.
a) Finish: Manufacturer's standard finish **OR** Mill **OR** Class I, clear anodic **OR** Class II, clear anodic **OR** Class I, color anodic **OR** Class II, color anodic **OR** High-performance organic **OR** No. 2B **OR** No. 4, **as directed**.
b) Color: As selected from full range of industry colors and color densities.
2) Secondary Seal: Manufacturer's standard extruded-elastomeric seal designed to prevent water and moisture infiltration.
b. Type: Flat seal.
1) Seal Material: Santoprene.
a) Color: As selected from manufacturer's full range.
2) Secondary Seal: Manufacturer's standard extruded-elastomeric seal designed to prevent water and moisture infiltration.
3) Pantograph Mechanism: Manufacturer's standard nylon pantographic wind-load support mechanism with stainless-steel fasteners.
c. Type: Preformed cellular foam.

1) Foam Material: Manufacturer's standard **OR** Non-extruded, low-density, crosslinked, nitrogen-blown, ethylene-vinyl-acetate copolymer **OR** Polyurethane, **as directed**.
   a) Color: As selected from manufacturer's full range.

d. Fire-Resistance Rating: Match adjacent construction.

E. Architectural Joint Systems For Open-Air Structures
1. Slab-to-Slab Joint Systems for Parking Structures **OR** Plaza Decks **OR** Stadiums, **as directed**:
   a. Type: Metal plate.
      1) Exposed Metal: Aluminum **OR** Stainless steel, **as directed**.
         a) Finish: Manufacturer's standard finish **OR** Mill **OR** Class I, clear anodic **OR** Class II, clear anodic **OR** Class I, color anodic **OR** Class II, color anodic **OR** High-performance organic **OR** No. 2B **OR** No. 4, **as directed**.
         b) Color: As selected from full range of industry colors and color densities.
   b. Type: Sealant T-joint **OR** Rubber pad **OR** Compression seal **OR** Strip seal **OR** Winged seal **OR** Epoxy-bonded seal **OR** Split-slab membrane, **as directed**.
      1) Seal Material: Santoprene **OR** Neoprene **OR** Silicone **OR** EPDM **OR** PVC **OR** Manufacturer's standard, **as directed**.
         a) Color: As selected from manufacturer's full range.
   c. Attachment Method: Mechanical anchors **OR** Cast in **OR** Elastomeric concrete header **OR** Compressed, epoxy adhered **OR** Compressed, lubricant adhesive adhered, **as directed**.
   d. Load Capacity: Heavy **OR** Extra heavy, **as directed**, duty.
   e. Fire-Resistance Rating: Match adjacent construction.
   f. Gutter: Flexible, fabric-reinforced neoprene gutter system with drain tubes.
2. Slab-to-Wall Joint Systems for Parking Structures **OR** Plaza Decks **OR** Stadiums, **as directed**:
   a. Type: Metal plate.
      1) Exposed Metal: Aluminum **OR** Stainless steel, **as directed**.
         a) Finish: Manufacturer's standard finish **OR** Mill **OR** Class I, clear anodic **OR** Class II, clear anodic **OR** Class I, color anodic **OR** Class II, color anodic **OR** High-performance organic **OR** No. 2B **OR** No. 4, **as directed**.
         b) Color: As selected from full range of industry colors and color densities.
   b. Type: Sealant T-joint **OR** Rubber pad **OR** Compression seal **OR** Strip seal **OR** Winged seal **OR** Epoxy-bonded seal **OR** Split-slab membrane, **as directed**.
      1) Seal Material: Santoprene **OR** Neoprene **OR** Silicone **OR** EPDM **OR** PVC **OR** Manufacturer's standard, **as directed**.
         a) Color: As selected from manufacturer's full range.
   c. Attachment Method: Mechanical anchors **OR** Cast in **OR** Elastomeric concrete header **OR** Compressed, epoxy adhered **OR** Compressed, lubricant adhesive adhered, **as directed**.
   d. Fire-Resistance Rating: Match adjacent construction.
   e. Gutter: Flexible, fabric reinforced neoprene gutter system with drain tubes.
3. Wall-to-Wall Joint Systems for Parking Structures **OR** Plaza Decks **OR** Stadiums, **as directed**:
   a. Type: Compression seal.
      1) Seal Material: Santoprene **OR** Neoprene **OR** Silicone **OR** EPDM **OR** PVC **OR** Manufacturer's standard, **as directed**.
         a) Color: As selected from manufacturer's full range.
   b. Type: Preformed cellular foam.
      1) Foam Material: Manufacturer's standard **OR** Non-extruded, low-density, crosslinked, nitrogen-blown, ethylene-vinyl-acetate copolymer **OR** Polyurethane, **as directed**.
         a) Color: As selected from manufacturer's full range.
   c. Attachment Method: Mechanical anchors **OR** Cast in **OR** Compressed, epoxy adhered **OR** Compressed, lubricant adhesive adhered, **as directed**.
   d. Fire-Resistance Rating: Match adjacent construction.

F. Finishes

1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Appearance of Finished Work: Noticeable variations in same piece are not acceptable.

1.3 EXECUTION

A. Installation
1. Comply with manufacturer's written instructions for storing, handling, and installing architectural joint assemblies and materials unless more stringent requirements are indicated.
2. Metal Frames: Perform cutting, drilling, and fitting required to install joint systems.
   a. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
   b. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation.
   c. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
   d. Locate in continuous contact with adjacent surfaces.
   e. Support underside of frames continuously to prevent vertical deflection when in service.
   f. Locate anchors at interval recommended by manufacturer, but not less than 3 inches (75 mm) from each end and not more than 24 inches (600 mm) o.c.
3. Seals in Metal Frames: Install elastomeric seals in frames to comply with manufacturer's written instructions. Install with minimum number of end joints.
   a. Provide in continuous lengths for straight sections.
   b. Seal transitions according to manufacturer's written instructions.
4. Compression Seals: Apply adhesive or lubricant adhesive as recommended by manufacturer to both frame interfaces **OR** sides of slabs, **as directed**, before installing compression seals.
5. Foam Seals: Install with adhesive recommended by manufacturer.
6. Epoxy-Bonded Seals: Pressurize seal for time period and to pressure recommended by manufacturer. Do not overpressurize.
7. Terminate exposed ends of joint assemblies with field- or factory-fabricated termination devices.
8. Fire-Resistance-Rated Assemblies: Coordinate so complete assemblies comply with assembly performance requirements.
   a. Fire Barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and field splices.
9. Water Barrier: Provide water barrier at exterior joints and where called for on Drawings.

B. Protection
1. Do not remove protective covering until finish work in adjacent areas is complete.
2. Protect the installation from damage by work of other Sections.

END OF SECTION 07 95 13 13

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SECTION 07 95 13 16 - ROOF EXPANSION ASSEMBLIES

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for roof expansion assemblies. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Metal-flanged, bellows-type roof expansion assemblies.
   b. Aluminum roof expansion assemblies.
   c. Seismic roof expansion assemblies.

C. Performance Requirements
1. General: Provide roof expansion assemblies that, when installed, remain watertight within movement limitations specified by manufacturer.

D. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Include plans, elevations, sections, details, joints, splices, locations of joints and splices, intersections, transitions, fittings, and attachments to other work. Where joint assemblies change planes, provide isometric drawings depicting how components interconnect to achieve continuity.
3. Samples: For each type of exposed factory-applied finish required, prepared on Samples of size to adequately show color.
4. Research/Evaluation Reports: For roof expansion assemblies.
5. Warranties: Special warranties specified in this Section.

E. Quality Assurance
1. Fire-Test-Response Characteristics: Provide fire-barrier assemblies with fire-test-response characteristics not less than that of adjacent construction, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Assemblies shall be capable of anticipated movement while maintaining fire rating. Identify assemblies with appropriate markings of applicable testing and inspecting agency.
   a. Fire-Resistance Ratings: UL 2079 **OR** ASTM E 119, **as directed**.

F. Warranty
1. Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace roof expansion assemblies that leak, deteriorate in excess of rates specified in manufacturer's published product literature, or otherwise fail to perform within Two years from date of Final Completion.
2. Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied fluoropolymer finishes within 20 years from date of Final Completion.

1.2 PRODUCTS

A. Metals

1. Galvanized Steel Sheet: ASTM A 653/A 653M, hot-dip zinc-coating designation G90 (Z275), stretcher-leveled standard of flatness and either commercial or forming steel, minimum 0.019 inch (0.5 mm) thick.
2. Stainless-Steel Sheet: ASTM A 666, Type 304, stretcher-leveled standard of flatness, minimum 0.015 inch (0.4 mm) thick.
3. Copper Sheet: ASTM B 370, Temper H00 (cold rolled) unless Temper 060 is required for forming, minimum 16 oz./sq. ft. (0.55 mm thick).
4. Sheet Aluminum: ASTM B 209 (ASTM B 209M); Alloy 3003-H14, 5052-H32, or 6061-T6; minimum 0.032 inch (0.8 mm) thick.
5. Extruded Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6063-T5 or 6063-T52, minimum 0.040 inch (1.0 mm) thick.
6. Aluminum Finishes:
    a. Mill Finish: AA-M10 (Mechanical Finish: as fabricated; no other applied finish unless buffing is required to removed scratches, welding, or grinding produced in fabrication process).
    b. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.
    c. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
    d. Class II, Color Anodic Finish: AA-M12C22A32/A34 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, integrally colored or electrolytically deposited color coating 0.010 mm or thicker).
    e. Class I, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
        1) Color: As selected from manufacturer's full range.
    f. High-Performance Organic Finish (2-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2604 and with coating and resin manufacturers' written instructions.
        1) Color and Gloss: As selected from manufacturer's full range.

B. Miscellaneous Materials
1. Roof Cement: ASTM D 4586, Type II.
2. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane **OR** polysulfide **OR** silicone, **as directed,** polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and to remain watertight.
3. Mineral-Fiber Blanket: ASTM C 665.
4. Flexible Cellular Sponge or Expanded Rubber: ASTM D 1056.
5. Silicone Extrusions: Classified according to ASTM D 2000, UV stabilized, and do not propagate flame.
6. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to withstand design loads.
    a. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.

C. Fire Barriers
1. Fire Barriers: Devices complying with requirements specified in Part 1.1 "Quality Assurance" Article for fire-test-response characteristics and designed for dynamic structural movement

without material degradation or fatigue when tested according to ASTM E 1399. Provide roof expansion assemblies with manufacturer's continuous, standard, flexible fire-barrier seals in back of joint system at locations indicated to provide fire-resistance rating not less than rating of adjacent construction.

D. Bellows-Type Roof Expansion Assemblies

1. Metal-Flanged, Bellows-Type Roof Expansion Assemblies: Provide manufacturer's standard assemblies of sizes and types indicated, with prefabricated units for corner and joint intersections and horizontal and vertical transitions including those to other building expansion joints, splicing units, adhesives, coatings, and other components as recommended by roof expansion assembly manufacturer for complete installation. Fabricate assemblies specifically for roof-to-roof **OR** roof-to-wall **OR** curb-to-curb **OR** curb-to-wall, **as directed,** applications.
2. Provide assemblies consisting of exposed polymeric sheet over foam bellows, securely anchored at both edges to 3- to 4-inch- (76- to 100-mm-) wide sheet metal nailing flanges, either flat or angle formed to fit cant or curbs as required. Insulate bellows with closed-cell, flexible rubber or plastic foam not less than 5/16 inch (8 mm) thick; adhere bellows to underside of polymeric sheet.
   a. Polymeric Sheet: Manufacturer's standard **OR** Neoprene, 60 mils (1.5 mm) thick **OR** EPDM, 60 mils (1.5 mm) thick, black **OR** EPDM, 60 mils (1.5 mm) thick, white **OR** Reinforced chlorinated polyethylene, 30 mils (0.8 mm) thick **OR** Chlorosulfonated polyethylene, 36 mils (0.9 mm) thick **OR** Glass-reinforced PVC, 40 to 50 mils (1.0 to 1.3 mm) thick, **as directed**.
   b. Metal Flanges: Zinc-coated (galvanized) steel, minimum 0.019 inch (0.5 mm) thick **OR** Copper, minimum 16 oz./sq. ft. (0.55 mm thick) **OR** Stainless steel, minimum 0.015 inch (0.4 mm) thick **OR** Sheet aluminum, minimum 0.032 inch (0.8 mm) thick, mill finish, **as directed**.
      1) Mortar Flanges: Where flanges will be embedded in concrete or mortar, provide manufacturer's standard perforated-metal mortar flanges.
   c. Moisture Barrier: Manufacturer's standard, flexible, continuous, polymeric moisture barrier looped under roof expansion assemblies at locations indicated. Fill space with blanket-type, mineral-fiber insulation.
   d. Fire Barrier: Provide manufacturer's standard fire barrier.

E. Aluminum Roof Expansion Assemblies

1. Aluminum Roof Expansion Assemblies: Provide assemblies consisting of aluminum base members with sloped cants and provisions for anchoring and sealing to roofing membrane or flashing in a waterproof-sealed joint. Provide free-to-move, extruded-aluminum cover plate anchored against displacement and waterproofed by integral seals. Provide prefabricated units for corner and joint intersections and horizontal and vertical transitions, including those to other building expansion joints, splicing units, adhesives, coatings, and other components as recommended by roof expansion assembly manufacturer for complete installation. Fabricate assemblies specifically for curb-to-curb **OR** wall, **as directed,** applications.
   a. Base Frame Members: Extruded aluminum with mill **OR** anodic **OR** high-performance organic, **as directed,** finish.
   b. Extruded-Aluminum Covers: Minimum 0.080 inch (2.03 mm) **OR** 0.125 inch (3 mm), **as directed,** thick, with mill **OR** clear anodic **OR** color anodic **OR** high-performance organic, **as directed,** finish.
   c. Formed-Aluminum Covers: Minimum 0.078 inch (2 mm) thick, with mill **OR** clear anodic **OR** color anodic **OR** high-performance organic, **as directed,** finish.
   d. Moisture Barrier:
      1) Semiconcealed, captive, polymeric sheet bellows unit of neoprene, EPDM, reinforced chlorinated polyethylene, or PVC, not less than 30 mils (0.8 mm) thick.
      2) Semiconcealed, captive gaskets at both curb members, of neoprene, EPDM, or PVC, with spring-loaded mechanism to maintain positive pressure between gaskets and curb cap.
   e. Fire Barrier: Provide manufacturer's standard fire barrier.

F. Seismic Roof Expansion Assemblies
1. General: Provide manufacturer's assemblies designed to accommodate seismic movement. Provide prefabricated units for corner and joint intersections and horizontal and vertical transitions including those to other building expansion joints, splicing units, inner seals, adhesives, coatings, and other components as recommended by roof expansion assembly manufacturer for complete installation. Fabricate assemblies specifically for roof-to-roof **OR** roof-to-wall **OR** curb-mounted, **as directed,** applications.
2. Extruded Seals: Two continuous, single-layered elastomeric profiles made of a vinyl inner seal and silicone **OR** neoprene **OR** Santoprene, **as directed,** outer seal, both seals retained in a pair of compatible extruded-aluminum frames.
   a. Exterior Seal Color: As selected from manufacturer's full range.
3. Aluminum Roof Expansion Assemblies: Assemblies consisting of pairs of aluminum curb units with sloped cants and provisions for anchoring and sealing to roofing membrane or flashing in a waterproof-sealed joint. Provide free-to-move, extruded-aluminum curb cap anchored against displacement and waterproofed by integral seals, with interior of expansion joint filled with blanket-type mineral-fiber insulation.
   a. Base Frame Members: Extruded aluminum with mill **OR** clear anodic **OR** color anodic **OR** high-performance organic, **as directed,** finish.
   b. Extruded-Aluminum Covers: Minimum 0.080 inch (2.03 mm) **OR** 0.125 inch (3 mm), **as directed,** thick, with mill **OR** clear anodic **OR** color anodic **OR** high-performance organic, **as directed,** finish.
   c. Formed-Aluminum Covers: Minimum 0.078 inch (2 mm) thick, with mill **OR** clear anodic **OR** color anodic **OR** high-performance organic, **as directed,** finish.
   d. Moisture Barrier:
      1) Semiconcealed, captive, polymeric sheet bellows unit of neoprene, EPDM, reinforced chlorinated polyethylene, or PVC, not less than 30 mils (0.8 mm) thick.
      2) Semiconcealed, captive gaskets at both curb members, of neoprene, EPDM, or PVC, with spring-loaded mechanism to maintain positive pressure between gaskets and curb cap.
   e. Fire Barrier: Provide manufacturer's standard fire barrier.

1.3 EXECUTION

A. Installation
1. Comply with manufacturer's written instructions for handling and installing roof expansion assemblies and materials unless more stringent requirements are indicated.
2. Coordinate installation of roof expansion assembly materials and associated work so complete assemblies comply with assembly performance requirements.
3. Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of roof expansion assembly, including transitions and end joints.
4. Extend roof expansion assemblies over curbs, parapets, cornices, gutters, valleys, fasciae, and other elements in the construction profile, with factory-fabricated intersections and transitions to provide continuous, uninterrupted, waterproof roof expansion assemblies.
   a. Install factory-fabricated transitions between roof expansion assemblies and building architectural joint systems, specified in Division 07 Section "Expansion Control", to provide continuous, uninterrupted, watertight construction.
5. Splice roof expansion assemblies with materials provided by roof expansion assembly manufacturer for this purpose, according to manufacturer's written instructions, to provide continuous, uninterrupted, waterproof roof expansion assemblies.
6. Provide uniform profile of roof expansion assembly throughout length of each installation; do not stretch polymeric sheets.
7. Install mineral-fiber blanket insulation to fill joint space within joint and moisture barrier.
8. Bed anchorage flanges in cement or sealant recommended by manufacturer and securely nail to curbs and cant strips as recommended by manufacturer but not less than 6 inches (150 mm) o.c.

9. Anchor roof expansion assemblies complying with manufacturer's written instructions.
10. Embed flanges not less than 4 inches (100 mm) in bituminous membranes, with hot bitumen or roof cement. Cover with stripping material and install according to requirements in roofing section.
11. On single-ply roofing, install roof expansion assemblies complying with manufacturer's written instructions. Anchor to cants or curbs and seal to membrane with sealant compatible with roofing membrane and roof expansion assembly. Cover flanges with stripping or flashing and install according to requirements in roofing section.

B. Protection
1. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensures that roof expansion assemblies are without damage or deterioration at time of Final Completion.

END OF SECTION 07 95 13 16

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Task	Specification	Specification Description
07 95 13 16	07 95 13 13	Architectural Joint Systems

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SECTION 08 01 11 61 - STEEL DOORS AND FRAMES

1.1 GENERAL

A. Description Of Work
  1. This specification covers the furnishing and installation of material for steel doors and frames. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
  1. Section Includes:
     a. Standard hollow metal doors and frames.
     b. Custom hollow metal doors and frames.

C. Definitions
  1. Minimum Thickness: Minimum thickness of base metal without coatings.
  2. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.
  3. Custom Hollow Metal Work: Hollow metal work fabricated according to ANSI/NAAMM-HMMA 861.

D. Submittals
  1. Product Data: For each type of product indicated.
  2. Shop Drawings: Include elevations, door edge details, frame profiles, metal thicknesses, preparations for hardware, and other details.
  3. Samples for Verification: For each type of exposed finish required.
  4. Schedule: Prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings.
  5. Oversize Construction Certification: For assemblies required to be fire rated and exceeding limitations of labeled assemblies.
  6. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of hollow metal door and frame assembly.

E. Quality Assurance
  1. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure **OR** as close to neutral pressure as possible, **as directed**, according to NFPA 252 **OR** IBC Standard 716.5, **as directed**, or UL 10B**OR** UL 10C, **as directed**.
     a. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
     b. Temperature-Rise Limit: Where indicated **OR** At vertical exit enclosures and exit passageways, **as directed**, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
  2. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9 **OR** IBC Standard 716.5, **as directed**. Label each individual glazed lite.
  3. Smoke-Control Door Assemblies: Comply with NFPA 105 or UL 1784 **OR** IBC Standard 716.5, **as directed**.

F. Delivery, Storage, And Handling

1. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
   a. Provide additional protection to prevent damage to finish of factory-finished units.
2. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
3. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch- (102-mm-) high wood blocking. Do not store in a manner that traps excess humidity.
   a. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation.

1.2 PRODUCTS

A. Materials
1. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
2. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
3. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum A40 (ZF120) **OR** G60 (Z180) or A60 (ZF180), **as directed**, metallic coating.
4. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z (12G) coating designation; mill phosphatized.
   a. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.
5. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
6. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.
7. Grout: ASTM C 476, except with a maximum slump of 4 inches (102 mm), as measured according to ASTM C 143/C 143M.
8. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6- to 12-lb/cu. ft. (96- to 192-kg/cu. m) density; with maximum flame-spread and smoke-development indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
9. Glazing: Comply with requirements in Division 08 Section "Glazing".
10. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat.

B. Standard Hollow Metal Doors
1. General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8.
   a. Design: Flush panel **OR** Embossed panel **OR** As indicated, **as directed**.
   b. Core Construction: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core.
      1) Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.
      2) Thermal-Rated (Insulated) Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than 4.0 deg F x h x sq. ft./Btu (0.704 K x sq. m/W) **OR** 6.0 deg F x h x sq. ft./Btu (1.057 K x sq. m/W) **OR** 12.3 deg F x h x sq. ft./Btu (2.166 K x sq. m/W), **as directed**, when tested according to ASTM C 1363.
         a) Locations: Exterior doors and interior doors where indicated, **as directed**.

c. Vertical Edges for Single-Acting Doors: Beveled edge **OR** Square edge **OR** Manufacturer's standard, **as directed**.
   1) Beveled Edge: 1/8 inch in 2 inches (3 mm in 50 mm).
d. Vertical Edges for Double-Acting Doors: Round vertical edges with 2-1/8-inch (54-mm) radius.
e. Top and Bottom Edges: Closed with flush or inverted 0.042-inch- (1.0-mm-) thick, end closures or channels of same material as face sheets.
f. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."

2. Exterior Doors: Face sheets fabricated from metallic-coated steel sheet. Provide doors complying with ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
   a. Level 1 and Physical Performance Level C (Standard Duty), Model 1 (Full Flush) **OR** Model 2 (Seamless), **as directed**.
      1) Width: 1-3/4 inches (44.5 mm) **OR** 1-3/8 inches (34.9 mm) **OR** As indicated on Drawings, **as directed**.
   b. Level 2 and Physical Performance Level B (Heavy Duty), Model 1 (Full Flush) **OR** Model 2 (Seamless), **as directed**.
   c. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 1 (Full Flush) **OR** Model 2 (Seamless) **OR** Model 3 (Stile and Rail), **as directed**.
   d. Level 4 and Physical Performance Level A (Maximum Duty), Model 1 (Full Flush) **OR** Model 2 (Seamless), **as directed**.
3. Interior Doors: Face sheets fabricated from cold-rolled steel sheet unless metallic-coated sheet is indicated. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
   a. Level 1 and Physical Performance Level C (Standard Duty), Model 1 (Full Flush) **OR** Model 2 (Seamless), **as directed**.
      1) Width: 1-3/4 inches (44.5 mm) **OR** 1-3/8 inches (34.9 mm) **OR** As indicated on Drawings, **as directed**.
   b. Level 2 and Physical Performance Level B (Heavy Duty), Model 1 (Full Flush) **OR** Model 2 (Seamless), **as directed**.
   c. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 1 (Full Flush) **OR** Model 2 (Seamless) **OR** Model 3 (Stile and Rail), **as directed**.
   d. Level 4 and Physical Performance Level A (Maximum Duty), Model 1 (Full Flush) **OR** Model 2 (Seamless), **as directed**.
4. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.
5. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

C. Standard Hollow Metal Frames
1. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.
2. Exterior Frames: Fabricated from metallic-coated steel sheet.
   a. Fabricate frames with mitered or coped corners.
   b. Fabricate frames as knocked down **OR** face welded **OR** full profile welded, **as directed,** unless otherwise indicated.
   c. Frames for Level 1 Steel Doors: 0.042-inch- (1.0-mm-) thick steel sheet.
   d. Frames for Level 2 Steel Doors: 0.053-inch- (1.3-mm-) thick steel sheet.
   e. Frames for Level 3 Steel Doors: 0.053-inch- (1.3-mm-) thick steel sheet.
   f. Frames for Level 4 Steel Doors: 0.067-inch- (1.7-mm-) thick steel sheet.
3. Interior Frames: Fabricated from cold-rolled steel sheet unless metallic-coated sheet is indicated.
   a. Fabricate frames with mitered or coped corners.
   b. Fabricate frames as knocked down **OR** face welded **OR** full profile welded, **as directed**, unless otherwise indicated.
   c. Fabricate knocked-down, drywall slip-on frames for in-place gypsum board partitions**, as directed**.

d. Frames for Level 1 Steel Doors: 0.042-inch- (1.0-mm-) thick steel sheet.
e. Frames for Level 2 Steel Doors: 0.053-inch- (1.3-mm-) thick steel sheet.
f. Frames for Level 3 Steel Doors: 0.053-inch- (1.3-mm-) thick steel sheet.
g. Frames for Level 4 Steel Doors: 0.067-inch- (1.7-mm-) thick steel sheet.
h. Frames for Wood Doors: 0.042-inch- (1.0-mm-) **OR** 0.053-inch- (1.3-mm-) **OR** 0.067-inch- (1.7-mm-), **as directed**, thick steel sheet.
i. Frames for Borrowed Lights: 0.042-inch- (1.0-mm-) thick steel sheet **OR** 0.053-inch- (1.3-mm-) thick steel sheet **OR** 0.067-inch- (1.7-mm-) thick steel sheet **OR** Same as adjacent door frame, **as directed**.

4. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.

D. Custom Hollow Metal Doors

1. General: Provide doors not less than 1-3/4 inches (44.5 mm) thick, of seamless hollow construction unless otherwise indicated. Construct doors with smooth surfaces without visible joints or seams on exposed faces. Comply with ANSI/NAAMM-HMMA 861.
2. Exterior Door Face Sheets: Fabricated from metallic-coated steel sheet, minimum 0.053 inch (1.3 mm) thick.
3. Interior Door Face Sheets: Fabricated from cold-rolled steel sheet unless metallic-coated sheet is indicated, minimum 0.042 inch (1.0 mm) thick.
4. Core Construction: Provide thermal-resistance-rated cores for exterior doors and interior doors where indicated, **as directed**.
   a. Steel-Stiffened Core: 0.026-inch- (0.7-mm-) thick, steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches (152 mm) apart, spot welded to face sheets a maximum of 5 inches (127 mm) o.c. Spaces filled between stiffeners with glass- or mineral-fiber insulation.
      1) Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.
      2) Thermal-Rated (Insulated) Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than 4.0 deg F x h x sq. ft./Btu (0.704 K x sq. m/W) **OR** 6.0 deg F x h x sq. ft./Btu (1.057 K x sq. m/W), **as directed,** when tested according to ASTM C 1363.
5. Vertical Edges for Single-Acting Doors: Beveled 1/8 inch in 2 inches (3 mm in 50 mm).
6. Vertical Edges for Double-Acting Doors: Round vertical edges with 2-1/8-inch (54-mm) radius.
7. Top and Bottom Channels: Closed with continuous channels, minimum 0.053 inch (1.3 mm) thick, of same material as face sheets and spot welded to both face sheets.
8. Hardware Reinforcement: Fabricate according to ANSI/NAAMM-HMMA 861 with reinforcing plates from same material as door face sheets.

E. Custom Hollow Metal Frames

1. General: Fabricate frames of construction indicated. Close contact edges of corner joints tight with faces mitered and stops butted or mitered. Continuously weld faces and soffits and finish faces smooth. Comply with ANSI/NAAMM-HMMA 861.
   a. Door Frames for Openings 48 Inches (1219 mm) Wide or Less: Fabricated from 0.053-inch- (1.3-mm-) thick steel sheet.
   b. Door Frames for Openings More Than 48 Inches (1219 mm) Wide: Fabricated from 0.067-inch- (1.7-mm-) thick steel sheet.
   c. Sidelight and Transom Frames: Fabricated from same thickness material as adjacent door frame.
   d. Borrowed-Light Frames: Fabricated from 0.053-inch- (1.3-mm-) thick steel sheet.
2. Exterior Frames: Formed from metallic-coated steel sheet.
3. Interior Frames: Fabricated from cold-rolled steel sheet unless metallic-coated sheet is indicated.
4. Hardware Reinforcement: Fabricate according to ANSI/NAAMM-HMMA 861 with reinforcing plates from same material as frame.

5. Head Reinforcement: Provide minimum 0.093-inch- (2.3-mm-) thick, steel channel or angle stiffener for opening widths more than 48 inches (1219 mm).

F. Frame Anchors
1. Jamb Anchors:
   a. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch (1.0 mm) thick, with corrugated or perforated straps not less than 2 inches (50 mm) wide by 10 inches (250 mm) long; or wire anchors not less than 0.177 inch (4.5 mm) thick.
   b. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch (1.0 mm) thick.
   c. Compression Type for Drywall Slip-on Frames: Adjustable compression anchors.
   d. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch- (9.5-mm-) diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
2. Floor Anchors: Formed from same material as frames, not less than 0.042 inch (1.0 mm) thick, and as follows:
   a. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
   b. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch (50-mm) height adjustment. Terminate bottom of frames at finish floor surface.

G. Hollow Metal Panels
1. Provide hollow metal panels of same materials, construction, and finish as specified for adjoining hollow metal work.

H. Stops And Moldings
1. Moldings for Glazed Lites in Doors: Minimum 0.032 inch (0.8 mm) thick, fabricated from same material as door face sheet in which they are installed.
2. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch (16 mm) high unless otherwise indicated.
3. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch (0.8 mm) thick, fabricated from same material as frames in which they are installed.
4. Terminated Stops: Where indicated on interior door frames, terminate stops 6 inches (152 mm) above finish floor with a 45-degree **OR** 90-degree, **as directed**, angle cut, and close open end of stop with steel sheet closure. Cover opening in extension of frame with welded-steel filler plate, with welds ground smooth and flush with frame.

I. Louvers
1. Provide louvers for interior doors, where indicated, that comply with SDI 111C, with blades or baffles formed of 0.020-inch- (0.5-mm-) thick, cold-rolled steel sheet set into 0.032-inch- (0.8-mm-) thick steel frame.
   a. Sightproof Louver: Stationary louvers constructed with inverted V-shaped or Y-shaped blades.
   b. Lightproof Louver: Stationary louvers constructed with baffles to prevent light from passing from one side to the other, any angle.
   c. Fire-Rated Automatic Louvers: Louvers constructed with movable blades closed by actuating fusible link, and listed and labeled for use in fire-rated door assemblies of type and fire-resistance rating indicated by same testing and inspecting agency that established fire-resistance rating of door assembly.

J. Accessories
1. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.
2. Ceiling Struts: Minimum 1/4-inch-thick by 1-inch- (6.4-mm-thick by 25.4-mm-) wide steel.
3. Grout Guards: Formed from same material as frames, not less than 0.016 inch (0.4 mm) thick.

K. Fabrication

1. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
2. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117 **OR** ANSI/NAAMM-HMMA 861, **as directed**.
3. Hollow Metal Doors:
   a. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
   b. Glazed Lites: Factory cut openings in doors.
   c. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch (19 mm) beyond edge of door on which astragal is mounted.
4. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
   a. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
   b. Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
   c. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
   d. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
   e. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
   f. Jamb Anchors: Provide number and spacing of anchors as follows:
      1) Masonry Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
         a) Two anchors per jamb up to 60 inches (1524 mm) high.
         b) Three anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
         c) Four anchors per jamb from 90 to 120 inches (2286 to 3048 mm) high.
         d) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 120 inches (3048 mm) high.
      2) Stud-Wall Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
         a) Three anchors per jamb up to 60 inches (1524 mm) high.
         b) Four anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
         c) Five anchors per jamb from 90 to 96 inches (2286 to 2438 mm) high.
         d) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 96 inches (2438 mm) high.
         e) Two anchors per head for frames above 42 inches (1066 mm) wide and mounted in metal-stud partitions.
      3) Compression Type: Not less than two anchors in each jamb.
      4) Postinstalled Expansion Type: Locate anchors not more than 6 inches (152 mm) from top and bottom of frame. Space anchors not more than 26 inches (660 mm) o.c.
   g. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Keep holes clear during construction.
      1) Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
      2) Double-Door Frames: Drill stop in head jamb to receive two door silencers.

5. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.
6. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware".
    a. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8 **OR** ANSI/NAAMM-HMMA 861.
    b. Reinforce doors and frames to receive nontemplated, mortised and surface-mounted door hardware.
    c. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
    d. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26.
7. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
    a. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow metal work.
    b. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
    c. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
    d. Provide loose stops and moldings on inside of hollow metal work.
    e. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

L. Steel Finishes
1. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
    a. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.
2. Factory-Applied Paint Finish: Manufacturer's standard, complying with ANSI/SDI A250.3 for performance and acceptance criteria.
    a. Color and Gloss: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.

1.3 EXECUTION

A. Installation
1. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.
2. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11 **OR** HMMA 840, **as directed**.
    a. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
        1) At fire-protection-rated openings, install frames according to NFPA 80.
        2) Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
        3) Install frames with removable glazing stops located on secure side of opening.
        4) Install door silencers in frames before grouting.
        5) Remove temporary braces necessary for installation only after frames have been properly set and secured.
        6) Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

7) Field apply bituminous coating to backs of frames that are filled with grout containing antifreezing agents.

b. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
   1) Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
c. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
d. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
e. Concrete Walls: Solidly fill space between frames and concrete with grout. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.
f. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
g. In-Place Gypsum Board Partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
h. Ceiling Struts: Extend struts vertically from top of frame at each jamb to overhead structural supports or substrates above frame unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction. Provide adjustable wedged or bolted anchorage to frame jamb members.
i. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
   1) Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
   2) Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
   3) Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
   4) Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.

3. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
   a. Non-Fire-Rated Standard Steel Doors:
      1) Jambs and Head: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
      2) Between Edges of Pairs of Doors: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
      3) Between Bottom of Door and Top of Threshold: Maximum 3/8 inch (9.5 mm).
      4) Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch (19 mm).
   b. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
   c. Smoke-Control Doors: Install doors according to NFPA 105 **OR** IBC Standard 716.5, **as directed**.
4. Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with hollow metal manufacturer's written instructions.
   a. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c. and not more than 2 inches (50 mm) o.c. from each corner.

B. Adjusting And Cleaning
1. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.
2. Remove grout and other bonding material from hollow metal work immediately after installation.

3. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
4. Metallic-Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION 08 01 11 61

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SECTION 08 01 11 61a - STEEL ENTRY DOORS

1.1 DESCRIPTION OF WORK

A. This specification covers the furnishing and installation of materials for steel entry doors. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 GENERAL

A. Definitions
   1. Supply and Delivery Only: Include supply and delivery to site(s) FOB destination freight prepaid. Unless otherwise specified or scheduled, unloading and handling at site is by the Owner.

B. System Description
   1. Door Assemblies: Include doors, frames, and hardware
      a. Provide with fire rating as indicated or specified.
      b. Door and Frame Assemblies: Comply with dimensional requirements of SDI 100.
      c. Exterior Doors: Sealed, weatherstripped and provided with thresholds.
   2. Insulated Entry Door System (Assembly) Performance Requirements:
      a. Mechanical Properties: Comply with ANSI/SDI A151.1, Level C (250,000 cycles).
      b. Air Infiltration: ANSI/ISDSI 101 and ASTM E 283, not exceed 0.029 cu m/s/mm (0.20 CFM/foot) of crack length at test pressure of 75 Pa (1.57 PSF).
      c. Water Resistance: ANSI/ISDSI 104 and ASTM E 331, no leakage at test pressure of 75 Pa (1.57 PSF).
      d. Thermal Performance: ANSI/ISDSI 107, minimum acceptance criteria as defined in standard except U-Value of 1.42 W/sq. m C (0.25 BTU/HR/SF degree F).
      e. Acoustical Performance: ANSI/ISDSI 103, Minimum Sound Transmission Class (STC) of 24.
   3. Hollow Core Heavy Duty System (Assembly) Performance Requirements:
      a. Mechanical Properties: Comply with ANSI/SDI A151.1, Level B (500,000 cycles).
      b. Air Infiltration: SDI 116 and ASTM E 283, not exceed 0.072 cu m/s/mm (0.50 CFM/foot) of crack length at test pressure of 75 Pa (1.57 PSF).
      c. Water Resistance: ASTM E 331, no leakage at test pressure of 75 Pa (1.57 PSF).
   4. Insulated Heavy Duty Door System (Assembly) Performance Requirements:
      a. Mechanical Properties: Comply with ANSI/SDI A151.1, Level B (500,000 cycles).
      b. Air Infiltration: ANSI/ISDSI 101/ASTM E 283, not exceed 0.029 cu m/s/mm (0.20 CFM/foot) of crack length at test pressure of 75 Pa (1.57 PSF).
      c. Water Resistance: ANSI/ISDSI 104 and ASTM E 331, no leakage at test pressure of 75 Pa (1.57 PSF).
      d. Thermal Performance: ANSI/ISDSI 107, minimum acceptance criteria as defined in standard except U-Value of 1.42 W/sq. m C (0.25 BTU/HR SF degree F) is required.
      e. Acoustical Performance: ANSI/ISDSI 103, Minimum Sound Transmission Class (STC) of 24.
   5. Security Door System (Assembly) Performance Requirements:
      a. Mechanical Properties: Comply with ANSI/SDI A151.1, Level A (1,000,000 cycles).
      b. Air Infiltration: SDI 116 and ASTM E 283, not exceed 0.72 cu m/s/mm (0.50 CFM/foot) of crack length at test pressure of 75 Pa (1.57 PSF).
      c. Water Resistance: ASTM E 331, no leakage at test pressure of 75 Pa (1.57 PSF).
      d. Forced Entry: ASTM F 476, Grade 40.

C. Submittals
1. Product Data.
2. Shop Drawings:
    a. Include details showing recommendations for installation of doors. Include size of fasteners, spacing, minimum penetration of fasteners into load-bearing material and maximum clearance between frame and rough opening.
3. Samples: Submit full set of finish color samples for color selection.
    a. For Supply and Deliver Only Contract: Submit one full size sample of each type of steel entry door with specified finish for acceptance.
4. Quality Assurance/Control Submittals:
    a. Test Reports: Results of testing by accredited independent laboratory demonstrating compliance of door systems with specified performance requirements.
        1) Indicate that tests were performed in accordance with standard referenced.
        2) Weak Link Testing. Submit reports for each model door in its weakest condition in order to quality superior variations of same model.
    b. Certificates: Manufacturer's written certification that door systems meet or exceed specified requirements.
    c. Manufacturer's installation instructions.
5. Closeout Submittals:
    a. Operation and maintenance data.
    b. Special warranty.

D. Quality Assurance
1. Regulatory Requirements: Comply with following:
    a. Fire Rated Label: Determined using ASTM E 152 and bear label of UL or other recognized fire rating program.
    b. Glazing Materials: Comply with CPSC 16 CFR 1201 or ANSI Z97.1.
    c. Accessibility:
        1) Architectural Barriers Act of 1968 as amended (42 USC 4151-4157) and HUD implementing regulations (24 CFR Part 40).
            a) Uniform Federal Accessibility Standards (UFAS).
        2) Section 504 of the Rehabilitation Act of 1973 as amended (29 USC 794) and HUD implementing regulations 24 CFR Part 8.
        3) Fair Housing Accessibility Guidelines (24 CFR Chapter 1).
        4) Americans with Disabilities Act of 1990 (ADA) (42 USC §§ 12101, et seq.) and implementing regulations (28 CFR Part 35).
2. Certifications:
    a. Door Systems: Meet or exceed performance requirements and other requirements specified and be labeled under HUD accepted Materials Releases.
    b. Some Material Releases (MR) do not include all of performance requirements specified. Therefore, additional testing, certification may be required for submission with HUD Material Releases.
        1) Material Releases are part of HUD Technical Suitability of Building Products Program. Contact: Department of Housing and Urban Development, Manufactured Housing and Construction Standards, 451 7th Street, SW, Washington, D.C. 20410-8000.
3. Mock-ups: Install one mock-up of each type of entry door system including doors, frames, hardware, weatherstripping, thresholds, and accessories.
    a. Location: As directed.
    b. Approved Mock-up: Standard for rest of work.
    c. Approved Mock-up: May remain part of completed project.

E. Delivery, Storage, And Handling
1. Packing, Shipping, Handling, and Unloading: Pack materials at manufacturing plant to prevent damage during shipping.

2. Acceptance at Site: Inspect door systems upon delivery. Replace damaged or defective materials before installation.

F. Project Conditions
1. Field Measurements: Field measure openings for door systems before start of fabrication.

G. Scheduling And Sequencing
1. Scheduling and Completion: Comply with requirements of Detailed Scope of Work.

H. Warranty
1. Special Warranty: Provide one year written warranty covering materials and installation for steel entry doors.
a. Warranty: Include coverage of hardware.
1) Glazing not included.
2) Defects resulting from vandalism not included.
b. For Supply and Delivery Only Contract:
1) Contractor: Agrees to supply and deliver to the Owner, free of charge, any required replacement parts that can be readily installed by the Owner without special tools.
2) Contractor: Agrees to supply and deliver free of charge, complete replacement door, when defective part or parts cannot be installed without use of special tools.
c. For Supply and Install Contract:
1) Contractor: Agrees to supply and install, free of charge, any required replacement parts or complete replacement door.

1.3 PRODUCTS

A. Doors
1. Doors: Consist of two steel face sheets, wood or steel stiles and rails with full support lock reinforcement.
a. Thickness: Nominal 44.4 mm (1-3/4 inch)
b. Steel Face: Minimum of 24 gage (0.57 mm) galvanized and bonderized steel.
c. Wood Stiles and Rails: Kiln dried clear Ponderosa Pine, Douglas Fir, or equal.
d. Embossed Designs: Emboss 24 gage (0.57 mm) doors and 18 gage (1.07 mm) doors to achieve scheduled or indicated designs.
2. Hollow Core Heavy Duty Doors: Fabricated of 18 gage (1.07 mm) minimum steel face sheets, stiles, top and bottom closures.
a. Comply with Performance Requirements in this Section.
b. Fire Rating: When required, provide B Label, 1-1/2 hour fire rating.
3. Insulated Heavy Duty Doors: Fabricated of 18 gage (1.07 mm) minimum steel face sheets, stiles, top and bottom closures.
a. Comply with Performance Requirements in this Section.
b. Fire Rating: When required, provide B Label, 1-1 /2 hour fire rating.
4. Security Doors: Comply with SDI 100, Models 1, 1A, 2, or 2A, minimum 16 gage (1.35 mm) steel face sheets .
a. Comply with Performance Requirements in this Section.
b. Fire Rating: When required, provide B Label, 1-1/2 hour fire rating.
5. Hardware Preparation:
a. Door System: Facilitate installation of standard cylindrical and/or full mortise locks with multiple point throw if specified.
b. 24 gage (0.57 mm) Doors: Prepare to receive three 102 mm (4 inch) full mortise or bun hinges flush with edge of door.
c. 18 Gage (1.07 mm) and Heavier Doors: Prepare to receive three 114 mm (4-1/2 inch) full mortise or butt hinges flush with edge of door.
6. Insulated Doors: Solid foam core of polyurethane, or polystyrene.
a. Core: Fully adhere to steel face sheets, stiles, rails and lock block and completely fill void.

B. Frames
1. Wood Frames: Kiln dried Ponderosa Pine, toxic treated, and primed.
2. Steel Frames and/or Adapter Frames: Minimum of 18 gage (1.07 mm) galvanized bonderized steel, pre-drilled and reinforced for hinges as required.
   a. Shape of Frame: Generally L-shaped.
3. Hollow Core Heavy Duty Door Frames: Fabricated of 16 gage (1.35 mm) minimum thickness.
   a. When required, provide B Label, 1-1/2 hour fire rating.
4. Insulated Heavy Duty Door Frames: Fabricated of 16 gage (1.35 mm) minimum thickness.
   a. When required, provide B Label, 1-1/2 hour fire rating.
5. Security Door Frames: Comply with SDI 100, minimum of 14 gage (1.70 mm) galvanized bonderized steel, pre-drilled and reinforced for hinges as required.
   a. When required, provide B Label, 1-1/2 hour fire rating.
   b. Comply with Performance Requirements in this Section.
6. Frames: Weatherstripped at head, jambs and threshold.

C. Hardware
1. General: Comply with ANSI/BHMA A156.1 and applicable accessibility regulatory requirements and perform functions for which it was intended.
2. Butts and Hinges: ANSI/BHMA A156.1, as scheduled.
   a. Install non-rising pins (NRP) on out-swing doors.
   b. Self Closing: ANSI/BHMA A156.17.
   c. Security Door Comply with Performance Requirements in this Section.
3. Fire Rate Doors Hardware: Comply with NFPA 80.
   a. Exit Doors: Comply with NFPA 101 (Life Safety Code) for exit doors, as well as other requirements specified.
   b. Labeling and Listing: Listed in UL Building Materials Directory.
      1) In Lieu of UL Labeling and Listing: Test reports from nationally recognized testing agency showing that hardware has been tested in accordance with UL test methods and conforms to NFPA requirements.
   c. Install minimum latch throw as specified on label of individual door.
   d. Provide hardware listed by UL, except where heavier materials, larger sizes or higher grades are specified.
   e. Closers: ANSI/BHMA A156.4.
4. Lock Sets: As scheduled. Comply with following standards:
   a. Bored and Preassembled Locks and Latches: ANSI/BHMA A156.2, Grade 2.
   b. Dead Bolt: ANSI/BHMA Al 56.5.
   c. Mortise Locks and Latches: ANSI/BHMA A156.13, Grade 1 or Security Grade, single or multiple throw.
   d. Interconnected Deadlock and Passage Set: ANSI/BHMA A156.12, Grade 2.
   e. Cylindrical Lock: Grade 2, cylindrical deadbolt lock/passage set combination.
   f. Security Door Locksets: ANSI/BHMA A156.13 Security Grade or UL 437 Key locks.
      1) Comply with Performance Requirements in this Section.
   g. Keys: Provide two keys for each lock provided. Provide master keying and keying alike on any locks as directed at no additional charge.
   h. Locks: Provide with interchangeable cores.
5. Door Viewers: ANSI/BHMA A156.16.

D. Accessories
1. Glazing Materials: Comply with CPSC 16 CFR 1201 or ANSI Z97.1.
   a. Glass: ASTM C 1036, Type 1, Class 1, Glazing B Quality.
      1) Fire Rated Doors: ASTM C 1036, Type 11, Class 1, Glazing Quality, wired glass.
   b. Tempered Glass: ASTM C 1048, Kind FT. Condition A, Type 1, Class 1, Glazing B Quality.
   c. Plastic: Extruded polycarbonate clear sheets, minimum 3 mm (0.118 inch) thick with following characteristics:
      1) Impact Resistance: ASTM D 256, Method A, 12-18 foot-pound per inch.

2) Elongation/Modulus of Elasticity: ASTM D 638, 110 percent maximum/340,000 PSI.
3) Heat Deflection: ASTM D 648, 132.2 degrees C (270 degrees F) at 264 PSI.
4) Abrasion Resistance: Coated on both surfaces to produce abrasion resistance of 3-19 percent maximum haze increase for 500 revolutions of CS-1 OF wheel per ASTM D 1044.

d. Insulating Glass Units: HUD UM 82 and ASTM E 774, Class C.
1) Provide insulating glass units in insulated doors and insulated heavy duty doors.

e. Glass Thickness: In accordance with AAMA 1002.10 Appendix, minimum 5 mm (3/16 inch).
1) Design Wind Pressures: Determined in accordance with applicable codes and regulations.

f. Glass: Labeled to show name of manufacturer and type.

2. Joint Sealants:
a. Exterior Joint Sealant: AAMA 800, Type 808.3 Exterior Perimeter Sealing Compound.
b. Back-up Material: Standard preformed and pre-compressed foam material, round rod or semi-circular type, permanently elastic, mildew resistant, nonmigratory, nonstaining, and compatible with joint substrates and with sealant.
1) Materials impregnated with oil, solvents, or bituminous materials not allowed.
2) Provide type as recommended by sealant manufacturer for particular installation.
3) Material: Neoprene, butyl, polyurethane, vinyl, or polyethylene rod.
c. Interior Joint Sealant: ASTM C 834, latex acrylic.

3. Weatherstripping and Thresholds: Comply with FS 00-A-200-9D, Alloy 6063-T-5; ASTM D 2287, Grade as required; MIL-S-6855, Class 11, Grade 40 (Solid neoprene); and MIL-R-6130C, Type 11, Grade C (Sponge neoprene).
a. Weatherstripping for Doors and Frames: Adjustable types with replaceable contact stops. Types are listed below:
1) Type A1 (for bottom of door with threshold greater than 6 mm (1/4 inch)): Solid neoprene or vinyl strips mounted in extruded aluminum retainers.
2) Type B (for bottom of door with thresholds less than 6 mm (1/4 inch) in height): Curved vinyl strips with extruded aluminum retainers.
3) Type C (for door frame heads and jambs): Extruded aluminum retainer with extruded solid vinyl insert.
4) Type D1 (for door frame heads and jambs): Closed cell sponge neoprene or vinyl strip with leveled edge mounted in extruded aluminum retainer.
b. Rain Drips: Extruded aluminum with sufficient projection.
c. Fasteners: Cad plated steel, brass plated steel, black oxide plated steel, or stainless steel.
1) Threshold to Concrete: Provide lead expansion shields.
2) Exposed Finish: Match finish of weatherstrip.

E. Finishes
1. Entry Door System: Clean and free from serious surface blemishes.
a. Exposed Surfaces: ASTM A 525 hot dipped galvanized, minimum A40 (or G60) Electrolytic Class B coating weight.
b. Primer: Factory final finished including primer meeting performance requirements of ANSI A224.1.
c. Finish Coat: One of the following as specified or scheduled:
1) Factory Finished: Electrostatically factory applied baked on enamel finish.
a) Color: As selected from manufacturers' list of colors.
2) Field painted under Division 9 Section "Painting."

F. Source Quality Control
1. Testing: Performed by accredited independent testing laboratory.
2. Shop Tests:
a. Mechanical Properties Tests: ANSI/SDI A151.1, perform on lightest gage frame and leaf.
1) Security Doors: ASTM F 476.
2) Doors with Glass Lites: Mechanical test not required.

b. Air Infiltration and Water Resistance Tests: Perform on door with largest glass lite. Retest variations in frame to leaf sealing system.
   1) Air Infiltration Tests: ANSI/ISDSI 101, SDI 116, and ASTM E 283.
   2) Water Resistance Tests: ANSI/ISDSI 104 and ASTM E 331.
c. Thermal Performance Tests: Perform on heaviest gage frame and leaf with largest area of glass. Retest variation in thermal design aspects of door such as different insulation, type of thermal break, or type of frame.
   1) Thermal Performance Tests: ANSI/ISDSI 107 and SDI 113.
d. Test Sample Size for Door System: Minimum 914 mm (36 inches) by 1 727 mm (68 inches), complete with hardware and subframe.

1.4 EXECUTION

A. Examination
1. Site Verification of Conditions:
   a. Field Measurements: Verify field measurements are as indicated on Shop Drawings.
   b. Existing Conditions: Examine openings before beginning installation.
   c. Do not proceed with installation until conditions are satisfactory.

B. Preparation
1. Protection: Protect adjacent elements from damage and disfiguration in accordance with Detailed Scope of Work.
   a. Contractor: Responsible for damage to grounds, plantings, buildings and any other facilities or property caused by construction operations.
   b. Adequately enclose and protect against weather any interior space where installation is incomplete at end of working day.
   c. Repair or replace damaged elements in accordance with Detailed Scope of Work.
2. Existing Entry Doors: Remove existing entry doors and debris from site in accordance with Detailed Scope of Work.
3. Prepare existing openings in accordance with ANSI/ISDSI 102, SDI 105, ASTM E 737, manufacturer’s recommendations, and approved Shop Drawings.

C. Installation
1. General: Install in accordance with ANSI/ISDSI 102, SDI 105, ASTM E 737, manufacturer's recommendations, and approved Shop Drawings.
   a. Install doors and frames securely, water tight, straight, plumb and level without distortion.
2. Weatherstripping and Thresholds: Accurately cut, fit, align, and secure to maintain weatherproof seal without hampering operation of door.
   a. Rain Drips: Install on door heads which are not protected by canopy or soffit.
   b. Secure thresholds to concrete with stainless screws or equal and lead expansion shields.
   c. Blocking: Provide as necessary to secure hardware. Prime cut wood surfaces with wood sealer before weatherstripping is installed.
3. Joint Sealants: Apply in accordance with manufacturers recommendations.
   a. Surfaces to be Sealed: Clean, dry and free of any foreign matter that would degrade adhesion. Remove existing caulking and joint sealants from areas to receive new joint sealant.
   b. Prime cleaned surfaces in accordance with sealant manufacturer’s recommendations.
   c. Protect surfaces adjacent to joints by masking tape before applying sealant. Remove tape upon finishing sealing work.
   d. Seal door frames and thresholds where joining other materials on exterior and interior with joint sealant to accomplish weather-tight installation.
   e. Maximum Width of Sealed Joint: 13 mm (1/2 inch).

D. Adjusting And Cleaning

1. Adjusting: At completion of job, check, adjust, and lubricate hardware as required and leave doors and hardware in proper operating condition.
2. Cleaning: Comply with requirements of Detailed Scope of Work.
   a. Clean doors, after installation is completed, to remove foreign matter and surface blemishes.
   b. Scratched or Abraded Surfaces: Touch-up with rust inhibitor primer and enamel paint compatible with factory finish.

E. Protection
   1. Installed Work: Protect doors from damage after installation.

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Task	Specification	Specification Description
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SECTION 08 01 52 61 - WOOD WINDOWS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for wood windows. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes fixed and operable wood-framed windows of the following type:
   a. Unfinished.
   b. Aluminum clad.
   c. Vinyl clad.

C. Definitions
1. Performance class designations according to AAMA/WDMA 101/I.S.2/NAFS:
   a. AW: Architectural.
   b. HC: Heavy Commercial.
   c. C: Commercial.
   d. LC: Light Commercial.
   e. R: Residential.
2. Performance grade number according to AAMA/WDMA 101/I.S.2/NAFS:
   a. Design pressure number in pounds force per square foot (pascals) used to determine the structural test pressure and water test pressure.
3. Structural Test Pressure: For uniform load structural test, is equivalent to 150 percent of the design pressure.
4. Minimum Test Size: Smallest size permitted for performance class (gateway test size). Products must be tested at minimum test size or at a size larger than minimum test size to comply with requirements for performance class.

D. Performance Requirements
1. General: Provide wood windows capable of complying with performance requirements indicated, based on testing manufacturer's windows that are representative of those specified, and that are of test size required by AAMA/WDMA 101/I.S.2/NAFS.
2. Structural Performance: Provide wood windows capable of withstanding the effects of the following loads based on testing units representative of those indicated for Project that pass AAMA/WDMA 101/I.S.2/NAFS, Uniform Load Structural Test:
   a. Design Wind Loads: Determine design wind loads applicable to Project from basic wind speed indicated in miles per hour (meters per second) at 33 feet (10 m) above grade, according to ASCE 7, Section 6.5, "Method 2-Analytical Procedure," based on mean roof heights above grade indicated on Drawings.
      1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s), **as directed**.
      2) Importance Factor: I **OR** II **OR** III **OR** IV, **as directed**.
      3) Exposure Category: A **OR** B **OR** C **OR** D, **as directed**.
   b. Deflection: Design glass framing system to limit lateral deflections of glass edges to less than 1/175 of glass-edge length or 3/4 inch (19 mm), whichever is less, at design pressure based on testing performed according to AAMA/WDMA 101/I.S.2/NAFS, Uniform Load Deflection Test or structural computations.
3. Windborne-Debris Resistance: Provide glazed windows capable of resisting impact from windborne debris, based on the pass/fail criteria as determined from testing glazed windows identical to those specified, according to ASTM E 1886 and testing information in ASTM E 1996 **OR** AAMA 506, **as directed**, and requirements of authorities having jurisdiction.

E. Submittals
1. Product Data: For each type of wood window indicated.
2. LEED Submittal:
a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood windows comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
1) Include statement indicating costs for each certified wood product.
3. Shop Drawings: Include plans, elevations, sections, details, hardware, attachments to other work, operational clearances, installation details.
4. Samples: For each exposed finish.
5. Product Schedule: Use same designations indicated on Drawings.
6. Product test reports.
7. Maintenance data.

F. Quality Assurance
1. Installer: A qualified installer, approved by manufacturer to install manufacturer's products.
2. Manufacturer Qualifications: A qualified manufacturer who is certified for chain of custody by an FSC-accredited certification body.
3. Forest Certification: Provide windows made with not less than 70 percent of wood products **OR** all wood products, **as directed**, obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
4. Fenestration Standard: Comply with AAMA/WDMA 101/I.S.2/NAFS, "North American Fenestration Standard Voluntary Performance Specification for Windows, Skylights and Glass Doors," for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.
a. Provide AAMA-certified **OR** WDMA-certified, **as directed**, wood windows with an attached label.
5. Glazing Publications: Comply with published recommendations of glass manufacturers and with GANA's "Glazing Manual" unless more stringent requirements are indicated.
6. Preinstallation Conference: Conduct conference at Project site.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace wood windows that fail in materials or workmanship within specified warranty period.
a. Warranty Period:
1) Window: Two **OR** Three, **as directed**, years from date of Final Completion.
2) Glazing: Five **OR** 10, **as directed**, years from date of Final Completion.
3) Metal Finish: Five years from date of Final Completion.

1.2 PRODUCTS

A. Materials
1. Wood: Clear ponderosa pine or another suitable fine-grained lumber; kiln dried to a moisture content of 6 to 12 percent at time of fabrication; free of visible finger joints, blue stain, knots, pitch pockets, and surface checks larger than 1/32 inch (0.8 mm) deep by 2 inches (51 mm) wide; water-repellent preservative treated.
2. Aluminum Extrusions and Rolled Aluminum for Cladding: Manufacturer's standard formed sheet or extruded-aluminum cladding, mechanically bonded to exterior exposed wood members. Provide aluminum alloy and temper recommended by wood window manufacturer for strength, corrosion resistance, and application of required finish, but not less than 22,000-psi (150-MPa) ultimate tensile strength, and not less than 16,000-psi (110-MPa) minimum yield strength.
a. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

b. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

c. Baked-Enamel Finish for Extrusions and Sheet: Manufacturer's standard baked enamel complying with AAMA 2603 and paint manufacturer's written specifications for cleaning, conversion coating, and painting.

1) Color: White **OR** Bronze **OR** Brown **OR** Beige **OR** Gray **OR** Green **OR** As selected from manufacturer's full range **OR** Custom color as selected, **as directed**.

d. High-Performance Organic Finish for Extrusions and Sheet: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1) Fluoropolymer Two-Coat System: Manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2604.

a) Color and Gloss: As selected from manufacturer's full range.

e. Baked-Enamel Finish for Coil: Manufacturer's standard baked enamel complying with AAMA 620 and paint manufacturer's written specifications for cleaning, conversion coating, and painting.

1) Color: White **OR** Bronze **OR** Brown **OR** Beige **OR** Gray **OR** Green **OR** As selected from manufacturer's full range **OR** Custom color as selected, **as directed**.

3. Vinyl for Cladding: Consisting of a rigid PVC sheath, made from PVC complying with ASTM D 4726, not less than 35-mil (0.9-mm) average thickness, in permanent, integral color, white **OR** bronze **OR** tan, **as directed**, finish, mechanically bonded to exterior wood sash and frame members.

4. Wood Trim and Glazing Stops: Material and finish to match frame members.

5. Clad Trim and Glazing Stops: Hollow extrusions **OR** Roll-formed sheet material **OR** Clad-wood material, **as directed**, and finish to match clad frame members.

6. Fasteners: Aluminum, nonmagnetic stainless steel, epoxy adhesive, or other materials warranted by manufacturer to be noncorrosive and compatible with wood window members, cladding, trim, hardware, anchors, and other components.

a. Exposed Fasteners: Unless unavoidable for applying hardware, do not use exposed fasteners. For application of hardware, use fasteners that match finish of member or hardware being fastened, as appropriate.

7. Anchors, Clips, and Accessories: Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

8. Reinforcing Members: Aluminum, or nonmagnetic stainless steel, or nickel/chrome-plated steel complying with ASTM B 456 for Type SC 3 severe service conditions, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

9. Compression-Type Weather Stripping: Provide compressible weather stripping designed for permanently resilient sealing under bumper or wiper action and for complete concealment when wood window is closed.

a. Weather-Stripping Material:

1) Elastomeric cellular preformed gaskets complying with ASTM C 509.

2) Dense elastomeric gaskets complying with ASTM C 864.

3) Manufacturer's standard system and materials complying with AAMA/WDMA 101/I.S.2/NAFS.

10. Sliding-Type Weather Stripping: Provide woven-pile weather stripping of wool, polypropylene, or nylon pile and resin-impregnated backing fabric. Comply with AAMA 701/702.

a. Weather Seals: Provide weather stripping with integral barrier fin or fins of semirigid, polypropylene sheet or polypropylene-coated material. Comply with AAMA 701/702.

11. Replaceable Weather Seals: Comply with AAMA 701/702.

B. Window
1. Window Type: Casement **OR** Double hung **OR** Fixed **OR** Horizontal sliding **OR** Projected awning **OR** Single hung **OR** Bay **OR** Bow **OR** Specialty product **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
2. AAMA/WDMA Performance Requirements: Provide wood windows of performance indicated that comply with AAMA/WDMA 101/I.S.2/NAFS unless more stringent performance requirements are indicated.
   a. Performance Class and Grade: R15 **OR** 20 **OR** 25, **as directed**.
   b. Performance Class and Grade: LC25 **OR** 30 **OR** 35, **as directed**.
   c. Performance Class and Grade: C30 **OR** 35 **OR** 40, **as directed**.
   d. Performance Class and Grade: HC40 **OR** 45 **OR** 50, **as directed**.
   e. Performance Class and Grade: AW40 **OR** 45 **OR** 50, **as directed**.
   f. Performance Class and Grade: As indicated.
3. Condensation-Resistance Factor (CRF): Provide wood windows tested for thermal performance according to AAMA 1503, showing a CRF of 45 **OR** 52, **as directed**.
4. Thermal Transmittance: Provide wood windows with a whole-window, U-factor maximum indicated at 15-mph (24-km/h) exterior wind velocity and winter condition temperatures when tested according to AAMA 1503 **OR** ASTM E 1423 **OR** NFRC 100, **as directed**.
   a. U-Factor: 0.35 Btu/sq. ft. x h x deg F (2.0 W/sq. m x K) **OR** 0.40 Btu/sq. ft. x h x deg F (2.3 W/sq. m x K) **OR** 0.43 Btu/sq. ft. x h x deg F (2.5 W/sq. m x K) **OR** 0.60 Btu/sq. ft. x h x deg F (3.4 W/sq. m x K), **as directed**, or less.
5. Solar Heat-Gain Coefficient (SHGC): Provide wood windows with a whole-window SHGC maximum of 0.40 **OR** 0.50 **OR** 0.55, **as directed**, determined according to NFRC 200 procedures.
6. Sound Transmission Class (STC): Provide glazed windows rated for not less than 26 **OR** 30 **OR** 35, **as directed**, STC when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 413.
7. Air Infiltration: Maximum rate not more than indicated when tested according to AAMA/WDMA 101/I.S.2/NAFS, Air Infiltration Test.
   a. Maximum Rate:
      1) 0.3 cfm/sq. ft. (5 cu. m/h x sq. m) of area at an inward test pressure of 1.57 lbf/sq. ft. (75 Pa) which is equivalent to 25-mph (40-km/h) wind speed and is typically used to test R, C, and LC performance classes.
      2) 0.3 cfm/sq. ft. (5 cu. m/h x sq. m) of area at an inward test pressure of 6.24 lbf/sq. ft. (300 Pa) which is equivalent to a 50-mph (80-km/h) wind speed and is typically used to test HC and AW performance classes.
   b. Water Resistance: No water leakage as defined in AAMA/WDMA referenced test methods at a water test pressure equaling that indicated, when tested according to AAMA/WDMA 101/I.S.2/NAFS, Water Resistance Test.
   c. Test Pressure:
      1) 15 percent of positive design pressure, but not less than 2.86 lbf/sq. ft. (140 Pa) or more than 15 lbf/sq. ft. (720 Pa).
      2) 20 percent of positive design pressure, but not more than 15 lbf/sq. ft. (720 Pa).
8. Forced-Entry Resistance: Comply with Performance Grade 10 **OR** 20 **OR** 30 **OR** 40, **as directed**, requirements when tested according to ASTM F 588.
9. Life-Cycle Testing: Test according to AAMA 910 and comply with AAMA/WDMA 101/I.S.2/NAFS.
10. Operating Force and Auxiliary (Durability) Tests: Comply with AAMA/WDMA 101/I.S.2/NAFS for operating window types indicated.

C. Glazing
1. Glass and Glazing Materials: Refer to Division 08 Section "Glazing"" for glass units and glazing requirements applicable to glazed wood window units.
2. Glass: Clear, insulating-glass units **OR** Clear, insulating-glass units, with low-E coating pyrolytic on second surface or sputtered on second or third surface, **OR** Clear, insulating-glass units,

argon gas filled, with low-E coating pyrolytic on second surface or sputtered on second or third surface, **as directed**, complying with Division 08 Section "Glazing".

3. Glazing System: Manufacturer's standard factory-glazing system that produces weathertight seal **OR** Manufacturer's standard factory-glazing system that produces weathertight seal and complies with requirements for windborne-debris resistance **OR** Manufacturer's standard factory-glazing system as indicated in Division 08 Section "Glazing", **as directed**.
4. Dual-Glazing System for Venetian Blinds: Manufacturer's standard dual-glazing system with 2 lites of clear float glass, complying with ASTM C 1036, Type I, Quality q3, glazed independently into the sash and separated by a minimum dead-air space of 1-1/2 inches (38 mm).
5. Triple-Glazing System for Venetian Blinds: Manufacturer's standard insulated glass of type specified, combined with an auxiliary lite of clear float glass, complying with ASTM C 1036, Type I, Quality q3, retained in a separate glazing channel or frame and separated from insulated-glass unit by a minimum dead-air space of 1-1/2 inches (38 mm).

D. Hardware

1. General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with wood and aluminum cladding, **as directed**; designed to smoothly operate, tightly close, and securely lock wood windows, and sized to accommodate sash or ventilator weight and dimensions. Do not use aluminum in frictional contact with other metals. Where exposed, provide solid bronze **OR** extruded, cast, or wrought aluminum **OR** die-cast zinc with special coating finish **OR** nonmagnetic stainless steel, **as directed**.
2. Counterbalancing Mechanism: Comply with AAMA 902.
   a. Sash-Balance Type: Concealed, tape-spring **OR** spiral-tube **OR** spring-loaded, block-and-tackle, **as directed**, type, of size and capacity to hold sash stationary at any open position.
3. Sill Cap/Track: Extruded-aluminum track with natural anodized finish **OR** Rigid PVC or other weather-resistant plastic track with manufacturer's standard integral color, **as directed**, of thickness, dimensions, and profile indicated; designed to comply with performance requirements indicated and to drain to the exterior.
4. Locks and Latches: Designed to allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only. Provide custodial locks, **as directed**.
5. Roller Assemblies: Low-friction design.
6. Push-Bar Operators: Provide telescoping-type, push-bar operator designed to open and close ventilators with fixed screens.
7. Gear-Type Rotary Operators: Comply with AAMA 901 when tested according to ASTM E 405, Method A.
   a. Operation Function: All ventilators move simultaneously and securely close at both jambs without using additional manually controlled locking devices.
8. Four- or Six-Bar Friction Hinges: Comply with AAMA 904.
   a. Locking mechanism and handles for manual operation.
   b. Friction Shoes: Provide friction shoes of nylon or other nonabrasive, nonstaining, noncorrosive, durable material.
9. Limit Devices: Provide concealed friction adjustor, adjustable stay bar **OR** concealed support arms with adjustable, limited, hold-open, **as directed**, limit devices designed to restrict sash or ventilator opening.
   a. Safety Devices: Limit clear opening to 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, for ventilation; with custodial key release.
10. Pole Operators: Tubular-shaped anodized aluminum; with rubber-capped lower end and standard push-pull hook at top to match hardware design; of sufficient length to operate window without reaching more than 60 inches (1500 mm) above floor; 1 pole operator and pole hanger per room that has operable windows more than 72 inches (1800 mm) above floor.

E. Insect Screens

1. General: Design windows and hardware to accommodate screens in a tight-fitting, removable arrangement, with a minimum of exposed fasteners and latches. Fabricate insect screens to fully

integrate with window frame. Locate screens on inside **OR** outside, **as directed**, of window and provide for each operable exterior sash or ventilator.

a. Aluminum Tubular Frame Screens: Comply with SMA 1004, "Specifications for Aluminum Tubular Frame Screens for Windows," Residential R-20 **OR** Architectural C-24 **OR** Monumental M-32, **as directed**, class.

2. Aluminum Insect Screen Frames: Manufacturer's standard aluminum alloy complying with SMA 1004. Fabricate frames with mitered or coped joints or corner extrusions, concealed fasteners, adjustable rollers, **as directed**, and removable PVC spline/anchor concealing edge of frame.
   a. Aluminum Tubular Framing Sections and Cross Braces: Roll formed from aluminum sheet with minimum wall thickness as required for class indicated.
   b. Finish:
      1) Anodized aluminum **OR** Baked-on organic coating, **as directed**, in manufacturer's standard color **OR** in color selected from manufacturer's full range, **as directed**.
      OR
      Manufacturer's standard.
3. Glass-Fiber Mesh Fabric: 18-by-14 (1.1-by-1.4-mm) or 18-by-16 (1.0-by-1.1-mm) **OR** 20-by-20 (0.85-by-0.85-mm) or 20-by-30 (0.85-by-0.42-mm), **as directed**, mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration; in the following color. Comply with ASTM D 3656.
   a. Mesh Color: Charcoal gray **OR** Silver gray **OR** Aquamarine, **as directed**.
4. Aluminum Wire Fabric: 18-by-16 (1.1-by-1.3-mm) mesh of 0.011-inch- (0.28-mm-) diameter, coated aluminum wire.
   a. Wire-Fabric Finish: Natural bright **OR** Charcoal gray **OR** Black, **as directed**.
5. Wickets: Provide sliding **OR** hinged, **as directed**, wickets, framed and trimmed for a tight fit and for durability during handling.

F. Accessories
1. Dividers (False Muntins): Provide dividers in designs indicated for each sash lite, one per sash, removable from the exposed surface of interior lite of the sash **OR** two per sash, removable from the exposed surfaces of interior and exterior lites of the sash, **as directed**, and one permanently located between glazing lites in the airspace, **as directed**.
   a. Material: Extruded, rigid PVC **OR** Prefinished wood, **as directed**.
   b. Design: Rectangular **OR** Diamond, **as directed**.
   c. Color: White **OR** Bronze, **as directed**.
2. Storm Panels: Provide removable auxiliary glazing panels of clear float glass for each fixed and operating sash of window units. Glass shall comply with ASTM C 1036, Type I, Quality q3. Provide glass of thickness required to comply with requirements in Division 08 Section "Glazing". Frame, preglaze, and attach storm windows to the sash according to manufacturer's published standards. Omit storm panels on sash glazed with insulating glass, **as directed**.
3. Integral Louver Blinds: Provide remotely operated horizontal louver blinds in the space between two panes of glass. Construct blinds of aluminum slats, approximately 1 inch (25 mm) wide, with polyester fiber cords, equipped for tilting, raising, and lowering by standard operating hardware located on inside face of sash.

G. Fabrication
1. Fabricate wood windows in sizes indicated. Include a complete system for assembling components and anchoring windows.
2. Fabricate wood windows that are reglazable without dismantling sash or ventilator framing.
3. Weather Stripping: Provide full-perimeter weather stripping for each operable sash and ventilator, unless otherwise indicated.
   a. Double-Hung Windows: Provide weather stripping only at horizontal rails of operable sash.
4. Factory machine windows for openings and for hardware that is not surface applied.
5. Mullions: Provide mullions and cover plates as shown, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances

and provide for movement of window units due to thermal expansion and building deflections, as indicated. Provide mullions and cover plates capable of withstanding design loads of window units.

6. Factory-Glazed Fabrication: Except for light sizes in excess of 100 united inches (2500 mm width plus length), glaze wood windows in the factory where practical and possible for applications indicated. Comply with requirements in Division 08 Section "Glazing" and with AAMA/WDMA 101/I.S.2/NAFS.
7. Glazing Stops: Provide nailed or snap-on glazing stops coordinated with Division 08 Section "Glazing" and glazing system indicated. Provide glazing stops to match sash and ventilator frames.
8. Bow **OR** Bay, **as directed**, Windows: Provide wood windows in configuration indicated. Provide window frames, fixed and operating sash, operating hardware, and other trim and components necessary for a complete, secure, and weathertight installation, including the following:
   a. Angled mullion posts with interior and exterior trim.
   b. Angled interior and exterior extension and trim.
   c. Clear pine head and seat boards.
   d. Top and bottom plywood platforms.
   e. Exterior head and sill casings and trim.
   f. Support brackets.
9. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation. Allow for scribing, trimming, and fitting at Project site.

H. Wood Finishes
1. Factory-Primed Windows: Provide manufacturer's standard factory-prime coat complying with WDMA T.M. 11 on exposed exterior **OR** interior **OR** exterior and interior, **as directed**, wood surfaces.
2. Factory-Finished Windows: Provide manufacturer's standard factory finish complying with WDMA T.M. 12. Apply finish to exposed exterior and interior wood surfaces.
   a. Color: White **OR** Brown **OR** Gray **OR** As selected from manufacturer's full range, **as directed**.

1.3 EXECUTION

A. Installation
1. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing windows, hardware, accessories, and other components.
2. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction.
3. Set sill members in bed of sealant or with gaskets, as indicated, for weathertight construction.
4. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

B. Adjusting, Cleaning, And Protection
1. Adjust operating sashes and ventilators, screens, hardware, and accessories for a tight fit at contact points and weather stripping for smooth operation and weathertight closure. Lubricate hardware and moving parts.
2. Clean exposed surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.
3. Clean factory-glazed glass immediately after installing windows. Comply with manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels, and clean surfaces.
4. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

5. Protect window surfaces from contact with contaminating substances resulting from construction operations. In addition, monitor window surfaces adjacent to and below exterior concrete and masonry surfaces during construction for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written recommendations.

END OF SECTION 08 01 52 61

Task	Specification	Specification Description
08 01 81 10	07 42 13 19	Glazing

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SECTION 08 05 13 00 - FLUSH WOOD DOORS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for flush wood doors. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Solid-core doors and transom panels with wood-veneer, medium-density-overlay, hardboard or MDF, and plastic-laminate faces.
   b. Hollow-core doors with wood-veneer, hardboard or MDF, and plastic-laminate faces.
   c. Shop priming and Factory finishing flush wood doors.
   d. Factory fitting flush wood doors to frames and factory machining for hardware.

C. Submittals
1. Product Data: For each type of door indicated. Include factory-finishing specifications.
2. LEED Submittals:
   a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that flush wood doors comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
      1) Include statement indicating costs for each certified wood product.
   b. Product Data for Credit EQ 4.4: For adhesives and composite wood products, documentation indicating that product contains no urea formaldehyde.
3. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.
   a. Indicate dimensions and locations of mortises and holes for hardware.
   b. Indicate dimensions and locations of cutouts.
   c. Indicate requirements for veneer matching.
   d. Indicate doors to be factory finished and finish requirements.
   e. Indicate fire-protection ratings for fire-rated doors.
4. Samples: For plastic-laminate door faces and factory-finished doors.

D. Quality Assurance
1. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
2. Quality Standard: In addition to requirements specified, comply with AWI's "Architectural Woodwork Quality Standards Illustrated" **OR** WDMA I.S.1-A, "Architectural Wood Flush Doors" **OR** WI's "Manual of Millwork", **as directed**.
3. Forest Certification: Provide doors made with cores **OR** veneers **OR** not less than 70 percent of wood products **OR** all wood products, **as directed**, obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
4. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure **OR** as close to neutral pressure as possible, **as directed**, according to NFPA 252 **OR** IBC Standard 716.5 **OR** UL 10B **OR** UL 10C, **as directed**.
   a. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

b. Temperature-Rise Limit: Where indicated **OR** At vertical exit enclosures and exit passageways, **as directed**, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.

5. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling

1. Comply with requirements of referenced standard and manufacturer's written instructions.
2. Package doors individually in plastic bags or cardboard cartons **OR** cardboard cartons and wrap bundles of doors in plastic sheeting, **as directed**.
3. Mark each door on bottom **OR** top and bottom, **as directed**, rail with opening number used on Shop Drawings.

F. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
   a. Warranty Period for Solid-Core Exterior Doors: Two **OR** Five, **as directed**, years from date of Final Completion.
   b. Warranty Period for Solid-Core Interior Doors: Life of installation.
   c. Warranty Period for Hollow-Core Interior Doors: One **OR** Two, **as directed**, year(s) from date of Final Completion.

1.2 PRODUCTS

A. Door Construction, General

1. Low-Emitting Materials: Provide doors made with adhesives and composite wood products that do not contain urea formaldehyde.
2. WDMA I.S.1-A Performance Grade:
   a. Heavy Duty unless otherwise indicated.
   b. Extra Heavy Duty: Classrooms, public toilets, janitor's closets, assembly spaces, exits, patient rooms, and where indicated.
   c. Standard Duty: Closets (not including janitor's closets), private toilets, and where indicated.
3. Particleboard-Core Doors:
   a. Particleboard:
      1) ANSI A208.1, Grade LD-1 **OR** Grade LD-2, **as directed**, made with binder containing no urea-formaldehyde resin, **as directed**.
      OR
      Straw-based particleboard complying with ANSI A208.1, Grade LD-2 or M-2, except for density.
   b. Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware.
   c. Provide doors with glued-wood-stave **OR** structural-composite-lumber, **as directed**, cores instead of particleboard cores for doors indicated to receive exit devices.
4. Structural-Composite-Lumber-Core Doors:
   a. Structural Composite Lumber: WDMA I.S.10.
      1) Screw Withdrawal, Face: 700 lbf (3100 N).
      2) Screw Withdrawal, Edge: 400 lbf (1780 N).
5. Fire-Protection-Rated Doors: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
   a. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.

b. Pairs: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals, **as directed**. Comply with specified requirements for exposed edges.
OR
Pairs: Provide formed-steel edges and astragals with intumescent seals, **as directed**.
1) Finish steel edges and astragals with baked enamel same color as doors, **as directed**.
OR
Finish steel edges and astragals to match door hardware (locksets or exit devices).

6. Mineral-Core Doors:
a. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
b. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as needed to eliminate through-bolting hardware.
c. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

7. Hollow-Core Doors:
a. Construction: Institutional **OR** Standard, **as directed**, hollow core.

B. Veneered-Faced Doors For Transparent Finish
1. Exterior Solid-Core Doors:
a. Grade: Premium, with Grade AA faces **OR** Premium, with Grade A faces **OR** Custom (Grade A faces) **OR** Economy (Grade B faces), **as directed**.
b. Species: Anigre **OR** Select white ash **OR** Figured select white ash **OR** Select white birch **OR** Cherry **OR** Select red gum **OR** Figured select red gum **OR** Select white maple **OR** Red oak **OR** Persimmon **OR** Sapele **OR** Sycamore **OR** Walnut **OR** White oak **OR** Ucuuba (Virola Duckei) **OR** Cupiuba (Goupia glabra), **as directed**.
c. Cut: Rotary cut **OR** Plain sliced (flat sliced) **OR** Quarter sliced **OR** Rift cut, **as directed**.
d. Match between Veneer Leaves: Book **OR** Slip **OR** Pleasing, **as directed**, match.
e. Assembly of Veneer Leaves on Door Faces: Center-balance **OR** Balance **OR** Running, **as directed**, match.
f. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions, **as directed**.
g. Exposed Vertical **OR** Vertical and Top, **as directed**, Edges: Same species as faces or a compatible species **OR** Same species as faces **OR** Applied wood-veneer edges of same species as faces and covering edges of faces **OR** Applied wood edges of same species as faces and covering edges of crossbands, **as directed**.
h. Core: Particleboard **OR** Glued wood stave **OR** Structural composite lumber**, as directed**.
i. Construction: Five **OR** Five or seven, **as directed**, plies. Stiles and rails are bonded to core, then entire unit abrasive planed before veneering. Faces are bonded to core using a hot press, **as directed**.
j. Adhesives: Type I per WDMA TM-6.

2. Interior Solid-Core Doors:
a. Grade: Premium, with Grade AA faces **OR** Premium, with Grade A faces **OR** Custom (Grade A faces) **OR** Economy (Grade B faces), **as directed**.
b. Species: Anigre **OR** Select white ash **OR** Figured select white ash **OR** Select white birch **OR** Cherry **OR** Select red gum **OR** Figured select red gum **OR** Select white maple **OR** Red oak **OR** Persimmon **OR** Sapele **OR** Sycamore **OR** Walnut **OR** White oak **OR** Ucuuba (Virola Duckei) **OR** Cupiuba (Goupia glabra), **as directed**.
c. Cut: Rotary cut **OR** Plain sliced (flat sliced) **OR** Quarter sliced **OR** Rift cut, **as directed**.
d. Match between Veneer Leaves: Book **OR** Slip **OR** Pleasing, **as directed**, match.
e. Assembly of Veneer Leaves on Door Faces: Center-balance **OR** Balance **OR** Running, **as directed**, match.

f. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions, **as directed**.

g. Room Match:

1) Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by 10 feet (3 m) **OR** 20 feet (6 m), **as directed**, or more.

OR

Provide door faces of compatible color and grain within each separate room or area of building.

h. Transom Match: Continuous match **OR** End match **OR** As indicated, **as directed**.

i. Blueprint Match: Where indicated, provide doors with faces produced from same flitches as adjacent wood paneling and arranged to provide blueprint match with wood paneling. Comply with requirements in Division 06 Section(s) "Interior Architectural Woodwork" OR "Wood Paneling", **as directed**.

j. Exposed Vertical **OR** Vertical and Top, **as directed**, Edges: Same species as faces or a compatible species **OR** Same species as faces **OR** Applied wood-veneer edges of same species as faces and covering edges of faces **OR** Applied wood edges of same species as faces and covering edges of crossbands, **as directed**.

k. Core: Particleboard **OR** Glued wood stave **OR** Nonglued wood stave **OR** Structural composite lumber**, as directed.**

l. Construction:

1) Five **OR** Five or seven, **as directed**, plies. Stiles and rails are bonded to core, then entire unit abrasive planed before veneering. Faces are bonded to core using a hot press, **as directed**.

OR

Seven plies, either bonded or nonbonded construction.

3. Interior Hollow-Core Doors:

a. Grade: Premium, with Grade AA faces **OR** Premium, with Grade A faces **OR** Custom (Grade A faces) **OR** Economy (Grade B faces), **as directed**.

b. Species: Anigre **OR** Select white ash **OR** Figured select white ash **OR** Select white birch **OR** Cherry **OR** Select red gum **OR** Figured select red gum **OR** Select white maple **OR** Red oak **OR** Persimmon **OR** Sapele **OR** Sycamore **OR** Walnut **OR** White oak **OR** Ucuuba (Virola Duckei) **OR** Cupiuba (Goupia glabra), **as directed**.

c. Cut: Rotary cut **OR** Plain sliced (flat sliced) **OR** Quarter sliced **OR** Rift cut, **as directed**.

d. Match between Veneer Leaves: Book **OR** Slip **OR** Pleasing, **as directed**, match.

e. Assembly of Veneer Leaves on Door Faces: Center-balance **OR** Balance **OR** Running, **as directed**, match.

f. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions, **as directed**.

g. Exposed Vertical **OR** Vertical and Top, **as directed**, Edges: Same species as faces or a compatible species **OR** Same species as faces **OR** Applied wood-veneer edges of same species as faces and covering edges of faces **OR** Applied wood edges of same species as faces and covering edges of crossbands, **as directed**.

h. Construction: Seven plies.

C. Doors For Opaque Finish

1. Exterior Solid-Core Doors:

a. Grade: Premium **OR** Custom **OR** Economy, **as directed**.

b. Faces: Medium-density overlay **OR** Any closed-grain hardwood of mill option, **as directed**.

1) Apply medium-density overlay to standard-thickness, closed-grain, hardwood face veneers **OR** directly to high-density hardboard crossbands, **as directed**.

c. Exposed Vertical **OR** Vertical and Top, **as directed**, Edges: Any closed-grain hardwood.

d. Core: Particleboard **OR** Glued wood stave **OR** Structural composite lumber, **as directed**.

e. Construction: Five **OR** Five or seven, **as directed**, plies. Stiles and rails are bonded to core, then entire unit abrasive planed before veneering. Faces are bonded to core using a hot press, **as directed**.
f. Adhesives: Type I per WDMA TM-6.

2. Interior Solid-Core Doors:
   a. Grade: Premium **OR** Custom **OR** Economy, **as directed**.
   b. Faces: Medium-density overlay **OR** Any closed-grain hardwood of mill option **OR** Hardboard or MDF, **as directed**.
      1) Apply medium-density overlay to standard-thickness, closed-grain, hardwood face veneers **OR** directly to high-density hardboard crossbands, **as directed**.
      2) Hardboard Faces: AHA A135.4, Class 1 (tempered) or Class 2 (standard).
      3) MDF Faces: ANSI A208.2, Grade 150 or 160.
   c. Exposed Vertical **OR** Vertical and Top, **as directed**, Edges: Any closed-grain hardwood.
   d. Core: Particleboard **OR** Glued wood stave **OR** Nonglued wood stave **OR** Structural composite lumber, **as directed**.
   e. Construction:
      1) Three **OR** Five **OR** Five or seven, **as directed**, plies. Stiles and rails are bonded to core, then entire unit abrasive planed before veneering. Faces are bonded to core using a hot press, **as directed**.
         OR
         Three **OR** Seven, **as directed**, plies, either bonded or nonbonded construction.
3. Interior Hollow-Core Doors:
   a. Grade: Premium **OR** Custom **OR** Economy, **as directed**.
   b. Faces: Medium-density overlay **OR** Any closed-grain hardwood of mill option **OR** Hardboard or MDF, **as directed**.
      1) Hardboard Faces: AHA A135.4, Class 1 (tempered) or Class 2 (standard).
      2) MDF Faces: ANSI A208.2, Grade 150 or 160.
   c. Exposed Vertical **OR** Vertical and Top, **as directed**, Edges: Any closed-grain hardwood.
   d. Construction: Three **OR** Seven, **as directed**, plies.

D. Plastic-Laminate-Faced Doors
1. Interior Solid-Core Doors:
   a. Grade: Premium **OR** Custom **OR** Economy, **as directed**.
   b. Plastic-Laminate Faces: High-pressure decorative laminates complying with NEMA LD 3, Grade HGS **OR** Grade HSH, **as directed**.
   c. Colors, Patterns, and Finishes: As indicated **OR** As selected from laminate manufacturer's full range of products, **as directed**.
   d. Exposed Vertical **OR** Vertical and Top, **as directed**, Edges: Hardwood edges for staining to match faces **OR** Hardwood edges for painting **OR** Plastic laminate that matches faces, applied before faces **OR** Impact-resistant polymer edging, applied after faces, **as directed**.
      1) Polymer Edging Color: Beige **OR** Brown **OR** Same color as faces, **as directed**.
   e. Core: Particleboard **OR** Glued wood stave **OR** Structural composite lumber, **as directed**.
   f. Construction:
      1) Three plies. Stiles and rails are bonded to core, then entire unit abrasive planed before faces are applied. Faces are bonded to core using a hot press, **as directed**.
         OR
         Five plies. Stiles and rails are bonded to core, then entire unit abrasive planed before faces and crossbands are applied. Faces are bonded to core using a hot press, **as directed**.
2. Interior Hollow-Core Doors:
   a. Grade: Premium **OR** Custom **OR** Economy, **as directed**.
   b. Plastic-Laminate Faces: High-pressure decorative laminates complying with NEMA LD 3, Grade HGS **OR** Grade HSH, **as directed**.
   c. Colors, Patterns, and Finishes: As indicated **OR** As selected from laminate manufacturer's full range of products, **as directed**.

d. Exposed Vertical **OR** Vertical and Top, **as directed**, Edges: Hardwood edges for staining to match faces **OR** Hardwood edges for painting **OR** Plastic laminate that matches faces, applied before faces **OR** Impact-resistant polymer edging, applied after faces, **as directed**.
   1) Polymer Edging Color: Beige **OR** Brown **OR** Same color as faces, **as directed**.
e. Construction: Plastic-laminate faces glued directly to core.

E. Louvers And Light Frames
1. Wood Louvers: Door manufacturer's standard solid-wood louvers unless otherwise indicated.
   a. Wood Species: Same species as door faces **OR** Species compatible with door faces **OR** Any closed-grain hardwood, **as directed**.
2. Metal Louvers:
   a. Blade Type: Vision-proof, inverted V **OR** Vision-proof, inverted Y **OR** Darkroom-type, double inverted V, **as directed**.
   b. Metal and Finish:
      1) Hot-dip galvanized steel, 0.040 inch (1.0 mm) thick, factory primed for paint finish **OR** with baked-enamel- or powder-coated finish, **as directed**.
         OR
         Extruded aluminum with Class II, clear anodic finish, AA-M12C22A31.
         OR
         Extruded aluminum with light bronze **OR** medium bronze **OR** dark bronze **OR** black, **as directed**, Class II, color anodic finish, AA-M12C22A32/A34.
3. Louvers for Fire-Rated Doors: Metal louvers with fusible link and closing device, listed and labeled for use in doors with fire-protection rating of 1-1/2 hours and less.
   a. Metal and Finish: Hot-dip galvanized steel, 0.040 inch (1.0 mm) thick, factory primed for paint finish **OR** with baked-enamel- or powder-coated finish, **as directed**.
4. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads as follows unless otherwise indicated.
   a. Wood Species: Same species as door faces **OR** Species compatible with door faces **OR** Any closed-grain hardwood, **as directed**.
   b. Profile: Flush rectangular beads **OR** Recessed tapered beads **OR** Recessed tapered beads with exposed banding **OR** Lipped tapered beads **OR** Manufacturer's standard shape, **as directed**.
   c. At wood-core doors with 20-minute fire-protection ratings, provide wood beads and metal glazing clips approved for such use.
5. Wood-Veneered Beads for Light Openings in Fire-Rated Doors: Manufacturer's standard wood-veneered noncombustible beads matching veneer species of door faces and approved for use in doors of fire-protection rating indicated. Include concealed metal glazing clips where required for opening size and fire-protection rating indicated.
6. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of 0.048-inch- (1.2-mm-) thick, cold-rolled steel sheet; factory primed for paint finish **OR** with baked-enamel- or powder-coated finish, **as directed**; and approved for use in doors of fire-protection rating indicated.

F. Fabrication
1. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
   a. Comply with requirements in NFPA 80 for fire-rated doors.
2. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.
   a. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
   b. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

3. Transom and Side Panels: Fabricate matching panels with same construction, exposed surfaces, and finish as specified for associated doors. Finish bottom edges of transoms and top edges of rabbeted doors same as door stiles.
    a. Fabricate door and transom panels with full-width, solid-lumber, rabbeted, **as directed**, meeting rails. Provide factory-installed spring bolts for concealed attachment into jambs of metal door frames.
4. Openings: Cut and trim openings through doors in factory.
    a. Light Openings: Trim openings with moldings of material and profile indicated.
    b. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Division 08 Section "Glazing".
    c. Louvers: Factory install louvers in prepared openings.
5. Exterior Doors: Factory treat exterior doors with water repellent after fabrication has been completed but before shop priming **OR** factory finishing, **as directed**.
    a. Flash top of outswinging doors (with manufacturer's standard metal flashing).

G. Shop Priming
1. Doors for Opaque Finish: Shop prime doors with one coat of wood primer specified in Division 09 Section(s) "Exterior Painting" OR "Interior Painting", **as directed**. Seal all four edges, edges of cutouts, and mortises with primer.
2. Doors for Transparent Finish: Shop prime doors with stain (if required), other required pretreatments, and first coat of finish as specified in Division 09 Section(s) "Exterior Painting" OR "Interior Painting" OR "Staining And Transparent Finishing", **as directed**. Seal all four edges, edges of cutouts, and mortises with first coat of finish.

H. Factory Finishing
1. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
    a. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on bottom **OR** top and bottom, **as directed**, edges, edges of cutouts, and mortises.
2. Finish doors at factory.
   OR
   Finish doors at factory that are indicated to receive transparent finish. Field finish doors indicated to receive opaque finish.
   OR
   Finish doors at factory where indicated in schedules or on Drawings as factory finished.
3. Transparent Finish:
    a. Grade: Premium **OR** Custom, **as directed**.
    b. Finish:
        1) AWI conversion varnish **OR** catalyzed polyurethane, **as directed**, system.
           OR
           WDMA TR-4 conversion varnish **OR** TR-6 catalyzed polyurethane, **as directed**.
           OR
           WI System 4 clear conversion varnish **OR** 5 catalyzed polyurethane **OR** 8 UV-curable coating, **as directed**.
    c. Staining: Match sample **OR** As selected from manufacturer's full range **OR** None required, **as directed**.
    d. Effect: Open-grain finish **OR** Filled finish **OR** Semifilled finish, produced by applying an additional finish coat to partially fill the wood pores, **as directed**.
    e. Sheen: Satin **OR** Semigloss, **as directed**.
4. Opaque Finish:
    a. Grade: Premium **OR** Custom, **as directed**.
    b. Finish:
        1) AWI conversion varnish **OR** catalyzed polyurethane, **as directed**, system.
           OR
           WDMA OP-4 conversion varnish **OR** OP-6 catalyzed polyurethane, **as directed**.

OR
WI System 4 conversion varnish **OR** 5 catalyzed polyurethane **OR** 8 UV-curable coating, **as directed**.

c. Color: Match sample **OR** As selected from manufacturer's full range, **as directed**.
d. Sheen: Satin **OR** Semigloss **OR** Gloss, **as directed**.

1.3 EXECUTION

A. Installation

1. Hardware: For installation, see Division 08 Section "Door Hardware".
2. Installation Instructions: Install doors to comply with manufacturer's written instructions and the referenced quality standard, and as indicated.
   a. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.
3. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
   a. Clearances: Provide 1/8 inch (3.2 mm) at heads, jambs, and between pairs of doors. Provide 1/8 inch (3.2 mm) from bottom of door to top of decorative floor finish or covering unless otherwise indicated. Where threshold is shown or scheduled, provide 1/4 inch (6.4 mm) from bottom of door to top of threshold unless otherwise indicated.
      1) Comply with NFPA 80 for fire-rated doors.
   b. Bevel non-fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) at lock and hinge edges.
   c. Bevel fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) at lock edge; trim stiles and rails only to extent permitted by labeling agency.
4. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
5. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

B. Adjusting

1. Operation: Rehang or replace doors that do not swing or operate freely.
2. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 08 05 13 00

Task	Specification	Specification Description
08 05 13 00	01 22 16 00	No Specification Required
08 05 13 00	08 01 11 61	Steel Doors And Frames
08 05 13 00	06 48 13 00	Wood Doors
08 05 13 00	08 34 73 16	Sound Control Doors

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SECTION 08 11 63 13 - STEEL STORM DOORS

DESCRIPTION OF WORK

This specification covers the furnishing and installation of materials for steel storm doors. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

GENERAL

Definitions

1. Supply and Delivery only: Include supply and delivery to site(s) FOB destination freight prepaid. Unless otherwise specified or scheduled, unloading and handling at site is by Owner.

System Description

2. Performance Requirements: Comply with following:
   a. Steel Storm Doors: Largest steel storm door size: Meet or exceed performance requirements of Section 2.1 (CSD-1) of ANSI/AAMA 1102.7 and ASTM B 117.
   b. Steel Storm Doors: Completely assembled storm door measuring at least 914 mm (36 inches) wide x 2 032 mm (80 inches) high with necessary braces and hardware:
      1) Sag Test: Meet or exceed ANSI/AAMA 1102.7 Sag Test.
      2) Forced Entry Resistance Test: Meet or exceed ANSI/SMA 6001 Paragraph 4.2.4.3 for Heavy Type.
      3) Storm Door Screen Insert: Completely assembled screen of 914 mm (36 inches) by 1 524 mm (60 inches) size with necessary braces: Meet or exceed ANSI/SMA 6001 Paragraph 4.2.4.1 Impact Test performance requirements for Medium Type.
   c. Steel Screen Doors: Completely assembled screen door measuring at least 914 mm (36 inches) wide by 2 032 mm (80 inches) high with necessary braces and hardware:
      1) Impact Test: Meet or exceed performance requirements of ANSI/SMA 6001 Paragraph 4.2.4.1 for Medium Type.
      2) Sag Test: Meet or exceed ANSI/AAMA 1102.7 Sag Test.
   d. Door Finish: Subjected to ASTM B117 Salt Spray Fog Test for minimum of 250 hours. Cut tubular section open to check finish performance.

Submittals

3. Product Data.
4. Shop Drawings:
   a. Include exploded view of manufactured door, similar to ANSI/AAMA 1102.7, page 12.
   b. Indicate fabrication of all parts, metal thickness, installation details, fastening, and sealing.
   c. Include sections of typical members and details of latching devices.
5. Samples: Submit full set of finish color samples for color selection.
   a. For Supply and Deliver Only Contract: Submit one full size sample of each type of storm door with specified finish for acceptance.
6. Quality Assurance/Control Submittals:
   a. Certificates: Manufacturer's written third party certification that storm doors meet or exceed ANSI/AAMA 1102.7 (CSD-1), Paragraph 2.1.6.5 of ANSI/SMA 6001, ASTM B117, and other specified requirements.
   b. Manufacturer's installation instructions.
7. Closeout Submittals:
   a. Operation and maintenance data.
   b. Special warranty.

SAN BERNARDINO COUNTY

Quality Assurance

8. Regulatory Requirements: Comply with following:
    a. Glazing Materials: Comply with CPSC 16 CFR 1201 or ANSI Z97.1.
    b. Accessibility:
        1) Architectural Barriers Act of 1968 as amended (42 USC 4152-4157) and HUD implementing regulations (24 CFR Part 40).
            a) Uniform Federal Accessibility Standards (UFAS).
        2) Section 504 of the Rehabilitation Act of 1973 as amended (29 USC 794) and HUD implementing regulations 24 CFR Part 8.
        3) Fair Housing Accessibility Guidelines (24 CFR Chapter 1).
        4) Americans with Disabilities Act of 1990 (ADA) (28 CFR Part 35).
9. Certifications: Comply with ANSI Z34.2.
10. Mock-ups: For Supply and Install Contract: Install one full size mock-up of each type of storm door with specified finish for acceptance.
    a. Location: As directed.
    b. Approved Mock-up: Standard for rest of work.
    c. Approved Mock-up: May remain part of completed project.

Delivery, Storage, And Handling

11. Packing, Shipping, Handling, and Unloading: Pack materials at manufacturing plant to prevent damage during shipping.
    a. Screens: Label attached signifying compliance with ANSI/AAMA 1102.7 (CSD-1), ANSI/SMA 6001, ASTM B 117 performance requirements.
        1) Labels: Include manufacturers name and code identifying plant location and validation date.
        2) Labels: Affixed to inside of vertical member of each door.
12. Acceptance at Site: Inspect storm doors upon delivery. Replace damaged or defective materials before installation.
13. Storage and Protection: Store storm doors in manner to protect from weather and other damage.

Project Conditions

14. Field Measurements: Field measure openings for storm doors before start of fabrication.

Scheduling And Sequencing

15. Scheduling and Completion: Comply with requirements of Detailed Scope of Work.

Warranty

16. Special Warranty: Provide one year written covering materials and installation for storm doors.
    a. Warranty: Include coverage of inserts, closers, chains, hardware, and latches.
        1) Screening and glazing not included.
        2) Defects resulting from vandalism not included.
    b. For Supply and Delivery Only Contract:
        1) Contractor: Agrees to supply and deliver to Owner, free of charge, any required replacement parts that can be readily installed by Owner without special tools.
        2) Contractor: Agrees to supply and deliver free of charge, complete replacement door, when defective part or parts cannot be installed without use of special tools.
    c. For Supply and Install Contract:
        1) Contractor: Agrees to supply and install, free of charge, any required replacement parts or complete replacement door.

PRODUCTS

Steelstorm Doors

17. Storm Doors: Type(s) and size(s) indicated, specified, or scheduled manufactured of steel and provided with pro-hung aluminum frame liner (Z-bar) to fit entrance door apertures requiring frame sizes of 762 mm (30 inches) to 940 mm (37 inches) in width and 2 007 mm (79 inches) to 2 134 mm (84 inches) in height.
    a. Storm Doors: Complete with Z-bar frame liner, glazing, replaceable screen insert, durable steel kick plate, adjustable sill sweep, and necessary hardware.
    b. Assembly: Secure and workmanlike manner permitting storm door to perform properly and assuring its neat and weather-resistant construction.
18. Materials:
    a. Master Frame: Minimum 22 gage (0.85 mm) roll formed steel, or 16 gage (1.6 mm) tubular steel as applicable to item specified.
    b. Fasteners: Stainless, cadmium plated, or zinc-plated steel screws, nuts, washers, bolts and other miscellaneous fastening devices and hardware in accordance with ASTM B 633 or ASTM B 766.
    c. Kick Plate: Minimum 18 gage (1.3 mm) embossed galvanized panel for roll formed frame or 16 gage (1.6 mm) flat galvanized steel sheet for tubular steel frame.
    d. Screen Insert:
        1) Screening: ANSI/SMA 6001, Paragraph 4.2.4.1, Medium Type, 12 x 12 stainless steel, at least 0.58 mm (0.023 inch) diameter.
        2) Screen Frame: Roll formed or tubular lock seam type formed from not less than 25 gage (0.53 mm) hot dipped galvanized steel or extruded aluminum.
    e. Glazing Bead, Storm Door Sweep and Screen Spline: Polyvinyl chloride (PVC) or equal material
    f. Frame Liner (Z-bar): Extruded aluminum, 6063 J5.
    g. Weatherstripping: Wool pile, or vinyl.
19. Glazing Materials: Comply with CPSC 16 CFR 1201 or ANSI Z97.1.
    a. Tempered Glass: ASTM C 1048, Kind FT. Condition A, Type 1, Class 1, Glazing B Quality.
    b. Plastic: Extruded polycarbonate clear sheets, minimum 4.5 mm (0.177 inch) thick with following characteristics:
        1) Impact Resistance: ASTM D 256, Method A, 12-18 foot-pound per inch.
        2) Elongation/Modulus of Elasticity: ASTM D 638, 110 percent maximum 340,000 PSI.
        3) Heat Deflection: ASTM D 648, 132.2 degrees C (270 degrees F) at 264 PSI.
        4) Abrasion Resistance: Coated on both surfaces to produce abrasion resistance of 3-19 percent maximum haze increase for 500 revolutions of CS-1 OF wheel per ASTM D 1044.
    c. Glass Thickness: In accordance with ANSI/AAMA 1002.10 Appendix, minimum 5 mm (3/16 inch).
        1) Design Wind Pressures: Determined in accordance with applicable codes and regulations.
    d. Glass: Labeled to show name of manufacturer and type.
    e. Glazing Material: Installed in rigid removable steel or extruded aluminum subframe.
20. Construction:
    a. Master Frame: Roll Formed tubular lock-seam construction formed from 22 gage (0.85 m) hot dipped galvanized steel.
        1) Comers: Either mitered or butt-jointed and rigidly fastened together by brazing or welding. Insert steel gussets at comers of mitered or butt-jointed storm doors when edge brazing is used.
        2) Welded tubular galvanized steel of 16 gage (1.6 mm) wall thickness is not required to use comer blocks or gussets.
    b. Transom Rail (mullion): Accurately machined or accurately fit frame and rigidly welded to side of stiles.
        1) Kick Plate: Rigidly retained in place by steel or aluminum spline.
    c. Glazing Frames: Mitered joints with comer gussets securely staked or brazed at comers.
        1) Inserts: Securely held in door.
        2) Provide positive contact between inserts and master frame to stop passage of insects and to prevent rattling.

d. Screen Inserts: Constructed to withstand performance requirements of ANSI/SMA 6001, Heavy Type.
   1) Screen Frames: Rolled, tubular lock seam construction or extruded aluminum.
e. Adjustable Expander: Installed at bottom of each storm door to receive vinyl sweep.
   1) Adjustment Limit: Minimum 7.9 mm (5/16 inch).
   2) Vinyl Door Sweep: Installed in entire length of expander.
f. Frame Liner (Z-bar): Track to receive weather stripping and necessary installation holes.
   1) Head Section of Frame Liner: Formed to function as drip cap.

21. Dimensions:
   a. Widths across Master Frames:
      1) For Roll Form Door Minimum 70 mm (2-3/4 inches).
      2) For Tubular Doors: Minimum 51 mm (2 inches) with 23.7 mm (15/16 inch) minimum thickness.
   b. Mullion Bar Following minimum widths across:
      1) Roll Form Door 48 mm (1-7/8 inches).
      2) Tubular Door: 23.7 mm (15/16 inch). Frame Liner: Minimum 27 mm (1-1/16 inch) return offset on outside face for side flange width for bearing against door buck. Wall Thickness of Frame Liner: Minimum 1.57 mm (0.062 inch). Storm Door: Supported by adequate reinforcing ribs.
   c. Insert Frame: Maximum 4.8 mm (1/8 inch) overall clearance in width and height and interchangeable in storm doors having same nominal size.
   d. Master Frame Dimensions: Manufacturing tolerance of plus or minus 4.8 mm (1/8 inch).

22. Hardware: Stainless steel, aluminum or other non-corrosive material.
   a. Cadmium or Zinc Plated Steel: ASTM B 633 or ASTM B 766.
   b. Include latch equipped with exterior handle, interior locking mechanism with anti-lockout feature, adjustable heavy duty door closer, necessary screws, and hurricane chain with spring.
   c. Hinges: Install one of following hinge types on each frame liner and storm door:
      1) At least 4 concealed 304 stainless steel hinges on bronze oilite bearings, each minimum 75 mm (3 inches) long.
      2) At least 3 surface-mounted (H) type galvanized steel hinges.

Accessories

23. Joint Sealant: AAMA 800, Type 808.3 Exterior Perimeter Sealing Compound.

Finishes

24. Finish: Baked enamel or polyester poly powder coat applied to phosphatized, zinc impregnated or coated hot dipped galvanized steel.
   a. Finish: Not show fading or corrosion when exposed to salt-spray test specified in this Section.

Source Quality Control

25. Testing: Performed by accredited independent testing laboratory.

EXECUTION

Examination

26. Site Verification of Conditions:
   a. Field Measurements: Verify field measurements are as indicated on Shop Drawings.
   b. Existing Conditions: Examine openings before beginning installation.
   c. Verify that surfaces to receive storm doors are clean.

Preparation

27. Protection: Protect adjacent elements from damage and disfiguration in accordance with Detailed Scope of Work.
    a. Contractor: Responsible for damage to grounds, plantings, buildings and any other facilities or property caused by construction operations.
    b. Repair or replace damaged elements in accordance with Detailed Scope of Work.
28. Existing Storm Doors: Remove existing screen and storm doors and debris from site in accordance with Detailed Scope of Work.
29. Prime Door Jambs of Existing Prime Doors: Prepare as necessary to provide for straight, plumb, level, tight and aesthetically appealing installation of steel storm doors.
    a. Preparatory Work: Include, but not limited to repair of iambs, filling holes and/or dents, removing peeling and scaling paint, etc.

Installation

30. General: Install in accordance with ASTM E 737, manufacturer's recommendations, Reference Standards, and approved Shop Drawings.
    a. Securely fasten doors in place to straight, plumb and level condition, without distortion of door or door frame, and make final adjustments for proper operation and satisfactory weatherstrip contact and seal.
    b. In high wind areas, install storm door hinges on side to prevailing wind as directed.
31. Joint Sealants: Apply in accordance with manufacturers recommendations.
    a. Surfaces to be Sealed: Clean, dry and free of any foreign matter that would degrade adhesion. Remove existing caulking and joint sealants from areas to receive new joint sealant.
    b. Prime cleaned surfaces in accordance with sealant manufacturers recommendations.
    c. Protect surfaces adjacent to joints by masking tape before applying sealant. Remove tape upon finishing sealing work.
    d. Seal joints between perimeter of door frame and underlying or surrounding construction with joint sealant to accomplish weather-tight installation.
    e. Maximum Width of Sealed Joint: 13 mm (1/2 inch).
32. Dissimilar Materials: Isolate materials from incompatible materials as necessary to prevent deterioration.
    a. Separate dissimilar metals with bituminous paint, suitable sealant, nonabsorptive plastic or elastomeric tape, or gasket between surfaces.

Adjusting And Cleaning

33. Adjusting: At completion of job, check, adjust, and lubricate hardware as required and leave storm doors and hardware in proper operating condition.
34. Cleaning: Comply with requirements of Detailed Scope of Work.
    a. Clean storm doors after installation is completed to remove foreign matter and surface blemishes.
    b. Scratched or Abraded Surfaces: Touch-up with rust inhibitor primer and enamel paint compatible with factory finish.

Protection

35. Installed Work: Protect storm doors from damage after installation.

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SECTION 08 11 63 13a - SECURITY WINDOW SCREENS AND DOORS

DESCRIPTION OF WORK

This specification covers the furnishing and installation of materials for security window screens and doors. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

GENERAL

Definitions

1. Type of Screens (Frames and Screening): Light, Medium, and Heavy Types: As defined by and comply with requirements of ANSI/SMA 6001.
2. Supply and Delivery Only: Include supply and delivery to site(s) FOB destination freight prepaid. Unless otherwise specified or scheduled, unloading and handling at site is by Owner.

System Description

3. Performance Requirements: Comply with following:
   a. Screens: Comply with ANSI/SMA 6001 performance requirements for Type specified or scheduled.
      1) Sag Test Described in ANSI/SMA 6001 Paragraph 4.2.4.2: Applicable to vertical or side hinged operable window screens only.
   b. Operable Screens: Tested with emergency egress locking system:
      1) Screens: Meet or exceed ANSI/SMA 6001 performance requirements for Type specified or scheduled.
   c. Security Screen Insert for Storm Doors: Completely assembled screen of 914 mm (36 inches) by 1 524 mm (60 inches) size with necessary braces:
      1) Impact Test: Meet or exceed ANSI/SMA 6001 Paragraph 4.2.4.1 performance requirements for Heavy Type.
   d. Security Screen Doors: Completely assembled screen door measuring at least 914 mm (36 inches) wide by 2 032 mm (80 inches) high with necessary braces and hardware:
      1) Impact Test: Meet or exceed performance requirements of ANSI/SMA 6001 Paragraph 4.2.4.1 for Heavy Type.
      2) Sag Test: Meet or exceed ANSI/AAMA 1102.7 Sag Test.

Submittals

4. Product Data
5. Shop Drawings: Include standard details showing recommendations for installation. Include size of fasteners, maximum dimensions from each end, center-to-center spacing on all four sides, minimum penetration of fasteners into loading material, and maximum clearance between frame and rough opening.
6. Samples: Submit full set of samples of finish colors for color selection.
   a. For Supply and Deliver Only Contract: Submit one full size sample of each type of security window screen and screen door with specified finish for acceptance.
7. Quality Assurance/Control Submittals:
   a. Certificates: Manufacturers written certification that security window screens and door screens meet or exceed ANSI/SMA 6001 and other specified requirements.
   b. Manufacturer's installation instructions.
8. Closeout Submittals:
   a. Operation and maintenance data.
   b. Special warranty.

Quality Assurance

9. Regulatory Requirements:
    a. Egress Requirements: Comply with applicable codes and regulations.
    b. Provide emergency egress, single point locking release, and bit key lock fire entry from exterior as and where required by applicable codes and regulations.
    c. Accessibility:
        1) Architectural Barriers Act of 1968 as amended (42 USC 4152-4157) and HUD implementing regulations (24 CFR Part 40).
            a) Uniform Federal Accessibility Standards (UFAS).
        2) Section 504 of the Rehabilitation Act of 1973 as amended (29 USC 794) and HUD implementing regulations 24 CFR Part 8.
        3) Fair Housing Accessibility Guidelines (24 CFR Chapter 1).
        4) Americans with Disabilities Act of 1990 (ADA) (28 CFR Part 35).
10. Certifications: Comply with ANSI Z34.2.
11. Mock-ups: For Supply and Install Contract: Install one full size mock-up of each type of security window screen and screen door with specified finish for acceptance.
    a. Locations: As directed.
    b. Approved Mock-ups: Standard for rest of work.
    c. Approved Mock-ups: May remain part of completed project.

Delivery, Storage, And Handling

12. Packing, Shipping, Handling, and Unloading: Pack materials at manufacturing plant to prevent damage during shipping.
    a. Screens: Label attached signifying compliance with ANSI/SMA 6001 performance requirements.
13. Acceptance at Site: Inspect screens upon delivery. Replace damaged or defective materials before installation.
14. Storage and Protection: Store screens in manner to protect from weather and other damage.

Project Conditions

15. Field Measurements: Field measure openings for screens before start of fabrication.

Scheduling And Sequencing

16. Scheduling and Completion: Comply with requirements of Detailed Scope of Work.

Warranty

17. Special Warranty: Provide one year written covering materials and installation for security window screens and screen doors.
    a. Warranty: Include coverage of inserts, hardware, and latches.
        1) Screening not included.
        2) Defects resulting from vandalism not included.
    b. For Supply and Delivery Only Contract:
        1) Contractor: Agrees to supply and deliver to Owner, free of charge, any required replacement parts that can be readily installed by Owner without special tools.
        2) Contractor: Agrees to supply and deliver free of charge, complete replacement security window screen or screen door, when defective part or parts cannot be installed without use of special tools.
    c. For Supply and Install Contract:
        1) Contractor: Agrees to supply and install, free of charge, any required replacement parts or complete replacement screen.

PRODUCTS

Security Window Screens And Screen Doors

18. General: Manufactured of commercially accepted materials, free from blemishes, dents, and scratches or any other defects, which are visible when viewed at distance of 1 800 mm (6 ft), or which might otherwise affect their serviceability or appearance.
    a. Screens: Type(s) and size(s) indicated, specified, or scheduled with necessary hardware, anchors, and equipment.
    b. Screens: Label attached signifying compliance with ANSI/SMA 6001 requirements.
19. Framing and Cross Brace Members: Made of material which will provide sufficient strength to meet performance requirements of ANSI/SMA 6001, Types as specified or scheduled.
    a. Thickness: Thickness necessary to provide durability and meet performance requirements.
    b. Material: Steel or aluminum as specified or scheduled complying with applicable Federal Specification or ASTM tests and specifications for chemical, physical or mechanical properties.
    c. Light Type: Mechanical comers acceptable.
    d. Medium and Heavy Type: Provide continuously face welded corner joints.
20. Screening: ANSI/SMA 6001 Section 4.3.1, type 304 stainless steel (carbon steel not allowed), Types as specified and scheduled.
    a. Light Type: Minimum 16 by 16 mesh, 0.46 mm (0.018 inch) diameter.
    b. Medium Type: Minimum 12 by 12 mesh, 0.58 mm (0.023 inch) diameter.
    c. Heavy Type: Minimum 12 by 12 mesh, 0.71 mm (0.028 inch) diameter with tensile (high tensile) strength of 1.43 kg per lineal mm width (800 pounds per linear inch width).
    d. Certification: Provide certificate of compliance with specified requirements.
    e. Assembly: Assembled in secure manner to perform as specified to assure neat construction.
        1) Welding or Brazing Flux: Completely removed immediately upon completion of welding or brazing operation.
    f. Window Screens: Include warning label indicating that screen will not stop child from falling out of window in accordance with SMA 7001.
21. Operable Screens: Frame, or frame and subframe assembly, as required, scribe angles (where required), hinged main frame as required, screening, egress locking system from interior, and concealed hinges.
    a. Screening: Type as specified or scheduled.
    b. Main and Subframes: Steel or extruded aluminum as specified or scheduled and shall conceal locking mechanism from exterior, Type as specified or scheduled.
        1) Aluminum: ANSI/SMA 1004, extruded aluminum.
    c. Operable Screens: May be mounted with vertically or horizontally positioned hinge as indicated.
    d. Operating Hardware: Releasable from interior but properly guarded to prevent access from exterior when window is open.
22. Fixed Screens:
    a. Fixed Frame: Steel or extruded aluminum as specified or scheduled.
    b. Screening: Type as specified or scheduled.
23. Storm Door Screen Inserts: Main frame for application to existing storm door.
    a. Frames: Steel or extruded aluminum as specified or scheduled.
    b. Screening: ANSI/SMA 6001 Heavy Type.
24. Security Screen Doors: Fully assembled pre-hung doors with Z-bar frame, sill expanders with necessary hardware.
    a. Doors Frames: Steel or extruded aluminum as specified or scheduled, ANSI/SMA 6001 Heavy Type.
    b. Screening: ANSI/SMA 6001 Heavy Type.

Aluminum Security Screen Doors

25. Aluminum Screen Doors: Type(s) and size(s) indicated, specified, or scheduled manufactured and provided with prehung aluminum frame line (Z-bar) to fit entrance door apertures requiring frame sizes of 762 mm (30 inches) to 940 mm (37 inches) in width and 2 007 mm (79 inches) to 2 134 mm (84 inches) in height.
    a. Doors: Sized to fit existing openings.

26. Materials:
    a. Master Frame and Mullions: ANSI/SMA 3001, extruded aluminum and minimum 151 kPa (22,000 PSI) tensile strength.
    b. Kick Plate: Embossed or Corrugated Aluminum: Minimum 1.27 mm (0.50 inch) embossed or corrugated thickness, fabricated of minimum 1.02 mm (0.040 inch) thick material.
    c. Screening: Secure by use of aluminum spline integrally mounted and secured with fasteners.
27. Bottom of Door: Provide bottom expander door sweep of non-hardening rubber or extruded vinyl plastic, adjustable to 15.8 mm (5/8 inch).
    a. Bottom Expander: Minimum 1.4 mm (0.055 inch) wall thickness.
28. Door Master Frame Construction: Mitered joint construction and joined at corners by welding or mechanical joints.
    a. Frame Members: Minimum 60 mm (2-3/8 inch) width across flat surface and minimum 31 mm (1-1/4 inch) thickness.
    b. Wall Thickness: Minimum 1.57 mm (0.062 inch).
    c. Mitered Comer Joint Construction: inert gas tungsten arc or heliarc welding to provide screen doors to comply with performance requirements.
        1) Weld: Penetrate on both exterior and interior sides of joint.
        2) Dress weld beads and flat surfaces (edge surfaces not included) to smooth flush surface within satin finish.
        3) Minimum Width of Weld: 9.5 mm (3/8 inch) prior to dressing.
        4) Minimum Penetration of Weld Build-up: Minimum of 2.4 mm (3/32 inch).
    d. Mechanical Comer Joints: Screw boss or gusset construction using screw fasteners standard to manufacturer to provide screen doors to comply with performance requirements.
    e. Master Frame Dimensions: Manufacturing tolerance of plus/minus 4.8 mm (1/8 inch).
    f. Extrusion Tolerances: In accordance with Aluminum Extruded Products Division of Aluminum Association standards.
29. Mullion Bars: Hollow extruded shape designed to permit being used as kick panel mullion or as upper mullion.
    a. Mullion Bars: Minimum 50 mm (2 inch) width across flat surface and minimum 31 mm (1-1/4 inch) thickness.
    b. Wall Thickness: Minimum 1.57 mm (0.062 inch).
    c. Mullions: Accurately machined to fit frame and joined to side stiles by inert gas tungsten arc or heliarc welding or by mechanical clip designed for compatibility.
    d. Dress weld beads down to make smooth flush surface.
    e. Provide main frame and mullion bar with 4.8 mm (3/16 inch) deep grooves to accommodate kick plate.
    f. Utilize weather resisting cement utilized to provide maximum strength and rigidity.
30. Head and Side Z-bars: Designed to receive weatherstripping.
    a. Z-bars: Prepunched installation holes and hinges attached with machine screws.
    b. Head Section: Formed to function as drip cap.
    c. Frame Liner: Z-bar of extruded aluminum, minimum 1.57 mm (0.062 inch) wall thickness.
    d. Weatherstripping: Wool pile or vinyl.
31. Each Door: Three hinges attached to pre-punched Z-bar.
    a. Hinges: Full or 1/2 surface hinges, with three bronze oilite bushings per hinge.

Steel Security Screen Doors

32. Steel Screen Doors: Type(s) and size(s) indicated, specified, or scheduled manufactured of steel and provided with pre-hung aluminum frame liner (Z-bar) to fit entrance door apertures requiring frame sizes of 762 mm (30 inches) to 940 mm (37 inches) in width and 2 007 mm (79 inches) to 2 134 mm (84 inches) in height.
33. Materials:
    a. Master Frame: Not be less than 22 gage (0.85 mm) roll formed steel, or 16 gage (1.6 mm) tubular steel as applicable to hem specified.

b. Kick Plate: At least 18 gage (1.3 mm) embossed galvanized panel for roll formed frame or 16 gage (1.6 mm) flat galvanized steel sheet for tubular steel frame.
c. Screen Insert:
   1) Screening: Secured with fasteners.
   2) Screen Frame: Roll formed or tubular lock seam type formed from not less than 25 gage (0.53 mm) hot dipped galvanized steel or extruded aluminum.
d. Door Sweep Spline: Polyvinyl chloride (PVC) or equal material
e. Frame Liner (Z-bar): Extruded aluminum, 6063 J5.
f. Weatherstripping: Wool pile, or vinyl.

34. Construction:
a. Master Frame: Roll Formed tubular lock-seam construction formed from 22 gage (0.85 mm) hot dipped galvanized steel.
   1) Comers: Either mitered or butt-jointed and rigidly fastened together by brazing or welding. Insert steel gussets at comers of mitered or butt-jointed screen doors when edge brazing is used.
   2) Welded tubular galvanized steel of 16 gage (1.6 mm) wall thickness is not required to use comer blocks or gussets.
b. Transom Rail (mullion): Accurately machined or fit frame and rigidly welded to side of stiles.
   1) Kick Plate: Rigidly retained in place by steel or aluminum spline, or form fitted.
c. Adjustable Expander Installed at bottom of each screen door to receive vinyl sweep.
   1) Adjustment Limit: At least 7.9 mm (5/16 inch).
   2) Vinyl Door Sweep: Installed in entire length of expander.
d. Frame Liner (Z-bar): Track to receive weather stripping and necessary installation holes.
   1) Head Section of Frame Liner Formed to function as drip cap.

35. Dimensions:
a. Widths across Master Frames:
   1) For Roll Form Door: Minimum 70 mm (2-3/4 inches).
   2) For Tubular Doors: Minimum 51 mm (2 inches) with 23.7 mm (15/16 inch) minimum thickness.
b. Mullion Bar: Following minimum widths across:
   1) Roll Form Door: 48 mm (1-7/8 inches).
   2) Tubular Door: 23.7 mm (15/16 inch). Frame Liner: Not less than 27 mm (1-1/16 inch) return offset on outside face for side flange width for bearing against door buck. Wall Thickness of Frame Liner: Minimum 1.57 mm (0.062 inch). Screen Door: Supported adequate reinforcing ribs.
c. Master Frame Dimensions: Manufacturing tolerance of plus or minus 4.8 mm (1/8 inch).

36. Hinges: Install one of following hinge types on each frame liner and screen door:
a. At least four concealed 304 stainless steel hinges on bronze oilite bearings, each minimum 75 mm (3 inches) long.
b. At least three surface-mounted (H) type galvanized steel hinges.

Accessories

37. Hardware: Designed to afford ease of operation, perform functions for which it is intended, and securely attached to screen.
a. Materials: Stainless steel, aluminum, or made corrosion resistant by plating.
   1) Material: Compatible with frame material.
   2) Stainless Steel: Alloys of 302, and 304.
   3) Aluminum: Extrusions from commercially produced 6063-T5 alloy.
   4) Cadmium or Zinc Plated Steel: ASTM B 633 or ASTM B 766.
   5) Plastic parts not allowed.
b. Fasteners: Stainless, cadmium plated, or zinc-plated steel screws, nuts, washers, bolts, and' other miscellaneous fastening devices and hardware.
c. Hinges: Concealed from exterior, with compression guards, and of sufficient strength to comply with performance requirements of ANSI/SMA 6001.

d. Locking System: Non-corrosive materials permitting emergency egress and of sufficient strength to comply with performance requirements of ANSI/SMA 6001.
   1) Provide single point release as and where required by applicable codes and regulations.
   2) Provide bit key lock fire entry from exterior if required by applicable codes and regulations.
   3) Locking Hardware: Remain completely concealed from exterior viewing and tampering with lock bolts positively locked when in thrown position, so that they cannot be operated from direct pressure on bolts.

38. Security Screen Door Hardware: Include latch with exterior handle, interior locking mechanism with anti-lockout feature, adjustable heavy duty door closer, necessary screws, and hurricane chain with spring.
39. Window Screens: Include warning label that screen will not stop child from failing out of window in accordance with SMA 7001.
40. Anchors: Non-magnetic stainless steel or other non-corrosive material compatible with screen.
    a. Anchors Exposed when Screen is Closed and Locked: Non-removable security type.

Finishes

41. Screens: Factory applied baked on enamel or polyester powder coat finish.
    a. Exposed Surfaces: Clean and free from serious surface blemishes.
    b. Dress and finish exposed welded joints.
    c. Color: As selected from manufacturers standard colors.

Source Quality Control

42. Testing: Performed by accredited independent testing laboratory.

EXECUTION

Examination

43. Site Verification of Conditions:
    a. Field Measurements: Verify field measurements are as indicated on Shop Drawings.
    b. Existing Conditions: Examine openings before beginning installation.
    c. Verify that surfaces to receive security screens are clean.
    d. Do not proceed with installation until conditions are satisfactory.

Preparation

44. Protection: Protect adjacent elements from damage and disfiguration in accordance with Detailed Scope of Work.
    a. Contractor: Responsible for damage to grounds, plantings, buildings and any other facilities or property caused by construction operations.
    b. Repair or replace damaged elements in accordance with Detailed Scope of Work.
45. Existing Window Screens and Screen Doors: Remove existing window screens and screen doors and debris from site in accordance with Detailed Scope of Work.
46. Preparation: Prepare openings and existing frames in accordance with ASTM E 737 for storm doors and storm windows.
    a. Existing Window and Door Jambs: Prepare as necessary to provide for straight, plumb, level, tight and aesthetically appealing installation of new window screens and screen doors.
    b. Preparatory Work: Include, but not limited to repair of jambs, filling holes and/or dents, removing peeling and scaling paint, etc.

Installation

47. General: Install in accordance with ASTM E 737 for storm doors and storm windows, manufacturers recommendations, Reference Standards, and approved Shop Drawings.

a. Window Screens and Screen Doors: Securely anchor in place to straight, plumb and level condition, without distortion.

b. Comply with applicable codes and regulations regarding egress requirements and fireman entry.

48. Dissimilar Materials: Isolate materials from incompatible materials as necessary to prevent deterioration.

a. Separate dissimilar metals with bituminous paint, suitable sealant, nonabsorptive plastic or elastomeric tape, or gasket between surfaces.

b. Coat aluminum in direct contact with concrete, masonry, steel, or other non-compatible materials with bituminous paint, zinc chromate primer, or other suitable insulating material.

Adjusting And Cleaning

49. Adjusting: At completion of job, check, adjust, and lubricate hardware as required and leave window screens, screen doors, and hardware in proper operating condition.

50. Cleaning: Comply with requirements of Detailed Scope of Work.

a. Clean window screens and screen doors after installation is completed to remove foreign matter and surface blemishes.

b. Scratched or Abraded Surfaces: Touch-up with rust inhibitor primer and enamel paint compatible with factory finish.

Protection

51. Installed Work: Protect window screens and screen doors from damage after installation.

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SECTION 08 11 63 23 - ALUMINUM STORM DOORS

DESCRIPTION OF WORK

This specification covers the furnishing and installation of materials for aluminum storm doors. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

GENERAL

Definitions

1. Supply and Delivery Only: Include supply and delivery to site(s) FOB destination freight prepaid. Unless otherwise specified or scheduled, unloading and handling at site is by Owner

System Description

2. Performance Requirements: Comply with following:
   a. Aluminum Storm Doors: ANSI/AAMA 1102.7, Performance Class 25 - 1.2 kPa (25 PSF) Design Pressure, 1.8 kPa (37.5 PSF) Test Pressure.
   b. Stainless Steel Screen Insert: Completely assembled screen of 914 mm (36 inches) by 1 524 mm (60 inches) size with necessary braces:
      1) Impact Test: Meet or exceed ANSI/SMA 6001 Paragraph 4.2.4.1 performance requirements for Medium Type.
   c. Aluminum Screen Doors: Completely assembled screen door measuring at least 914 mm (36 inches) wide by 2 032 mm (80 inches) high with necessary braces and hardware:
      1) Impact Test: Meet or exceed performance requirements of ANSI/SMA 6001 Paragraph 4.2.4.1 for Medium Type.
      2) Sag Test: Meet or exceed ANSI/AAMA 1102.7 Sag Test.

Submittals

3. Product Data.
4. Shop Drawings:
   a. Include exploded view of manufactured door, similar to AAMA 1102.7, page 12.
   b. Indicate fabrication of all parts, metal thickness, installation details, fastening, and sealing.
   c. Include sections of typical members and details of latching devices.
5. Samples: Submit full set of finish color samples for color selection.
   a. For Supply and Deliver Only Contract: Submit one full size sample of each type of storm door with specified finish for acceptance.
6. Quality Assurance/Control Submittals:
   a. Certificates: Manufacturers written third party certification that storm doors meet or exceed ANSI/AAMA 1102.7, HUD 39a, and other specified requirements.
   b. Manufacturers installation instructions.
7. Closeout Submittals:
   a. Operation and maintenance data.
   b. Special warranty.

Quality Assurance

8. Regulatory Requirements: Comply with following:
   a. Glazing Materials: Comply with CPSC 16 CFR 1201 or ANSI Z97.1.
   b. Accessibility:
      1) Architectural Barriers Act of 1968 as amended (42 USC 4152-4157) and HUD implementing regulations (24 CFR Part 40).

a) Uniform Federal Accessibility Standards (UFAS).
2) Section 504 of the Rehabilitation Act of 1973 as amended (29 USC 794) and HUD implementing regulations 24 CFR Part 8.
3) Fair Housing Accessibility Guidelines (24 CFR Chapter 1).
4) Americans with Disabilities Act of 1990 (ADA) (28 CFR Part 35).
9. Certifications: Comply with HUD 39a, ANSI Z34.1, and HUD 24 CFR 200.935.
10. Mock-ups: For Supply and Install Contract: Install one full size mock-up of each type of storm door with specified finish for acceptance.
a. Location: As directed.
b. Approved Mock-up: Standard for rest of work.
c. Approved Mock-up: May remain part of completed project.

Delivery, Storage, And Handling
11. Packing, Shipping, Handling, and Unloading: Pack materials at manufacturing plant to prevent damage during shipping.
a. Storm Doors: Label in accordance with HUD UM 39a signifying compliance with ANSI/AAMA 1102.7 performance requirements.
12. Acceptance at Site: Inspect storm doors upon delivery. Replace damaged or defective materials before installation.
13. Storage and Protection: Store storm doors in manner to protect from weather and other damage.

Project Conditions
14. Field Measurements: Field measure openings for storm doors before start of fabrication.

Scheduling And Sequencing
15. Scheduling and Completion: Comply with requirements of Detailed Scope of Work.

Warranty
16. Special Warranty: Provide one year written covering materials and installation for storm doors.
a. Warranty: Include coverage of inserts, closers, chains, hardware, and latches.
1) Screening and glazing not included.
2) Defects resulting from vandalism riot included.
b. For Supply and Delivery Only Contract:
1) Contractor: Agrees to supply and deliver to Owner, free of charge, any required replacement parts that can be readily installed by Owner without special tools.
2) Contractor: Agrees to supply and deliver free of charge, complete replacement door, when defective part or parts cannot be installed without use of special tools.
c. For Supply and Install Contract:
1) Contractor: Agrees to supply and install, free of charge, any required replacement parts or complete replacement storm door.

PRODUCTS

Aluminum Storm And Screen Doors
17. Storm Doors: Type(s) and size(s) indicated, specified, or scheduled with mechanical or welded comer construction complete with tempered glass or plastic glazing inserts where storm glazing is specified or scheduled, screen inserts where specified or scheduled, durable metal kick panel, push plate, adjustable bottom expander with sill sweep, necessary hardware, fasteners, and miscellaneous equipment.
a. Screen Doors: Meet or exceed Performance Requirements in this Section.
b. Storm Doors: Meet or exceed applicable requirements of AAMA/ANSI 1102.7, Performance Class 60 and HUD UM 39a.
c. Storm Doors: Self-storing or seasonal replacement as specified or scheduled.

d. Door Construction: Not necessary to remove door from its installed position to reglaze, rescreen, or replace kick plate, push plate, or protective grille.
e. Glazed Sash and Glazing Materials: Permit reglazing without special tools.
f. Doors: Sized to fit existing openings.

18. Finished Master Frame, Extruded Screen Insert Frame and Z-bar: Minimum 1.4 mm (0.055 inch) wall thickness.
    a. Z-bar: Adequate reinforcing ribs to support door.
19. Glazing Materials: Comply with CPSC 16 CFR 1201 or ANSI Z97.1.
    a. Tempered Glass: ASTM C 1048, Kind FT, Condition A, Type 1, Class 1, Glazing B Quality.
    b. Plastic: Extruded polycarbonate clear sheets, minimum 4.5 mm (0.177 inch) thick with following characteristics:
        1) Impact Resistance: ASTM D 256, Method A, 12-18 foot-pound per inch.
        2) Elongation/Modulus of Elasticity: ASTM D 638, 110 percent maximum/340,000 PSI.
        3) Heat Deflection: ASTM D 648, 132.2 degrees C (270 degrees F) at 264 PSI.
        4) Abrasion Resistance: Coated on both surfaces to produce abrasion resistance of 3-19 percent maximum haze increase for 500 revolutions of CS-1 OF wheel per ASTM D 1044.
    c. Glass Thickness: In accordance with AAMA 1002.10 Appendix, minimum 5 mm (3/16 inch).
        1) Design Wind Pressures: Determined in accordance with applicable codes and regulations.
    d. Glass: Labeled to show name of manufacturer and type.
    e. Glazing Material: Installed in rigid removable aluminum sub-frame.
20. Screens: Manufacturer's standard design.
    a. Screens Not Part of Door Frame: Extruded aluminum frames, of suitable alloy, and of sufficient rigidity, crossbraced as required, to lie flat against door and to prevent excessive bow in frame members and sag in screening.
        1) Screen Spline: Firmly jointed in secure manner.
    b. Screening: Aluminum Wire Fabric: One of following as specified or scheduled:
        1) Regular Aluminum: FS RR-W-365, Type VII, 18 x 16 or 18 by 18 regular, 0.28 mm (0.011 inch) wire.
        2) Heavy Aluminum: FS RR-W-365, Type VII, 18 x 14 regular, 0.33 mm (0.013 inch) wire.
    c. When screen is completely assembled with insect screening and spline in place, outside dimension as measured from midpoint of opposite framing members shall not vary more than 4.8 mm (3/16 inch) from outside dimension as measured at extreme ends of such framing members.
    d. Screening: Fastened to frame in manner to permit replacement of screening.
21. Stainless Steel Screen: As specified or scheduled:
    a. Screen Frames: Rolled, tubular lock seam construction formed from not less than 25 gage (0.53 mm) hot-dipped galvanized steel or 0.66 mm (0.026 inch) minimum aluminum extruded 6063-T5 alloy (with galvanic protection).
    b. Screening: Stainless Steel: ANSI/SMA 6001 Medium Type, 12 x 12 mesh stainless steel with wire diameter of 0.58 mm (0.023 inch).
    c. Provide screen with fastening devices for application to specific windows for which they are intended and of sufficient strength to perform satisfactorily.
22. Bottom of Door: Provide bottom expander door sweep of non-hardening rubber or extruded vinyl plastic, adjustable to 15.8 mm (5/8 inch).
    a. Bottom Expander: Minimum 1.4 mm (0.055 inch) wall thickness.
23. Kick Plate: Embossed or Corrugated Aluminum: Minimum 1.27 mm (0.50 inch) embossed or corrugated thickness, fabricated of minimum 1.02 mm (0.040 inch) thick material.
24. Hardware: Aluminum, stainless steel, or other non-corrosive materials compatible with aluminum.
    a. Cadmium or Zinc Plated Steel: ASTM B 633 or ASTM B 766.
    b. Include latch with exterior handle and interior locking mechanism with anti-lockout feature, adjustable heavy duty door closer, necessary screws, hurricane chain with spring.
    c. Each Door: 3 hinges attached to Z-bar.

d. Hinges: Full or 1/2 surface hinges, with 3 bronze bushings per hinge.

25. Optional Accessories:
    a. Optional Protective Grille: Perforated aluminum sheet, 0.61 mm (0.24 inches) minimum thickness, riveted or screwed to door frame to completely cover exterior of screen.
    b. Optional Pushplate: Embossed aluminum strip 150 mm (6 inches) high, 1.02 mm (0.040 inch) minimum thickness.
        1) Overall Height of Mullions and Pushplate: Minimum of 200 mm (8 inches) and installed opposite and centered with latch.

Hollow Core Aluminum Storm Doors

26. Door: Hollow extruded smooth surface master frame, 2 hollow extruded smooth surface mullion or cross bars; 2 extruded screen frame inserts, extruded side and head Z-bars, and extruded external telescoping bottom expander.
    a. Extrusions: Manufactured from 6063-T5 extruded aluminum alloy, minimum 1.57 mm (0.062 inch) thick, minimum 151 600 kPa (22,000 PSI) tensile strength.
    b. Glazing Strip, Bottom Sweep, Screening Spline and Z-bar Seal: Virgin polyvinyl plastic.
27. Door Master Frame Comer Construction: Mitered joint construction and joined at comers by welding or mechanical joints.
    a. Mitered Comer Joint Construction: Inert gas tungsten arc or heliarc welding to provide storm doors to comply with performance requirements.
        1) Weld: Penetrate on both exterior and interior sides of joint.
        2) Dress weld beads and flat surfaces (edge surfaces not included) to smooth flush surface within satin finish.
        3) Minimum Width of Weld: 9.5 mm (3/8 inch) prior to dressing.
        4) Minimum Penetration of Weld Build-up: Minimum of 2.4 mm (3/32 inch).
    b. Mechanical Comer Joints: Screw boss or gusset construction using screw fasteners standard to manufacturer to provide storm doors to comply with Performance Requirements in this Section.
28. Mullion Bars: Hollow extruded shape designed to permit being used as kick panel mullion or as upper mullion.
    a. Mullions: Accurately machined to fit frame and joined to side stiles by inert gas tungsten arc or heliarc welding.
    b. Dress weld beads down to make smooth flush surface.
    c. Provide top surface of extrusions for both center and bottom mullion bars with channel to accommodate inserts.
    d. Provide main frame and mullion bar with 4.8 mm (3/16 inch) deep grooves to accommodate kick plate.
    e. Utilize weather resisting cement utilized to provide maximum strength and rigidity and rattle proof operation.
    f. Bottom Mullion Bar: Receive top of kick plate.
    g. Mullion Bar: Same thickness as frame and have minimum 50 mm (2 inch) face.
29. Head and Side Z-bars: Designed to receive vinyl plastic closure strip for maximum seal against air and dust infiltration.
    a. Head Z-bar: Designed and extruded to also function as drip cap over top of door.
    b. Z-bars: Prepunched installation holes and hinges attached with machine screws.
30. Finished Master Frame: Minimum 60 mm (2-3/8 inch) width across flat surface and minimum 25 mm (1 inch) thickness.
    a. Mullion Bars: Minimum 50 mm (2 inch) width across flat surface and minimum 25 mm (1 inch) thickness.
    b. Wall Thickness: Minimum 1.4 mm (0.055 inch).
    c. Extruded Screen Insert Frames: 19 mm (3/4 inch) wide, minimum 7.9 mm (5/16 inch) thick, and minimum 1.57 mm (0.062 inch) wall thickness.
    d. Z-bars: Minimum 1.4 mm (0.055 inch) wall thickness plus adequate reinforcing ribs to support door.

e. Insert Frame: Fabricated to have minimum overall clearance of 4.8 mm (1/8 inch) in width and height, and interchangeable in doors of same nominal size.
f. Master Frame Dimensions: Manufacturing tolerance of plus/minus 4.8 mm (1/8 inch).
g. Extrusion Tolerances: In accordance with Aluminum Extruded Products Division of Aluminum Association standards.

31. Glazing Insert Frames: Extruded with mitered joint construction secured at comers by staking into comer gussets.
    a. Inserts: Equal height making them interchangeable on doors with upper and lower openings.
    b. Inserts: Held in door by aluminum clips and machine screws.
    c. Install maximum of 6 rivnuts into door per insert.
    d. Install rivnuts in master frame, 2 on each side and top of each insert, located not to interfere with installation of door closer or safety chain.
    e. Insert: Positive contact with master frame to stop passage of insects and prevent rattling.
32. Screening Insert Frames: Extruded tubular with mitered joint construction and secured at comers by staking into comer gussets.
    a. Make square comer gussets of 0.46 mm (0.180 inch) minimum extruded aluminum to fit firmly against extruded insert frames to minimize twist and distortion.
    b. Insert screening into groove provided in frame and secure by vinyl spline.
    c. Inserts in Doors with Upper and Lower Openings: Equal height making them interchangeable, and secured into master frame by same method as specified for glazed inserts.
33. Hinges: 3 knuckle construction, not less than 98 mm (3-7/8 inches) in length, with minimum of 3 prepunched screw holes in hinge leaf of minimum thickness 0.31 mm (0.120 inch) plus adequate longitudinal reinforcing ribs to support door.
    a. Each Door: Supported with not less than 4 built-in type hinges employing raised knuckle on extruded Z-bar to receive half-extruded aluminum hinge leaf joined at knuckle by using 2 stainless steel or cadmium plated steel pins pivoting through oilite or nylon bushings.
    b. Pins: Held securely in place by cadmium plated steel compression springs.
    c. Hinge: Allow door to open 180 degrees.

Solid Core (Laminated) Storm Door

34. Materials:
    a. Main Frame and Glass Edge Surround Members (if not part of main frame): Aluminum of sufficient strength to comply with performance requirements of ANSI/AAMA 1102.7.
    b. Reinforcing Members: Aluminum or other non-corrosive materials compatible with aluminum.
        1) Carbon Steel: Cadmium or zinc-plated in accordance with ASTM B 633 or ASTM B 766.
35. Finished Master Frame: Extruded screen insert frame and Z-bar minimum 1.4 mm (0.055 inch) wall thickness.
    a. Z-bar: Adequate reinforcing ribs to support door.
36. Door: Laminated construction consisting of minimum 19.1 mm (3/4 inch) thick particle board, grade 1-M-3 with seamless aluminum skins bonded together.
    a. Particle Board Core Material: Completely sealed with polyurethane for moisture protection.
    b. Ureaformaldehyde binders not allowed.
37. Screws, Nuts, Washers, Bolts, Rivets and Other Fastening Devices: Aluminum, stainless steel or other non-corrosive materials compatible with aluminum.
    a. Cadmium or Zinc-plated Steel: ASTM B 633 or ASTM B 766.
38. Weatherstrip: Weatherstrip Z-bars with woven pile so that there is no metal to metal contact between main frame and Z-bar.
    a. Install weatherstripping in specially extruded ports and in accordance with AAMA 701.2.
39. Anti-galling Devices: Non-corrosive materials compatible with aluminum and of sufficient strength to perform as designed.

Accessories

40. Joint Sealant: AAMA 800, Type 808.3 Exterior Perimeter Sealing Compound.

Finishes

41. Finish:
    a. Aluminum Finish: Provide one of following as specified or scheduled:
        1) Factory applied pigmented organic coating, AAMA 603.8.
            a) Color: As selected from manufacturer's standard colors.
        2) Clear Anodized: Factory applied anodic coating, AAMA 607.1, Class 1.
    b. Exposed Surfaces of Aluminum Members: Clean and free from serious surface blemishes.
    c. Dress and finish exposed welded joints.

Source Quality Control

42. Testing: Performed under Third Party Administrator in compliance with HUD 39a, ANSI Z34.1, and HUD 24 CFR 200.935.

EXECUTION

Examination

43. Site Verification of Conditions:
    a. Field Measurements: Verity field measurements are as indicated on Shop Drawings.
    b. Existing Conditions: Examine openings before beginning installation.
    c. Verity that surfaces to receive storm doors are clean.
    d. Do not proceed with installation until conditions are satisfactory.

Preparation

44. Protection: Protect adjacent elements from damage and disfiguration in accordance with Detailed Scope of Work.
    a. Contractor: Responsible for damage to grounds, plantings, buildings and any other facilities or property caused by construction operations.
    b. Repair or replace damaged elements in accordance with Detailed Scope of Work.
45. Existing Storm Doors: Remove existing screen and storm doors and debris from site in accordance with Detailed Scope of Work.
46. Preparation: Prepare openings and existing frames in accordance with ASTM E 737.
    a. Prime Door Jambs of Existing Prime Doors: Prepare as necessary to provide for straight, plumb, level, tight and aesthetically appealing installation of new storm doors.
    b. Preparatory Work: Include, but not limited to repair of jambs, filling holes and/or dents, removing peeling and scaling paint, etc.

Installation

47. General: Install in accordance with ASTM E 737, manufacturer's recommendations, Reference Standards, and approved Shop Drawings.
    a. Securely fasten storm doors in place to straight, plumb and level condition, without distortion of door or door frame, and make final adjustments for proper operation and satisfactory weatherstrip contact and seal.
    b. In high wind areas, install storm door hinges on side to prevailing wind as directed.
48. Joint Sealants: Apply in accordance with manufacturer's recommendations.
    a. Surfaces to be Sealed: Clean, dry and free of any foreign matter that would degrade adhesion. Remove existing caulking and joint sealants from areas to receive new joint sealant.
    b. Prime cleaned surfaces in accordance with sealant manufacturer's recommendations.
    c. Protect surfaces adjacent to joints by masking tape before applying sealant. Remove tape upon finishing sealing work.
    d. Seal joints between perimeter of storm door frame and underlying or surrounding construction with joint sealant to accomplish weather-tight installation.

e. Maximum Width of Sealed Joint: 13 mm (1/2 inch).

49. Dissimilar Materials: Isolate materials from incompatible materials as necessary to prevent deterioration.
    a. Separate dissimilar metals with bituminous paint, suitable sealant, nonabsorptive plastic or elastomeric tape, or gasket between surfaces.
    b. Coat aluminum in direct contact with concrete, masonry, steel, or other non-compatible materials with bituminous paint, zinc chromate primer, or other suitable insulating material.

Adjusting And Cleaning

50. Adjusting: At completion of job, check, adjust, and lubricate hardware as required and leave storm doors and hardware in proper operating condition.
51. Cleaning: Comply with requirements of Detailed Scope of Work.
    a. Clean storm doors after installation is completed to remove foreign matter and surface blemishes.
    b. Scratched or Abraded Surfaces: Touch-up with rust inhibitor primer and enamel paint compatible with factory finish.

Protection

52. Installed Work: Protect storm doors from damage after installation.

END OF SECTION 08 11 63 23

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SECTION 08 11 73 00 - SLIDING METAL FIRE DOORS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for sliding metal fire doors. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Single-leaf, power-operated and manually operated sliding door with or without pass door.
b. Biparting, power-operated and manually operated sliding door with or without pass door.
c. Multiple-leaf, power-operated and manually operated sliding door with or without pass door.

C. Performance Requirements
1. Structural Performance: Provide horizontal sliding doors capable of withstanding the effects of gravity loads and the following loads and stresses without evidencing permanent deformation of door components:
a. Wind Load: Uniform pressure (velocity pressure) of 20 lbf/sq. ft. (960 Pa), **unless required otherwise by the location of the work**, acting inward or outward.

D. Submittals
1. Product Data: For each type of product indicated.
a. Fire-Rated Doors: Include description of fire-release system including testing and resetting instructions.
2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
3. Product Certificates: For sliding metal fire doors, signed by product manufacturer.
4. Oversize Construction Certification: For door assemblies required to be fire rated and that exceed size limitations of labeled assemblies, signed by authorized representative of testing agency.
5. Operation and Maintenance Data: For sliding metal fire doors to include in emergency, operation, and maintenance manuals.

E. Quality Assurance
1. Fire-Rated Sliding Door Assemblies: Provide assemblies complying with NFPA 80 that are identical to door assemblies tested for fire-test-response characteristics according to NFPA 252 or UL 10B, and that are listed and labeled for fire ratings indicated by UL, FMG, ITS, or another testing agency acceptable to authorities having jurisdiction.
a. Test Pressure: Test at as close to neutral pressure as possible.
b. Oversize Fire-Rated Sliding Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a testing agency acceptable to authorities having jurisdiction that doors comply with all standard construction requirements of tested and labeled fire-rated door assemblies except for size.
c. Provide units with labels showing 250 deg F (139 deg C) **OR** 450 deg F (250 deg C) **OR** 650 deg F (361 deg C), **as directed**, temperature-rise ratings.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.2 PRODUCTS

A. Materials
1. Cold-Rolled Steel Sheets: ASTM A 1008/A 1008M, Commercial Steel (CS), or Drawing Steel (DS), Type B, exposed, matte finish.
2. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B, with A60 (ZF180) **OR** A90 (ZF275), **as directed**, zinc-iron-alloy (galvannealed) coating or G90 (Z275) **OR** G60 (Z180), **as directed**, zinc coating; restricted flatness.
3. Stainless-Steel Sheets: ASTM A 240/A 240M, Type 304 **OR** 316, **as directed**; stretcher-leveled standard of flatness; No. 4 satin **OR** 6 dull, **as directed**, finish.
4. Hardware and Fasteners: Manufacturer's standard units **OR** Hot-dip galvanize per ASTM A 153/A 153M where items are used on galvanized steel exterior doors **OR** Stainless steel **OR** Stainless steel where indicated, **as directed**.

B. Sliding Metal Fire Doors
1. Overhead-Supported Doors: Provide composite **OR** hollow-metal **OR** tubular-frame, **as directed**,-type construction fire door assemblies with wall-mounted overhead track support and the following fire-protection rating and panel facing sheet material and thickness:
2. Bottom-Support Doors: Provide bottom-support, tubular-frame-type construction fire door assemblies with floor track, top guides, and the following fire-protection rating, temperature-rise rating, and face sheet material and thickness:
   a. Fire-Protection Rating: 4 hours **OR** 3 hours **OR** 1-1/2 hours **OR** 3/4 hour **OR** As indicated, **as directed**.
   b. Panel Facing:
      1) Steel: 0.033-inch (0.8-mm) **OR** 0.043-inch (1.1-mm) **OR** 0.053-inch (1.35-mm) **OR** 0.067-inch (1.7-mm), **as directed**, minimum thickness.
      2) Metallic-Coated Steel: 0.040-inch (1.0-mm) **OR** 0.052-inch (1.3-mm) **OR** 0.064-inch (1.6-mm) **OR** 0.079-inch (2.0-mm), **as directed**, nominal thickness.
      3) Stainless Steel: 0.038-inch (0.96-mm) **OR** 0.050-inch (1.3-mm) **OR** 0.062-inch (1.57-mm) **OR** 0.078-inch (1.98-mm), **as directed**, nominal thickness.
3. Operating Hardware: Manufacturer's standard, labeled, automatic-closing-type, sliding fire door assemblies complete with track, adjustable roller guides, binders, floor stops, cables, sheaves, counterweights, and fusible links. Furnish necessary hangers, fittings, and fasteners required for attaching hardware to door and for door sliding operation, including latch or handle for manual operation. Provide hot-dip galvanized steel **OR** electrogalvanized steel **OR** factory-prime-painted steel **OR** stainless-steel, **as directed**, hardware.
4. Weight Boxes: 0.064-inch- (1.6-mm-) thick, metallic-coated steel counterweight boxes or guards; size as required for counterweights and clearance.
5. Crush Plates: 3/16-inch-thick by 6-inch-wide (4.8-mm-thick by 150-mm-wide), continuous steel plates on hollow concrete masonry walls.
6. Track Hood: Formed, metallic-coated steel sheet **OR** stainless-steel, **as directed**; size as required for clearance and to protect tracks on exterior installations.
7. Weather Stripping: UL-classified, brush-style weather stripping with attachments for mounting at head, jambs, and bottom surface of door.
8. Motorized Operator: UL-approved, high-starting torque, reversing motor and adjustable speed operator with thermal-overload protection. Include fusible-link release to disengage operator and to allow door to close automatically.
   a. Design operator for current characteristics of electrical service supplied. Provide UL-listed, 1/2-hp, 208- to 230-V ac, single-phase **OR** 208-V ac, 3-phase **OR** 220-V ac, 3-phase **OR** 480-V ac, 3-phase, **as directed**, 60-cycle motor with NEMA 250, Type 1 enclosure and 24-V ac, secondary control voltage.
   b. Equip door for completely automatic operation with clutch, speed reducer, brake, limit switches, electric reverse edge, brackets, bolts, and release for manual operation. Control equipment includes two pull cords **OR** two 3-button control stations with push buttons labeled "OPEN," "CLOSE," and "STOP" **OR** two motion detectors **OR** two loop detectors

OR two photoelectric obstruction detectors **OR** time delay for closing, **as directed**, and electric interlock for pass door.

9. Interconnecting Device: Device for connecting fusible links for doors on both sides of wall.
10. Door Release Devices: Electromagnetic release devices compatible with smoke detectors or building's fire alarm system.
11. Fire Detection: Provide early warning, photoelectric smoke detectors or ionization detectors to be coupled to electromagnetic door release devices.
12. Pass Door: UL-listed swing door and frame.
13. Pass Door Hardware: Factory installed with one and one-half pairs of mortise spring hinges **OR** butt hinges and closer, **as directed**, and mortise latchset **OR** mortise lock **OR** exit device **OR** panic device, **as directed**.
    a. Provide hardware complying with Division 08 Section "Door Hardware".
14. Vision Panels: Factory fabricated in door with integral removable glass stops. Provide UL-approved, wired glass panels or other fire-resistive glazing product acceptable to authorities having jurisdiction; do not exceed area allowed for door rating.

C. Fabrication
1. Composite-Type Doors: Fabricate in modular panels. Bond face materials to both sides of core and reinforce perimeter with minimum 0.043-inch- (1.1-mm-) thick, internal steel channel. Encase panel edges with minimum 0.067-inch- (1.7-mm-) thick, steel channel. Back joints in face sheets with minimum 0.043-inch- (1.1-mm-) thick, steel H column. Connect panels with H column and cover plate. Attach armor edges and astragals to doors.
2. Hollow-Metal Doors: Bond face materials to both sides of core and reinforce perimeter with minimum 0.043-inch- (1.1-mm-) thick, internal steel channel. Back joints in face sheets with minimum 0.043-inch- (1.1-mm-) thick, steel H column. Weld and fill joints and grind exposed welds smooth. Attach armor edges and astragals to doors.
3. Tubular-Frame Doors: Fabricate perimeter frame and internal stiffeners of minimum 0.043-inch- (1.1-mm-) thick steel tubes. Miter corner joints in frame and weld frame and stiffener joints. Locate joints in face sheets over stiffeners. Weld and fill joints and grind exposed welds smooth. Attach armor edges and astragals to doors.
4. Core Construction: Provide core materials complying with fire-protection-rating and temperature-rise requirements.
    a. Resin-impregnated honeycomb.
    b. Mineral-fiber board.
    c. Urethane.
    d. Fiberglass.
    e. Calcium silicate
    f. Inorganic mineral.
    g. Manufacturer's standard.

D. Steel Finishes
1. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Preparation for Shop Priming: After galvanizing, thoroughly clean metal of grease, dirt, oil, flux, and other foreign matter, and treat with metallic-phosphate pretreatment.
3. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of sliding metal fire doors:
    a. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
    b. Interiors (SSPC Zone 1A): SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
4. Prime Finish: Immediately after cleaning and pretreating, apply manufacturer's standard rust-inhibiting primer on **OR** zinc-rich primer on metallic-coated, **as directed**, steel doors for field painting.
5. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat. Comply with

paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).

a. Color and Gloss: As selected from manufacturer's full range.

1.3 EXECUTION

A. Installation

1. Install sliding metal fire doors according to NFPA 80 and manufacturer's written instructions for type of door operation indicated and fire-protection rating required.
   a. Interface fire-detection devices with building's fire alarm system.
2. Drill necessary holes cleanly, with no broken areas or spalls, for installation of fasteners in concrete or masonry. Remove and replace damaged masonry as directed.

B. Adjusting And Cleaning

1. Operate sliding metal fire doors on completion of installation to ensure satisfactory operation. Check moving parts for proper alignment and lubrication. Make adjustments for smooth, easy operation.
   a. Test door closing when activated by detector or alarm-connected, fire-release system. Reset door-closing mechanism after successful test.
2. Clean surfaces and refinish abraded or damaged surfaces to match factory finish.

END OF SECTION 08 11 73 00

SECTION 08 12 13 13 - STAINLESS STEEL DOORS AND FRAMES

1.1 GENERAL

A. Description
1. This specification covers the furnishing and installation of stainless steel doors and frames. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Stainless-steel, hollow-metal doors and panels.
   b. Stainless-steel, hollow-metal frames.

C. Submittals
1. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, fire-resistance rating, temperature-rise ratings, and finishes.
2. Shop Drawings: Include the following:
   a. Elevations of each door design.
   b. Details of doors, including vertical and horizontal edge details and metal thicknesses.
   c. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
   d. Locations of reinforcement and preparations for hardware.
   e. Details of each different wall opening condition.
   f. Details of anchorages, joints, field splices, and connections.
   g. Details of accessories.
   h. Details of moldings, removable stops, and glazing.
   i. Details of conduit and preparations for power, signal, and control systems.
3. Samples:
   a. Finishes: For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches (75 by 125 mm).
   b. Doors: Include section of vertical-edge, top, and bottom construction; core construction; glazing; and hinge and other applied hardware reinforcement.
   c. Frames: Show profile, corner joint, floor and wall anchors, and silencers. Include separate section showing fixed hollow-metal panels and glazing if applicable.
4. Schedule: Provide a schedule of stainless-steel, hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with a door hardware schedule.
5. Oversize Construction Certification: For assemblies required to be fire rated and exceeding limitations of labeled assemblies.
6. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of stainless-steel, hollow-metal door and frame assembly.

D. Quality Assurance
1. Source Limitations: Obtain stainless-steel, hollow-metal work from single source from single manufacturer.
2. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
   a. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
   b. Temperature-Rise Limit: Where indicated **OR** At vertical exit enclosures and exit passageways, **as directed**, provide doors that have a maximum transmitted temperature

end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.

3. Smoke- and Draft-Control Door Assemblies: Where indicated **OR** At corridors, smoke barriers, and smoke partitions, **as directed**, provide assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
   a. Air Leakage Rate: Maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) at the tested pressure differential of 0.3-inch wg (75 Pa) of water.
4. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies that are listed and labeled, by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9. Label each individual glazed lite. Install in compliance with NFPA 80.
5. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
1. Deliver doors and frames palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
2. Shipping Spreaders: Deliver welded frames with two removable spreader bars across bottom of frames, tack welded or mechanically attached to jambs and mullions.
3. Store doors and frames under cover at Project site. Place units in a vertical position with heads up, spaced by blocking, on minimum 4-inch- (100-mm-) high wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber.
   a. If wrappers on doors become wet, remove cartons immediately. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation.

F. Project Conditions
1. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

G. Coordination
1. Coordinate installation of anchorages for stainless-steel frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.2 PRODUCTS

A. Stainless-Steel Doors
1. Description: Stainless-steel doors, not less than 1-3/4 inches (44 mm) thick, of seamed **OR** seamless, **as directed**, hollow-metal construction. Construct doors with smooth, flush surfaces without visible joints or seams on faces.
   a. Face Sheets: Fabricate from 0.050-inch- (1.27-mm-) **OR** 0.062-inch- (1.59-mm-) **OR** 0.078-inch- (1.98-mm-), **as directed**, thick, stainless-steel sheet.
   b. Core Construction: Fabricate doors with core indicated.
      1) Welded Steel-Stiffened Core: 0.031-inch- (0.79-mm-) thick, stainless-steel **OR** 0.030-inch- (0.76-mm-) nominal thickness uncoated steel **OR** 0.034-inch- (0.86-mm-) nominal thickness metallic-coated steel, **as directed**, vertical stiffeners extending full-door height, spaced not more than 6 inches (152 mm) apart, spot welded to face sheets a maximum of 5 inches (127 mm) o.c. Fill spaces between stiffeners with mineral-fiber insulation.
      2) Laminated Core: Honeycomb of resin-impregnated kraft paper with maximum 1-inch (25.4-mm) cells or foam-plastic insulation fastened to face sheets with waterproof adhesive.
         a) Foam-Plastic Insulated Doors: Thermal-resistance value (R-value) of not less than 4.0 deg F x h x sq. ft./Btu (0.704 K x sq. m/W) **OR** 6.0 deg F x h x sq.

ft./Btu (1.057 K x sq. m/W) **OR** 12.3 deg F x h x sq. ft./Btu (2.166 K x sq. m/W), **as directed**, when tested according to ASTM C 1363.

i. Locations: Exterior doors and interior doors, where indicated.

3) Laminated Steel-Stiffened Core: 0.031-inch- (0.79-mm-) thick, stainless-steel **OR** 0.030-inch- (0.76-mm-) nominal thickness uncoated steel **OR** 0.034-inch- (0.86-mm-) nominal thickness metallic-coated steel, **as directed**, vertical stiffeners extending full-door height, spaced not more than 6 inches (152 mm) apart, fastened to face sheets with waterproof adhesive. Fill spaces between stiffeners with mineral-fiber insulation.

4) Fire-Rated Door Core: As required to provide fire-protection and temperature-rise ratings indicated.

c. Vertical Edges for Single-Acting Doors: Beveled 1/8 inch in 2 inches (3 mm in 50 mm).

d. Vertical Edges for Double-Acting Doors: Round vertical edges with 2-1/8-inch (54-mm) radius.

e. Moldings for Glazed Lites in Doors: 0.038-inch- (0.95-mm-) thick stainless steel.

f. Loose Stops for Glazed Lites in Doors: 0.038-inch- (0.95-mm-) thick stainless steel.

g. Top and Bottom Channels: Closed with continuous channels, 0.062-inch- (1.59-mm-) thick stainless steel **OR** 0.060-inch- (1.52-mm-) nominal thickness uncoated steel **OR** 0.064-inch- (1.63-mm-) nominal thickness metallic-coated steel, **as directed**.

1) Spot welded to both face sheets.
OR
Securely fastened using adhesive.

h. Hardware Reinforcement: Fabricate according to ANSI/NAAMM-HMMA 866 with reinforcing plates from stainless **OR** uncoated **OR** metallic-coated, **as directed**, steel.

i. Electrical Hardware Enclosures: Provide enclosures and junction boxes within doors for electrically operated door hardware, interconnected with UL-approved, 1/2-inch- (12.7-mm-) diameter conduit and connectors.

1) Where indicated for installation of wiring, provide access plates to junction boxes, fabricate from same material and thickness as face sheet and fasten with at least four security fasteners spaced not more than 6 inches (152 mm) o.c.

2. Performance: Level A, ANSI A250.4.

3. Materials:

a. Stainless-Steel Sheet: ASTM A 240/A 240M, austenitic stainless steel, Type 304 **OR** Type 316 **OR** Type 317LMN **OR** 904L, **as directed**.

b. Steel Sheet: ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, Commercial Steel (CS), Type B.

c. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

d. Foam-Plastic Insulation: Manufacturer's standard polystyrene **OR** urethane, **as directed**, board insulation with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84. Enclose insulation completely within door.

e. Mineral-Fiber Insulation: Insulation composed of rock-wool fibers, slag-wool fibers, or glass fibers.

4. Stainless-Steel Finishes:

a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

b. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1) Run grain of directional finishes with long dimension of each piece.

2) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

3) Directional Satin Finish: No. 4.

4) Dull Satin Finish: No. 6.

5) Mirrorlike Reflective, Nondirectional Polish: No. 8.

c. Bright, Cold-Rolled, Unpolished Finish: No. 2B. Factory primed for field finish, **as directed**.

B. Stainless-Steel Panels
1. Provide stainless-steel panels of same construction, materials, and finish as specified for adjoining stainless-steel doors.

C. Stainless-Steel Frames
1. Description: Fabricate stainless-steel frames of construction indicated, with faces of corners mitered and contact edges closed tight.
   a. Door Frames: Machine mitered, faces only welded **OR** Saw mitered and full (continuously) welded **OR** Machine mitered and full welded **OR** Knock down **OR** Slip on **OR** As indicated, **as directed**.
      1) Weld frames according to HMMA 820.
   b. Sidelight, Transom and Borrowed-Light Frames: Machine mitered, faces only welded **OR** Saw mitered and full (continuously) welded **OR** Machine mitered and full welded, **as directed**.
   c. Door Frames for Openings 48 Inches (1219 mm) Wide or Less: Fabricate from 0.062-inch- (1.59-mm-) **OR** 0.078-inch- (1.98-mm-) **OR** 0.109-inch- (2.78-mm-), **as directed**, thick, stainless-steel sheet.
   d. Door Frames for Openings More Than 48 Inches (1219 mm) Wide: Fabricate from 0.078-inch- (1.98-mm-) **OR** 0.109-inch- (2.78-mm-), **as directed**, thick, stainless-steel sheet.
   e. Borrowed-Light Frames: Fabricate from 0.062-inch- (1.59-mm-) **OR** 0.078-inch- (1.98-mm-) **OR** 0.109-inch- (2.78-mm-), **as directed**, thick, stainless-steel sheet.
   f. Sidelight and Transom Frames: Fabricate from stainless-steel sheet of same thickness as adjacent door frame.
   g. Glazing and Panel Stops: Formed integral with stainless-steel frames, minimum 5/8 inch (16 mm) high, unless otherwise indicated.
   h. Loose Stops for Glazed Lites and Panels: 0.038-inch- (0.95-mm-) thick stainless steel.
   i. Hardware Reinforcement: Fabricate according to ANSI/NAAMM-HMMA 866 with reinforcing plates from stainless **OR** uncoated **OR** metallic-coated, **as directed**, steel.
   j. Head Reinforcement: 0.109-inch- (2.78-mm-) thick, stainless-steel channel or angle stiffener for openings widths more than 48 inches (1219 mm).
   k. Jamb Anchors:
      1) Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.062-inch- (1.59-mm-) thick stainless steel **OR** 0.060-inch- (1.52-mm-) nominal thickness uncoated steel **OR** 0.064-inch- (1.63-mm-) nominal thickness metallic-coated steel, **as directed**, with corrugated or perforated straps not less than 2 inches (50 mm) wide by 10 inches (250 mm) long; or wire anchors not less than 0.156 inch (4.0 mm) thick.
      2) Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.050-inch- (1.27-mm-) thick stainless steel **OR** 0.048-inch- (1.21-mm-) nominal thickness uncoated steel **OR** 0.052-inch- (1.32-mm-) nominal thickness metallic-coated steel, **as directed**.
      3) Compression Type for Slip-on Frames: Fabricate adjustable compression anchors from stainless **OR** uncoated **OR** metallic-coated, **as directed**, steel.
      4) Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch- (9.5-mm-) diameter, stainless-steel **OR** uncoated steel **OR** metallic-coated steel, **as directed**, bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
   l. Floor Anchors: Not less than 0.078-inch- (1.98-mm-) thick stainless steel **OR** 0.075-inch- (1.90-mm-) nominal thickness uncoated steel **OR** 0.079-inch- (2.01-mm-) nominal thickness metallic-coated steel, **as directed**, and as follows:
      1) Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
      2) Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch (50-mm) height adjustment. Terminate bottom of frames at finish floor surface.

m. Ceiling Struts: Minimum 3/8-inch-thick by 2-inch- (9.5-mm-thick by 50-mm-) wide from stainless **OR** uncoated **OR** metallic-coated, **as directed**, steel.
n. Plaster Guards: Not less than 0.019-inch- (0.48-mm-) thick stainless steel **OR** 0.018-inch- (0.46-mm-) nominal thickness uncoated steel **OR** 0.022-inch- (0.56-mm-) nominal thickness metallic-coated steel, **as directed**.

2. Performance: Level A, ANSI A250.4.
3. Materials:
   a. Stainless-Steel Sheet: ASTM A 240/A 240M, austenitic stainless steel, Type 304 **OR** Type 316 **OR** Type 317LMN **OR** 904L, **as directed**.
   b. Steel Sheet: ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, Commercial Steel (CS), Type B.
   c. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.
   d. Frame Anchors: Stainless-steel sheet. Same type as door face.
      OR
      Frame Anchors: Steel sheet **OR** Metallic-coated steel sheet, **as directed**, hot-dip galvanized according to ASTM A 153/A 153M, Class B.
   e. Inserts, Bolts, and Anchor Fasteners: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Alloy Group 1 or 4) for bolts and nuts.
      OR
      Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.
4. Finishes:
   a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
   b. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
      1) Run grain of directional finishes with long dimension of each piece.
      2) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
      3) Directional Satin Finish: No. 4.
      4) Dull Satin Finish: No. 6.
      5) Mirrorlike Reflective, Nondirectional Polish: No. 8.
   c. Bright, Cold-Rolled, Unpolished Finish: No. 2B. Factory primed for field finish, **as directed**.

D. Accessories
1. Glazing: Comply with requirements in Division 08 Section "Glazing".
2. Grout: Comply with ASTM C 476, with a slump of not more than 4 inches (102 mm) as measured according to ASTM C 143/C 143M.
3. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
4. Mineral Fiber Insulation: Insulation composed of rock-wool fibers, slag-wool fibers, or glass fibers.

E. Fabrication
1. Stainless-Steel Door Fabrication: Stainless-steel doors to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal.
   a. Seamed Edge Construction: Both vertical door edges joined by visible, continuous interlocking seam (lock seam) full height of door.
      OR
      Seamed Edge Construction: Both vertical door edges joined by visible seam that is projection, spot, or tack welded on inside edges of door at minimum 6 inches (152 mm) o.c.

b. Seamless Edge Construction: Door face sheets joined at vertical edges by continuous weld extending full height of door; with edges ground and polished, providing smooth, flush surfaces with no visible seams.
c. Exterior Doors: Close top edges flush and seal joints against water penetration. Provide weep-hole openings in bottom of exterior doors to permit moisture to escape.
d. Stops and Moldings: Factory cut openings in doors. Provide stops and moldings around glazed lites. Form corners of stops and moldings with butted or mitered hairline joints.
   1) Glazed Lites: Provide fixed stops and moldings welded on secure side of door.
   2) Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.
e. Hardware Preparation: Factory prepare stainless-steel doors to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping, according to the Door Hardware Schedule and templates furnished as specified in Division 8 Section "Door Hardware".
   1) Reinforce doors to receive nontemplated mortised and surface-mounted door hardware.
f. Locate hardware as indicated, or if not indicated, according to HMMA 831, "Recommended Hardware Locations for Custom Hollow Metal Doors and Frames."
g. Tolerances: Fabricate doors to tolerances indicated in ANSI/NAAMM-HMMA 866.

2. Stainless-Steel Frame Fabrication: Fabricate stainless-steel frames to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
   a. Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated from same thickness metal as frames.
   b. Mullions, Rails and Transom Bars: Provide closed tubular members with no visible face seams or joints. Fasten members at crossings and to jambs by butt welding according to joint designs in HMMA 820.
      1) Provide false head member to receive lower ceiling where frames extend to finish ceilings of different heights.
   c. Provide countersunk, flat-, or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
   d. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
   e. Jamb Anchors: Provide number and spacing of anchors as follows:
      1) Masonry Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
         a) Two anchors per jamb up to 60 inches (1524 mm) in height.
         b) Three anchors per jamb from 60 to 90 inches (1524 to 2286 mm) in height.
         c) Four anchors per jamb from 90 to 96 inches (2286 to 2438 mm) in height.
         d) Four anchors per jamb plus one additional anchor per jamb for each 24 inches (610 mm) or fraction thereof more than 96 inches (2438 mm) in height.
      2) Stud-Wall Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
         a) Three anchors per jamb up to 60 inches (1524 mm) in height.
         b) Four anchors per jamb from 60 to 90 inches (1524 to 2286 mm) in height.
         c) Five anchors per jamb from 90 to 96 inches (2286 to 2438 mm) in height.
         d) Five anchors per jamb plus one additional anchor per jamb for each 24 inches (610 mm) or fraction thereof more than 96 inches (2438 mm) in height.
         e) Two anchors per head for frames more than 42 inches (1066 mm) wide and mounted in metal-stud partitions.

3) Compression Type: Not less than two anchors in each jamb.
4) Postinstalled Expansion Type: Locate anchors not more than 6 inches (152 mm) from top and bottom of frame. Space anchors not more than 26 inches (660 mm) o.c.

f. Head Reinforcement: For frames more than 48 inches (1219 mm) wide, provide continuous head reinforcement for full width of opening, welded to back of frame at head.

g. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Provide plastic plugs to keep holes clear during construction.
1) Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
2) Double-Door Frames: Drill stop in head jamb to receive two door silencers.

h. Stops and Moldings: Provide stops and moldings around glazed lites and solid panels where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
1) Single Glazed Lites: Provide fixed stops and moldings welded on secure side of door or frame.
2) Multiple Glazed Lites: Provide fixed and removable stops and moldings such that each lite is capable of being removed independently.
3) Coordinate rabbet width between fixed and removable stops with type of glazing or panel and type of installation indicated.
4) Terminated Stops: Where indicated for interior door frames, terminate stops 6 inches (152 mm) above finish floor with a 45 **OR** 90, **as directed**,-degree angle cut, and close open end of stop with stainless-steel sheet closure. Cover opening in extension of frame with welded-stainless-steel filler plate, with welds ground smooth and flush with frame.

i. Hardware Preparation: Factory prepare stainless-steel frames to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping, according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware (scheduled By Describing Products)".
1) Reinforce frames to receive nontemplated mortised and surface-mounted door hardware.
2) Locate hardware as indicated, or if not indicated, according to HMMA 831, "Recommended Hardware Locations for Custom Hollow Metal Doors and Frames."

j. Plaster Guards: Weld guards to frame at back of hardware mortises and mounting holes in frames to be grouted.

k. Tolerances: Fabricate frames to tolerances indicated in ANSI/NAAMM-HMMA 866.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of stainless-steel doors and frames.
2. Examine roughing-in for embedded and built-in anchors to verify actual locations of stainless-steel, door-frame connections before frame installation.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
2. Prior to installation and with installation spreaders in place, adjust and securely brace stainless-steel door frames for squareness, alignment, twist, and plumb to the following tolerances:
a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.

c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a perpendicular line from head to floor.
3. Drill and tap doors and frames to receive nontemplated mortised and surface-mounted door hardware.

C. Installation
1. General: Install stainless-steel doors and frames plumb, rigid, properly aligned, and securely fastened in place; comply with ANSI/NAAMM-HMMA 866 and manufacturer's written instructions.
2. Stainless-Steel Frames: Install stainless-steel frames of size and profile indicated.
a. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
1) At fire-protection-rated openings, install frames according to NFPA 80.
2) Where frames are fabricated in sections due to shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
3) Install frames with removable glazing stops located on secure side of opening.
4) Install door silencers in frames before grouting.
5) Remove temporary braces necessary for installation only after frames have been properly set and secured.
6) Check plumb, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
7) Apply corrosion-resistant coating to backs of grout-filled frames.
b. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor and secure with postinstalled expansion anchors.
1) Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors, if so indicated and approved on Shop Drawings.
c. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
d. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
e. In-Place Gypsum Board Partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
f. Ceiling Struts: Extend struts vertically from top of frame at each jamb to supporting construction above, unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable wedged or bolted anchorage to frame jamb members.
g. Grouted Frames: Solidly fill space between frames and substrate with grout. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.
h. Installation Tolerances: Adjust stainless-steel frames for squareness, alignment, twist, and plumb to the following tolerances:
1) Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
2) Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
3) Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
4) Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.
3. Stainless-Steel Doors: Fit non-fire-rated doors accurately in frames with the following clearances:
a. Non-Fire-Rated Doors:

1) Jambs and Head: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
2) Between Edges of Pairs of Doors: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
3) Between Bottom of Door and Top of Threshold: Maximum 3/8 inch (9.5 mm).
4) Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch (19 mm).

b. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
c. Smoke-Control Doors: Install doors according to NFPA 105.

4. Glazing: Install glazing in sidelights, transoms, and borrowed lights to comply with installation requirements in Division 08 Section "Glazing".
   a. Secure stops with countersunk, flat-, or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c., and not more than 2 inches (50 mm) o.c. from each corner.

D. Adjusting And Cleaning
1. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work including stainless-steel doors or frames that are warped, bowed, or otherwise unacceptable.
2. Clean grout and other bonding material off stainless-steel doors and frames immediately after installation.
3. Stainless-Steel Touchup: Immediately after erection, smooth any abraded areas of stainless steel and polish to match undamaged finish.

END OF SECTION 08 12 13 13

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Task	Specification	Specification Description
08 12 13 13	08 01 11 61	Steel Doors And Frames
08 12 13 13	08 01 11 61a	Steel Entry Doors
08 13 13 13	08 01 11 61	Steel Doors And Frames
08 13 13 13	08 12 13 13	Stainless Steel Doors And Frames
08 13 73 00	08 35 13 13	Folding Doors
08 14 00 00	06 48 13 00	Wood Doors

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SECTION 08 14 16 00 - STILE AND RAIL WOOD DOORS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of material for stile and rail wood doors. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Exterior stile and rail wood doors and sidelites.
   b. Interior stile and rail wood doors.
   c. Interior fire-rated, stile and rail wood doors.
   d. Interior fire-rated, wood door and sidelite frames.
   e. Priming and Finishing stile and rail wood doors.
   f. Fitting stile and rail wood doors to frames and machining for hardware.
   g. Prehanging doors in frames.

C. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood used for stile and rail wood doors complies with forest certification requirements.
      1) Include statement indicating costs for each certified wood product.
   b. Product Data for Credit EQ 4.4: For adhesives and composite wood materials, documentation indicating that products contain no urea formaldehyde.
3. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; and other pertinent data.
4. Samples: Representing typical range of color and grain for each species of veneer and solid lumber required. Finish Sample with same materials proposed for factory-finished doors.

D. Quality Assurance

1. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
2. Forest Certification: Provide doors made with veneers **OR** not less than 70 percent of wood products **OR** all wood products, **as directed**, obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
3. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure **OR** as close to neutral pressure as possible, **as directed**, according to NFPA 252 **OR** IBC Standard 716.5 **OR** UL 10B **OR** UL 10C, **as directed**.
   a. Temperature-Rise Limit: Where indicated **OR** At vertical exit enclosures and exit passageways, **as directed**, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
4. Safety Glass: Provide products complying with testing requirements in 16 CFR 1201, for Category II materials, unless those of Category I are expressly indicated and permitted.

E. Delivery, Storage, And Handling

1. Comply with manufacturer's written instructions and requirements of quality standard referenced in Part 1.2.

2. Package doors individually in opaque plastic bags or cardboard cartons.
3. Mark each door on top and bottom edge with opening number used on Shop Drawings.

F. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship, or have warped (bow, cup, or twist) more than 1/4 inch (6.4 mm) in a 42-by-84-inch (1067-by-2134-mm) section.
a. Warranty shall be in effect during the following period of time from date of Final Completion:
1) Exterior Doors: None **OR** One year **OR** Two years **OR** Five years, **as directed**.
2) Interior Doors: One year **OR** Five years **OR** Life of installation, **as directed**.
3) Insulated **OR** Insulating Leaded, **as directed**, Glass Vision Panels: Three **OR** Five, **as directed**, years.

1.2 PRODUCTS

A. Materials
1. General: Use only materials that comply with referenced standards and other requirements specified.
a. Assemble exterior doors and sidelites, including components, with wet-use adhesives complying with ASTM D 5572 for finger joints and with ASTM D 5751 for joints other than finger joints.
b. Assemble interior doors, frames, and sidelites, including components, with either dry-use or wet-use adhesives complying with ASTM D 5572 for finger joints and with ASTM D 5751 for joints other than finger joints.
2. Low-Emitting Materials: Provide doors made with adhesives and composite wood products that do not contain urea-formaldehyde resins.
3. Panel Products: Any of the following:
a. Particleboard made from wood particles, with binder containing no urea-formaldehyde resin, complying with ANSI A208.1, Grade M-2.
OR
Particleboard made from straw, complying with ANSI A208.1, Grade M-2, except for density.
b. Medium-density fiberboard made from wood fiber, with binder containing no urea-formaldehyde resin, complying with ANSI A208.2, Grade 130.
c. Hardboard, complying with AHA A135.4.
d. Veneer core plywood, made with adhesive containing no urea-formaldehyde resin.

B. Exterior Stile And Rail Wood Doors
1. Exterior Stile and Rail Wood Doors: Stock exterior doors complying with WDMA I.S.6, "Industry Standard for Wood Stile and Rail Doors," and with other requirements specified.
a. Finish and Grade: Transparent and Premium or Select **OR** Opaque and Standard, **as directed**.
b. Wood Species: Idaho white, lodgepole, ponderosa, or sugar pine **OR** Manufacturer's standard softwood species and cut, **as directed**.
c. Stile and Rail Construction: Edge-glued solid lumber **OR** veneered, structural composite lumber **OR** veneered edge- and end-glued lumber, **as directed**.
d. Panel Construction: Edge-glued solid lumber **OR** veneered panel product, **as directed**.
e. Raised-Panel Thickness: Manufacturer's standard, but not less than that required by WDMA I.S.6 for design group indicated **OR** As indicated, **as directed**.
f. Molding Profile (Sticking): Manufacturer's standard **OR** As selected from manufacturer's full range, **as directed**.
g. Glass: Uncoated, clear, fully tempered float glass, 5.0 mm thick **OR** laminated glass made from two lites of 3.0-mm-thick annealed glass **OR** insulating-glass units made from two

lites of 3.0-mm-thick, fully tempered glass with 1/4-inch (6.4-mm) interspace, **as directed**, complying with Division 08 Section "Glazing".

h. WDMA Design Group: 1-3/4 Front Entrance Doors (Exterior) **OR** 1-3/4 Thermal (Insulated-Glass) Doors (Exterior) **OR** 8'-0" High Doors **OR** Side Lights **OR** 1-3/4 and 1-3/8 Entrance Doors (Exterior) **OR** Combination Doors **OR** Screen Doors, **as directed**.

i. Mark, label, or otherwise identify stile and rail wood doors as complying with WDMA I.S.6 and grade specified. Include panel design number if applicable.

2. Exterior Stile and Rail Wood Doors: Stock **OR** Custom, **as directed**, exterior doors complying with AWI's "Architectural Woodwork Quality Standards," **OR** WI's "Manual of Millwork," **OR** WDMA I.S.6A, "Industry Standard for Architectural Stile and Rail Doors," **as directed**, and with other requirements specified.

a. Panel Designs: Indicated by Drawings. Do not modify intended aesthetic effects, as judged solely by the Owner, except with the Owner's approval. If modifications are proposed, submit comprehensive explanatory data to the Owner for review.

b. Grade: Premium **OR** Custom, **as directed**.

c. Finish: Transparent **OR** Opaque, **as directed**.

d. Wood Species and Cut for Transparent Finish: Idaho white, lodgepole, ponderosa, or sugar pine, plain sawed/sliced **OR** Douglas fir or western hemlock, quarter sawed/sliced (vertical grain) **OR** Red oak, quarter sawed/sliced stiles and rails, plain sawed/sliced panels **OR** Species indicated in schedule, plain sawed/sliced, **as directed**.

e. Door Construction for Transparent Finish:

1) Stile and Rail Construction:

a) Clear lumber; may be edge glued for width. Select lumber for similarity of grain and color, and arrange for optimum match between adjacent pieces.

OR

Veneered, structural composite lumber or veneered, edge- and end-glued clear lumber, **as directed**. Select veneers for similarity of grain and color, and arrange for optimum match between adjacent pieces. Use veneers not less than 1/16 inch (1.6 mm) thick, **as directed**.

2) Raised-Panel Construction:

a) Clear lumber; edge glued for width. Select lumber for similarity of grain and color, and arrange for optimum match between adjacent pieces.

OR

Edge-glued, clear lumber; glued to both sides of a wood-based panel product. Select lumber for similarity of grain and color, and arrange for optimum match between adjacent pieces.

OR

Veneered, wood-based panel product with mitered, raised rims made from matching clear lumber.

OR

Veneered, shaped, wood-based panel product with veneer conforming to raised-panel shape.

f. Door Construction for Opaque Finish:

1) Stile and Rail Construction: Clear softwood; may be edge glued for width and finger jointed.

OR

Stile and Rail Construction: Veneered, structural composite lumber or veneered edge- and end-glued lumber, **as directed**.

2) Raised-Panel Construction: Clear softwood lumber; edge glued for width.

OR

Raised-Panel Construction: Veneered, wood-based panel product.

g. Stile and Rail Widths: As indicated **OR** Manufacturer's standard, but not less than the following, **as directed**:

1) Stiles, Top and Intermediate Rails: 5-3/8 inches (137 mm).

2) Bottom Rails: 11-3/8 inches (289 mm).

h. Raised-Panel Thickness: As indicated **OR** 1-3/4 inches (44 mm) **OR** 1-3/8 inches (35 mm) **OR** Manufacturer's standard, but not less than 1-1/8 inches (29 mm), **as directed**.

i. Molding Profile (Sticking): Bead and cove **OR** Ogee **OR** Ovalo **OR** Recessed bevel **OR** Recessed square **OR** Manufacturer's standard **OR** As selected from manufacturer's full range, **as directed**.

j. Glass: Uncoated, clear, fully tempered float glass, 5.0 mm thick **OR** laminated glass made from two lites of 3.0-mm-thick annealed glass **OR** insulating-glass units made from two lites of 3.0-mm-thick, fully tempered glass with 1/4-inch (6.4-mm) interspace, **as directed**, complying with Division 08 Section "Glazing".

k. Provide AWI Quality Certification Labels or an AWI letter of licensing for Project indicating that doors comply with requirements of grades specified.
OR
Provide WI-Certified Compliance Certificate indicating that doors comply with requirements of grades specified.

l. Mark, label, or otherwise identify stile and rail wood doors as complying with WDMA I.S.6A and grade specified.

C. Interior Stile And Rail Wood Doors

1. Interior Stile and Rail Wood Doors: Stock interior doors complying with WDMA I.S.6, "Industry Standard for Wood Stile and Rail Doors," and with other requirements specified.

a. Finish and Grade: Transparent and Premium or Select **OR** Opaque and Standard, **as directed**.

b. Wood Species: Idaho white, lodgepole, ponderosa, or sugar pine **OR** Douglas fir or western hemlock, vertical sawed/sliced **OR** Red oak, quarter sawed/sliced **OR** Manufacturer's standard softwood species and cut, **as directed**.

c. Stile and Rail Construction: Edge-glued solid lumber **OR** veneered, structural composite lumber **OR** veneered edge- and end-glued lumber, **as directed**.

d. Raised-Panel Construction: Edge-glued solid lumber **OR** Veneered panel product **OR** shaped, medium-density fiberboard, **as directed**.

e. Flat-Panel Construction: Veneered panel product **OR** hardboard or medium-density fiberboard, **as directed**.

f. Raised-Panel Thickness: Manufacturer's standard, but not less than that required by WDMA I.S.6 for design group indicated **OR** As indicated, **as directed**.

g. Flat-Panel Thickness: Manufacturer's standard, but not less than that required by WDMA I.S.6 for design group indicated **OR** As indicated, **as directed**.

h. Molding Profile (Sticking): Manufacturer's standard **OR** As selected from manufacturer's full range, **as directed**.

i. Glass: Uncoated, clear, fully tempered float glass, 5.0 mm thick **OR** laminated glass made from two lites of 3.0-mm-thick annealed glass, **as directed**, complying with Division 08 Section "Glazing".

j. WDMA Design Group: 1-3/8 Interior Panel Doors **OR** French Doors **OR** 8'-0" High Doors **OR** Bifold Doors, **as directed**.

k. Mark, label, or otherwise identify stile and rail wood doors as complying with WDMA I.S.6 and grade specified. Include panel design number if applicable.

2. Interior Stile and Rail Wood Doors: Stock **OR** Custom, **as directed**, interior doors complying with AWI's "Architectural Woodwork Quality Standards," **OR** WI's "Manual of Millwork," **OR** WDMA I.S.6A, "Industry Standard for Architectural Stile and Rail Doors," **as directed**, and with other requirements specified.

a. Panel Designs: Indicated by Drawings. Do not modify intended aesthetic effects, as judged solely by the Owner, except with the Owner's approval. If modifications are proposed, submit comprehensive explanatory data to the Owner for review.

b. Grade: Premium **OR** Custom, **as directed**.

c. Finish: Transparent **OR** Opaque, **as directed**.

d. Wood Species and Cut for Transparent Finish: Idaho white, lodgepole, ponderosa, or sugar pine, plain sawed/sliced **OR** Douglas fir or western hemlock, quarter sawed/sliced (vertical grain) **OR** Red oak, quarter sawed/sliced stiles and rails, plain sawed/sliced panels **OR** Species indicated in schedule, plain sawed/sliced, **as directed**.

e. Door Construction for Transparent Finish:
   1) Stile and Rail Construction: Clear lumber; may be edge glued for width. Select lumber for similarity of grain and color, and arrange for optimum match between adjacent pieces.
      OR
      Stile and Rail Construction: Veneered, structural composite lumber **OR** veneered, edge- and end-glued clear lumber, **as directed**. Select veneers for similarity of grain and color, and arrange for optimum match between adjacent pieces. Use veneers not less than 1/16 inch (1.6 mm) thick, **as directed**.
   2) Raised-Panel Construction: Clear lumber; edge glued for width. Select lumber for similarity of grain and color, and arrange for optimum match between adjacent pieces.
      OR
      Raised-Panel Construction: Edge-glued, clear lumber; glued to both sides of a wood-based panel product. Select lumber for similarity of grain and color, and arrange for optimum match between adjacent pieces.
      OR
      Raised-Panel Construction: Veneered, wood-based panel product with mitered, raised rims made from matching clear lumber.
      OR
      Raised-Panel Construction: Veneered, shaped, wood-based panel product with veneer conforming to raised-panel shape.
   3) Flat-Panel Construction: Veneered, wood-based panel product.

f. Door Construction for Opaque Finish:
   1) Stile and Rail Construction: Clear softwood; may be edge glued for width and finger jointed.
      OR
      Stile and Rail Construction: Veneered, structural composite lumber **OR** veneered edge- and end-glued lumber, **as directed**.
   2) Raised-Panel Construction: Clear softwood lumber; edge glued for width.
      OR
      Raised-Panel Construction: Shaped, medium-density fiberboard.
   3) Flat-Panel Construction: Veneered, wood-based panel product **OR** Medium-density fiberboard, **as directed**.

g. Stile and Rail Widths: As indicated **OR** Manufacturer's standard, but not less than the following, **as directed**:
   1) Stiles, Top and Intermediate Rails: 4-1/2 inches (114 mm).
   2) Bottom Rails: 9 inches (229 mm).

h. Raised-Panel Thickness: As indicated **OR** 1-3/4 inches (44 mm) **OR** 1-3/8 inches (35 mm) **OR** Manufacturer's standard, but not less than 1-1/8 inches (29 mm) **OR** Manufacturer's standard, but not less than 3/4 inch (19 mm), **as directed**.

i. Flat-Panel Thickness: As indicated **OR** 1/2 inch (13 mm) **OR** 3/8 inch (10 mm) **OR** 1/4 inch (6.4 mm), **as directed**.

j. Molding Profile (Sticking): Bead and cove **OR** Ogee **OR** Ovalo **OR** Recessed bevel **OR** Recessed square **OR** Manufacturer's standard **OR** As selected from manufacturer's full range, **as directed**.

k. Glass: Uncoated, clear, fully tempered float glass, 5.0 mm thick **OR** laminated glass made from two lites of 3.0-mm-thick annealed glass, **as directed**, complying with Division 08 Section "Glazing".

l. Provide AWI Quality Certification Labels or an AWI letter of licensing for Project indicating that doors comply with requirements of grades specified.
   OR
   Provide WI-Certified Compliance Certificate indicating that doors comply with requirements of grades specified.

m. Mark, label, or otherwise identify stile and rail wood doors as complying with WDMA I.S.6A and grade specified.

3. Interior Stile and Rail Wood Doors: Fire-rated (20-minute rating) doors complying with AWI's "Architectural Woodwork Quality Standards," **OR** WI's "Manual of Millwork," **OR** WDMA I.S.6A, "Industry Standard for Architectural Stile and Rail Doors," **as directed**, and with other requirements specified.
   a. Panel Designs: Indicated by Drawings. Do not modify intended aesthetic effects, as judged solely by the Owner, except with the Owner's approval. If modifications are proposed, submit comprehensive explanatory data to the Owner for review.
   b. Grade: Premium **OR** Custom, **as directed**.
   c. Finish: Transparent **OR** Opaque, **as directed**.
   d. Wood Species and Cut for Transparent Finish: Idaho white, lodgepole, ponderosa, or sugar pine, plain sawed/sliced **OR** Douglas fir or western hemlock, quarter sawed/sliced (vertical grain) **OR** Red oak, quarter sawed/sliced stiles and rails, plain sawed/sliced panels **OR** Species indicated in schedule, plain sawed/sliced, **as directed**.
   e. Door Construction for Transparent Finish: 1-3/4-inch- (44-mm-) thick stiles and rails and veneered flat panels not less than 5/8 inch (16 mm) thick **OR** raised panels not less than 1-1/8 inches (29 mm) thick, **as directed**.
      1) Stile and Rail Construction: Veneered, structural composite lumber **OR** veneered, edge- and end-glued clear lumber, **as directed**. Select veneers for similarity of grain and color, and arrange for optimum match between adjacent pieces. Use veneers not less than 1/16 inch (1.6 mm) thick, **as directed**.
      2) Raised-Panel Construction: Veneered, shaped, wood-based panel product with veneer conforming to raised-panel shape.
      3) Flat-Panel Construction: Veneered, wood-based panel product.
   f. Door Construction for Opaque Finish: 1-3/4-inch- (44-mm-) thick stiles and rails and veneered flat panels not less than 5/8 inch (16 mm) thick **OR** raised panels not less than 1-1/8 inches (29 mm) thick, **as directed**.
      1) Stile and Rail Construction: Veneered, structural composite lumber **OR** veneered edge- and end-glued lumber, **as directed**.
      2) Raised-Panel Construction: Shaped, medium-density fiberboard.
      3) Flat-Panel Construction: Veneered, wood-based panel product **OR** Medium-density fiberboard, **as directed**.
   g. Stile and Rail Widths: As indicated **OR** Manufacturer's standard, but not less than the following, **as directed**:
      1) Stiles, Top and Intermediate Rails: 4-1/2 inches (114 mm).
      2) Bottom Rails: 9 inches (229 mm).
   h. Molding Profile (Sticking): Bead and cove **OR** Ogee **OR** Ovalo **OR** Recessed bevel **OR** Recessed square **OR** Manufacturer's standard **OR** As selected from manufacturer's full range, **as directed**.
   i. Provide AWI Quality Certification Labels or an AWI letter of licensing for Project indicating that doors comply with requirements of grades specified.
      OR
      Provide WI-Certified Compliance Certificate indicating that doors comply with requirements of grades specified.
   j. Mark, label, or otherwise identify stile and rail wood doors as complying with WDMA I.S.6A and grade specified.

4. Interior Stile and Rail Wood Doors: Fire-rated (45-minute rating) doors complying with AWI's "Architectural Woodwork Quality Standards," **OR** WI's "Manual of Millwork," **as directed**, and with other requirements specified.
   a. Panel Designs: Indicate by Drawings. Do not modify intended aesthetic effects, as judged solely by the Owner, except with the Owner's approval. If modifications are proposed, submit comprehensive explanatory data to the Owner for review.
   b. Grade: Premium **OR** Custom, **as directed**.
   c. Finish: Transparent **OR** Opaque, **as directed**.

d. Wood Species and Cut for Transparent Finish: Idaho white, lodgepole, ponderosa, or sugar pine, plain sawed/sliced **OR** Douglas fir or western hemlock, quarter sawed/sliced (vertical grain) **OR** Red oak, quarter sawed/sliced stiles and rails, plain sawed/sliced panels **OR** Species indicated in schedule, plain sawed/sliced, **as directed**.

e. Interior Fire-Rated Door Construction: 1-3/4-inch- (44-mm-) thick, edged and veneered mineral-core stiles and rails and 1-1/8-inch- (29-mm-) thick, veneered mineral-core raised panels.

f. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
   1) Screw-Holding Capability: 550 lbf (2440 N) **OR** 475 lbf (2110 N) **OR** 400 lbf (1780 N), **as directed**, per NWWDA T.M.-10.

g. Stile and Rail Widths: As indicated **OR** Manufacturer's standard, but not less than the following, **as directed**:
   1) Stiles, Top and Intermediate Rails: 4-1/2 inches (114 mm).
   2) Bottom Rails: 9 inches (229 mm).

h. Molding Profile (Sticking): Bead and cove **OR** Ogee **OR** Ovalo **OR** Recessed bevel **OR** Recessed square **OR** Manufacturer's standard **OR** As selected from manufacturer's full range, **as directed**.

i. Provide AWI Quality Certification Labels or an AWI letter of licensing for Project indicating that doors comply with requirements of grades specified.
   OR
   Provide WI-Certified Compliance Certificate indicating that doors comply with requirements of grades specified.

D. Interior Fire-Rated Wood Door Frames
   1. Interior Fire-Rated Wood Door Frames: Frames, complete with casings **OR** sidelite frames and casings, **as directed**, fabricated from solid fire-retardant-treated wood or from veneered fire-retardant particleboard, fire-retardant medium-density fiberboard, or mineral board.
   2. Species: Red oak **OR** White oak **OR** White maple **OR** Cherry, **as directed**.

E. Stile And Rail Wood Door Fabrication
   1. Fabricate stile and rail wood doors in sizes indicated for field fitting.
   2. Factory fit doors to suit frame-opening sizes indicated, with the following uniform clearances and bevels unless otherwise indicated:
      a. Clearances: Provide 1/8 inch (3 mm) at heads, jambs, and between pairs of doors. Provide 1/2 inch (13 mm) from bottom of door to top of decorative floor finish or covering. Where threshold is shown or scheduled, provide not more than 3/8 inch (10 mm) from bottom of door to top of threshold.
         1) Comply with NFPA 80 for fire-rated doors.
      b. Bevel non-fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) at lock and hinge edges.
      c. Bevel fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) on lock edge; trim stiles and rails only to extent permitted by labeling agency.
   3. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W Series standards, and hardware templates.
   4. Glazed Openings: Trim openings indicated for glazing with solid wood moldings, with one side removable. Miter wood moldings at corner joints.
      OR
      Glazed Openings: Glaze doors at factory with glass of type and thickness indicated, complying with Division 08 Section "Glazing". Install glass using manufacturer's standard elastomeric glazing sealant complying with ASTM C 920. Secure glass in place with removable wood moldings. Miter wood moldings at corner joints.
   5. Transom and Side Panels: Fabricate panels to match adjoining doors in materials, finish, and quality of construction.

6. Exterior Doors: Factory treat exterior doors after fabrication with water-repellent preservative to comply with WDMA I.S.4. Flash top of outswinging doors with manufacturer's standard metal flashing.
7. Prehung Doors: Provide stile and rail doors as prehung units including doors, frames, weather stripping, **as directed**, and hardware.
   a. Provide wood door frames, other than fire-rated wood door frames, that comply with Division 06 Section(s) "Interior Finish Carpentry" OR "Interior Architectural Woodwork", **as directed**.
   b. Provide hardware, including weather stripping and thresholds, that complies with Division 08 Section "Door Hardware".

F. Shop Priming
1. Doors for Opaque Finish: Shop prime doors with one coat of wood primer specified in Division 09 Section(s) "Exterior Painting" OR "Interior Painting", **as directed**. Seal all four edges, edges of cutouts, and mortises with primer.
2. Doors for Transparent Finish: Shop prime doors with stain (if required), other required pretreatments, and first coat of finish as specified in Division 09 Section "Staining And Transparent Finishing". Seal all four edges, edges of cutouts, and mortises with first coat of finish.

G. Finishing
1. Finish wood doors at factory **OR** woodworking shop, **as directed**.
   OR
   Finish wood doors at factory **OR** woodworking shop, **as directed**, that are indicated to receive transparent finish. Wood doors that are indicated to receive opaque finish may be field finished.
   OR
   Finish wood doors at factory **OR** woodworking shop, **as directed**, where indicated in schedules or on Drawings. Wood doors that are not indicated to be factory **OR** shop, **as directed**, finished may be field finished.
2. For doors indicated to be factory **OR** shop, **as directed**, finished, comply with AWI's "Architectural Woodwork Quality Standards," **OR** WI's "Manual of Millwork," **OR** WDMA I.S.6A, "Industry Standard for Architectural Stile and Rail Doors," **as directed**, and with other requirements specified.
   a. Finish faces and all four edges of doors, including mortises and cutouts. Stains and fillers may be omitted on bottom **OR** top and bottom, **as directed**, edges, edges of cutouts, and mortises.
3. Transparent Finish:
   a. Grade: Premium **OR** Custom, **as directed**.
   b. Finish: AWI conversion varnish **OR** AWI catalyzed polyurethane, **as directed**, system.
      OR
      Finish: WDMA TR-4 conversion varnish **OR** WDMA TR-6 catalyzed polyurethane, **as directed**.
      OR
      Finish: WI System 4 clear conversion varnish **OR** WI System 5 catalyzed polyurethane **OR** WI System 8 UV-curable coating, **as directed**.
   c. Staining: Match sample **OR** As selected from manufacturer's full range **OR** None required, **as directed**.
   d. Effect: Open-grain finish **OR** Filled finish **OR** Semifilled finish, produced by applying an additional finish coat to partially fill the wood pores, **as directed**.
   e. Sheen: Satin **OR** Semigloss, **as directed**.
4. Opaque Finish:
   a. Grade: Premium **OR** Custom, **as directed**.
   b. Finish: AWI conversion varnish **OR** AWI catalyzed polyurethane, **as directed**, system.
      OR
      Finish: WDMA OP-4 conversion varnish **OR** WDMA OP-6 catalyzed polyurethane, **as directed**.

OR
Finish: WI System 4 conversion varnish **OR** WI System 5 catalyzed polyurethane **OR** WI System 8 UV-curable coating, **as directed**.

c. Color: Match sample **OR** As selected from manufacturer's full range, **as directed**.
d. Sheen: Satin **OR** Semigloss **OR** Gloss, **as directed**.

1.3 EXECUTION

A. Installation

1. Install fire-rated wood door frames level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.
   a. Countersink fasteners, fill surface flush, and sand smooth.
2. Hardware: For installation, see Division 08 Section "Door Hardware".
3. Install wood doors to comply with manufacturer's written instructions, WDMA I.S.6, "Industry Standard for Wood Stile and Rail Doors," **OR** AWI's "Architectural Woodwork Quality Standards," **OR** WI's "Manual of Millwork," **OR** WDMA I.S.6A, "Industry Standard for Architectural Stile and Rail Doors," **as directed**, and other requirements specified.
   a. Provide WI-Certified Compliance Certificate for Installation.
   b. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.
4. Field-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted with fire-rated doors. Machine doors for hardware. Seal cut surfaces after fitting and machining.
   a. Clearances: Provide 1/8 inch (3 mm) at heads, jambs, and between pairs of doors. Provide 1/8 inch (3 mm) **OR** 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm), **as directed**, from bottom of door to top of decorative floor finish or covering. Where threshold is shown or scheduled, provide 1/4 inch (6 mm) **OR** 3/8 inch (10 mm), **as directed**, from bottom of door to top of threshold.
      1) Comply with NFPA 80 for fire-rated doors.
   b. Bevel non-fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) at lock and hinge edges.
   c. Bevel fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) on lock edge; trim stiles and rails only to extent permitted by labeling agency.
5. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
6. Factory-Finished **OR** Shop-Finished, **as directed**, Doors: Restore finish before installation if fitting or machining is required at Project site.

B. Adjusting

1. Operation: Rehang or replace doors that do not swing or operate freely.
2. Finished Doors: Replace doors that are damaged or do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 08 14 16 00

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Task	Specification	Specification Description
08 14 16 00	08 05 13 00	Flush Wood Doors
08 14 23 13	01 22 16 00	No Specification Required
08 14 23 16	08 05 13 00	Flush Wood Doors
08 14 23 16	08 14 16 00	Stile And Rail Wood Doors
08 14 23 19	08 05 13 00	Flush Wood Doors
08 14 23 19	08 14 16 00	Stile And Rail Wood Doors
08 14 66 00	01 22 16 00	No Specification Required
08 14 73 00	06 48 13 00	Wood Doors
08 14 73 00	08 05 13 00	Flush Wood Doors
08 15 13 00	08 05 13 00	Flush Wood Doors

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SECTION 08 16 13 00 - FIBERGLASS REINFORCED PLASTIC (FRP) DOORS AND FRAMES

1.1 GENERAL

A. Description of Work
1. This specification covers the furnishing and installation of materials for fiberglass reinforced plastic (FRP) doors and frames. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Fire Rated Fiberglass reinforced Plastic (FRP) Doors certified by Intertek Testing Services for Warnock- Hersey in 45, 60 and 90-minute ratings, meeting all specifications of UL 10(c) fire door test standards. Category A and B.
1) Category A doors are labeled for compliance with IBC Standard (Positive Pressure) and do not require the application of an additional edge sealing system.
2) Category B doors are labeled to require the installation of a listed edge sealing system to meet the requirements of IBC Standard (Positive Pressure). This seal must be installed per the manufacturers instructions and may be factory or field applied.
3) Category B constructed doors, if requested and with certain restrictions, may be provided with an UL 10 (b) label (Negative Pressure) and at a later date can be upgraded to a UL 10 (c) category B label (Positive Pressure) with the application of a listed seal system.
b. Fire Rated Fiberglass Resin Transfer Molded Door Frames certified by Intertek Testing Services for Warnock- Hersey in 45, 60 and 90-minute ratings, meeting all specifications of UL 10(c) fire door test standards, Category C.
c. Fire Rated Fiberglass reinforced Plastic (FRP) Doors and Fiberglass Resin Transfer Molded Door Frames certified by Intertek Testing Services for Warnock- Hersey in 20, 45, 60 and 90-minute ratings, meeting all specifications of UL 10(b) fire door test standards.

C. Quality Assurance
1. Manufacturer Qualifications: A company specialized in the manufacture of fiberglass reinforced plastic (FRP) doors and frames as specified herein with a minimum of 25 years documented experience and with a record of successful in-service performance for the applications as required for this project.
2. Installer Qualifications: An experienced installer who has completed fire rated fiberglass door and frame installations similar in material, design, and extent to those indicated and whose work has resulted in construction with a record of successful in-service performance.
3. Source Limitations: Obtain fiberglass reinforced plastic doors and frames through one source fabricated from a single manufacturer, including fire rated fiberglass frames.
4. Source Limitations: Hardware and accessories for all FRP doors as specified in Division 08 Section "Door Hardware" should be provided and installed by the fiberglass door and frame manufacturer.
5. Source Limitations: Glass for windows in doors shall be furnished and installed by door and frame manufacturer in accordance with related section, Division 08 Section "Glazing".

D. Submittals
1. Product technical data including:
a. Acknowledgment that products submitted meet requirements of standards referenced
b. Manufacturer shall provide certificate of compliance with current local and federal regulations as it applies to the manufacturing process.
c. Manufacturer's installation instructions.

d. Schedule of doors and frames indicating the specific reference numbers as used on drawings, door type, frame type, size, handing and applicable hardware.
e. Details of core and edge construction. Include factory-construction specifications.
f. Certification of manufacturer's qualifications.

2. Submittal drawings for customer approval shall be submitted prior to manufacture and will include the following information and formatting.
   a. Summary door schedule indicating the specific reference numbers as used on owner's drawings, with columns noting door type, frame type, size, handing, accessories and hardware.
   b. A drawing depicting front and rear door elevations showing hardware with bill of material for each door.
   c. Drawing showing dimensional location of each hardware item and size of each door.
   d. Individual part drawing and specifications for each hardware item and FRP part or product.
   e. Construction and mounting detail for each frame type.
3. Samples:
   a. Provide one 21 x 18 inch completely assembled (hinged) door and frame corner section, with faces and edges representing typical color and finish. One edge should be exposed for view of interior door and frame composition.
4. Operation and Maintenance Manuals:
   a. Include recommended methods and frequency for maintaining optimum condition of fiberglass doors and frames under anticipated traffic and use conditions.
   b. Include one set of final as built drawings with the same requirements as mentioned above.
   c. Include certificate of warranty for door and frame listing specific door registration numbers.
   d. Include hardware data sheets and hardware manufacturer's warranties.

E. Delivery, Storage, And Handling
1. Each door and frame should be delivered individually crated for protection from damage in cardboard containers, clearly marked with project information, door location, specific reference number as shown on drawings, and shipping information. Each crate should contain all fasteners necessary for installation as well as complete installation instructions.
2. Doors should be stored in the original container out of inclement weather for protection against the elements.
3. Handle doors pursuant to the manufacturer's recommendations as posted on outside of crate.

F. Warranty
1. Warranty all fiberglass doors and frames for a period of 25 years against failure due to corrosion. Additionally, warranty all fiberglass doors and frames on materials and workmanship for a period of 10 years, including warp, separation or delamination, and expansion of the core.

1.2 PRODUCTS

A. Acceptable Manufacturers: Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Chem-Pruf Door Co., Ltd., P.O. Box 4560, Brownsville, Texas 78523 Phone: 1-800-444-6924, Fax: 956-544-7943, Website: www.chem-pruf.com
2. Substitutions may be considered, provided manufacturer can comply with the specifications as written herein. Requests for substitution must be submitted in writing no less than 10 days prior to bid date.

B. FRP Doors
1. Fire rated Fiberglass reinforced Plastic (FRP) Doors certified by Intertek Testing Services for Warnock-Hersey in 20, 45, 60 and 90 minute ratings meeting all specifications of UL 10(c) and UL 10(b) fire door test standards.

2. Doors shall be made of fiberglass reinforced plastic (FRP) using chemically proven fire retardant resins resistant to contaminants typically found in the environment for which these specifications are written. Doors shall be 1-3/4 inch thick and of flush construction, having no seams or cracks. All doors up to 4'-0 x 8'-0 shall have equal diagonal measurements with a maximum tolerance of +/-1/32 inch.
3. Door Plates shall be molded in one continuous piece, starting with a 25-mil gelcoat of the color specified, integrally molded with at least two layers of 1.5 ounce per square foot fiberglass. This will yield a plate ratio of 30/70 glass to resin.
4. Stiles and Rails Core shall be banded with firestop per factory drawings.
5. Core material shall be fire resistant mineral core placed within band structure allowing no voids within.
6. Finish of door and frame shall be identical in color and texture. At time of manufacture, 25 mil of resinrich gelcoat must be integrally molded into both the door and frame. Secondary painting to achieve color is not acceptable.
7. Window openings shall be provided for at time of manufacture and shall be completely sealed so that the interior of the door is not exposed to the environment. Window kits shall be fire rated per U.L. for rating of opening and function.

C. Frames
1. Frames shall be fiberglass and manufactured using the resin transfer method in closed rigid molds to assure uniformity in color and size. Beginning with a minimum 25-mil gel coat and a minimum of two layers continuous strand fiberglass mat saturated with fire retardant resin, the frame will be of one-piece construction with molded stop. All frame profiles shall have a core of firestop and mineral core. Frames must be fiberglass. Frames of dissimilar materials, such as metal or stainless steel will not be accepted.
2. Finish of frame shall be identical in color and texture to the door. 25-mil resin rich gel coat will be integrally molded into the frame at time of manufacture. Secondary painting to achieve color is not acceptable.
3. Jamb/Header connection shall be coped by CNC for tight fit.
4. Internal Reinforcement shall be continuous within the structure to allow for mounting of specified hardware.
5. Mortises for hardware shall be accurately machined by CNC to hold dimensions in all three axis.
6. Hinge pockets shall be accurately machined by CNC to facilitate heavy-duty hinges at all hinge locations, using spacers when standard weight hinges are used.

D. Hardware
1. See Division 08 Section "Door Hardware".
2. Due to the special nature of the material in this section, all related hardware as specified must be furnished and installed by the door and frame manufacturer.

1.3 EXECUTION

A. Installation Conditions
1. Verification of Conditions
   a. Openings are correctly prepared to receive doors and frames.
   b. Openings are correct size and depth in accordance with shop drawings or submittals.
2. Installer's Examination
   a. Have the installer examine conditions under which construction activities of this section are to be performed and submit a written report if conditions are unacceptable.
   b. Transmit two copies of the installer's report to the architect within 24 hours of receipt.
   c. Beginning construction activities of this section before unacceptable conditions have been corrected is prohibited.

B. Installation

1. Install door-opening assemblies in accordance with shop drawings and manufacturer's printed installation instructions, using installation methods and materials specified in installation instructions.
2. Field alteration of doors or frames to accommodate field conditions is strictly prohibited.
3. Site tolerances: Maintain plumb and level tolerance specified in manufacturers printed installation instructions.
4. Fire labeled doors and frames must be installed in strict accordance with manufacturer's instructions and the latest revision of NFPA 80.
5. UL 10 (c) Category B doors require field-applied seal per manufacture's instructions.

C. Adjusting
1. Adjust doors in accordance with door manufacturer's maintenance instructions to swing open and shut without binding and to remain in place at any angle without being moved by gravitational influence.
2. Adjust door hardware to operate correctly in accordance with hardware manufacturer's maintenance instructions.

D. Cleaning
1. Clean surfaces of door opening assemblies and exposed door hardware in accordance with respective manufacturer's maintenance instructions.

E. Protection Of Installed Products
1. Protect door opening assemblies and door hardware from damage by subsequent construction activities until final inspection.

END OF SECTION 08 16 13 00

Task	Specification	Specification Description
08 16 13 00	08 01 11 61	Steel Doors And Frames
08 16 13 00	08 01 11 61a	Steel Entry Doors
08 16 13 00	08 12 13 13	Stainless Steel Doors And Frames
08 17 23 00	06 48 13 00	Wood Doors
08 17 23 00	08 05 13 00	Flush Wood Doors

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SECTION 08 18 16 00 - SLIDING ALUMINUM-FRAMED GLASS DOORS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for sliding aluminum-framed glass doors. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes sliding aluminum-framed glass doors for exterior locations.

C. Performance Requirements
1. General: Provide sliding aluminum-framed glass doors capable of complying with performance requirements indicated, based on testing manufacturer's sliding doors that are representative of those specified, and that are of minimum test size indicated below:
    a. Size required by AAMA/WDMA/CSA 101/I.S.2/A440 for gateway performance **OR** optional performance grade **OR** gateway performance for both gateway performance and optional performance grade, **as directed**.
    OR
    Size indicated on Drawings **OR** in a schedule, **as directed**.
2. Structural Performance: Provide sliding aluminum-framed glass doors capable of withstanding the effects of the following loads, based on testing units representative of those indicated for Project that pass AAMA/WDMA/CSA 101/I.S.2/A440, Uniform Load Structural Test:
    a. Design Wind Loads: Determine design wind loads under conditions indicated according to ASCE/SEI 7.
        1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s), **as directed**.
        2) Importance Factor.
        3) Exposure Category: B **OR** C **OR** D, **as directed**.
    b. Deflection Limits: Design glass framing system to limit lateral deflections of glass edges to less than 1/175 of glass-edge length or 3/4 inch (19 mm), whichever is less, at design pressure based on testing performed according to AAMA/WDMA/CSA 101/I.S.2/A440, Uniform Load Deflection Test, or structural computations.
3. Windborne-Debris Resistance: Provide sliding aluminum-framed glass doors capable of resisting impact from windborne debris, based on the pass/fail criteria as determined from testing sliding aluminum-frames glass doors identical to those specified, according to ASTM E 1886 and testing information in ASTM E 1996 **OR** AAMA 506, **as directed**, and requirements of authorities having jurisdiction.
4. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
    a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

D. Submittals
1. Product Data: For each type of product indicated. Include construction details, material descriptions, fabrication methods, dimensions of individual components and profiles, hardware, finishes, and operating instructions.
2. Shop Drawings: For sliding aluminum-framed glass doors. Include plans, elevations, sections, details, hardware, attachments to other work, operational clearances, and the following:
    a. Mullion details for fenestration combinations including reinforcement and stiffeners.
    b. Joinery details.
    c. Expansion provisions.

d. Flashing and drainage details.
e. Weather-stripping details.
f. Thermal-break details.
g. Glazing details.
h. Accessories.

3. Samples: For sliding aluminum-framed glass doors and components required, prepared on Samples of size indicated below:
   a. Main Framing Member: 12-inch- (300-mm-) long section with weather stripping, **as directed**, glazing bead and factory-applied color finish.
   b. Hardware: Full-size units with factory-applied finish.
4. Delegated-Design Submittal: For sliding aluminum-framed glass doors indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation and used to determine the following:
   a. Structural test pressures and design pressures from wind loads indicated.
   b. Deflection limitations of glass framing systems.
5. Qualification Data: For qualified Installer, manufacturer, professional engineer and testing agency.
6. Product Test Reports: Based on evaluation of comprehensive tests performed within the last four years by a qualified testing agency, for each class, grade, and size of sliding aluminum-framed glass door. Test results based on use of downsized test doors will not be accepted, **as directed**.
7. Field quality-control reports.
8. Maintenance Data: For finishes, weather stripping, operable panels, and operating hardware to include in maintenance manuals.
9. Warranty: Sample of special warranty.

E. Quality Assurance

1. Manufacturer Qualifications: A manufacturer capable of fabricating sliding aluminum-framed glass doors that meet or exceed performance requirements indicated and of documenting this performance by inclusion in lists and by labels, test reports, and calculations.
2. Installer Qualifications: An installer acceptable to sliding door manufacturer for installation of units required for this Project.
   a. Installer's responsibilities include providing professional engineering services needed to assume engineering responsibility including preparation of data for sliding aluminum-framed glass doors, including Shop Drawings and Designated-Design Submittal, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
3. Source Limitations: Obtain sliding aluminum-framed glass doors from single source from single manufacturer.
4. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of sliding aluminum-framed glass doors. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.
   OR
   Product Options: Drawings indicate size, profiles, and dimensional requirements of sliding aluminum-framed glass doors and are based on the specific system indicated. Do not modify size and dimensional requirements.
   a. Do not modify intended aesthetic effects, as judged solely by the Owner, except with the Owner's approval. If modifications are proposed, submit comprehensive explanatory data to the Owner for review.
5. Fenestration Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440, "Standard/Specification for Windows, Doors, and Unit Skylights," for minimum standards of performance, materials, components, accessories, and fabrication. Comply with more stringent requirements if indicated.

a. Provide AAMA **OR** WDMA, **as directed**,-certified, sliding aluminum-framed glass doors with an attached label.

6. Safety Glass: Category II materials complying with testing requirements in 16 CFR 1201.
   a. Subject to compliance with requirements, permanently mark safety glass with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction.
7. Glazing Publications: Comply with published recommendations of glass manufacturers and with GANA's "Glazing Manual" unless more stringent requirements are indicated.
8. Preinstallation Conference: Conduct conference at Project site.

F. Project Conditions
1. Field Measurements: Verify actual dimensions of sliding aluminum-framed glass door openings by field measurements before fabrication.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of sliding aluminum-framed glass doors that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Failure to meet performance requirements.
      2) Structural failures including excessive deflection.
      3) Water leakage or air infiltration.
      4) Faulty operation of movable sash and hardware.
      5) Deterioration of metals, metal finishes, and other materials beyond normal weathering.
      6) Deterioration of insulating glass and laminated glass as defined in Division 8 Section "Glazing."
   b. Warranty Period:
      1) Sliding Door: Three **OR** Five, **as directed**, years from date of Final Completion.
      2) Glazing: 10 **OR** 20, **as directed**, years from date of Final Completion.
      3) Metal Finish: Five **OR** 10 **OR** 15, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Materials
1. Aluminum Extrusions: Provide alloy and temper recommended by sliding aluminum-framed glass door manufacturer for strength, corrosion resistance, and application of required finish. Comply with AAMA/WDMA/CSA 101/I.S.2/A440.
2. Fasteners: Provide fasteners of aluminum, nonmagnetic stainless steel, or other materials warranted by manufacturer to be noncorrosive for SC 3 severe service conditions and compatible with members, trim, hardware, anchors, and other components of sliding aluminum-framed glass doors. Comply with AAMA/WDMA/CSA 101/I.S.2/A440.
   a. Exposed Fasteners: Unless unavoidable for applying hardware, do not use exposed fasteners. For application of hardware, use fasteners that match finish of member or hardware being fastened, as appropriate.
3. Anchors, Clips, and Accessories: Provide anchors, clips, and accessories of aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron for sliding aluminum-framed glass doors, complying with ASTM B 456 or ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.
4. Reinforcing Members: Provide aluminum, nonmagnetic stainless steel, or nickel/chrome-plated steel reinforcing members that are noncorrosive for SC 3 severe service conditions and that comply with AAMA/WDMA/CSA 101/I.S.2/A440; provide sufficient strength to withstand design pressure indicated.

5. Compression-Type Weather Stripping: Provide compressible weather stripping designed for permanently resilient sealing under bumper or wiper action, and completely concealed when sliding aluminum-framed glass door is closed.
   a. Weather-Stripping Material: Closed-cell elastomeric, preformed gaskets complying with ASTM C 509.
   OR
   Weather-Stripping Material: Dense elastomeric gaskets complying with ASTM C 864.
   OR
   Weather-Stripping Material: Manufacturer's standard system and materials complying with AAMA/WDMA/CSA 101/I.S.2/A440.
6. Sliding-Type Weather Stripping: Provide woven-pile weather stripping of wool, polypropylene, or nylon pile and resin-impregnated backing fabric. Comply with AAMA 701.
   a. Weather Seals: Provide weather stripping with integral barrier fin or fins of semirigid, polypropylene sheet or polypropylene-coated material. Comply with AAMA 702.
7. Sealant: For sealants required within fabricated sliding doors, provide sliding aluminum-framed glass door manufacturer's standard, permanently elastic, nonshrinking, and nonmigrating type recommended by sealant manufacturer for joint size and movement.

B. Sliding Door
1. AAMA/WDMA/CSA Performance Requirements: Provide sliding aluminum-framed glass doors of performance indicated that comply with AAMA/WDMA/CSA 101/I.S.2/A440 unless more stringent performance requirements are indicated.
   a. Performance Class and Grade: R15 **OR** 20 **OR** 25, **as directed**.
   b. Performance Class and Grade: LC25 **OR** 30 **OR** 35, **as directed**.
   c. Performance Class and Grade: C30 **OR** 35 **OR** 40, **as directed**.
   d. Performance Class and Grade: HC40 **OR** 45 **OR** 50, **as directed**.
   e. Performance Class and Grade: AW40 **OR** 45 **OR** 50, **as directed**.
   f. Performance Class and Grade: As indicated.
2. Condensation Resistance: Provide sliding aluminum-framed glass doors with a minimum CRF when tested according to AAMA 1503 **OR** CR determined according to NFRC 500, **as directed**, of 45 **OR** 52, **as directed**.
3. Thermal Transmittance: Provide sliding aluminum-framed glass doors with a maximum whole fenestration product U-factor indicated, when tested according to AAMA 1503 **OR** determined according to ASTM E 1423 **OR** determined according to NFRC 100, **as directed**.
   a. U-Factor: 0.35 **OR** 0.40 **OR** 0.65, **as directed**, Btu/sq. ft. x h x deg F (W/sq. m x K).
4. Solar Heat-Gain Coefficient (SHGC): Provide sliding aluminum-framed glass doors with a whole-fenestration product SHGC maximum of 0.40 **OR** 0.55, **as directed**, determined according to NFRC 200.
5. Acoustical Performance: Provide sliding aluminum-framed glass doors with an STC **OR** OITC, **as directed**, rating of 29 **OR** 34, **as directed**, when tested according to and determined by ASTM E 90 and ASTM E 413 **OR** ASTM E 1425 and ASTM E 1332, **as directed**, respectively.
6. Air Leakage Resistance: Maximum rate not more than indicated when tested according to AAMA/WDMA/CSA 101/I.S.2/A440, Air Leakage Resistance Test.
   a. Maximum Rate: 0.3 cfm/sq. ft. (1.5 L/s x sq. m) of area at an inward test pressure of 1.6 lbf/sq. ft. (75 Pa), [equivalent to 25-mph (11-m/s) wind speed and typically used to test R, C, LC, and HC (sliding seal units) performance classes].
   OR
   Maximum Rate: 0.3 cfm/sq. ft. (1.5 L/s x sq. m) of area at an inward test pressure of 6.2 lbf/sq. ft. (300 Pa)., [equivalent to a 50-mph (22-m/s) wind speed and typically used to test AW (sliding seal units) performance classes].
7. Water Penetration Resistance: No water leakage as defined in the AAMA/WDMA/CSA referenced test methods at a water test pressure equaling that indicated, when tested according to AAMA/WDMA/CSA 101/I.S.2/A440, Water Penetration Resistance Test.

a. Test Pressure: 15 percent of positive design pressure, but not less than 2.9 lbf/sq. ft. (140 Pa) or more than 12 lbf/sq. ft. (580 Pa), (if performance equal to minimum for all other classes set by AAMA/WDMA/CSA 101/I.S.2/A440 is required).
b. Test Pressure: 20 percent of positive design pressure, but not more than 12 lbf/sq. ft. (580 Pa), (if performance equal to minimum for AW class sliding doors set by AAMA/WDMA/CSA 101/I.S.2/A440 is required).

8. Forced-Entry Resistance: Comply with Performance Grade 10 requirements when tested according to ASTM F 842 (if AAMA/WDMA/CSA 101/I.S.2/A440 is the method selected for specifying sliding door performance).
9. Life-Cycle Testing (for AW class sliding doors only): Tested according to and complying with AAMA/WDMA/CSA 101/I.S.2/A440.
10. Operating Force and Auxiliary (Durability) Tests: Tested according to and complying with AAMA/WDMA/CSA 101/I.S.2/A440.

C. Glazing
1. Glass and Glazing System: Comply with Division 08 Section "Glazing" for safety glass, insulating-glass units, laminated glass, and glazing requirements applicable to glazed sliding aluminum-framed glass doors.

D. Hardware
1. Comply with AAMA/WDMA/CSA 101/I.S.2/A440.

E. Insect Screens
1. General: Design sliding aluminum-framed glass doors and hardware to accommodate screens in a tight-fitting, removable arrangement, with a minimum of exposed fasteners and latches. Fabricate insect screens to fully integrate with door frame. Locate screens on the inside **OR** outside, **as directed**, of door and provide for each operable door panel. Comply with SMA 1201.
2. Insect Screen Frames: Manufacturer's standard extruded-aluminum **OR** formed-tubular-aluminum, **as directed**, members, with mitered or coped joints, concealed fasteners, adjustable rollers, and removable PVC or PE spline/anchor concealing edge of mesh.
   a. Finish: Anodized aluminum **OR** Baked-on organic coating, **as directed**, in manufacturer's standard color.
   OR
   Finish: Anodized aluminum **OR** Baked-on organic coating, **as directed**, in color selected from manufacturer's full range.
   OR
   Finish: Manufacturer's standard.
3. Glass-Fiber Mesh Fabric: ASTM D 3656, 18-by-14 or 18-by-16 **OR** 20-by-20 or 20-by-30, **as directed**, count per sq. in. (645-sq. mm) mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration.
   a. Mesh Color: Charcoal gray **OR** Silver gray **OR** Aquamarine, **as directed**.
4. Aluminum Wire Fabric: 18-by-16 count per sq. in. (645-sq. mm) mesh of 0.011-inch- (0.28-mm-) diameter, coated aluminum wire.
   a. Wire-Fabric Finish: Natural bright **OR** Charcoal gray **OR** Black, **as directed**.
5. Hardware: Extruded, cast, or wrought aluminum **OR** Die-cast zinc with special coating finish **OR** Cadmium-plated steel **OR** Zinc-plated steel **OR** Nonmagnetic stainless steel, **as directed**.
   a. Lock: Manufacturer's standard pull and keyless locking device on each movable panel, lockable from inside only. Adjust locking device to allow unobstructed movement of panel across adjacent panel in direction indicated.

F. Fabrication
1. Fabricate sliding aluminum-framed glass doors in sizes indicated. Include a complete system for assembling components and anchoring doors.
2. Fabricate sliding aluminum-framed glass doors that are reglazable without dismantling panel framing.

3. Thermally Improved Construction: Fabricate sliding aluminum-framed glass doors with an integral, concealed, low-conductance thermal barrier; locate between exterior materials and door members exposed on interior side, and in a manner that eliminates direct metal-to-metal contact.
   a. Provide thermal-break construction that has been in use for not less than three years and has been tested to demonstrate resistance to thermal conductance and condensation and to show adequate strength and security of glass retention.
   b. Provide thermal barriers tested according to AAMA 505; determine the allowable design shear flow per the appendix in AAMA 505.
   c. Provide hardware with low conductivity, or provide nonmetallic material for hardware bridging thermal breaks at frame.
4. Weather Stripping: Provide operable panels with a double row of sliding weather stripping in horizontal rails and single-row **OR** double-row, **as directed**, weather stripping in meeting or jamb stiles. Provide compression-type weather stripping at the perimeter of each movable panel where sliding-type weather stripping is not appropriate.
   a. Provide weather stripping locked into extruded grooves in door panels or frames.
5. Weep Holes: Provide weep holes and internal drainage passages to conduct infiltrating water to exterior.
6. Factory-Glazed Fabrication: Glaze sliding aluminum-framed glass doors in the factory where practical and possible for applications indicated. Comply with requirements in Division 8 Section "Glazing" and with AAMA/WDMA/CSA 101/I.S.2/A440.
7. Glazing Stops: Provide snap-on glazing stops coordinated with Division 8 Section "Glazing" and with glazing system indicated. Provide glazing stops to match panel frames.

G. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

H. Aluminum Finishes
1. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
2. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from full range of industry colors and color densities, **as directed**.
3. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
4. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
5. High-Performance Organic Finish: Three **OR** Four, **as directed**,-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

1.3 EXECUTION

A. Examination
1. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
   a. Masonry Surfaces: Visibly dry and free of excess mortar, sand, and other construction debris.
   b. Wood Frame Walls: Dry, clean, sound, well nailed, free of voids, and without offsets at joints. Ensure that nail heads are driven flush with surfaces in opening and within 3 inches (76 mm) of opening.
   c. Metal Surfaces: Dry; clean; free of grease, oil, dirt, rust, corrosion, and welding slag; without sharp edges or offsets at joints.
2. Verify rough opening dimensions, levelness of threshold substrate, and operational clearances.
3. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure a coordinated, weathertight sliding aluminum-framed glass door installation.
4. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation
1. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing doors, hardware, accessories, and other components.
2. Install sliding aluminum-framed glass doors level, plumb, square, true to line, without distortion, warp or rack of frames and panels, or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing, vapor retarders, air barriers, water/weather barriers, and other adjacent construction.
3. Set sill members in bed of sealant or with gaskets, as indicated, to provide weathertight construction.
4. Install sliding aluminum-framed glass doors and components to drain condensation, water penetrating joints, and moisture migrating within doors to the exterior.
5. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials according to ASTM E 2112, Section 5.12 "Dissimilar Materials."

C. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Tests and Inspections:
   a. Testing Methodology: Testing of sliding aluminum-framed glass doors for air penetration resistance and water resistance will be performed according to AAMA 502, Test Method A **OR** Test Method B, **as directed**, by applying same test pressures required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440.
   b. Testing Extent: Three sliding aluminum-framed glass doors as selected by the Owner and a qualified independent testing and inspecting agency. Sliding doors shall be tested immediately after installation.
3. Sliding aluminum-framed glass door will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports according to AAMA 502. Testing agency will interpret test results and state in each report whether tested work complies with or deviates from requirements.

D. Adjusting, Cleaning, And Protection
1. Lubricate hardware and moving parts.

2. Adjust operating panels and screens to provide a tight fit at contact points and weather stripping for smooth operation, without binding, and a weathertight closure.
3. Adjust hardware for proper alignment, smooth operation, and proper latching without unnecessary force or excessive clearance.
4. Clean aluminum surfaces immediately after installing sliding doors. Comply with manufacturer's written recommendations for final cleaning and maintenance. Avoid damaging protective coatings and finishes. Remove nonpermanent labels, and clean surfaces.
5. Clean glass immediately after installing sliding aluminum-framed glass doors. Comply with manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels and clean surfaces.
6. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.
7. Protect sliding door surfaces from contact with contaminating substances resulting from construction operations. During construction, monitor sliding door surfaces adjacent to and below exterior concrete and masonry surfaces for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances do contact sliding door surfaces, remove contaminants immediately according to manufacturer's written instructions.
8. Refinish or replace sliding aluminum-framed glass doors with damaged finishes.
9. Replace damaged components.

END OF SECTION 08 18 16 00

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. This specification covers the furnishing and installation of materials. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 SUMMARY

A. Section Includes:

1. Aluminum-clad sliding wood-framed glass doors.
2. Vinyl-clad sliding wood-framed glass doors.
3. Unclad sliding wood-framed glass doors.

B. Related Requirements:

1. Section 085200 "Wood Windows" for related wood-framed transom and sidelite windows and mullions.
2. [**Section 087100 "Door Hardware"**] [**Section 087111 "Door Hardware (Descriptive Specification)"**] for hardware not specified in Section 083219.
3. Section 099300 "Staining and Transparent Finishing" for on-site finishing of unfinished sliding wood-framed glass doors.
4. [**Section 099113 "Exterior Painting"**] [**and**] [**Section 099123 "Interior Painting"**] for on-site finishing of [**unfinished**] [**and**] [**factory-primed**] sliding wood-framed glass doors.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, fabrication methods, dimensions of individual components and profiles, hardware, finishes, and operating instructions.

B. Sustainable Design Submittals:

1. <u>Chain-of-Custody Certificates</u>: For certified wood products. Include statement of costs.
2. <u><Double click to insert sustainable design text for certified wood.></u>

C. Shop Drawings: For sliding wood-framed glass doors.

1. Include plans, elevations, sections, and details.
2. Detail attachments to other work, and between units, if any.

3. Include hardware and required clearances.

D. Samples: For each exposed product and for each color specified, 12-inch-long (300-mm-long) section with weather stripping, glazing bead, and factory-applied color finish.

E. Samples for Initial Selection: For units with factory-applied color finishes.

1. Include Samples of hardware and accessories involving color selection.

F. Samples for Verification: For sliding wood-framed glass doors and components required, prepared on Samples of size indicated below:

1. Main Framing Member: 12-inch-long (300-mm-long) section with weather stripping, glazing bead, and factory-applied color finish.
2. Hardware: Full-size units with factory-applied finish.
3. <**Insert component**>:.

G. Product Schedule: For sliding wood-framed glass doors.[**Use same designations indicated on Drawings.**]

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**] [**and**] [**testing agency**].

B. Product Test Reports: For each sliding wood-framed glass door, for tests performed by [**manufacturer and witnessed by a qualified testing agency**] [**a qualified testing agency**], and for each class and performance grade indicated, tested at AAMA gateway size.

C. Field quality-control reports.

D. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For [**finishes,**]weather stripping, operable panels, and operating hardware to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. <Double click to insert sustainable design text for manufacturer qualifications.>

B. <Double click to insert sustainable design text for vendor qualifications.>

C. Installer Qualifications: An installer acceptable to sliding wood-framed glass door manufacturer for installation of units required for this Project.

D. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup for sliding wood-framed glass doors, as shown on Drawings.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless the Owner specifically approves such deviations in writing.

1.8 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace sliding wood-framed glass doors that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to meet performance requirements.
b. Structural failures including excessive deflection.
c. Excessive water leakage or air infiltration.
d. Faulty operation of movable panels and hardware.
e. Deterioration of wood, metals, finishes, vinyl, and other materials beyond normal weathering.
f. Failure of insulating glass[**and laminated glass**].
g. .

2. Warranty Period:

a. Sliding Door: [**Two**] [**Three**] [**Five**] years from date of Substantial Completion.
b. Insulating Glass: [**10**] [**20**] years from date of Substantial Completion.
c. Laminated Glass: [**Five**] years from date of Substantial Completion.
d. Metal Finish: [**Five**] [**10**] [**20**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain sliding wood-framed glass doors from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

1. Product Certification: AAMA certified with label attached to each door.

B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:

1. Minimum Performance Class: [**Class R**] [**Class LC**] [**Class CW**] [**As indicated on Drawings**].
2. Minimum Performance Grade: [**Grade 15**] [**Grade 20**] [**Grade 25**] [**Grade 30**] [**Grade 35**] [**Grade 40**] [**Grade 45**] [**Grade 50**] [**As indicated on Drawings**].

C. Thermal Transmittance: NFRC 100 maximum total fenestration product U-factor of [**0.32 Btu/sq. ft. x h x deg F (1.83 W/sq. m x K)**] [**0.54 Btu/sq. ft. x h x deg F (3.06 W/sq. m x K)**] [**0.56 Btu/sq. ft. x h x deg F (3.17 W/sq. m x K)**].

D. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum total fenestration product SHGC of [**0.30**] [**0.27**].

E. Sound Transmission Class (STC): Rated for not less than [**28**] [**32**] STC when tested for laboratory sound transmission loss according to ASTM E90 and determined by ASTM E413.

F. Outside-Inside Transmission Class (OITC): Rated for not less than [**23**] [**27**] [**29**] OITC when tested for laboratory sound transmission loss according to ASTM E90 and determined by ASTM E1332.

G. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**] [**2**] [**3**] [**4**] for [**basic**] [**enhanced**] protection.

1. Large-Missile Test: For glazing located within [**30 feet (9.1 m)**] of grade.
2. Small-Missile Test: For glazing located between 30 feet (9.1 m) and [**60 feet (18.3 m)**] above grade.

2.3 ALUMINUM-CLAD SLIDING WOOD-FRAMED GLASS DOORS

A.

B. Exterior Surfaces: Aluminum cladding with [**manufacturer's standard baked-on enamel finish**] [**manufacturer's standard high-performance organic finish**] [**manufacturer's standard fluoropolymer two-coat system with fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight and complying with AAMA 2605**].

1. Color: [**As selected by the Owner from manufacturer's full range**].

C. Interior Surfaces: [**Unfinished**] [**Manufacturer's standard factory-applied primer**] [**Manufacturer's standard factory-applied color finish**] [**Manufacturer's standard stain-and varnish-finish**].

1. Wood Species: [**Manufacturer's standard species**] [**Pine**] [**Mahogany**] [**Fir**] [**Alder**] [**Oak**] [**Cherry**] <**Insert species**>.
2. Color: [**As selected by the Owner from manufacturer's full range**].

D. Frames and Door Panels: Fabricate from wood components complying with indicated requirements. Provide factory-assembled [**narrow-profile**] [**standard-profile**] [**wide-profile**] door panels and [**factory-assembled**] [**or**] [**field-assembled**] frames.

1. True Divided Lites: Provide glazing with true muntins resulting in individually glazed lites, in pattern indicated.

E. Certified Wood: Wood doors shall [**contain not less than 60 percent**] [**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "Technical Barriers to Trade."

F. Wood Components: Manufacturer's standard LVL or fine-grained wood lumber complying with AAMA/WDMA/CSA 101/I.S.2/A440; kiln dried to a moisture content of not more than 12 percent at time of fabrication; free of visible finger joints, blue stain, knots, pitch pockets, and surface checks larger than 1/32 inch (0.8 mm) deep by 2 inches (51 mm) wide; water-repellent preservative treated.

G. Trim and Glazing Stops: Material and finish to match [**frame members**] [**cladding**].

H. Mullions: Provide mullions and mullion casing and cover plates as shown, matching door units, complete with anchors for support to structure and installation of sliding wood-framed glass door units. Allow for erection tolerances and provide for movement of door units due to thermal expansion and building deflections, as indicated. Provide mullions and cover plates capable of withstanding design loads of door units.

I. Integral Nailing Fin: Aluminum nailing fins for securing frame to structure; provide sufficient strength to withstand design pressure indicated.

J. Drip Caps: Extruded aluminum, factory fabricated and finished to match door frame; designed to direct water away from building when installed horizontally at head of sliding wood-framed glass doors.

K. Threshold and Sill Cap/Track: Provide [**pultruded fiberglass threshold with polycarbonate track**] [**extruded-aluminum threshold and track**] [**extruded-aluminum threshold and track with nonmagnetic stainless-steel cover**] [**manufacturer's standard threshold and track**] <**Insert description of threshold and track**> of thickness, dimensions, and profile indicated; designed to comply with performance requirements indicated and to drain to exterior.

1. Color: [**Bronze**] [**Black**] [**Beige**] [**Mill finish**] [**Manufacturer's standard**].
2. Low-Profile Floor Track: ADA-ABA compliant.

2.4 VINYL-CLAD SLIDING WOOD-FRAMED GLASS DOORS

A.

B. Exterior Surfaces: Vinyl-clad frames; vinyl-clad or high performance color-coated finish door panels.

1. Color: [**As selected by the Owner from manufacturer's full range**].

C. Interior Surfaces: [**Unfinished**] [**Manufacturer's standard factory-applied primer**] [**Manufacturer's standard factory-applied color finish**] [**Manufacturer's standard stain-and-varnish finish**].

1. Wood Species: [**Manufacturer's standard species**] [**Pine**] [**Mahogany**] [**Fir**] [**Alder**] [**Oak**] [**Cherry**] <**Insert species**>.
2. Color: [**As selected by the Owner from manufacturer's full range**].

D. Frames and Door Panels: Fabricate from wood components complying with indicated requirements. Provide factory-assembled [**narrow-profile**] [**standard-profile**] [**wide-profile**] door panels and [**factory-assembled**] [**or**] [**field-assembled**] frames.

1. True Divided Lites: Provide glazing with true muntins resulting in individually glazed lites, in pattern indicated.

E. <u>Certified Wood</u>: Wood doors shall [**contain not less than 60 percent**] [**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "Technical Barriers to Trade."

F. Wood Components: Manufacturer's standard LVL or fine-grained wood lumber complying with AAMA/WDMA/CSA 101/I.S.2/A440; kiln dried to a moisture content of not more than 12 percent at time of fabrication; free of visible finger joints, blue stain, knots, pitch pockets, and surface checks larger than 1/32 inch (0.8 mm) deep by 2 inches (51 mm) wide; water-repellent preservative treated.

G. Trim and Glazing Stops: Material and finish to match [**frame members**] [**cladding**].

H. Mullions: Provide mullions and mullion casing and cover plates as shown, matching door units, complete with anchors for support to structure and installation of sliding wood-framed glass door units. Allow for erection tolerances and provide for movement of door units due to thermal expansion and building deflections, as indicated. Provide mullions and cover plates capable of withstanding design loads of door units.

I. Integral Nailing Fin: PVC nailing fins for securing frame to structure; provide sufficient strength to withstand design pressure indicated.

J. Drip Caps: Extruded aluminum, factory fabricated and finished to match door frame; designed to direct water away from building when installed horizontally at head of sliding wood-framed glass doors.

K. Threshold and Sill Cap/Track: Provide [**pultruded fiberglass threshold with polycarbonate track**] [**extruded-aluminum threshold and track**] [**extruded-aluminum threshold and track with nonmagnetic stainless-steel cover**] [**manufacturer's standard threshold and track**] <**Insert description of threshold and track**> of thickness, dimensions, and profile indicated; designed to comply with performance requirements indicated and to drain to exterior.

1. Color: [**Bronze**] [**Black**] [**Beige**] [**Mill finish**] [**Manufacturer's standard**].
2. Low-Profile Floor Track: ADA-ABA compliant.

2.5 UNCLAD SLIDING WOOD-FRAMED GLASS DOORS

A.

B. Exterior Surfaces: [**Manufacturer's standard factory-applied primer**] [**Manufacturer's standard factory-applied color finish**] [**Unfinished**].

1. Wood Species: [**Manufacturer's standard paint-grade species**] [**Pine**] [**Mahogany**] <**Insert species**>.
2. Color: [**As selected by the Owner from manufacturer's full range**].

C. Interior Surfaces: [**Unfinished**] [**Manufacturer's standard factory-applied primer**] [**Manufacturer's standard factory-applied color finish**] [**Manufacturer's standard stain-and-varnish finish**].

1. Wood Species: [**Pine**] [**Mahogany**] [**Fir**] [**Alder**] [**Oak**] [**Cherry**] [**Manufacturer's standard paint-grade species**] <**Insert species**>.
2. Color: [**As selected by the Owner from manufacturer's full range**].

D. Frames and Door Panels: Fabricate from wood components complying with indicated requirements. Provide factory-assembled [**narrow-profile**] [**standard-profile**] [**wide-profile**] door panels and [**factory-assembled**] [**or**] [**field-assembled**] frames.

1. True Divided Lites: Provide glazing with true muntins resulting in individually glazed lites, in pattern indicated.

E. <u>Certified Wood</u>: Wood doors shall [**contain not less than 60 percent**] [**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "Technical Barriers to Trade."

F. Wood Components: Manufacturer's standard LVL or fine-grained wood lumber complying with AAMA/WDMA/CSA 101/I.S.2/A440; kiln dried to a moisture content of not more than 12 percent at time of fabrication; free of visible finger joints, blue stain, knots, pitch pockets, and surface checks larger than 1/32 inch (0.8 mm) deep by 2 inches (51 mm) wide; water-repellent preservative treated.

G. Trim and Glazing Stops: Material and finish to match [**frame members**] [**cladding**].

H. Mullions: Provide mullions and mullion casing and cover plates as shown, matching door units, complete with anchors for support to structure and installation of sliding wood-framed glass door units. Allow for erection tolerances and provide for movement of door units due to thermal expansion and building deflections, as indicated. Provide mullions and cover plates capable of withstanding design loads of door units.

I. Integral Nailing Fin: [**PVC**] [**Aluminum**] nailing fins for securing frame to structure; provide sufficient strength to withstand design pressure indicated.

J. Drip Caps: Extruded aluminum, factory fabricated and finished to match door frame; designed to direct water away from building when installed horizontally at head of sliding wood-framed glass doors.

K. Threshold and Sill Cap/Track: Provide [**pultruded fiberglass threshold with polycarbonate track**] [**extruded-aluminum threshold and track**] [**extruded-aluminum threshold and track with nonmagnetic stainless-steel cover**] [**manufacturer's standard threshold and track**] <**Insert description of threshold and track**> of thickness, dimensions, and profile indicated; designed to comply with performance requirements indicated and to drain to exterior.

1. Color: [**Bronze**] [**Black**] [**Beige**] [**Mill finish**] [**Manufacturer's standard**].
2. Low-Profile Floor Track: ADA-ABA compliant.

2.6 GLAZING

A. Glass and Glazing: Manufacturer's standard glazing system that produces weathertight seal.[**Comply with requirements for windborne-debris resistance.**] <**Insert glazing requirements.**>

1. Glass: ASTM C1036, Type 1, q3, Category II safety glass complying with testing requirements in 16 CFR 1201.
2. Safety Glazing Labeling: Permanently mark safety glazing with certification label of [**the SGCC**] [**the SGCC or another certification agency acceptable to authorities having jurisdiction**] [**or**] [**the manufacturer**]. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
3. Tint: [**Clear**] [**Gray**] [**Bronze**] [**Green**] <**Insert tint**>.
4. Insulating-Glass Units: ASTM E2190[**, certified through IgCC as complying with requirements of IgCC**].

   a. Filling: Fill space between glass lites with [**air**] [**argon**].
   b. Lites: [**Two**] [**Three**].
   c. Low-E Coating: [**Manufacturer's standard**] [**Pyrolytic on second surface**] [**Sputtered on second surface**] [**Sputtered on third surface**] [**Sputtered on second or third surface**] <**Insert coating**>.
   d. Integral Louver Blinds: Glass manufacturer's standard horizontal louver blinds with aluminum slats and polyester fiber cords, located in space between glass lites, and operated by hardware located on inside face of door panel.

      1) Operation: [**Tilt only**] [**Tilt, raising, and lowering**].
      2) Color: [**As indicated by manufacturer's designations**] [**Match the Owner's sample**] [**As selected by the Owner from manufacturer's full range**].

5. Dual Glazing:

a. Interior Lite: [**Glass**].
b. Exterior Lite: [**Glass**] [**Insulating-glass unit**].

2.7 HARDWARE

A. General: Provide manufacturer's standard hardware, fabricated from a corrosion-resistant material compatible with wood[**and aluminum cladding**] complying with AAMA 907; designed to smoothly operate, tightly close, and securely lock sliding wood-framed glass doors; and sized to accommodate panel weight and dimensions.

B. Door Pulls: Provide manufacturer's standard [**metal**] [**wood**] [**metal or wood**] pull grips.

C. Lock: Install manufacturer's keyed cylinder lock and [**multipoint**] locking device on each movable panel, lockable from the inside [**only**] [**and outside**]. Adjust locking device to allow unobstructed movement of the panel across adjacent panel in the direction indicated.

1. Keying System: [**All cylinders keyed alike**] [**Keyed to match other building entrances**] <**Insert instructions**>.

D. Security Foot Bolt: Provide security foot-operated dead bolt attached to bottom rail of movable sliding door panels to lock the panel when fully closed and when partially open to permit ventilation.

E. Limit Stops: Resilient rubber.

2.8 INSECT SCREENS

A. General: Design sliding wood-framed glass doors to accommodate screens in a tight-fitting, removable arrangement fully integrated with door frame. Locate screens on the [**inside**] [**outside**] of door and provide for each operable door panel. Comply with SMA 1201.

B. Insect Screen Frames: Manufacturer's standard [**extruded-aluminum**] [**or**] [**formed-tubular-aluminum**] members, with mitered or coped joints, concealed fasteners, adjustable rollers, and removable PVC or PE spline/anchor concealing edge of mesh. Provide finish to match door frame.

C. Glass-Fiber Mesh Fabric: ASTM D3656, [**18-by-14 or 18-by-16**] [**20-by-20 or 20-by-30**] count per sq. in. (645-sq.-mm) mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration. Comply with ASTM D3656.

1. Mesh Color: [**Manufacturer's standard**] [**Charcoal gray**] [**Silver gray**].

D. Aluminum Wire Fabric: 18-by-16 (1.1-by-1.3-mm) mesh of 0.011-inch-diameter (0.28-mm-diameter) coated aluminum wire.

1. Wire-Fabric Finish: [**Manufacturer's standard**] [**Natural bright**] [**Charcoal gray**] [**Black**].

E. Hardware: Manufacturer's standard noncorrosive metal.

1. Lock: Manufacturer's standard pull and keyless locking device on each movable panel, lockable from inside only designed to allow unobstructed movement of panel across adjacent panel.

2.9 ACCESSORIES

A. Grilles (False Muntins): Provide grilles in designs indicated, for removable application to inside of each panel lite.

1. Type: [**Interior, removable**] [**Exterior and interior, removable**] [**Exterior and interior, adhered to glass**] [**with between-glass grille**].
2. Material: To match adjacent finish of door panel.
3. Design: [**Rectangular**] [**Diamond**] [**as indicated on Drawings**] <**Insert design**>.
4. Bar Width: Not less than [**3/4 inch (19 mm)**] [**7/8 inch (22 mm)**] [**1-1/8 inches (28 mm)**] wide.
5. Bar Profile: [**Beveled**] [**Ovolo**] [**Square**].
6. Color: [**White**] [**Bronze**] [**As selected by the Owner from manufacturer's full range**].

B. Fasteners: Noncorrosive and compatible with door members, trim, hardware, anchors, and other components.

1. Exposed Fasteners: Do not use exposed fasteners to the greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

C. Anchors, Clips, and Accessories: Provide anchors, clips, and accessories of aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron for sliding wood-framed glass doors, complying with ASTM B456 or ASTM B633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

1. Windborne-Debris Resistance: Provide anchors of same design used in windborne-debris resistance testing.

2.10 FABRICATION

A. Fabricate sliding wood-framed glass doors in sizes indicated. Include a complete system for assembling components and anchoring doors.

B. Fabricate sliding wood-framed glass doors that are reglazable without dismantling panel framing.

C. Weather Stripping: Provide full-perimeter weather stripping for each door panel unless otherwise indicated.

D. Factory-machine sliding wood-framed glass doors for openings and hardware that is not surface applied.

E. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation. Allow for scribing, trimming, and fitting at Project site.

F. Factory-Glazed Fabrication: Glaze sliding wood-framed glass doors in the factory.

2.11 WOOD FINISHES

A. Factory-Applied Primer: Provide manufacturer's standard factory-applied prime coat complying with WDMA T.M. 11. <**Insert specific requirements for factory-applied prime coat if any**> on exposed [**exterior**] [**and**] [**interior**] wood surfaces.

B. Factory-Applied Color Finish: Provide manufacturer's standard factory-applied finish [**complying with WDMA T.M. 12**] <**Insert manufacturer's standard finish**>. Apply finish to exposed [**exterior**] [**and**] [**interior**] wood surfaces.

1. Color: [**White**] [**Brown**] [**Gray**] [**As selected by the Owner from manufacturer's full range**].

2.12 ALUMINUM FINISHES

A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**] [**Match the Owner's sample**] [**As selected by the Owner from manufacturer's full range**].

B. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with [**AAMA 2604**] [**AAMA 2605**] and containing not less than [**50**] [**70**] percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**] [**Match the Owner's sample**] [**As selected by the Owner from manufacturer's full range**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify rough opening dimensions, levelness of threshold substrate, and operational clearances.

C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure a coordinated, weathertight sliding door installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing sliding doors, hardware, accessories, and other components.

B. Windborne-Debris Resistance: Anchor sliding wood-framed glass doors that have been tested for windborne-debris resistance to structure using anchoring method, fastener type, and fastening frequency identical to that used in windborne-debris resistance testing.

C. Install sliding wood-framed glass doors level, plumb, square, true to line, without distortion, without warp or rack of frames and panels, and without impeding thermal movement; anchored securely in place to structural support; and in proper relation to wall flashing, vapor retarders, air barriers, water/weather barriers, and other adjacent construction. Comply with ASTM E2112.

D. Set sill members in bed of sealant or with gaskets, as indicated, to provide weathertight construction.

E. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials according to ASTM E2112, Section 5.12, "Dissimilar Materials."

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.

B. Testing Services: Test and inspect installed sliding wood-framed glass doors as follows:

1. Testing Methodology: Test sliding wood-framed glass doors for air infiltration and water resistance according to AAMA 502.
2. Air-Infiltration Testing:

a. Test Pressure: That required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance class indicated.
b. Allowable Air-Leakage Rate: [**1.5**] times the applicable AAMA/WDMA/CSA 101/I.S.2/A440 rate for product type and performance class rounded down to one decimal place.

3. Water-Resistance Testing:

a. Test Pressure: [**Two-thirds**] times test pressure required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance grade indicated.
b. Allowable Water Infiltration: No water penetration.

4. Testing Extent: [**Three**] [**Three mockup**] <**Insert number or description**> sliding wood-framed glass doors of each type as selected by the Owner and a qualified independent testing and inspecting agency. Conduct tests after perimeter sealants have cured.
5. Test Reports: Prepared according to AAMA 502.

C. Sliding wood-framed glass door will be considered defective if it does not pass tests and inspections.

3.4 ADJUSTING, CLEANING, AND PROTECTION

A. Lubricate hardware and moving parts.

B. Adjust operating panels and screens to provide a tight fit at contact points and weather stripping for smooth operation, without binding, and weathertight closure.

C. Adjust hardware for proper alignment, smooth operation, and proper latching without unnecessary force or excessive clearance.

D. Clean exposed surfaces immediately after installing sliding wood-framed glass doors. Avoid damaging protective coatings and finishes. Remove nonpermanent labels, excess sealants, glazing materials, dirt, and other substances.

E. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

F. Protect sliding wood-framed glass door surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances contact sliding wood-framed glass door surfaces, remove contaminants immediately according to manufacturer's written instructions.

G. Refinish or replace sliding doors with damaged finishes.

H. Replace damaged components.

END OF SECTION 08 18 16 00a

SECTION 08 31 13 00 - ACCESS DOORS AND FRAMES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of material for access doors and frames. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Access doors and frames for walls and ceilings.
      b. Floor access doors and frames.

C. Submittals
   1. Product Data: For each type of access door and frame indicated.
   2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   3. Samples: For each door face material in specified finish.
   4. Schedule: Types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

D. Quality Assurance
   1. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics per the following test method and that are listed and labeled by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
      a. NFPA 252 or UL 10B for vertical access doors and frames.
      b. ASTM E 119 or UL 263 for horizontal access doors and frames.

1.2 PRODUCTS

A. Steel Materials
   1. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
      a. ASTM A 123/A 123M, for galvanizing steel and iron products.
      b. ASTM A 153/A 153M, for galvanizing steel and iron hardware.
   2. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.
      a. ASTM A 123/A 123M, for galvanizing steel and iron products
      b. ASTM A 153/A 153M, for galvanizing steel and iron hardware.
   3. Steel Sheet: Uncoated or electrolytic zinc-coated, ASTM A 591/A 591M with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.
   4. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS) with A60 (ZF180) zinc-iron-alloy (galvannealed) coating or G60 (Z180) mill-phosphatized zinc coating.
   5. Steel Finishes: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
      a. Surface Preparation for Steel Sheet: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
      b. Surface Preparation for Metallic-Coated Steel Sheet: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds,

mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.
1) Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.
c. Factory-Primed Finish: Apply shop primer immediately after cleaning and pretreating.
d. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).
e. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils (0.04 mm). Prepare, treat, and coat metal to comply with resin manufacturer's written instructions.
6. Drywall Beads: Edge trim formed from 0.0299-inch (0.76-mm) zinc-coated steel sheet formed to receive joint compound and in size to suit thickness of gypsum board.
7. Plaster Beads: Casing bead formed from 0.0299-inch (0.76-mm) zinc-coated steel sheet with flange formed out of expanded metal lath and in size to suit thickness of plaster.

B. Stainless-Steel Materials
1. Rolled-Stainless-Steel Floor Plate: ASTM A 793, manufacturer's standard finish.
2. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304 **OR** 316 **OR** Type 317LMN **OR** 904L, **as directed**. Remove tool and die marks and stretch lines or blend into finish.
a. Finish: Directional Satin Finish, No. 4 **OR** Manufacturer's standard, **as directed**.

C. Aluminum Materials
1. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T6, mill finish.
2. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T6, mill finish.
3. Aluminum Sheet: ASTM B 209 (ASTM B 209M).
a. Mill Finish: AA-M10 (Mechanical Finish: as fabricated, unspecified).
b. Anodic Finish: Class II, clear anodic coating complying with AAMA 611 **OR** Class I, clear anodic coating complying with AAMA 611, **as directed**.
c. Baked-Enamel Finish: Manufacturer's standard.

D. Access Doors And Frames For Walls And Ceilings
1. Flush Access Doors and Frames with Exposed Trim: Fabricated from steel **OR** metallic-coated steel **OR** stainless-steel, **as directed**, sheet.
a. Locations: Wall **OR** Ceiling **OR** Wall and ceiling, **as directed**, surfaces.
b. Door: Minimum 0.060-inch- (1.5-mm-), **as directed,** thick sheet metal, set flush with exposed face flange of frame.
c. Frame: Minimum 0.060-inch- (1.5-mm-), **as directed**, thick sheet metal with 1-inch- (25-mm-) **OR** 1-1/4-inch- (32-mm-), **as directed**, wide, surface-mounted trim.
d. Hinges: Spring-loaded, concealed-pin type **OR** Continuous piano, **as directed**.
e. Latch: Cam latch **OR** Slam latch **OR** Self-latching bolt, **as directed**, operated by screwdriver **OR** knurled knob **OR** hex head wrench **OR** pinned hex head wrench **OR** spanner head wrench **OR** flush key **OR** ring turn, **as directed**, with interior release.
f. Lock: Cylinder **OR** Mortise cylinder, **as directed**.
1) Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware".
2. Flush Access Doors and Trimless Frames: Fabricated from steel **OR** metallic-coated steel **OR** stainless-steel, **as directed**, sheet.
a. Locations: Wall **OR** Ceiling **OR** Wall and ceiling, **as directed**, surfaces.
b. Door: Minimum 0.060-inch- (1.5-mm-), **as directed**, thick sheet metal, set flush with surrounding finish surfaces.

c. Frame: Minimum 0.060-inch- (1.5-mm-), **as directed**, thick sheet metal with drywall **OR** plaster, **as directed**, bead flange.
d. Hinges: Spring-loaded, concealed-pin type **OR** Continuous piano, **as directed.**
e. Latch: Cam latch **OR** Slam latch **OR** Self-latching bolt, **as directed**, operated by screwdriver **OR** knurled knob **OR** hex head wrench **OR** pinned hex head wrench **OR** spanner head wrench **OR** flush key **OR** ring turn, **as directed**, with interior release.
f. Lock: Cylinder **OR** Mortise cylinder, **as directed**.
   1) Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware".

3. Recessed Access Doors and Trimless Frames: Fabricated from steel **OR** metallic-coated steel **OR** stainless-steel, **as directed**, sheet.
   a. Locations: Wall **OR** Ceiling **OR** Wall and ceiling, **as directed**, surfaces.
   b. Door: Minimum 0.060-inch- (1.5-mm-), **as directed,** thick sheet metal in the form of a pan recessed 5/8 inch (16 mm) **OR** 1 inch (25 mm), **as directed**, for gypsum board **OR** plaster **OR** acoustical tile, **as directed**, infill.
   c. Frame: Minimum 0.060-inch- (1.5-mm-), **as directed**, thick sheet metal with drywall bead for gypsum board surfaces **OR** with plaster bead for plaster surfaces **OR** designed for insertion into acoustical tile ceiling, **as directed.**
   d. Hinges: Spring-loaded, concealed-pin type **OR** Concealed pivoting rod hinge, **as directed**.
   e. Latch: Cam latch **OR** Slam latch **OR** Self-latching bolt, **as directed**, operated by screwdriver **OR** knurled knob **OR** hex head wrench **OR** pinned hex head wrench **OR** spanner head wrench **OR** flush key **OR** ring turn, **as directed**, with interior release.
   f. Lock: Cylinder **OR** Mortise cylinder, **as directed**.
      1) Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware".
4. Aluminum Flush Access Doors and Frames with Exposed Trim: Fabricated from aluminum sheet and extruded-aluminum shapes.
   a. Locations: Wall **OR** Ceiling **OR** Wall and ceiling, **as directed**, surfaces.
   b. Door: Minimum 0.080-inch- (2.0-mm-), **as directed**, thick aluminum sheet.
   c. Frame: Minimum 0.060-inch- (1.5-mm-), **as directed**, thick extruded aluminum with 1-1/4-inch- (32-mm-) wide rolled flange.
   d. Hinges: Concealed continuous aluminum.
   e. Latch: Screwdriver-operated cam latch.
5. Lightweight Flush Access Doors and Frames with Exposed Trim: Fabricated from lightweight metal.
   a. Locations: Wall **OR** Ceiling **OR** Wall and ceiling, **as directed**, surfaces.
   b. Door: Minimum 0.018-inch- (0.45-mm-) thick steel sheet.
   c. Frame: Minimum 0.045-inch- (1.1-mm-) thick extruded aluminum with 1-1/4-inch- (32-mm-) wide rolled flange.
   d. Hinges: Continuous piano.
   e. Latch: Screwdriver-operated cam latch.
6. Plastic Flush Access Doors and Frames with Exposed Trim: Fabricated from 1/8-inch- (3.2-mm-) thick high-impact plastic with UV stabilizer.
   a. Locations: Wall **OR** Ceiling **OR** Wall and ceiling, **as directed**, surfaces.
   b. Door: Flush to frame with rounded corners.
   c. Frame: 1 piece, 3/4 inch (19 mm) deep.
   d. Latch: Snap latch.
   e. Finish: White with textured exposed surfaces.
7. Exterior Flush Access Doors and Frames with Exposed Trim: Weatherproof with extruded door gasket.
   a. Locations: Wall **OR** Ceiling **OR** Wall and ceiling, **as directed**, surfaces.
   b. Door: Minimum 0.040-inch- (1.0-mm-), **as directed**, thick, metallic-coated steel sheet; flush panel construction with manufacturer's standard 2-inch- (50-mm-) thick fiberglass insulation.
   c. Frame: Minimum 0.060-inch- (1.5-mm-), **as directed**, thick extruded aluminum.
   d. Hinges: Continuous piano, zinc plated.

e. Lock: Dual-action handles with key lock.

8. Fire-Rated, Insulated, Flush Access Doors and Frames with Exposed Trim: Fabricated from steel **OR** metallic-coated steel **OR** stainless-steel, **as directed**, sheet.
   a. Locations: Wall **OR** Ceiling **OR** Wall and ceiling, **as directed**, surfaces.
   b. Fire-Resistance Rating: Not less than that indicated **OR** that of adjacent construction **OR** 45 minutes **OR** 1 hour **OR** 1-1/2 hours **OR** 2 hours **OR** 3 hours, **as directed**.
   c. Temperature Rise Rating: 250 deg F (139 deg C) at the end of 30 minutes.
   d. Door: Flush panel with a core of mineral-fiber insulation enclosed in sheet metal with a minimum thickness of 0.036 inch (0.9 mm), **as directed**.
   e. Frame: Minimum 0.060-inch- (1.5-mm-), **as directed**, thick sheet metal with 1-inch- (25-mm-), **as directed,** wide, surface-mounted trim.
   f. Hinges: Concealed-pin type **OR** Continuous piano, **as directed**.
   g. Automatic Closer: Spring type.
   h. Latch: Self-latching device operated by knurled knob **OR** flush key **OR** ring turn, **as directed**, with interior release.
   i. Lock: Self-latching device with cylinder **OR** mortise cylinder, **as directed**, lock.
      1) Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware".
9. Fire-Rated, Insulated, Flush Access Doors and Trimless Frames: Fabricated from steel **OR** metallic-coated steel **OR** stainless-steel, **as directed**, sheet.
   a. Locations: Wall **OR** Ceiling **OR** Wall and ceiling, **as directed**, surfaces.
   b. Fire-Resistance Rating: Not less than that indicated **OR** that of adjacent construction **OR** 45 minutes **OR** 1 hour **OR** 1-1/2 hours **OR** 2 hours **OR** 3 hours, **as directed**.
   c. Temperature Rise Rating: 250 deg F (139 deg C) at the end of 30 minutes.
   d. Door: Flush panel with a core of mineral-fiber insulation enclosed in sheet metal with a minimum thickness of 0.036 inch (0.9 mm), **as directed**.
   e. Frame: Minimum 0.060-inch- (1.5-mm-), **as directed**, thick sheet metal with drywall **OR** plaster, **as directed**, bead.
   f. Hinges: Concealed-pin type **OR** Continuous piano, **as directed**.
   g. Automatic Closer: Spring type.
   h. Latch: Self-latching device operated by knurled knob **OR** flush key **OR** ring turn, **as directed**, with interior release.
   i. Lock: Self-latching device with cylinder **OR** mortise cylinder, **as directed**, lock.
      1) Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware".
10. Fire Rated, Uninsulated, Flush Access Doors and Frames with Exposed Trim: Fabricated from steel **OR** metallic-coated steel **OR** stainless-steel, **as directed**, sheet.
   a. Locations: Wall surfaces.
   b. Fire-Resistance Rating: Not less than that indicated **OR** that of adjacent construction **OR** 45 minutes **OR** 1 hour **OR** 1-1/2 hours **OR** 2 hours **OR** 3 hours, **as directed**.
   c. Door: Minimum 0.060-inch- (1.5-mm-), **as directed**, thick sheet metal, flush construction.
   d. Frame: Minimum 0.060-inch- (1.5-mm-), **as directed**, thick sheet metal with 1-inch- (25-mm-) **OR** 1-1/4-inch- (32-mm-), **as directed**, wide, surface-mounted trim.
   e. Hinges: Concealed-pin type **OR** Continuous piano, **as directed**.
   f. Automatic Closer: Spring type.
   g. Latch: Self-latching device operated by knurled knob **OR** flush key **OR** ring turn, **as directed**, with interior release.
   h. Lock: Self-latching device with cylinder **OR** mortise cylinder, **as directed**, lock.
      1) Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware".
11. Medium-Security, Flush Access Doors and Frames with Exposed Trim: Fabricated from steel **OR** metallic-coated steel **OR** stainless-steel, **as directed**, sheet.
   a. Locations: Wall **OR** Ceiling **OR** Wall and ceiling, **as directed**, surfaces.
   b. Door: Minimum 0.105-inch- (2.7-mm-) thick sheet metal, flush construction.

c. Frame: Minimum 0.105-inch- (2.7-mm-) thick sheet metal with 1-inch- (25-mm-) **OR** 1-1/4-inch- (32-mm-), **as directed**, wide, surface-mounted trim.
d. Hinges: Concealed continuous piano.
e. Lock: Detention.
   1) Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware".

12. Medium-Security, Flush Access Doors with Trimless Frames: Fabricated from steel **OR** metallic-coated steel **OR** stainless-steel, **as directed**, sheet.
   a. Locations: Wall **OR** Ceiling **OR** Wall and ceiling, **as directed**, surfaces.
   b. Door: Minimum 0.105-inch- (2.7-mm-) thick sheet metal, flush construction.
   c. Frame: Minimum 0.105-inch- (2.7-mm-) thick sheet metal with drywall **OR** plaster, **as directed**, bead.
   d. Hinges: Concealed continuous piano.
   e. Lock: Detention.
      1) Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware".
13. High-Security, Flush Access Doors and Frames with Exposed Trim: Fabricated from steel **OR** metallic-coated steel **OR** stainless-steel, **as directed,** sheet and angles.
   a. Locations: Wall **OR** Ceiling **OR** Wall and ceiling, **as directed,** surfaces.
   b. Door: Minimum 0.135-inch- (3.4-mm-) thick sheet metal, flush construction.
   c. Frame: Minimum 3/16-by-2-by-2-inch (4.7-by-50-by-50-mm) angle welded with joints ground smooth.
   d. Hinges: Heavy-duty steel welded to door and frame.
   e. Lock: Heavy-duty, detention deadbolt.
      1) Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware".
14. Maximum-Security, Flush Access Doors and Frames with Exposed Trim: Fabricated from steel **OR** metallic-coated steel **OR** stainless-steel, **as directed**, sheet and angles.
   a. Locations: Wall **OR** Ceiling **OR** Wall and ceiling, **as directed,** surfaces.
   b. Door: Minimum 0.180-inch- (4.55-mm-) thick sheet metal, flush construction.
   c. Frame: Minimum 3/16-by-2-by-2-by-3-inch (4.7-by-50-by-50-by-76-mm) angle welded with joints ground smooth.
   d. Hinges: Heavy-duty steel welded to door and frame.
   e. Lock: Heavy-duty detention deadbolt.
      1) Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware".
15. Fire-Rated, Insulated, Medium-Security, Flush Access Doors and Frames with Exposed Trim: Fabricated from steel **OR** metallic-coated steel **OR** stainless-steel, **as directed,** sheet.
   a. Locations: Wall surfaces.
   b. Fire-Resistance Rating: Not less than that indicated **OR** that of adjacent construction **OR** 45 minutes **OR** 1 hour **OR** 1-1/2 hours **OR** 2 hours **OR** 3 hours, **as directed**.
   c. Temperature Rise Rating: 250 deg F (139 deg C) at the end of 30 minutes.
   d. Door: Flush panel with a core of 2-inch- (50-mm-) thick, mineral-fiber insulation enclosed in sheet metal with a minimum thickness of 0.075 inch (1.9 mm).
   e. Frame: Minimum 0.060-inch- (1.5-mm-) thick sheet metal with 1-inch- (25-mm-) **OR** 1-1/4-inch- (32-mm-), **as directed**, wide, surface-mounted trim.
   f. Hinges: Concealed-pin type **OR** Continuous piano, **as directed**.
   g. Automatic Closer: Spring type.
   h. Lock: Self-latching device with detention lock.
      1) Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware".
16. Fire-Rated, Insulated, Medium-Security, Flush Access Doors with Trimless Frames: Fabricated from steel **OR** metallic-coated steel **OR** stainless-steel, **as directed,** sheet.
   a. Locations: Wall surfaces.
   b. Fire-Resistance Rating: Not less than that indicated **OR** that of adjacent construction **OR** 45 minutes **OR** 1 hour **OR** 1-1/2 hours **OR** 2 hours **OR** 3 hours, **as directed**.

c. Temperature Rise Rating: 250 deg F (139 deg C) at the end of 30 minutes.
d. Door: Flush panel with a core of 2-inch- (50-mm-) thick, mineral-fiber insulation enclosed in sheet metal with a minimum thickness of 0.075 inch (1.9 mm).
e. Frame: Minimum 0.060-inch- (1.5-mm-) thick sheet metal with drywall **OR** plaster, **as directed**, bead.
f. Hinges: Concealed-pin type **OR** Continuous piano, **as directed**.
g. Automatic Closer: Spring type.
h. Lock: Self-latching device with detention lock.
   1) Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware".

E. Floor Access Doors And Frames
1. Floor Doors, General: Equip each door with adjustable counterbalancing springs, heavy-duty hold-open arm that automatically locks door open at 90 degrees, release handle with red vinyl grip that allows for one-handed closure, and recessed lift handle.
2. Aluminum Floor Door: Single **OR** Double, **as directed,**-leaf opening. Extruded-aluminum angle frame with 1/4-inch- (6.4-mm-) thick, diamond-pattern, aluminum tread plate door; nonwatertight; loading capacity to support 150-lbf/sq. ft. (7.2-kN/sq. m) pedestrian live load **OR** 300-lbf/sq. ft. (14.4-kN/sq. m) pedestrian live load **OR** AASHTO H20 concentrated wheel load, without impact, **as directed**.
3. Watertight Aluminum Floor Door: Single **OR** Double, **as directed,**-leaf opening. Extruded-aluminum gutter frame with NPS 1-1/2 (DN 40) drainage coupling and 1/4-inch- (6.4-mm-) thick, diamond-pattern, aluminum tread plate door; watertight; loading capacity to support 150-lbf/sq. ft. (7.2-kN/sq. m) pedestrian live load **OR** 300-lbf/sq. ft. (14.4-kN/sq. m) pedestrian live load **OR** AASHTO H20 concentrated wheel load, without impact, **as directed**.
4. Steel Angle-Frame Floor Door: Single **OR** Double, **as directed,**-leaf opening. Prime-painted structural **OR** Galvanized structural **OR** Stainless, **as directed**,-steel frame with 3/16- or 1/4-inch- (4.8- or 6.4-mm-) **OR** 3/16-inch- (4.8-mm-) **OR** 1/4-inch- (6.4-mm-), **as directed**, thick, diamond-pattern, prime-painted structural **OR** galvanized structural **OR** stainless, **as directed,**-steel tread plate door; nonwatertight; loading capacity to support 150-lbf/sq. ft. (7.2-kN/sq. m) pedestrian live **OR** 300-lbf/sq. ft. (14.4-kN/sq. m) pedestrian live **OR** AASHTO H20 concentrated wheel, **as directed**, load.
   a. Fire-Resistance Rating: Not less than that indicated **OR** that of adjacent construction **OR** 45 minutes **OR** 1 hour **OR** 1-1/2 hours **OR** 2 hours **OR** 3 hours, **as directed**.
   b. Finish painted in yellow with wording "FIRE DOOR - DO NOT STORE MATERIALS ON SURFACE."
5. Watertight Steel Gutter-Frame Floor Door: Single **OR** Double, **as directed**,-leaf opening. Prime-painted structural **OR** Galvanized structural **OR** Stainless, **as directed**,-steel channel frame forming gutter with NPS 1-1/2 (DN 40) drainage coupling and 3/16- or 1/4-inch- (4.8- or 6.4-mm-) **OR** 3/16-inch- (4.8-mm-) **OR** 1/4-inch- (6.4-mm-), **as directed**, thick, diamond-pattern, prime-painted structural **OR** galvanized structural **OR** stainless, **as directed**,-steel tread plate door; watertight; loading capacity to support 150-lbf/sq. ft. (7.2-kN/sq. m) pedestrian live **OR** 300-lbf/sq. ft. (14.4-kN/sq. m) pedestrian live **OR** AASHTO H20 concentrated wheel, **as directed**, load.
   a. Fire-Resistance Rating: Not less than that indicated **OR** that of adjacent construction **OR** 45 minutes **OR** 1 hour **OR** 1-1/2 hours **OR** 2 hours **OR** 3 hours, **as directed**.
   b. Finish painted in yellow with wording "FIRE DOOR - DO NOT STORE MATERIALS ON SURFACE."
6. Hardware: Provide the following:
   a. Hinges: Heavy-duty, zinc-coated steel **OR** aluminum **OR** stainless-steel **OR** brass, **as directed**, butt hinges with stainless-steel pins.
   b. Latch: Stainless-steel slam latch.
   c. Lock: Staple for a padlock **OR** Recessed hasp **OR** Keyed deadlock bolt **OR** Hasp and staple, **as directed**.

d. Hardware Material: Manufacturer's standard **OR** Stainless steel, including latch and lifting mechanism assemblies, hold-open arms, and all brackets, hinges, pins, and fasteners, **as directed**.

7. Insulation: Fiberglass **OR** Urethane, **as directed**, with liner pan.
8. Safety Accessories: Safety chains **OR** net **OR** railing, **as directed**.

F. Fabrication

1. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
2. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
3. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of supports indicated.
4. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling.
5. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.
   a. For cylinder lock, furnish two keys per lock and key all locks alike.
   b. For recessed panel doors, provide access sleeves for each locking device. Furnish plastic grommets and install in holes cut through finish.
6. Extruded Aluminum: After fabrication, apply manufacturer's standard protective coating on aluminum that will come in contact with concrete.

1.3 EXECUTION

A. Installation

1. Comply with manufacturer's written instructions for installing access doors and frames.
2. Set frames accurately in position and attach securely to supports with plane of face panels aligned with adjacent finish surfaces.
3. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

B. Adjusting And Cleaning

1. Adjust doors and hardware after installation for proper operation.
2. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION 08 31 13 00

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SECTION 08 33 16 00 - OVERHEAD COILING GRILLES

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of material for overhead coiling grilles. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Open-curtain overhead coiling grilles.
   b. Closed-curtain overhead coiling grilles.

C. Performance Requirements

1. Delegated Design: Design overhead coiling grilles, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Seismic Performance: Overhead coiling grilles shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
   b. Seismic Component Importance Factor: 1.5 **OR** 1.0, **as directed**.
3. Operation Cycles: Provide overhead coiling grille components and operators capable of operating for not less than number of cycles indicated for each grille. One operation cycle is complete when a grille is opened from the closed position to the fully open position and returned to the closed position.

D. Submittals

1. Product Data: For each type and size of overhead coiling grille and accessory. Include the following:
   a. Construction details, material descriptions, dimensions of individual components, profiles for curtain components, and finishes.
   b. Rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
2. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work.
   a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   b. Wiring Diagrams: For power, signal, and control wiring.
3. Samples: For each type of exposed finish required, prepared on Samples of size indicated below.
   a. Open-Curtain Grille: 18-inch- (457-mm-) square assembly with full-size components consisting of rods, spacers, and links as required to illustrate each assembly, including glazed inserts, **as directed**.
   b. Closed-Curtain Grille: 18-inch- (457-mm-) square assembly with full-size components consisting of ribs and infill as required to illustrate each assembly.
   c. Bottom Bar: 6 inches (150 mm) long with sensor edge, **as directed**.
   d. Guides: 6 inches (150 mm) long.
   e. Mounting Frame: 6 inches (150 mm) long.
   f. Brackets: 6 inches (150 mm) square.
   g. Hood: 6 inches (150 mm) square.

4. Delegated-Design Submittal: For overhead coiling grilles indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   a. Detail fabrication and assembly of seismic restraints.
   b. Summary of forces and loads on walls and jambs.
5. Qualification Data: For qualified Installer.
6. Seismic Qualification Certificates: For overhead coiling grilles, accessories, and components, from manufacturer.
7. Maintenance Data: For overhead coiling grilles to include in maintenance manuals.

E. Quality Assurance
1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.
2. Source Limitations: Obtain overhead coiling grilles from single source from single manufacturer.
   a. Obtain operators and controls from overhead coiling grille manufacturer.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

1.2 PRODUCTS

A. Grille Curtain Materials And Construction
1. Open-Curtain Grilles: Fabricate metal grille curtain as an open network of horizontal rods, spaced at regular intervals, that are interconnected with vertical links, which are formed and spaced as indicated and are free to rotate on the rods.
   a. Aluminum Grille Curtain: ASTM B 221 (ASTM B 221M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
   b. Stainless-Steel Grille Curtain: ASTM A 666, Type 300 series.
   c. Steel Grille Curtain: Hot-dip zinc-coated (galvanized) complying with ASTM A 123/A 123M, or electrogalvanized complying with ASTM 653/A 653M, and phosphatized before fabrication.
   d. Glazing Insert: Manufacturer's standard glazing of clear polycarbonate sheet secured by the curtain links.
2. Closed-Curtain Grilles: Fabricate curtain as a series of horizontal double-C ribs, spaced at regular intervals, that alternate with continuous horizontal infill panels secured by the ribs.
   a. Aluminum Horizontal Ribs: ASTM B 221 (ASTM B 221M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
   b. Glass Panels: Uncoated, clear, heat-treated, fully tempered float glass; complying with ASTM C 1048, Condition A, Type I, Class I, Quality q3, Kind FT; manufacturer's standard panel dimensions and thickness.
   c. Plastic Panels: Fire-retardant polycarbonate sheet manufactured by the extrusion process; UV resistant; manufacturer's standard panel dimensions and thickness.
   d. Aluminum Panels: ASTM B 209 (ASTM B 209M), alloy and temper standard with manufacturer for type of use and finish indicated; manufacturer's standard panel dimensions and thickness; finished to match ribs.
      1) Perforations: Manufacturer's standard pinholes.
3. Endlocks: Continuous end links, chains, or other devices at ends of rods; locking and retaining grille curtain in guides against excessive pressures, maintaining grille curtain alignment, and preventing lateral movement.
4. Bottom Bar: Manufacturer's standard continuous channel or tubular shape, finished to match grille.

a. Astragal: Equip each grille bottom bar with a replaceable, adjustable, continuous, compressible gasket of flexible vinyl, rubber, or neoprene as a cushion bumper.
b. Provide motor-operated grilles with combination bottom astragal and sensor edge.
5. Grille Curtain Jamb Guides: Manufacturer's standard shape having curtain groove with return lips or bars to retain curtain. Provide continuous integral wear strips to prevent metal-to-metal contact and to minimize operational noise; with removable stops on guides to prevent overtravel of curtain.
a. Removable Posts and Jamb Guides: Manufacturer's standard.

B. Hoods And Accessories
1. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.
a. Galvanized Steel: Nominal 0.028-inch- (0.71-mm-) thick, hot-dip galvanized steel sheet with G90 (Z275) zinc coating, complying with ASTM A 653/A 653M.
b. Stainless Steel: 0.025-inch- (0.64-mm-) thick stainless-steel sheet, Type 304, complying with ASTM A 666.
c. Aluminum: 0.040-inch- (1.02-mm-) thick aluminum sheet complying with ASTM B 209 (ASTM B 209M), of alloy and temper recommended by manufacturer and finisher for type of use and finish indicated.
2. Removable Metal Soffit: Formed or extruded from same metal and with same finish as curtain if hood is mounted above ceiling, unless otherwise indicated.
3. Mounting Frame: Manufacturer's standard mounting frame designed to support grille; factory fabricated from ASTM A 36/A 36M structural-steel tubes or shapes, hot-dip galvanized per ASTM A 123/A 123M; fastened to floor and structure above grille; to be built into wall construction; and complete with anchors, connections, and fasteners.
4. Push/Pull Handles: Equip each push-up-operated or emergency-operated grille with lifting handles on each side of grille, finished to match grille.
a. Provide pull-down straps or pole hooks for grilles more than 84 inches (2130 mm) high.

C. Locking Devices
1. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.
2. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.
a. Lock Cylinders: Provide cylinders specified in Division 08 Section "Door Hardware" **OR** standard with manufacturer, **as directed**, and keyed to building keying system, **as directed**.
b. Keys: Two **OR** Three, **as directed**, for each cylinder.
3. Chain Lock Keeper: Suitable for padlock.
4. Safety Interlock Switch: Equip power-operated grilles with safety interlock switch to disengage power supply when grille is locked.

D. Counterbalancing Mechanism
1. General: Counterbalance grilles by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.
2. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, welded or seamless carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of parts and to limit barrel deflection to not more than 0.03 in./ft. (2.5 mm/m) of span under full load.

3. Spring Balance: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.
4. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.
5. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

E. Manual Grille Operators
1. Equip grille with manufacturer's recommended manual grille operator unless another type of grille operator is indicated.
2. Push-up Grille Operation: Design counterbalance mechanism so required lift or pull for grille operation does not exceed 25 lbf (111 N).
3. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum 25 lbf (111 N) **OR** 30 lbf (133 N), **as directed**, force for grille operation. Provide alloy-steel hand chain with chain holder secured to operator guide.
4. Crank Operator: Consisting of crank and crank gearbox, steel crank drive shaft, and gear-reduction unit, of type indicated. Size gears to require not more than 25 lbf (111 N) **OR** 30 lbf (133 N), **as directed**, force to turn crank. Fabricate gearbox to be oil tight and to completely enclose operating mechanism. Provide manufacturer's standard crank-locking device.

F. Electric Grille Operators
1. General: Electric grille operator assembly of size and capacity recommended and provided by grille manufacturer for grille and operation-cycles requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, remote-control stations, control devices, integral gearing for locking grille, and accessories required for proper operation.
   a. Comply with NFPA 70.
   b. Provide control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24 V, ac or dc.
2. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each grille.
3. Grille Operator Location(s): Operator location indicated for each grille.
   a. Top-of-Hood Mounted: Operator is mounted to the right or left grille head plate with the operator on top of the grille-hood assembly and connected to the grille drive shaft with drive chain and sprockets. Headroom is required for this type of mounting.
   b. Front-of-Hood Mounted: Operator is mounted to the right or left grille head plate with the operator on coil side of the grille-hood assembly and connected to the grille drive shaft with drive chain and sprockets. Front clearance is required for this type of mounting.
   c. Wall Mounted: Operator is mounted to the inside front wall on the left or right side of grille and connected to grille drive shaft with drive chain and sprockets. Side room is required for this type of mounting. Wall mounted operator can also be mounted above or below shaft; if above shaft, headroom is required.
   d. Bench Mounted: Operator is mounted to the right or left grille head plate and connected to the grille drive shaft with drive chain and sprockets. Side room is required for this type of mounting.
   e. Through-Wall Mounted: Operator is mounted on other side of wall from coil-side of grille.
4. Electric Motors: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 11 Section "Common Motor Requirements For Equipment" unless otherwise indicated.
   a. Electrical Characteristics:
      1) Phase: Single phase **OR** Polyphase, **as directed**.
      2) Volts: 115 **OR** 208 **OR** 230 **OR** 460, **as directed**, V.
      3) Hertz: 60.
   b. Motor Type and Controller: Reversible motor and controller (disconnect switch) for motor exposure indicated.

c. Motor Size: Minimum size as indicated. If not indicated, large enough to start, accelerate, and operate grille in either direction from any position, at a speed not less than 8 in./sec. (203 mm/s) and not more than 12 in./sec. (305 mm/s), without exceeding nameplate ratings or service factor.
d. Operating Controls, Controllers (Disconnect Switches), Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
e. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.

5. Limit Switches: Equip each motorized grille with adjustable switches interlocked with motor controls and set to automatically stop grille at fully opened and fully closed positions.
6. Obstruction Detection Device: Equip motorized grille with indicated external automatic safety sensor capable of protecting full width of grille opening. Activation of sensor immediately stops and reverses downward grille travel.
   a. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in grille opening without contact between grille and obstruction.
      1) Self-Monitoring Type: Designed to interface with grille operator control circuit to detect damage to or disconnection of sensing device. When self-monitoring feature is activated, grille closes only with sustained pressure on close button.
   b. Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.
      1) Self-Monitoring Type: Four-wire configured device designed to interface with grille operator control circuit to detect damage to or disconnection of sensing device.
7. Remote-Control Station: Momentary-contact, three-button control station with push-button controls labeled "Open," "Close," and "Stop."
   a. Interior units, full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
   b. Exterior units, full-guarded, standard-duty, surface-mounted, weatherproof type; NEMA ICS 6, Type 4 enclosure, key operated.
8. Emergency Manual Operation: Equip each electrically powered grille with capability for emergency manual operation. Design manual mechanism so required force for grille operation does not exceed 25 lbf (111 N) **OR** 30 lbf (133 N), **as directed**.
9. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
10. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.
11. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with regulatory requirements for accessibility.
12. Emergency-Egress Release: Flush, wall-mounted handle mechanism, for ADA-ABA-compliant egress feature, not dependent on electric power. The release allows an unlocked grille to partially open without affecting limit switches to permit passage, and it automatically resets motor drive upon return of handle to original position.
13. Self-Opening Mechanism: Automatic release mechanism triggered by smoke detector, **OR** emergency push-button station, **as directed**, fire alarm or power failure. When activated, the grille self opens by means of a fail-safe operator to the fully open position without the need of power operation or battery backup systems. When the alarm is cleared **OR** emergency push-button is reset, and the alarm is cleared, **as directed**, and power is restored, the grille will operate normally.

G. Open-Curtain Grille Assembly
1. Open-Curtain Grille: Overhead coiling grille with a curtain having a network of horizontal rods that interconnect with vertical links.
2. Operation Cycles: Not less than 10,000 **OR** 20,000 **OR** 50,000 **OR** 100,000, **as directed**.

a. Include tamperproof cycle counter.
3. Grille Curtain Material: Aluminum **OR** Stainless steel **OR** Galvanized steel, **as directed**.
   a. Space rods at approximately 1-1/2 inches (38 mm) **OR** 2 inches (51 mm) **OR** 3 inches (76 mm), **as directed**, o.c.
   b. Space links approximately 3 inches (76 mm) **OR** 6 inches (152 mm) **OR** 9 inches (228 mm), **as directed**, apart in a straight in-line **OR** brick (staggered), **as directed**, pattern.
   c. Glazing Inserts: Manufacturer's standard.
   d. Spacers: Metal tubes matching curtain material **OR** PVC, **as directed**.
4. Curtain Jamb Guides: Aluminum **OR** Stainless steel **OR** Galvanized steel, **as directed**, with exposed finish matching curtain slats. Provide continuous integral wear strips to prevent metal-to-metal contact and to minimize operational noise. Provide removable post(s) and jamb guides where shown on Drawings, **as directed**.
5. Hood: Match curtain material and finish **OR** Aluminum **OR** Stainless steel **OR** Galvanized steel, **as directed**.
   a. Shape: Round **OR** Square **OR** As shown on Drawings, **as directed**.
   b. Mounting: Face of wall **OR** Between jambs **OR** On mounting frame **OR** As shown on Drawings, **as directed**.
6. Locking Devices: Equip grille with slide bolt for padlock **OR** locking device assembly, **as directed**, and chain lock keeper, **as directed**.
   a. Locking Device Assembly: Single-jamb side **OR** Cremone type, both jamb sides, **as directed**, locking bars, operable from inside with thumb turn **OR** outside with cylinder **OR** outside only, with cylinder **OR** inside and outside with cylinders, **as directed**.
7. Manual Grille Operator: Push-up operation **OR** Chain-hoist operator **OR** Manufacturer's standard crank operator **OR** Awning-crank operator **OR** Wall-crank operator, **as directed**.
   a. Provide operator with through-wall shaft operation.
   b. Provide operator with manufacturer's standard removable operating arm.
8. Electric Grille Operator:
   a. Usage Classification: Heavy duty, 60 to 90 cycles per hour **OR** Standard duty, up to 60 cycles per hour **OR** Medium duty, up to 15 cycles per hour **OR** Light duty, up to 10 cycles per hour, **as directed**.
   b. Operator Location: Top of hood **OR** Front of hood **OR** Wall **OR** Bench **OR** Through wall **OR** As shown on Drawings, **as directed**.
   c. Motor Exposure: Interior **OR** Exterior, wet, and humid, **as directed**.
   d. Emergency Manual Operation: Push-up **OR** Chain **OR** Crank, **as directed**, type.
   e. Obstruction-Detection Device: Automatic photoelectric sensor **OR** electric sensor edge on bottom bar **OR** pneumatic sensor edge on bottom bar, **as directed**; self-monitoring type, **as directed**.
      1) Sensor Edge Bulb Color: Black **OR** As selected from manufacturer's full range, **as directed**.
   f. Remote-Control Station: Interior **OR** Exterior **OR** Where shown on Drawings, **as directed**.
   g. Other Equipment: Audible and visual signals **OR** Emergency-egress release **OR** Self-opening mechanism, **as directed**.
9. Grille Finish:
   a. Aluminum Finish: Mill **OR** Clear anodized **OR** Light bronze anodized **OR** Medium bronze anodized **OR** Dark bronze anodized **OR** Black anodized **OR** Anodized color matching sample **OR** Anodized color as selected from full range of industry colors and color densities, **as directed**.
   b. Baked-Enamel or Powder-Coated Finish: Color as indicated by manufacturer's designations **OR** Color matching sample **OR** Color as selected from manufacturer's full range, **as directed**.
   c. Factory Prime Finish: Manufacturer's standard color.
   d. Stainless-Steel Finish: No. 2B (bright, cold rolled) **OR** No. 4 (polished directional satin), **as directed**.
   e. PVC Spacers: Color as indicated by manufacturer's designations **OR** Color as selected from manufacturer's full range, **as directed**.

H. Closed-Curtain Grille Assembly
1. Closed-Curtain Grille: Overhead coiling grille with a curtain having a series of horizontal ribs alternating with continuous horizontal infill panels secured by the ribs.
2. Operation Cycles: Not less than 10,000 **OR** 20,000 **OR** 50,000 **OR** 100,000, **as directed**.
   a. Include tamperproof cycle counter.
3. Grille Curtain Material: Aluminum ribs with continuous inserts indicated.
   a. Space ribs at approximately 3 inches (76 mm), **as directed**, o.c.
   b. Inserts: Glass panels.
   c. Inserts: Clear, transparent **OR** Translucent, **as directed**, plastic panels.
   d. Inserts: Solid **OR** Perforated, **as directed**, aluminum panels.
4. Curtain Jamb Guides: Aluminum with exposed finish matching curtain slats. Provide continuous integral wear strips to prevent metal-to-metal contact and to minimize operational noise. Provide removable post(s) and jamb guides where shown on Drawings, **as directed**.
5. Hood: Match curtain material and finish **OR** Aluminum **OR** Stainless steel **OR** Galvanized steel, **as directed**.
   a. Shape: Round **OR** Square **OR** As shown on Drawings, **as directed**.
   b. Mounting: Face of wall **OR** Between jambs **OR** On mounting frame **OR** As shown on Drawings, **as directed**.
6. Locking Devices: Equip grille with slide bolt for padlock **OR** locking device assembly, **as directed**, and chain lock keeper, **as directed**.
   a. Locking Device Assembly: Single-jamb side **OR** Cremone type, both jamb sides, **as directed**, locking bars, operable from inside with thumbturn **OR** outside with cylinder **OR** outside only, with cylinder **OR** inside and outside with cylinders, **as directed**.
7. Manual Grille Operator: Push-up operation **OR** Chain-hoist operator **OR** Manufacturer's standard crank operator **OR** Awning-crank operator **OR** Wall-crank operator, **as directed**.
   a. Provide operator with through-wall shaft operation.
   b. Provide operator with manufacturer's standard removable operating arm.
8. Electric Grille Operator:
   a. Usage Classification: Heavy duty, 60 to 90 cycles per hour **OR** Standard duty, up to 60 cycles per hour **OR** Medium duty, up to 15 cycles per hour **OR** Light duty, up to 10 cycles per hour, **as directed**.
   b. Operator Location: Top of hood **OR** Front of hood **OR** Wall **OR** Bench **OR** Through wall **OR** As shown on Drawings, **as directed**.
   c. Motor Exposure: Interior **OR** Exterior, wet, and humid, **as directed**.
   d. Emergency Manual Operation: Push-up **OR** Chain **OR** Crank, **as directed**, type.
   e. Obstruction-Detection Device: Automatic photoelectric sensor **OR** electric sensor edge on bottom bar **OR** pneumatic sensor edge on bottom bar, **as directed**; self-monitoring type, **as directed**.
      1) Sensor Edge Bulb Color: Black **OR** As selected from manufacturer's full range, **as directed**.
   f. Remote-Control Station: Interior **OR** Exterior **OR** Where shown on Drawings, **as directed**.
   g. Other Equipment: Audible and visual signals **OR** Emergency-egress release **OR** Self-opening mechanism, **as directed**.
9. Grille Finish:
   a. Aluminum Finish: Mill **OR** Clear anodized **OR** Light bronze anodized **OR** Medium bronze anodized **OR** Dark bronze anodized **OR** Black anodized **OR** Anodized color matching sample **OR** Anodized color as selected from full range of industry colors and color densities, **as directed**.
   b. Baked-Enamel or Powder-Coated Finish: Color as indicated by manufacturer's designations **OR** Color matching sample **OR** Color as selected from manufacturer's full range, **as directed**.
   c. Factory Prime Finish: Manufacturer's standard color.
   d. Stainless-Steel Finish: No. 2B (bright, cold rolled) **OR** No. 4 (polished directional satin), **as directed**.

I. General Finish Requirements

1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

J. Aluminum Finishes
1. Mill Finish: Manufacturer's standard.
2. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
3. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
4. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, application, and baking.

K. Steel And Galvanized-Steel Finishes
1. Factory Prime Finish: Manufacturer's standard primer, compatible with field-applied finish. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.
2. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

L. Stainless-Steel Finishes
1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
   a. Run grain of directional finishes with long dimension of each piece.
   b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
   c. Directional Satin Finish: No. 4.
3. Bright, Cold-Rolled, Unpolished Finish: No. 2B.

1.3 EXECUTION

A. Examination
1. Examine substrates areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.
2. Examine locations of electrical connections.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation
1. Install overhead coiling grilles and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.
2. Install overhead coiling grilles, hoods, and operators at the mounting locations indicated for each grille.
3. Accessibility: Install overhead coiling grilles, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.

C. Startup Service
1. Engage a factory-authorized service representative to perform startup service.
   a. Perform installation and startup checks according to manufacturer's written instructions.
   b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

c. Test grille opening when activated by detector, fire-alarm system, emergency-egress release, or self-opening mechanism as required. Reset grille-opening mechanism after successful test.

D. Adjusting
1. Adjust hardware and moving parts to function smoothly so that grilles operate easily, free of warp, twist, or distortion.
2. Lubricate bearings and sliding parts as recommended by manufacturer.

E. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling grilles.

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SECTION 08 33 23 11 - OVERHEAD COILING DOORS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of material for overhead coiling doors. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Service doors with integral pass doors.
   b. Insulated service doors with integral pass doors.
   c. Counter doors.
   d. Fire-rated service doors with integral pass doors.
   e. Fire-rated, insulated service doors with integral pass doors.
   f. Fire-rated counter doors.

C. Performance Requirements

1. Delegated Design: Design overhead coiling doors, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Structural Performance, Exterior Doors: Exterior overhead coiling doors shall withstand the wind loads, the effects of gravity loads, and loads and stresses within limits and under conditions indicated according to SEI/ASCE 7.
   a. Wind Loads: As indicated on Drawings **OR** Uniform pressure (velocity pressure) of 20 lbf/sq. ft. (960 Pa), acting inward and outward, **as directed**.
      1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s) **OR** 100 mph (44 m/s) **OR** 110 mph (49 m/s), **as directed**.
      2) Importance Factor: <**Insert factor**>.
      3) Exposure Category: A **OR** B **OR** C **OR** D, **as directed**.
   b. Deflection Limits: Design overhead coiling doors to withstand design wind load without evidencing permanent deformation or disengagement of door components.
3. Operability under Wind Load: Design overhead coiling doors to remain operable under design **OR** uniform pressure (velocity pressure) of 20 lbf/sq. ft. (960 Pa), **as directed**, wind load, acting inward and outward.
4. Windborne-Debris-Impact-Resistance Performance: Provide glazed and impact-protective overhead coiling doors that pass missile-impact and cyclic-pressure tests when tested according to ASTM E 1886 and ASTM E 1996.
   a. Large Missile Test: For overhead coiling doors located within 30 feet (9.144 m) of grade.
   b. Small Missile Test: For overhead coiling doors located more than 30 feet (9.144 m) above grade.
5. Seismic Performance: Overhead coiling doors shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
6. Operation Cycles: Provide overhead coiling door components and operators capable of operating for not less than number of cycles indicated for each door. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

D. Submittals

1. Product Data: For each type and size of overhead coiling door and accessory.

2. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work.
   a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   b. Show locations of replaceable fusible links.
   c. Wiring Diagrams: For power, signal, and control wiring.
3. Samples: For each exposed product and for each color and texture specified.
4. Delegated-Design Submittal: For overhead coiling doors indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
5. Qualification Data: For qualified Installer.
6. Seismic Qualification Certificates: For overhead coiling doors, accessories, and components, from manufacturer.
7. Oversize Construction Certification: For door assemblies required to be fire-rated and that exceed size limitations of labeled assemblies.
8. Maintenance Data.

E. Quality Assurance
1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.
2. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to NFPA 252 **OR** IBC Standard 716.5 **OR** UL 10B, **as directed**.
   a. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
   b. Temperature-Rise Limit: Where indicated **OR** At vertical exit enclosures and exit passageways, **as directed**, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
   c. Smoke Control: Where indicated **OR** In corridors and smoke barriers, **as directed**, provide doors that are listed and labeled with the letter "S" on the fire-rating label by a qualified testing agency for smoke- and draft-control based on testing according to IBC Standard 716.5 **OR** UL 1784, **as directed**; with maximum air-leakage rate of 3.0 cfm/sq. ft. (0.01524 cu. m/s x sq. m) of door opening at 0.10 inch wg (24.9 Pa) for both ambient and elevated temperature tests.
3. Sound-Control Doors: Assemblies that have been fabricated and tested to control the passage of sound and have minimum certified STC rating according to ASTM E 413.
4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines **OR** ICC/ANSI A117.1, **as directed**.

1.2 PRODUCTS

A. Door Curtain Materials And Construction
1. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:

a. Steel Door Curtain Slats: Zinc-coated (galvanized), cold-rolled structural steel sheet; complying with ASTM A 653/A 653M, with G90 (Z275) zinc coating; nominal sheet thickness (coated) of 0.028 inch (0.71 mm) and as required to meet requirements.
b. Stainless-Steel Door Curtain Slats: ASTM A 666, Type 304; sheet thickness of 0.025 inch (0.64 mm) and as required to meet requirements.
c. Aluminum Door Curtain Slats: ASTM B 209 (ASTM B 209M) sheet or ASTM B 221 (ASTM B 221M) extrusions, alloy and temper standard with manufacturer for type of use and finish indicated; thickness of 0.050 inch (1.27 mm) and as required to meet requirements.
d. Vision-Panel Glazing: Manufacturer's standard clear glazing, fabricated from transparent acrylic sheet or fire-protection rated glass as required for type of door; set in glazing channel secured to curtain slats.
e. Insulation: Fill slats for insulated doors with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84. Enclose insulation completely within slat faces.
f. Metal Interior Curtain-Slat Facing: Match metal of exterior curtain-slat face.
g. Plastic Interior Curtain-Slat Facing: Extruded PVC plastic with maximum flame-spread index of 25 **OR** 75 **OR** 200, **as directed**, and smoke-developed index of 450, according to ASTM E 84.
h. Gasket Seal: Provide insulated slats with manufacturer's standard interior-to-exterior thermal break or with continuous gaskets between slats.

2. Endlocks and Windlocks for Service Doors: Malleable-iron casings galvanized after fabrication, secured to curtain slats with galvanized rivets or high-strength nylon. Provide locks on not less than alternate curtain slats for curtain alignment and resistance against lateral movement.
3. Endlocks for Counter Doors: Manufacturer's standard locks on not less than alternate curtain slats for curtain alignment and resistance against lateral movement.
4. Bottom Bar for Service Doors: Consisting of two angles, each not less than 1-1/2 by 1-1/2 by 1/8 inch (38 by 38 by 3 mm) thick; fabricated from manufacturer's standard hot-dip galvanized steel, stainless steel, or aluminum extrusions to match curtain slats and finish.
5. Bottom Bar for Counter Doors: Manufacturer's standard continuous channel or tubular shape, fabricated from manufacturer's standard hot-dip galvanized steel, stainless steel, or aluminum extrusions to match curtain slats and finish.
6. Astragal for Interior Doors: Equip each door bottom bar with a replaceable, adjustable, continuous, compressible gasket of flexible vinyl, rubber, or neoprene as a cushion bumper.
7. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain, and a continuous bar for holding windlocks.
   a. Removable Posts and Jamb Guides for Counter Doors: Manufacturer's standard.
8. Pass Door(s): Door and frame assembly constructed integrally with the coiling-door assembly and bearing the same fire rating. Complying with egress and accessibility requirements of authorities having jurisdiction.
   a. Door Frame and Integral Jamb Guide: Fabricate of angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading.
   b. Hinged Frame: Hinged pass door and frame that swings out of the way, as a unit, to allow use of the full coiling-door opening width. One jamb of the pass-door frame is hinged and the other jamb includes a guide for the lower, narrower part of the coiling-door curtain.
   c. Rigid Frame: Rigid pass door and frame that are built into the rigid, lower part of the door curtain and that raise with the curtain.
   d. Locking Hardware:
      1) Lockset **OR** Exit Hardware: As specified in Division 08 Section "Door Hardware" **OR** As selected from manufacturer's full range, **as directed**.

2) Lock Cylinders: Provide cylinders specified in Division 08 Section "Door Hardware" **OR** standard with manufacturer, **as directed**, and keyed to building keying system, **as directed**.
3) Keys: Two **OR** Three, **as directed**, for each cylinder.

e. Thresholds: Equip pass doors with integral thresholds that comply with egress and accessibility requirements of authorities having jurisdiction.

B. Hood

1. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.
   a. Galvanized Steel: Nominal 0.028-inch- (0.71-mm-) thick, hot-dip galvanized steel sheet with G90 (Z275) zinc coating, complying with ASTM A 653/A 653M.
   b. Stainless Steel: 0.025-inch- (0.64-mm-) thick stainless-steel sheet, Type 304, complying with ASTM A 666.
   c. Aluminum: 0.040-inch- (1.02-mm-) thick aluminum sheet complying with ASTM B 209 (ASTM B 209M), of alloy and temper recommended by manufacturer and finisher for type of use and finish indicated.
   d. Include automatic drop baffle on fire-rated doors to guard against passage of smoke or flame.
   e. Exterior-Mounted Doors: Fabricate hood to act as weather protection and with a perimeter sealant-joint-bead profile for applying joint sealant.

C. Counter Doors

1. Integral Frame, Hood, and Fascia for Counter Door: Welded sheet metal assembly of the following sheet metal:
   a. Galvanized Steel: Nominal 0.064-inch- (1.63-mm-) thick, hot-dip galvanized steel sheet with G90 (Z275) zinc coating, complying with ASTM A 653/A 653M.
   b. Stainless Steel: 0.062-inch- (1.59-mm-) thick stainless-steel sheet, Type 304, complying with ASTM A 666.
2. Integral Metal Sill for Counter Door: Fabricate sills as integral part of frame assembly of Type 304 stainless steel in manufacturer's standard thickness with No. 4 finish.
3. Fire-Rated, Laminate Counter: Fire-door manufacturer's high-pressure decorative laminate-covered countertop, UL or ITS tested and labeled for 1-1/2-hour fire rating for approved use with fire-door assembly.

D. Locking Devices

1. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.
2. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.
   a. Lock Cylinders: Provide cylinders specified in Division 08 Section "Door Hardware" **OR** standard with manufacturer, **as directed**, and keyed to building keying system, **as directed**.
   b. Keys: Provide Two **OR** Three, **as directed**, for each cylinder.
3. Chain Lock Keeper: Suitable for padlock.
4. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

E. Curtain Accessories

1. Smoke Seals: Equip each fire-rated door with smoke-seal perimeter gaskets for smoke and draft control as required for door listing and labeling by a qualified testing agency.

2. Weatherseals: Equip each exterior door with weather-stripping gaskets fitted to entire perimeter of door for a weathertight installation, unless otherwise indicated.
   a. At door head, use 1/8-inch- (3-mm-) thick, replaceable, continuous sheet secured to inside of hood.
   b. At door jambs, use replaceable, adjustable, continuous, flexible, 1/8-inch- (3-mm-) thick seals of flexible vinyl, rubber, or neoprene.
3. Push/Pull Handles: Equip each push-up-operated or emergency-operated door with lifting handles on each side of door, finished to match door.
   a. Provide pull-down straps or pole hooks for doors more than 84 inches (2130 mm) high.
4. Automatic-Closing Device for Fire-Rated Doors: Equip each fire-rated door with an automatic-closing device that is inoperative during normal door operations and that has a governor unit complying with NFPA 80 and an easily tested and reset release mechanism designed to be activated by the following:
   a. Replaceable fusible links with temperature rise and melting point of 165 deg F (74 deg C) interconnected and mounted on both sides of door opening.
   b. Manufacturer's standard UL-labeled smoke detector and door-holder-release devices.
   c. Manufacturer's standard UL-labeled heat detector and door-holder-release devices.
   d. Building fire-detection and -alarm systems and manufacturer's standard door-holder-release devices.

F. Counterbalancing Mechanism
1. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.
2. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, welded or seamless carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. (2.5 mm/m) of span under full load.
3. Spring Balance: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.
4. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.
5. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

G. Manual Door Operators
1. Equip door with manufacturer's recommended manual door operator unless another type of door operator is indicated.
2. Push-up Door Operation: Design counterbalance mechanism so required lift or pull for door operation does not exceed 25 lbf (111 N).
3. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum 25 lbf (111 N) **OR** 30 lbf (133 N), **as directed**, force for door operation. Provide alloy-steel hand chain with chain holder secured to operator guide.
4. Crank Operator: Consisting of crank and crank gearbox, steel crank drive shaft, and gear-reduction unit, of type indicated. Size gears to require not more than 25 lbf (111 N) **OR** 30 lbf (133 N), **as directed**, force to turn crank. Fabricate gearbox to be oil tight and to completely enclose operating mechanism. Provide manufacturer's standard crank-locking device.

H. Electric Door Operators
1. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and operation-cycles requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, remote-control stations, control devices, integral gearing for locking door, and accessories required for proper operation.
   a. Comply with NFPA 70.

b. Provide control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24 V, ac or dc.

2. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.
3. Door Operator Location(s): Operator location indicated for each door.
   a. Top-of-Hood Mounted: Operator is mounted to the right or left door head plate with the operator on top of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Headroom is required for this type of mounting.
   b. Front-of-Hood Mounted: Operator is mounted to the right or left door head plate with the operator on coil side of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Front clearance is required for this type of mounting.
   c. Wall Mounted: Operator is mounted to the inside front wall on the left or right side of door and connected to door drive shaft with drive chain and sprockets. Side room is required for this type of mounting. Wall mounted operator can also be mounted above or below shaft; if above shaft, headroom is required.
   d. Bench Mounted: Operator is mounted to the right or left door head plate and connected to the door drive shaft with drive chain and sprockets. Side room is required for this type of mounting.
   e. Through-Wall Mounted: Operator is mounted on other side of wall from coil side of door.
4. Electric Motors: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 11 Section "Common Motor Requirements For Equipment", unless otherwise indicated.
   a. Electrical Characteristics:
      1) Phase: Single phase **OR** Polyphase, **as directed**.
      2) Volts: 115 **OR** 208 **OR** 230 **OR** 460, **as directed**, V.
      3) Hertz: 60.
   b. Motor Type and Controller: Reversible motor and controller (disconnect switch) for motor exposure indicated.
   c. Motor Size: Minimum size as indicated. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. (203 mm/s) and not more than 12 in./sec. (305 mm/s), without exceeding nameplate ratings or service factor.
   d. Operating Controls, Controllers (Disconnect Switches), Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
   e. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.
5. Limit Switches: Equip each motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.
6. Obstruction Detection Device: Equip motorized door with indicated external automatic safety sensor capable of protecting full width of door opening. For non-fire-rated doors, activation of device immediately stops and reverses downward door travel. For fire-rated doors, activation delays closing.
   a. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.
      1) Self-Monitoring Type: Designed to interface with door operator control circuit to detect damage to or disconnection of sensing device. When self-monitoring feature is activated, door closes only with sustained pressure on close button.
   b. Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.
      1) Self-Monitoring Type: Four-wire configured device designed to interface with door operator control circuit to detect damage to or disconnection of sensor edge.
7. Remote-Control Station: Momentary-contact, three-button control station with push-button controls labeled "Open," "Close," and "Stop."

a. Interior units, full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
b. Exterior units, full-guarded, standard-duty, surface-mounted, weatherproof type, NEMA ICS 6, Type 4 enclosure, key operated.

8. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 25 lbf (111 N) **OR** 30 lbf (133 N), **as directed**.
9. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
10. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.
11. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with regulatory requirements for accessibility.
12. Radio-Control System: Consisting of the following:
    a. Three-channel universal coaxial receiver to open, close, and stop door; one **OR** two, **as directed**, per operator.
    b. Multifunction remote control.
    c. Remote-antenna mounting kit.

I. Door Assembly
1. Service **OR** Insulated Service **OR** Counter, **as directed**, Door: Overhead coiling door formed with curtain of interlocking metal slats.
2. Operation Cycles: Not less than 10,000 **OR** 20,000 **OR** 50,000 **OR** 100,000, **as directed**.
    a. Include tamperproof cycle counter.
3. STC Rating: 26.
4. Curtain R-Value: 4.5 deg F x h x sq. ft./Btu (0.792 K x sq. m/W) **OR** 5.0 deg F x h x sq. ft./Btu (0.881 K x sq. m/W) **OR** 6.0 deg F x h x sq. ft./Btu (1.057 K x sq. m/W), **as directed**.
5. Door Curtain Material: Galvanized steel **OR** Stainless steel **OR** Aluminum, **as directed**.
6. Door Curtain Slats: Curved **OR** Flat, **as directed**, profile slats of 1-1/4-inch (32-mm) **OR** 1-1/2-inch (38-mm) **OR** 1-7/8-inch (48-mm) **OR** 2-5/8-inch (67-mm) **OR** 3-1/4-inch (83-mm), **as directed**, center-to-center height.
    a. Perforated Slats: Approximately 1/16-inch (1.6-mm) pinholes **OR** 3/32-inch (2.4-mm) pinholes **OR** 7/8-inch- (22-mm-) wide by 3/8-inch- (10-mm-) high slots, **as directed**.
    b. Fenestrated Slats: Approximately 3- by 5/8-inch (76- by 16-mm) **OR** 4- by 5/8-inch (102- by 16-mm) **OR** 10- by 1-5/8-inch (254- by 41-mm), **as directed**, openings spaced approximately 1-1/2 inches (38 mm) apart and beginning 12 inches (305 mm) from jamb guides.
    c. Vision Panels: Approximately 10- by 1-5/8-inch (254- by 41-mm) openings spaced approximately 2 inches (51 mm) apart and beginning 12 inches (305 mm) from end guides; in two **OR** three, **as directed**, rows of slats at height indicated on Drawings; installed with insulated, **as directed**, vision-panel glazing.
    d. Insulated-Slat Interior Facing: Metal **OR** Plastic, **as directed**.
7. Curtain Jamb Guides: Galvanized steel **OR** Stainless steel **OR** Aluminum, **as directed**, with exposed finish matching curtain slats. Provide continuous integral wear strips to prevent metal-to-metal contact and to minimize operational noise. Provide removable post(s) and jamb guides where shown on Drawings.
8. Pass Door(s): Hinged **OR** Rigid, **as directed**, frame with lockset **OR** exit hardware, **as directed**.
9. Hood: Match curtain material and finish **OR** Galvanized steel **OR** Stainless steel **OR** Aluminum, **as directed**.
    a. Shape: Round **OR** Square **OR** As shown on Drawings, **as directed**.
    b. Mounting: Face of wall **OR** Between jambs **OR** As shown on Drawings, **as directed**.
10. Integral Frame, Hood, and Fascia for Counter Door: Galvanized steel **OR** Stainless steel, **as directed**.

a. Mounting: Face of wall **OR** Between jambs **OR** As shown on Drawings, **as directed**.

11. Sill Configuration for Counter Door: No sill **OR** Integral metal sill, **as directed**.
12. Locking Devices: Equip door with slide bolt for padlock **OR** locking device assembly, **as directed**, and chain lock keeper, **as directed**.
    a. Locking Device Assembly: Single-jamb side **OR** Cremone type, both jamb sides, **as directed**, locking bars, operable from inside with thumb turn **OR** outside with cylinder **OR** outside only, with cylinder **OR** inside and outside with cylinders, **as directed**.
13. Manual Door Operator: Push-up operation **OR** Chain-hoist operator **OR** Manufacturer's standard crank operator **OR** Awning-crank operator **OR** Wall-crank operator, **as directed**.
    a. Provide operator with through-wall shaft operation.
    b. Provide operator with manufacturer's standard removable operating arm.
14. Electric Door Operator:
    a. Usage Classification: Heavy duty, 60 to 90 cycles per hour **OR** Standard duty, up to 60 cycles per hour **OR** Medium duty, up to 15 cycles per hour **OR** Light duty, up to 10 cycles per hour, **as directed**.
    b. Operator Location: Top of hood **OR** Front of hood **OR** Wall **OR** Bench **OR** Through wall **OR** As shown on Drawings, **as directed**.
    c. Motor Exposure: Interior **OR** Exterior, wet, and humid, **as directed**.
    d. Emergency Manual Operation: Push-up **OR** Chain **OR** Crank, **as directed**, type.
    e. Obstruction-Detection Device: Automatic photoelectric sensor **OR** electric sensor edge on bottom bar **OR** pneumatic sensor edge on bottom bar, **as directed**; self-monitoring type, **as directed**.
        1) Sensor Edge Bulb Color: Black **OR** As selected from manufacturer's full range, **as directed**.
    f. Remote-Control Station: Interior **OR** Exterior **OR** Where shown on Drawings, **as directed**.
    g. Other Equipment: Audible and visual signals **OR** Radio-control system, **as directed**.
15. Door Finish:
    a. Aluminum Finish: Mill **OR** Clear anodized **OR** Light bronze anodized **OR** Medium bronze anodized **OR** Dark bronze anodized **OR** Black anodized **OR** Anodized color matching sample **OR** Anodized color as selected from full range of industry colors and color densities, **as directed**.
    b. Baked-Enamel or Powder-Coated Finish: Color as indicated by manufacturer's designations **OR** Color matching sample **OR** Color as selected from manufacturer's full range, **as directed**.
    c. Factory Prime Finish: Manufacturer's standard color.
    d. Stainless-Steel Finish: No. 2B (bright, cold rolled) **OR** No. 4 (polished directional satin), **as directed**.
    e. Interior Curtain-Slat Facing: Match finish of exterior curtain-slat face **OR** PVC plastic, **as directed**.

J. Fire-Rated Door Assembly

1. Fire-Rated Service **OR** Insulated Service **OR** Counter, **as directed**, Door: Overhead fire-rated coiling door formed with curtain of interlocking metal slats.
2. Operation Cycles: Not less than 10,000 **OR** 20,000 **OR** 50,000 **OR** 100,000, **as directed**.
    a. Include tamperproof cycle counter.
3. Fire Rating: 3/4 hour **OR** 1 hour **OR** 1-1/2 hours **OR** 3 hours **OR** 4 hours, **as directed**, with temperature-rise limit, **as directed**, and with smoke control, **as directed**.
4. STC Rating: 27.
5. Curtain R-Value: 4.5 deg F x h x sq. ft./Btu (0.792 K x sq. m/W) **OR** 5.0 deg F x h x sq. ft./Btu (0.881 K x sq. m/W) **OR** 6.0 deg F x h x sq. ft./Btu (1.057 K x sq. m/W), **as directed**.
6. Door Curtain Material: Galvanized steel **OR** Stainless steel, **as directed**.
7. Door Curtain Slats: Curved **OR** Flat, **as directed**, profile slats of 1-1/4-inch (32-mm) **OR** 1-1/2-inch (38-mm) **OR** 1-7/8-inch (48-mm) **OR** 2-5/8-inch (67-mm) **OR** 3-1/4-inch (83-mm), **as directed**, center-to-center height.

a. Vision Panels: Approximately 10- by 1-5/8-inch (254- by 41-mm) openings spaced approximately 2 inches (51 mm) apart and beginning 12 inches (305 mm) from end guides; in two **OR** three, **as directed**, rows of slats at height indicated on Drawings; installed with fire-rated vision-panel glazing.
b. Insulated-Slat Interior Facing: Metal.

8. Curtain Jamb Guides: Galvanized steel **OR** Stainless steel, **as directed**, with exposed finish matching curtain slats.
9. Pass Door(s): Hinged **OR** Rigid, **as directed**, frame with lockset **OR** exit hardware, **as directed**.
10. Hood: Match curtain material and finish **OR** Galvanized steel **OR** Stainless steel, **as directed**.
    a. Shape: Round **OR** Square **OR** As shown on Drawings, **as directed**.
    b. Mounting: Face of wall **OR** Between jambs **OR** As shown on Drawings, **as directed**.
11. Integral Frame, Hood, and Fascia for Counter Door: Galvanized steel **OR** Stainless steel, **as directed**.
    a. Mounting: Face of wall **OR** Between jambs **OR** As shown on Drawings, **as directed**.
12. Sill Configuration for Fire-Rated Counter Door: No sill **OR** Integral metal sill **OR** Fire-rated, laminate counter, **as directed**.
    a. High-Pressure Decorative Laminate: Match color, pattern, and finish as indicated by manufacturer's designations **OR** of sample **OR** as selected from manufacturer's full range, **as directed**.
13. Locking Devices: Equip door with slide bolt for padlock **OR** locking device assembly, **as directed**, and chain lock keeper, **as directed**.
    a. Locking Device Assembly: Single-jamb side **OR** Cremone type, both jamb sides, **as directed**, locking bars, operable from inside with thumbturn **OR** outside with cylinder **OR** outside only, with cylinder **OR** inside and outside with cylinders, **as directed**.
14. Manual Door Operator: Push-up operation **OR** Chain-hoist operator **OR** Manufacturer's standard crank operator **OR** Awning-crank operator **OR** Wall-crank operator, **as directed**.
    a. Provide operator with through-wall shaft operation.
    b. Provide operator with manufacturer's standard removable operating arm.
15. Electric Door Operator:
    a. Usage Classification: Heavy duty, 60 to 90 cycles per hour **OR** Standard duty, up to 60 cycles per hour **OR** Medium duty, up to 15 cycles per hour **OR** Light duty, up to 10 cycles per hour, **as directed**.
    b. Operator Location: Top of hood **OR** Front of hood **OR** Wall **OR** Bench **OR** Through wall **OR** As shown on Drawings, **as directed**.
    c. Motor Exposure: Interior **OR** Exterior, wet, and humid, **as directed**.
    d. Emergency Manual Operation: Push-up **OR** Chain **OR** Crank, **as directed**, type.
    e. Obstruction Detection Device: Automatic photoelectric sensor **OR** electric sensor edge on bottom bar **OR** pneumatic sensor edge on bottom bar, **as directed**; self-monitoring type, **as directed**.
        1) Sensor Edge Bulb Color: Black **OR** As selected from manufacturer's full range, **as directed**.
    f. Remote-Control Station: Interior **OR** Exterior **OR** Where shown on Drawings, **as directed**.
    g. Other Equipment: Audible and visual signals **OR** Radio-control system, **as directed**.
16. Door Finish:
    a. Baked-Enamel or Powder-Coated Finish: Color as indicated by manufacturer's designations **OR** Color matching sample **OR** Color as selected from manufacturer's full range, **as directed**.
    b. Factory Prime Finish: Manufacturer's standard color.
    c. Stainless-Steel Finish: No. 2B (bright, cold rolled) **OR** No. 4 (polished directional satin), **as directed**.
    d. Interior Curtain-Slat Facing: Match finish of exterior curtain-slat face.

K. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

L. Aluminum Finishes
1. Mill Finish: Manufacturer's standard.
2. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
3. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
4. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, application, and baking.

M. Steel And Galvanized-Steel Finishes
1. Factory Prime Finish: Manufacturer's standard primer, compatible with field-applied finish. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.
2. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

N. Stainless-Steel Finishes
1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
   a. Run grain of directional finishes with long dimension of each piece.
   b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
   c. Directional Satin Finish: No. 4.
3. Bright, Cold-Rolled, Unpolished Finish: No. 2B.

1.3 EXECUTION

A. Installation
1. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.
2. Install overhead coiling doors, hoods, and operators at the mounting locations indicated for each door.
3. Accessibility: Install overhead coiling doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.
4. Fire-Rated Doors: Install according to NFPA 80.
5. Smoke-Control Doors: Install according to NFPA 80 and NFPA 105.

B. Startup Service
1. Engage a factory-authorized service representative to perform startup service.
   a. Perform installation and startup checks according to manufacturer's written instructions.
   b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   c. Test door closing when activated by detector or alarm-connected fire-release system. Reset door-closing mechanism after successful test.

C. Adjusting
1. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.

2. Lubricate bearings and sliding parts as recommended by manufacturer.
3. Adjust seals to provide weathertight fit around entire perimeter.

END OF SECTION 08 33 23 11

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Task	Specification	Specification Description
08 33 23 11	08 33 16 00	Overhead Coiling Grilles
08 33 23 13	01 22 16 00	No Specification Required
08 33 26 00	08 33 16 00	Overhead Coiling Grilles

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SECTION 08 33 36 00 - SIDE COILING GRILLES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of material for side coiling grilles. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Performance Requirements
   1. Operation-Cycle Requirements: Provide side coiling grille components and operators capable of operating for not less than 10,000 **OR** 20,000, **as directed**, cycles and for 10 cycles per day.

C. Submittals
   1. Product Data: For each type and size of side coiling grille and accessory.
   2. Shop Drawings: Include plans, elevations, sections, details, and attachment to other work.
   3. Samples: For each exposed finish.

D. Quality Assurance
   1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.
   2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100.

1.2 PRODUCTS

A. Grille Curtain Materials And Construction
   1. Grille Curtain: Network of 1/4-inch- (6-mm-) **OR** 5/16-inch- (8-mm-), **as directed**, minimum diameter horizontal rods, or rods covered with tube spacers. Interconnect rods by vertical links approximately 5/8 inch (16 mm) wide and rotating on rods.
      a. Space rods at approximately 1-1/2 inches (38 mm) o.c.
      b. Space links approximately 3 inches (76 mm) apart in a straight in-line **OR** staggered, **as directed**, pattern.
      c. Steel Grille Curtain: Hot-dip zinc-coated (galvanized), complying with ASTM A 123/A 123M, or electrogalvanized complying with ASTM 653/A 653M, and phosphatized before fabrication.
      d. Stainless-Steel Grille Curtain: ASTM A 666, Type 300 series.
      e. Aluminum Grille Curtain: ASTM B 221 (ASTM B 221M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
   2. Top Track: Extruded aluminum channel mechanically attached to a support angle with provisions for take-up bolts to compensate for a maximum deflection of 1/2-inch.
   3. Bottom Track: Manufacturer's standard, finished to match grille.
   4. Coil Box: Entirely enclose coiled grille, operating mechanism, supporting disk and the drum around which the grille will coil.
   5. Power Operated Grille: Safety interlock switch to disengage power supply when grille is locked.
   6. Manual Grille Operator: Crank or Push-Pull.
   7. Electric Grille Operator: Manufacturer's standard type, size, and capacity for grille and operation-cycle requirements specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, remote-control stations, control devices, integral gearing for locking grille, and accessories. Comply with NFPA 70.
      a. Disconnect Device: Hand-operated for automatically engaging chain and sprocket operator and releasing brake for emergency manual operation while disconnecting motor,

without affecting timing of limit switch. Mount to be accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
   b. Grille-Operator Type: Wall- or bracket-mounted unit with electric motor, gear-reduction drive, and chain and sprocket secondary drive**.**

8. Electric Motors: High-starting torque, reversible, continuous-duty, polyphase, Class A insulated, electric motors complying with NEMA MG 1; with overload protection; sized to start, accelerate, and operate grille in either direction from any position, at not less than 2/3 fps (0.2 m/s) and not more than 1 fps (0.3 m/s), without exceeding nameplate ratings or service factor. Coordinate wiring requirements and electrical characteristics of motors with building electrical system.
   a. Open dripproof-type motor, and controller with NEMA ICS 6, Type 1 enclosure.
   b. Totally enclosed, nonventilated or fan-cooled motor, fitted with plugged drain, and controller with NEMA ICS 6, Type 4 enclosure where indicated.
9. Remote-Control Station: Momentary-contact **OR** Sustained-pressure, **as directed**, three-button control station; fully guarded, weatherproof (if for exterior location), key operated.
10. Obstruction Detection Device: External automatic safety sensor capable of protecting full width of grille opening. Activation of sensor immediately stops and reverses grille travel.
11. Provide electric operators with ADA-compliant audible alarm and visual indicator lights.

B. Finishes
1. Aluminum Anodic Finish: Mill finish **OR** Class II, clear anodic coating complying with AAMA 611, **as directed**.
2. Galvanized Steel Finish: Manufacturer's standard primer **OR** Powder-coat finish, **as directed**.
   a. Color and Gloss: As selected from manufacturer's full range.
   b. Painting is specified in Division 09 Section(s) "Interior Painting" OR "Staining And Transparent Finishing".
3. Stainless-Steel Finish: Bright, cold-rolled, unpolished finish: No. 2B finish **OR** Bright, directional polish: No. 4 finish, **as directed**.

1.3 EXECUTION

A. Installation
1. General: Install side coiling grilles and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports.
2. Lubricate bearings and sliding parts; adjust grilles to operate easily, free of warp, twist, or distortion.

END OF SECTION 08 33 36 00

Task	Specification	Specification Description
08 34 13 00	01 22 16 00	No Specification Required
08 34 16 00	01 22 16 00	No Specification Required
08 34 23 00	08 31 13 00	Access Doors And Frames

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SECTION 08 34 53 00 - DETENTION DOORS AND FRAMES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of material for detention doors and frames. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Swinging detention doors.
      b. Sliding detention doors.
      c. Detention panels.
      d. Detention frames.

C. Definitions
   1. Minimum-Thickness Steel: Indicated as the specified minimum thicknesses for base metal without coatings, according to HMMA 803.
   2. Nominal-Thickness Stainless Steel: Indicated as the specified thicknesses for which over- and under-thickness tolerances apply, according to ASTM A 480/A 480M.
   3. Nominal Surface of Floor Covering: Top surface of floor; for resilient tile and carpet, nominal surface of floor covering is defined as top of concrete slab.

D. Performance Requirements
   1. Detention Doors and Frame Assemblies: Provide detention doors and frames that comply with the following, based on testing manufacturer's standard units in assemblies similar to those indicated for this Project:
      a. Security Grade: Comply with Grade 1 **OR** Grade 2 **OR** Grade 3 **OR** Grade 4, **as directed**, according to ASTM F 1450.
      b. Bullet Resistance: Comply with Level 3 rating when tested according to UL 752.
         1) Listed and labeled, by a testing agency acceptable to authorities having jurisdiction, as bullet resisting.
      c. Tool-Attack Resistance: Comply with small-tool-attack-resistance rating when tested according to UL 437 and UL 1034.
   2. Detention Frames: Provide sidelight and borrowed-light detention frames that comply with ASTM F 1592 and removable stop test according to HMMA 863, based on testing manufacturer's standard units in assemblies similar to those indicated for this Project.

E. Submittals
   1. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, label compliance, fire-resistance rating, and temperature-rise ratings, and finishes for each type of detention doors and frames specified.
   2. Shop Drawings: In addition to requirements below, provide a schedule using same reference numbers for details and openings as those on Drawings:
      a. Elevations of each door design.
      b. Direction of swing **OR** slide, **as directed**.
      c. Inmate and non-inmate sides.
      d. Details of doors, including vertical and horizontal edge details, and metal thicknesses.
      e. Details of frames, including dimensioned profiles, and metal thicknesses.
      f. Locations of reinforcement and preparations for hardware.
      g. Details of each different wall opening condition.
      h. Details of anchorages, joints, field splices, and connections.

i. Details of food-pass openings, louvers, speaking apertures, and gun ports.
j. Details of moldings, removable stops, and glazing.
k. Details of conduit, junction boxes, and preparations for electrified and pneumatic door hardware.

3. Samples:
   a. For each type of exposed finish required.
   b. For the following items to demonstrate compliance with requirements for quality of materials and construction:
      1) Detention Doors: Show vertical-edge, top, and bottom construction; insulation; face stiffeners; and hinge and other applied hardware reinforcement. Include separate section showing glazing if applicable.
      2) Detention Frames: Show profile, welded corner joint, welded hinge reinforcement, grout-cover boxes, floor and wall anchors, and silencers. Include separate section showing fixed steel panels and glazing if applicable.
4. Coordination Drawings: Drawings of each detention door and frame, drawn to scale, on which connections and interface with electrified and pneumatic control systems are shown.
5. Oversize Construction Certification: For assemblies required to be fire rated and exceeding limitations of labeled assemblies.
6. Welding certificates.
7. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency for detention doors and frames. Indicate metal thickness of each component of tested assembly and describe construction methods.
8. Field quality-control reports documenting inspections of installed products.

F. Quality Assurance
1. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. AWS D1.3, "Structural Welding Code - Sheet Steel."
   c. AWS D1.6, "Structural Welding Code - Stainless Steel."
2. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure **OR** as close to neutral pressure as possible, **as directed**, according to NFPA 252 **OR** IBC Standard 716.5 **OR** UL 10B **OR** UL 10C, **as directed**.
   a. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
   b. Temperature-Rise Limit: Where indicated **OR** At vertical exit enclosures and exit passageways, **as directed**, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
3. Fire-Rated Detention Sidelight and Borrow-Light Frames: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 257.
4. Smoke-Control Detention Door Assemblies: Comply with NFPA 105.

G. Delivery, Storage, And Handling
1. Deliver detention doors and frames palleted, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
2. Deliver detention frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
3. Inspect units, on delivery, for damage. Minor damage may be repaired provided refinished items match new work and are approved by Architect; otherwise, remove and replace damaged items as directed.

4. Store detention doors and frames under cover at building site. Place units in a vertical position with heads up, spaced by blocking, on minimum 4-inch- (102-mm-) high wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber.
    a. Provide minimum 1/4-inch (6-mm) space between each stacked unit to permit air circulation.

H. Maintenance Tools
1. Tool Kit: Provide six sets of tools for use with security fasteners, each packaged in a compartmented kit configured for easy handling and storage.

1.2 PRODUCTS

A. Materials
1. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, CS (Commercial Steel), Type B; free of scale, pitting, or surface defects; pickled and oiled.
2. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, CS (Commercial Steel), Type B.
3. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, CS (Commercial Steel), Type B; with G60 (Z180) zinc (galvanized) or A60 (ZF180) zinc-iron-alloy (galvannealed) coating designation.
4. Stainless-Steel Sheet: ASTM A 240/A 240M, austenitic stainless steel, Type 304.
5. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
6. Concealed Bolts: ASTM A 307, Grade A unless otherwise indicated.
7. Masonry Anchors: Fabricated from same steel sheet as door face.
8. Embedded Anchors: Fabricated from mild steel shapes and plates, hot-dip galvanized according to ASTM A 153/A 153M.
9. Postinstalled Expansion Anchors: With capability to sustain, without failure, a load equal to 4 times the load imposed, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
    a. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition (mild).
    b. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Alloy Group 1 or 4) for bolts and nuts; ASTM A 276 or ASTM A 666, Type 304 or 316, for anchors.
    c. Corrosion Protection: Components fabricated from nickel-copper-alloy rods complying with ASTM B 164 for UNS No. N04400 alloy.
10. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
11. Glazing: Comply with Division 08 Section "Security Glazing".
12. Grout: Comply with ASTM C 476, with a slump of not more than 4 inches (102 mm) as measured according to ASTM C 143/C 143M.
13. Insulation: Slag-wool-fiber/rock-wool-fiber or glass-fiber blanket insulation. ASTM C 665, Type I (unfaced); with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics. Minimum 1.5-lb/cu. ft. (24-kg/cu. m) density.
14. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

B. Detention Doors
1. General: Provide flush-design detention doors of seamless hollow construction, 2 inches (51 mm) thick unless otherwise indicated. Construct detention doors with smooth, flush surfaces without visible joints or seams on exposed faces or stile edges.
    a. For single-acting swinging detention doors, bevel both vertical edges 1/8 inch in 2 inches (3 mm in 51 mm).
    b. For sliding detention doors, square both vertical edges.
2. Core Construction: Provide the following core construction of same material as detention door face sheets, welded to both detention door faces:

a. Steel-Stiffened Core: 0.042-inch- (1.0-mm-) thick, steel vertical stiffeners extending full-door height, with vertical webs spaced not more than 4 inches (102 mm) apart, spot welded to face sheets a maximum of 3 inches (76 mm) o.c. Fill spaces between stiffeners with insulation.
b. Truss-Stiffened Core: 0.013-inch- (0.3-mm-) thick, steel, truncated triangular stiffeners extending between face sheets and for full height and width of door; with stiffeners welded to face sheets not more than 3 inches (76 mm) o.c. vertically and 2-3/4 inches (70 mm) horizontally. Fill spaces between stiffeners with insulation.

3. Vertical Edge Channels: 0.123-inch- (3.1-mm-) thick, continuous channel of same material as detention door face sheets, extending full-door height at each vertical edge; welded to top and bottom channels to create a fully welded perimeter channel. Noncontiguous channel is permitted to accommodate lock-edge hardware only if lock reinforcement is welded to and made integral with channel.
4. Top and Bottom Channels: 0.123-inch- (3.1-mm-) thick metal channel of same material as detention door face sheets, spot welded, not more than 4 inches (102 mm) o.c., to face sheets.
   a. Reinforce top edge of detention door with 0.053-inch- (1.3-mm-) thick closing channel, inverted and nesting in top channel; welded so channel web is flush with top door edges.
5. Hardware Reinforcement: Fabricate reinforcing plates from same material as detention door face sheets to comply with the following minimum thicknesses:
   a. Full-Mortise Hinges and Pivots: 0.187 inch (4.7 mm) thick.
   b. Maximum-Security Surface Hinges: 0.250 inch (6.3 mm) thick.
   c. Strike Reinforcements: 0.187 inch (4.7 mm) thick.
   d. Slide-Device Hanger Attachments: As recommended by device manufacturer.
   e. Lock Fronts, Concealed Holders, and Surface-Mounted Closers: 0.093 inch (2.3 mm) thick.
   f. All Other Surface-Mounted Hardware: 0.093 inch (2.3 mm) thick.
   g. Lock Pockets: 0.123 inch (3.1 mm) thick at non-inmate side, welded to face sheet.
6. Hardware Enclosures: Provide enclosures and junction boxes for electrically operated detention door hardware of same material as detention door face sheets, interconnected with UL-approved, 1/2-inch- (13-mm-) diameter conduit and connectors.
   a. Where indicated for installation of wiring, provide access plates to junction boxes, fabricated from same material and thickness as face sheet and fastened with at least 4 security fasteners spaced not more than 6 inches (152 mm) o.c.
7. Interior Detention Door Face Sheets: Fabricated from cold-rolled steel sheets **OR** metallic-coated steel sheets **OR** stainless-steel sheets, **as directed**.
   a. Security Grade 1: 0.093-inch- (2.3-mm-) minimum-thickness steel **OR** 0.109-inch (2.8-mm) nominal-thickness stainless steel, **as directed**.
   b. Security Grade 2: 0.093-inch- (2.3-mm-) minimum-thickness steel **OR** 0.109-inch (2.8-mm) nominal-thickness stainless steel, **as directed**.
   c. Security Grade 3: 0.067-inch- (1.7-mm-) minimum-thickness steel **OR** 0.078-inch (2.0-mm) nominal-thickness stainless steel, **as directed**.
   d. Security Grade 4: 0.067-inch- (1.7-mm-) minimum-thickness steel **OR** 0.078-inch (2.0-mm) nominal-thickness stainless steel, **as directed**.
8. Exterior Detention Door Face Sheets: Fabricated from metallic-coated steel sheets **OR** stainless-steel sheets, **as directed**.
   a. Security Grade 1: 0.093-inch- (2.3-mm-) minimum-thickness steel **OR** 0.109-inch (2.8-mm) nominal-thickness stainless steel, **as directed**.
   b. Security Grade 2: 0.093-inch- (2.3-mm-) minimum-thickness steel **OR** 0.109-inch (2.8-mm) nominal-thickness stainless steel, **as directed**.
   c. Security Grade 3: 0.067-inch- (1.7-mm-) minimum-thickness steel **OR** 0.078-inch (2.0-mm) nominal-thickness stainless steel, **as directed**.
   d. Security Grade 4: 0.067-inch- (1.7-mm-) minimum-thickness steel **OR** 0.078-inch (2.0-mm) nominal-thickness stainless steel, **as directed**.

C. Detention Panels

1. Provide fixed detention panels of same materials, construction, and finish as specified for adjoining detention frame.

D. Detention Frames

1. General: Provide fully welded detention frames with integral stops, of seamless construction without visible joints or seams. Fabricate detention frames with contact edges closed tight and corners mitered, reinforced, and continuously welded full depth and width of detention frame.
2. Provide two temporary steel spreaders spot welded to bottom of jambs to act as bracing during shipping and storage. Remove prior to installation.
3. Stop Height: Provide minimum stop height of 0.625 inch (16 mm) **OR** 0.750 inch (19 mm), **as directed,** for detention door openings and minimum stop height of 1-1/4 inches (32 mm) in security glazing or detention panel openings unless otherwise indicated.
4. Interior Detention Frames: Fabricated from cold-rolled steel sheets **OR** metallic-coated steel sheets where indicated **OR** stainless-steel sheets for stainless-steel detention doors, **as directed**.
   a. Security Grade 1: 0.093-inch- (2.3-mm-) minimum-thickness steel **OR** 0.109-inch (2.8-mm) nominal-thickness stainless steel, **as directed**.
   b. Security Grade 2: 0.093-inch- (2.3-mm-) minimum-thickness steel **OR** 0.109-inch (2.8-mm) nominal-thickness stainless steel, **as directed**.
   c. Security Grade 3: 0.067-inch- (1.7-mm-) minimum-thickness steel **OR** 0.078-inch (2.0-mm) nominal-thickness stainless steel, **as directed**.
   d. Security Grade 4: 0.067-inch- (1.7-mm-) minimum-thickness steel **OR** 0.078-inch (2.0-mm) nominal-thickness stainless steel, **as directed**.
5. Exterior Detention Frames: Fabricated from metallic-coated steel sheets **OR** stainless-steel sheets for stainless-steel detention doors, **as directed**.
   a. Security Grade 1: 0.093-inch- (2.3-mm-) minimum-thickness steel **OR** 0.109-inch (2.8-mm) nominal-thickness stainless steel, **as directed**.
   b. Security Grade 2: 0.093-inch- (2.3-mm-) minimum-thickness steel **OR** 0.109-inch (2.8-mm) nominal-thickness stainless steel, **as directed**.
   c. Security Grade 3: 0.067-inch- (1.7-mm-) minimum-thickness steel **OR** 0.078-inch (2.0-mm) nominal-thickness stainless steel, **as directed**.
   d. Security Grade 4: 0.067-inch- (1.7-mm-) minimum-thickness steel **OR** 0.078-inch (2.0-mm) nominal-thickness stainless steel, **as directed**.
6. Hardware Reinforcement: Fabricate reinforcing plates from same material as detention frame to comply with the following minimum thicknesses:
   a. Hinges and Pivots: 0.187 inch (4.7 mm) thick by 1-1/2 inches (38 mm) wide by 10 inches (254 mm) long.
   b. Strikes, Flush Bolts, and Closers: 0.187 inch (4.7 mm) thick.
   c. Surface-Mounted Hardware: 0.093 inch (2.3 mm) thick.
   d. Lock Pockets: 0.123 inch (3.1 mm) thick at non-inmate side, welded to face sheet. Provide 0.123-inch- (3.1-mm-) thick, lock protection plate for attachment to lock pocket with security fasteners.
7. Hardware Enclosures: Provide enclosures and junction boxes for electrically operated detention door hardware, interconnected with UL-approved, 1/2-inch- (13-mm-) diameter conduit and connectors.
   a. Where indicated for installation of wiring, provide access plates to junction boxes, fabricated from same material and thickness as face sheet and fastened with at least 4 security fasteners spaced not more than 6 inches (152 mm) o.c.
8. Mullions and Transom Bars: Provide closed or tubular mullions and transom bars where indicated. Fasten mullions and transom bars at crossings and to jambs by butt welding. Reinforce joints between detention frame members with concealed clip angles or sleeves of same metal and thickness as detention frame.
9. Jamb Anchors: Weld jamb anchors to detention frames near hinges and directly opposite on strike jamb or as required to secure detention frames to adjacent construction.
   a. Number of Anchors: Provide two anchors per jamb plus the following:
      1) Detention Door Frames: One additional anchor for each 18 inches (457 mm), or fraction thereof, above 54 inches (1372 mm) in height.

2) Detention Frames with Security Glazing or Detention Panels: One additional anchor for each 18 inches (457 mm), or fraction thereof, above 36 inches (914 mm) in height.

b. Masonry Anchors: Adjustable, corrugated or perforated, strap-and-stirrup anchors to suit detention frame size; formed of same material and thickness as detention frame; with strap not less than 2 inches (51 mm) wide by 10 inches (254 mm) long.

c. Embedded Anchors: Provide detention frames with removable faces at jambs where embedded anchors are indicated. Anchors consist of three parts:

1) Embedded Plates: Steel plates, 0.188 inch thick by 4 inches wide by 6 inches (4.7 mm thick by 102 mm wide by 152 mm) long. Continuously weld 2 steel bars, 1/2 inch (13 mm) in diameter and 10 inches (254 mm) long with 2-inch (51-mm) 90-degree turndown on ends, to the embedded end of each plate. Weld steel angles, 0.188 inch thick by 2 by 2 by 4 inches (4.7 mm thick by 51 by 51 by 102 mm) long, to the exposed end of each plate. Embed at locations to match frame angles.

2) Frame Angles: Steel angles, 0.188 inch thick by 2 by 2 by 4 inches (4.7 mm thick by 51 by 51 by 102 mm) long, welded to detention frames with 1-inch- (25-mm-) long welds at each end of angle.

3) Connector Angles: Steel angles, of size required, to connect frame angles and embedded plates.

d. Postinstalled Expansion Anchors: Minimum 1/2-inch- (13-mm-) diameter concealed bolts with expansion shields or inserts. Provide conduit spacer from detention frame to wall, welded to detention frame. Reinforce detention frames at anchor locations.

10. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, formed of same material and thickness as detention frame, and as follows:

a. Monolithic Concrete Slabs: Clip anchors, with two holes to receive fasteners, welded to bottom of jambs and mullions with at least four spot welds per anchor.

b. Separate Topping Concrete Slabs: Adjustable anchors with extension clips, allowing not less than 2-inch (51-mm) height adjustment, welded to jambs and mullions with at least 4 spot welds per anchor. Terminate bottom of detention frames at finish floor surface.

11. Rubber Door Silencers: Except on weather-stripped detention doors, drill stops in strike jambs to receive three silencers on single-detention-door frames and drill head jamb stop to receive two silencers on double-detention-door frames. Keep holes clear during construction.

12. Grout Guards: Provide factory-installed grout guards of same material as detention frame, welded to detention frame at back of hardware cutouts, silencers, and glazing-stop screw preparations to close off interior of openings and prevent mortar or other materials from obstructing hardware operation or installation.

E. Moldings And Stops

1. Provide fixed moldings on inmate side of glazed openings and removable stops on non-inmate side.

a. Height: As required to provide minimum 1-inch (25-mm) glass engagement, but not less than 1-1/4 inches (32 mm).

b. Fixed Moldings: Formed from same material as detention door and frame face sheets, but not less than 0.093-inch- (2.3-mm-) thick, spot welded to face sheets a maximum of 5 inches (127 mm) o.c.

c. Removable Stops: Formed from 0.123-inch- (3.1-mm-) thick angle, of same material as detention door face sheets. Secure with button head security fasteners spaced uniformly not more than 9 inches (229 mm) **OR** 6 inches (152 mm), **as directed,** o.c. and not more than 2 inches (51 mm) from each corner, and as necessary to satisfy performance requirements. Form corners with notched or mitered hairline joints.

2. Coordinate rabbet width between fixed and removable stops with type of glass or panel and type of installation indicated.

F. Accessories

1. Pass-Through Openings: Fabricate flush openings using 0.093-inch- (2.3-mm-) thick interior channels of same material as detention door faces, inverted to be flush with openings, welded to inside of both face sheets and with corners fully welded. Mount shutters on non-inmate side of detention doors. Reinforce for locks and food-pass hinges.
   a. Inset Shutters: Fabricate from 2 steel plates, 0.123 inch (3.1 mm) thick, of same material as detention door face sheets, spot welded together and sized to inset inside opening and to prevent inmate tampering of lock and hinges.
   b. Overlapping Shutters: For surface application on non-inmate side of door. Fabricate from a single steel plate, of same material as detention door face sheets, 0.187 inch (4.7 mm) thick, sized to overlap food-pass openings 1/2 inch (13 mm).
2. Detention Door Louvers: Fabricate flush louver openings using 0.093-inch- (2.3-mm-) thick, interior steel channels of same material as detention door faces, welded to inside of both detention door face sheets and with corners fully welded. Provide welded, inverted V- or Y-shaped vanes allowing specified airflow, fabricated from same material as detention door face sheets, 0.093 inch (2.3 mm) thick, and spaced so no rigid flat instrument can pass through.
   a. Reinforcement: Reinforce louvers that exceed 18 inches (457 mm) in height at louver midpoint with 1/4-by-1-1/2-inch- (6.3-by-38-mm-) square, vertical rectangular steel bar or 3/4-inch- (19-mm-) diameter, vertical steel bar.
   b. Airflow: Airflow and static-pressure loss **as directed**.
   c. Exterior Detention Door Insect Screens: Fabricated from 12-by-12 (2.1-by-2.1-mm) mesh of 0.028-inch- (0.71-mm-) diameter, stainless-steel wire or from perforated metal of same material and thickness as detention door face sheet with 1/8-inch- (3-mm-) diameter holes spaced 1 inch (25 mm) o.c.; where indicated.
3. Speaking Apertures: Consisting of a rectangular pattern of holes, minimum 1 inch high by 4 inches wide (25 mm high by 102 mm wide), with holes 1/4 inch (6 mm) in diameter. Locate holes in both face sheets directly across from each other and spaced not more than 1 inch (25 mm) o.c. vertically and horizontally. Provide 0.067-inch- (1.7-mm-) thick, pressed-steel baffles in interior of detention door between hole patterns to prevent passage of objects.
4. Gun Ports: Fabricate units to comply with UL 752 and to resist same security level as detention doors in which they are installed.

G. Security Fasteners
1. Security Fasteners: Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator.
2. Drive-System Type, Head Style, Material, and Protective Coating: Provide as required for assembly, installation, and strength, and as follows:
   a. Drive-System Types: Pinned Torx-Plus **OR** Pinned Torx, **as directed**.
   b. Fastener Strength: Grade 8 (Class 10.9).
   c. Socket Button Head Fasteners:
      1) Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
      2) Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.
   d. Socket Flat Countersunk Head Fasteners:
      1) Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
      2) Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.
   e. Socket Head Cap Fasteners:
      1) Heat-treated alloy steel, ASTM A 574 (ASTM A 574M).
      2) Stainless steel, ASTM F 837 (ASTM F 837M), Group 1 CW.
   f. Protective Coatings for Heat-Treated Alloy Steel:
      1) Zinc and clear trivalent chromium, for exterior applications and interior applications where indicated.
      2) Zinc phosphate with oil, ASTM F 1137, Grade I, or black oxide unless otherwise indicated.

H. Fabrication
1. Fabricate detention doors and frames rigid, neat in appearance, and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of

metal. Weld exposed joints continuously; grind, fill, dress, and make smooth, flush, and invisible. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

2. Tolerances: Fabricate detention doors and frames to comply with manufacturing tolerances indicated in HMMA 863.
3. Fabricate multiple-opening detention frames with mullions that have closed tubular shapes and with no visible seams or joints.
4. Exterior Detention Doors: Provide weep-hole openings in bottom of detention doors to permit entrapped moisture to escape. Seal joints in top edges of detention doors against water penetration.
5. Hardware Preparation: Factory prepare detention doors and frames to receive mortised hardware, including cutouts, reinforcement, mortising, drilling, and tapping, according to final door hardware schedule and templates provided by detention door hardware supplier.
    a. Reinforce detention doors and frames to receive surface-mounted door hardware. Drilling and tapping may be done at Project site.
    b. Locate door hardware as indicated or, if not indicated, according to HMMA 831.
6. Factory cut openings in detention doors.
7. Weld components to comply with referenced AWS standard. Weld before finishing components to greatest extent possible. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

I. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Finish detention doors and frames after assembly.

J. Metallic-Coated Steel Sheet Finishes
1. Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and apply galvanizing repair paint, complying with SPPC-Paint 20, to comply with ASTM A 780.
2. Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment. Apply a smooth coat of even consistency to provide a uniform dry film thickness of not less than 0.7 mils (0.02 mm).
    a. Shop Primer: Manufacturer's or fabricator's standard, fast-curing, lead- and chromate-free primer complying with ANSI A250.10 acceptance criteria; recommended by primer manufacturer for zinc-coated steel; compatible with substrate and field-applied finish paint system indicated; and providing a sound foundation for field-applied topcoats despite prolonged exposure.

K. Steel Sheet Finishes
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning"; remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 3, "Power Tool Cleaning," or SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment. Apply a smooth coat of even consistency to provide a uniform dry film thickness of not less than 0.7 mils (0.02 mm).
    a. Shop Primer: Manufacturer's or fabricator's standard, fast-curing, corrosion-inhibiting, lead- and chromate-free, universal primer complying with ANSI A250.10 acceptance criteria; compatible with substrate and field-applied finish paint system indicated; and providing a sound foundation for field-applied topcoats despite prolonged exposure.

L. Stainless-Steel Finishes
1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
   a. Run grain of directional finishes with long dimension of each piece.
   b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
   c. Directional Satin Finish: No. 4.

1.3 EXECUTION

A. Preparation
   1. Remove welded-in shipping spreaders installed at factory.
   2. Prior to installation and with shipping spreaders removed, adjust detention frames for squareness, alignment, twist, and plumbness to the following tolerances:
      a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb and perpendicular to frame head.
      b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of face.
      c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of door rabbet.
      d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a perpendicular line from head to floor.

B. Installation
   1. General: Install detention doors and frames plumb, rigid, properly aligned, and securely fastened in place, complying with Drawings, schedules, and manufacturer's written recommendations.
   2. Anchorage: Set detention frame anchorage devices according to details on Shop Drawings and per anchorage device manufacturer's written instructions.
      a. Masonry Anchors: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
      b. Embedded Anchors: Install embedded plates in wall surrounding frame openings to match frame angle locations.
      c. Postinstalled Expansion Anchors: Drill holes in existing construction at locations to match bolt locations and install bolt expansion shields or inserts.
   3. Assemble detention frames fabricated in sections. Install angle splices at each corner, of same material and thickness as detention frame, and extend at least 4 inches (102 mm) on both sides of joint.
      a. Field splice only at approved locations. Weld, grind, and finish as required to conceal evidence of splicing on exposed faces.
      b. Continuously weld and finish smooth joints between faces of abutted, multiple-opening, detention frame members.
      c. Field Welding: Comply with the following requirements:
         1) Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
         2) Obtain fusion without undercut or overlap.
         3) Remove welding flux immediately.
         4) At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
   4. Apply bituminous coating to backs of frames prior to filling with grout.
   5. Placing Detention Frames: Install detention frames of sizes and profiles indicated. Set detention frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.
      a. Embedded Anchors: Remove jamb faces from detention frames and set detention frames into opening. Weld steel connector angle to frame angle and to embedded plate with 1-

inch- (25-mm-) long welds at each end of connector angle to form a rigid frame assembly solidly anchored. Reinstall jamb faces using security fasteners.

b. Postinstalled Expansion Anchors: Install bolt. After bolt is tightened, weld bolt head to provide nonremovable condition. Grind, dress, and finish smooth welded bolt head.

c. At fire-rated openings, install detention frames according to NFPA 80.

d. Install detention frames with removable stops located on non-inmate side of opening.

6. Grout: Fully grout detention frame jambs and heads. Completely fill space between frames and adjacent substrates. Hand trowel grout and take other precautions, including bracing detention frames, to ensure that frames are not deformed or damaged by grout forces.

7. Swinging Detention Doors: Fit non-fire-rated detention doors accurately in their frames, with the following clearances:
   a. Between Doors and Frames at Jambs and Head: 1/8 inch (3.2 mm).
   b. Between Edges of Pairs of Doors: 1/8 inch (3.2 mm).
   c. At Door Sills with Threshold: 3/8 inch (9.5 mm).
   d. At Door Sills without Threshold: 3/4 inch (19.1 mm).
   e. Between Door Bottom and Nominal Surface of Floor Covering: 1/2 inch (12.7 mm).

8. Sliding Detention Doors: Fit sliding detention doors in their frames according to manufacturer's written instructions and as required to allow doors to slide without binding.

9. Fire-Rated Detention Doors: Install with clearances as specified in NFPA 80.

10. Smoke-Control Detention Doors: Install according to NFPA 105.

11. Installation Tolerances: Comply with installation tolerances indicated in HMMA 863.

12. Glazing: Comply with installation requirements in Division 08 Section "Security Glazing", unless otherwise indicated.

C. Field Quality Control

1. Inspect installed products to verify compliance with requirements. Prepare inspection reports and indicate compliance with and deviations from the Contract Documents.

2. Remove and replace detention work where inspections indicate that work does not comply with specified requirements.

3. Perform additional inspections to determine compliance of replaced or additional work. Prepare inspection reports.

4. Prepare field quality-control certification that states installed products and their installation comply with requirements in the Contract Documents.

5. Select one detention door at random from detention doors delivered to Project and have it cut in half or otherwise taken apart for verification that construction complies with requirements.

6. Test Method: Verify weld strength by prying or chiseling door apart at edge seams, end channels, or stiffeners. Not more than five percent of welds may fail test.
   a. If tested door fails, replace or rework all detention doors to bring them into compliance at Contractor's expense.
   b. If tested door passes, replace tested door at Contractor's expense.

D. Adjusting And Cleaning

1. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including detention doors and frames that are warped, bowed, or otherwise unacceptable.

2. Clean grout and other bonding material off detention doors and frames immediately after installation.

3. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying primer.
   a. After finishing smooth field welds, apply air-drying primer.

4. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

5. Stainless-Steel Surfaces: Clean surfaces according to manufacturer's written instructions.

END OF SECTION 08 34 53 00

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SECTION 08 34 53 00a - SECURITY GRILLES

DESCRIPTION OF WORK

This specification covers the furnishing and installation of materials for security grilles. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

GENERAL

System Description

1. Performance Requirements: Comply with following:
   a. Performance Tests: Conducted by accredited independent testing laboratory in accordance with specified requirements in this Section.
      1) Source Quality Control Performance Tests: Conducted in shop or laboratory by accredited independent laboratory.
      2) Field Quality Performance Tests: Conducted in field.
   b. Test Grilles: Completely assembled grille, including hardware, mounted vertically in accordance with manufacturer's recommendations.
      1) Test Grille Size: 914 mm (36 inches) wide by 1 219 mm (48 inches) high.
2. Bar Type Security Grilles:
   a. Impact Test: Test Grille: Withstand impact force of 111 N (25 foot-pounds) with no breaking of welds or bar separation exceeding 127 mm (5 inches).
   b. Bar Separation Test: Test Grille: Withstand bar separation test force of 227 kg (500 pounds) with no breaking of welds or bar separation exceeding 127 mm (5 inches).
   c. Sag Test: If grille is equipped with side (jamb) hinges, Test Grille in Fully Extended Position: Withstand sag load of 34 kg (75 pounds) with permanent set after load removal not exceeding 1.6 mm (0.063 inch).
   d. Forced Entry Resistance Test: If grille is equipped with side (jamb) hinges, test in closed position. Grille shall withstand forced entry loads and shall not be rendered openable throughout test.
3. Window Type Security Grilles:
   a. Operating Force: Operating Panels: Operate with force exceeding 16 kg (35 pounds) after panel is in motion.
   b. Impact Test: Test Grille: Withstand impact force of 111 N (25 foot-pounds). Sheet of double strength glass placed 76 mm (3 inches) behind grille material shall remain uncracked or unbroken after impact. No damage occurs that would allow entry through grille.
   c. Forced Entry Resistance Test: If grille is operable, test grille in closed position. Grille shall withstand forced entry loads and shall not be rendered openable throughout test.
4. Child Guard Security Grilles:
   a. Impact Test: Test Grille: Withstand impact force of 67 N (15 foot- pounds) with no weld or fastener breakage or bar separation exceeding 127 mm (5 inches).
   b. Bar Separation Test: Withstand bar separation test force of 23 kg (50 pounds) with no weld or fastener breakage or bar separation exceeding 127 mm (5 inches).
5. Security Guard Security Grilles:
   a. Impact Test: Test Grille in Fully Extended Position: Withstand impact force of 111 N (25 foot-pounds) with no weld or fastener breakage or bar separation exceeding 127 mm (5 inches).
   b. Bar Separation Test: Withstand bar separation test force of 23 kg (50 pounds) with no breaking of welds or bar separation exceeding 127 mm (5 inches).

c. Sag Test: If grille is operable and equipped with side (jamb) hinges, test grille in fully extended position. Grille shall withstand sag load of 34 kg (75 pounds) with permanent set after load removal not exceeding 1.6 mm (0.063 inch).
d. Forced Entry Resistance Test: If grille is operable, test grille in closed position. Grille shall withstand forced entry loads and shall not be rendered openable throughout test.

Submittals
6. Product Data:
7. Shop Drawings:
   a. Include standard details showing recommendations for installation.
   b. Include size of fasteners, maximum spacing from each end, center-to-center spacing on all four sides, minimum penetration of fasteners into load-bearing material and maximum clearance between frame and rough opening.
8. Samples: Submit full set of finish color samples for color selection.
9. Quality Assurance/Control Submittals:
   a. Test Reports: Results of testing by accredited independent laboratory demonstrating compliance of security grilles with specified performance requirements.
   b. Certificates: Manufacturer's written certification that security grilles meet or exceed specified performance requirements.
10. Closeout Submittals:
   a. Special warranty.

Quality Assurance
11. Certifications: Comply with ANSI Z34.2.
12. Regulatory Requirements:
   a. Egress Requirements and Fireman Access: Comply with applicable codes and regulations.
      1) Accessibility: Architectural Barriers Act of 1968 as amended (42 USC 4152-4157) and HUD implementing regulations (24 CFR Part 40).
         a) Uniform Federal Accessibility Standards (UFAS).
      2) Section 504 of the Rehabilitation Act of 1973 as amended (29 USC 794) and HUD implementing regulations 24 CFR Part 8.
      3) Fair Housing Accessibility Guidelines (24 CFR Chapter 1).
      4) Americans with Disabilities Act of 1990 (ADA) (28 CFR Part 35).
13. Mock-ups: For Supply and Install Contract: Install one full size mock-up of each type of security grille with specified finish for acceptance.
   a. Locations: As directed.
   b. Approved Mock-ups: Standard for rest of work.
   c. Approved Mock-ups: May remain part of completed project.

Delivery, Storage, And Handling
14. Packing, Shipping, Handling, and Unloading: Pack materials at manufacturing plant to pevent damage during shipping.
15. Acceptance at Site: Inspect security grilles upon delivery. Replace damaged or defective materials before installation.
16. Storage and Protection: Store security grilles in manner to protect from weather and other damage.

Project Conditions
17. Field Measurements: Field measure openings for security grilles before start of fabrication.

Scheduling And Sequencing
18. Scheduling and Completion: Comply with requirements of Detailed Scope of Work.

Warranty
19. Special Warranty: Provide one year written covering materials and installation for security grilles.

a. Warranty: Include coverage of hardware.
b. Contractor: Agrees to supply and install, free of charge, any required replacement parts or complete replacement security grille.

PRODUCTS

Security Grilles: KANE Screens, or approved equivalent.

20. General: Type(s) and size(s) indicated, specified, or scheduled with necessary hardware, anchors and equipment.
    a. Egress Requirements and Fireman Access: Comply with applicable codes and regulations.
21. Materials:
    a. Aluminum: ASTM B 221 commercial quality and of proper alloy for grille construction, free from defects impairing strength and/or durability.
        1) Zinc Limit: 3.0 percent in order to assure that cladding is anodic to core.
        2) Aluminum Extrusions: Minimum ultimate tensile strength of 151 600 kPa (22,000 PSI) and maximum yield strength of 110 300 kPa (16,000 PSI).
    b. Steel :
        1) Shapes, Plates and Bars: ASTM A 36 or ASTM A 569.
        2) Steel Pipe: ASTM A 53.

Accessories

22. Hardware: Designed to perform functions for which it is intended and securely attached to grille.
    a. Operable Grilles: Equipped with locks capable of meeting specified forced-entry requirements.
    b. Locks: Releasable from interior but properly guarded to prevent access from exterior when window is open.
23. Anchoring Devices Used in Erection of Grilles: Nonmagnetic stainless steel or other noncorrosive material compatible with grille.
    a. Anchors Exposed when Grille is Closed and Locked: Non-removable security type.
24. Fasteners:
    a. Screws, Nuts, Washers, Bolts, Rivets, and Other Miscellaneous Fastening Devices Incorporated in Grilles: Nonmagnetic stainless steel or other corrosion resistant materials compatible with security grille and of sufficient strength to perform functions for which they are used.
    b. Fasteners Concealed when Grille is installed and Closed: Magnetic stainless steel having chromium content of not less than 16 percent.
    c. Fasteners Concealed when Grille is installed and Open: ASTM B 766 cadmium plated steel, ASTM B 633 zinc plated steel, or ASTM B 456 nickel or chrome plated steel.

Fabrication

25. Security Grilles: Fabricated of aluminum or steel and assembled in secure and workmanlike manner to perform as specified and to assure neat construction.
    a. Welding or Brazing Flux: Completely removed immediately upon completion of welding or brazing operation.
    b. Grilles: Constructed to reject passage of 102 mm (4 inch) diameter sphere at every space and interval when installed.
    c. Grille Swing Width for Side Mounting: Maximum of 900 mm (3 feet). For opening in excess of 900 mm (3 feet), provide combination of fixed and operable grilles.
    d. Grilles: Meet or exceed specified performance requirements in this Section.
    e. Grilles: Comply with applicable fire codes.
26. Bar Type Security Grilles: Constructed of rigid aluminum or steel bars and of construction to meet or exceed specified performance requirements in this Section.
    a. Fixed and Operable Bar Type Security Grilles: May be jamb or side hinged for egress.
27. Window Type Security Grilles: Constructed of aluminum or steel frame with two movable vent frames.

a. Vent Frames: Glazed with vinyl coated expanded carbon steel, No. 9 - 38 mm (1-1/2 inch) diamond pattern or equal.
b. Grilles: Constructed in manner to meet or exceed specified performance requirements in this Section.

28. Child Guard Security Grilles: Constructed of aluminum or steel bar or tubes and constructed to adjust and mount to exterior track of existing double or single hung windows.
    a. Grilles: Constructed in manner to meet or exceed specified performance requirements in this Section.
29. Security Guard Security Grilles: Constructed of aluminum or steel bars or tubes and constructed to adjust and mount to exterior of existing double or single hung window.
    a. Fixed and Operable Window Guard Security Grilles: May be jamb or side hinged, or top hinged, for egress.
    b. Grilles: Constructed in manner to meet or exceed specified performance requirements in this Section.

Finishes

30. Grilles: Factory applied baked on enamel painted finish.
    a. Exposed Surfaces: Clean and free from serious surface blemishes.
    b. Dress and finish exposed welded joints.
    c. Steel: Rust resistive primer under baked on enamel.
    d. Color: As selected from manufacturer's standard colors.

Source Quality Control

31. Testing: Performed by accredited independent testing laboratory. Use following HUD test procedures to determine if security grilles comply with specified performance requirements in this Section:
32. Sag Test for Side Mounted Grilles: Mount test grille into rigid frame to prevent movement of grille frame during loading.
    a. Fully Assembled Grille: Opened to 90 degrees or to its open stop.
    b. Test Load: Applied vertically at point 760mm (30 inches) from face of frame on operating portion of grille.
    c. Load: Maintained for period of 3 minutes.
    d. After removal of load, measure permanent sag at point of load application.
33. Impact Test: Mount test grille into rigid frame per manufacturer's recommendations.
    a. One Impact: Made at center of grille or point deemed most susceptible to impact by testing agency.
    b. Application of Impact Load: Made using 275 mm (11 inch) diameter sphere on free-swinging pendulum.
    c. Impact: Made at bottom of pendulum arc.
    d. Impact for Window Type Grille: Made at center of interior sash.
34. Bar Separation Test: Subject test grille to separation test at its weakest point of resistance.
    a. Separation Load: Applied by means of pneumatic or hydraulic cylinder with adequate controls to apply load slowly to avoid quick impact.
    b. Load: Maintained for period of 10 seconds before release.
35. Forced Entry Resistance Test: Mount test grille into rigid frame to prevent movement of grille during test.
    a. Test Loads: Applied at point within 150 mm (6 inches) of locking mechanism in direction tending to open grille.
    b. Load A of 34 kg (75 pounds) and Load B of 68 kg (150 pounds): Applied simultaneously, held for 10 seconds and released.
    c. Load A of 34 kg (75 pounds): Applied vertically upward.
    d. Load B of 68 kg (150 pounds): Applied perpendicular to face of grille in opening direction.
    e. Load C of 34 kg (75 pounds): Applied horizontally from load point toward jamb opposite load.

EXECUTION

Examination

36. Site Verification of Conditions:
    a. Field Measurements: Verify field measurements are as indicated on Shop Drawings.
    b. Existing Conditions: Examine openings before beginning installation.
    c. Do not proceed with installation until conditions are satisfactory.

Preparation

37. Protection: Protect adjacent elements from damage and disfiguration in accordance with Detailed Scope of Work.
    a. Contractor: Responsible for damage to grounds, plantings, buildings and any other facilities or property caused by construction operations.
    b. Repair or replace damaged elements in accordance with Detailed Scope of Work.
38. Existing Security Grilles: Remove existing grilles and debris from site in accordance with Detailed Scope of Work.
39. Preparation: Prepare openings and existing frames as required to comply with Performance Requirements.

Installation

40. General: Install in accordance with manufacturer's recommendations, Reference Standards, and approved Shop Drawings to comply with Performance Requirements.
    a. Security Grilles: Securely anchor in place to straight, plumb and level condition, without distortion.
    b. Egress Requirements and Fireman Access: Comply with applicable codes and regulations.
41. Dissimilar Materials: Isolate materials from incompatible materials as necessary to prevent deterioration.
    a. Separate dissimilar metals with bituminous paint, suitable sealant, non-absorptive plastic or elastomeric tape, or gasket between surfaces.
        1) Coat aluminum in direct contact with concrete, masonry, steel, or other non-compatible materials with bituminous paint, zinc chromate primer, or other suitable insulating material.

Field Quality Control

42. Field Testing: Contractor shall have field testing of installed security grilles conducted by a testing agency in accordance with performance test described under Performance Requirements in this Section and Source Quality Control in this Section. Tests will be modified as required for field conditions.
    a. Contractor: Provide incidental labor facilities necessary to facilitate inspections and tests.
    b. Costs of Testing:
        1) By Contractor: Initial tests with failures and subsequent tests as required because of test failures. Costs shall include costs of Architect/Engineer and other consultants for observations of tests and corrective work.
    c. Corrective Measures: Meet standards of quality of specified security grille and subject to acceptance of the Owner.

Adjusting And Cleaning

43. Adjusting: At completion of job, check, adjust, and lubricate hardware as required and leave security grilles and hardware in proper operating condition.
44. Cleaning: Comply with requirements of Detailed Scope of Work.
    a. Clean security grilles after installation is completed to remove foreign matter and surface blemishes.
    b. Scratched or Abraded Surfaces: Touch-up with rust inhibitor primer and enamel paint compatible with factory finish.

Protection

45. Installed Work: Protect security grilles from damage after installation.

END OF SECTION 08 34 53 00a

Task	Specification	Specification Description
08 34 53 00	08 11 63 13a	Security Window Screens and Doors
08 34 56 00	08 11 63 13a	Security Window Screens and Doors
08 34 56 00	08 34 53 00	Detention Doors And Frames
08 34 56 00	08 34 53 00a	Security Grilles
08 34 73 13	08 01 11 61	Steel Doors And Frames
08 34 73 13	08 01 11 61a	Steel Entry Doors
08 34 73 13	08 12 13 13	Stainless Steel Doors And Frames

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SECTION 08 34 73 16 - SOUND CONTROL DOORS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for sound-control door assemblies. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Steel sound-control doors.
b. Wood sound-control doors.
c. Steel frames and sound-control seals.

C. Submittals
1. Product Data: For each type of product indicated. Include sound ratings, construction details, material descriptions, core descriptions, fire-resistance rating, temperature-rise ratings, and finishes.
2. LEED Submittals:
a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood doors comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body, **as directed**.
b. Product Data for Credit EQ 4.4: For adhesives and composite wood products, indicating that product contains no urea formaldehyde.
3. Shop Drawings: Include the following:
a. Elevations of each door design.
b. Details of sound-control seals, door bottoms, and thresholds.
c. Details of doors, including vertical and horizontal edge details and metal thicknesses.
d. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
e. Locations of reinforcement and preparations for hardware.
f. Details of each different wall opening condition.
g. Details of anchorages, joints, field splices, and connections.
h. Details of accessories.
i. Details of moldings, removable stops, and glazing.
j. Details of conduit and preparations for power, signal, and control systems.
4. Samples:
a. Finishes: For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches (75 by 125 mm).
b. Doors: Include section of vertical-edge, top, and bottom construction; automatic door bottom or gasket; core construction; glazing; and hinge and other applied hardware reinforcement.
c. Frames: Include profile, corner joint, floor and wall anchors, and seals. Include separate section showing fixed sound panels if applicable.
5. Schedule: Provide a schedule of sound-control door assemblies prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with the Door Hardware Schedule.
6. Qualification Data: For qualified Installer, manufacturer, and acoustical testing agency.
7. Product Certificates: For each type of sound-control door assembly, from manufacturer.
8. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of sound-control door assembly.
9. Field quality-control reports.
10. Maintenance Data: For sound-control door assemblies to include in maintenance manuals.

11. Warranty: Samples of special warranty.

D. Quality Assurance
1. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
2. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
3. Acoustical Testing Agency Qualifications: An independent agency accredited as an acoustical laboratory according to the National Voluntary Laboratory Accreditation Program of NIST.
4. Source Limitations: Obtain sound-control door assemblies, including doors, frames, sound-control seals, hinges (when integral for sound control), thresholds, and other items essential for sound control, from single source from single manufacturer.
5. Sound Rating: Provide sound-control door assemblies identical to those of assemblies tested as sound-retardant units by an acoustical testing agency, and have the following minimum rating:
   a. STC Rating: As indicated on Drawings **OR** As indicated in the Door Schedule, **as directed**, as determined by ASTM E 413 when tested in an operable condition according to ASTM E 90 and ASTM E 1408.
6. Forest Certification: Provide doors made with cores **OR** veneers **OR** not less than 70 percent of wood products **OR** all wood products, **as directed**, obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
7. Fire-Rated Door Assemblies: Assemblies listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
   a. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
8. Smoke- and Draft-Control Door Assemblies: Where indicated **OR** At corridors, smoke barriers, and smoke partitions, **as directed**, provide assemblies tested according to UL 1784.
   a. Air-Leakage Rate: Maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m/m x sq. m) at the tested pressure differential of 0.3-inch wg (75 Pa) of water.
9. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
1. Deliver doors and frames palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
   a. Provide additional protection to prevent damage to finish of factory-finished wood doors.
2. Shipping Spreaders: Deliver welded frames with two removable spreader bars across bottom of frames, tack welded or mechanically attached to jambs and mullions.
3. Store doors and frames under cover at Project site. Place units in a vertical position with heads up, spaced by blocking, on minimum 4-inch- (100-mm-) high, wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber.
   a. If wrappers on doors become wet, remove cartons immediately. Provide a minimum of 1/4-inch (6-mm) space between each stacked door to permit air circulation.

F. Project Conditions
1. Environmental Limitations: Do not deliver or install wood sound-control wood doors until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
2. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

G. Coordination

1. Coordinate installation of anchorages for sound-control door assemblies. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

H. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of sound-control door assemblies that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Failure to meet sound rating requirements.
      2) Faulty operation of sound seals.
      3) Deterioration of metals, metal finishes, and other materials beyond normal use or weathering.
      4) Wood doors that are warped (bow, cup, or twist) more than 1/4 inch (6 mm) in a 42-by-84-inch (1067-by-2134-mm) section, or show telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch (0.25 mm in a 75-mm) span.
   b. Warranty Period for Steel Doors: Five years from date of Final Completion.
   c. Warranty Period for Wood Doors: Two years from date of Final Completion.

1.2 PRODUCTS

A. Steel Sound-Control Doors
1. Description: Provide flush-design sound-control doors, 1-3/4 inches (44 mm) thick, of seamless construction; with manufacturer's standard sound-retardant core as required to provide STC **OR** STC and fire, **as directed**, rating indicated. Construct doors with smooth, flush surfaces without visible joints or seams on exposed faces or stile edges. Fabricate according to ANSI/NAAMM-HMMA 865.
   a. Exterior Doors: Fabricate from metallic-coated steel sheet 0.052-inch (1.32-mm) nominal thickness, or thicker as required to provide STC rating indicated.
   b. Interior Doors: Fabricate from cold-rolled steel sheet unless otherwise indicated, 0.048-inch (1.21-mm) nominal thickness, or thicker as required to achieve STC rating indicated.
   c. Loose Stops for Glazed Lites in Doors: Same material as face sheets.
   d. Top and Bottom Channels: Closed with continuous channels of same material as face sheets, spot welded to face sheets not more than 6 inches (150 mm) o.c.
   e. Hardware Reinforcement: Same material as face sheets.
2. Materials:
   a. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
   b. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
   c. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B, with G60 (Z180) zinc (galvanized) or A40 (ZF120) zinc-iron-alloy (galvannealed) coating designation.
   d. Glazing: As required by sound-control door assembly manufacturer to comply with sound-control **OR** sound-control and fire-rated-door labeling, **as directed**, requirements.
3. Finishes:
   a. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
      1) Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.
   b. Factory-Applied Paint Finish: Manufacturer's standard primer and finish coats, complying with ANSI/SDI A250.3 for performance and acceptance criteria.

1) Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

B. Wood Sound-Control Doors

1. Description: Provide flush-design sound-control doors, 1-3/4 inches (44 mm) thick; with manufacturer's standard sound-retardant core as required to provide STC **OR** STC and fire, **as directed**, rating indicated. Fabricate according to WDMA 1.S.1-A.
2. Materials: Comply with Division 08 Section(s) "Flush Wood Doors" OR "Stile And Rail Wood Doors", **as directed**, for grade, faces, veneer matching, fabrication, finishing, and other requirements unless otherwise indicated.
   a. Glazing: As required by sound-control door assembly manufacturer to comply with sound-control **OR** sound-control and fire-rated-door labeling, **as directed**, requirements.
3. Finishes:
   a. Factory finish sound-control wood doors to match doors specified in Division 08 Section(s) "Flush Wood Doors" OR "Stile And Rail Wood Doors", **as directed**.

C. Sound-Control Panels

1. Provide sound-control panels of same materials, construction, sound rating, and finish as specified for adjoining sound-control steel **OR** wood, **as directed**, doors.

D. Sound-Control Frames

1. Description: Fabricate sound-control door frames with corners mitered, reinforced, and continuously welded full depth and width of frame. Fabricate according to ANSI/NAAMM-HMMA 865.
   a. Weld frames according to NAAMM-HMMA 820.
   b. Exterior Frames: Fabricate from metallic-coated steel sheet 0.079-inch (2.01-mm) nominal thickness, or thicker as required to provide STC rating indicated.
   c. Interior Frames: Fabricate from cold-rolled steel sheet unless otherwise indicated, 0.075-inch (1.90-mm) nominal thickness, or thicker as required to provide STC rating indicated.
   d. Sound-Control Panel Stops: Formed integral with frames, a minimum of 5/8 inch (16 mm) high, unless otherwise indicated.
   e. Hardware Reinforcement: Fabricate according to ANSI/NAAMM-HMMA 865 of same material as face sheets.
   f. Head Reinforcement: Reinforce frames with metallic-coated steel channel or angle stiffener, 0.108-inch (2.74-mm) nominal thickness, welded to head.
   g. Jamb Anchors:
      1) Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.064-inch (1.63-mm) nominal thickness metallic-coated steel with corrugated or perforated straps not less than 2 inches (50 mm) wide by 10 inches (250 mm) long; or wire anchors not less than 0.156 inch (4.0 mm) thick.
      2) Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.048-inch (1.21-mm) nominal thickness uncoated steel unless otherwise indicated.
      3) Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch- (9.5-mm-) diameter, metallic-coated steel bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
   h. Floor Anchors: Not less than 0.079-inch (2.01-mm) nominal thickness metallic-coated steel, and as follows:
      1) Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
      2) Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch (50-mm) height adjustment. Terminate bottom of frames at finish floor surface.
   i. Ceiling Struts: Minimum 3/8-inch-thick by 2-inch- (9.5-mm-thick by 50-mm-) wide uncoated steel unless otherwise indicated.
   j. Plaster Guards: Metallic-coated steel sheet, not less than 0.026 inch (0.6 mm) thick.

2. Materials:
   a. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
   b. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
   c. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B, with G60 (Z180) zinc (galvanized) or A40 (ZF120) zinc-iron-alloy (galvannealed) coating designation.
   d. Supports and Anchors: After fabricating, galvanize units to be built into exterior walls according to ASTM A 153/A 153M, Class B.
   e. Inserts, Bolts, and Fasteners: Provide items to be built into exterior walls, hot-dip galvanized according to ASTM A 153/A 153M or ASTM F 2329.
   f. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching sound-control door frames of type indicated.
   g. Mineral-Fiber Insulation: Insulation composed of rock-wool fibers, slag-wool fibers, or glass fibers.
3. Finishes:
   a. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
      1) Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.
   b. Factory-Applied Paint Finish: Manufacturer's standard primer and finish coats, complying with ANSI/SDI A250.3 for performance and acceptance criteria.
      1) Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

E. Sound-Control Hardware
1. Description: Provide manufacturer's standard sound-control system, including head and jamb seals, door bottoms, cam-lift hinges, and thresholds, as required by testing to achieve STC **OR** STC and fire, **as directed**, rating indicated.
   a. Compression Seals: One-piece units; consisting of closed-cell sponge neoprene seal held in place by metal retainer; with retainer cover of same material as door frame; attached to door frame with concealed screws.
      OR
      Magnetic Seals: One-piece units; consisting of closed-cell sponge neoprene seal and resiliently mounted magnet held in place by metal retainer; with retainer cover of same material as door frame; attached to door frame with concealed screws.
   b. Automatic Door Bottoms: Neoprene or silicone gasket, held in place by metal housing, that automatically drops to form seal when door is closed; mounted to bottom edge of door with screws.
      1) Mounting: Mortised or semimortised into bottom of door or surface mounted on face of door as required by testing to achieve STC rating indicated.
      OR
      Door Bottoms: Neoprene or silicone gasket held in place by metal housing; mortised into bottom edge of door.
   c. Cam-Lift Hinges: Full-mortise template type that raises door 1/2 inch (13 mm) when door is fully open; with hardened pin; fabricated from stainless steel.
   d. Thresholds: Flat, smooth, unfluted type as recommended by manufacturer; fabricated from aluminum **OR** stainless steel **OR** solid wood matching wood door faces, **as directed**.
      1) Finish: Clear **OR** Color, **as directed**, anodic finish.
      2) Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from full range of industry colors and color densities, **as directed**.
2. Other Hardware: Comply with requirements in Division 08 Section "Door Hardware".

F. Sound-Control Accessories
1. Glazing: Comply with requirements in Division 08 Section "Glazing"
2. Grout: Comply with ASTM C 476, with a slump of not more than 4 inches (102 mm) as measured according to ASTM C 143/C 143M.
3. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

G. Fabrication
1. Sound-Control Steel Door Fabrication: Sound-control doors to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal.
   a. Seamless Edge Construction: Fabricate doors with faces joined at vertical edges by welding; welds shall be ground, filled, and dressed to make them invisible and to provide a smooth, flush surface.
   b. Exterior Doors: Close top edges flush and seal joints against water penetration. Provide weep-hole openings in bottom of exterior doors to permit moisture to escape.
   c. Glazed Lites: Factory install glazed lites according to requirements of tested assembly to achieve STC rating indicated. Provide fixed stops and moldings welded on secure side of door.
   d. Hardware Preparation: Factory prepare sound-control doors to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping, according to the Door Hardware Schedule and templates furnished as specified in "Door Hardware".
      1) Reinforce doors to receive nontemplated mortised and surface-mounted door hardware.
      2) Locate door hardware as indicated, or if not indicated, according to NAAMM-HMMA 831, "Recommended Hardware Locations for Custom Hollow Metal Doors and Frames."
   e. Tolerances: Fabricate doors to tolerances indicated in ANSI/NAAMM-HMMA 865.
2. Sound-Control Wood Door Fabrication: Factory fit doors to suit frame-opening sizes indicated, with uniform clearances and bevels according to referenced quality standard, unless otherwise indicated. Comply with final door hardware schedules and hardware templates.
   a. Comply with clearance requirements in NFPA 80 for fire-rated doors.
   b. Locate door hardware as indicated, or if not indicated, according to DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
      1) Coordinate measurements of hardware mortises in steel frames to verify dimensions and alignment before factory machining.
3. Sound-Control Frame Fabrication: Fabricate sound-control frames to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
   a. Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated from same thickness metal as frames.
   b. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
   c. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
   d. Jamb Anchors: Provide number and spacing of anchors as follows:
      1) Masonry Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
         a) Two anchors per jamb up to 60 inches (1524 mm) in height.
         b) Three anchors per jamb from 60 to 90 inches (1524 to 2286 mm) in height.

c) Four anchors per jamb from 90 to 96 inches (2286 to 2438 mm) in height.
d) Four anchors per jamb plus one additional anchor per jamb for each 24 inches (610 mm) or fraction thereof more than 96 inches (2438 mm) in height.

2) Stud Wall Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
   a) Three anchors per jamb up to 60 inches (1524 mm) in height.
   b) Four anchors per jamb from 60 to 90 inches (1524 to 2286 mm) in height.
   c) Five anchors per jamb from 90 to 96 inches (2286 to 2438 mm) in height.
   d) Five anchors per jamb plus one additional anchor per jamb for each 24 inches (610 mm) or fraction thereof more than 96 inches (2438 mm) in height.
   e) Two anchors per head for frames more than 42 inches (1066 mm) wide and mounted in metal stud partitions.
3) Postinstalled Expansion Type: Locate anchors not more than 6 inches (152 mm) from top and bottom of frame. Space anchors not more than 26 inches (660 mm) o.c.

e. Head Reinforcement: For frames more than 48 inches (1219 mm) wide, provide continuous head reinforcement for full width of opening, welded to back of frame at head.

f. Hardware Preparation: Factory prepare sound-control frames to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping, according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware".
   1) Reinforce frames to receive nontemplated mortised and surface-mounted door hardware.
   2) Locate hardware as indicated, or if not indicated, according to NAAMM-HMMA 831, "Recommended Hardware Locations for Custom Hollow Metal Doors and Frames."

g. Plaster Guards: Weld guards to frame at back of hardware cutouts and glazing-stop screw and sound-control seal preparations to close off interior of openings in frames to be grouted.

h. Tolerances: Fabricate frames to tolerances indicated in ANSI/NAAMM-HMMA 865.

1.3 EXECUTION

A. Examination

1. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of sound-control door assemblies.
2. Examine roughing-in for embedded and built-in anchors to verify actual locations of sound-control door frame connections before frame installation.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation

1. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
2. Prior to installation and with installation spreaders in place, adjust and securely brace sound-control door frames to the following tolerances:
   a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
   b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
   c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
   d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a perpendicular line from head to floor.

3. Drill and tap doors and frames to receive nontemplated mortised and surface-mounted door hardware.

C. Installation
1. General: Install sound-control door assemblies plumb, rigid, properly aligned, and securely fastened in place; comply with manufacturer's written instructions.
2. Frames: Install sound-control door frames in sizes and profiles indicated.
   a. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
      1) At fire-rated openings, install frames according to NFPA 80.
      2) At openings requiring smoke and draft control, install frames according to NFPA 105.
      3) Where frames are fabricated in sections due to shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, and dress; make splice smooth, flush, and invisible on exposed faces.
      4) Install sound-control frames with removable glazing stops located on secure side of opening.
      5) Remove temporary braces only after frames or bucks have been properly set and secured.
      6) Check squareness, twist, and plumbness of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
      7) Apply corrosion-resistant coatings coating to backs of frames to be filled with mortar, grout, and plaster containing antifreezing agents.
   b. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor and secure with postinstalled expansion anchors.
      1) Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors, if so indicated and approved on Shop Drawings.
   c. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
   d. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
   e. In-Place Gypsum Board Partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
   f. Ceiling Struts: Extend struts vertically from top of frame at each jamb to supporting construction above, unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable wedged or bolted anchorage to frame jamb members.
   g. Grouted Frames: Solidly fill space between frames and substrate with grout. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.
   h. Installation Tolerances: Adjust sound-control door frames for squareness, alignment, twist, and plumbness to the following tolerances:
      1) Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
      2) Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
      3) Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
      4) Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a perpendicular line from head to floor.
3. Doors: Fit sound-control doors accurately in frames, within clearances indicated below. Shim as necessary.

a. Non-Fire-Rated Doors: Fit non-fire-rated doors accurately in frames with the following clearances:
   1) Jambs: 1/8 inch (3 mm).
   2) Head with Butt Hinges: 1/8 inch (3 mm).
   3) Head with Cam-Lift Hinges: As required by manufacturer, but not more than 3/8 inch (9.5 mm).
   4) Sill: Manufacturer's standard.
   5) Between Edges of Pairs of Doors: 1/8 inch (3 mm).
b. Fire-Rated Doors: Install fire-rated doors with clearances according to NFPA 80.

4. Sound-Control Seals: Where seals have been prefit and preinstalled in the factory and subsequently removed for shipping, reinstall seals and adjust according to manufacturer's written instructions.
5. Cam-Lift Hinges: Install hinges according to manufacturer's written instructions.
6. Thresholds: Set thresholds in full bed of sealant complying with requirements in Division 7 Section "Joint Sealants."
7. Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with sound-control door assembly manufacturer's written instructions.
   a. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c., and not more than 2 inches (50 mm) o.c. from each corner.

D. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Testing Services: Acoustical testing and inspecting agency shall select one sound-control door at random from sound-control door assemblies that are completely installed and perform testing for verification that assembly complies with STC rating requirements.
   a. Field tests shall be conducted according to ASTM E 336, with results calculated according to ASTM E 413. Acceptable field STC values shall be within 5 dB of laboratory STC values.
   b. Inspection Report: Acoustical testing agency shall submit report in writing to the Owner and Contractor within 24 hours after testing.
   c. If tested door fails, replace or rework all sound-control door assemblies to bring them into compliance at Contractor's expense.
      1) Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
3. Prepare test and inspection reports.

E. Adjusting And Cleaning
1. Final Adjustments: Check and adjust seals, door bottoms, and other sound-control hardware items right before final inspection. Leave work in complete and proper operating condition.
2. Remove and replace defective work, including defective or damaged sound seals and doors and frames that are warped, bowed, or otherwise unacceptable.
   a. Adjust gaskets, gasket retainers, and retainer covers to provide contact required to achieve STC rating.
3. Clean grout off sound-control door frames immediately after installation.
4. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying primer.
5. Metallic-Coated Surfaces: Clean abraded areas of doors and repair with galvanizing repair paint according to manufacturer's written instructions.

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SECTION 08 35 13 13 - FOLDING DOORS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for folding doors. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Accordion folding doors.
   b. Panel folding doors.
   c. Bifold doors.
   d. Bifold mirror doors.
   e. Fire-rated folding doors.

C. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Include plans, elevations, sections, details, attachments to other work.
   a. Fire-Release System: Describe system, including testing and resetting instructions.
   b. Wiring Diagrams: For power, signal, and control wiring.
3. Samples: For each exposed product and for each color and texture specified.
4. Product Schedule: For folding doors. Use same designations indicated on Drawings.
5. Product certificates.
6. Maintenance data.

D. Quality Assurance
1. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   a. Flame-Spread Index: 25 or less.
   b. Smoke-Developed Index: 50 **OR** 450, **as directed**, or less.
2. Fire-Rated Folding Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing according to NFPA 252 **OR** IBC Standard 716.5 **OR** UL 10B, **as directed**.
   a. Oversize Fire-Rated Folding Doors: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
3. Project Conditions
   a. Environmental Limitations: Do not deliver or install folding doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
   b. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication

1.2 PRODUCTS

A. Accordion Folding Doors
1. General: Top-supported, horizontal-sliding, manually operated accordion folding doors, with chain controlling the spacing and extension of pantographic or X-type accordion folding frames.

Inner and outer covers are continuous surface facings that attach to and completely cover the folding frames and are pleated as the door is retracted.

2. Outer Covering: Of type indicated below, complying with indicated surface-burning characteristics; attached to door support frames in a concealed manner at sufficient intervals to prevent sagging and separation and to permit on-site removal and repair, with vertical seams located in valleys and material hemmed at top and bottom.
   a. Vinyl reinforced with woven backing weighing not less than 20 oz./linear yd. (567 g/m).
      1) Color, Texture, and Pattern: As selected from manufacturer's full range.
   b. Fabric weighing not less than 16 oz./linear yd. (496 g/m), treated to resist stains.
      1) Color, Texture, and Pattern: As selected from manufacturer's full range.
   c. Manufacturer's standard nonwoven carpet, needle punched with fused fibers to prevent unraveling.
      1) Color, Texture, and Pattern: As selected from manufacturer's full range.
3. Sweep Seals: Manufacturer's standard top and bottom sweep seals on both **OR** one, **as directred**, side(s).
4. Carriers: Four-wheel carriers at lead post and two-wheel carriers at intermediate spacing, as necessary for size and weight of partition, to ensure secure, easy, and quiet operation.
   a. Doors 96 Inches (2438 mm) High or Less: Nylon wheels on steel shafts.
   b. Doors More Than 96 Inches (2438 mm) High: Ball-bearing wheels with nylon tread and steel shafts.
5. Tracks: Manufacturer's standard metal track made of extruded aluminum or formed steel with factory-applied, corrosion-resistant finish. Limit track deflection, independent of structural supporting system, to no more than 80 percent of bottom clearance. Design and fabricate track to support accordion folding doors and enable their operation without damage to track, folding unit, or adjacent surfaces; complying with the following requirements:
   a. Head Trim: Prefinished wood molding for surface-mounted tracks.
   b. Center stop for center-opening partitions.
   c. Galvanized-steel sheet or aluminum subchannel for forming pocket for recessed suspension track.
   d. Metal ceiling contact guard to protect finished ceiling surface from damage by moving top sweep seals; with finish matching other exposed metal.
   e. Curved track sections with ceiling clips to accommodate configuration indicated.
   f. Glide switch to divert door to auxiliary track.
   g. Pivot switch to change track direction.
   h. Cross-track switch to allow one door to cross another.
6. Hardware: Manufacturer's standard heavy-duty, manually operated metal pulls and latches as follows:
   a. Finish: Clear-anodized aluminum **OR** Satin stainless steel **OR** Dull chromium-finish brass **OR** Dull chromium-finish steel, **as directed**.
   b. Latch: Operable from both **OR** one, **as directed**, side(s) of closed door with coin-slot release on opposite side, **as directed**.
   c. Lock: Manufacturer's standard key-operated cylinder lock, operable from both sides **OR** Manufacturer's standard key-operated cylinder lock, operable from one side; privacy lock on other side **OR** Deadlock to receive cylinder, operable from both sides. Refer to Division 08 Section "Door Hardware" for cylinder requirements **OR** Deadlock to receive cylinder, operable from both sides, **as directed**.
   d. Foot bolts on lead post where indicated. Secure to post to avoid interference with seals.
7. Jamb Molding: Manufacturer's standard wood or metal molding at closing jamb as required for light-tight jamb closure.
8. Lead Posts and Jamb Posts: Not less than 0.048-inch- (1.2-mm-) thick steel **OR** extruded aluminum, **as directed**, formed for rigidity and light seal at supporting construction.
   a. Nonferrous jamb strip for single-operating partitions to ensure tight closure by engaging rubber bumper on lead post.
9. Meeting Post: Fixed single jamb for single-stacked doors **OR** Center meeting post for center-opening doors, **as directed**.

10. Stacking: Tiebacks to maintain door in stacked position.
11. Stacking Configuration: Stack single doors at one end of opening **OR** center-opening doors at both ends of opening **OR** doors in pockets with hinged pocket doors, **as directed**.
12. Opening Size: As directed or as indicated on Drawings.

B. Panel Folding Doors
1. General: Top-supported, horizontal-sliding, manually operated panel folding doors, with panels joined by continuous hinge connectors for the full height of panels.
2. Core Material and Thickness: Manufacturer's standard.
3. Panel Width: 4-inch (100-mm) **OR** 5-inch (125-mm) **OR** 6-inch (150-mm) **OR** 8-inch (200-mm), **as directed**, nominal width.
4. Panel Facing: Facings that comply with indicated surface-burning characteristics.
   a. Vinyl Facing: Vinyl not less than 7 mils (0.175 mm) thick, factory bonded to core.
      1) Color and Texture: As selected from manufacturer's full range.
   b. Vinyl Facing with Woven Backing: Vinyl reinforced with woven backing weighing not less than 12 oz./linear yd. (372 g/m), factory bonded to core.
      1) Color and Texture: As selected from manufacturer's full range.
   c. Plastic-Laminate Facing: Grade VGS, high-pressure plastic laminate complying with NEMA LD 3; adhesive applied under pressure to core.
      1) Color, Texture, and Pattern: As selected from manufacturer's full range.
   d. Wood-Veneer Facing: as directed by the Owner, wood veneer, laminated to core, with manufacturer's standard clear **OR** stained, **as directed**, transparent finish.
      1) Stain Color: As selected from manufacturer's full range.
5. Carriers: Four-wheel carriers at lead post and two-wheel carriers at intermediate spacing, as necessary for size and weight of partition, to ensure secure, easy, and quiet operation.
   a. Panels 5 Inches (125 mm) Wide or Less: Nylon wheels and axles.
   b. Panels More Than 5 Inches (125 mm) Wide: Ball-bearing wheels with nylon tread and steel shafts.
6. Tracks: Manufacturer's standard surface-mounted **OR** recessed, **as directed**, extruded-aluminum or steel track with factory-applied, corrosion-resistant finish. Limit track deflection, independent of structural supporting system, to no more than 80 percent of bottom clearance. Design and fabricate track to support operation without damage to track, folding unit, or adjacent surfaces; complying with the following requirements:
   a. Prefinished ceiling guard/channel for recessed tracks.
   b. Center stop for biparting partitions.
   c. Galvanized-steel sheet or aluminum subchannel for forming pocket for recessed suspension track.
   d. Nonferrous jamb strip for single-operating partitions to ensure tight closure by engaging rubber bumper on lead post.
   e. Curved track sections to accommodate configuration indicated.
   f. Glide switch to divert door to auxiliary track.
   g. Pivot switch to change track direction.
   h. Cross-track switch to allow one door to cross another.
7. Hinge Connector: Manufacturer's standard extruded-vinyl hinge connector.
   a. Color: As selected from manufacturer's full range **OR** Match or coordinate with facing color, **as directed**.
8. Hardware: Manufacturer's standard heavy-duty, manually operated metal pulls and latches as follows:
   a. Finish: Clear-anodized aluminum **OR** Satin stainless steel **OR** Dull chromium-finish brass **OR** Dull chromium-finish steel, **as directed**.
   b. Latch: Operable from both **OR** one, **as directed**, side(s) of closed door.
   c. Lock: Manufacturer's standard key-operated cylinder lock, operable from both sides **OR** Manufacturer's standard key-operated cylinder lock, operable from one side; privacy lock on other side **OR** Deadlock to receive cylinder, operable from both sides. Refer to Division 08 Section "Door Hardware" for cylinder requirements **OR** Deadlock to receive cylinder, operable from both sides, **as directed**.

d. Foot bolts on lead post where indicated. Secure to post to avoid interference with seals.

9. Jamb Molding: Manufacturer's standard wood or metal molding at closing jamb as required for light-tight jamb closure.
   a. Wood: Match species and finish of panel facing.
   b. Metal: Manufacturer's standard finish.
10. Wood Track Molding: Manufacturer's standard wood molding on each side of surface-mounted track to match species and finish of panel facings. Install with tight, hairline joints with all fasteners concealed.
11. Meeting Post: Fixed single jamb for single-stacked doors **OR** Center meeting post for biparting doors, **as directed**.
12. Stacking: Tiebacks to maintain door in stacked position.

C. Bifold Doors

1. General: Metal folding doors hinged together in pairs and supported on pivots at jamb, with floor and overhead track and door guide pins.
2. Metal Panels: Sizes as indicated, formed from nominal 0.024-inch- (0.6-mm-) thick, cold-rolled steel sheet. Channel form vertical edges and weld cross bracing to panel and channel-formed edges.
   a. Surface Profile: Fully louvered **OR** Flush **OR** Paneled **OR** Louvered and paneled, **as directed**.
   b. Configuration: Two **OR** Four, **as directed**,-panel bifold.
   c. Sheet Metal Texture: Smooth **OR** Simulated leather, **as directed**.
   d. Protective Finish: Hot-dip galvanized coating applied to panels, stiffeners, hinges, and decorative trim.
   e. Baked Finish: Baked-enamel factory finish in white **OR** ivory **OR** custom color as selected, **as directed**.
3. Hardware: Manufacturer's standard felt pads, screws, and pulls in standard finish. Hinges, pivots, and manufacturer's standard wheels factory installed and as follows:
   a. Hinges: 3 self-aligning hinges.
   b. Guides and Pivots: Not less than 5/16-inch- (7.9-mm-) diameter, adjustable screw-type, weight-bearing, zinc-plated pivot rod held in place by nylon rod clamp assemblies; with not less than 1/4-inch- (6.4-mm-) diameter, spring-loaded, self-aligning, zinc-plated steel guide rods and top pivot rods held in place by nylon sleeves.
   c. Track: Prefinished rolled steel with baked-enamel paint finish **OR** Aluminum extrusion, Alloy 6063-T5, 0.05 inch (1.3 mm) thick, with manufacturer's standard metal finish, **as directed**.

D. Bifold Mirror Doors

1. General: Folding doors hinged together in pairs and supported on pivots at jamb, with floor and overhead track and door guide pins.
2. Steel-Panel Door Construction: Sizes as indicated, flush profile, formed from nominal 0.024-inch- (0.6-mm-) thick, cold-rolled steel sheet. Channel form vertical edges and weld cross bracing to panel- and channel-formed edges. Attach mirrored glass facing to steel sheet by means of mechanically attached channels at top and bottom and by dual-faced cushion tape.
   a. Configuration: Two **OR** Four, **as directed**,-panel bifold.
   b. Protective Finish: Hot-dip galvanized coating applied to panels, stiffeners, hinges, and decorative trim.
   c. Baked Finish: Baked-enamel factory finish in white **OR** custom color as selected, **as directed**.
3. Metal-Framed Door Construction: Aluminum **OR** Steel, **as directed**, stiles and mechanically fitted rails with screw-attached stiffeners and with mirrored-glass facing attached securely to frames.
   a. Panel Style: Exposed **OR** Concealed, **as directed**, frame.
   b. Configuration: Two **OR** Four, **as directed**,-panel bifold.

c. Baked Finish: Electrostatically applied, baked-enamel factory finish in white **OR** custom color as selected, **as directed**.
d. Bright, Reflective Metallic Finish: Chrome **OR** Gold **OR** Selected from manufacturer's full range, **as directed**.

4. Mirror Facing: Smooth **OR** Beveled, **as directed**,-edged, silvered, mirrored, film-backed safety glass complying with 16 CFR 1201 for Category II safety glass; with ASTM C 1036 for Type I (transparent, flat), Class 1(clear), Quality q2 (mirror) annealed float glass; with the following:
   a. Glass Thickness: 3 mm thick for doors up to 84 inches (2133 mm) in height **OR** 4 mm thick for doors with height more than 84 inches (2133 mm), **as directed**.
   b. Edge Protection: Vertical mirror edges protected by metal **OR** Mylar, **as directed**, trim.
   c. Film-Backed Safety Mirrors: Apply film backing with pressure-sensitive adhesive coating over mirror-backing paint as recommended in writing by film-backing manufacturer to produce a surface free of bubbles, blisters, and other imperfections.
5. Hardware: Manufacturer's standard felt pads, screws, and pulls in standard finish. Hinges, pivots, and manufacturer's standard wheels factory installed and as follows:
   a. Hinges: 3 self-aligning hinges.
   b. Guides and Pivots: Manufacturer's standard.
   c. Guides and Pivots: Spring-loaded, zinc-plated steel guides and tops, and adjustable bottom pivot pins with nylon bushings and tips.
   d. Guides and Pivots: Not less than 5/16-inch- (7.9-mm-) diameter, adjustable screw-type, weight-bearing, zinc-plated pivot rod held in place by nylon rod clamp assemblies; with not less than 1/4-inch- (6.4-mm-) diameter, spring-loaded, self-aligning, zinc-plated steel guide rods and top pivot rods held in place by nylon sleeves.
6. Track: Prefinished rolled steel with baked-enamel paint finish **OR** Aluminum extrusion, Alloy 6063-T5, 0.05 inch (1.3 mm) thick, with manufacturer's standard metal finish, **as directed**.

E. Fire-Rated Folding Doors
1. General: Electrically **OR** Gravity-, **as directed**, operated, automatic- or self-closing, UL- or ITS-listed, biparting folding fire-rated assembly; top supported from overhead track or dual tracks without floor guides; complete with hardware, seals, track, closing devices, releasing devices, controls, pocket doors, and accessories necessary for intended operation and complying with the following requirements:
   a. Assembly remains in normal open (stacked) position. Signal from fire-alarm system initiates self-closing operation.
   b. Controls allow manual operation in either conventional or emergency mode. When opened manually during emergency mode, control mechanism automatically closes assembly.
2. Fire Rating: 1 **OR** 1-1/2 **OR** 3, **as directed**, hour(s).
3. Panel Construction: Formed-steel **OR** Formed stainless-steel, **as directed**, sheet panels connected by formed-steel **OR** formed stainless-steel, **as directed**, hinges.
4. Fire Insulation:
   a. Cover interior surface of both series of panels in parallel panel doors with continuous fire-resistive blanket secured to each panel with metal clip system.
   b. Extend fire insulation from bottom edge of panels to tracks and meet at interior centers of fixed jamb and lead post, forming an effective fire barrier.
5. Perimeter Seals and Closures: Manufacturer's standard vinyl or neoprene vertical seals, horizontal top and bottom seals, and closures identical to products tested for fire rating indicated, and forming an effective smoke and draft seal.
6. Track and Trolley System: 1 track or 2 parallel steel tracks on 8-inch (200-mm) centers, with ball-bearing roller trolleys and adjustable steel hanger rods for overhead support; designed for type of operation, size, and weight of fire-rated folding door indicated. Provide a continuous system of track sections and accessories identical to products tested for fire rating indicated, to accommodate configuration and layout indicated for door operation and storage.
7. Lead Posts: Formed from not less than 0.026-inch (0.66-mm-) thick steel **OR** stainless-steel, **as directed**, sheet, connected to door panels by specially adapted panels and equipped with manufacturer's standard handle on each side.
8. Electric Operators and Controls:

a. Operators: Factory-assembled power-drive unit consisting of motor, remote-located, **as directed**, control panel, limit switches, torque-limiting devices, clutch, reversing magnetic motor operator, leading-edge obstruction detectors, and key-switch control for conventional operation.
   1) Motor: 1/2 hp, controlled by reversing magnetic starter and equipped with overload protection.
   2) Limit Switches: To prevent overtravel.
   3) Roller Chain or Cable: Connected to lead posts by means of vertical stabilizer bar assembly.
   4) Drive Mechanism: Protected by torque limiter and emergency clutch.
   5) Travel Speed: 18 inches (450 mm) per second, maximum; 6 inches (150 mm) per second, minimum.

b. In case of fire, closing system is activated by building's fire- and smoke-detection equipment and automatically closes fire-rated folding doors.

c. Electrical Service: Equip for 120 V, single phase, 60-cycle ac.

d. Battery: Electrical current connects through relay to battery charger that continuously charges 12-V dc battery and automatically maintains battery at capacity. Automatic audible signal device sounds off if battery falls below or exceeds proper charge, power loss has occurred, or high-ac line voltage has been experienced.

e. Leading-Edge Obstruction Detector:
   1) Equip with pressure-sensitive leading edge that, on contact with an obstruction, causes door to stop and pause before attempting to re-close.
   2) Disable leading-edge obstruction detector until fire-rated folding door has opened pocket door.

f. Fire-rated folding doors can be manually opened at any time by pushing against leading edge.

g. Audible alarm sounds at automatic closing of door.

9. Accessories:
   a. Vision panels.
   b. Exit Hardware: Located on both sides of fire-rated folding door. In emergency mode, slight pressure on hardware causes door to open a minimum of 32 inches (812 mm), pause for 3 seconds, and then automatically close. Furnish hardware that can be field programmable to allow automatic opening distances of up to the entire opening width. In conventional mode, hardware is used to operate door and move it back into storage pocket.

10. Finishes:
    a. Baked-enamel finish for panels and hinges in colors selected from manufacturer's full range.
    b. Manufacturer's standard finish for handles.

11. Pocket Door:
    a. Solid-core pocket doors with reverse-action spring **OR** continuous, **as directed**, hinge; 90-degree minimum swing.
    b. Face Finish: Match adjacent finishes.
    c. Magnetic Catch: Holding force of no more than 30 lbf (133 N).
    d. Maximum Opening Force: 50 lbf (222 N).
    e. Bumper on interior side of pocket door as required by fire-rated folding door manufacturer to prevent interference with opening or retracting operation of fire-rated folding door.
    f. Coordinate pocket door sizes with fire-rated folding door manufacturer.

1.3 EXECUTION

A. Preparation

1. For folding doors supported by or anchored to permanent construction, advise installers of specific requirements for placement of anchorage devices. Furnish installers of other work with templates and drawings showing locations of anchorage devices and similar items.
2. In path of fire-rated folding doors, level floor with header to tolerance of plus or minus 1/16 inch (1.6 mm) across opening; grind or fill floor as necessary.

B. Installation
   1. General: Install folding doors complying with manufacturer's written installation instructions. Install track in one piece.
      a. Comply with NFPA 80 for installing fire-rated folding doors.
   2. Standard Floor Clearances: 1/4 to 3/4 inch (6.4 to 19 mm) maximum (above floor finish).
      a. Comply with NFPA 80 for clearances required for fire-rated folding doors.
   3. Coordinate provisions for electrical service, sensing devices, and final connections for fire-rated folding doors.

C. Adjusting
   1. Adjust units as necessary to ensure smooth, quiet operation without warping or binding. Adjust hardware to function smoothly. Confirm that latches engage accurately and securely without forcing or binding.
      a. Fire-Rated Folding Doors: Verify that all operations are functional and comply with requirements of authorities having jurisdiction.
   2. Pocket Doors: Adjust to operate smoothly and easily, without binding or warping. Adjust hardware to function smoothly. Confirm that latches and locks engage accurately and securely without forcing or binding.

D. Demonstration
   1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-rated folding doors.

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SECTION 08 36 13 00 - SECTIONAL OVERHEAD DOORS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for sectional overhead doors. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes manually **OR** electrically, **as directed**, operated sectional doors with integral pass doors, **as directed**.

C. Performance Requirements
1. General Performance: Sectional doors shall meet performance requirements specified without failure due to defective manufacture, fabrication, installation, or other defects in construction and without requiring temporary installation of reinforcing components.
2. Delegated Design: Design sectional doors, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
3. Structural Performance: Exterior sectional doors shall withstand the effects of gravity loads, and the following loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   a. Wind Loads: As indicated on Drawings **OR** Uniform pressure (velocity pressure) of 20 lbf/sq. ft. (960 Pa), acting inward and outward, **as directed**.
      1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s) **OR** 100 mph (44 m/s) **OR** 110 mph (49 m/s), **as directed**.
      2) Exposure Category: A **OR** B **OR** C **OR** D, **as directed**.
   b. Deflection Limits: Design sectional doors to withstand design wind loads without evidencing permanent deformation or disengagement of door components. Deflection of door in horizontal position (open) shall not exceed 1/120 of the door width.
4. Air Infiltration: Maximum rate not more than indicated when tested according to ASTM E 283 **OR** DASMA 105, **as directed**.
   a. Air Infiltration: Maximum rate of 0.08 cfm/sq. ft. (0.406 L/s per sq. m) at 15 and 25 mph (24.1 and 40.2 km/h).
5. Windborne-Debris-Impact-Resistance Performance: Provide sectional doors **OR** glazed sectional doors, **as directed**, that pass large-missile-impact and cyclic-pressure tests when tested according to ASTM E 1886 and ASTM E 1996 **OR** DASMA 115, **as directed**.
6. Seismic Performance: Sectional doors shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
   b. Seismic Component Importance Factor: 1.5 **OR** 1.0, **as directed**.
7. Operation Cycles: Provide sectional door components and operators capable of operating for not less than number of cycles indicated for each door. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

D. Submittals
1. Product Data: For each type and size of sectional door and accessory.
2. LEED Submittal:
   a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that flush wood doors comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body, **as directed**. Include statement indicating costs for each certified wood product.

3. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work.
   a. Wiring Diagrams: For power, signal, and control wiring.
4. Samples: For each exposed product and for each color and texture specified.
5. Delegated-Design Submittal: For sectional doors indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
6. Seismic Qualification Certificates: For sectional doors, accessories, and components, from manufacturer.
7. Maintenance data.
8. Warranties: Sample of special warranties.

E. Quality Assurance
1. Wood Door Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
2. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.
3. Forest Certification: Provide wood doors made with not less than 70 percent of wood products **OR** all wood products, **as directed**, obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. Standard for Sectional Doors: Fabricate sectional doors to comply with DASMA 102 unless otherwise indicated.
6. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities" and ICC/ANSI A117.1, **as directed**.

F. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of sectional doors that fail in materials or workmanship within Two **OR** Five, **as directed**, years from date of Final Completion.
2. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied finishes within 10 years from date of Final Completion.

1.2 PRODUCTS

A. Steel Door Sections
1. Exterior Section Faces and Frames: Fabricate from zinc-coated (galvanized), cold-rolled, commercial steel (CS) sheet, complying with ASTM A 653/A 653M, with indicated zinc coating and thickness.
   a. Fabricate section faces from single sheets to provide sections not more than 24 inches (610 mm) high and of indicated thickness. Roll horizontal meeting edges to a continuous, interlocking, keyed, rabbeted, shiplap, or tongue-in-groove weathertight seal, with a reinforcing flange return.
   b. For insulated doors, provide sections with continuous thermal-break construction, separating the exterior and interior faces of door.
2. Section Ends and Intermediate Stiles: Enclose open ends of sections with channel end stiles formed from galvanized-steel sheet not less than 0.064-inch- (1.63-mm-) nominal coated thickness and welded to door section. Provide intermediate stiles formed from not less than

0.064-inch- (1.63-mm-) thick galvanized-steel sheet, cut to door section profile, and welded in place. Space stiles not more than 48 inches (1219 mm) apart.

3. Reinforce bottom section with a continuous channel or angle conforming to bottom-section profile and allowing installation of astragal, **as directed**.
4. Reinforce sections with continuous horizontal and diagonal reinforcement, as required to stiffen door and for wind loading. Provide galvanized-steel bars, struts, trusses, or strip steel, formed to depth and bolted or welded in place. Ensure that reinforcement does not obstruct vision lites, **as directed**.
5. Provide reinforcement for hardware attachment.
6. Board Thermal Insulation: Insulate interior of steel sections with door manufacturer's standard CFC-free polystyrene or polyurethane board insulation, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84; or with glass-fiber-board insulation. Secure insulation to exterior face sheet. Enclose insulation completely within steel sections that incorporate the following interior facing material, with no exposed insulation:
   a. Interior Facing Material:
      1) Zinc-coated (galvanized), cold-rolled, commercial steel (CS) sheet, complying with ASTM A 653/A 653M, with indicated thickness.
      2) Manufacturer's standard prefinished hardboard panel, 1/8 inch (3 mm) thick and complying with ANSI A135.5.
7. Foamed-in-Place Thermal Insulation: Insulate interior of steel sections with door manufacturer's standard CFC-free polyurethane insulation, foamed in place to completely fill interior of section and pressure bonded to face sheets to prevent delamination under wind load, and with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84. Enclose insulation completely within steel sections that incorporate the following interior facing material, with no exposed insulation:
   a. Interior Facing Material:
      1) Zinc-coated (galvanized), cold-rolled, commercial steel (CS) sheet, complying with ASTM A 653/A 653M, with indicated thickness.
      2) Manufacturer's standard prefinished hardboard panel, 1/8 inch (3 mm) thick and complying with ANSI A135.5.
8. Fabricate sections so finished door assembly is rigid and aligned, with tight hairline joints and free of warp, twist, and deformation.

B. Wood Door Sections
1. Paneled Sections: Fabricate stiles and rails of clear, vertical-grain, straight, kiln-dried Douglas fir, West Coast hemlock, or Sitka spruce, not less than 1-3/4 inches (44 mm) thick. Form meeting rails to provide rabbeted, weathertight-seal joint.
   a. Panel Inserts: Tempered hardboard, 1/4 inch (6 mm) thick, smooth on two sides, complying with ANSI A135.4.
   b. Glazed Panel Inserts: 6-mm-thick, clear float glass, complying with ASTM C 1036, Type I, Class 1, Quality Q3, with removable glazing stops of same wood as stiles and rails.
2. Flush Sections: Construct flush wood door sections with top, bottom, and end closures of clear, vertical-grain, straight, kiln-dried Douglas fir, West Coast hemlock, or Sitka spruce. Provide wood blocking to receive hardware, end stiles, and frames for glazing, glued and doweled in place. Form meeting rails to provide rabbeted weathertight-seal joint.
   a. Core: Manufacturer's standard polystyrene or polyurethane board insulation or honeycomb core complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84. Bond to facing.
   b. Facing: 1/8-inch- (3-mm-) thick, tempered hardboard complying with ANSI A135.4 and smooth on one side.
3. Fabricate sections of mortise-and-tenon construction with waterproof glue and steel dowels, or of rabbeted construction with waterproof glue and steel dowels and pins.
4. Reinforce sections with continuous horizontal and diagonal galvanized-steel members as required to stiffen door and for wind loading. Ensure that reinforcement does not obstruct vision lites.

5. Treat wood door members after machining with water-repellent preservative formulation according to WDMA I.S. 4.
6. Fabricate sections so finished door assembly is rigid and aligned, with tight hairline joints and free of warp, twist, deformation, and delamination.
7. Factory prime door sections with one coat of exterior primer compatible with field-applied finish, applied at a minimum dry film thickness of 1 mil (0.025 mm).

C. Aluminum Door Sections
1. Sections: Construct door sections with stiles and rails formed from extruded-aluminum shapes, complying with ASTM B 221 (ASTM B 221M), alloy and temper recommended by manufacturer for type of use and finish indicated, with wall thickness not less than 0.065 inch (1.7 mm) for door section 1-3/4 inches (44 mm) deep. Fabricate sections with stile and rail dimensions and profiles shown on Drawings. Join stiles and rails by welding or with concealed, 1/4-inch- (6-mm-) minimum diameter, aluminum or nonmagnetic stainless-steel through bolts, full height of door section. Form meeting rails to provide a weathertight-seal joint.
   a. Reinforce sections with continuous horizontal and diagonal reinforcement, as required to stiffen door and for wind loading. Ensure that reinforcement does not obstruct vision lites.
   b. Provide reinforcement for hardware attachment.
2. Solid Panels: Fabricate of aluminum sheet, complying with ASTM B 209 (ASTM B 209M), alloy and temper standard with manufacturer for type of use and finish indicated, not less than 0.040 inch (1.02 mm) thick, set in continuous vinyl channel retained with rigid, snap-in, extruded-vinyl moldings or with rubber or neoprene glazing gasket with aluminum stop.
3. Full-Vision Sections: Manufacturer's standard, tubular, aluminum-framed section fully glazed with 6-mm-thick, clear acrylic glazing set in vinyl, rubber, or neoprene glazing channel and with removable extruded-vinyl or aluminum stops.

D. Translucent Door Sections
1. Construct door sections of not less than 0.063-inch- (1.6-mm-) thick, extruded-aluminum stiles and rails complying with ASTM B 221 (ASTM B 221M) and with alloy and temper recommended by manufacturer for type of use and finish indicated, to provide door sections at least 1-3/4 inches (44 mm) deep. Fabricate units with overlapped or interlocked weathertight-seal joints at meeting rails. Reinforce or truss each section as required for strength and rigidity. Provide reinforcement for hardware attachment.
2. Provide translucent, ribbed, glass-fiber-reinforced plastic panels, secured and sealed watertight to framing, and reinforced to meet performance requirements.

E. Tracks, Supports, And Accessories
1. Tracks: Manufacturer's standard, galvanized-steel track system of configuration indicated, sized for door size and weight, designed for lift type indicated and clearances shown on Drawings, and complying with ASTM A 653/A 653M for minimum G60 (Z180) zinc coating. Provide complete track assembly including brackets, bracing, and reinforcement for rigid support of ball-bearing roller guides for required door type and size. Slot vertical sections of track spaced 2 inches (51 mm) apart for door-drop safety device. Slope tracks at proper angle from vertical or design tracks to ensure tight closure at jambs when door unit is closed.
2. Track Reinforcement and Supports: Galvanized-steel track reinforcement and support members, complying with ASTM A 36/A 36M and ASTM A 123/A 123M. Secure, reinforce, and support tracks as required for door size and weight to provide strength and rigidity without sag, sway, and vibration during opening and closing of doors.
   a. Vertical Track Assembly: Track with continuous reinforcing angle attached to track and attached to wall with jamb brackets **OR** wall jamb brackets attached to track and attached to wall, **as directed**.
   b. Horizontal Track Assembly: Track with continuous reinforcing angle attached to track and supported at points from curve in track to end of track by laterally braced attachments to overhead structural members.

3. Removable Center Posts: Manufacturer's standard carry-away **OR** roll-away **OR** swing-up, **as directed**, type for multiple doors in one opening.
4. Weatherseals: Replaceable, adjustable, continuous, compressible weather-stripping gaskets of flexible vinyl, rubber, or neoprene fitted to bottom and top of sectional door unless otherwise indicated.
5. Windows: Manufacturer's standard window units of type and size indicated and in arrangement shown. Set glazing in vinyl, rubber, or neoprene glazing channel for metal-framed doors and elastic glazing compound for wood doors, as required. Provide removable stops of same material as door-section frames.
6. Pass Doors: Manufacturer's standard pass doors where indicated, complete with glazing, operating hardware, and mortise lock. Construct pass doors of same materials, design, and finish as sectional door assembly.
   a. Lock Cylinders: Provide cylinders specified in Division 08 Section "Door Hardware" **OR** standard with manufacturer, **as directed**, and keyed to building keying system, **as directed**.
   b. Keys: Two **OR** Three, **as directed**, for each cylinder.

F. Hardware
1. General: Provide heavy-duty, corrosion-resistant hardware, with hot-dip galvanized, stainless-steel, or other corrosion-resistant fasteners, to suit door type.
2. Hinges: Heavy-duty, galvanized-steel hinges of not less than 0.079-inch- (2.01-mm-) nominal coated thickness at each end stile and at each intermediate stile, according to manufacturer's written recommendations for door size. Attach hinges to door sections through stiles and rails with bolts and lock nuts or lock washers and nuts. Use rivets or self-tapping fasteners where access to nuts is not possible. Provide double-end hinges where required, for doors over 16 feet (4.88 m) wide unless otherwise recommended by door manufacturer.
3. Rollers: Heavy-duty rollers with steel ball-bearings in case-hardened steel races, mounted with varying projections to suit slope of track. Extend roller shaft through both hinges where double hinges are required. Provide 3-inch- (76-mm-) diameter roller tires for 3-inch- (76-mm-) wide track and 2-inch- (51-mm-) diameter roller tires for 2-inch- (51-mm-) wide track.
4. Push/Pull Handles: For push-up or emergency-operated doors, provide galvanized-steel lifting handles on each side of door.

G. Locking Devices
1. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on single-jamb side, operable from inside only.
2. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded deadbolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.
   a. Lock Cylinders: Provide cylinders specified in Division 08 Section "Door Hardware" **OR** standard with manufacturer, **as directed**, and keyed to building keying system, **as directed**.
   b. Keys: Two **OR** Three, **as directed**, for each cylinder.
3. Chain Lock Keeper: Suitable for padlock.
4. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

H. Counterbalance Mechanism
1. Torsion Spring: Counterbalance mechanism consisting of adjustable-tension torsion springs fabricated from steel-spring wire complying with ASTM A 229/A 229M, mounted on torsion shaft made of steel tube or solid steel. Provide springs designed for number of operation cycles indicated.
2. Weight Counterbalance: Counterbalance mechanism consisting of filled pipe weights that move vertically in a galvanized-steel weight pipe. Connect pipe weights with cable to weight-cable drums mounted on torsion shaft made of steel tube or solid steel.
3. Cable Drums and Shaft for Doors: Cast-aluminum or gray-iron casting cable drums mounted on torsion shaft and grooved to receive door-lifting cables as door is raised. Mount counterbalance

mechanism with manufacturer's standard ball-bearing brackets at each end of torsion shaft. Provide one additional midpoint bracket for shafts up to 16 feet (4.88 m) long and two additional brackets at one-third points to support shafts more than 16 feet (4.88 m) long unless closer spacing is recommended by door manufacturer.

4. Cables: Galvanized-steel lifting cables with cable safety factor of at least 5 **OR** 7, **as directed**, to 1.
5. Cable Safety Device: Include a spring-loaded steel or spring-loaded bronze cam mounted to bottom door roller assembly on each side and designed to automatically stop door if either lifting cable breaks.
6. Bracket: Provide anchor support bracket as required to connect stationary end of spring to the wall and to level the shaft and prevent sag.
7. Provide a spring bumper at each horizontal track to cushion door at end of opening operation.

I. Manual Door Operators
1. Equip door with manufacturer's recommended manual door operator unless another type of door operator is indicated.
2. Push-up Operation: Lift handles and pull rope for raising and lowering doors, with counterbalance mechanism designed so that required lift or pull for door operation does not exceed 25 lbf (111 N).
3. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum 25-lbf (111-N) **OR** 35-lbf (155-N), **as directed**, force for door operation. Provide alloy-steel hand chain with chain holder secured to operator guide.

J. Electric Door Operators
1. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and "operation cycles" requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, remote-control stations, control devices, integral gearing for locking door, and accessories required for proper operation.
   a. Comply with NFPA 70.
   b. Provide control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6; with NFPA 70, Class 2 control circuit, maximum 24-V ac or dc.
2. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.
3. Door-Operator Type: Unit consisting of electric motor, gears, pulleys, belts, sprockets, chains, and controls needed to operate door and meet required usage classification.
   a. Trolley: Trolley operator mounted to ceiling above and to rear of door in raised position and directly connected to door with drawbar.
   b. Jackshaft, Center Mounted: Jackshaft operator mounted on the inside front wall above door and connected to torsion shaft with an adjustable coupling or drive chain.
   c. Jackshaft, Side Mounted: Jackshaft operator mounted on the inside front wall on right or left side of door and connected to torsion shaft with an adjustable coupling or drive chain.
4. Electric Motors: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 11 Section "Common Motor Requirements For Equipment", unless otherwise indicated.
   a. Electrical Characteristics:
      1) Phase: Single phase **OR** Polyphase, **as directed**.
      2) Volts: 115 **OR** 208 **OR** 230 **OR** 460, **as directed**, V.
      3) Hertz: 60.
   b. Motor Type and Controller: Reversible motor and controller (disconnect switch) for motor exposure indicated.
   c. Motor Size: Minimum size as indicated. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. (203 mm/s) and not more than 12 in./sec. (305 mm/s), without exceeding nameplate ratings or service factor.

d. Operating Controls, Controllers (Disconnect Switches), Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
e. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.
f. Use adjustable motor-mounting bases for belt-driven operators.

5. Limit Switches: Equip each motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.
6. Obstruction Detection Device: Equip motorized door with indicated external automatic safety sensor capable of protecting full width of door opening. Activation of device immediately stops and reverses downward door travel.
   a. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.
      1) Self-Monitoring Type: Designed to interface with door operator control circuit to detect damage to or disconnection of sensor device. When self-monitoring feature is activated, door closes only with sustained pressure on close button.
   b. Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.
      1) Self-Monitoring Type: Four-wire configured device designed to interface with door-operator control circuit to detect damage to or disconnection of sensor edge.
7. Remote-Control Station: Momentary-contact, three-button control station with push-button controls labeled "Open," "Close," and "Stop."
   a. Interior units, full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
   b. Exterior units, full-guarded, standard-duty, surface-mounted, weatherproof type, NEMA ICS 6, Type 4 enclosure, key operated.
8. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 25 lbf (111 N) **OR** 35 lbf (155 N), **as directed**.
9. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
10. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.
11. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with regulatory requirements for accessibility.
12. Radio-Control System: Consisting of the following:
    a. Three-channel universal coaxial receiver to open, close, and stop door; one **OR** two, **as directed**, per operator.
       OR
       Multifunction remote control.
       OR
       Remote antenna and mounting kit.

K. Door Assembly
1. Steel **OR** Wood **OR** Aluminum **OR** Full-Vision Aluminum **OR** Translucent, **as directed**, Sectional Door: Sectional door formed with hinged sections.
2. Operation Cycles: Not less than 10,000 **OR** 20,000 **OR** 50,000 **OR** 100,000, **as directed.**
3. R-Value **OR** Installed R-Valu, **as directed**: 4.5 deg F x h x sq. ft./Btu (0.792 K x sq. m/W) **OR** 6.0 deg F x h x sq. ft./Btu (1.057 K x sq. m/W) **OR** 12.0 deg F x h x sq. ft./Btu (2.113 K x sq. m/W) **OR** 15.0 deg F x h x sq. ft./Btu (2.642 K x sq. m/W) **OR** 17.5 deg F x h x sq. ft./Btu (3.082 K x sq. m/W), **as directed**.
4. Steel Sections: Zinc-coated (galvanized) steel sheet with G60 (Z180) **OR** G90 (Z275), **as directed**, zinc coating.

a. Section Thickness: 1-3/8 inches (35 mm) **OR** 1-3/4 inches (44 mm) **OR** 2 inches (51 mm), **as directed**.
b. Exterior-Face, Steel Sheet Thickness: 0.064-inch- (1.63-mm-) **OR** 0.040-inch- (1.02-mm-) **OR** 0.028-inch- (0.71-mm-) **OR** 0.022-inch- (0.56-mm-) **OR** 0.019-inch- (0.48-mm-), **as directed**, nominal coated thickness.
   1) Surface:
      a) Flat.
         OR
         Manufacturer's standard, grooved **OR** ribbed **OR** paneled **OR** wood-grain embossed, **as directed**.
c. Insulation: Board **OR** Foamed in place, **as directed**.
d. Interior Facing Material: Zinc-coated (galvanized) steel sheet of 0.028-inch- (0.71-mm-) **OR** 0.022-inch- (0.56-mm-) **OR** 0.019-inch- (0.48-mm-) **OR** manufacturer's recommended thickness to meet performance requirements, **as directed**, nominal coated thickness.
e. Interior Facing Material: Hardboard panel.

5. Wood Sections: Paneled **OR** Flush, **as directed**, and with manufacturer's standard insulation, **as directed**.
6. Aluminum Sections: Solid panels **OR** Full vision, **as directed**, with manufacturer's standard, nonglazed panels across bottom section of door, **as directed**.
7. Translucent Sections: Manufacturer's standard with manufacturer's standard, nonglazed panels across bottom section of door, **as directed**.
8. Track Configuration: Standard-lift **OR** Low-headroom **OR** High-lift **OR** Vertical-lift **OR** Contour, **as directed**, track with removable center post shared with adjacent door, **as directed**.
9. Weatherseals: Fitted to bottom and top and around entire perimeter of door. Provide combination bottom weatherseal and sensor edge, **as directed**.
10. Windows: Approximately 24 by 7 inches (610 by 178 mm) **OR** 24 by 11 inches (610 by 279 mm), **as directed**, with curved corners, **OR** with square corners, **as directed**, and spaced apart the approximate distance as indicated on Drawings; in one row **OR** two rows, **as directed**, at height indicated on Drawings; installed with glazing **OR** insulated glazing, **as directed**, of the following type:
   a. Clear Float Glass: 3 mm thick and complying with ASTM C 1036, Type I, Class 1, Quality Q3.
   b. Clear Acrylic Plastic: 3 mm thick, transparent, smooth or polished, and formulated to be UV resistant.
   c. Clear Polycarbonate Plastic: 3-mm-thick, transparent, fire-retardant, UV-resistant, polycarbonate sheet manufactured by extrusion process.
   d. Insulating Glass: Manufacturer's standard.
11. Pass Door: As shown.
12. Roller-Tire Material: Case-hardened steel **OR** Neoprene or bronze **OR** Manufacturer's standard, **as directed**.
13. Locking Devices: Equip door with slide bolt for padlock **OR** locking device assembly, **as directed**, and chain lock keeper, **as directed**.
   a. Locking Device Assembly: Single-jamb side **OR** Cremone type, both jamb sides, **as directed**, locking bars, operable from inside with thumbturn **OR** outside with cylinder **OR** outside only, with cylinder **OR** inside and outside, with cylinders, **as directed**.
14. Counterbalance Type: Torsion spring **OR** Weight counterbalance, **as directed**.
15. Manual Door Operator: Push-up operation **OR** Chain-hoist operator, **as directed**.
16. Electric Door Operator:
   a. Usage Classification: Heavy duty, 60 to 90 cycles per hour **OR** Standard duty, up to 60 cycles per hour **OR** Medium duty, up to 15 cycles per hour **OR** Light duty, up to 10 cycles per hour, **as directed**.
   b. Operator Type: Trolley **OR** Jackshaft, center mounted **OR** Jackshaft, side mounted **OR** As shown on Drawings, **as directed**.
   c. Motor Exposure: Interior, clean, and dry **OR** Exterior, dusty, wet, or humid, **as directed**.
   d. Emergency Manual Operation: Push-up **OR** Chain, **as directed**, type.

e. Obstruction-Detection Device: Automatic photoelectric sensor **OR** electric sensor edge on bottom bar **OR** pneumatic sensor edge on bottom bar, **as directed**; self-monitoring type, **as directed**.
    1) Sensor Edge Bulb Color: Black **OR** As selected from manufacturer's full range, **as directed**.
f. Remote-Control Station: Interior **OR** Exterior **OR** Where shown on Drawings, **as directed**.
g. Other Equipment: Audible and visual signals **OR** Radio-control system, **as directed**.

17. Door Finish:
    a. Aluminum Finish: Clear anodized **OR** Bronze anodized **OR** Anodized color matching sample **OR** Anodized color as selected from manufacturer's full range, **as directed**.
    b. Baked-Enamel or Powder-Coated Finish: Color and gloss as selected from manufacturer's full range.
    c. Factory Prime Finish: Manufacturer's standard color.
    d. Finish of Interior Facing Material: Match finish of exterior section face **OR** Finish as selected from manufacturer's full range, **as directed**.

L. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

M. Aluminum Finishes
1. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
2. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
3. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, application, and baking.

N. Steel And Galvanized-Steel Finishes
1. Factory Prime Finish: Manufacturer's standard primer, compatible with field-applied finish. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.
2. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

1.3 EXECUTION

A. Installation
1. Install sectional doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.
2. Tracks:
    a. Fasten vertical track assembly to opening jambs and framing, spaced not more than 24 inches (610 mm) apart.
    b. Hang horizontal track assembly from structural overhead framing with angles or channel hangers attached to framing by welding or bolting, or both. Provide sway bracing, diagonal bracing, and reinforcement as required for rigid installation of track and door-operating equipment.
    c. Repair galvanized coating on tracks according to ASTM A 780.
3. Accessibility: Install sectional doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.

B. Startup Services
1. Engage a factory-authorized service representative to perform startup service.
   a. Complete installation and startup checks according to manufacturer's written instructions.
   b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Adjusting
1. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.
2. Lubricate bearings and sliding parts as recommended by manufacturer.
3. Adjust doors and seals to provide weathertight fit around entire perimeter.
4. Align and adjust motors, pulleys, belts, sprockets, chains, and controls according to manufacturer's written instructions.
5. Touch-up Painting: Immediately after welding galvanized materials, clean welds and abraded galvanized surfaces and repair galvanizing to comply with ASTM A 780.

END OF SECTION 08 36 13 00

Task	Specification	Specification Description
08 36 13 00	08 33 23 11	Overhead Coiling Doors

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SECTION 08 38 13 00 - FLEXIBLE DOORS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of flexible doors. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals

1. Product Data: For each type of product indicated.
2. Shop drawings shall be submitted for approval.

1.2 PRODUCTS

A. General: Each new door unit shall be a complete unit produced by one manufacturer including hardware, accessories, mounting, and installation components.

B. Door Panels: Door panels shall be constructed of the following materials.

1. Heavy-Duty, Abrasive-Resistant Rubber, 60 durometer, roto-cured process, 2,200 psi tensile strength. Panel thickness shall be I/2- inch. Lower door panel shall be reinforced with additional rubber extrusions bonded horizontally to the door facing on 8 inch centers.
2. Flexible Polycarbonate transparent panels 1/2 inch thick.
3. Flexible Polyvinylchloride (PVC) transparent panels min. 0.196 inch (5mm) thick.
4. Flexible Polyvinylchloride (PVC) opaque panels min. 0.196 inch (5mm) thick.

C. Door Facings shall be high strength fabric reinforced vinyl bonded to door frame. Facing shall not be mechanically fastened.

D. The Vision Panels shall be double glazed, damage resistant with optical clarity exceeding 90%. Vision Panels shall be mounted flush.

E. Door Panels shall be single or double-acting, as required.

F. Panel Frame: Framing materials to which door panels shall be secured shall be galvanized steel, ASTM A525, 11 gauge. Door panels shall be suspended between L-shaped rolled formed rails and stiles by removable bolt and nut connectors.

G. Hardware shall conform to the requirements of ASTM A 164 or ASTM A 386, as required.

1. Hinges shall be adjustable spring-type gravity self-lubricating hinges.
2. Magnetic Catch shall be provided at door overlap at pair of door panels to give positive closure.
3. Header and Jamb Seals shall be door mounted PVC seals at head and jamb.
4. Bumpers shall be center or bottom bumpers.
5. Jamb Guards shall be formed steel guards to enclose and protect lower hinge hardware and closures.

H. Door Jamb shall be constructed of steel tube, ASTM A 500, with integral wall anchors, galvanized in compliance with ASTM A 386 or stainless steel bent plate, Type 304, with integral wall anchors, as required.

I. Finish: All ferrous metal parts shall be finish-coated with polyurethane paint.

J. Fire Hazard Classification: All door material shall have a fire hazard classification determined by ASTM E 84. Provide materials with the following fire hazard classifications:
Flame spread not more than 25.
Smoke developed not more than 50.

K. Vertical PVC Vinyl Strip Doors
1. Door shall consist of overlapping transparent minimum PVC strips with pre-punched galvanized hanger brackets which mate with formed metal arms on the universal hardware.
2. Hardware shall provide full swivel action. A cover plate shall prevent accidental removal.
3. End Strips shall be orange to frame opening. Strips shall have rounded edges and overlap to form a seal.

1.3 EXECUTION

A. Products shall be installed per manufacturer's written instruction. Products shall be firmly attached to adjacent materials. Products shall be installed level and plumb and shall be demonstrated to operate properly and as intended for a complete installation.

END OF SECTION 08 38 13 00

Task	Specification	Specification Description
08 38 16 00	08 01 11 61	Steel Doors And Frames
08 38 16 00	08 01 11 61a	Steel Entry Doors
08 38 16 00	08 12 13 13	Stainless Steel Doors And Frames
08 38 19 00	08 01 11 61	Steel Doors And Frames
08 38 19 00	08 01 11 61a	Steel Entry Doors
08 38 19 00	08 12 13 13	Stainless Steel Doors And Frames

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SECTION 08 42 13 00 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for aluminum framed entrances and storefronts. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Exterior and interior storefront framing.
b. Storefront framing for window walls.
c. Storefront framing for ribbon walls.
d. Storefront framing for punched openings.
e. Exterior and interior manual-swing entrance doors and door-frame units.

C. Definitions
1. ADA/ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disability Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities."

D. Performance Requirements
1. General Performance: Aluminum-framed systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction:
a. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
b. Dimensional tolerances of building frame and other adjacent construction.
c. Failure includes the following:
1) Deflection exceeding specified limits.
2) Thermal stresses transferring to building structure.
3) Framing members transferring stresses, including those caused by thermal and structural movements to glazing.
4) Glazing-to-glazing contact.
5) Noise or vibration created by wind and by thermal and structural movements.
6) Loosening or weakening of fasteners, attachments, and other components.
7) Sealant failure.
8) Failure of operating units.
2. Delegated Design: Design aluminum-framed systems, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
3. Structural Loads:
a. Wind Loads: As indicated on Drawings **OR as directed**.
1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s) **OR** 100 mph (44 m/s) **OR** 110 mph (49 m/s), **as directed**.
2) Exposure Category: A **OR** B **OR** C **OR** D, **as directed**.
4. Deflection of Framing Members:
a. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane shall not exceed L/175 of the glass edge length for each individual glazing lite **OR** 1/175 of clear span for spans up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 13 feet 6 inches (4.1 m), **as directed**, or an

amount that restricts edge deflection of individual glazing lites to 3/4 inch (19 mm), whichever is less.

b. Deflection Parallel to Glazing Plane: Limited to L/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller **OR** amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components directly below them to less than 1/8 inch (3.2 mm) and clearance between members and operable units directly below them to less than 1/16 inch (1.5 mm), **as directed**.

5. Structural-Test Performance: Provide aluminum-framed systems tested according to ASTM E 330 as follows:
   a. When tested at positive and negative wind-load design pressures, systems do not evidence deflection exceeding specified limits.
   b. When tested at 150 percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
   c. Test Durations: As required by design wind velocity, but not fewer than 10 seconds.
6. Windborne-Debris-Impact-Resistance Performance: Provide aluminum-framed systems that pass missile-impact and cyclic-pressure tests when tested according to ASTM E 1886 and testing information in ASTM E 1996 **OR** AAMA 506, **as directed**.
   a. Large-Missile Impact: For aluminum-framed systems located within 30 feet (9.1 m) of grade.
   b. Small-Missile Impact: For aluminum-framed systems located more than 30 feet (9.1 m) above grade.
7. Story Drift: Provide aluminum-framed systems that accommodate design displacement of adjacent stories indicated.
   a. Design Displacement: As indicated on Drawings **OR as directed**.
   b. Test Performance: Meet criteria for passing, based on building occupancy type, when tested according to AAMA 501.4 at design displacement and 1.5 times design displacement.
8. Air Infiltration: Provide aluminum-framed systems with maximum air leakage through fixed glazing and framing areas of 0.06 cfm/sq. ft. (0.03 L/s per sq. m) of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 1.57 lbf/sq. ft. (75 Pa) **OR** 6.24 lbf/sq. ft. (300 Pa), **as directed**.
9. Water Penetration under Static Pressure: Provide aluminum-framed systems that do not evidence water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).
10. Water Penetration under Dynamic Pressure: Provide aluminum-framed systems that do not evidence water leakage through fixed glazing and framing areas when tested according to AAMA 501.1 under dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).
    a. Maximum Water Leakage: According to AAMA 501.1 **OR** No uncontrolled water penetrating aluminum-framed systems or water appearing on systems' normally exposed interior surfaces from sources other than condensation, **as directed**. Water leakage does not include water controlled by flashing and gutters that is drained to exterior and water that cannot damage adjacent materials or finishes.
11. Thermal Movements: Provide aluminum-framed systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
    a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
    b. Test Performance: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.

1) High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F (82 deg C).
2) Low Exterior Ambient-Air Temperature: 0 deg F (minus 18 deg C).

c. Interior Ambient-Air Temperature: 75 deg F (24 deg C).

12. Condensation Resistance: Provide aluminum-framed systems with fixed glazing and framing areas having condensation-resistance factor (CRF) of not less than 45 **OR** 53, **as directed**, when tested according to AAMA 1503.
13. Thermal Conductance: Provide aluminum-framed systems with fixed glazing and framing areas having an average U-factor of not more than 0.57 Btu/sq. ft. x h x deg F (3.23 W/sq. m x K) **OR** 0.69 Btu/sq. ft. x h x deg F (3.92 W/sq. m x K), **as directed**, when tested according to AAMA 1503.
14. Sound Transmission: Provide aluminum-framed systems with fixed glazing and framing areas having the following sound-transmission characteristics:
    a. Sound Transmission Class (STC): Minimum 26 **OR** 30 **OR** 35, **as directed**, STC when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 413.
    b. Outdoor-Indoor Transmission Class (OITC): Minimum 26 **OR** 30 **OR** 34, **as directed**, OITC when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 1332.
15. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by aluminum-framed systems without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
    a. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
    b. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.
16. Structural-Sealant Joints: Designed to produce tensile or shear stress of less than 20 psi (138 kPa).

E. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittal:
    a. Product Data for Credit EQ 4.1: For adhesives and sealants used inside of the weatherproofing system, including printed statement of VOC content.
3. Shop Drawings: For aluminum-framed systems. Include plans, elevations, sections, details, and attachments to other work.
    a. Include details of provisions for system expansion and contraction and for drainage of moisture in the system to the exterior.
    b. For entrance doors, include hardware schedule and indicate operating hardware types, functions, quantities, and locations.
4. Samples: For each type of exposed finish required.
5. Other Action Submittals:
    a. Entrance Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.
6. Delegated-Design Submittal: For aluminum-framed systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
7. Seismic Qualification Certificates: For aluminum-framed systems, accessories, and components, from manufacturer.
    a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
8. Welding certificates.

9. Product Test Reports.
10. Quality-Control Program for Structural-Sealant-Glazed System: Include reports.
11. Field quality-control reports.
12. Maintenance Data.
13. Warranties: Sample of special warranties.

F. Quality Assurance
1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.
3. Engineering Responsibility: Prepare data for aluminum-framed systems, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in systems similar to those indicated for this Project.
4. Quality-Control Program for Structural-Sealant-Glazed System: Develop quality control program specifically for Project. Document quality-control procedures and verify results for aluminum-framed systems. Comply with ASTM C 1401 recommendations including, but not limited to, system material-qualification procedures, preconstruction sealant-testing program, procedures for system fabrication and installation, and intervals of reviews and checks.
5. Product Options: Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.
   a. Do not revise intended aesthetic effects, as judged solely by the Owner, except with the Owner's approval. If revisions are proposed, submit comprehensive explanatory data to the Owner for review.
6. Accessible Entrances: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1, **as directed**.
7. Source Limitations for Aluminum-Framed Systems: Obtain from single source from single manufacturer.
8. Structural-Sealant Glazing: Comply with ASTM C 1401, "Guide for Structural Sealant Glazing" for design and installation of structural-sealant-glazed systems.
9. Structural-Sealant Joints: Design reviewed and approved by structural-sealant manufacturer.
10. Welding Qualifications: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code - Aluminum."
11. Preinstallation Conference: Conduct conference at Project site.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that fail in materials or workmanship within two **OR** five **OR** 10, **as directed**, years from date of Final Completion.
2. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes do not comply with requirements or that fail in materials or workmanship within five **OR** 10 **OR** 20, **as directed**, years from date of Final Completion. Warranty does not include normal weathering.

1.2 PRODUCTS

A. Materials
1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
   a. Sheet and Plate: ASTM B 209 (ASTM B 209M).

b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
c. Extruded Structural Pipe and Tubes: ASTM B 429.
d. Structural Profiles: ASTM B 308/B 308M.
e. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

2. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer, complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
   a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
   b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
   c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

B. Framing Systems
1. Framing Members: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.
   a. Construction: Nonthermal **OR** Thermally improved **OR** Thermally broken **OR** Structurally glazed, **as directed**.
   b. Glazing System: Retained mechanically with gaskets on four sides **OR** Retained by structural sealant at vertical edges and mechanically with gaskets at horizontal edges, **as directed**.
   c. Glazing Plane: As indicated **OR** Front **OR** Center **OR** Back **OR** Multiplane, **as directed**.
2. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
3. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
   a. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
   b. Reinforce members as required to receive fastener threads.
   c. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system **OR** fabricated from stainless steel, **as directed**.
4. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts, complying with ASTM A 123/A 123M or ASTM A 153/A 153M.
5. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials **OR** Dead-soft, 0.018-inch- (0.457-mm-) thick stainless steel, ASTM A 240/A 240M of type recommended by manufacturer, **as directed**.
6. Framing System Gaskets and Sealants: Manufacturer's standard, recommended by manufacturer for joint type.
   a. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Glazing Systems
1. Glazing: As specified in Division 08 Section "Glazing".
2. Glazing Gaskets: Manufacturer's standard compression types; replaceable, molded or extruded, of profile and hardness required to maintain watertight seal.
3. Spacers and Setting Blocks: Manufacturer's standard elastomeric type.
4. Bond-Breaker Tape: Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.
5. Glazing Sealants: For structural-sealant-glazed systems, as recommended by manufacturer for joint type, and as follows:
   a. Structural Sealant: ASTM C 1184, single-component neutral-curing silicone formulation that is compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant and approved by a structural-sealant manufacturer for use in aluminum-framed systems indicated.
      1) Provide sealants for use inside of the weatherproofing system that have a VOC content of 100 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2) Color: Black **OR** As selected from manufacturer's full range of colors, **as directed**.

b. Weatherseal Sealant: ASTM C 920 for Type S, Grade NS, Class 25, Uses NT, G, A, and O; single-component neutral-curing formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and aluminum-framed-system manufacturers for this use.

1) Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2) Color: Matching structural sealant.

D. Entrance Door Systems

1. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing operation.

a. Door Construction: 1-3/4-inch (44.5-mm) overall thickness, with minimum 0.125-inch- (3.2-mm-) **OR** 2-inch (50.8-mm) overall thickness, with minimum 0.188-inch- (4.8-mm-) **OR** 2- to 2-1/4-inch (50.8- to 57.2-mm) overall thickness, with minimum 0.125-inch- (3.2-mm-), **as directed**, thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.

1) Thermal Construction: High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior.

b. Door Design: As indicated **OR** Narrow stile; 2-1/8-inch (54-mm) nominal width **OR** Medium stile; 3-1/2-inch (88.9-mm) nominal width **OR** Wide stile; 5-inch (127-mm) nominal width, **as directed**.

1) Accessible Doors: Smooth surfaced for width of door in area within 10 inches (255 mm) above floor or ground plane.

c. Glazing Stops and Gaskets: Beveled **OR** Square, **as directed**, snap-on, extruded-aluminum stops and preformed gaskets.

1) Provide nonremovable glazing stops on outside of door.

E. Entrance Door Hardware

1. General: Provide entrance door hardware and entrance door hardware sets indicated in door and frame schedule **OR** and entrance door hardware sets indicated in "Entrance Door Hardware Sets" Article, **as directed**, for each entrance door to comply with requirements in this Section.

a. Entrance Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturers' products **OR** products equivalent in function and comparable in quality to named products **OR** products complying with BHMA standard referenced, **as directed**.

b. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.

c. Opening-Force Requirements:

1) Egress Doors: Not more than 15 lbf (67 N) to release the latch and not more than 30 lbf ((133 N))to set the door in motion and not more than 15 lbf (67 N) to open the door to its minimum required width.

2) Accessible Interior Doors: Not more than 5 lbf (22.2 N) to fully open door.

2. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of entrance door hardware are indicated in "Entrance Door Hardware Sets" Article. Products are identified by using entrance door hardware designations as follows:

a. References to BHMA Standards: Provide products complying with these standards and requirements for description, quality, and function.

3. Opening-Force Requirements:

a. Delayed-Egress Locks: Lock releases within 15 seconds after applying a force of not more than 15 lbf (67 N) for not more than 3 seconds.

b. Latches and Exit Devices: Not more than 15 lbf (67 N) required to release latch.

4. Pivot Hinges: BHMA A156.4, Grade 1.

a. Offset-Pivot Hinges: Provide top, bottom, and intermediate offset pivots at each door leaf.

5. Butt Hinges: BHMA A156.1, Grade 1, radius corner.
   a. Nonremovable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while entrance door is closed.
   b. Exterior Hinges: Stainless steel, with stainless-steel pin **OR** Nonferrous, **as directed**.
   c. Quantities:
      1) For doors up to 87 inches (2210 mm) high, provide 3 hinges per leaf.
      2) For doors more than 87 and up to 120 inches (2210 and up to 3048 mm) high, provide 4 hinges per leaf.
6. Continuous-Gear Hinges: Manufacturer's standard with stainless-steel bearings between knuckles, fabricated to full height of door and frame.
7. Mortise Auxiliary Locks: BHMA A156.5, Grade 1.
8. Manual Flush Bolts: BHMA A156.16, Grade 1.
9. Automatic and Self-Latching Flush Bolts: BHMA A156.3, Grade 1.
10. Panic Exit Devices: BHMA A156.3, Grade 1, listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.
11. Cylinders: As specified in Division 08 Section "Door Hardware" **OR** BHMA A156.5, Grade 1, **as directed**.
    a. Keying: No master **OR** Master, **as directed**, key system. Permanently inscribe each key with a visual key control number and include notation "DO NOT DUPLICATE" **OR** to be furnished by Owner, **as directed**.
12. Strikes: Provide strike with black-plastic dust box for each latch or lock bolt; fabricated for aluminum framing.
13. Operating Trim: BHMA A156.6.
14. Removable Mullions: BHMA A156.3, extruded aluminum.
    a. When used with panic exit devices, provide removable mullions listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305. Use only mullions that have been tested with exit devices to be used.
15. Closers: BHMA A156.4, Grade 1, with accessories required for a complete installation, sized as required by door size, exposure to weather, and anticipated frequency of use; adjustable to meet field conditions and requirements for opening force.
16. Concealed Overhead Holders: BHMA A156.8, Grade 1.
17. Surface-Mounted Holders: BHMA A156.16, Grade 1.
18. Door Stops: BHMA A156.16, Grade 1, floor or wall mounted, as appropriate for door location indicated, with integral rubber bumper.
19. Weather Stripping: Manufacturer's standard replaceable components.
    a. Compression Type: Made of ASTM D 2000, molded neoprene, or ASTM D 2287, molded PVC.
    b. Sliding Type: AAMA 701, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.
20. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.
21. Silencers: BHMA A156.16, Grade 1.
22. Thresholds: BHMA A156.21, raised thresholds beveled with a slope of not more than 1:2, with maximum height of 1/2 inch (13 mm).
23. Finger Guards: Manufacturer's standard collapsible neoprene or PVC gasket anchored to frame hinge-jamb at center-pivoted doors.

F. Accessory Materials
   1. Joint Sealants: For installation at perimeter of aluminum-framed systems, as specified in Division 07 Section "Joint Sealants".
      a. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos; formulated for 30-mil (0.762-mm) thickness per coat.

G. Fabrication
1. Form or extrude aluminum shapes before finishing.
2. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
3. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:
   a. Profiles that are sharp, straight, and free of defects or deformations.
   b. Accurately fitted joints with ends coped or mitered.
   c. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
   d. Physical and thermal isolation of glazing from framing members.
   e. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
   f. Provisions for field replacement of glazing from exterior **OR** interior **OR** interior for vision glass and exterior for spandrel glazing or metal panels, **as directed**.
   g. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
4. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
5. Structural-Sealant-Glazed Framing Members: Include accommodations for using temporary support device to retain glazing in place while structural sealant cures.
6. Storefront Framing: Fabricate components for assembly using shear-block system **OR** screw-spline system **OR** head-and-sill-receptor system with shear blocks at intermediate horizontal members, **as directed**.
7. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
   a. At exterior doors, provide compression weather stripping at fixed stops.
   b. At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.
8. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
   a. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
   b. At exterior doors, provide weather sweeps applied to door bottoms.
9. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.
10. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

H. Aluminum Finishes
1. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
2. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Champagne **OR** Black **OR** Match sample **OR** As selected from full range of industry colors and color densities, **as directed**.
3. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

a. Color and Gloss: Match sample **OR** As selected from manufacturer's full range, **as directed**.

4. High-Performance Organic Finish:
    a. 2-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    OR
    3-coat **OR** 4-coat, **as directed**, fluoropolymer finish complying with AAMA 2605 and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
        1) Color and Gloss: Match sample **OR** As selected from manufacturer's full range, **as directed**.

1.3 EXECUTION

A. Installation

1. General:
    a. Comply with manufacturer's written instructions.
    b. Do not install damaged components.
    c. Fit joints to produce hairline joints free of burrs and distortion.
    d. Rigidly secure nonmovement joints.
    e. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
    f. Seal joints watertight unless otherwise indicated.
2. Metal Protection:
    a. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or applying sealant or tape, or by installing nonconductive spacers as recommended by manufacturer for this purpose.
    b. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
3. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
4. Set continuous sill members and flashing in full sealant bed as specified in Division 07 Section "Joint Sealants" to produce weathertight installation.
5. Install components plumb and true in alignment with established lines and grades, and without warp or rack.
6. Install glazing as specified in Division 08 Section "Glazing".
    a. Structural-Sealant Glazing:
        1) Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
        2) Install weatherseal sealant according to Division 07 Section "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.
7. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.
    a. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
    b. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.
8. Install perimeter joint sealants as specified in Division 07 Section "Joint Sealants" to produce weathertight installation.

B. Erection Tolerances

1. Install aluminum-framed systems to comply with the following maximum erection tolerances:
   a. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet (3 mm in 3.7 m); 1/4 inch (6 mm) over total length.
   b. Alignment:
      1) Where surfaces abut in line, limit offset from true alignment to 1/16 inch (1.5 mm).
      2) Where surfaces meet at corners, limit offset from true alignment to 1/32 inch (0.8 mm).
2. Diagonal Measurements: Limit difference between diagonal measurements to 1/8 inch (3 mm).

C. Field Quality Control
1. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections.
2. Testing Services: Testing and inspecting of representative areas to determine compliance of installed systems with specified requirements shall take place as follows and in successive phases as indicated on Drawings. Do not proceed with installation of the next area until test results for previously completed areas show compliance with requirements.
   a. Structural-Sealant Compatibility and Adhesion: Structural sealant shall be tested according to recommendations in ASTM C 1401.
      1) Destructive Test Method A, "Hand Pull Tab (Destructive)," in ASTM C 1401, Appendix X2, shall be used.
         a) A minimum of two **OR** four **OR** six, **as directed**, areas on each building face shall be tested.
         b) Repair installation areas damaged by testing.
   b. Structural-Sealant Glazing Inspection: After installation of aluminum-framed systems is complete, structural-sealant glazing shall be inspected and evaluated according to recommendations in ASTM C 1401.
   c. Air Infiltration: Areas shall be tested for air leakage of 1.5 times the rate specified for laboratory testing under "Performance Requirements" Article, but not more than 0.09 cfm/sq. ft. (0.03 L/s per sq. m), of fixed wall area when tested according to ASTM E 783 at a minimum static-air-pressure difference of 1.57 lbf/sq. ft. (75 Pa) **OR** 6.24 lbf/sq. ft. (300 Pa), **as directed**.
   d. Water Penetration: Areas shall be tested according to ASTM E 1105 at a minimum uniform and cyclic static-air-pressure difference of 0.67 times the static-air-pressure difference specified for laboratory testing under "Performance Requirements" Article, but not less than 4.18 lbf/sq. ft. (200 Pa), and shall not evidence water penetration.
   e. Water Spray Test: Before installation of interior finishes has begun, a minimum area of 75 feet (23 m) by 1 story of aluminum-framed systems designated by the Owner shall be tested according to AAMA 501.2 and shall not evidence water penetration.
3. Repair or remove work if test results and inspections indicate that it does not comply with specified requirements.
4. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
5. Aluminum-framed assemblies will be considered defective if they do not pass tests and inspections.
6. Prepare test and inspection reports.

D. Adjusting
1. Adjust operating entrance door hardware to function smoothly as recommended by manufacturer.
   a. For entrance doors accessible to people with disabilities, adjust closers to provide a 3-second closer sweep period for doors to move from a 70-degree open position to 3 inches (75 mm) from the latch, measured to the leading door edge.

END OF SECTION 08 42 13 00

SECTION 08 42 26 00 - ALL-GLASS ENTRANCES AND STOREFRONTS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of material for all-glass entrances and storefronts. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Interior **OR** Exterior **OR** Interior and exterior, **as directed**, manual-swinging **OR** manual-sliding, **as directed**, all-glass entrance doors.
      b. All-glass sidelights and transoms.
      c. Interior **OR** Exterior **OR** Interior and exterior, **as directed**, all-glass storefronts.

C. Definitions
   1. ADA/ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disability Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities."

D. Performance Requirements
   1. General Performance: All-glass systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction.
   2. Structural Performance: All-glass systems shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to SEI/ASCE 7.
      a. Wind Loads: **As directed**.
         1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s) **OR** 100 mph (44 m/s) **OR** 110 mph (49 m/s), **as directed**.
         2) Importance Factor.
         3) Exposure Category: A **OR** B **OR** C **OR** D, **as directed**.
      b. Seismic Loads: **As directed**.
      c. Deflection Limits: Deflection normal to glazing plane is limited to 1 inch (25 mm) **OR** 1/175 of clear span or 3/4 inch (19 mm), whichever is smaller, **as directed**.
   3. Delegated Design: Design all-glass systems, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
   4. Thermal Movements: Allow for thermal movements resulting from the following ambient and surface temperature changes.
      a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

E. Submittals
   1. Product Data: For each type of product indicated.
   2. Shop Drawings: Show fabrication and installation details, including the following:
      a. Plans, elevations, and sections.
      b. Details of fittings and glazing, including isometric drawings of patch fittings **OR** rail fittings **OR** patch and rail fittings, **as directed**.
      c. Door hardware locations, mounting heights, and installation requirements.
   3. Samples: For each type of exposed finish required

4. Delegated-Design Submittal: For all-glass systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
5. Seismic Qualification Certificates
6. Product Test Reports.
7. Field quality-control reports.
8. Maintenance Data.
9. Warranty: Sample of special warranty.

F. Quality Assurance
1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.
3. Engineering Responsibility: Prepare data for all-glass systems, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in systems similar to those indicated for this Project.
4. Source Limitations: Obtain all-glass systems from single source from single manufacturer.
5. Accessible All-Glass Entrance Doors: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.
6. Preinstallation Conference: Conduct conference at Project site.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of all-glass systems that do not comply with requirements or that fail in materials or workmanship within two years from date of Final Completion

1.2 PRODUCTS

A. Materials
1. Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated surfaces), Type I (transparent), tested for surface and edge compression per ASTM C 1048 and for impact strength per 16 CFR 1201 for Category II materials.
   a. Class 1: Clear monolithic.
      1) Thickness: 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm) **OR** 3/4 inch (19 mm), **as directed**.
      2) Locations: As directed.
   b. Class 2: Tinted monolithic.
      1) Color: Gray **OR** Bronze, **as directed**.
      2) Thickness: 3/8 inch (10 mm) **OR** 1/2 inch (13 mm), **as directed**.
      3) Locations: As directed.
   c. Exposed Edges: Machine ground and flat polished.
   d. Butt Edges: Flat ground.
   e. Corner Edges: Lap-joint corners with exposed edges polished.
2. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), with strength and durability characteristics of not less than Alloy 6063-T5.
   a. Bronze Cladding: ASTM B 36/B 36M, alloy matching sample **OR** UNS No. C28000 (muntz metal, 60 percent copper) **OR** UNS No. C22000 (commercial bronze, 90 percent copper) **OR** as standard with manufacturer, **as directed**.
   b. Brass Cladding: ASTM B 36/B 36M, alloy matching sample **OR** UNS No. C26000 (cartridge brass, 70 percent copper) **OR** UNS No. C28000 (muntz metal, 60 percent copper) **OR** as standard with manufacturer, **as directed**.
   c. Stainless-Steel Cladding: ASTM A 666, Type 304.

B. Metal Components
1. Fitting Configuration:
a. Manual-Swinging, All-Glass Entrance Doors Sidelights and Transoms: Patch fittings at head and sill on pivot side only **OR** Patch fittings at head and sill on pivot side, and for lock at sill of swing side **OR** Patch fitting at top and continuous rail fitting at bottom **OR** Continuous rail fitting at top and bottom, **as directed**.
b. Manual-Sliding, All-Glass Entrance Doors Sidelights and Transoms: Continuous rail fitting at top and bottom.
c. All-Glass Storefronts: Recessed glazing channel at top and continuous rail fitting at bottom **OR** Recessed glazing channel at top and bottom **OR** Continuous rail fitting at top and bottom, **as directed**.
2. Patch Fittings: Aluminum **OR** Bronze-clad aluminum **OR** Brass-clad aluminum **OR** Stainless-steel-clad aluminum, **as directed**.
3. Rail Fittings:
a. Material: Match patch-fitting metal and finish **OR** Aluminum **OR** Bronze-clad aluminum **OR** Brass-clad aluminum **OR** Stainless-steel-clad aluminum, **as directed**.
b. Height:
1) Top Rail: 3-1/2 inches (89 mm) **OR** As indicated, **as directed**.
2) Bottom Rail: 3-1/2 inches (89 mm) **OR** 10 inches (255 mm) **OR** As indicated, **as directed**.
c. Profile: Tapered **OR** Tapered flat **OR** Tapered at 60 degrees minimum from the horizontal **OR** Square **OR** Curved **OR** As indicated, **as directed**.
d. End Caps: Manufacturer's standard precision-fit end caps for rail fittings.
4. Accessory Fittings: Match patch-fitting **OR** rail-fitting **OR** patch- and rail-fitting, **as directed**, metal and finish for the following:
a. Overhead doorstop.
b. Center-housing lock.
c. Glass-support-fin brackets.
5. Anchors and Fastenings: Concealed.
6. Weather Stripping: Pile type; replaceable without removing all-glass entrance doors from pivots.

C. Fabrication
1. Provide holes and cutouts in glass to receive hardware, fittings, and accessory fittings before tempering glass. Do not cut, drill, or make other alterations to glass after tempering.
a. Fully temper glass using horizontal (roller-hearth) process, and fabricate so that when glass is installed, roll-wave distortion is parallel with bottom edge of door or lite.
2. Factory assemble components and factory install hardware and fittings to greatest extent possible.

D. Aluminum Finishes
1. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
2. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black, **as directed**.

E. Stainless-Steel Finishes
1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
a. Run grain of directional finishes with long dimension of each piece.
b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
c. Directional Satin Finish: No. 4.
d. Mirrorlike Reflective, Nondirectional Polish: No. 8.

F. Copper-Alloy Finishes

1. Buffed Finish, Lacquered: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear organic, air drying, as specified below).
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in 2 coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
2. Hand-Rubbed Finish, Lacquered: M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear organic, air drying, as specified below).
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in 2 coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
3. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide).
   a. Color: Match sample.

1.3 EXECUTION

A. Installation
1. Install all-glass systems and associated components according to manufacturer's written instructions.
2. Set units level, plumb, and true to line, with uniform joints.
3. Maintain uniform clearances between adjacent components.
4. Lubricate hardware and other moving parts according to manufacturer's written instructions.
5. Set, seal, and grout floor closer cases as required to suit hardware and substrate indicated.
6. Install joint sealants as specified in Division 07 Section "Joint Sealants" and to produce weathertight installation.

B. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. After completion of all-glass storefront installation and nominal curing of sealant and glazing compounds, but before installation of interior finishes, test for water leaks according to AAMA 501.2.
3. Perform test for total areas as designated.
4. Work will be considered defective if it does not pass tests and inspections.
5. Prepare test and inspection reports.

C. Adjusting And Cleaning
1. Adjust all-glass entrance doors and hardware to produce smooth operation and tight fit at contact points and weather stripping.
   a. For all-glass entrance doors accessible to people with disabilities, adjust closers to provide a 3-second closer sweep period for doors to move from a 70-degree open position to 3 inches (75 mm) from the latch measured to the leading door edge.
2. Remove excess sealant and glazing compounds and dirt from surfaces.

END OF SECTION 08 42 26 00

SECTION 08 42 29 23 - ICU/CCU ENTRANCE DOORS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of material for ICU/CCU entrance doors. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section includes manually operated ICU/CCU entrances.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. Shop Drawings: For ICU/CCU entrances. Include plans, elevations, sections, details, hardware mounting heights, and attachments to other work.
   3. Samples: For each exposed product and for each color and texture specified.
   4. Warranties: Sample of special warranties.

D. Quality Assurance
   1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation and maintenance of units required for this Project.
   2. Preinstallation Conference: Conduct conference at Project site.

E. Warranty
   1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of ICU/CCU entrances that fail in materials or workmanship within two years from date of Final Completion.
   2. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within 10 **OR** 20, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Materials
   1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
      a. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
      b. Sheet and Plate: ASTM B 209 (ASTM B 209M).
   2. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304, stretcher-leveled standard of flatness, in entrance manufacturer's standard thickness.
   3. Brass Sheet: ASTM B 36/B 36M, Alloy UNS No. C26000 (cartridge brass, 70 percent copper), in entrance manufacturer's standard thickness.
   4. Bronze Sheet: ASTM B 36/B 36M, Alloy UNS No. C28000 (muntz metal, 60 percent copper) or Alloy UNS No. C23000 (red brass, 85 percent copper), in entrance manufacturer's standard thickness.
   5. Sealants and Joint Fillers: As specified in Division 07 Section "Joint Sealants".
   6. Shrinkage-Resistant Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout complying with ASTM C 1107; of consistency suitable for application.
   7. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

B. ICU/CCU Entrance Assemblies

1. General: Provide manufacturer's standard factory-glazed, **as directed**, ICU/CCU entrances including door leaves, sidelites, framing, headers, carrier assemblies, roller tracks, and accessories required for a complete installation.
2. Opening-Force Requirement, Sliding: Not more than 5 lbf (22.2 N) to fully open door.
3. ICU/CCU Entrance:
   a. Configuration:
      1) Single-sliding two-panel door, with one operable leaf and sidelite; with breakaway capability for sliding leaf only **OR** for sliding leaf and sidelite **OR** as indicated on Drawings, **as directed**.
      2) Configuration: Single-sliding three-panel door, with one operable leaf and two sidelites; with breakaway capability for sliding leaf only **OR** for sliding leaf and one sidelite **OR** for sliding leaf and both sidelites **OR** as indicated on Drawings, **as directed**.
      3) Configuration: Biparting-sliding four-panel door, with one operable leaf and sidelite on each side; with breakaway capability for sliding leaves only **OR** for sliding leaves and both sidelites **OR** as indicated on Drawings, **as directed**.
      4) Configuration: Single-telescoping three-panel door, with two operable leaves and one sidelite; with breakaway capability for sliding leaves only **OR** for sliding leaves and sidelite **OR** as indicated on Drawings, **as directed**.
      5) Configuration: Biparting-telescoping six-panel door, with two operable leaves and one sidelite on each side; with breakaway capability for sliding leaves only **OR** for sliding leaves and both sidelites **OR** as indicated on Drawings, **as directed**.
   b. Mounting: Between jambs **OR** Surface, **as directed**.
   c. Floor Track Configuration: No track across sliding-door opening and at sidelites (trackless) **OR** recessed, pin-guide track system at sidelites **OR** surface-mounted, roller-guide track system at sidelites, **as directed**.
   d. Finish: Finish framing, door(s), sidelite(s), and header with Class I, clear anodic finish **OR** Class II, clear anodic finish **OR** Class I, color anodic finish **OR** Class II, color anodic finish **OR** baked-enamel or powder-coat finish **OR** high-performance organic finish (two-coat fluoropolymer) **OR** metal cladding, **as directed**.
      1) Color: Light bronze **OR** Dark bronze **OR** Black **OR** As selected from full range of industry colors and color densities, **as directed**.
      2) Metal Cladding: No. 4, directional-satin-finish stainless steel **OR** No. 8, mirrorlike reflective, nondirectional-polish-finish stainless steel **OR** Manufacturer's standard satin brass **OR** Manufacturer's standard polished brass **OR** Manufacturer's standard satin bronze, **as directed**.

C. Components
1. Framing and Transom Members: Manufacturer's standard extruded aluminum, minimum 0.125 inch (3.2 mm) thick and reinforced as required to support imposed loads.
   a. Nominal Size: 1-3/4 by 4-1/2 inches (45 by 115 mm) **OR** 1-3/4 by 6 inches (45 by 150 mm) **OR** As indicated on Drawings, **as directed**.
   b. Extruded Glazing Stops and Applied Trim: Minimum 0.062-inch (1.6-mm) wall thickness.
2. Stile and Rail Doors: Manufacturer's standard 1-3/4-inch- (45-mm-) thick glazed doors with minimum 0.125-inch- (3.2-mm-) thick, extruded-aluminum tubular stile and rail members. Mechanically fasten corners with reinforcing brackets that are welded, or incorporate concealed tie rods that span full length of top and bottom rails.
   a. Glazing Stops and Gaskets: Beveled **OR** Square, **as directed**, snap-on, extruded-aluminum stops and preformed gaskets for glazing indicated.
   b. Stile Design: Narrow stile; 2-1/8-inch (55-mm) nominal width **OR** Medium stile; 3-1/2-inch (90-mm) nominal width **OR** Wide stile; more than 4-inch (100-mm) nominal width **OR** As indicated on Drawings, **as directed**.
   c. Rail Design: 3-1/2-inch (90-mm) nominal height **OR** 5-inch (125-mm) nominal height **OR** As indicated on Drawings, **as directed**.
   d. Muntin Bars: Horizontal tubular rail member for each door; match stile design.

3. Sidelites: Manufacturer's standard 1-3/4-inch- (45-mm-) deep sidelites with minimum 0.125-inch- (3.2-mm-) thick, extruded-aluminum tubular stile and rail members matching door design and finish.
    a. Glazing Stops and Gaskets: Same materials and design as for stile and rail door.
    b. Muntin Bars: Horizontal tubular rail member for each sidelite; match stile design.
4. Glazing: As specified in Division 08 Section "Glazing".
5. Headers: Fabricated from minimum 0.125-inch- (3.2-mm-) thick extruded aluminum, and extending full width of ICU/CCU entrance units to conceal carrier assemblies and roller tracks. Provide hinged or removable access panels for service and adjustment. Secure panels to prevent unauthorized access.
    a. Capacity: Capable of supporting doors up to 100 lb (45 kg) per leaf over spans up to 14 feet (4.3 m) without intermediate supports.
    b. Provide sag rods for spans exceeding 14 feet (4.3 m).
6. Carrier Assemblies and Overhead Roller Tracks: Manufacturer's standard carrier assembly that allows vertical adjustment; consisting of nylon- or delrin-covered, ball-bearing-center steel wheels operating on a continuous roller track or of ball-bearing-center steel wheels operating on a nylon- or delrin-covered, continuous roller track. Support doors from carrier assembly by cantilever and pivot assembly. Provide minimum of two ball-bearing roller wheels and two antirise rollers for each active leaf.
7. Concealed Bottom Rollers: Manufacturer's standard.
8. Brackets and Reinforcements: Manufacturer's standard, high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
9. Fasteners and Accessories: Manufacturer's standard, corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

D. Hardware
1. General: Provide units in sizes and types recommended by ICU/CCU entrance and hardware manufacturers for entrances and uses indicated. Finish exposed parts to match door finish unless otherwise indicated.
2. Breakaway Hardware: Provide release hardware that allows indicated panels to swing out in direction of egress to full 90 degrees from sliding mode.
    a. Maximum Force to Open Panel: 50 lbf (222 N).
    b. Release Position: Sliding door fully open **OR** At any point in sliding door travel, **as directed**.
3. Limit Arm: Provide to control doors in the swing mode.
4. Pulls: Manufacturer's standard recessed units on both sides of each operable door and surface-mounted, D-shaped pull for each swing-out sidelite.
5. Manual Flush Bolts: BHMA A156.16, Grade 1, edge mortised, lever-extension type; located at bottom of each swing-out sidelite.
6. Deadlocks: Manufacturer's standard, operated by exterior cylinder and interior thumb turn.
    a. Deadbolts: Laminated-steel hook, mortise type, BHMA A156.5, Grade 1.
    b. Cylinders: BHMA A156.5, Grade 1, six-pin mortise type **OR** As specified in Division 08 Section "Door Hardware", **as directed**.
        1) Keying: No master **OR** Integrate into building master, **as directed**, key system, and key all cylinders alike, **as directed**.
        2) Keys: Two **OR** Three, **as directed**, for each cylinder.
7. Weather Stripping: Manufacturer's standard replaceable components.
    a. Compression Type: ASTM D 2000, molded neoprene, or ASTM D 2287, molded PVC.
    b. Sliding Type: AAMA 701, wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.
8. Weather Sweeps: Manufacturer's standard, nylon brush sweep mounted to underside of door bottom.

E. Fabrication
1. General: Factory fabricate ICU/CCU entrance components to designs, sizes, and thicknesses indicated and to comply with indicated standards.

a. Fabricate aluminum components before finishing.

b. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

c. Use concealed fasteners to greatest extent possible. Where exposed fasteners are required, use countersunk Phillips flat-head machine screws, finished to match framing **OR** fabricated from stainless steel, **as directed**.

1) Where fasteners are subject to loosening or turning out from structural movements or vibration, use self-locking devices.

2) Reinforce members as required to receive fastener threads.

d. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.

2. Framing: Provide ICU/CCU entrances as prefabricated assemblies. Complete fabrication, assembly, finishing, hardware application, and other work before shipment to Project site.

a. Fabricate tubular and channel frame assemblies with manufacturer's standard welded or mechanical joints. Provide subframes and reinforcement as required for a complete system to support required loads.

b. Perform fabrication operations in manner that prevents damage to exposed finish surfaces.

c. Form profiles that are straight and free of defects or deformations.

d. Provide components with concealed fasteners and anchor and connection devices.

e. Fabricate components with accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion.

f. Provide anchorage and alignment brackets for concealed support of assembly from the building structure.

3. Doors: Factory fabricated and assembled in profiles indicated. Reinforce as required to support imposed loads and for installing hardware.

4. Glazing: Fabricate framing with minimum glazing edge clearances for thickness and type of glazing indicated, according to GANA's "Glazing Manual."

5. Hardware: Factory install hardware to the greatest extent possible; remove only as required for final finishing operation and for delivery to and installation at Project site. Cut, drill, and tap for factory-installed hardware before applying finishes.

a. Provide sliding weather stripping, mortised into door, at perimeter of sliding doors and breakaway sidelites.

6. Electrical Grounding: Fabricate ICU/CCU entrances to be internally grounded, complying with requirements of authorities having jurisdiction.

F. General Finish Requirements

1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.

3. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

G. Aluminum Finishes

1. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.

2. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.

3. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, application, and baking.

4. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF

resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1.3 EXECUTION

A. Installation

1. General: Do not install damaged components. Fit frame joints to produce hairline joints free of burrs and distortion. Rigidly secure nonmovement joints. Seal joints watertight.
   a. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
   b. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous coating.
2. Install ICU/CCU entrances plumb and true in alignment with established lines and grades without warp or rack of framing members and doors. Anchor securely in place.
   a. Install surface-mounted hardware using concealed fasteners to greatest extent possible.
   b. Set headers, carrier assemblies, tracks, operating brackets, and guides level and true to location with anchorage for permanent support.
   c. Level recesses for recessed floor tracks using shrinkage-resistant grout.
3. Glazing: Install glazing as specified in Division 08 Section "Glazing".
4. Sealants: Comply with requirements in Division 07 Section "Joint Sealants" for installing sealants, fillers, and gaskets.
   a. Set framing members, floor tracks, and flashings in full sealant bed.
   b. Seal perimeter of framing members with sealant.
5. Grounding: Connect ICU/CCU-entrance, electrical grounding systems to building grounding system as specified in Division 26 Section "Grounding And Bonding For Electrical Systems".

B. Adjusting

1. Adjust operating hardware and moving parts for smooth and safe operation; lubricate as recommended by manufacturer.
2. Adjust force to open swing panels.
3. Test grounding system for compliance with requirements of authorities having jurisdiction.

C. Cleaning And Protection

1. Clean glass and metal surfaces promptly after installation. Remove excess glazing and sealant compounds, dirt, and other substances. Repair damaged finish to match original finish.
2. Comply with requirements in Division 08 Section "Glazing" for cleaning and protecting glass.

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Task	Specification	Specification Description
08 42 29 23	08 18 16 00	Sliding Aluminum-Framed Glass Doors

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SECTION 08 42 33 00 - REVOLVING ENTRANCE DOORS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of material for revolving entrance doors. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Manual revolving door entrances.
      b. Automatic revolving door entrances.
      c. Access-control revolving door entrances.

C. Submittals
   1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for revolving door entrances.
   2. Shop Drawings: For revolving door entrances. Include plans, elevations, sections, details, and attachments to other work. Indicate enclosures, speed-control units, and other components not in manufacturer's product data.
      a. Wiring Diagrams: Power, signal, and control wiring.
   3. Samples:
      a. Finishes: For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches (76 by 127 mm).
      b. Glass Samples: For each type of tinted glass; 12 inches (300 mm) square.
   4. Qualification Data: For qualified Installer, manufacturer and testing agency.
   5. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for revolving door entrances.
   6. Operation and Maintenance Data: For revolving door entrances to include in operation and maintenance manuals.
   7. Warranties: Samples of special warranties.

D. Quality Assurance
   1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
   2. Regulatory Requirements: Wings shall be capable of collapsing into a book-fold position to provide minimum aggregate parallel width of 36 inches (914 mm) when breakaway force of no more than 130 lbf (572N) **OR** 180 lbf (801N), **as directed**, is applied within 3 inches (76 mm) of outer edges. Set maximum turning speed to comply with requirements of authorities having jurisdiction.
   3. Safety Glass: Category II materials complying with testing requirements in 16 CFR 1201.
      a. Safety-Glass Labeling: Where safety-glass labeling is indicated, permanently mark glass with certification label of the SGCC, another certification agency acceptable to authorities having jurisdiction, or the manufacturer. Label shall indicate manufacturer's name, type of glass, thickness, and safety-glass standard with which glass complies.
   4. Revolving Door Entrance Standard: BHMA A156.27.
   5. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
   1. Deliver revolving door entrance glass, decorative metalwork, and other exposed elements in padded blankets or other approved protective wrapping.

2. Protect finish surfaces from damage during handling and installation.

F. Coordination
1. Recesses: Coordinate size and location of recesses in floor construction for recessed, floor-mounted speed-control units, pivot bearings, foot grilles and recessed mats including anchorages for frames and supports. Furnish setting drawings, templates, and directions for installing anchorages that are to be embedded into concrete. Deliver these items to Project site in time for installation. Concrete, reinforcement, and formwork requirements are specified in Division 31.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of revolving door entrances that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Lateral deflection of glass lite edges in excess of 1/175 of their length or 3/4 inch (19 mm), whichever is less.
      2) Excessive air leakage.
      3) Faulty operation of speed-control unit and hardware.
      4) Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   b. Warranty Period for Revolving Door Entrances: Three years from date of Final Completion.
   c. Warranty Period for Speed-Control Units: Five years from date of Final Completion.
   d. Warranty Period for Finishes: 20 years from date of Final Completion.

1.2 PRODUCTS

A. Revolving Door Entrances
1. Air Infiltration: Maximum air leakage of 1.25 cfm/sq. ft. (6.4 L/s x sq. m) of wing area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 1.57 lbf/sq. ft. (75 Pa), [equivalent to a 25-mph (40-km/h) wind].
2. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
   a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
3. Windborne-Debris-Impact Resistance: Provide exterior glazing that passes basic **OR** enhanced, **as directed**,-protection testing requirements in ASTM E 1996 for Wind Zone 1 **OR** Wind Zone 2 **OR** Wind Zone 3 **OR** Wind Zone 4, **as directed**, when tested using the large-missile test according to ASTM E 1886. Test specimens shall be no smaller in width and length than glazing indicated for use on the Project and shall be installed in same manner as glazing indicated for use on the Project.
4. Seismic Performance: Revolving door entrances shall withstand the effects of gravity loads and loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

B. Manual Revolving Door Entrances
1. Description: Provide manufacturer's standard two-wing **OR** three-wing **OR** four-wing, **as directed**, manual revolving door entrance, complete with center shaft, speed-control unit, wings, enclosure walls, canopy, hardware, glass and glazing, and accessories as indicated.
   a. Manual Speed-Control Unit: Mechanical speed regulator that allows free rotation of wings up to a predetermined rate of speed and that engages a clutch-type brake to prevent rapid acceleration of wings.
      1) Location: Recessed, floor mounted **OR** Overhead, **as directed**.

2) Fold-to-Side Mechanism: Manufacturer's standard overhead carriage, guide support track, pivot mechanism, and other components necessary to permit folded wings to be moved to one side of revolving door entrance enclosure.

b. Stile-and-Rail Wings: Manufacturer's standard with 1-3/4-inch- (45-mm-) thick tubular stile-and-rail members.
   1) Stile Design: Narrow stile, 2-inch (51-mm) nominal width **OR** Medium stile, 3-1/2-inch (89-mm) nominal width **OR** Wide stile, 5-inch (127-mm) nominal width **OR** As indicated on Drawings, **as directed**.
   2) Rail Design: 3-inch (76-mm) nominal height **OR** 4-inch (102-mm) nominal height **OR** As indicated on Drawings, **as directed**.
   3) Muntin Design: To match stile design.
   4) Glass: Clear, fully tempered float glass.
      a) Thickness: 6 mm **OR** 8 mm **OR** 10 mm, **as directed**.

c. All-Glass Wings: Manufacturer's standard all-glass wings with tubular metal top and bottom rail members.
   1) Glass: Clear, fully tempered float glass.
      a) Thickness: 12 mm.

d. Push Bars: Manufacturer's standard push bars, finished to match wings.
   1) Shape: Round bars, 1 inch (25 mm) in diameter **OR** Flat bars, 1/2 inch thick and 1-1/2 inches (13 mm thick and 38 mm) high **OR** Manufacturer's standard, **as directed**.

e. Locks: Manufacturer's standard deadbolt locks to receive cylinders; minimum of two for each revolving door entrance.
   1) Cylinders: Comply with requirements in Division 08 Section "Door Hardware".
   2) Mounting: Surface applied **OR** Mortised, **as directed**.
   3) Location: Extend bolt from bottom of wing into floor **OR** top of wing into ceiling **OR** bottom of wing into base of wall enclosure, **as directed**.

f. Enclosure Walls: Manufacturer's standard, with 1-3/4-inch- (45-mm-) thick tubular framing members.
   1) Configuration: Curved **OR** Segmented, **as directed**.
   2) Glass: Clear **OR** Tinted, **as directed**, fully tempered float glass.
      a) Thickness: 6 mm **OR** 8 mm, **as directed**.
      b) Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
   3) Glass: Clear **OR** Tinted, **as directed**, laminated glass with two plies of float glass separated by an interlayer.
      a) Thickness: Two 3-mm-thick lites **OR** Two 5-mm-thick lites **OR** Two 6-mm-thick lites **OR** Two 8-mm-thick lites **OR** As indicated, **as directed**.
      b) Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
   4) Muntin Bars: Horizontal tubular rail member for each enclosure wall; match stile design.

g. Canopy: Manufacturer's standard ceiling, fascia, roof, **as directed**, and framing with size, layout, materials, and exposed finishes matching enclosure walls unless otherwise indicated.
   1) Metal-Clad Plywood: Fabricate from 3/4-inch- (19-mm-) thick plywood clad with metal sheet. Provide ceiling access panels for repairs to or maintenance of speed-control unit.

      OR

      Metal: Fabricate from minimum 0.125-inch- (3.18-mm-) thick, aluminum sheet. Provide ceiling access panels for repairs to or maintenance of speed-control unit.

      OR

      Glass: Clear **OR** Tinted, **as directed**, laminated glass ceiling with two plies of float glass separated by an interlayer.
      a) Thickness: Two 6-mm-thick lites **OR** 6-mm-thick top lite and 12-mm-thick bottom lite **OR** As indicated, **as directed**.
      b) Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.

2) Ceiling Lights: Manufacturer's standard, consisting of two recessed light fixtures within the ceiling of the revolving door entrance enclosure, complete with lamps and translucent lenses.
3) Canopy Roof: Manufacturer's standard, of material and finish matching enclosure walls where visible.

h. Floors: Extend adjacent flooring material specified in a Division 07 into enclosure as indicated on Drawings.
1) Recessed Grilles: Provide grille at entry segment only. Fabricate, using welded joints, from minimum 1/4-inch-wide by 1-inch-tall (6-mm-wide by 25-mm-tall), concentrically curved metal bar stock with 1/4-inch (6-mm) spacing. Finish to match wings.

2. Materials: Extruded aluminum **OR** Stainless-steel-clad, extruded aluminum **OR** Copper-alloy-clad, extruded aluminum, **as directed**.
a. Main Extrusions and Tubing: Minimum wall thickness of 0.125 inch (3.2 mm).
b. Cladding: Minimum 0.04 inch (1.0 mm) thick.

3. Fabrication: Fabricate revolving door entrance components to designs, sizes, thicknesses, and configurations indicated with profiles that are sharp, straight, and free of defects or deformations. Accurately fit joints with ends coped or mitered to produce hairline joints free of burrs and distortion. Prefit all hardware at the factory. Provide anchorage and alignment brackets for concealed support of assembly from the building structure.
a. Wings: Factory fabricated and assembled in profiles indicated. Reinforce as required to support imposed loads and for installing hardware.
1) Glaze wings at the factory. Comply with glazing requirements specified in this Section and in Division 08 Section "Glazing". Provide minimum clearances for thickness and type of glass indicated according to GANA's "Glazing Manual."
2) Provide sliding weather stripping, mortised into stiles and rails of wings, to be adjustable and replaceable without dismantling wings.
3) Welded Construction: Weld reinforcement firmly in place. Weld corners. Grind and polish welds to produce an invisible joint. Mechanically finish exposed surfaces after fabrication to eliminate surface blemishes caused by welding, rolling, bending, and forming.
OR
Mechanically Joined Construction: Joints shall be tightly bolted together. Glass stops shall be snap-in type where possible.
OR
Mechanically Joined Clad Construction: Joints shall be tightly bolted together to produce hairline joints. Finish material before fabrication. Carefully assemble to prevent welds or adhesives from blemishing finished surfaces. Glass stops shall be snap-in type where possible.

b. Enclosure Walls and Canopy: Fabricate tubular and channel frame assemblies in configuration indicated, with welded or mechanical joints, according to manufacturer's standards and as specified. Provide subframes as required for a complete system to support required loads.
1) Exterior Framing: Fabricate components to drain water passing joints and condensation and moisture occurring or migrating within the system to the exterior. Provide anchorage and alignment brackets for concealed support of assembly from the building structure. Allow for thermal expansion of exterior units.

4. Aluminum Finishes: Clear anodic **OR** Color anodic **OR** Baked enamel or powder coat **OR** High performance, organic, **as directed**.
a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

5. Stainless-Steel Finishes: No. 4 **OR** No. 7 **OR** No. 8, **as directed**.
6. Copper-Alloy Finishes: Buffed finish, lacquered **OR** Hand-rubbed finish, lacquered **OR** Medium-satin finish, lacquered **OR** Statuary conversion coating over satin finish, **as directed**.

C. Automatic Revolving Door Entrances
1. Description: Provide manufacturer's standard two-wing **OR** three-wing **OR** four-wing, **as directed**, automatic revolving door entrance, complete with center shaft **OR** core **OR** core with rotating glazed display case, **as directed**, speed-control unit, wings, enclosure walls, canopy, hardware, glass and glazing, activation devices, safety devices, and accessories as indicated.
a. Powered Speed-Control Unit: Provide an electric or electrohydraulic speed regulator to permit automatic rotation of wings. Unit shall allow for manual operation when power is off. Furnish power-operation equipment to suit current characteristics of building electrical service.
1) Location: Recessed, floor mounted **OR** Overhead, **as directed**.
2) Fold-to-Side Mechanism: Manufacturer's standard overhead carriage, guide support track, pivot mechanism, and other components necessary to permit folded wings to be moved to one side of revolving door entrance enclosure.
b. Manual-Push Activation: Pushing wing activates unit and maintains rotation of wings for manufacturer's standard preset time.
OR
Continuous Operation: Wings revolve continuously.
OR
Signal Activation: Signal from activation device begins and maintains rotation of wings for manufacturer's standard preset time.
1) Motion Detectors: Self-contained, K-band-frequency, microwave-scanner units with metal or plastic housing; to provide adjustable detection-field sizes, patterns, and functions required by BHMA A156.10. Mount centered on both sides of canopy fascia.
2) Presence Detectors: Self-contained, infrared-scanner units with metal or plastic housing; to provide adjustable detection-field sizes, patterns, and functions required by BHMA A156.10. Detectors shall remain active at all times. Mount recessed in canopy ceiling **OR** on each wing, **as directed**.
3) Combination Motion-Presence Detectors: Self-contained, one-piece units consisting of both motion and presence detectors in a single metal or plastic housing adjustable to provide detection-field sizes, patterns, and functions required by BHMA A156.10. Mount on both sides of canopy fascia.
4) Photoelectric Beams: Pulsed infrared, sender-receiver assembly recessed in canopy ceiling **OR** on each wing, **as directed**.
5) Control Mats: 1/2-inch- (13-mm-) thick, synthetic-rubber or flexible-plastic mat in safety-ribbed surface pattern, with extruded-aluminum frame; with pressure switches for low-voltage control wiring; and complying with performance requirements in BHMA A156.10 including Appendix A.
a) Color: As indicated by manufacturer's designations **OR** As selected from full range of industry colors, **as directed**.
b) Frame: Recessed to fit flush with floor; with concealed anchors **OR** Surface mounted; with tapered safety edge, **as directed**.
6) Push-Plate Switch: Momentary-contact control switch with flat stainless-steel push plate engraved with message "Push to Open" **OR** plastic push-plate engraved with message "Push to Open" in contrasting color, **as directed**.
a) Mounting: Recess mounted, semiflush in wall **OR** Surface mounted on wall **OR** Surface mounted on bollard **OR** As indicated on Drawings, **as directed**, on right-hand side of opening.
7) Push-Button Switch: Momentary-contact control switch with one red-button actuator. Provide blue plastic cover engraved with message "Press to Open" in white letters.
a) Mounting: Recess mounted, semiflush in wall **OR** Surface mounted on wall **OR** Surface mounted on bollard **OR** As indicated on Drawings, **as directed**, on right-hand side of opening.

8) Key Switch: Recess-mounted control switch with key-controlled actuator and enclosed in 2-by-4-inch (50-by-100-mm) junction box. Provide faceplate engraved with letters indicating switch functions.
   a) Functions: On-off **OR** On-off, momentary contact, **as directed**.
   b) Mounting: Recess mounted, semiflush in wall **OR** Surface mounted on wall **OR** Surface mounted on bollard **OR** As indicated on Drawings, **as directed**, on right-hand side of opening.

c. Stile-and-Rail Wings: Manufacturer's standard with 1-3/4-inch- (45-mm-) thick tubular stile-and-rail members.
   1) Stile Design: Narrow stile, 2-inch (51-mm) nominal width **OR** Medium stile, 3-1/2-inch (89-mm) nominal width **OR** Wide stile, 5-inch (127-mm) nominal width **OR** As indicated on Drawings, **as directed**.
   2) Rail Design: 3-inch (76-mm) nominal height **OR** 4-inch (102-mm) nominal height **OR** As indicated on Drawings, **as directed**.
   3) Muntin Design: To match stile design.
   4) Glass: Clear, fully tempered float glass.
      a) Thickness: 6 mm **OR** 8 mm **OR** 10 mm, **as directed**.

d. All-Glass Wings: Manufacturer's standard all-glass wings with tubular metal top and bottom rail members.
   1) Glass: Clear, fully tempered float glass.
      a) Thickness: 12 mm.

e. Push Bars: Manufacturer's standard push bars, finished to match wings.
   1) Shape: Round bars, 1 inch (25 mm) in diameter **OR** Flat bars, 1/2 inch thick and 1-1/2 inches (13 mm thick and 38 mm) high **OR** Manufacturer's standard, **as directed**.

f. Locks: Manufacturer's standard deadbolt locks to receive cylinders; minimum of two for each revolving door entrance.
   1) Cylinders: Comply with requirements in Division 08 Section "Door Hardware".
   2) Mounting: Surface applied **OR** Mortised, **as directed**.
   3) Location: Extend bolt from bottom of wing into floor **OR** top of wing into ceiling **OR** bottom of wing into base of wall enclosure, **as directed**.

g. Enclosure Walls: Manufacturer's standard, with 1-3/4-inch- (45-mm-) thick tubular framing members.
   1) Configuration: Curved **OR** Segmented, **as directed**.
   2) Glass: Clear **OR** Tinted, **as directed**, fully tempered float glass.
      a) Thickness: 6 mm **OR** 8 mm, **as directed**.
      b) Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.

      OR

      Glass: Clear **OR** Tinted, **as directed**, laminated glass with two plies of float glass separated by an interlayer.
      a) Thickness: Two 3-mm-thick lites **OR** Two 5-mm-thick lites **OR** Two 6-mm-thick lites **OR** Two 8-mm-thick lites **OR** As indicated, **as directed**.
      b) Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
   3) Muntin Bars: Horizontal tubular rail member for each enclosure wall; match stile design.

h. Canopy: Manufacturer's standard ceiling, fascia, roof, **as directed**, and framing with size, layout, materials, and exposed finishes matching enclosure walls unless otherwise indicated.
   1) Metal-Clad Plywood: Fabricate from 3/4-inch- (19-mm-) thick plywood clad with metal sheet. Provide ceiling access panels for repairs to or maintenance of speed-control units.
   2) Metal: Fabricate from minimum 0.125-inch- (3.18-mm-) thick, aluminum sheet. Provide ceiling access panels for repairs to or maintenance of speed-control units.
   3) Glass: Clear **OR** Tinted, **as directed**, laminated glass ceiling with two plies of float glass separated by an interlayer.

a) Thickness: Two 6-mm-thick lites **OR** 6-mm-thick top lite and 12-mm-thick bottom lite **OR** As indicated, **as directed**.
b) Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.

4) Ceiling Lights: Manufacturer's standard, consisting of two recessed light fixtures within the ceiling of the revolving door entrance enclosure, complete with lamps and translucent lenses.
5) Canopy Roof: Manufacturer's standard, of material and finish matching enclosure walls where visible.

i. Floors: Extend adjacent flooring material specified in a Division 07 into enclosure as indicated on Drawings.
1) Recessed Grilles: Provide grille at entry quadrant only. Fabricate, using welded joints, from minimum 1/4-inch-wide by 1-inch-tall (6-mm-wide by 25-mm-tall), concentrically curved metal bar stock with 1/4-inch (6-mm) spacing. Finish to match wings.

j. Rotating Glazed Display Case: Glazed enclosure incorporated into core, with framing matching wings and with panel on one side for access to display area.

k. Safety Devices: Manufacturer's standard safety devices as required to stop or slow rotation. Provide the following:
1) Emergency Stop Button: Momentary contact, red push-button switch to immediately stop wing rotation and reverse direction to entry position, **as directed**. Provide sign indicating "Emergency Stop."
a) Mounting: Recess mounted, semiflush in wall **OR** Surface mounted on wall **OR** Surface mounted on bollard **OR** As indicated on Drawings, **as directed**, on right-hand side of opening.
2) Slow-Speed Operation Button: Momentary contact push-button switch or plate to slow wing rotation by reducing rpm by one half. Include sign indicating operation.
a) Mounting: Recess mounted, semiflush in wall **OR** Surface mounted on wall **OR** Surface mounted on bollard **OR** As indicated on Drawings, **as directed**, on right-hand side of opening.
3) Vertical Safety Strip: Compressible safety switch consisting of an impact-pressure-activated, internal-contact switch plate encapsulated in a flexible housing. Mount on enclosure walls at vertical edge of entry.
4) Horizontal Safety Strip: Compressible safety switch consisting of an impact-pressure-activated, internal-contact switch plate encapsulated in a flexible housing. Mount at bottom edge of each wing.

2. Materials: Extruded aluminum **OR** Stainless-steel-clad, extruded aluminum **OR** Copper-alloy-clad, extruded aluminum, **as directed**.
a. Main Extrusions and Tubing: Minimum wall thickness of 0.125 inch (3.2 mm).
b. Cladding: Minimum 0.04 inch (1.0 mm) thick.

3. Fabrication: Fabricate revolving door entrance components to designs, sizes, thicknesses, and configurations indicated with profiles that are sharp, straight, and free of defects or deformations. Accurately fit joints with ends coped or mitered to produce hairline joints free of burrs and distortion. Prefit all hardware at the factory. Provide anchorage and alignment brackets for concealed support of assembly from the building structure.
a. Wings: Factory fabricated and assembled in profiles indicated. Reinforce as required to support imposed loads and for installing hardware.
1) Glaze wings at the factory. Comply with glazing requirements specified in this Section and in Division 08 Section "Glazing". Provide minimum clearances for thickness and type of glass indicated according to GANA's "Glazing Manual."
2) Provide sliding weather stripping, mortised into stiles and rails of wings, to be adjustable and replaceable without dismantling wings.
3) Welded Construction: Weld reinforcement firmly in place. Weld corners. Grind and polish welds to produce an invisible joint. Mechanically finish exposed surfaces after fabrication to eliminate surface blemishes caused by welding, rolling, bending, and forming.
OR

Mechanically Joined Construction: Joints shall be tightly bolted together. Glass stops shall be snap-in type where possible.
OR
Mechanically Joined Clad Construction: Joints shall be tightly bolted together to produce hairline joints. Finish material before fabrication. Carefully assemble to prevent welds or adhesives from blemishing finished surfaces. Glass stops shall be snap-in type where possible.

b. Enclosure Walls and Ceilings: Fabricate tubular and channel frame assemblies in configuration indicated, with welded or mechanical joints, according to manufacturer's standards and as specified. Provide subframes as required for a complete system to support required loads.
   1) Exterior Framing: Fabricate components to drain water passing joints and condensation and moisture occurring or migrating within the system to the exterior. Provide anchorage and alignment brackets for concealed support of assembly from the building structure. Allow for thermal expansion of exterior units.

4. Aluminum Finishes: Clear anodic **OR** Color anodic **OR** Baked enamel or powder coat **OR** High performance, organic, **as directed**.
   a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
5. Stainless-Steel Finishes: No. 4 **OR** No. 7 **OR** No. 8, **as directed**.
6. Copper-Alloy Finishes: Buffed finish, lacquered **OR** Hand-rubbed finish, lacquered **OR** Medium-satin finish, lacquered **OR** Statuary conversion coating over satin finish **as directed**.

D. Access-Control Revolving Door Entrances
1. Description: Provide manufacturer's standard four-wing **OR** three-wing, **as directed**, access-control revolving door entrance, complete with center shaft **OR** core, **as directed**, speed-control unit, wings, enclosure walls, canopy, hardware, glass and glazing, activation devices, safety devices, and accessories as indicated.
   a. Powered Speed-Control Unit: Provide an electric or electrohydraulic speed regulator to permit automatic rotation of wings. Unit shall allow for manual operation when power is off. Furnish power-operation equipment to suit current characteristics of building electrical service.
      1) Location: Recessed, floor mounted **OR** Overhead, **as directed**.
      2) Fold-to-Side Mechanism: Manufacturer's standard overhead carriage, guide support track, pivot mechanism, and other components necessary to permit folded wings to be moved to one side of revolving door entrance enclosure.
   b. Activation Devices: Keypads **OR** Card readers **OR** Biometric identity verification equipment, **s directed**, as specified in Division 28 Section "Access Control".
      1) Mounting: Recess mounted, semiflush in wall **OR** Surface mounted on wall **OR** Surface mounted on bollard **OR** As indicated on Drawings, **as directed**, on right-hand side of opening.
   c. Stile-and-Rail Wings: Manufacturer's standard with 1-3/4-inch- (45-mm-) thick tubular stile-and-rail members.
      1) Stile Design: Narrow stile, 2-inch (51-mm) nominal width **OR** Medium stile, 3-1/2-inch (89-mm) nominal width **OR** Wide stile, 5-inch (127-mm) nominal width **OR** As indicated on Drawings, **as directed**.
      2) Rail Design: 3-inch (76-mm) nominal height **OR** 4-inch (102-mm) nominal height **OR** As indicated on Drawings, **as directed**.
      3) Muntin Design: To match stile design.
      4) Glass: Clear, fully tempered float glass.
         a) Thickness: 6 mm **OR** 8 mm **OR** 10 mm, **as directed**.
   d. Locks: Manufacturer's standard deadbolt locks to receive cylinders; minimum of two for each revolving door entrance.
      1) Cylinders: Comply with requirements in Division 08 Section "Door Hardware".
      2) Mounting: Surface applied **OR** Mortised, **as directed**.

3) Location: Extend bolt from bottom of wing into floor **OR** top of wing into ceiling **OR** bottom of wing into base of wall enclosure, **as directed**.

e. Enclosure Walls: Manufacturer's standard, with 1-3/4-inch- (45-mm-) thick tubular framing members.

1) Configuration: Curved **OR** Segmented.

2) Glass: Clear **OR** Tinted, **as directed**, fully tempered float glass.

a) Thickness: 6 mm **OR** 8 mm, **as directed**.

b) Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.

OR

Glass: Clear **OR** Tinted, **as directed**, laminated glass with two plies of float glass separated by an interlayer.

a) Thickness: Two 3-mm-thick lites **OR** Two 5-mm-thick lites **OR** Two 6-mm-thick lites **OR** Two 8-mm-thick lites **OR** As indicated, **as directed**.

b) Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.

3) Muntin Bars: Horizontal tubular rail member for each enclosure wall; match stile design.

f. Canopy: Manufacturer's standard ceiling, fascia, roof, **as directed**, and framing with size, layout, materials, and exposed finishes matching enclosure walls unless otherwise indicated.

1) Metal-Clad Plywood: Fabricate from 3/4-inch- (19-mm-) thick plywood clad with metal sheet. Provide ceiling access panels for repairs to or maintenance of speed-control units.

2) Metal: Fabricate from minimum 0.125-inch- (3.18-mm-) thick, aluminum sheet. Provide ceiling access panels for repairs to or maintenance of speed-control units.

3) Ceiling Lights: Manufacturer's standard, consisting of two recessed light fixtures within the ceiling of the revolving door entrance enclosure, complete with lamps and translucent lenses.

4) Canopy Roof: Manufacturer's standard, of material and finish matching enclosure walls where visible.

g. Floors: Extend adjacent flooring material specified in a Division 07 into enclosure as indicated on Drawings.

1) Recessed Grilles: Provide grille at entry quadrant only. Fabricate, using welded joints, from minimum 1/4-inch-wide by 1-inch-tall (6-mm-wide by 25-mm-tall), concentrically curved metal bar stock with 1/4-inch (6-mm) spacing. Finish to match wings.

h. Safety Devices: Manufacturer's standard safety devices as required to stop or slow rotation. Provide the following:

1) Emergency Stop Button: Momentary contact, red push-button switch to immediately stop wing rotation and reverse direction to entry position, **as directed**. Provide sign indicating "Emergency Stop."

a) Mounting: Recess mounted, semiflush in wall **OR** Surface mounted on wall **OR** Surface mounted on bollard **OR** As indicated on Drawings, **as directed**, on right-hand side of opening.

2) Slow-Speed Operation Button: Momentary contact push-button switch or plate to slow wing rotation by reducing rpm by one half. Include sign indicating operation.

a) Mounting: Recess mounted, semiflush in wall **OR** Surface mounted on wall **OR** Surface mounted on bollard **OR** As indicated on Drawings, **asdirected**, on right-hand side of opening.

3) Vertical Safety Strip: Compressible safety switch consisting of an impact-pressure-activated, internal-contact switch plate encapsulated in a flexible housing. Mount on enclosure walls at vertical edge of entry.

4) Horizontal Safety Strip: Compressible safety switch consisting of an impact-pressure-activated, internal-contact switch plate encapsulated in a flexible housing. Mount at bottom edge of each wing.

2. Materials: Extruded aluminum **OR** Stainless-steel-clad, extruded aluminum **OR** Copper-alloy-clad, extruded aluminum, **as directed**.

a. Main Extrusions and Tubing: Minimum wall thickness of 0.125 inch (3.2 mm).
b. Cladding: Minimum 0.04 inch (1.0 mm) thick.

3. Fabrication: Fabricate revolving door entrance components to designs, sizes, thicknesses, and configurations indicated with profiles that are sharp, straight, and free of defects or deformations. Accurately fit joints with ends coped or mitered to produce hairline joints free of burrs and distortion. Prefit all hardware at the factory. Provide anchorage and alignment brackets for concealed support of assembly from the building structure.
   a. Wings: Factory fabricated and assembled in profiles indicated. Reinforce as required to support imposed loads and for installing hardware.
      1) Glaze wings at the factory. Comply with glazing requirements specified in this Section and in Division 08 Section "Glazing". Provide minimum clearances for thickness and type of glass indicated according to GANA's "Glazing Manual."
      2) Provide sliding weather stripping, mortised into stiles and rails of wings, to be adjustable and replaceable without dismantling wings.
      3) Welded Construction: Weld reinforcement firmly in place. Weld corners. Grind and polish welds to produce an invisible joint. Mechanically finish exposed surfaces after fabrication to eliminate surface blemishes caused by welding, rolling, bending, and forming.
         OR
         Mechanically Joined Construction: Joints shall be tightly bolted together. Glass stops shall be snap-in type where possible.
         OR
         Mechanically Joined Clad Construction: Joints shall be tightly bolted together to produce hairline joints. Finish material before fabrication. Carefully assemble to prevent welds or adhesives from blemishing finished surfaces. Glass stops shall be snap-in type where possible.
   b. Enclosure Walls and Ceilings: Fabricate tubular and channel frame assemblies in configuration indicated, with welded or mechanical joints, according to manufacturer's standards and as specified. Provide subframes as required for a complete system to support required loads.
      1) Exterior Framing: Fabricate components to drain water passing joints and condensation and moisture occurring or migrating within the system to the exterior. Provide anchorage and alignment brackets for concealed support of assembly from the building structure. Allow for thermal expansion of exterior units.
4. Aluminum Finishes: Clear anodic **OR** Color anodic **OR** Baked enamel or powder coat **OR** High performance, organic, **as directed**.
   a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
5. Stainless-Steel Finishes: No. 4 **OR** No. 7 **OR** No. 8, **as directed**.
6. Copper-Alloy Finishes: Buffed finish, lacquered **OR** Hand-rubbed finish, lacquered **OR** Medium-satin finish, lacquered **OR** Statuary conversion coating over satin finish, **as directed**.

E. Materials
1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
   a. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
   b. Sheet and Plate: ASTM B 209 (ASTM B 209M).
2. Stainless-Steel Sheet: ASTM A 240/A 240M, austenitic stainless steel, Type 304 **OR** Type 316, **as directed**.
3. Plate, Sheet, Strip, and Bars; Bronze: ASTM B 36/B 36M, alloy UNS No. C28000 (muntz metal, 60 percent copper).
4. Steel: ASTM A 36/A 36M plate, shapes, and bars; or ASTM A 1008/A 1008M sheet.
5. Fasteners: Manufacturer's standard, of same basic metal as fastened metal, unless otherwise indicated.
6. Glazing Materials: Comply with requirements in Division 08 Section "Glazing".
7. Weather Stripping: Heavy-duty, single-piece rubber or combination of rubber and felt.

8. Nonshrink, Nonmetallic Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout; complying with ASTM C 1107/C 1107M; of consistency suitable for application.
9. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
10. Lacquer for Copper Alloys: Clear, acrylic lacquer specially developed for coating copper-alloy products.

F. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Finish revolving door entrance components to match adjacent curtain wall or storefront.

G. Aluminum Finishes
1. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
2. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
3. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
4. High-Performance Organic Finish: Two-coat **OR** Three-coat, **as directed**, fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

H. Stainless-Steel Finishes
1. General: Remove tool and die marks and stretch lines or blend into finish. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
2. Directional Satin Finish: No. 4.
3. Reflective, Directional Polish: No. 7.
4. Mirrorlike Reflective, Nondirectional Polish: No. 8.
5. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

I. Copper-Alloy Finishes
1. Finish designations for copper alloys comply with the system established for designating copper-alloy finish systems defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."
2. Buffed Finish, Lacquered: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear organic, air drying, as specified below).
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
3. Hand-Rubbed Finish, Lacquered: M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear organic, air drying, as specified below).
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
4. Medium-Satin Finish, Lacquered: M32-O6x (Mechanical Finish: directionally textured, medium satin; Coating: clear organic, air drying, as specified below).
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).

5. Statuary Conversion Coating over Satin Finish: M31-C55-O6x (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide; Coating: clear, organic, air drying, as specified below), with color matching the Owner's sample.
    a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).

1.3 EXECUTION

A. Examination
1. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation
1. General: Do not install damaged components. Fit frame joints to produce hairline joints free of burrs and distortion. Rigidly secure nonmovement joints. Seal joints watertight.
    a. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
    b. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with corrosion-resistant coatings.
2. Recessed, Floor-Mounted Speed-Control Unit: Insert control unit in rough-in floor opening set on level bed of nonshrink, nonmetallic grout. Fill annular space between control unit and sides of recess with nonshrink, nonmetallic grout. Mix and place grout to comply with grout manufacturer's written instructions.
    a. Connect speed-control unit to electrical power distribution system as specified in Division 22.

    OR

    Overhead-Mounted Speed-Control Unit: Insert pivot bearing in rough-in floor opening set on level bed of nonshrink, nonmetallic grout. Fill annular space between pivot bearing and sides of recess with nonshrink, nonmetallic grout. Mix and place grout to comply with grout manufacturer's written instructions.
    b. Connect speed-control unit to electrical power distribution system as specified in Division 22.
3. Install revolving door entrances according to manufacturer's written instructions, plumb and true, without warp or rack of framing members and wings. Anchor securely in place.
    a. Install surface-mounted hardware using concealed fasteners to greatest extent possible.
    b. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the assembly to exterior.
    c. Cut and trim framing during installation only with approval of manufacturer.
        1) Restore finish and remove and replace members, as directed, where cutting and trimming have impaired strength or appearance.
        2) Do not install members that are warped, bowed, deformed, or otherwise damaged or defaced to such an extent as to impair strength or appearance. Remove and replace members that have been damaged during installation.
4. Activation and Safety Devices: Adjust devices to provide detection field and functions indicated.
5. Sealants: Comply with requirements specified in Division 07 Section "Joint Sealants" to provide weathertight installation.
    a. Set continuous sill members and flashings in full sealant bed.
    b. Seal perimeter of framing members with sealant.

C. Adjusting

1. Adjust wings to provide an even, tight fit at contact points and weather stripping for smooth operation and weathertight closure. Adjust wings to operate smoothly and rotate evenly, with hardware and operators functioning properly.
   a. Lubricate operating hardware and other moving parts.
   b. Adjust speed-control unit for specified rpm.
   c. Adjust pressure for collapse of wings for specified breakaway force.
2. Readjust wings and speed-control units after repeated operation of completed installation equivalent to three days' use by normal traffic (100 to 300 cycles). Lubricate hardware and other moving parts.

D. Cleaning And Protection
1. Clean glass and aluminum surfaces promptly after installation. Remove excess glazing and sealant compounds, dirt, and other substances. Repair damaged finish to match original finish.
2. Limit construction traffic during remainder of construction period.

E. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain revolving door entrances.

END OF SECTION 08 42 33 00

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Task	Specification	Specification Description
08 42 36 00	08 01 11 61	Steel Doors And Frames
08 42 36 00	08 12 13 13	Stainless Steel Doors And Frames
08 43 13 00	08 42 13 00	Aluminum-Framed Entrances And Storefronts
08 43 19 00	01 22 16 00	No Specification Required

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SECTION 08 44 13 00 - GLAZED ALUMINUM CURTAIN WALLS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for glazed aluminum curtain walls. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes conventionally glazed aluminum curtain walls installed as stick, unitized, and unit-and-mullion assemblies.

C. Performance Requirements
1. General Performance: Comply with performance requirements specified, as determined by testing of manufacturer's standard glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
   a. Glazed aluminum curtain walls shall withstand movements of supporting structure indicated on Drawings **OR as directed,** including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
   b. Failure also includes the following:
      1) Thermal stresses transferring to building structure.
      2) Glass breakage.
      3) Noise or vibration created by wind and thermal and structural movements.
      4) Loosening or weakening of fasteners, attachments, and other components.
      5) Failure of operating units.
2. Delegated Design: Design glazed aluminum curtain walls, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
3. Structural Loads:
   a. Wind Loads: As indicated on Drawings **OR as directed**.
      1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s) **OR** 100 mph (44 m/s) **OR** 110 mph (49 m/s), **as directed**.
      2) Exposure Category: A **OR** B **OR** C **OR** D, **as directed**.
   b. Blast Loads: As indicated on Drawings **OR as directed**.
   c. Periodic Maintenance-Equipment Loads: As indicated on Drawings **OR as directed**.
4. Structural-Test Performance: Test according to ASTM E 330 as follows:
   a. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
   b. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
   c. Test Durations: As required by design wind velocity, but not less than 10 seconds.
5. Deflection of Framing Members: At design wind pressure, as follows:
   a. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding L/175 of the glass edge length for each individual glazing lite **OR** 1/175 of clear span for spans up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 13 feet 6 inches (4.1 m), **as directed**, or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19 mm), whichever is less.

b. Deflection Parallel to Glazing Plane: Limited to L/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller **OR** amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch (3.2 mm), **as directed**.
   1) Operable Units: Provide a minimum 1/16-inch (1.6-mm) clearance between framing members and operable units.
c. Cantilever Deflection: Where framing members overhang an anchor point, limit deflection to two times the length of cantilevered member, divided by 175.

6. Windborne-Debris-Impact-Resistance Performance: Pass missile-impact and cyclic-pressure tests when tested according to ASTM E 1886 and testing information in ASTM E 1996 for Wind Zone 1 **OR** Zone 2 **OR** Zone 3 **OR** Zone 4, **as directed**.
   a. Large-Missile Test: For glazed openings located within 30 feet (9.1 m) of grade.
   b. Small-Missile Test: For glazed openings located more than 30 feet (9.1 m) above grade.
7. Seismic Performance: Glazed aluminum curtain walls shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
   a. Component Importance Factor is 1.5 **OR** 1.0, **as directed**.
8. Story Drift: Accommodate design displacement of adjacent stories indicated.
   a. Design Displacement: As indicated on Drawings **OR as directed**.
   b. Test Performance: Meeting criteria for passing based on building occupancy type when tested according to AAMA 501.4 at design displacement and 1.5 times the design displacement, **as directed**.
9. Water Penetration under Static Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa) **OR** 10 lbf/sq. ft. (480 Pa) **OR** 15 lbf/sq. ft. (720 Pa), **as directed**.
10. Water Penetration under Dynamic Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to AAMA 501.1 at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa) **OR** 10 lbf/sq. ft. (480 Pa) **OR** 15 lbf/sq. ft. (720 Pa), **as directed**.
    a. Maximum Water Leakage: According to AAMA 501.1 **OR** No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation, **as directed**. Water leakage does not include water controlled by flashing and gutters that is drained to exterior.
11. Thermal Movements: Allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures:
    a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
    b. Test Interior Ambient-Air Temperature: 75 deg F (24 deg C).
    c. Test Performance: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.
12. Energy Performance: Glazed aluminum curtain walls shall have certified and labeled energy performance ratings in accordance with NFRC.
    a. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.45 Btu/sq. ft. x h x deg F (2.55 W/sq. m x K) **OR** 0.57 Btu/sq. ft. x h x deg F (3.23 W/sq. m x K) **OR** 0.69 Btu/sq. ft. x h x deg F (3.92 W/sq. m x K), **as directed**, as determined according to NFRC 100.
    b. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.35 **OR** 0.40 **OR** 0.45, **as directed**, as determined according to NFRC 200.
    c. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of 0.30 cfm/sq. ft. (1.50 L/s per sq. m) of fixed wall area as determined according to ASTM E 283 at a minimum static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa) **OR** 6.24 lbf/sq. ft. (300 Pa), **as directed**.

d. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC- certified condensation resistance rating of no less than 15 **OR** 25 **OR** 35 **OR** 45, **as directed**, as determined according to NFRC 500.

13. Sound Transmission: Provide glazed aluminum curtain walls with fixed glazing and framing areas having the following sound-transmission characteristics:
    a. Outdoor-Indoor Transmission Class: Minimum 26 **OR** 30 **OR** 34, **as directed**, when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 1332.

D. Submittals

1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. LEED Submittal:
    a. Product Data for Credit EQ 4.1: For glazing sealants used inside of the weatherproofing system, including printed statement of VOC content.
3. Shop Drawings: For glazed aluminum curtain walls. Include plans, elevations, sections, full-size details, and attachments to other work.
    a. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
    b. Include full-size isometric details of each vertical-to-horizontal intersection of glazed aluminum curtain walls, showing the following:
        1) Joinery, including concealed welds.
        2) Anchorage.
        3) Expansion provisions.
        4) Glazing.
        5) Flashing and drainage.
4. Samples: For each type of exposed finish required.
5. Delegated-Design Submittal: For glazed aluminum curtain walls indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
6. Qualification Data: For qualified Installer and testing agency, **as directed**.
7. Seismic Qualification Certificates: For glazed aluminum curtain walls, accessories, and components, from manufacturer.
    a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
8. Welding certificates.
9. Energy Performance Certificates: For glazed aluminum curtain walls, accessories, and components, from manufacturer.
    a. Basis for Certification: NFRC-certified energy performance values for each glazed aluminum curtain wall.
10. Product test reports.
11. Field quality-control reports.
12. Maintenance data.
13. Warranties: Sample of special warranties.

E. Quality Assurance

1. Manufacturer Qualifications: A manufacturer capable of fabricating glazed aluminum curtain walls that meet or exceed energy performance requirements indicated and of documenting this performance by certification, labeling, and inclusion in lists.
2. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
3. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.
4. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

5. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
6. Energy Performance Standards: Comply with NFRC for minimum standards of energy performance, materials, components, accessories, and fabrication. Comply with more stringent requirements if indicated.
   a. Provide NFRC-certified glazed aluminum curtain walls with an attached label.
7. Preinstallation Conference: Conduct conference at Project site.

F. Warranty
1. Special Assembly Warranty: Standard form in which manufacturer **OR** Installer, **as directed**, agrees to repair or replace components of glazed aluminum curtain walls that do not comply with requirements or that fail in materials or workmanship within Two **OR** Five **OR** 10, **as directed**, years from date of Final Completion.
2. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within Five **OR** 10 **OR** 20, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Materials
1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
   a. Sheet and Plate: ASTM B 209 (ASTM B 209M).
   b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
   c. Extruded Structural Pipe and Tubes: ASTM B 429.
   d. Structural Profiles: ASTM B 308/B 308M.
   e. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.
2. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
   a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
   b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
   c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

B. Framing
1. Framing Members: Manufacturer's standard extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
   a. Construction: Nonthermal **OR** Thermally improved **OR** Thermally broken, **as directed**.
   b. Glazing System: Retained mechanically with gaskets on four sides.
   c. Glazing Plane: Front.
2. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
3. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
   a. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
   b. Reinforce members as required to receive fastener threads.
   c. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system **OR** fabricated from 300 series stainless steel, **as directed**.
4. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch (25.4 mm) that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

a. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
5. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials **OR** Dead-soft, 0.018-inch- (0.457-mm-) thick stainless steel, ASTM A 240/A 240M of type recommended by manufacturer, **as directed**.
6. Framing Sealants: Manufacturer's standard sealants.

C. Glazing
1. Glazing: Comply with Division 08 Section "Glazing".
2. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers **OR** Comply with Division 08 Section "Glazing", **as directed**.
3. Glazing Sealants: As recommended by manufacturer **OR** Comply with Division 08 Section "Glazing", **as directed**.
   a. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Insulated Spandrel Panels
1. Insulated Spandrel Panels: Laminated, metal-faced flat panels with no deviations in plane exceeding 0.8 percent of panel dimension in width or length.
   a. Overall Panel Thickness: As indicated **OR** 1 inch (25.4 mm), **as directed**.
   b. Exterior Skin: Aluminum.
      1) Thickness: Manufacturer's standard for finish and texture indicated.
      2) Finish: Matching framing system.
      3) Texture: Smooth **OR** Embossed, **as directed**.
      4) Backing Sheet: 1/8-inch- (3.2-mm-) thick, tempered hardboard **OR** 0.157-inch- (4-mm-) thick, cement board **OR** 0.125-inch- (3.2-mm-) thick, corrugated, high-density polyethylene, **as directed**.
   c. Interior Skin: Aluminum **OR** Manufacturer's standard galvanized-steel sheet, **as directed**.
      1) Thickness: Manufacturer's standard for finish and texture indicated.
      2) Finish: Matching curtain-wall framing **OR** Low-gloss, white baked enamel **OR** Mill finish, **as directed**.
      3) Texture: Smooth **OR** Embossed, **as directed**.
      4) Backing Sheet: 1/8-inch- (3.2-mm-) thick, tempered hardboard **OR** 0.157-inch- (4-mm-) thick, cement board **OR** 1/2-inch- (12.7-mm-) thick, gypsum board with proprietary fire-resistance-rated core **OR** 0.125-inch- (3.2-mm-) thick, corrugated, high-density polyethylene, **as directed**.
   d. Thermal Insulation Core: Manufacturer's standard rigid, closed-cell, polyisocyanurate board **OR** extruded-polystyrene board **OR** expanded-perlite, mineral-insulation board, **as directed**.
   e. Surface-Burning Characteristics: For exposed interior surfaces of panels, when tested according to ASTM E 84 as follows:
      1) Flame-Spread Index: 25 or less.
      2) Smoke-Developed Index: 450 or less.

E. Operable Units
1. Venting Windows: Comply with Division 08 Section "Aluminum Windows".
2. Doors: Comply with Division 08 Section "Aluminum-framed Entrances And Storefronts".

F. Accessory Materials
1. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

G. Fabrication
1. Form or extrude aluminum shapes before finishing.

2. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
3. Fabricate components that, when assembled, have the following characteristics:
   a. Profiles that are sharp, straight, and free of defects or deformations.
   b. Accurately fitted joints with ends coped or mitered.
   c. Physical and thermal isolation of glazing from framing members.
   d. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
   e. Provisions for field replacement of glazing from exterior **OR** interior **OR** interior for vision glass and exterior for spandrel glazing or metal panels, **as directed**.
   f. Provisions for safety railings mounted on interior face of mullions **OR** between mullions at interior, **as directed**.
   g. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
   h. Components curved to indicated radii.
4. Fabricate components that, when assembled, have the following characteristics:
   a. Internal guttering system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
   b. Pressure-equalized system or double barrier design with primary air and vapor barrier at interior side of glazed aluminum curtain wall and secondary seal weeped and vented to exterior.
5. Curtain-Wall Framing: Fabricate components for assembly using shear-block system **OR** screw-spline system **OR** head-and-sill-receptor system with shear blocks at intermediate horizontal members, **as directed**.
6. Factory-Assembled Frame Units:
   a. Rigidly secure nonmovement joints.
   b. Seal joints watertight unless otherwise indicated.
   c. Install glazing to comply with requirements in Division 08 Section "Glazing".
7. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

H. Aluminum Finishes
1. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
2. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, a**s directed**, or thicker.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Champagne **OR** Black **OR** Match sample **OR** As selected from full range of industry colors and color densities, **as directed**.
3. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
4. High-Performance Organic Finish:
   a. Two-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      OR
      Three-coat **OR** Four-coat, **as directed**, fluoropolymer finish complying with AAMA 2605 and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

OR
Two-coat fluoropolymer finish complying with AAMA 2604 and containing 100 percent FEVE resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

b. Color and Gloss: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.

1.3 EXECUTION

A. Installation

1. General:
    a. Comply with manufacturer's written instructions.
    b. Do not install damaged components.
    c. Fit joints to produce hairline joints free of burrs and distortion.
    d. Rigidly secure nonmovement joints.
    e. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
    f. Weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
    g. Seal joints watertight unless otherwise indicated.
2. Metal Protection:
    a. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape or installing nonconductive spacers as recommended by manufacturer for this purpose.
    b. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
3. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
4. Install components plumb and true in alignment with established lines and grades.
5. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.
6. Install glazing as specified in Division 08 Section "Glazing".

B. Erection Tolerances

1. Erection Tolerances: Install glazed aluminum curtain walls to comply with the following maximum tolerances:
    a. Plumb: 1/8 inch in 10 feet (3.2 mm in 3 m); 1/4 inch in 40 feet (6 mm in 12 m).
    b. Level: 1/8 inch in 20 feet (3.2 mm in 6 m); 1/4 inch in 40 feet (6 mm in 12 m).
    c. Alignment:
        1) Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch (12.7 mm) wide, limit offset from true alignment to 1/16 inch (1.6 mm).
        2) Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch (12.7 to 25.4 mm) wide, limit offset from true alignment to 1/8 inch (3.2 mm).
        3) Where surfaces are separated by reveal or protruding element of 1 inch (25.4 mm) wide or more, limit offset from true alignment to 1/4 inch (6 mm).
    d. Location: Limit variation from plane to 1/8 inch in 12 feet (3.2 mm in 3.7 m); 1/2 inch (12.7 mm) over total length.

C. Field Quality Control

1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Testing Services: Testing and inspecting of representative areas of glazed aluminum curtain walls shall take place as installation proceeds to determine compliance of installed assemblies with specified requirements.
    a. Air Infiltration: Areas shall be tested for air leakage of 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article, but not more than 0.50 cfm/sq. ft.

(2.25 L/s per sq. m), of fixed wall area when tested according to ASTM E 783 at a minimum static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa) **OR** 6.24 lbf/sq. ft. (300 Pa), **as directed**.

1) Test Area: One bay wide, but not less than 30 feet (9.1 m), by one story of glazed aluminum curtain wall.
2) Perform a minimum of two **OR** three, **as directed**, tests in areas as directed by the Owner.
OR
Perform tests in each test area as directed by the Owner. Perform at least three tests, prior to 10, 35, and 70 percent completion.

b. Water Penetration: Areas shall be tested according to ASTM E 1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft. (300 Pa), and shall not evidence water penetration.
1) Test Area: One bay wide, but not less than 30 feet (9.1 m), by one story of glazed aluminum curtain wall.
2) Perform a minimum of two **OR** three, **as directed**, tests in areas as directed by the Owner.
OR
Perform tests in each test area as directed by the Owner. Perform at least three tests, prior to 10, 35, and 70 percent completion.

c. Water Spray Test: Before installation of interior finishes has begun, areas designated by the Owner shall be tested according to AAMA 501.2 and shall not evidence water penetration.
1) Test Area: A minimum area of 75 feet (23 m) by one story of glazed aluminum curtain wall.

3. Glazed aluminum curtain walls will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

END OF SECTION 08 44 13 00

SECTION 08 44 13 00a - STRUCTURAL-SEALANT-GLAZED CURTAIN WALLS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of material for structural-sealant-glazed curtain walls. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Factory-glazed **OR** Field-glazed, **as directed**, two-sided structural-sealant-glazed curtain-wall assemblies.
      b. Factory-glazed, four-sided structural-sealant-glazed curtain-wall assemblies.

C. Performance Requirements
   1. General Performance: Comply with performance requirements specified, as determined by testing manufacturer's standard of structural-sealant-glazed curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
      a. Structural-sealant-glazed curtain walls shall withstand movements of supporting structure indicated on Drawings, **OR as directed**, including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
      b. Failure also includes the following:
         1) Thermal stresses transferring to building structure.
         2) Glass breakage.
         3) Noise or vibration created by wind and thermal and structural movements.
         4) Loosening or weakening of fasteners, attachments, and other components.
         5) Failure of operating units.
   2. Delegated Design: Design structural-sealant-glazed curtain walls, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
   3. Structural Loads:
      a. Wind Loads: As indicated on Drawings **OR as directed**.
         1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s) **OR** 100 mph (44 m/s) **OR** 110 mph (49 m/s), **as directed**.
         2) Exposure Category: A **OR** B **OR** C **OR** D, **as directed**.
      b. Blast Loads: As indicated on Drawings **OR as directed**.
      c. Periodic Maintenance-Equipment Loads: As indicated on Drawings **OR as directed**.
   4. Structural-Test Performance: Provide structural-sealant-glazed curtain walls tested according to ASTM E 330 as follows:
      a. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
      b. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
      c. Test Durations: As required by design wind velocity, but not less than 10 seconds.
   5. Deflection of Framing Members: At design wind pressure, as follows:
      a. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding L/175 of the glass edge length for each individual glazing lite **OR** 1/175 of clear span for spans up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 13 feet 6 inches (4.1 m), **as directed**, or an

amount that restricts edge deflection of individual glazing lites to 3/4 inch (19 mm), whichever is less.

b. Deflection Parallel to Glazing Plane: Limited to L/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller **OR** amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch (3.2 mm), **as directed**.
    1) Operable Units: Provide a minimum 1/16-inch (1.6-mm) clearance between framing members and operable units.
c. Cantilever Deflection: Where framing members overhang an anchor point, limit deflection to 2 times the length of cantilevered member divided by 175.

6. Windborne-Debris-Impact-Resistance Performance: Pass missile-impact and cyclic-pressure tests when tested according to ASTM E 1886 and testing information in ASTM E 1996 for Wind Zone 1 **OR** Zone 2 **OR** Zone 3 **OR** Zone 4, **as directed**.
    a. Large-Missile Test: For glazed openings located within 30 feet (9.1 m) of grade.
    b. Small-Missile Test: For glazed openings located more than 30 feet (9.1 m) above grade.
7. Seismic Performance: Structural-sealant-glazed curtain walls shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
    a. Component Importance Factor is 1.5 **OR** 1.0, **as directed**.
8. Story Drift: Accommodate design displacement of adjacent stories indicated.
    a. Design Displacement: As indicated on Drawings **OR as directed**.
    b. Test Performance: Meets criteria for passing based on building occupancy type when tested according to AAMA 501.4 at design displacement and 1.5 times the design displacement, **as directed**.
9. Water Penetration under Static Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa) **OR** 10 lbf/sq. ft. (480 Pa) **OR** 15 lbf/sq. ft. (720 Pa), **as directed**.
10. Water Penetration under Dynamic Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to AAMA 501.1 at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa) **OR** 10 lbf/sq. ft. (480 Pa) **OR** 15 lbf/sq. ft. (720 Pa), **as directed**.
    a. Maximum Water Leakage: According to AAMA 501.1 **OR** No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation, **as directed**. Water leakage does not include water controlled by flashing and gutters that is drained to exterior.
11. Thermal Movements: Allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures:
    a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
    b. Test Interior Ambient-Air Temperature: 75 deg F (24 deg C).
    c. Test Performance: No buckling, stress on glass, sealant failure, or excess stress on framing, anchors, and fasteners and no reduction of performance when tested according to AAMA 501.5.
12. Energy Performance: Structural-sealant-glazed curtain walls shall have certified and labeled energy performance ratings according to NFRC.
    a. Thermal Transmittance (U-Factor): Fixed glazing and framing areas shall have U-factor of not more than 0.45 Btu/sq. ft. x h x deg F (2.55 W/sq. m x K) **OR** 0.57 Btu/sq. ft. x h x deg F (3.23 W/sq. m x K) **OR** 0.69 Btu/sq. ft. x h x deg F (3.92 W/sq. m x K), **as directed**, as determined according to NFRC 100.
    b. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a SHGC of no greater than 0.35 **OR** 0.40 **OR** 0.45, **as directed**, as determined according to NFRC 200.
    c. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of 0.30 cfm/sq. ft. (1.50 L/s per sq. m) of fixed wall area as determined according to ASTM E 283

at a minimum static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa) **OR** 6.24 lbf/sq. ft. (300 Pa), **as directed**.

d. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC-certified CR rating of no less than 15 **OR** 25 **OR** 35 **OR** 45, **as directed**, as determined according to NFRC 500

13. Sound Transmission: Fixed glazing and framing areas shall have the following sound-transmission characteristics:
    a. Outdoor-Indoor Transmission Class: Minimum 26 **OR** 30 **OR** 34, **as directed**, when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 1332.
14. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed curtain walls without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
    a. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
    b. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.
15. Structural-Sealant Joints:
    a. Designed to carry gravity loads of glazing.
    b. Designed to produce tensile or shear stress of less than 20 psi (138 kPa).
    c. Design reviewed and approved by structural-sealant manufacturer.

D. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittal:
    a. Product Data for Credit EQ 4.1: For glazing sealants used inside of the weatherproofing system, including printed statement of VOC content.
3. Shop Drawings: For structural-sealant-glazed curtain walls. Include plans, elevations, sections, full-size details, and attachments to other work.
    a. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
    b. Include full-size isometric details of each vertical-to-horizontal intersection of structural-sealant-glazed curtain walls, showing the following:
        1) Joinery, including concealed welds.
        2) Anchorage.
        3) Expansion provisions.
        4) Glazing.
        5) Flashing and drainage.
4. Samples: For each type of exposed finish required.
5. Delegated-Design Submittal: For structural-sealant-glazed curtain walls indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
6. Qualification Data: For qualified Installer and testing agency.
7. Seismic Qualification Certificates: For structural-sealant-glazed curtain walls, accessories, and components, from manufacturer.
    a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
8. Welding certificates.
9. Energy-Performance Certificates: For structural-sealant-glazed curtain walls, accessories, and components, from manufacturer.
    a. Basis for Certification: NFRC-certified energy-performance values for each structural-sealant-glazed curtain wall.
10. Product test reports.
11. Preconstruction sealant test reports.

12. Quality-Control Program: Developed specifically for Project, including fabrication and installation, according to recommendations in ASTM C 1401. Include periodic quality-control reports.
13. Source quality-control reports.
14. Field quality-control reports.
15. Maintenance Data: For structural-sealant-glazed curtain walls to include in maintenance manuals. Include ASTM C 1401 recommendations for postinstallation-phase quality-control program.
16. Warranties: Sample of special warranties.

E. Quality Assurance
1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.
3. Product Options: Information on Drawings and in Specifications establishes requirements for assemblies' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
4. Structural-Sealant Glazing: Comply with ASTM C 1401 for design and installation of structural-sealant-glazed curtain walls.
5. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
6. Energy-Performance Standards: Comply with NFRC for minimum standards of energy performance, materials, components, accessories, and fabrication. Comply with more stringent requirements if indicated.
   a. Provide NFRC-certified, structural-sealant-glazed curtain walls with an attached label.
7. Preinstallation Conference: Conduct conference at Project site.

F. Warranty
1. Special Assembly Warranty: Standard form in which manufacturer **OR** Installer, ,**as directed** agrees to repair or replace components of structural-sealant-glazed curtain walls that do not comply with requirements or that fail in materials or workmanship within Two **OR** Five **OR** 10, **as directed**, years from date of Final Completion.
2. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within Five **OR** 10 **OR** 20, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Materials
1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
   a. Sheet and Plate: ASTM B 209 (ASTM B 209M).
   b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
   c. Extruded Structural Pipe and Tubes: ASTM B 429.
   d. Structural Profiles: ASTM B 308/B 308M.
   e. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.
2. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer, complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
   a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
   b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
   c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

B. Framing
1. Framing Members: Manufacturer's standard formed- or extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.
2. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
a. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
b. Reinforce members as required to receive fastener threads.
c. Use exposed fasteners with countersunk Phillips screw heads finished to match framing system **OR** fabricated from Series 300 stainless steel, **as directed**.
3. Anchors: Three-way adjustable anchors, with minimum adjustment of 1 inch (25.4 mm), that accommodate fabrication and installation tolerances in material and finish and are compatible with adjoining materials and recommended by manufacturer.
a. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
4. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials **OR** Dead-soft, 0.018-inch- (0.457-mm-) thick stainless steel, ASTM A 240/A 240M of type recommended by manufacturer, **as directed**.
5. Framing Sealants: Manufacturer's standard sealants with VOC content of 250g/L or less when calculated according to 40 CFR 59, Subpart D (EPA method 24), **as directed**.

C. Glazing
1. Glazing: Comply with Division 08 Section "Glazing".
2. Glazing Gaskets, Spacers, Setting Blocks, Sealant Backings, and Bond Breakers: Manufacturer's standard permanent, nonmigrating types compatible with sealants and suitable for joint movement and assembly performance requirements.
3. Glazing Sealants: For structural-sealant-glazed curtain walls, as recommended by manufacturer for joint type, and as follows:
a. Structural Sealant: ASTM C 1184, chemically curing silicone formulation that is compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in curtain-wall assembly indicated.
1) Provide sealants for use inside of the weatherproofing system that have a VOC content of 100 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2) Color: Black **OR** Gray **OR** As selected from manufacturer's full range of colors, **as directed**.
b. Weatherseal Sealant: ASTM C 920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed curtain-wall manufacturers for this use.
1) Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2) Color: Matching structural sealant.

D. Operable Units
1. Venting Windows: Comply with Division 08 Section "Aluminum Windows".
2. Doors: Comply with Division 08 Section "Aluminum-framed Entrances And Storefronts".

E. Accessory Materials
1. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.
2. Cleaning Agent and Cloth: As recommended by structural-sealant manufacturer.

F. Fabrication
1. Form or extrude aluminum shapes before finishing.
2. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
3. Fabricate components that, when assembled, have the following characteristics:
   a. Profiles that are sharp, straight, and free of defects or deformations.
   b. Accurately fitted joints with ends coped or mitered.
   c. Physical and thermal isolation of glazing from framing members.
   d. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
   e. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
   f. Provisions for field replacement of glazing from exterior **OR** interior **OR** interior for vision glass and exterior for spandrel glazing or metal panels, **as directed**. Include accommodations for using temporary support device (dutchman) to retain glazing in place while sealant cures.
   g. Provisions for safety railings mounted on interior face of mullions **OR** between mullions at interior, **as directed**.
   h. Components curved to indicated radii.
   i. Internal guttering systems or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within structural-sealant-glazed curtain wall to exterior.
4. Factory-Assembled Frame Units:
   a. Rigidly secure nonmovement joints.
   b. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion.
   c. Preparation includes, but is not limited to, cleaning and priming surfaces.
   d. Seal joints watertight unless otherwise indicated.
   e. Install glazing to comply with requirements in Division 08 Section "Glazing".
5. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

G. Aluminum Finishes
1. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
2. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Champagne **OR** Black **OR** Match sample **OR** As selected from full range of industry colors and color densities, **as directed**.
3. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
   a. Color and Gloss: As selected from manufacturer's full range, **as directed**.
4. High-Performance Organic Finish:
   a. Two-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   OR
   Three-coat **OR** Four-coat, **as directed**, fluoropolymer finish complying with AAMA 2605 and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   OR

Two-coat fluoropolymer finish complying with AAMA 2604 and containing 100 percent FEVE resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

b. Color and Gloss: As selected from manufacturer's full range.

H. Source Quality Control

1. Perform quality-control procedures complying with ASTM C 1401 recommendations including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

1.3 EXECUTION

A. Installation

1. General:
   a. Comply with manufacturer's written instructions.
   b. Do not install damaged components.
   c. Fit joints to produce hairline joints free of burrs and distortion.
   d. Rigidly secure nonmoving joints.
   e. Install anchors with separators and isolators to prevent metal corrosion, electrolytic deterioration, and impediments to movement of joints.
   f. Weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
   g. Seal joints watertight unless otherwise indicated.
2. Metal Protection:
   a. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
   b. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
3. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within structural-sealant-glazed curtain walls to exterior.
4. Install components plumb and true in alignment with established lines and grades.
5. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.
6. Install glazing as specified in Division 08 Section "Glazing". Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
7. Install weatherseal sealant according to Division 07 Section "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

B. Erection Tolerances

1. Erection Tolerances: Install to comply with the following nonaccumulating maximum tolerances:
   a. Plumb: 1/8 inch in 10 feet (3 mm in 3 m); 1/4 inch in 40 feet (6 mm in 12 m).
   b. Level: 1/8 inch in 20 feet (3 mm in 6 m); 1/4 inch in 40 feet (6 mm in 12 m).
   c. Alignment:
      1) Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch (12.7 mm) wide, limit offset from true alignment to 1/16 inch (1.6 mm).
      2) Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch (12.7 to 25.4 mm) wide, limit offset from true alignment to 1/8 inch (3.2 mm).
      3) Where surfaces are separated by reveal or protruding element of 1 inch (25.4 mm) wide or more, limit offset from true alignment to 1/4 inch (6 mm).
   d. Location: Limit variation from plane to 1/8 inch in 12 feet (3 mm in 3.7 m); 1/2 inch (12.7 mm) over total length.

C. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Testing Services: Testing and inspecting of representative areas of structural-sealant-glazed curtain walls shall take place as installation proceeds to determine compliance of installed assemblies with specified requirements.
    a. Structural-Sealant Adhesion: Test structural sealant according to recommendations in ASTM C 1401, Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.
        1) Test a minimum of two **OR** four **OR** six, **as directed**, areas on each building facade.
        2) Repair installation areas damaged by testing.
    b. Air Infiltration: Areas shall be tested for air leakage of 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article, but not more than 0.50 cfm/sq. ft. (2.25 L/s per sq. m), of fixed wall area when tested according to ASTM E 783 at a minimum static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa) **OR** 6.24 lbf/sq. ft. (300 Pa), **as directed**.
        1) Test Area: One bay wide, but not less than 30 feet (9.1 m), by one story of structural-sealant-glazed curtain wall.
        2) Perform a minimum of two **OR** three, **as directed**, tests in areas as directed by the Owner.
        OR
        Perform tests in each test area as directed by the Owner. Perform at least three tests, prior to 10, 35, and 70 percent completion.
    c. Water Penetration: Areas shall be tested according to ASTM E 1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft. (300 Pa), and shall not evidence water penetration.
        1) Test Area: One bay wide, but not less than 30 feet (9.1 m), by one story of structural-sealant-glazed curtain wall.
        2) Perform a minimum of two **OR** three, **as directed**, tests in areas as directed by the Owner.
        OR
        Perform tests in each test area as directed by the Owner. Perform at least three tests, prior to 10, 35, and 70 percent completion.
    d. Water Spray Test: Before installation of interior finishes has begun, areas designated by the Owner shall be tested according to AAMA 501.2 and shall not evidence water penetration.
        1) Test Area: A minimum area of 75 feet (23 m) by one story of structural-sealant-glazed curtain wall.
3. Structural-sealant-glazed curtain walls will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

END OF SECTION 08 44 13 00a

SECTION 08 44 13 00b - SLOPED GLAZING ASSEMBLIES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of material for sloped glazing systems. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Conventionally glazed sloped glazing assemblies.
      b. Two-sided, structural-sealant-glazed sloped glazing assemblies.
      c. Four-sided, structural-sealant-glazed sloped glazing assemblies.

C. Performance Requirements
   1. General Performance: Sloped glazing assemblies shall withstand movements of supporting structure (where applicable) without failure due to defective manufacture, fabrication, installation, or other defects in construction.
      a. Sloped Glazing Assemblies: Comply with performance requirements specified, as determined by testing manufacturer's standard assemblies representing those indicated for this Project.
      b. Failures also include, but are not limited to, the following:
         1) Thermal stresses transferring to building structure.
         2) Glass breakage.
         3) Noise or vibration created by wind and thermal and structural movements.
         4) Loosening or weakening of fasteners, attachments, and other components.
         5) Failure of operating units.
         6) Glazing-to-glazing contact.
   2. Delegated Design: Design sloped glazing assemblies, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
   3. Structural Performance: Sloped glazing assemblies shall withstand the wind loads, the effects of gravity loads, and loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
      a. Wind Loads: As indicated on Drawings **OR as directed**.
         1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s) **OR** 100 mph (44 m/s) **OR** 110 mph (49 m/s), **as directed**.
         2) Exposure Category: A **OR** B **OR** C **OR** D, **as directed**.
      b. Snow Loads: As indicated on Drawings **OR as directed**.
      c. Concentrated Live Loads: As indicated on Drawings **OR as directed**, applied to framing members at locations that will produce greatest stress or deflection.
      d. Uniform Live Loads: As indicated on Drawings **OR as directed**.
      e. Load Combinations: Calculate according to requirements of applicable code indicated on Drawings **OR as directed**.
      f. Blast Loads: As indicated on Drawings **OR as directed**.
      g. Periodic Maintenance-Equipment Loads: As indicated on Drawings **OR as directed**.
   4. Structural Performance: Provide sloped glazing assemblies tested according to ASTM E 330, as follows:
      a. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.

b. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
c. Test Durations: As required by design wind velocity, but not less than 10 seconds.

5. Deflection of Framing Members: At design wind pressure, as follows:
   a. Deflection Normal to Glazing Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding L/175 of the glass edge length for each individual glazing lite **OR** 1/175 of clear span for spans up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans more than 13 feet 6 inches (4.1 m), **as directed**, or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19.1 mm), whichever is less.
   b. Deflection Parallel to Glazing Plane: Limited to L/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller **OR** amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch (3.2 mm), **as directed**.
6. Flexural Members: Design for lateral bracing of compression flanges by cross members with minimum depth equal to 50 percent of braced flexural member. Glazing does not provide lateral support.
7. Windborne-Debris-Impact-Resistance Performance: Pass missile-impact and cyclic-pressure tests when tested according to ASTM E 1886 and testing information in ASTM E 1996 for Wind Zone 1 **OR** Zone 2 **OR** Zone 3 **OR** Zone 4, **as directed**.
   a. Large-Missile Test: For glazed openings located within 30 feet (9.1 m) of grade.
   b. Small-Missile Test: For glazed openings located more than 30 feet (9.1 m) above grade.
8. Seismic Performance: Sloped glazing assemblies shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   a. Component Importance Factor is 1.5 **OR** 1.0, **as directed**.
9. Story Drift: Accommodate design displacement of adjacent stories indicated.
   a. Design Displacement: As indicated on Drawings **OR as directed**.
   b. Test Performance: Meet criteria for passing based on building occupancy type when tested according to AAMA 501.4 at design displacement and 1.5 times the design displacement.
10. Water Penetration under Static Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa) **OR** 10 lbf/sq. ft. (480 Pa) **OR** 15 lbf/sq. ft. (720 Pa), **as directed**.
11. Water Penetration under Dynamic Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to AAMA 501.1 at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa) **OR** 10 lbf/sq. ft. (480 Pa) **OR** 15 lbf/sq. ft. (720 Pa), **as directed**.
    a. Maximum Water Leakage: According to AAMA 501.1 **OR** No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation, **as directed**. Water leakage does not include water controlled by flashing and gutters that is drained to exterior.
12. Thermal Movements: Allow for thermal movements from the following maximum change (range) in ambient and surface temperature:
    a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
    b. Test Interior Ambient-Air Temperature: 75 deg F (24 deg C).
    c. Test Performance: No buckling, stress on glass, sealant failure, or excess stress on framing, anchors, and fasteners and no reduction of performance when tested according to AAMA 501.5.
13. Energy Performance: Sloped glazing assemblies shall have certified and labeled energy-performance ratings according to the NFRC.

a. Thermal Transmittance (U-Factor): Fixed glazing and framing areas shall have U-factor of not more than 0.45 Btu/sq. ft. x h x deg F (2.55 W/sq. m x K) **OR** 0.57 Btu/sq. ft. x h x deg F (3.23 W/sq. m x K) **OR** 0.69 Btu/sq. ft. x h x deg F (3.92 W/sq. m x K), **as directed**, as determined according to NFRC 100.
b. Solar Heat-Gain Coefficient: Fixed glazing and framing areas shall have an SHGC of not more than 0.35 **OR** 0.40 **OR** 0.45, **as directed**, as determined according to NFRC 200.
c. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of 0.30 cfm/sq. ft. (1.50 L/s per sq. m) of fixed area as determined according to ASTM E 283 at a minimum static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa) **OR** 6.24 lbf/sq. ft. (300 Pa), **as directed**.
d. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC-certified CR rating of not less than 15 **OR** 25 **OR** 35 **OR** 45, as **directed**, as determined according to NFRC 500.

14. Sound Transmission: Fixed glazing and framing areas shall have the following characteristics:
    a. Outdoor-Indoor Transmission Class: Minimum 26 **OR** 30 **OR** 34, **as directed**, when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 1332.
15. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by structural-sealant glazing without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
    a. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
    b. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.
16. Structural-Sealant Joints:
    a. Designed to carry gravity loads of glazing.
    b. Designed to produce tensile or shear stress of less than 20 psi (138 kPa).
    c. Design reviewed and approved by structural-sealant manufacturer.

D. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
    a. Product Data for Credit EQ 4.1: For glazing sealants used inside the weatherproofing system, including printed statement of VOC content.
3. Shop Drawings: For sloped glazing assemblies. Include plans, elevations, sections, details, and attachments to other work.
    a. Include details of provisions for assembly expansion and contraction and for draining moisture within the assembly to the exterior.
    b. Include full-size isometric details of each vertical-to-horizontal intersection of assembly, showing the following:
        1) Joinery including concealed welds.
        2) Anchorage.
        3) Expansion provisions.
        4) Glazing.
        5) Flashing and drainage.
4. Samples: For each type of exposed finish required.
5. Delegated-Design Submittal: For sloped glazing assemblies indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
6. Qualification Data: For qualified Installer and testing agency.
7. Seismic Qualification Certificates: For sloped glazing assemblies, accessories, and components, from manufacturer.
    a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
8. Welding certificates.

9. Product test reports.
10. Preconstruction sealant test reports.
11. Quality-Control Program: Developed specifically for Project, including fabrication and installation, according to recommendations in ASTM C 1401. Include periodic quality-control reports.
12. Source quality-control reports.
13. Field quality-control reports.
14. Maintenance data.
15. Warranties: Sample of special warranties.

E. Quality Assurance
1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.
3. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
4. Structural-Sealant Glazing: Comply with ASTM C 1401 for design and installation.
5. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
6. NFRC Certification: Provide NFRC-certified and -labeled sloped glazing assemblies.
7. Preinstallation Conference: Conduct conference at Project site.

F. Warranty
1. Special Assembly Warranty: Standard form in which manufacturer **OR** Installer, **as directed**, agrees to repair or replace components of sloped glazing assemblies that do not comply with requirements or that fail in materials or workmanship within Two **OR** Five **OR** 10, **as directed**, years from date of Final Completion.
2. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within Five **OR** 10 **OR** 20, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Materials
1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
   a. Sheet and Plate: ASTM B 209 (ASTM B 209M).
   b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
   c. Extruded Structural Pipe and Tubes: ASTM B 429.
   d. Structural Profiles: ASTM B 308/B 308M.
   e. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.
2. Steel Reinforcement: With manufacturer's standard, zinc-rich, corrosion-resistant primer, complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
   a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
   b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
   c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

B. Framing
1. Framing Members: Manufacturer's standard, formed- or extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.

a. Framing-Member Type: Self-supporting **OR** Skin type, supported by structural-steel members indicated, **as directed**.
b. Glass Retention: Field-installed pressure caps on four sides **OR** Field-installed structural sealant at horizontal members (purlins) and pressure caps at rafters **OR** Factory-installed structural sealant on four sides, **as directed**.

2. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.
   a. Include snap-on aluminum trim that conceals fasteners.
3. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning assembly components.
4. Fasteners and Accessories: Manufacturer's standard, corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
   a. At pressure caps, use ASTM A 193/A 193M stainless-steel screws.
   b. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
   c. Reinforce members as required to receive fastener threads.
   d. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system **OR** fabricated from Series 300 stainless steel, **as directed**.
5. Anchors: Three-way adjustable anchors, with minimum adjustment of 1 inch (25 mm), that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials, and recommended by manufacturer.
   a. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with requirements in ASTM A 123/A 123M or ASTM A 153/A 153M.
6. Anchor Bolts: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), galvanized steel.
7. Concealed Flashing: Manufacturer's standard, corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials **OR** Dead-soft, 0.018-inch- (0.457-mm-) thick stainless steel, ASTM A 240/A 240M; of type recommended by manufacturer, **as directed**.
8. Exposed Flashing and Closures: Manufacturer's standard aluminum components not less than 0.040 inch (1.016 mm) **OR** 0.060 inch (1.524 mm), **as directed**, thick.
9. Framing Sealants: Manufacturer's standard.

C. Glazing
1. General: Comply with Division 08 Section "Glazing".
2. Glazing Gaskets: Manufacturer's standard resilient elastomeric glazing gaskets, setting blocks, and shims or spacers **OR** As specified in Division 08 Section "Glazing", **as directed**.
3. Glazing Sealants: As recommended by manufacturer **OR** Comply with Division 08 Section "Glazing", **as directed**.
   a. Provide sealants for use inside the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
4. Glazing Sealants: For structural-sealant glazing, as recommended by manufacturer for joint type, and as follows:
   a. Structural Sealant: ASTM C 1184, chemically curing silicone formulation that is compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant, and approved by structural-sealant manufacturer for use in sloped glazing assemblies indicated.
      1) Provide sealants for use inside the weatherproofing system that have a VOC content of 100 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
      2) Color: Black **OR** Gray **OR** As selected from manufacturer's full range of colors, **as directed**.
   b. Weatherseal Sealant: ASTM C 920, Type S, Grade NS, Class 25, Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and sloped glazing assembly manufacturers for this use.
      1) Provide sealants for use inside the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2) Color: Matching structural sealant.

5. Bond-Breaker Tape: Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.

D. Accessory Materials

1. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 33 requirements except containing no asbestos, formulated for 30-mil (0.76-mm) thickness per coat.
2. Cleaning Agent and Cloth: As recommended by structural-sealant manufacturer.

E. Fabrication

1. Form or extrude aluminum shapes before finishing.
2. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
3. Fabricate components that, when assembled, have the following characteristics:
   a. Profiles that are sharp, straight, and free of defects or deformations.
   b. Accurately fitted joints with ends coped or mitered.
   c. Physical and thermal isolation of glazing from framing members.
   d. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
   e. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
   f. Components curved to indicated radii.
   g. Internal guttering systems or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
4. Fabricate continuous, one-piece-type aluminum sill closures with weep holes.
5. Four-Sided, Structural-Sealant-Glazed Frame Units:
   a. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion.
   b. Preparation includes, but is not limited to, cleaning and priming surfaces.
   c. Seal joints watertight unless otherwise indicated.
   d. Factory install glazing to comply with requirements in Division 08 Section "Glazing".
6. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

F. Aluminum Finishes

1. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
2. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Champagne **OR** Black **OR** Match sample **OR** As selected from full range of industry colors and color densities, **as directed**.
3. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
   a. Color and Gloss: As selected from manufacturer's full range, **as directed**.
4. High-Performance Organic Finish:
   a. Two-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

      OR

      Three-coat **OR** Four-coat, **as directed**, fluoropolymer finish complying with AAMA 2605 and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in both

color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
OR
Two-coat fluoropolymer finish complying with AAMA 2604 and containing 100 percent FEVE resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

b. Color and Gloss: As selected from manufacturer's full range.

G. Source Quality Control

1. Four-Sided, Structural-Sealant Glazing: Perform quality-control procedures complying with recommendations in ASTM C 1401 including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

1.3 EXECUTION

A. Installation

1. General:
   a. Comply with manufacturer's written instructions.
   b. Do not install damaged components.
   c. Fit joints to produce hairline joints free of burrs and distortion.
   d. Rigidly secure nonmovement joints.
   e. Install anchors with separators and isolators to prevent metal corrosion, electrolytic deterioration, and impediments to movement of joints.
   f. Weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
   g. Seal joints watertight unless otherwise indicated.
2. Metal Protection:
   a. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
   b. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
   c. Where aluminum will contact pressure-treated wood, separate dissimilar materials by method recommended by sloped glazing assembly manufacturer.
3. Install continuous sill closure with weatherproof expansion joints and locked and sealed or welded corners. Locate weep holes at rafters.
4. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the sloped glazing assembly to exterior.
5. Install components plumb and true in alignment with established lines and grades.
6. Install glazing as specified in Division 08 Section "Glazing".
   a. Two-Sided, Structural-Sealant Glazing:
      1) Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
      2) Install weatherseal sealant according to Division 08 Section "Glazing" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

B. Erection Tolerances

1. General: Install sloped glazing assemblies to comply with the following maximum tolerances:
   a. Level: 1/8 inch in 20 feet (3 mm in 6 m); 1/4 inch in 40 feet (6 mm in 12 m).
   b. Alignment: Limit offset from true alignment to 1/32 inch (0.8 mm) where surfaces abut in line, edge to edge, at corners, or where a reveal or protruding element separates aligned surfaces by less than 3 inches (76 mm); otherwise limit offset to 1/8 inch (3 mm).

c. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet (3 mm in 3.7 m); 1/2 inch (13 mm) over total length.

C. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Testing Services: Testing and inspecting of representative areas of sloped glazing assemblies shall take place as installation proceeds to determine compliance of installed assemblies with specified requirements.
   a. Structural-Sealant Adhesion: Test structural sealant according to recommendations in ASTM C 1401, Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.
      1) Test a minimum of two **OR** four **OR** six, **as directed**, areas on each assembly face.
      2) Repair installation areas damaged by testing.
   b. Air Infiltration: Areas shall be tested for air leakage of 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article, but not more than 0.50 cfm/sq. ft. (2.25 L/s per sq. m), of assembly surface area when tested according to ASTM E 783 at a minimum static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa) **OR** 6.24 lbf/sq. ft. (300 Pa), **as directed**.
      1) Test Area: One bay wide, but not less than 30 by 30 feet (9.1 by 9.1 m) of sloped glazing assembly.
      2) Perform a minimum of two **OR** three, **as directed**, tests in areas as directed by the Owner.
      OR
      Perform tests in each test area as directed by the Owner. Perform at least three tests prior to 10, 35, and 70 percent completion.
   c. Water Penetration: Areas shall be tested according to ASTM E 1105 at a minimum uniform and cyclic static-air-pressure difference of 0.67 times the static-air-pressure difference specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft. (300 Pa), and shall not evidence water penetration.
      1) Test Area: One bay wide, but not less than 30 by 30 feet (9.1 by 9.1 m) of sloped glazing assembly.
      2) Perform a minimum of two **OR** three tests in areas as directed by the Owner.
      OR
      Perform tests in each test area as directed by the Owner. Perform at least three tests prior to 10, 35, and 70 percent completion.
   d. Water-Spray Test: Before installation of interior finishes has begun, areas designated by the Owner shall be tested according to AAMA 501.2 and shall not evidence water penetration.
      1) Test Area: A minimum area of 30 by 30 feet (9.1 by 9.1 m) of sloped glazing assembly.
3. Sloped glazing assemblies will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

END OF SECTION 08 44 13 00b

SECTION 08 45 23 00 - UNIT SKYLIGHTS

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for unit skylights. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Self-flashing unit skylights with integral curb.
b. Unit skylights mounted on prefabricated **OR** site-built, **as directed**, curbs.

C. Performance Requirements
1. AAMA/WDMA Performance Requirements: Provide unit skylights of performance class and grade indicated that comply with AAMA/WDMA 101/I.S.2/NAFS unless more stringent performance requirements are indicated.
a. Performance Class and Grade:
1) SKG-R15/15-1200x1200 **OR** SKP-R15/15-1200x1200, **as directed**.
2) SKG-C30/30-1200x1200 **OR** SKP-C30/30-1200x1200, **as directed**.
3) SKG-HC40/40-1200x2500 **OR** SKP-HC40/40-1200x2500, **as directed**.
4) As indicated.
2. Windborne-Debris-Impact-Resistance Performance: Provide unit skylights that pass missile-impact and cyclic-pressure tests when tested according to ASTM E 1886 and testing information in ASTM E 1996 **OR** AAMA 506, **as directed**.
a. Large-Missile Impact: For unit skylights located within 30 feet (9.1 m) of grade.
b. Small-Missile Impact: For unit skylights located more than 30 feet (9.1 m) above grade.

D. Submittals
1. Product Data: For each type of unit skylight indicated.
2. Shop Drawings: For unit skylight work. Include plans, elevations, sections, details, and connections to supporting structure and other adjoining work.
a. Unit Skylight Operating System: Show locations, mounting, and details for installing operator components and controls.
b. Unit Skylight Operating System: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
c. Wiring Diagrams: For power, signal, and control wiring for electric motors of operable unit skylights.
3. Samples: For each type of exposed finish required, in a representative section of each unit skylight in manufacturer's standard size.
4. Qualification Data.
5. Product Test Reports.
6. Field quality-control reports.
7. Maintenance Data: For unit skylights and unit skylight operating system to include in maintenance manuals.
8. Warranty: Sample of special warranty.

E. Quality Assurance
1. Manufacturer Qualifications: A manufacturer capable of fabricating unit skylights that meet or exceed performance requirements indicated and of documenting this performance by inclusion in lists and by labels, test reports, and calculations.

2. Installer Qualifications: An installer acceptable to unit skylight manufacturer for installation of units required for this Project.
3. Surface-Burning Characteristics of Plastic Glazing: Provide plastic glazing sheets identical to those tested for fire-exposure behavior per test method indicated below by a testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
   a. Self-Ignition Temperature: 650 deg F (343 deg C) or more for plastic sheets in thickness indicated when tested per ASTM D 1929.
   b. Smoke-Production Characteristics: Comply with either requirement below:
      1) Smoke-Developed Index: 450 or less when tested per ASTM E 84 on plastic sheets in manner indicated for use.
      2) Smoke Density: 75 or less when tested per ASTM D 2843 on plastic sheets in thickness indicated for use.
   c. Burning Characteristics: Tested per ASTM D 635.
      1) Acrylic Glazing: Class CC2, burning rate of 2-1/2 inches (64 mm) per minute or less for nominal thickness of 0.060 inch (1.5 mm) or thickness indicated for use.
      2) Polycarbonate Glazing: Class CC1, burning extent of 1 inch (25 mm) or less for nominal thickness of 0.060 inch (1.5 mm) or thickness indicated for use.
      3) Polycarbonate-Insulating-Panel Glazing: Class CC2, burning rate of 2-1/2 inches (64 mm) per minute or less for nominal thickness of 0.060 inch (1.5 mm) or thickness indicated for use.
4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. Unit Skylight Standard: Comply with AAMA/WDMA 101/I.S.2/NAFS, "North American Fenestration Standard Voluntary Performance Specification for Windows, Skylights and Glass Doors," for minimum standards of performance, materials, components, accessories, and fabrication. Comply with more stringent requirements if indicated.
   a. Provide AAMA-certified unit skylights with an attached label.
6. Preinstallation Conference: Conduct conference at Project site.

F. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of unit skylights that fail in materials or workmanship within five years from date of Final Completion.

1.2 PRODUCTS

A. Materials
1. Aluminum Components:
   a. Sheets: ASTM B 209 (ASTM B 209M), alloy and temper to suit forming operations and finish requirements but with not less than the strength and durability of alclad Alloy 3005-H25.
   b. Extruded Shapes: ASTM B 221 (ASTM B 221M), alloy and temper to suit structural and finish requirements but with not less than the strength and durability of Alloy 6063-T52.
2. Fasteners: Same metal as metal being fastened, nonmagnetic stainless steel, or other noncorrosive metal as recommended by manufacturer. Finish exposed fasteners to match material being fastened.
   a. Where removal of exterior exposed fasteners might allow access to building, provide nonremovable fastener heads.

B. Glazing
1. Acrylic Glazing: ASTM D 4802, thermoformable, monolithic sheet, category as standard with manufacturer, Finish 1 (smooth or polished), Type UVF (formulated with UV absorber).
   a. Single-Glazing Profile: Dome, 25 percent rise **OR** Pyramid, 30-degree slope, **as directed**.

1) Thickness: As indicated **OR** Not less than thickness required to exceed performance requirements, **as directed**.
2) Color: Colorless, transparent **OR** White, translucent **OR** Bronze-tinted, transparent **OR** Gray-tinted, transparent, **as directed**.

b. Double-Glazing Profile: Dome, 25 percent rise **OR** Pyramid, 30-degree slope, **as directed**.
1) Thicknesses: As indicated **OR** Not less than thicknesses required to exceed performance requirements, **as directed**.
2) Outer Glazing Color: Colorless, transparent **OR** White, translucent **OR** Bronze-tinted, transparent **OR** Gray-tinted, transparent, **as directed**.
3) Inner Glazing Color: Colorless, transparent **OR** White, translucent **OR** Bronze-tinted, transparent **OR** Gray-tinted, transparent, **as directed**.

2. Polycarbonate Glazing: Thermoformable, extruded monolithic sheets, UV resistant, burglar-resistance rated per UL 972, and with average impact strength of 12 to 16 ft-lb/in. (640 to 854 J/m) of width when tested per ASTM D 256, Test Method A (Izod).
a. Single-Glazing Profile: Dome, 25 percent rise **OR** Pyramid, 30-degree slope, **as directed**.
1) Thickness: As indicated **OR** Not less than thickness required to exceed performance requirements, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** As selected from full range of industry colors, **as directed**.

b. Double-Glazing Profile: Dome, 25 percent rise **OR** Pyramid, 30-degree slope, **as directed**.
1) Thicknesses: As indicated **OR** Not less than thicknesses required to exceed performance requirements, **as directed**.
2) Inner Glazing Color: As indicated by manufacturer's designations **OR** As selected from full range of industry colors, **as directed**.
3) Outer Glazing Color: As indicated by manufacturer's designations **OR** As selected from full range of industry colors, **as directed**.

3. Insulating Glass: Clear, sealed units that comply with Division 08 Section "Glazing", in manufacturer's standard overall thickness.
a. Exterior Lite: 1/4-inch (6-mm) clear **OR** tinted, **as directed,** heat-strengthened **OR** fully tempered, **as directed**, glass.
b. Interior Lite:
1) Laminated glass; 2 plies of 1/8-inch (3-mm) clear heat-strengthened glass with 0.030-inch (0.762-mm) clear polyvinyl butyral interlayer.
2) 1/4-inch (6-mm) clear **OR** tinted, **as directed,** heat-strengthened **OR** fully tempered **OR** wire, **as directed**, glass.

c. Interspace Content: Air **OR** Argon, **as directed**.
d. Low-Emissivity Coating: Manufacturer's standard.

4. Polycarbonate-Insulating-Panel Glazing: Manufacturer's standard polycarbonate sheet with cellular cross section that provides isolated airspaces and that is coextruded with a UV-protective layer.
a. Thickness: As indicated **OR** Not less than thickness required to exceed performance requirements, **as directed**.
b. Color: As indicated by manufacturer's designations **OR** As selected from full range of industry colors, **as directed**.

5. Fiberglass-Sandwich-Panel Glazing: Manufacturer's standard with uniformly colored, translucent, fiberglass-reinforced-polymer face sheets permanently adhered to a grid core.
a. Thickness: As indicated **OR** Not less than thickness required to exceed performance requirements, **as directed**.
b. Color: As indicated by manufacturer's designations **OR** As selected from full range of industry colors, **as directed**.

6. Glazing Gaskets: Manufacturer's standard **OR** EPDM, neoprene, partially vulcanized butyl tape, or liquid-applied elastomeric sealant, **as directed**.

C. Installation Materials
1. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic, nominally free of sulfur and containing no asbestos fibers, formulated for 15-mil (0.4-mm) dry film thickness per coating.

2. Joint Sealants: As specified inDivision 07 Section "Joint Sealants".
3. Mastic Sealant: Polyisobutylene; nonhardening, nonskinning, nondrying, nonmigrating sealant.
4. Roofing Cement: ASTM D 4586, asbestos free, designed for trowel application or other adhesive compatible with roofing system.

D. Unit Skylights
1. General: Provide factory-assembled unit skylights that include glazing, extruded-aluminum glazing retainers, gaskets, and inner frames and that are capable of withstanding performance requirements indicated.
2. Integral Curb: Extruded-aluminum **OR** Vinyl **OR** Reinforced-thermoset-fiberglass profile, **as directed**, self-flashing type.
   a. Height: As indicated **OR** 8 inches (200 mm) **OR** 9 inches (225 mm) **OR** 12 inches (300 mm), **as directed**.
   b. Construction: Single **OR** Double, **as directed**, wall.
   c. Insulation: Manufacturer's standard rigid or semirigid type.
3. Prefabricated Curb: As specified in Division 07 Section "Roof Accessories".
4. Site-Built Curb: As indicated.
5. Unit Shape and Size: As indicated **OR** Square, 40-by-40-inch (1016-by-1016-mm) inside curb **OR** Rectangular, 40-by-48-inch (1016-by-1220-mm) inside curb **OR** Circular, 40-inch- (1016-mm-) diameter inside curb, **as directed**.
6. Condensation Control: Fabricate unit skylights with integral internal gutters and non-clogging weeps to collect and drain condensation to the exterior.
7. Thermal Break: Fabricate unit skylights with thermal barrier separating exterior and interior metal framing.
8. Operable Unit Skylight System: Equip vent-type unit skylights with manufacturer's standard hinges, chain-driven operating hardware, and weather-sealing gaskets.
   a. Manual Operator: Manufacturer's standard, rotary-crank extension device.
      1) Pole Operator: Manual, 60 inches (1524 mm) long **OR** Manual, telescoping to 144 inches (3658 mm) **OR** Rechargeable-motor power-driven type, telescoping to 144 inches (3658 mm), **as directed**.
   b. Motor Operator: Manufacturer's standard electronic control, including switch, transformer, low-voltage motor, cover, and mounting hardware.
      1) Provide motor of size and capacity recommended by unit skylight manufacturer to suit unit skylight indicated.
      2) Provide rain sensor that automatically closes venting unit when water is detected.
      3) Provide motor operator with portable remote-control device.
9. Security Grilles: 1/2-inch- (13-mm-) diameter, hardened steel bars spaced not more than 5 inches (130 mm) o.c. in 1 direction and 16 inches (400 mm) o.c. in other direction **OR** 5 inches (130 mm) o.c. in both directions, **as directed**.
10. Protective Screens: Manufacturer's standard to protect interior glazing lite from breakage **OR** personnel from falls **OR** against windborne debris **OR** against hail, **as directed**.

E. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

F. Aluminum Finishes
1. Mill Finish: Manufacturer's standard.
2. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
3. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.

a. Color: As selected from full range of industry colors and color densities.

4. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
5. High-Performance Organic Finish: 2-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
6. High-Performance Organic Finish: 3 **OR** 4, **as directed**,-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

1.3 EXECUTION

A. Installation
1. Coordinate installation of unit skylight with installation of substrates, vapor retarders, roof insulation, roofing membrane, and flashing as required to ensure that each element of the Work performs properly and that combined elements are waterproof and weathertight.
2. Comply with recommendations in AAMA 1607 and with manufacturer's written instructions for installing unit skylights.
3. Install unit skylights level, plumb, and true to line, without distortion.
4. Anchor unit skylights securely to supporting substrates.
5. Where metal surfaces of unit skylights will contact incompatible metal or corrosive substrates, including preservative-treated wood, apply bituminous coating on concealed metal surfaces, or provide other permanent separation recommended in writing by unit skylight manufacturer.
6. Set unit skylight flanges in thick bed of roofing cement to form a seal unless otherwise indicated.
7. Where cap flashing is indicated, install to produce waterproof overlap with roofing or roof flashing. Seal with thick bead of mastic sealant except where overlap is indicated to be left open for ventilation.

B. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. After completion of installation and nominal curing of sealant and glazing compounds but before installation of interior finishes, test for water leaks according to AAMA 501.2.
3. Perform test for total area of each unit skylight.
4. Work will be considered defective if it does not pass tests and inspections.
5. Additional testing and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

C. Cleaning
1. Clean exposed unit skylight surfaces according to manufacturer's written instructions. Touch up damaged metal coatings and finishes.
2. Remove excess sealants, glazing materials, dirt, and other substances.
3. Remove and replace glazing that has been broken, chipped, cracked, abraded, or damaged during construction period.
4. Protect unit skylight surfaces from contact with contaminating substances resulting from construction operations.

5. Unit Skylight Operating System: Clean and lubricate joints and hardware. Adjust for proper operation.

END OF SECTION 08 45 23 00

SECTION 08 45 23 00a - METAL-FRAMED SKYLIGHTS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for metal-framed skylights. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes aluminum-framed skylights with the following characteristics:
   a. Glazing is glass **OR** plastic, **as directed**.
   b. Glazing is retained by field-installed pressure caps on four sides **OR** field-installed structural sealant at horizontal members (purlins) and pressure caps at rafters **OR** factory-installed structural sealant on four sides, **as directed**.

C. Performance Requirements
1. Provide metal-framed skylights, including anchorage, capable of withstanding, without failure, the effects of the following:
   a. Structural loads.
   b. Thermal movements.
   c. Movements of supporting structure.
   d. Dimensional tolerances of building frame and other adjacent construction.
2. Failure includes the following:
   a. Deflection exceeding specified limits.
   b. Water leakage.
   c. Thermal stresses transferred to building structure.
   d. Noise or vibration created by wind and thermal and structural movements.
   e. Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
   f. Loosening or weakening of fasteners, attachments, and other components.
   g. Sealant failure.
3. Structural Loads:
   a. Wind Loads: As indicated by structural design data on Drawings **OR as directed**.
   b. Snow Loads: As indicated by structural design data on Drawings **OR as directed**.
   c. Concentrated Live Loads: 250 lbf (1112 N) applied to framing members at locations that will produce greatest stress or deflection.
   d. Seismic Loads: As indicated by earthquake design data on Drawings **OR as directed**.
   e. Load Combinations: Calculate according to requirements of applicable code indicated on Drawings **OR as directed**.
4. Deflection of Framing Members:
   a. Deflection Normal to Glazing Plane:
      1) Spans Up to 20 Feet (6 m): Limited to 1/175 **OR** 1/180, **as directed**, of clear span or 1 inch (25.4 mm), whichever is smaller.
      2) Spans Exceeding 20 Feet (6 m): Limited to 1/240 of clear span.
      3) Glass Edge Deflection: Limit edge deflection of individual glass lites to 3/4 inch (19 mm).
   b. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller **OR** amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch (3.2 mm), **as directed**.

5. Lateral Bracing of Framing Members: Compression flanges of flexural members are laterally braced by cross members with minimum depth equal to 50 percent of flexural member that is braced. Glazing does not provide lateral support.
6. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
7. Structural-Sealant Glazing:
   a. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by metal-framed skylight assemblies without failing adhesively or cohesively. Sealant fails cohesively before sealant releases from substrate when tested for adhesive compatibility with each substrate and joint condition required.
      1) Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
      2) Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.
   b. Structural-Sealant Joints: Designed to produce tensile or shear stress in structural-sealant joints of less than 20 psi (138 kPa).
      1) Structural-sealant joints do not carry gravity loads of glazing.

D. Performance Testing
1. Provide metal-framed skylights that comply with test-performance requirements indicated, as evidenced by reports of tests performed on manufacturer's standard assemblies by a qualified independent testing agency.
2. Structural-Performance Test: ASTM E 330.
   a. Performance at Design Load: When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
   b. Performance at Maximum Test Load: When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main supporting members exceeding 0.2 percent of span.
   c. Test Durations: As required by design wind velocity but not less than 10 seconds.
3. Air-Infiltration Test: ASTM E 283.
   a. Minimum Static-Air-Pressure Difference: 1.57 lbf/sq. ft. (75 Pa) which is equivalent to a 25-mph (40-km/h) wind **OR** 6.24 lbf/sq. ft. (300 Pa) which is equivalent to a 50-mph (80-km/h) wind, **as directed**.
   b. Maximum Air Leakage: 0.06 cfm/sq. ft. (0.30 L/s per sq. m).
4. Test for Water Penetration under Static Pressure: ASTM E 331.
   a. Minimum Static-Air-Pressure Difference: 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).
   b. Water Leakage: None.
5. Test for Water Penetration under Dynamic Pressure: AAMA 501.1.
   a. Dynamic Pressure: 20 percent of positive wind-load design pressure, but not less than 12 lbf/sq. ft. (574 Pa).
   b. Water Leakage: None, as defined by AAMA 501.1 **OR** No uncontrolled water penetrating systems or appearing on systems' normally exposed interior surfaces from sources other than condensation, **as directed**. Water controlled by flashing and gutters that is drained to exterior and cannot damage adjacent materials or finishes is not considered water leakage.

E. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:

a. Product Data for Credit EQ 4.1: For sealants used inside of the weatherproofing system, including printed statement of VOC content.

3. Shop Drawings: For metal-framed skylights. Include plans, elevations, sections, details, and attachments to other work.
    a. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
4. Samples: For each exposed finish.
5. Compatibility Test Reports: For structural-sealant-glazed skylights, preconstruction test reports from structural- and nonstructural-sealant manufacturer indicating that materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants. Include sealant manufacturer's interpretation of test results for sealant performance and written recommendations for primers and substrate preparation needed for adhesion.
6. Field quality-control test and inspection reports.
7. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for metal-framed skylights.
8. Structural-Sealant-Glazing, Quality-Control Program: Developed specifically for Project.
9. Structural-Sealant-Glazing, Quality-Control Program Reports: Documenting quality-control procedures and verifying results for metal-framed skylights.
10. Maintenance Data: For metal-framed skylights to include in maintenance manuals.
11. Warranties: Special warranties specified in this Section.

F. Quality Assurance

1. Installer Qualifications: Entity capable of assuming engineering responsibility and performing work of this Section and who is acceptable to manufacturer.
2. Compatibility Testing: For structural-sealant-glazed skylights, perform structural- and nonstructural-sealant manufacturer's standard preconstruction tests for compatibility and adhesion of sealants with each material that will come in contact with sealants and each condition required by metal-framed skylights.
3. Welding: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code - Aluminum."
4. Structural-Sealant Glazing: Comply with recommendations in ASTM C 1401, "Guide for Structural Sealant Glazing," for joint design and quality-control procedures.
    a. Joint designs are reviewed and approved by structural-sealant manufacturer.
5. Preinstallation Conference: Conduct conference at Project site.

G. Warranty

1. Special Assembly Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal-framed skylights that fail in materials or workmanship within specified warranty period.
    a. Failures include, but are not limited to, the following:
        1) Structural failures including, but not limited to, excessive deflection.
        2) Noise or vibration caused by thermal movements.
        3) Deterioration of metals, metal finishes, and other materials beyond normal weathering.
        4) Adhesive or cohesive sealant failures.
        5) Water leakage.
    b. Warranty Period: Two **OR** Five **OR** 10, **as directed**, years from date of Final Completion.
2. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering.
    a. Failures include, but are not limited to, checking, crazing, peeling, chalking, and fading of finishes.
    b. Warranty Period: Five **OR** 10 **OR** 20, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Framing Systems
1. Aluminum: Alloy and temper recommended in writing by manufacturer for type of use and finish indicated.
   a. Sheet and Plate: ASTM B 209 (ASTM B 209M).
   b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
   c. Extruded Structural Pipe and Tubes: ASTM B 429.
2. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.
   a. Include snap-on aluminum trim that conceals fasteners.
3. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning skylight components.
4. Anchors, Fasteners, and Accessories: Manufacturer's standard, corrosion-resistant, nonstaining, and nonbleeding; compatible with adjacent materials.
   a. At pressure caps, use ASTM A 193/A 193M, 300 series stainless-steel screws.
   b. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
   c. Exposed Fasteners:
      1) Use exposed fasteners with countersunk Phillips screw heads.
   d. Finish exposed portions to match framing system.
   e. At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended in writing by manufacturer.
5. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
6. Anchor Bolts: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), hot-dip zinc coating, ASTM A 153/A 153M, Class C **OR** mechanically deposited zinc coating, ASTM B 695, Class 50, **as directed**.
7. Concealed Flashing: Manufacturer's standard, corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials **OR** Dead-soft, 0.018-inch- (0.457-mm-) thick stainless steel, ASTM A 240/A 240M of type recommended in writing by manufacturer, **as directed**.
8. Exposed Flashing and Closures: Manufacturer's standard aluminum components not less than 0.030 inch (0.762 mm) **OR** 0.040 inch (1.016 mm) **OR** 0.060 inch (1.524 mm), **as directed**, thick.
9. Framing Gaskets: Manufacturer's standard.
10. Framing Sealants: As recommended in writing by manufacturer **OR** specified in Division 07 Section "Joint Sealants", **as directed**.
   a. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Glazing Systems
1. Glazing: As specified in Division 08 Section(s) "Glazing" OR "Plastic Glazing", **as directed**.
2. Spacers, Setting Blocks, and Gaskets: Manufacturer's standard elastomeric types **OR** As specified in Division 08 Section "Glazing", **as directed**.
3. Bond-Breaker Tape: Manufacturer's standard tetrafluoroethylene-fluorocarbon or polyethylene material to which sealants will not develop adhesion.
4. Glazing Sealants: As recommended in writing by manufacturer **OR** specified in Division 07 Section "Joint Sealants", **as directed**.
   a. Provide sealants for use inside of the weatherproofing system that have a VOC content as indicated when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. Structural Sealant: ASTM C 1184, neutral-curing silicone formulation compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant, and approved by structural-sealant manufacturer for use in metal-framed skylights indicated.
      1) VOC Content: 100 g/L or less.
      2) Color: Black **OR** As selected from manufacturer's full range, **as directed**.

c. Weatherseal Sealant: ASTM C 920 for Type S, Grade NS, Class 25, Uses NT, G, A, and O; neutral-curing silicone formulation compatible with structural sealant and other components with which it comes in contact; and recommended in writing by structural- and weatherseal-sealant and metal-framed skylight manufacturers for this use.
   1) VOC Content: 250 g/L or less.
   2) Color: Matching structural sealant.

C. Accessory Materials
1. Insulating Materials: Specified in Division 07 Section "Thermal Insulation".
2. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

D. Fabrication
1. Fabricate aluminum components before finishing.
2. Fabricate aluminum components that, when assembled, have the following characteristics:
   a. Profiles that are sharp, straight, and free of defects or deformations.
   b. Accurately fitted joints with ends coped or mitered.
   c. Internal guttering systems or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within skylight to exterior.
   d. Physical and thermal isolation of glazing from framing members.
   e. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
3. Fabricate aluminum sill closures with weep holes and for installation as continuous component.
4. Reinforce aluminum components as required to receive fastener threads.
5. Weld aluminum components in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
6. Factory-Glazed Units:
   a. Factory install glazing to comply with requirements in Division 08 Section(s) "Glazing" OR "Plastic Glazing", **as directed**.
   b. Prepare surfaces that will contact structural sealant according to structural-sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
7. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

E. Aluminum Finishes
1. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
3. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.
4. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
5. Class I, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** Match sample **OR** As selected from full range of industry colors and color densities, **as directed**.
6. High-Performance Organic Finish (2-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive

primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2604 **OR** AAMA 2605, **as directed**, and with coating and resin manufacturers' written instructions.

7. High-Performance Organic Finish (3-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: manufacturer's standard 3-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions.
   a. Color and Gloss: As selected from manufacturer's full range.

F. Source Quality Control
1. Structural-Sealant Glazing: Perform quality-control procedures complying with ASTM C 1401 recommendations including, but not limited to, material qualification procedures, sealant testing, and fabrication reviews and checks.

1.3 EXECUTION

A. Installation
1. General:
   a. Comply with manufacturer's written instructions.
   b. Do not install damaged components.
   c. Fit joints between aluminum components to produce hairline joints free of burrs and distortion.
   d. Rigidly secure nonmovement joints.
   e. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
   f. Weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
   g. Seal joints watertight, unless otherwise indicated.
2. Metal Protection: Where aluminum will contact dissimilar materials, protect against galvanic action by painting contact surfaces with bituminous paint or by installing nonconductive spacers as recommended in writing by manufacturer for this purpose.
3. Install continuous aluminum sill closure with weatherproof expansion joints and locked and sealed or welded corners. Locate weep holes at rafters.
4. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within skylight to exterior.
5. Install components plumb and true in alignment with established lines and elevations.
6. Install glazing as specified in Division 08 Section(s) "Glazing" OR "Plastic Glazing", **as directed**.
   a. Structural-Sealant Glazing:
      1) Prepare surfaces that will contact structural sealant according to structural-sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
      2) Install weatherseal sealant according to Division 07 Section "Joint Sealants" and according to weatherseal-sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind weatherseal sealant as recommended in writing by weatherseal-sealant manufacturer.
7. Install insulation materials as specified in Division 07 Section "Thermal Insulation".
8. Erection Tolerances: Install metal-framed skylights to comply with the following maximum tolerances:

a. Alignment: Limit offset from true alignment to 1/32 inch (0.8 mm) where surfaces abut in line, edge to edge, at corners, or where a reveal or protruding element separates aligned surfaces by less than 3 inches (76 mm); otherwise, limit offset to 1/8 inch (3.2 mm).

b. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet (3.2 mm in 3.7 m) but no greater than 1/2 inch (13 mm) over total length.

B. Field Quality Control

a. Structural-Sealant Compatibility and Adhesion: Structural sealant shall be tested according to recommendations in ASTM C 1401.

1) Destructive test method, Method A, Hand Pull Tab (Destructive) in ASTM C 1401, Appendix X2, shall be used.

a) A minimum of one **OR** two, **as directed**, area(s) on each skylight face shall be tested.

b) Repair installation areas damaged by testing.

b. Structural-Sealant Glazing Inspection: After installation of metal-framed skylights is complete, structural-sealant glazing shall be inspected and evaluated according to ASTM C 1401 recommendations for quality-control procedures.

c. Water Penetration under Static Pressure: Before installation of interior finishes has begun, areas shall be tested according to ASTM E 1105.

1) Test Procedures: Test under uniform and cyclic static air pressure.

2) Water Penetration: None.

d. Water-Spray Test: Before installation of interior finishes has begun, skylights shall be tested according to AAMA 501.2 and shall not evidence water penetration.

2. Repair or remove work where test results and inspections indicate that it does not comply with specified requirements.

3. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION 08 45 23 00a

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SECTION 08 45 23 00b - STRUCTURED-POLYCARBONATE-PANEL ASSEMBLIES

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of material for structured-polycarbonate-panel assemblies. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes aluminum-framed assemblies glazed with multiwalled (structured) polycarbonate panels as follows:
   a. Wall assemblies.
   b. Roof (sloped, overhead) assemblies.
   c. Skylight assemblies.

C. Performance Requirements

1. Provide assemblies, including anchorage, capable of withstanding, without failure, the effects of the following:
   a. Structural loads.
   b. Thermal movements.
   c. Movements of supporting structure.
   d. Dimensional tolerances of building frame and other adjacent construction.
2. Failure includes the following:
   a. Deflection exceeding specified limits.
   b. Water leakage.
   c. Thermal stresses transferred to building structure.
   d. Noise or vibration created by wind and thermal and structural movements.
   e. Loosening or weakening of fasteners, attachments, and other components.

D. Structural Loads:

   a. Wind Loads: As indicated by structural design data on Drawings **OR as directed**.
   b. Snow Loads: As indicated by structural design data on Drawings **OR as directed**.
   c. Concentrated Live Loads on Overhead Assemblies: 300 lbf (1334 N) applied to assemblies at locations that will produce greatest stress or deflection.
   d. Seismic Loads: As indicated by earthquake design data on Drawings **OR as directed**.
   e. Load Combinations: Calculate according to requirements of applicable code indicated on Drawings **OR as directed**.
2. Deflection of Assemblies:
   a. Vertical Assemblies: Limited to 1/100 of clear span for each assembly component.
   b. Overhead Assemblies: Limited to 1/100 **OR** 1/180, **as directed**, of clear span for each assembly component.
3. Roof Assemblies: Class A **OR** B **OR** C, **as directed**, per ASTM E 108 or UL 790.
4. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

E. Performance Testing

1. Provide assemblies that comply with test-performance requirements indicated, as evidenced by reports of tests performed on manufacturer's standard assemblies by a qualified independent testing agency.

2. Structural-Performance Test: ASTM E 330.
   a. Performance at Design Load: When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
   b. Performance at Maximum Test Load: When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main supporting members exceeding 0.2 percent of span.
   c. Test Durations: As required by design wind velocity but not less than 10 seconds.
3. Air-Infiltration Test: ASTM E 283.
   a. Minimum Static-Air-Pressure Difference: 1.57 lbf/sq. ft. (75 Pa) **OR** 6.24 lbf/sq. ft. (300 Pa), **as directed**.
   b. Maximum Air Leakage: 0.06 cfm/sq. ft. (0.30 L/s per sq. m).
4. Test for Water Penetration under Static Pressure: ASTM E 331.
   a. Minimum Static-Air-Pressure Difference: 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft. (718 Pa).
   b. Water Leakage: None.
5. Test for Water Penetration under Dynamic Pressure: AAMA 501.1.
   a. Dynamic Pressure: 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft. (718 Pa).
   b. Water Leakage: None, as defined by AAMA 501.1 **OR** No uncontrolled water penetrating systems or appearing on systems' normally exposed interior surfaces from sources other than condensation, **as directed**. Water controlled by flashing and gutters that is drained to exterior and cannot damage adjacent materials or finishes is not considered water leakage.

F. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
   a. Product Data for Credit EQ 4.1: For sealants used inside of the weatherproofing system, documentation including printed statement of VOC content.
3. Shop Drawings: For assemblies. Include plans, elevations, sections, details, and attachments to other work.
   a. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
4. Samples: For each exposed finish.
5. Field quality-control test reports.
6. Product test reports.
7. Maintenance data.
8. Special warranties specified in this Section.

G. Quality Assurance
1. Installer Qualifications: Entity capable of assuming engineering responsibility and performing work of this Section and who is acceptable to manufacturer.
2. Fire-Test-Response Characteristics: Where fire-test-response characteristics are indicated for assemblies and components, provide products identical to those tested per test method indicated by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
3. Welding: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code - Aluminum."
4. Preinstallation Conference: Conduct conference at Project site.

H. Warranty
1. Special Assembly Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of assemblies that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Structural failures including, but not limited to, excessive deflection.

2) Deterioration of metals, metal finishes, and other materials beyond normal weathering.
3) Water leakage.

b. Warranty Period: Two **OR** Five, **as directed**, years from date of Final Completion.

2. Special Structured-Polycarbonate-Panel Warranty: Manufacturer's standard form agreeing to replace polycarbonate sheet that breaks or develops defects from normal use that are attributed to manufacturing process and not to practices for maintaining and cleaning products contrary to manufacturer's written instructions.
   a. Defects include, but are not limited to, the following:
      1) Delamination.
      2) Color changes from original in excess of 3.0 units Delta E when measured per ASTM D 2244.
      3) Losses in light transmission beyond 6 percent from original when measured per ASTM D 1003.
   b. Warranty Period: 10 years from date of Final Completion.
3. Special Aluminum-Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering.
   a. Failures include, but are not limited to, checking, crazing, peeling, chalking, and fading of finishes.
   b. Warranty Period: Five **OR** 10 **OR** 20, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Aluminum Framing Systems

1. Aluminum: Alloy and temper recommended in writing by manufacturer for type of use and finish indicated.
   a. Sheet and Plate: ASTM B 209 (ASTM B 209M).
   b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
   c. Extruded Structural Pipe and Tubes: ASTM B 429.
2. Components: Manufacturer's standard extruded-aluminum members of thickness required and reinforced as required to support imposed loads.
   a. Construction: One-piece extruded-aluminum components **OR** Thermally broken; framing members are composite assemblies of two separate extruded-aluminum components permanently bonded by a material of low thermal conductance, **as directed**.
3. Exposed Flashing and Closures: Manufacturer's standard aluminum components not less than 0.040 inch (1.016 mm) **OR** 0.060 inch (1.524 mm), **as directed**, thick.
4. Framing Gaskets: Manufacturer's standard.
5. Framing Sealants: As recommended in writing by manufacturer **OR** specified in Division 07 Section "Joint Sealants", **as directed**.
   a. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Anchors, Fasteners, and Accessories: Manufacturer's standard, corrosion-resistant, nonstaining, and nonbleeding; compatible with adjacent materials.
   a. At closures, retaining caps, or battens, use ASTM A 193/A 193M, 300 series stainless-steel screws.
   b. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
   c. At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended in writing by manufacturer.
7. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
8. Anchor Bolts: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), hot-dip zinc coating, ASTM A 153/A 153M, Class C **OR** mechanically deposited zinc coating, ASTM B 695, Class 50, **as directed**.

9. Framing System Fabrication:
   a. Fabricate components before finishing.
   b. Fabricate components that, when assembled, have the following characteristics:
      1) Profiles that are sharp, straight, and free of defects or deformations.
      2) Accurately fitted joints with ends coped or mitered.
      3) Internal guttering systems or other means to drain water passing joints, condensation occurring within components, and moisture migrating within assembly to exterior.
   c. Fabricate sill closures with weep holes and for installation as continuous component.
   d. Reinforce components as required to receive fastener threads.
   e. Weld components in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

B. Structured Polycarbonate Panels
1. General: Translucent, extruded-polycarbonate sheet with cellular cross section that provides isolated airspaces and that is coextruded with a UV-protective layer.
   a. Plastic Self-Ignition Temperature: 650 deg F (343 deg C) or more per ASTM D 1929.
   b. Burning Extent: 1 inch (25 mm) or less per ASTM D 635.
   c. Burning Rate: 2.5 in/.min. (1.06 mm/s) or less per ASTM D 635.
   d. Smoke-Developed Index: 450 or less per ASTM E 84, or 75 or less per ASTM D 2843.
   e. Flame-Spread Index: Not more than 25 per ASTM E 84.
   f. Exterior-Fire-Exposure Class: Class A **OR** B **OR** C, **as directed**, per ASTM E 108 or UL 790.
2. Panel U-Factor: Not more than 0.73 (4.15) **OR** 0.63 (3.58) **OR** 0.48 (2.73) **OR** 0.38 (2.16) **OR** 0.24 (1.36) **OR** 0.22 (1.25), **as directed**, measured in Btu/sq. ft. x h x deg F (W/sq. m x K) according to ASTM C 1363 and using procedures described in ASTM C 1199 and ASTM E 1423.
3. Color Stability: Not more than 3.0 units Delta E when measured according to ASTM D 2244 after outdoor weathering according to procedures in ASTM D 1435.
   a. Outdoor Weathering Conditions: 60 months in Arizona or 120 months in a moderate North American climate.
4. Impact Resistance: No failure at impact of 200 ft. x lbf (271 J) according to free-falling-ball impact test using a 3-1/2-inch- (89-mm-) diameter, 6.3-lb (2.9-kg) ball.

C. Accessory Materials
1. Insulating Materials: Specified in Division 07 Section "Thermal Insulation".
2. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

D. Aluminum Finishes
1. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
3. Aluminum Anodic Finish: Class I, clear anodic coating complying with AAMA 611 **OR** Class I, color anodic coating complying with AAMA 611, **as directed**.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** Match sample **OR** As selected from full range of industry colors and densities, **as directed**.
4. Aluminum High-Performance Organic Finish: Two-coat **OR** Three-coat, **as directed**, thermocured system with fluoropolymer topcoats containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2604 **OR** AAMA 2605, **as directed**.
   a. Color and Gloss: As selected from manufacturer's full range.

1.3 EXECUTION

A. Installation
1. General:
a. Comply with manufacturer's written instructions.
b. Do not install damaged components.
c. Fit joints between aluminum components to produce hairline joints free of burrs and distortion.
d. Rigidly secure nonmovement joints.
e. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
f. Weld aluminum components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
g. Seal joints watertight, unless otherwise indicated.
2. Metal Protection: Where aluminum components will contact dissimilar materials, protect against galvanic action by painting contact surfaces with bituminous paint or by installing nonconductive spacers as recommended in writing by manufacturer for this purpose.
3. Install continuous aluminum sill closures with weatherproof expansion joints and locked and sealed or welded corners. Locate weep holes at rafters.
4. Install components to drain water passing joints, condensation occurring within aluminum members, and moisture migrating within assembly to exterior.
5. Install components plumb and true in alignment with established lines and elevations.
6. Install insulation materials as specified in Division 07 Section "Thermal Insulation".
7. Erection Tolerances: Install assemblies to comply with the following maximum tolerances:
a. Alignment: Limit offset from true alignment to 1/32 inch (0.8 mm) where surfaces abut in line, edge to edge, at corners, or where a reveal or protruding element separates aligned surfaces by less than 3 inches (76 mm); otherwise, limit offset to 1/8 inch (3.2 mm).
b. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet (3.2 mm in 3.7 m); 1/2 inch (13 mm) over total length.

B. Field Quality Control
1. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
2. Testing Services: Testing and inspecting of representative areas to determine compliance of installed assemblies with specified requirements shall take place as follows and in successive stages as indicated on Drawings. Do not proceed with installation of the next area until test results for previously completed areas show compliance with requirements.
a. Water Penetration under Static Pressure: Before installation of interior finishes has begun, areas shall be tested according to ASTM E 1105.
1) Test Procedures: Test under uniform and cyclic static air pressure.
2) Static-Air-Pressure Difference: as directed by the Owner.
3) Water Penetration: None.
b. Water-Spray Test: Before installation of interior finishes has begun, assemblies shall be tested according to AAMA 501.2 and shall not evidence water penetration.
3. Repair or remove work where test results and inspections indicate that it does not comply with specified requirements.
4. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

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SECTION 08 45 23 00c - FIBERGLASS-SANDWICH-PANEL ASSEMBLIES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for fiberglass-sandwich-panel assemblies. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes assemblies incorporating fiberglass sandwich panels and aluminum frame systems as follows:
   a. Wall assemblies.
   b. Roof (sloped, overhead) assemblies.
   c. Skylight assemblies.

C. Performance Requirements
1. Provide assemblies, including anchorage, capable of withstanding, without failure, the effects of the following:
   a. Structural loads.
   b. Thermal movements.
   c. Movements of supporting structure.
   d. Dimensional tolerances of building frame and other adjacent construction.
2. Failure includes the following:
   a. Deflection exceeding specified limits.
   b. Water leakage.
   c. Thermal stresses transferred to building structure.
   d. Noise or vibration created by wind and thermal and structural movements.
   e. Loosening or weakening of fasteners, attachments, and other components.
   f. Delamination of fiberglass-sandwich-panel faces from panel cores.
3. Structural Loads:
   a. Wind Loads: As indicated by structural design data on Drawings **OR as directed**.
   b. Snow Loads: As indicated by structural design data on Drawings **OR as directed**.
   c. Concentrated Live Loads on Overhead Assemblies: 300 lbf (1334 N) applied to assemblies at locations that will produce greatest stress or deflection.
   d. Seismic Loads: As indicated by earthquake design data on Drawings **OR as directed**.
   e. Load Combinations: Calculate according to requirements of applicable code indicated on Drawings **OR as directed**.
4. Deflection of Assemblies:
   a. Vertical Assemblies: Limited to 1/60 **OR** 1/90 **OR** 1/180, **as directed**, of clear span for each assembly component.
   b. Overhead Assemblies: Limited to 1/60 **OR** 1/90 **OR** 1/180, **as directed**, of clear span for each assembly component.
5. Roof Assemblies: Class A per ASTM E 108 or UL 790.
6. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

D. Performance Testing

1. Provide assemblies that comply with test-performance requirements indicated, as evidenced by reports of tests performed on manufacturer's standard assemblies by a qualified independent testing agency.
2. Structural-Performance Test: ASTM E 330.
   a. Performance at Design Load: When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
   b. Performance at Maximum Test Load: When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main supporting members exceeding 0.2 percent of span.
   c. Test Durations: As required by design wind velocity but not less than 10 seconds.
3. Air-Infiltration Test: ASTM E 283.
   a. Minimum Static-Air-Pressure Difference: 1.57 lbf/sq. ft. (75 Pa) **OR** 6.24 lbf/sq. ft. (300 Pa), **as directed**.
   b. Maximum Air Leakage: 0.06 cfm/sq. ft. (0.30 L/s per sq. m), **as directed**.
4. Test for Water Penetration under Static Pressure: ASTM E 331.
   a. Minimum Static-Air-Pressure Difference: 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft. (479 Pa).
   b. Water Leakage: None.
5. Test for Water Penetration under Dynamic Pressure: AAMA 501.1.
   a. Dynamic Pressure: 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft. (718 Pa).
   b. Water Leakage: None, as defined by AAMA 501.1 **OR** No uncontrolled water penetrating systems or appearing on systems' normally exposed interior surfaces from sources other than condensation, **as directed**. Water controlled by flashing and gutters that is drained to exterior and cannot damage adjacent materials or finishes is not considered water leakage.
6. Water-Penetration, Wind-Driven-Rain Test: Wind-driven-rain test in ICBO ES AC07, "Special Roofing Systems."
   a. Water Leakage: None.

E. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
   a. Product Data for Credit EQ 4.1: For sealants used inside of the weatherproofing system, documentation including printed statement of VOC content.
3. Shop Drawings: For assemblies. Include plans, elevations, sections, details, and attachments to other work.
   a. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
4. Field quality-control test reports.
5. Product test reports.
6. Maintenance data.
7. Special warranties specified in this Section.

F. Quality Assurance
1. Installer Qualifications: Entity capable of assuming engineering responsibility, including preparation of Shop Drawings, and performing work of this Section and who is acceptable to manufacturer.
2. Manufacturer Qualifications: For fiberglass sandwich panels, a qualified manufacturer whose facilities, processes, and products are monitored by an independent, accredited quality-control agency for compliance with applicable requirements in ICBO ES AC04, "Sandwich Panels."
3. Fire-Test-Response Characteristics: Where fire-test-response characteristics are indicated for assemblies and components, provide products identical to those tested per test method indicated by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

4. Welding: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code - Aluminum."
5. NFRC Certification: Provide fiberglass sandwich panels that are certified for U-factors indicated according to NFRC 100 and listed in its "National Fenestration Council Incorporated - Certified Products Directory."
6. Preinstallation Conference: Conduct conference at Project site.

G. Warranty
1. Special Assembly Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of assemblies that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Structural failures including, but not limited to, excessive deflection.
      2) Deterioration of metals, metal finishes, and other materials beyond normal weathering.
      3) Water leakage.
   b. Warranty Period: Two **OR** Five, **as directed**, years from date of Final Completion.
2. Special Fiberglass-Sandwich-Panel Warranty: Manufacturer's standard form in which manufacturer agrees to replace panels that exhibit defects in materials or workmanship.
   a. Defects include, but are not limited to, the following:
      1) Fiberbloom.
      2) Delamination of coating, if any, from exterior face sheet.
      3) Discoloration of exterior face sheet of more than 8.0 units Delta E when measured according ASTM D 2244.
      4) Delamination of panel face sheets from panel cores.
   b. Warranty Period: 10 years from date of Final Completion.
3. Special Aluminum-Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering.
   a. Failures include, but are not limited to, checking, crazing, peeling, chalking, and fading of finishes.
   b. Warranty Period: Five **OR** 10 **OR** 20, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Aluminum Frame Systems
1. Aluminum: Alloy and temper recommended in writing by manufacturer for type of use and finish indicated.
   a. Sheet and Plate: ASTM B 209 (ASTM B 209M).
   b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
   c. Extruded Structural Pipe and Tubes: ASTM B 429.
2. Components: Manufacturer's standard extruded-aluminum members of thickness required and reinforced as required to support imposed loads.
   a. Construction: One-piece extruded-aluminum components **OR** Thermally broken; framing members are composite assemblies of two separate extruded-aluminum components permanently bonded by a material of low thermal conductance, **as directed**.
3. Exposed Flashing and Closures: Manufacturer's standard aluminum components not less than 0.040 inch (1.016 mm) **OR** 0.060 inch (1.524 mm), **as directed**, thick.
4. Frame-System Gaskets: Manufacturer's standard.
5. Frame-System Sealants: As recommended in writing by manufacturer **OR** specified in Division 07 Section "Joint Sealants", **as directed**.
   a. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Anchors, Fasteners, and Accessories: Manufacturer's standard, corrosion-resistant, nonstaining, and nonbleeding; compatible with adjacent materials.

a. At closures, retaining caps, or battens, use ASTM A 193/A 193M, 300 series stainless-steel screws.
b. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
c. At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended in writing by manufacturer.

7. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
8. Anchor Bolts: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), hot-dip zinc coating, ASTM A 153/A 153M, Class C **OR** mechanically deposited zinc coating, ASTM B 695, Class 50, **as directed**.
9. Frame System Fabrication:
   a. Fabricate components before finishing.
   b. Fabricate components that, when assembled, have the following characteristics:
      1) Profiles that are sharp, straight, and free of defects or deformations.
      2) Accurately fitted joints with ends coped or mitered.
      3) Internal guttering systems or other means to drain water passing joints, condensation occurring within components, and moisture migrating within the assembly to exterior.
   c. Fabricate sill closures with weep holes and for installation as continuous component.
   d. Reinforce components as required to receive fastener threads.
   e. Weld components in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

B. Fiberglass Sandwich Panels

1. Panel Construction: Assembly of uniformly colored, translucent, thermoset, fiberglass-reinforced-polymer face sheets bonded to both sides of a grid core and complying with requirements applicable to panel materials in ICBO ES AC04, "Sandwich Panels."
   a. Face-Sheet, Self-Ignition Temperature: 650 deg F (343 deg C) or more per ASTM D 1929.
   b. Face-Sheet Burning Extent: 1 inch (25 mm) or less per ASTM D 635.
   c. Face-Sheet, Smoke-Developed Index: 450 or less per ASTM E 84.
   d. Interior Face-Sheet, Flame-Spread Index: Not more than 25 **OR** 75, **as directed**, per ASTM E 84.
   e. Roof-Covering Class: Class A **OR** Class A, burning brand test (only), **as directed**, per ASTM E 108 or UL 790.
2. Panel Thickness: 2-3/4 inches (70 mm) **OR** 1-1/2 to 1-9/16 inches (38 to 40 mm), **as directed**.
3. Panel U-Factor: Not more than 0.70 (3.97) **OR** 0.53 (3.01) **OR** 0.44 (2.50) **OR** 0.40 (2.27) **OR** 0.29 (1.65) **OR** 0.28 (1.59) **OR** 0.26 (1.48) **OR** 0.24 (1.36) **OR** 0.23 (1.31) **OR** 0.22 (1.25) **OR** 0.18 (1.02) **OR** 0.15 (0.85) **OR** 0.14 (0.79) **OR** 0.10 (0.57), **as directed**, measured in Btu/sq. ft. x h x deg F (W/sq. m x K) according to NFRC 100 or ASTM C 1363 using procedures described in ASTM C 1199 and ASTM E 1423.
4. Panel Strength Characteristics:
   a. Maximum Panel Deflection: 3-1/2 inches (89 mm) when a 4-by-12-foot (1.2-by-3.6-m) panel is tested according to ASTM E 72 at 34 lbf/ sq. ft. (1.6 kPa), with a maximum 0.090-inch (2.3-mm) set deflection after 5 minutes.
   b. Panel Support Strength: Capable of supporting, without failure, a 300-lbf (1334 N) concentrated load when applied to a 3-inch- (76-mm-) diameter disk according to ASTM E 661.
5. Grid Core: Mechanically interlocked extruded-aluminum I-beams, with a minimum flange width of 7/16 inch (11.1 mm).
   a. Extruded Aluminum: ASTM B 221 (ASTM B 221M), in alloy and temper recommended in writing by manufacturer.

b. I-Beam Construction: One-piece extruded-aluminum components **OR** Thermally broken; two separate extruded-aluminum components permanently bonded by a material of low thermal conductance, **as directed**.
c. Grid Pattern: Inline rectangle, nominal 12 by 24 inches (305 by 610 mm) **OR** Staggered rectangle, nominal 12 by 24 inches (305 by 610 mm) **OR** Square, nominal 12 inches (305 mm) **OR** As indicated on Drawings, **as directed**.

6. Exterior Face Sheet:
   a. Thickness: 0.070 inches (1.778 mm) **OR** 0.060 inches (1.524 mm) **OR** 0.052 inches (1.321 mm), **as directed**.
   b. Color: White **OR** Crystal **OR** As selected from manufacturer's full range, **as directed**.
   c. Color Stability: Not more than 3.0 **OR** 4.0 **OR** 7.0, **as directed**, units Delta E when measured according to ASTM D 2244 after outdoor weathering in southern Florida according to procedures in ASTM D 1435 with panels mounted facing south and as follows:
      1) Panel Mounting Angle: Not more than 5 **OR** 45, **as directed**, degrees from horizontal.
      2) Exposure Period: 60 months **OR** 30 months **OR** 60 months for vertical assemblies, 30 months for components of Class A roof assemblies, **as directed**.
   d. Erosion Protection: Manufacturer's standard **OR** Integral, embedded glass erosion barrier **OR** Surface-applied, polyvinyl fluoride film not less than 1.0 mils (0.03 mm) thick, **as directed**.
   e. Impact Resistance: No fracture or tear at impact of 60 ft. x lbf (81 J) **OR** 70 ft. x lbf (95 J) **OR** 230 ft. x lbf (312 J), **as directed**, by a 3-1/4-inch- (83-mm-) diameter, 5-lb (2.3-kg) free-falling ball according to test procedure in UL 972.
7. Interior Face Sheet:
   a. Thickness: 0.045 inch (1.143 mm) **OR** 0.060 inch (1.524 mm), **as directed**.
   b. Color: White **OR** Crystal **OR** As selected from manufacturer's full range, **as directed**.
8. Fiberglass-Sandwich-Panel Adhesive: ASTM D 2559.
   a. Compatible with facing and core materials.
   b. Tensile and shear bond strength of aged adhesive ensures permanent adhesion of facings to cores, as evidenced by testing according to ASTM C 297 and ASTM D 1002 after accelerated aging procedures that comply with aging requirements for adhesives with high resistance to moisture in ICBO ES AC05, "Sandwich Panel Adhesives."
9. Panel Fabrication: Factory assemble and seal panels.
   a. Laminate face sheets to grid core under a controlled process using heat and pressure to produce straight adhesive bonding lines that cover width of core members and that have sharp edges.
      1) White spots indicating lack of bond at intersections of grid-core members are limited in number to 4 for every 40 sq. ft. (3.7 sq. m) of panel and limited in diameter to 3/64 inch (1.2 mm).
   b. Fabricate with grid pattern that is symmetrical about centerlines of each panel.
   c. Fabricate panel to allow condensation within panel to escape.
   d. Reinforce panel corners.

C. Accessory Materials
1. Insulating Materials: Specified in Division 07 Section "Thermal Insulation".
2. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

D. Aluminum Finishes
1. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
3. Aluminum Anodic Finish: Class I, clear anodic coating complying with AAMA 611 **OR** Class I, color anodic coating complying with AAMA 611, **as directed**.

a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** Match sample **OR** As selected from full range of industry colors and densities, **as directed**.

4. Aluminum High-Performance Organic Finish: Two-coat **OR** Three-coat, **as directed**, thermocured system with fluoropolymer topcoats containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2604 **OR** AAMA 2605, **as directed**.
   a. Color: Match sample **OR** As selected from manufacturer's full range, **as directed**.

1.3 EXECUTION

A. Installation
1. General:
   a. Comply with manufacturer's written instructions.
   b. Do not install damaged components.
   c. Fit joints between aluminum components to produce hairline joints free of burrs and distortion.
   d. Rigidly secure nonmovement joints.
   e. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
   f. Weld aluminum components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
   g. Seal joints watertight, unless otherwise indicated.
2. Metal Protection: Where aluminum components will contact dissimilar materials, protect against galvanic action by painting contact surfaces with bituminous paint or by installing nonconductive spacers as recommended in writing by manufacturer for this purpose.
3. Install continuous aluminum sill closure with weatherproof expansion joints and locked and sealed or welded corners. Locate weep holes at rafters.
4. Install components to drain water passing joints, condensation occurring within aluminum members and panels, and moisture migrating within assembly to exterior.
5. Install components plumb and true in alignment with established lines and elevations.
6. Install insulation materials as specified in Division 07 Section "Thermal Insulation".
7. Erection Tolerances: Install assemblies to comply with the following maximum tolerances:
   a. Alignment: Limit offset from true alignment to 1/32 inch (0.8 mm) where surfaces abut in line, edge to edge, at corners, or where a reveal or protruding element separates aligned surfaces by less than 3 inches (76 mm); otherwise, limit offset to 1/8 inch (3.2 mm).
   b. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet (3.2 mm in 3.7 m); 1/2 inch (13 mm) over total length.

B. Field Quality Control
1. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
2. Testing Services: Testing and inspecting of representative areas to determine compliance of installed assemblies with specified requirements shall take place as follows and in successive stages as indicated on Drawings. Do not proceed with installation of the next area until test results for previously completed areas show compliance with requirements.
   a. Water Penetration under Static Pressure: Before installation of interior finishes has begun, areas shall be tested according to ASTM E 1105.
      1) Test Procedures: Test under uniform and cyclic static air pressure.
      2) Static-Air-Pressure Difference: as directed by the Owner.
      3) Water Penetration: None.
   b. Water-Spray Test: Before installation of interior finishes has begun, assemblies shall be tested according to AAMA 501.2 and shall not evidence water penetration.
3. Repair or remove work where test results and inspections indicate that it does not comply with specified requirements.

4. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

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SECTION 08 51 13 00 - ALUMINUM WINDOWS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of material for fixed and operable aluminum framed windows for exterior locations. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes fixed and operable aluminum-framed windows.

C. Definitions
   1. Performance class designations according to AAMA/WDMA 101/I.S.2/NAFS:
      a. AW: Architectural.
      b. HC: Heavy Commercial.
      c. C: Commercial.
      d. LC: Light Commercial.
      e. R: Residential.
   2. Performance grade number according to AAMA/WDMA 101/I.S.2/NAFS:
      a. Design pressure number in pounds force per square foot (pascals) used to determine the structural test pressure and water test pressure.
   3. Structural Test Pressure: For uniform load structural test, is equivalent to 150 percent of the design pressure.
   4. Minimum Test Size: Smallest size permitted for performance class (gateway test size). Products must be tested at minimum test size or at a size larger than minimum test size to comply with requirements for performance class.

D. Performance Requirements
   1. General: Provide aluminum windows capable of complying with performance requirements indicated, based on testing manufacturer's windows that are representative of those specified, and that are of minimum test size indicated below:
      a. Size required by AAMA/WDMA 101/I.S.2/NAFS for gateway performance **OR** optional performance grade **OR** gateway performance for both gateway performance and optional performance grade, **as directed**.
      b. Size indicated on Drawings **OR** in a schedule, **as directed**.
   2. Structural Performance: Provide aluminum windows capable of withstanding the effects of the following loads, based on testing units representative of those indicated for Project that pass AAMA/WDMA 101/I.S.2/NAFS, Uniform Load Structural Test:
      a. Design Wind Loads: Determine design wind loads applicable to Project from basic wind speed indicated in miles per hour (meters per second) at 33 feet (10 m) above grade, according to ASCE 7, Section 6.5, "Method 2-Analytical Procedure," based on mean roof heights above grade indicated on Drawings.
         1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s), **as directed**.
         2) Importance Factor.
         3) Exposure Category: A **OR** B **OR** C **OR** D, **as directed**.
      b. Deflection: Design glass framing system to limit lateral deflections of glass edges to less than 1/175 of glass-edge length or 3/4 inch (19 mm), whichever is less, at design pressure based on testing performed according to AAMA/WDMA 101/I.S.2/NAFS, Uniform Load Deflection Test or structural computations.
   3. Windborne-Debris Resistance: Provide glazed windows capable of resisting impact from windborne debris, based on the pass/fail criteria as determined from testing glazed windows

identical to those specified, according to ASTM E 1886 and testing information in ASTM E 1996 or AAMA 506 and requirements of authorities having jurisdiction.

4. Thermal Movements: Provide aluminum windows, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
    a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C) material surfaces.

E. Submittals
1. Product Data: For each type of aluminum window indicated.
2. Shop Drawings: Include plans, elevations, sections, details, hardware, attachments to other work, operational clearances, and installation details
3. Samples: For each exposed finish.
4. Product Schedule: Use same designations indicated on Drawings.
5. Field quality-control test reports.
6. Product test reports.
7. Maintenance data.

F. Quality Assurance
1. Installer: A qualified installer, approved by manufacturer to install manufacturer's products.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
3. Fenestration Standard: Comply with AAMA/WDMA 101/I.S.2/NAFS, "North American Fenestration Standard Voluntary Performance Specification for Windows, Skylights and Glass Doors," for definitions and minimum standards of performance, materials, components, accessories, and fabrication. Comply with more stringent requirements if indicated.
    a. Provide AAMA **OR** WDMA, **as directed**,-certified aluminum windows with an attached label.
4. Glazing Publications: Comply with published recommendations of glass manufacturers and with GANA's "Glazing Manual" unless more stringent requirements are indicated.
5. Preinstallation Conference: Conduct conference at Project site.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period.
    a. Failures include, but are not limited to, the following:
        1) Failure to meet performance requirements.
        2) Structural failures including excessive deflection, water leakage, air infiltration, or condensation.
        3) Faulty operation of movable sash and hardware.
        4) Deterioration of metals, other materials, and metal finishes beyond normal weathering.
        5) Failure of insulating glass.
    b. Warranty Period:
        1) Window: Two **OR** Three, **as directed**, years from date of Final Completion.
        2) Glazing: Five **OR** 10, **as directed**, years from date of Final Completion.
        3) Metal Finish: Five **OR** 10 **OR** 15, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Materials

1. Aluminum Extrusions: Alloy and temper recommended by aluminum window manufacturer for strength, corrosion resistance, and application of required finish, but not less than 22,000-psi (150-MPa) ultimate tensile strength, not less than 16,000-psi (110-MPa) minimum yield strength, and not less than 0.062-inch (1.6-mm) thickness at any location for the main frame and sash members.
2. Fasteners: Aluminum, nonmagnetic stainless steel, epoxy adhesive, or other materials warranted by manufacturer to be noncorrosive and compatible with aluminum window members, trim, hardware, anchors, and other components.
   a. Reinforcement: Where fasteners screw anchor into aluminum less than 0.125 inch (3.2 mm) thick, reinforce interior with aluminum or nonmagnetic stainless steel to receive screw threads, or provide standard, noncorrosive, pressed-in, splined grommet nuts.
   b. Exposed Fasteners: Unless unavoidable for applying hardware, do not use exposed fasteners. For application of hardware, use fasteners that match finish of member or hardware being fastened, as appropriate.
3. Anchors, Clips, and Accessories: Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.
4. Reinforcing Members: Aluminum, nonmagnetic stainless steel, or nickel/chrome-plated steel complying with ASTM B 456 for Type SC 3 severe service conditions, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.
5. Compression-Type Weather Stripping: Provide compressible weather stripping designed for permanently resilient sealing under bumper or wiper action and for complete concealment when aluminum window is closed.
   a. Weather-Stripping Material: Elastomeric cellular preformed gaskets complying with ASTM C 509.
   b. Weather-Stripping Material: Dense elastomeric gaskets complying with ASTM C 864.
   c. Weather-Stripping Material: Manufacturer's standard system and materials complying with AAMA/WDMA 101/I.S.2/NAFS.
6. Sliding-Type Weather Stripping: Provide woven-pile weather stripping of wool, polypropylene, or nylon pile and resin-impregnated backing fabric. Comply with AAMA 701/702.
   a. Weather Seals: Provide weather stripping with integral barrier fin or fins of semirigid, polypropylene sheet or polypropylene-coated material. Comply with AAMA 701/702.
7. Replaceable Weather Seals: Comply with AAMA 701/702.
8. Sealant: For sealants required within fabricated windows, provide window manufacturer's standard, permanently elastic, nonshrinking, and nonmigrating type recommended by sealant manufacturer for joint size and movement.

B. Window

1. Window Type: Casement **OR** Double hung **OR** Dual action **OR** Fixed **OR** Horizontal sliding **OR** Projected **OR** Projected awning **OR** Single hung **OR** Top-hinged inswinging **OR** Vertically pivoted **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
2. AAMA/WDMA Performance Requirements: Provide aluminum windows of performance indicated that comply with AAMA/WDMA 101/I.S.2/NAFS unless more stringent performance requirements are indicated.
   a. Performance Class and Grade: R15 **OR** R20 **OR** R25**, as directed**.
   b. Performance Class and Grade: LC25 **OR** LC30 **OR** LC35, **as directed**.
   c. Performance Class and Grade: C30 **OR** C35 **OR** C40, **as directed**.
   d. Performance Class and Grade: HC40 **OR** HC45 **OR** HC50, **as directed**.
   e. Performance Class and Grade: AW40 **OR** AW45 **OR** AW50, **as directed**.
   f. Performance Class and Grade: As indicated.

g. Performance Class (if test performance method is selected for specifying windows and designating a performance class does not conflict with basic wind speed and performance testing indicated): R **OR** LC **OR** C **OR** HC **OR** AW, **as directed**.
3. Condensation-Resistance Factor (CRF): Provide aluminum windows tested for thermal performance according to AAMA 1503, showing a CRF of 45 **OR** 52, **as directed**.
4. Thermal Transmittance: Provide aluminum windows with a whole-window, U-factor maximum indicated at 15-mph (24-km/h) exterior wind velocity and winter condition temperatures when tested according to AAMA 1503 **OR** ASTM E 1423 **OR** NFRC 100, **as directed**.
   a. U-Factor: 0.35 Btu/sq. ft. x h x deg F (2.0 W/sq. m x K) **OR** 0.40 Btu/sq. ft. x h x deg F (2.3 W/sq. m x K) **OR** 0.43 Btu/sq. ft. x h x deg F (2.5 W/sq. m x K) **OR** 0.60 Btu/sq. ft. x h x deg F (3.4 W/sq. m x K), **as directed**, or less.
5. Solar Heat-Gain Coefficient (SHGC): Provide aluminum windows with a whole-window SHGC maximum of 0.40 **OR** 0.50 **OR** 0.55, **as directed**, determined according to NFRC 200 procedures.
6. Sound Transmission Class (STC): Provide glazed windows rated for not less than 26 **OR** 30 **OR** 35, **as directed**, STC when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 413.
7. If test performance method is selected for specifying windows
   a. Air Infiltration: Maximum rate not more than indicated when tested according to AAMA/WDMA 101/I.S.2/NAFS, Air Infiltration Test.
      1) Maximum Rate: 0.3 cfm/sq. ft. (5 cu. m/h x sq. m) of area at an inward test pressure of 1.57 lbf/sq. ft. (75 Pa).
      2) Maximum Rate: 0.3 cfm/sq. ft. (5 cu. m/h x sq. m) of area at an inward test pressure of 6.24 lbf/sq. ft. (300 Pa).
      3) Maximum Rate: 0.1 cfm/sq. ft. (2 cu. m/h x sq. m) of area at an inward test pressure of 6.24 lbf/sq. ft. (300 Pa).
   b. Water Resistance: No water leakage as defined in AAMA/WDMA referenced test methods at a water test pressure equaling that indicated, when tested according to AAMA/WDMA 101/I.S.2/NAFS, Water Resistance Test.
      1) Test Pressure: 15 percent of positive design pressure, but not less than 2.86 lbf/sq. ft. (140 Pa) or more than 15 lbf/sq. ft. (720 Pa).
      2) Test Pressure: 20 percent of positive design pressure, but not more than 15 lbf/sq. ft. (720 Pa).
8. Forced-Entry Resistance: Comply with Performance Grade 10 **OR** 20 **OR** 30 **OR** 40, **as directed**, requirements when tested according to ASTM F 588.
9. Life-Cycle Testing: Test according to AAMA 910 and comply with AAMA/WDMA 101/I.S.2/NAFS.
10. Operating Force and Auxiliary (Durability) Tests: Comply with AAMA/WDMA 101/I.S.2/NAFS for operating window types indicated.

C. Glazing
1. Glass: Clear, insulating-glass units **OR** Clear, insulating-glass units, with low-E coating pyrolytic on second surface or sputtered on second or third surface, **OR** Clear, insulating-glass units, argon gas filled, with low-E coating pyrolytic on second surface or sputtered on second or third surface, **as directed**, complying with Division 08 Section "Glazing".
2. Glazing System: Manufacturer's standard factory-glazing system that produces weathertight seal. **OR** Manufacturer's standard factory-glazing system that produces weathertight seal and complies with requirements for windborne-debris resistance **OR** Manufacturer's standard factory-glazing system as indicated in Division 08 Section "Glazing", **as directed**.
3. Dual-Action Windows: Provide pivoting unit for double glazing, constructed of one sheet of glass in a removable sash for access to interior of unit, installed with airtight gaskets.

D. Hardware
1. General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with aluminum; designed to smoothly operate, tightly close, and securely lock aluminum windows, and

sized to accommodate sash or ventilator weight and dimensions. Do not use aluminum in frictional contact with other metals. Where exposed, provide solid bronze **OR** extruded, cast, or wrought aluminum **OR** die-cast zinc with special coating finish **OR** nonmagnetic stainless steel, **as directed**.

2. Counterbalancing Mechanism: Comply with AAMA 902.
   a. Sash Balance: Concealed, tape-spring type **OR** spiral-tube type **OR** spring-loaded, block-and-tackle type **OR** ultralift spring type capable of lifting 70 percent of sash weight, **as directed**, of size and capacity to hold sash stationary at any open position.
3. Sill Cap/Track: Extruded-aluminum track with natural anodized finish **OR** Rigid PVC or other weather-resistant plastic track with manufacturer's standard integral color, **as directed**, of thickness, dimensions, and profile indicated; designed to comply with performance requirements indicated and to drain to the exterior.
4. Locks and Latches: Designed to allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only.
5. Roller Assemblies: Low-friction design.
6. Push-Bar Operators: Provide telescoping-type, push-bar operator designed to open and close ventilators with fixed screens.
7. Gear-Type Rotary Operators: Comply with AAMA 901 when tested according to ASTM E 405, Method A.
   a. Operation Function: All ventilators move simultaneously and securely close at both jambs without using additional manually controlled locking devices.
8. Four- or Six-Bar Friction Hinges: Comply with AAMA 904.
   a. Locking mechanism and handles for manual operation.
   b. Friction Shoes: Provide friction shoes of nylon or other nonabrasive, nonstaining, noncorrosive, durable material.
9. Limit Devices: Provide limit devices designed to restrict sash or ventilator opening.
   a. Safety Devices: Limit clear opening to 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, for ventilation; with custodial key release.
10. Pole Operators: Tubular-shaped anodized aluminum; with rubber-capped lower end and standard push-pull hook at top to match hardware design; of sufficient length to operate window without reaching more than 60 inches (1500 mm) above floor; 1 pole operator and pole hanger per room that has operable windows more than 72 inches (1800 mm) above floor.
11. Casement Windows: Provide the following operating hardware:
    a. Operator: Gear-type rotary single-arm operator located on jamb at sill **OR** Gear-type rotary dual-arm operator located on jamb at sill, **as directed**.
       1) Rating: Provide rotary operator rated C-R15 **OR** C-C20 **OR** C-HC40, **as directed**, according to AAMA 901.
       2) Handle: Standard crank **OR** Folding crank **OR** Removable crank **OR** Knob **OR** T-handle, **as directed**.
    b. Hinge: Extension hinge or pivot, nonfriction type.
    c. Hinge: Heavy-duty, three **OR** five, **as directed**,-knuckle butt hinge with nylon bushings.
    d. Hinge: Standard **OR** Heavy, **as directed**,-duty, concealed, four- or six-bar friction hinge with adjustable-slide friction shoe; designed to permit ventilator operation for inside cleaning of outside glass face; two per ventilator.
    e. Hinge: Standard **OR** Heavy, **as directed**,-duty, concealed, four- or six-bar friction egress hinge with adjustable-slide friction shoe; designed to achieve 90-degree ventilator opening and to permit ventilator operation for inside cleaning of outside glass face; two per ventilator.
    f. Lock: Lift-type throw, cam-action lock with keeper; one **OR** two, **as directed**, per ventilator.
    g. Lock: Combination lever handle and cam-action lock with keeper; one **OR** two, **as directed**, per ventilator.
    h. Lock: Combination dual lever handles, tie rod, and cam-action lock with keepers.
    i. Lock: Key-operated custodial lock and keeper with removable handle; one **OR** two, **as directed**, per ventilator.

j. Lock: Concealed multipoint lock operated by single lever handle or lift-type throw; three per ventilator.
k. Limit Device: Concealed friction adjustor, adjustable stay bar **OR** support arms with adjustable, limited, hold-open, **as directed**, limit device.

12. Double **OR** Single, **as directed**,-Hung Windows: Provide the following operating hardware:
    a. Sash Balances: Two per sash.
    b. Handles: Applied sash lift bar **OR** pull-downs, **as directed**, on bottom rail of forward-placed operating sash; two per sash.
    c. Handle: Continuous, integral, sash lift bar **OR** pull-down, **as directed**, on bottom rail of forward-placed operating sash.
    d. Sash Lock: Cam-action sweep lock and keeper on meeting rail; one **OR** two, **as directed**, per sash.
    e. Sash Lock: Spring-loaded, snap-type lock on bottom rail of lower sash; two per sash.
    f. Sash Lock: Spring-loaded plunger lock with keeper on meeting rail of lower sash; two per sash.
    g. Sash Lock: Pole-operated, cam-action lock on meeting rail of windows with meeting rail more than 72 inches (1800 mm) above floor; with keeper.
    h. Pole Socket: Provide a pole socket or groove on inside face of top rail of upper **OR** lower, **as directed**, sash on windows with meeting rails more than 72 inches (1800 mm) above floor.
    i. Limit Device: Sash stop **OR** Keyed sash, **as directed**, limit device; for top **OR** bottom **OR** each operable, **as directed**, sash located at jamb; one **OR** two, **as directed**, per sash.
    j. Removable Lift-Out Sash: Design windows and provide with tamperproof, key-operated, **as directed**, hardware to permit removal of sash from inside for cleaning.
    k. Tilt Lock: Design windows and provide with tamperproof, key-operated, **as directed**, tilt latch and pivot bar hardware to permit tilting of sash inward for cleaning both sides of sash from interior.
13. Dual-Action Windows: Provide the following operating hardware:
    a. Operator: Two-position, combination lever handle and cam-type latch.
    b. Operator: Concealed, internal, multipoint locking bar and combination locking handle mechanism.
    c. Hinge: Combination three-knuckle **OR** five-knuckle butt, **as directed**, hinge and stay bar.
    d. Lock: Key-operated, concealed **OR** exposed, **as directed**, custodial lock.
    e. Stabilizing Arm: Aluminum.
14. Horizontal-Sliding Windows: Provide the following operating hardware:
    a. Sash Rollers: Nylon rollers **OR** Steel, lubricated ball-bearing rollers with nylon tires **OR** Stainless-steel, lubricated ball-bearing rollers with nylon tires, **as directed**.
    b. Sash Lock: Cam-action sweep sash lock and keeper at meeting rails.
    c. Sash Lock: Spring-loaded, snap-type lock at jambs; two per sash.
    d. Sash Lock: Spring-loaded plunger lock with keeper on meeting rail; two per sash.
    e. Limit Device: Sash stop limit device; mounted in bottom of pull stile.
    f. Removable Lift-Out Sash: Design windows and provide with tamperproof, key-operated, **as directed**, hardware to permit removal of sash from inside for cleaning.
15. Projected Windows: Provide the following operating hardware:
    a. Operator: Underscreen push-bar **OR** Underscreen pivot-shoe-type, gear-type rotary operator, **as directed**.
    b. Hinge: Five-knuckle butt hinge.
    c. Hinge: Concealed four- or six-bar friction hinge with adjustable-slide friction shoe; two per ventilator.
    d. Lock: Cam-action, sweep lock handle with strike; one **OR** two, **as directed**, per ventilator.
    e. Lock: Combination lever handle and cam-action lock with concealed pawl and keeper.
    f. Lock: Key-operated security lock and keeper.
    g. Lock: Key-operated custodial lock and keeper with removable handle.
    h. Lock: Pole-operated, spring-catch lock and keeper **OR** cam-action, sweep lock handle and strike, **as directed**.

i. Limit Device: Concealed friction adjustor, adjustable stay bar **OR** support arms with adjustable, limited, hold-open, **as directed**, limit device; located on jamb of each ventilator.

16. Projected Awning Windows: Provide the following operating hardware:
    a. Operator: Push-bar **OR** Lever **OR** Gear-type rotary, **as directed**, operator located on jamb at sill.
        1) Handle: Standard crank **OR** Folding crank **OR** Removable crank **OR** Knob **OR** T-handle, **as directed**.
    b. Window-Operating System: Wall-mounted, group or gang-type window operating system with chain-wheel **OR** rotary crank-type **OR** electric, **as directed**, operator.
    c. Hinge: Concealed four- or six-bar friction hinge located on each jamb near top rail; two per ventilator.
    d. Lock: Lift-type throw, cam-action lock with keeper; one **OR** two, **as directed**, per ventilator.
    e. Lock: Combination lever handle and cam-action lock with concealed pawl and keeper; one **OR** two, **as directed**, per ventilator.
    f. Lock: Pole-operated, combination handle and cam-action lock **OR** face-mounted transom latch, **as directed**, and keeper.
    g. Lock: Key-operated custodial lock with removable handle.
    h. Limit Device: Concealed friction adjustor, adjustable stay bar **OR** support arms with adjustable, limited, hold-open, **as directed**, limit device; located on jamb of each ventilator.
17. Top-Hinged Inswinging Windows: Provide the following operating hardware:
    a. Hinge: Exposed, applied butt hinge located at corners; two **OR** three, **as directed**, per ventilator.
    b. Hinge: Exposed, applied continuous hinge.
    c. Hinge: Concealed, applied pivot hinge located at corners; two **OR** three, **as directed**, per ventilator.
    d. Hinge: Continuous, integrally extruded hinge.
    e. Hinge: Four- or six-bar friction hinge with adjustable-slide friction shoe; two per ventilator.
    f. Lock: Internal, key-operated, limited-access locks located not more than 48 inches (1220 mm) o.c. at jambs and sill.
    g. Hold-Open Device: Automatic-locking hold-open arms **OR** stay bars, **as directed**,; designed to permit sash operation for inside cleaning of outside glass face; two per ventilator.
18. Vertically Pivoted Windows: Provide the following operating hardware:
    a. Pivot Assembly: Aluminum-alloy **OR** Manganese-bronze **OR** Stainless-steel, **as directed**, pivot assembly designed for center **OR** off-center, **as directed**, axis pivoting.
    b. Lock: Internal, key-operated, limited-access lock; one **OR** two, **as directed**, per jamb.
    c. Limit device.

E. Group Or Gang-Type Window Operating Systems
1. Provide window operating system of the type and in groups as indicated. Coordinate operating system design with window fabrication and hardware selection to ensure smooth, durable operation of ventilators.
2. Operation Function: All ventilators move simultaneously and securely close at sash frames without using additional manually controlled locking devices.
3. Rack-and-Pinion **OR** Screw, **as directed**,-Type Operating System: Complete with shafts, brackets, levers, rods, oil-encased gear boxes, and standard fittings and accessories for operation indicated.
4. Horizontal-Movement Operating System: Tension type; complete with mounting brackets, oil-encased gear boxes, steel rod or cable operating in conduit between sash operator units, and standard fittings and accessories for operation indicated.
5. Operation: Manual, with chain-wheel operator on each gear box shaft; with chain loops terminated 24 inches (600 mm) above floor.
6. Operation: Manual, with crank-type operator on each gear box shaft, with removable crank. Where necessary, extend crankshaft with universal joints and support brackets to a suitable

crank-mounting location not more than 44 inches (1115 mm) above floor, with an oil-encased miter gear box.

7. Operation: Electric, with factory-assembled electric operator designed for operating windows of type, size, weight, construction, use, and operating frequency indicated.
   a. Electric Operator: Provide operating system complying with NFPA 70; of size and capacity and with features, characteristics, and accessories suitable for Project conditions, recommended in writing by window manufacturer; complete with operating system indicated, electric motor and factory-prewired motor controls with limit switches,remote-remote-control stations, power disconnect switches, enclosures protecting controls and all operating parts, and accessories required for reliable operation. Include wiring from motor controls to motor. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
      1) Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6.
      2) Electric Motor: Comply with NEMA MG 1; with thermal-overload protection; sized to start and operate size and weight of window sash ventilators under any conditions; one per each gear box shaft.
         a) Motor Characteristics: Single phase, sized by electric operator manufacturer, 60 Hz.
      3) Remote Controls: Electric controls with NEMA ICS 6, Type 1 enclosure and momentary-contact, single push-button-operated control **OR** three-position, push-button-operated control with open, close, and stop functions, **as directed**.
      4) Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop sash ventilators at fully opened and fully closed positions.

F. Insect Screens
1. General: Design windows and hardware to accommodate screens in a tight-fitting, removable arrangement, with a minimum of exposed fasteners and latches. Fabricate insect screens to fully integrate with window frame. Locate screens on inside **OR** outside, **as directed**, of window and provide for each operable exterior sash or ventilator.
   a. Aluminum Tubular Frame Screens: Comply with SMA 1004, "Specifications for Aluminum Tubular Frame Screens for Windows," Residential R-20 **OR** Architectural C-24 **OR** Monumental M-32, **as directed**, class.
   b. Comply with SMA 1004, "Specifications for Aluminum Tubular Frame Screens for Windows," for minimum standards of appearance, fabrication, attachment of screen fabric, hardware, and accessories unless more stringent requirements are indicated.
2. Stainless-Steel Insect Screen Frames: Fabricate frames of nonmagnetic stainless-steel members of 0.020-inch (0.5-mm) minimum wall thickness, with mitered or coped joints or corner extrusions, concealed fasteners, adjustable rollers, and removable PVC spline/anchor concealing edge of frame. Finish frames with No. 2B, bright mill finish.
3. Aluminum Insect Screen Frames: Manufacturer's standard aluminum alloy complying with SMA 1004. Fabricate frames with mitered or coped joints or corner extrusions, concealed fasteners, adjustable rollers, **as directed**, and removable PVC spline/anchor concealing edge of frame.
   a. Aluminum Tubular Framing Sections and Cross Braces: Roll formed from aluminum sheet with minimum wall thickness as required for class indicated.
   b. Extruded-Aluminum or Aluminum Tubular Framing Sections and Cross Braces: Not less than 0.040-inch (1.0-mm) **OR** 0.050-inch (1.3-mm), **as directed**, wall thickness.
   c. Finish: Match aluminum window members.
   d. Finish: Anodized aluminum **OR** Baked-on organic coating, **as directed**, in manufacturer's standard color.
   e. Finish: Anodized aluminum **OR** Baked-on organic coating, **as directed**, in color selected from manufacturer's full range.
   f. Finish: Manufacturer's standard.
4. Glass-Fiber Mesh Fabric: 18-by-14 (1.1-by-1.4-mm) or 18-by-16 (1.0-by-1.1-mm) **OR** 20-by-20 (0.85-by-0.85-mm) or 20-by-30 (0.85-by-0.42-mm), **as directed**, mesh of PVC-coated, glass-fiber

threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration; in the following color. Comply with ASTM D 3656.
    a. Mesh Color: Charcoal gray **OR** Silver gray **OR** Aquamarine, **as directed**.
5. Aluminum Wire Fabric: 18-by-16 (1.1-by-1.3-mm) mesh of 0.011-inch- (0.28-mm-) diameter, coated aluminum wire.
    a. Wire-Fabric Finish: Natural bright **OR** Charcoal gray **OR** Black, **as directed**.
6. Copper Wire Fabric: 16-by-16 (1.3-by-1.3-mm) mesh of 0.011-inch- (0.28-mm-) diameter copper wire.
7. Bronze Wire Fabric: 18-by-14 (1.2-by-1.6-mm) mesh of 0.009-inch- (0.23-mm-) **OR** 18-by-14 (1.13-by-1.5-mm) mesh of 0.011-inch- (0.28-mm-), **as directed**, diameter bronze wire with a clear varnish finish.
8. Stainless-Steel Wire Fabric: 18-by-14 (1.2-by-1.6-mm) mesh of 0.009-inch- (0.23-mm-) **OR** 18-by-16 (1.2-by-1.4-mm) mesh of 0.009-inch- (0.23-mm-) **OR** 18-by-16 (1.13-by-1.3-mm) mesh of 0.011-inch- (0.28-mm-), **as directed**, diameter, nonmagnetic stainless-steel wire, Type 304 or 316, complying with FS RR-W-365, Type VI.
9. Solar-Screening Mesh Fabric: 17-by-15 (0.86-by-1.1-mm) **OR** 40-by-40 (0.3-by-0.3-mm), **as directed**, mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration. Comply with ASTM D 3656.
10. Wickets: Provide sliding **OR** hinged, **as directed**, wickets, framed and trimmed for a tight fit and for durability during handling.

G. Accessories
1. Integral Ventilating System/Device: Where indicated, provide weather-stripped, adjustable, horizontal fresh-air vent, with a free airflow slot, full width of window sash by approximately 1 inch (25 mm) **OR** 3 inches (75 mm), **as directed**, when open, complying with AAMA/WDMA 101/I.S.2/NAFS. Equip vent bar with an integral insect screen, removable for cleaning.
2. Window Cleaner Anchor Bolts: Provide window cleaner anchor bolts of standard design, complying with requirements of authorities having jurisdiction. Fabricate bolts of nonmagnetic stainless steel.
    a. Reinforce window units or mullions to receive bolts and provide additional anchorage of units at bolt locations.
3. Integral Louver Blinds: Provide remotely operated horizontal louver blinds in the space between two panes of glass. Construct blinds of aluminum slats, approximately 1 inch (25 mm) wide, with polyester fiber cords, equipped for tilting, raising, and lowering by standard operating hardware located on inside face of sash.
4. Exterior Louver Units: Manually adjustable, extruded-aluminum, solar-shade louver units; of type recommended by manufacturer for application over operable or fixed windows. Provide main extrusion members of 0.062-inch (1.6-mm) minimum wall thickness.
    a. Operator: Crank-type gang operator, operable from inside building, designed to rotate louver blades simultaneously at least 80 degrees and to lock units in closed position; one operator per each louver unit. Form unit framing or mounting without interfering with insect screens.

H. Fabrication
1. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.
2. Fabricate aluminum windows that are reglazable without dismantling sash or ventilator framing.
3. Thermally Improved Construction: Fabricate aluminum windows with an integral, concealed, low-conductance thermal barrier; located between exterior materials and window members exposed on interior side; in a manner that eliminates direct metal-to-metal contact.
    a. Provide thermal-break construction that has been in use for not less than three years and has been tested to demonstrate resistance to thermal conductance and condensation and to show adequate strength and security of glass retention.

b. Provide thermal barriers tested according to AAMA 505; determine the allowable design shear flow per the appendix in AAMA 505.
c. Provide hardware with low conductivity or nonmetallic material for hardware bridging thermal breaks at frame or vent sash.

4. Weather Stripping: Provide full-perimeter weather stripping for each operable sash and ventilator.
   a. Horizontal-Sliding Windows: Provide operable sash with a double row of sliding weather stripping in horizontal rails and single- or double-row weather stripping in meeting or jamb stiles, as required to meet specified performance requirements. Provide compression-type weather stripping at perimeter of each movable panel where sliding-type weather stripping is not appropriate.
   b. Vertically Pivoted Windows: Provide double-row weather stripping.
5. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.
6. Provide water-shed members above side-hinged ventilators and similar lines of natural water penetration.
7. Mullions: Provide mullions and cover plates as shown, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections, as indicated. Provide mullions and cover plates capable of withstanding design loads of window units.
8. Subframes: Provide subframes with anchors for window units as shown, of profile and dimensions indicated but not less than 0.062-inch- (1.6-mm-) thick extruded aluminum. Miter or cope corners, and weld and dress smooth with concealed mechanical joint fasteners. Finish to match window units. Provide subframes capable of withstanding design loads of window units.
9. Factory-Glazed Fabrication: Glaze aluminum windows in the factory where practical and possible for applications indicated. Comply with requirements in Division 08 Section "Glazing" and with AAMA/WDMA 101/I.S.2/NAFS.
10. Glazing Stops: Provide snap-on glazing stops coordinated with Division 08 Section "Glazing" and glazing system indicated. Provide glazing stops to match sash and ventilator frames.

I. Finishes, General
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

J. Aluminum Finishes
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.
3. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class II, Color Anodic Finish: AA-M12C22A32/A34 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, integrally colored or electrolytically deposited color coating 0.010 mm or thicker) complying with AAMA 611.

5. Class I, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** Match sample **OR** As selected from full range of industry colors and color densities, **as directed**.
6. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.
   a. Organic Coating: Thermosetting, modified-acrylic or polyester enamel primer/topcoat system complying with AAMA 2603, except with a minimum dry film thickness of 1.5 mils (0.04 mm), medium gloss.
   b. Color: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
7. High-Performance Organic Finish (2-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 50 **OR** 70, **as directed**, percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2604 **OR** AAMA 2605, **as directed**, and with coating and resin manufacturers' written instructions.
8. High-Performance Organic Finish (3-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coatings; Organic Coating: manufacturer's standard 3-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.

1.3 EXECUTION

A. Installation
1. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing windows, hardware, accessories, and other components.
2. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction.
3. Set sill members in bed of sealant or with gaskets, as indicated, for weathertight construction.
4. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.
5. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.
6. Connect automatic operators to building electrical system.

B. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
   a. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.
2. Testing Services: Testing and inspecting of installed windows shall take place as follows:
   a. Testing Methodology: Testing of windows for air infiltration and water resistance shall be performed according to AAMA 502, Test Method A **OR** B, **as directed**, by applying same

test pressures required to determine compliance with AAMA/WDMA 101/I.S.2/NAFS in Part 1 "Performance Requirements" Article.

b. Testing Extent: Three windows as selected by the Owner and a qualified independent testing and inspecting agency. Windows shall be tested immediately after installation.

c. Test Reports: Shall be prepared according to AAMA 502.

3. Remove and replace noncomplying aluminum window and retest as specified above.
4. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

C. Adjusting, Cleaning, And Protection

1. Adjust operating sashes and ventilators, screens, hardware, operators, **as directed**, and accessories for a tight fit at contact points and weather stripping for smooth operation and weathertight closure. Lubricate hardware and moving parts.
2. Clean aluminum surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.
3. Clean factory-glazed glass immediately after installing windows. Comply with manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels, and clean surfaces.
4. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.
5. Protect window surfaces from contact with contaminating substances resulting from construction operations. In addition, monitor window surfaces adjacent to and below exterior concrete and masonry surfaces during construction for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written recommendations.

END OF SECTION 08 51 13 00

SECTION 08 51 13 00a - ALUMINUM REPLACEMENT WINDOWS

DESCRIPTION OF WORK

This specification covers the furnishing and installation of materials for aluminum replacement windows. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

GENERAL

Definitions

1. Window Types: ANSI/AAMA 101.
   a. Horizontal Slider (HS): Primary horizontally operating window.
   b. Single Hung (SH): Primary vertically operating window with only one operable sash.
   c. Double Hung (DH): Primary vertically operating window with two operable sashes.
   d. Thermally Improved: Primary window with thermal break between interior and exterior metal surfaces both at frame and sash or panel members.
      1) Single Window Construction: Provide insulating glass.
      2) Thermally improved aluminum windows may use members with thermal breaks or be of dual window construction (i.e.. primary-secondary (storm) or primary-primary).
   e. Dual Window Construction (DW):
      1) Primary-Secondary: Primary window with either interior or exterior secondary (storm) window.
      2) Primary-Primary: Combination of two primary windows employing common frame.
2. Type of Stainless Steel Screens (Frames and Screening): Medium, and Heavy Types: As defined by and comply with requirements of ANSI/SMA 6001.
3. Supply and Delivery Only: Include supply and delivery to site(s) FOB destination freight prepaid. Unless otherwise specified or scheduled, unloading and handling at site is by the Owner.

System Description

4. Performance Requirements: Comply with following:
   a. Aluminum Replacement Windows: HUD UM 39a.
   b. Aluminum Replacement Windows: ANSI/AAMA 101 (Including test size requirements):
      1) Horizontal Sliding Windows: HS C35.
         a) Water Resistance: ASTM E 547, no leakage at 251.4 Pa (5.25 PSF) test pressure.
      2) Single Hung and Double Hung Windows: DH C35.
         a) Water Resistance: ASTM E 547, no leakage at 251.4 Pa (5.25 PSF) test pressure.
      3) Single Hung and Double Hung Windows: DH C45.
         a) Water Resistance: ASTM E 547, no leakage at 323.4 Pa (6.75 PSF) test pressure.
      4) Air Infiltration: ASTM E 283, Not exceed 0.049 cu m/s/mm (0.34 CFM/ft) of crack length of operable sash at 75 Pa (1.57 PSF) test pressure.
      5) Dual Window Construction: DW.
   c. Aluminum Replacement Windows: ASTM F 588, Annex AI, forced entry resistance performance level 10.
   d. Thermally Improved Windows: AAMA 1504:

1) Thermal Transmittance (U-Value): Maximum U70, 3.97 W/sq. m C (0.70 BTU/HR.FT.F) if not otherwise scheduled.
2) Condensation Resistance Factor (CRF): Minimum CRF C50 if not otherwise scheduled.

e. Sealed Insulating Glass: Tested and certified in accordance with HUD UM 82 complying with ASTM E 774, Class C.

Submittals

5. Product Data:
6. Shop Drawings:
   a. Include window elevations, installation details, anchorage details, clearance between frame and rough opening, hardware, glazing, and accessories.
7. Samples: Submit full set of finish color samples for color selection.
   a. For Supply and Deliver Only Contract: Submit one full size sample of each type of aluminum replacement window with specified finish for acceptance. Include sample of trickle ventilator.
8. Quality Assurance/Control Submittals:
   a. Certificates: Manufacturer's written third party certification that aluminum windows meet or exceed HUD UM 39a. HUD 82, and ANSI/AAMA 101 and other specified requirements.
   b. Manufacturer's installation instructions.
9. Closeout Submittals
   a. Operation and maintenance data.
   b. Special warranty.

Quality Assurance

10. Regulatory Requirements:
    a. Glazing Materials: Comply with CPSC 16 CFR 1201 or ANSI Z97.1.
    b. Egress Requirements: Comply with applicable codes and regulations.
    c. Provide emergency egress, single point locking release, and bit key lock fire entry from exterior as and where required by applicable codes and regulations.
    d. Accessibility:
       1) Architectural Barriers Act of 1968 as amended (42 USC 4151-4157) and HUD implementing regulations (24 CFR Part 40).
          a) Uniform Federal Accessibility Standards (UFAS).
       2) Section 504 of the Rehabilitation Act of 1973 as amended (29 USC 794) and HUD implementing regulations 24 CFR Part 8.
       3) Fair Housing Accessibility Guidelines (24 CFR Chapter 1).
       4) Americans with Disabilities Act of 1990 (ADA) (42 USC §§ 12101, et seq.) and implementing regulations (28 CFR Part 35).
11. Certifications: Comply with HUD UM 39a, HUD UM 82, ANSI Z34.1 and HUD 24 CFR 200.935.
12. Mock-ups: For Supply and Install Contract: Install one full size mock-up of each type of aluminum replacement window with specified finish for acceptance.
    a. Location
    b. Approved Mock-up: Standard for rest of work.
    c. Approved Mock-up: May remain part of completed project.

Delivery, Storage, And Handling

13. Packing. Shipping, Handling, and Unloading: Pack materials at manufacturing plant to prevent damage during shipping.
    a. Aluminum Replacement Windows: Label in accordance with HUD UM 39a attached signifying compliance with ANSI/AAMA 101 performance requirements.
    b. Thermally Improved Windows: Label in accordance with HUD UM 39a attached signifying compliance with specified AAMA 1504 performance requirements.
14. Acceptance at Site: Inspect aluminum replacement windows upon delivery. Replace damaged or defective materials before installation.

15. Storage and Protection: Store aluminum replacement windows in manner to protect from weather and other damage.

Project Conditions

16. Field Measurements: Field measure openings for aluminum replacement windows before start of fabrication.

Scheduling And Sequencing

17. Scheduling and Completion: Comply with requirements of Detailed Scope of Work.

Warranty

18. Special Warranty: Provide one year written covering materials and installation for aluminum replacement windows.
    a. Warranty: Include coverage of inserts, hardware, and latches.
        1) Screening and glazing not included.
        2) Defects resulting from vandalism not included.
    b. For Supply and Delivery Only Contract:
        1) Contractor: Agrees to supply and deliver to the Owner, free of charge, any required replacement parts that can be readily installed by the Owner without special tools.
        2) Contractor: Agrees to supply and deliver free of charge, complete replacement window, when defective part or parts cannot be installed without use of special tools.
    c. For Supply and Install Contract:
        1) Contractor: Agrees to supply and install, free of charge, any required replacement parts or complete replacement window.

PRODUCTS

Aluminum Replacement Windows

19. General: Type(s) and size(s) indicated, specified, or scheduled with necessary hardware, anchors and equipment.

Materials

20. Aluminum Materials:
    a. Extruded Aluminum: ASTM B 221, Alloy 6063-T5 or stronger.
    b. Aluminum Alloys: Commercial quality and of proper alloy for window construction, free from defects impairing strength and/or durability.
        1) Wrought Aluminum Alloys: Alloying Elements: ANSI/AAMA 101.
    c. Window Members, Including Muntins: Aluminum except as allowed by ANSI/AAMA 101.
        1) Sill Members: Minimum 2.0 mm (0.078 inch) thick.
    d. Interlocks and mating fins may vary by tapering at maximum projected distance of 8 mm (5/16 inch) from edge.
        1) Other appendages may taper providing design results in net area of at least that calculated by using prescribed wall thickness for appendage length.
    e. Edge or Corner: May be eased with radius not to exceed wall thickness permitted for member.
    f. Glazing Legs, Channels or Glazing Bead Retainers, Serrated or Not: Minimum 1.3 mm (0.050 inch) thick for distance of not more than 13 mm (1/2 inch) each leg.
21. Other Metal Materials:
    a. Carbon Steel (reinforcing members): ASTM A 36, zinc coated in accordance with ASTM B 633 or cadmium coated in accordance with ASTM B 766.
    b. Stainless Steel: ASTM A 167, Type 302.
    c. Welding Filler Rods: AWS A5.3.
22. Glazing Materials: Comply with CPSC 16 CFR 1201 or ANSI Z97.1.
    a. Glass: ASTM C 1036, Type 1, Class 1, Glazing B Quality.
    b. Tempered Glass: ASTM C 1048, Kind FT, Condition A, Type 1, Class 1, Glazing B Quality.

c. Plastic: Extruded polycarbonate clear sheets, minimum 4.5 mm (0.177 inch) thick with following characteristics:
   1) Impact Resistance: ASTM D 256, Method A, 12-18 foot-pound per inch.
   2) Elongation/Modulus of Elasticity: ASTM D 638, 110 percent maximum/340,000 PSI.
   3) Heat Deflection: ASTM D 648, 132.2 degrees C (270 degrees F) at 264 PSI.
   4) Abrasion Resistance: Coated on both surfaces to produce abrasion resistance of 3-19 percent maximum haze increase for 500 revolutions of CS-1 OF wheel per ASTM D 1044.
d. Insulating Glass Units: HUD UM 82 and ASTM E 774, Class CBA.
e. Glass Thickness: Determined in accordance with ANSI/AAMA 101 Appendix, minimum 3 mm (1/8 inch) (DS).
   1) Design Wind Pressures: Determined in accordance with applicable codes and regulations.
f. Glass: Labeled to show name of manufacturer and type.

23. Glazing Materials: Particularly suited for use with aluminum and not require painting.
   a. Make adequate provisions for use of glazing compound, if applicable.
   b. Remove material from glazing surfaces to which glazing compound will not readily adhere.
   c. Windows: May be either factory or field glazed by either channel-type gaskets or back-bedding materials.
   d. Glazing Clips: Not required when face stops are used.
24. Glazing Beads or Retainers: Material compatible with aluminum, and 6 required to retain glass, of sufficient strength and fixation to serve this purpose.
   a. Thickness of Glazing Beads: Optional except as otherwise specified.
25. Screens: Provide windows with screens as indicated, specified, or scheduled in manufacturer's standard approved design, applicable to specific aluminum windows.
   a. Screen Frames: Extruded aluminum frames of suitable alloy and of sufficient rigidity, crossbraces, as required, to lie flat against window and to prevent excessive bow in frame members and sag in screening.
      1) Frame Corners: Firmly joined in secure and rigid manner.
      2) Screen Spline: Aluminum or a material compatible with aluminum.
   b. Screening: One of following as indicated, specified, or scheduled:
      1) Vinyl Coated Fibrous Glass Yam: ASTM D 3656, Class 1, 18 by 16 mesh, 0.29 mm (0.0115 inch) diameter yam.
      2) Polyvinylidene Chloride or Polypropylene Filament: FS L-S-12513, Type I or III, Class 1 or 2, 18 by 18 mesh, 0.31 mm (0.012 inch) or 0.38 mm (0.015 inch) diameter filament.
      3) Aluminum: FS RR-W-365, Type VII, 18 x 16 or 18 by 18 regular, 0.28 mm (0.011 inch) diameter wire.
      4) Stainless Steel: Type 304 stainless steel:
         a) Medium: ANSI/SMA 6001 Medium Type, 12 x 12 mesh 0.58 mm (0.023 inch) diameter wire.
         b) Heavy: ANSI/SMA 6001 Heavy Type, 12 x 12 mesh 0.71 mm (0.028 inch) diameter wire, high tensile strength.
         c) Screen Frames: ANSI/SMA 6001 performance requirements, minimum 1.6 mm (0.062 inch) aluminum extruded 6063-T5 alloy designed to accept stainless steel wire cloth.
         d) Emergency Egress Windows: Design screen to be opened from interior only (to allow for egress to exterior).
   c. Screening: Fastened to frame in manner to permit replacement of screening.
   d. Screens: Provide with fastening devices, suited particularly for application to specific window made of aluminum or materials compatible with aluminum and of sufficient strength to perform satisfactorily.
   e. Assembled Screen with Insect Screening and Spline in Place: Outside dimension as measured from midpoint of opposite framing members shall not vary more than 4.8 mm (3/16 Inch) from outside dimension as measured at extreme ends of framing members.

f. Screens: Comply with applicable fire codes for egress and fireman access.
   1) Provide single point release as and where required by applicable codes and regulations.
   2) Provide bit key lock fire entry from exterior if required by applicable codes and regulations.
g. Window Screens: Include warning label indicating that screen will not stop child from falling out of window in accordance with SMA 7001.

Accessories

26. Hardware: Designed to perform functions for which it is intended and securely attached to window.
27. Thermal Break Material: Urethane, PVC, ISP, vinyl, or other material suitable for application that is compatible with aluminum.
28. Fasteners: Comply with ANSI/AAMA 101.
29. Panning and Receptor Systems: Extruded aluminum designed to fit existing openings, to receive windows, and to withstand wind forces as required by applicable codes and regulation.
    a. Exterior Trim System: Designed to withstand expansion/contraction forces of trim material.
    b. Interior Snap Trim: Provide manufacturer's standard interior trim package.
    c. Extruded Aluminum Minimum Thickness: 1.57 mm (0.062 inches).
30. Thermal Insulation: Unfaced fiberglass batt insulation in accordance with ASTM C 665, Type 1.
    a. Vapor Barrier: ASTM D 4397, 4 mil polyethylene sheeting with pressure sensitive adhesive sealing tape.
31. Joint Sealants:
    a. Exterior Joint Sealant: AAMA 800, Type 808.3 Exterior Perimeter Sealing Compound.
    b. Back-up Material: Standard preformed and precompressed foam material, round rod or semi-circular type, permanently elastic, mildew resistant, nonmigratory, nonstaining, and compatible with joint substrates and with sealant.
       1) Materials impregnated with oil, solvents, or bituminous materials not allowed.
       2) Provide type as recommended by sealant manufacturer for particular installation.
       3) Material: Neoprene, butyl, polyurethane, vinyl, or polyethylene rod.
    c. Interior Joint Sealant: ASTM C 834, latex acrylic.

Fabrication

32. Windows: Assembled in secure manner to perform as specified and to provide neat, weather tight construction.
    a. Make permanent watertight joints at junctions of sill and jamb members.
    b. Joint Sealant at Mechanically Fixed Joints: AAMA 800, Type 803.3.
    c. Welding or Brazing Flux: Completely removed immediately upon completion of welding or brazing operation.
33. Mullions and Structural Members: Mullion (whether joined by integral mullions, independent mullions, or by combination of frame members): Capable of withstanding load outlined under Uniform Load in ANSI/AAMA 101, Section 2 without deflecting more than 1/175th of its span.
34. Fin Trim or Installation Fins: Aluminum or other suitable material compatible with aluminum and of sufficient strength and thickness to assure satisfactory installation.
    a. Nailing grooves and/or break off score lines in extrusions are acceptable.
    b. Applied fins or fin trim may be assembled to windows by interlocking with frame members or with fasteners located not over 400 mm (16 inches) OC.
35. Thermally Improved Windows: Single window construction with thermal breaks and insulating glass units or dual window construction.
    a. Thermal Break in Two Frame or One Frame Windows: Not bridged by any screws, fasteners, panning, etc., that would allow excessive heat transfer through window frame.
    b. Do not make structural connection in loading bearing member into thermal break material.
36. Sills: Provide weep holes in sill of glazing pocket to provide means for water to flow to exterior.
37. Trickle Ventilators: Type which fits within glazing channels of sash frame, and contains gasketed channel to accept sealed insulating glass used in window sash.

a. Ventilator: Installed in top rail of upper sash, accurately sized to extend full width of sash, properly fit sash, and sash frame above and insulating glass below.
b. Ventilator: Consist of two piece aluminum housing connected by, and separated by, PVC extrusion forming thermal break.
c. Gasketed Shutter: Operate Internal flap to open and close ventilator.
d. Unit: Complete with fly-screen.
e. Color: Selected from manufacturers standard colors.

38. Secondary Windows (Storm Windows): Comply with Division 8 Section “Aluminum Storm Windows.”
39. Windows: Comply with applicable fire codes for egress.

Finishes

40. Finish:
    a. Aluminum: Provide one of following finishes as specified or scheduled:
        1) Pigmented Organic Coating: Factory applied pigmented organic coating, AAMA 603.8.
            a) Color: As selected from manufacturers standard colors.
        2) High Performance Organic Coating: Factory applied pigmented organic coating, AAMA 605.2.
            a) Color: As selected from manufacturer's standard colors.
        3) Color Anodized: Factory applied anodic coating, AAMA 608.1, Class 1.
            a) Color: As scheduled.
        4) Clear Anodized: Factory applied anodic coating, AAMA 607.1, Class 1.
    b. Exposed Surfaces of Aluminum Members: Clean and free from serious surface blemishes.
    c. Dress and finish exposed welded joints.
41. Protective Coatings:
    a. Steel Subframes: Insulate surfaces of steel from direct contact with aluminum surfaces by heavy coat or alkali-resistant bituminous paint or zinc-chromate prime coat, or other coating suitable for this purpose.
    b. Wood Subframes: Properly treat with preservative which will not promote corrosion of aluminum.
    c. Steel or Wood Subframes: Do not leave exposed on exterior of building.

Source Quality Control

42. Fabrication Tolerances: Wall Thickness, Cross-sectional Size and Overall Size: In accordance with ANSI/AAMA 101.
43. Testing: Performed under Third Party Administrator who is in compliance with HUD UM 39a, ANSI Z34.1, and HUD 24 CFR 200.935.

EXECUTION

Examination

44. Site Verification of Conditions:
    a. Field Measurements: Verify field measurements are as indicated on Shop Drawings.
    b. Existing Conditions: Examine openings before beginning installation.
    c. Do not proceed with installation until conditions are satisfactory.

Preparation

45. Protection: Protect adjacent elements from damage and disfiguration in accordance with Detailed Scope of Work.
    a. Contractor: Responsible for damage to grounds, plantings, buildings and any other facilities or property caused by construction operations.
    b. Adequately enclose and protect against weather any interior space where installation is incomplete at end of working day.

c. Repair or replace damaged elements in accordance with Detailed Scope of Work.

46. Existing Widows: Remove existing windows and debris from site in accordance with Detailed Scope of Work.

47. Preparation: Prepare openings and existing frames in accordance with ASTM E 737.
  a. Existing Window Jambs: Prepare as necessary to provide for straight, plumb, level, tight and aesthetically appealing installation of new windows.
  b. Preparatory Work: Include, but not limited to repair of jambs, filling holes and/or dents, removing peeling and scaling paint, etc.

Installation

48. General: Install In accordance with ASTM E 737 except as modified by ANSI/AAMA 101 Appendix, manufacturer's recommendations, Reference Standards, and approved Shop Drawings.
  a. Securely fasten windows in place to straight, plumb and level condition, without distortion of window or window frame, and make final adjustments for proper operation and satisfactory weatherstrip contact and seal.
  b. Make proper allowance for expansion/contraction movement of aluminum.
  c. Panning and Receptor Systems: Install to ensure watertight seal at joints with existing opening and with new replacement window.
    1) Thermal Insulation: Fill voids in panning system with thermal insulation.
    2) Vapor Barrier: Apply vapor barrier on inside between panning and existing opening. Seal laps and terminations with pressure sensitive tape.
  d. Comply with applicable codes and regulations regarding egress requirements and fireman entry.

49. Joint Sealants: Apply in accordance with manufacturers recommendations.
  a. Surfaces to be Sealed: Clean, dry and free of any foreign matter that would degrade adhesion. Remove existing calking and joint sealants from areas to receive new joint sealant.
  b. Prime cleaned surfaces in accordance with sealant manufacturer's recommendations.
  c. Protect surfaces adjacent to joints by masking tape before applying sealant. Remove tape upon finishing sealing work.
  d. Seal joints between perimeter of window frame and underlying or surrounding construction at
  e. Exterior and interior with joint sealant to accomplish weather-tight installation. Maximum Width of Sealed Joint: 13 mm (1/2 inch).

50. Dissimilar Materials: Isolate materials from incompatible materials as necessary to prevent deterioration and galvanic action.
  a. Separate dissimilar metals with bituminous paint, suitable sealant, nonabsorptive plastic or elastomeric tape. or gasket between surfaces.
  b. Coat aluminum in direct contact with concrete, masonry, steel, or other non-compatible materials with bituminous paint, zinc chromate primer, or other suitable insulating material.

Field Quality Control

51. Owners Field Testing: the Owner may have field testing of windows conducted by its own testing agency in accordance with AAMA 502.
  a. Tests: May include, but not limited to:
    1) Field Testing (Hose Test) for Water Leakage: AAMA 501.2.
    2) Field Testing (Air Pressure Difference) for Water Leakage: AAMA 502, Test Method B.
      a) Field Testing for Air Leakage: ASTM E 783.
      b) Field Testing for Water Determination: ASTM E 1105.
  b. Test Pressures: Comply with specified performance requirements.
  c. Contractor: Provide incidental labor facilities necessary to facilitate inspections and tests.
  d. Costs of Testing:
    1) By the Owner: Successful initial tests.

2) By Contractor: Initial tests with failures and subsequent tests as required because of test failures. Costs shall include costs of the Owner and other consultants for observations of tests and corrective work.

e. Corrective Measures: Meet standards of quality of specified window and subject to acceptance of the Owner.

Adjusting And Cleaning

52. Adjusting: At completion of job, check, adjust, and lubricate hardware as required and leave windows and hardware in proper operating condition.

53. Cleaning: Comply with requirements of Detailed Scope of Work.
    a. Clean windows after installation is completed to remove foreign matter and surface blemishes.
    b. Scratched or Abraded Surfaces: Touch-up with rust inhibitor primer and enamel paint compatible with factory finish.

Protection

54. Installed Work: Protect windows from damage after installation.

END OF SECTION 08 51 13 00a

Task	Specification	Specification Description
08 51 19 00	01 22 16 00	No Specification Required

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SECTION 08 51 23 00 - STEEL WINDOWS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for steel windows. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Steel windows from hot-rolled sections.
b. Steel windows from cold-formed steel members.

C. Performance Requirements
1. Structural Performance: Provide steel windows capable of withstanding the effects of the following loads and stresses within limits and under conditions indicated, based on testing windows that are representative of those specified according to ASTM E 330 or structural calculations:
a. Design Wind Loads: Determine design wind loads under conditions indicated according to ASCE/SEI 7.
1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s), **as directed**.
2) Importance Factor.
3) Exposure Category: B **OR** C **OR** D, **as directed**.
b. Deflection Limits: Design glass framing system to limit lateral deflections of glass edges to less than 1/175 of glass-edge length or 3/4 inch (19 mm), whichever is less, at design pressures.
2. Windborne-Debris Resistance: Provide glazed steel windows capable of resisting impact from windborne debris, based on the pass/fail criteria as determined from testing glazed steel windows identical to those specified, according to ASTM E 1886 and testing information in ASTM E 1996 and requirements of authorities having jurisdiction.
3. Condensation-Resistance: Provide steel windows with a CRF when tested according to AAMA 1503 **OR** CR determined according to NFRC 500, **as directed**, of 36 **OR** 40, **as directed**, minimum.
4. Thermal Transmittance: Provide steel windows with the maximum whole-fenestration product U-factor indicated, when tested according to AAMA 1503 **OR** determined according to ASTM E 1423 **OR** determined according to NFRC 100, **as directed**.
a. U-Factor: 0.49 Btu/sq. ft. x h x deg F **OR** 2.8 W/sq. m x K, **as directed**.
5. Solar Heat-Gain Coefficient (SHGC): Provide steel windows with a maximum whole-fenestration product SHGC of 0.40 **OR** 0.55, **as directed**, determined according to NFRC 200.
6. Air Infiltration for Weather-Stripped Ventilators: Not more than 0.37 cfm/ft. (0.18 L/s per m) of ventilator crack length at an inward test pressure of 6.24 lbf/sq. ft. (298 Pa) when tested according to ASTM E 283.
7. Air Infiltration for Non-Weather-Stripped Ventilators: Not more than 1.0 cfm/ft. (0.47 L/s per m) of ventilator crack length at an inward test pressure of 1.56 lbf/sq. ft. (75 Pa) when tested according to ASTM E 283.
8. Water Penetration: No leakage for 15 minutes when window is subjected to a rate of flow of 5 gal./h per sq. ft. (0.05 L/s per sq. m) with a differential pressure across the window of 2.86 lbf/sq. ft. (137 Pa) **OR** 6.24 lbf/sq. ft. (298 Pa), **as directed**, when tested according to ASTM E 331.
9. Forced-Entry Resistance: Comply with Performance Grade 10 requirements when tested according to ASTM F 588.
10. Crack Tolerances: Test each type and size of required window unit, with ventilators closed and locked, for compliance with the following tolerances:

a. Casement Windows: It shall not be possible to freely insert a steel feeler gage 2 inches (51 mm) wide by 0.020 inch (0.5 mm) thick between more than 40 percent of the inside metal-to-metal contacts between frames and ventilators without forcing.
b. Projected Windows: It shall not be possible to freely insert a steel feeler gage 2 inches (51 mm) wide by 0.031 inch (0.8 mm) thick between the inside metal-to-metal contacts between frames and ventilators without forcing, or to freely insert a steel feeler gage 2 inches (51 mm) wide by 0.020 inch (0.5 mm) thick between more than 40 percent of such contacts between frames and ventilators without forcing.

11. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

D. Submittals
1. Product Data: For each type of product indicated. Include construction details, material descriptions, fabrication methods, dimensions of individual components and profiles, hardware, finishes, and operating instructions.
   a. Motors: Show nameplate data, ratings, characteristics, and mounting arrangements.
2. LEED Submittal:
   a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
3. Shop Drawings: Include plans, elevations, sections, details, hardware, attachments to other work, operational clearances, installation details, and the following:
   a. Mullion details including reinforcement and stiffeners.
   b. Joinery details.
   c. Expansion provisions.
   d. Flashing and drainage details.
   e. Weather-stripping details.
   f. Glazing details.
   g. Window-cleaning provisions.
   h. Window System Operators: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
   i. Wiring Diagrams: Power, signal, and control wiring.
   j. Accessories.
4. Samples: For steel windows and components required, prepared on Samples of size indicated below:
   a. Main Framing Member: 12-inch- (300-mm-) long, full-sized sections, with glazing bead, weather stripping and factory-applied color finish.
   b. Hardware: Full-size units with factory-applied finish.
5. Product Schedule: For steel windows. Use same designations indicated on Drawings.
6. Delegated-Design Submittal: For steel windows indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
7. Qualification Data: For qualified Installer, manufacturer, professional engineer and testing agency.
8. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for steel windows.
9. Field quality-control reports.
10. Operation and Maintenance Data: For operable window sash, operable hardware, operable fire-rated window hardware, window system operators, weather stripping and finishes to include in operation and maintenance manuals.
11. Warranties: Sample of special warranty.

E. Quality Assurance
1. Manufacturer Qualifications: A manufacturer capable of fabricating steel windows that meet or exceed performance requirements indicated and of documenting this performance by inclusion in lists, and by labels, test reports, and calculations.
2. Installer Qualifications: An installer acceptable to window manufacturer for installation of units required for this Project.
   a. Installer's responsibilities include providing professional engineering services needed to assume engineering responsibility including preparation of data for steel windows, including Shop Drawings and Designated Design Submittal based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
3. Source Limitations: Obtain steel windows from single source from single manufacturer.
4. Fire-Test-Response Characteristics: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated on Drawings, based on testing indicated.
   a. Neutral-Pressure Test: NFPA 257 **OR** UL 9, **as directed**.
   OR
   Positive-Pressure Test: ASTM E 2010 **OR** NFPA 257 **OR** UBC 7-4 **OR** UL 9, **as directed**.
5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
6. SWI Publication: Comply with applicable requirements in SWI's "The Architect's Guide to Steel Windows and Doors" except where more stringent requirements are indicated.
7. Preinstallation Conference: Conduct conference at Project site.

F. Project Conditions
1. Field Measurements: Verify actual dimensions of steel window openings by field measurements before fabrication.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of steel windows that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Failure to meet performance requirements.
      2) Structural failures including excessive deflection.
      3) Water leakage or air infiltration.
      4) Faulty operation of operable sash and hardware.
      5) Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   b. Warranty Period: Two **OR** Three, **as directed**, years from date of Final Completion.
   c. Warranty Period for Metal Finishes: Five **OR** 10 **OR** 15, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Materials
1. Fasteners: Provide fasteners of bronze, brass, stainless steel, or other metal that are warranted by manufacturer to be noncorrosive and compatible with trim, hardware, anchors, and other components of steel windows.
   a. Exposed Fasteners: If exposed fasteners are used, provide Phillips flat-head machined screws that match finish of member or hardware being fastened, as appropriate.
2. Anchors, Clips, and Window Accessories: Provide units of stainless steel, hot-dip zinc-coated steel, bronze, brass, or iron complying with ASTM A 123/A 123M. Provide units with sufficient strength to withstand design pressure indicated.

3. Compression-Type Weather Stripping: Provide compressible weather stripping designed for permanently resilient sealing under bumper or wiper action and for complete concealment when steel window is closed.
    a. Weather-Stripping Material: Elastomeric, cellular, preformed gaskets complying with ASTM C 509.
       OR
       Weather-Stripping Material: Dense elastomeric gaskets complying with ASTM C 864.
       OR
       Weather-Stripping Material: Manufacturer's standard.
4. Sliding-Type Weather Stripping: Provide manufacturer's standard woven-pile weather stripping of wool, polypropylene, or nylon pile and resin-impregnated backing fabric.
    a. Weather Seals: Provide weather stripping with integral barrier fin or fins of semirigid, polypropylene sheet or polypropylene-coated material.
5. Trim Members, Screen Frames, Retainers for Weather Stripping, Flashing, and Similar Items: Extruded aluminum **OR** Formed sheet aluminum **OR** Stainless steel **OR** Formed steel **OR** Manufacturer's standard, **as directed**.
6. Glazing Stops: Extruded aluminum **OR** Formed sheet aluminum **OR** Stainless steel **OR** Formed steel **OR** Manufacturer's standard, **as directed**.
7. Sealant: For sealants required within fabricated windows, provide manufacturer's standard, permanently elastic, nonshrinking, and nonmigrating type recommended by sealant manufacturer for joint size and movement.

B. Window
1. Window Type: Casement **OR** Double hung **OR** Fixed **OR** Horizontally pivoted **OR** Horizontal sliding **OR** Projected **OR** Single hung **OR** Vertically pivoted **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
2. Hot-Rolled Steel Window Members: Provide frame and ventilator members formed from hot-rolled, new billet steel sections. For combined weight of frame and ventilator members and front-to-back depth of frame or ventilator members, comply with the following requirements:
    a. Light Intermediate Windows: Not less than 2.0 lb/ft. (2.98 kg/m) in combined weight and not less than 1 inch (25.4 mm) deep.
    b. Standard Intermediate Windows: Not less than 3.0 lb/ft. (4.46 kg/m) in combined weight and not less than 1-1/4 inches (32 mm) deep.
    c. Heavy Intermediate Windows: Not less than 3.5 lb/ft. (5.21 kg/m) in combined weight and not less than 1-5/16 inches (33.34 mm) deep.
    d. Heavy Custom Windows: Not less than 4.2 lb/ft. (6.25 kg/m) in combined weight and not less than 1-1/2 inches (38.1 mm) deep.
        1) Dimensions of Projected Frame and Ventilator Members: Nominally 1/8 inch (3 mm) thick by 1-3/8 inches (35 mm) deep except members nominally 1-1/4 inches (32 mm) deep may be used provided corners are welded and ground.
        2) Applied Weather Stripping: Where indicated, 0.074-inch (1.9-mm) **OR** 0.060-inch (1.5-mm), **as directed**, minimum thickness.
    e. Window Finish: Galvanized **OR** Galvanized and factory primed **OR** Factory primed **OR** Baked enamel **OR** Powder coat **OR** High performance, organic, **as directed**.
        1) Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
3. Cold-Formed Steel Window Members: Provide frame and ventilator members mechanically formed from metallic-coated, low-carbon, cold-rolled steel sheet complying with ASTM A 653/A 653M. For combined weight of frame and ventilator members and front-to-back depth of frame or ventilator members, comply with the following requirements:
    a. Commercial and Industrial Windows: Not less than 2.75 lb/ft. (4.09 kg/m) in combined weight, and not less than 1-1/4 inches (32 mm) deep.
    b. Window Finish: Baked enamel **OR** Powder coat, **as directed**.
        1) Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

C. Glazing
1. Glass and Glazing System: See Division 08 Section "Glazing" for glass units and glazing requirements for steel windows.

D. Hardware
1. General: Provide manufacturer's standard nonremovable, **as directed**, solid bronze **OR** malleable iron **OR** die-cast metal, **as directed**, hardware, with operating components of stainless steel, carbon steel complying with AAMA 907, brass, bronze, or other corrosion-resistant material designed to operate smoothly, to close tightly, and to lock steel window ventilators securely. Provide hardware of sufficient strength to accommodate size and weight of ventilator for which it is intended.
2. Sill Cap/Track: Designed to comply with performance requirements indicated and to drain to the exterior.
3. Locks and Latches: Designed to allow unobstructed movement of the sash across adjacent sash in direction indicated and to operate from the inside only.
4. Roller Assemblies: Low-friction design.
5. Friction Shoes: Adjustable friction shoes of bronze, brass, nylon, or other nonabrasive, nonstaining, noncorrosive, durable material.
6. Hinges: Four-bar friction hinges complying with AAMA 904.
7. Limit Device: Provide concealed friction adjustor/stay-bar **OR** friction adjustor/stay-bar with release key or tool **OR** support arms with adjustable, limited hold-open, **as directed**, limit devices designed to restrict sash or ventilator opening.
8. Gear-Type Rotary Operators: Comply with AAMA 901 when tested according to ASTM E 405, Method A.
   a. Operator shall operate all ventilators simultaneously, securely closing them at both jambs without use of additional manually controlled locking devices.
9. Pole Operators: Tubular-shaped, anodized aluminum; with rubber-capped lower end and standard push-pull hook at top to match hardware design; of sufficient length to operate window without reaching more than 60 inches (1500 mm) above floor; one pole operator and pole hanger per room that has operable windows more than 72 inches (1800 mm) above floor.
10. Casement Windows: Provide the following operating hardware:
   a. Operating Device: Gear-type rotary operator located on the jamb at the sill.
   OR
   Operating Device: Combination lever-handle and cam-type latch.
   b. Hinges: Concealed, four-bar friction hinges with adjustable slide shoes; two per ventilator.
   OR
   Hinges: Heavy duty, three-knuckle butt hinges with nylon bushings; two per ventilator.
   OR
   Hinges: Provide standard-duty, concealed, four-bar friction egress hinges with adjustable slide shoes; two per ventilator where indicated. Provide hinge designed to achieve 90-degree ventilator opening.
   OR
   Hinges: Extension hinges or pivots, nonfriction type; two per ventilator.
   c. Lock: Lift-type, cam-action lock.
   d. Limit Device: Stay bar with an adjustable hold-open device.
11. Double **OR** Single, **as directed**,-Hung Windows: Provide the following operating hardware:
   a. Sash Balances: Two per sash.
   b. Counterbalance and Pulley: Two per sash to operate ventilators in unison with stainless-steel-cable sash cord.
      1) Single-Hung Upper Sash Retainer: Manufacturer's standard.
   c. Self-Closing Device for Single-Hung, Fire-Rated Windows: Fusible link **OR** Electrically operated, resettable thermal link, labeled and tested per UL 33, **as directed**.
   d. Handle(s): Lift **OR** Pull-down, **as directed**, handle; one **OR** two, **as directed**, per sash.
   e. Lock: Cam-action sweep lock and keeper on meeting rail; one **OR** two, **as directed**, per sash.
12. Horizontal-Sliding Windows: Provide the following operating hardware:

a. Rollers: Steel, lubricated, ball-bearing rollers.
b. Lock: Manufacturer's standard.
c. Limit Device: Manufacturer's standard.
d. Pull Handle: Manufacturer's standard.
e. Automatic Closer for Fire-Rated Steel Sash: Heat- **OR** Heat- and electrically, **as directed**, activated spring-driven closer.

13. Pivoting Windows: Provide the following operating hardware:
    a. Pivot Assembly: Manganese-bronze pivot assembly designed for center **OR** off-center, **as directed**, axis pivoting.
    b. Lock: Internal, key-operated, limited-access locks; one **OR** two, **as directed**, per jamb.
        1) Bronze safety drop bolts.
        2) Bronze cam fasteners.
    c. Limit device.
14. Projected Windows: Provide the following operating hardware:
    a. Operating Device: Gear-type rotary **OR** Push-bar-type, **as directed**, underscreen, **as directed**, ventilator operator located at the sill.
    b. Hinges: Concealed, four-bar friction hinges with adjustable slide shoes; two per ventilator.
    OR
    Hinges: Balance arms with adjustable, nonabrasive friction pivots; two per ventilator.
    OR
    Hinges: Balance arms with adjustable, nonabrasive friction shoes; two per ventilator.
        1) Provide ventilator operation that permits cleaning of the outside glass face from the interior.
        2) Provide jamb-mounted, sliding, brass friction shoes with screw adjusters.
    c. Lock: Cam-action, sweep lock handle with surface-mounted strike.
    OR
    Lock: Key-operated security lock and keeper.
    OR
    Lock: Pole-operated, spring catch lock.
    OR
    Lock: Pole-operated, cam-action, sweep lock handle and keeper.

E. Group Window Operating Systems
1. Provide window operating system for window groups as indicated. Coordinate operating system design with window fabrication and hardware selections to ensure smooth, durable operation of ventilators.
2. Operation Function: All ventilators move simultaneously and close securely at sash frames without using additional manually controlled locking devices.
3. Operating System: Complete with shafts, brackets, levers, rods, oil-encased gear boxes, and standard fittings and accessories for operation indicated.
    a. Rack-and-Pinion Operating System: Torsion-type with steel pipe torsion shaft and factory-sealed, oil-encased gear box. Provide system with rack-and-pinion sets and operating arms. Provide standard fittings and accessories for operation indicated. Space support bearings at 10 feet (3 m) o.c. maximum.
        1) Space operating arms not more than 60 inches (1500 mm) o.c.
        2) Provide one operating arm for each operating vent.
    b. Horizontal-Movement Operating System: Tension-type with steel rod or cable transmission lines operating in conduit between ventilator operators, factory-sealed lubricated rotary thrust unit, and toggle-type operator arms. Provide standard fittings and accessories for operation indicated. Provide support bracket at each operator, at bends, and not more than 10 feet (3 m) o.c. elsewhere.
        1) Space operating arms not more than 10 feet (3 m) o.c. along each continuous unit.
        2) Provide one operating arm for each operating vent.
4. Operation: Manual, with chain-wheel operator on each gear box shaft; with chain loops terminated 24 inches (600 mm) above floor.

OR
Operation: Manual, with crank-type operator on each gear box shaft; with removable crank and oil-enclosed miter gear box. Where necessary, extend crankshaft with universal joints and support brackets to a suitable crank-operator mounting location not more than 44 inches (1115 mm) above floor.

5. Operation: Electric, with factory-assembled electric operator designed for operating windows of type, size, weight, construction, use, and operating frequency indicated.
   a. Electric Operator: Provide operating system complying with NFPA 70; of size and capacity and with features, characteristics, and accessories suitable for Project conditions recommended in writing by window manufacturer; complete with operating system indicated, electric motor and factory-prewired motor controls with limit switches, remote-control stations, power disconnect switches, enclosures to protect controls and all operating parts, and accessories required for reliable operation. Include wiring from motor controls to motor. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
      1) Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6.
      2) Electric Motor: Comply with NEMA MG 1; with thermal-overload protection; sized to start and operate size and weight of window sash ventilators under any conditions; one per each gear-box shaft.
         a) Motor Characteristics: Single phase, sized by electric operator manufacturer, 60 Hz.
      3) Remote Controls: Electric controls with NEMA ICS 6, Type 1 enclosure and momentary-contact, single push-button-operated control **OR** three-position, push-button-operated control with open, close, and stop functions, **as directed**.
      4) Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop sash ventilators at fully opened and fully closed positions.

F. Insect Screens
   1. Design windows and hardware to accommodate screens in a tight-fitting, removable arrangement, with a minimum of exposed fasteners and latches. Fabricate insect screens to fully integrate with window frame, with mitered or coped joints or corner extrusions, concealed fasteners, adjustable rollers, **as directed**, and removable PVC spline/anchor concealing edge of frame. Locate screens on inside **OR** outside, **as directed**, of window and provide for each operable exterior sash or ventilator.
      a. Screen Frames: Fabricate frames of tubular-shaped, extruded- **OR** formed-, **as directed**, aluminum members of 0.04-inch (1.0-mm) minimum wall thickness.
         1) Finish: Anodized aluminum **OR** Baked-on organic coating, **as directed**, in manufacturer's standard color.
            OR
            Finish: Anodized aluminum **OR** Baked-on organic coating, **as directed**, in color selected from manufacturer's full range.
            OR
            Finish: Manufacturer's standard.
      b. Screen Frames: Fabricate frames of tubular-shaped, nonmagnetic stainless-steel members of 0.02-inch (0.5-mm) minimum wall thickness.
         1) Finish: No. 2B bright mill finish **OR** Match steel window finish, **as directed**.
      c. Screen Frames (inside only): Fabricate frames of tubular-shaped, steel sheet members of 0.03-inch (0.8-mm) minimum wall thickness. Finish the frames to match window units.
   2. Glass-Fiber Mesh Fabric: ASTM D 3656, 18-by-14 or 18-by-16 **OR** 20-by-20 or 20-by-30, **as directed**, count per sq. in. (645 sq. mm) mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration.
      a. Mesh Color: Gray.
   3. Aluminum Wire Fabric: 18-by-16 count per sq. in. (645 sq. mm) mesh of 0.011-inch- (0.28-mm-) diameter, coated aluminum wire.
      a. Wire-Fabric Finish: Natural bright **OR** Charcoal gray **OR** Black, **as directed**.

4. Copper Wire Fabric: 16-by-16 count per sq. in. (645 sq. mm) mesh of 0.011-inch- (0.28-mm-) diameter copper wire.
5. Bronze Wire Fabric: 18-by-14 count per sq. in. (645 sq. mm) mesh of 0.011-inch- (0.28-mm-) diameter bronze wire with a clear varnish finish.
6. Stainless-Steel Wire-Fabric: 18-by-16 **OR** 18-by-18, **as directed**, count per sq. in. (645 sq. mm) mesh of 0.009-inch- (0.2-mm-) minimum diameter, nonmagnetic stainless-steel wire, Type 304 or 316.
7. Solar-Screening Mesh Fabric: 17-by-15 **OR** 40-by-40, **as directed**, count per sq. in. (645 sq. mm) mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration. Comply with ASTM D 3656.
8. Wickets: Provide sliding or hinged wickets, framed and trimmed for a tight fit and durability during handling.

G. Accessories
1. General: Provide manufacturer's standard accessories that comply with indicated standards.
2. Window Cleaner Anchor Bolts: Provide window cleaner anchor bolts of standard design, complying with requirements of authorities having jurisdiction. Fabricate bolts of nonmagnetic stainless steel.
   a. Reinforce window units or mullions to receive bolts and provide additional anchorage of units at bolt locations.

H. Fabrication
1. General: Fabricate steel windows of type and in sizes indicated to comply with SWI standards. Include a complete system for assembly of components and anchorage of window units.
   a. Provide units that are reglazable without dismantling ventilator framing.
   b. Prepare window ventilators for site glazing **OR** factory glazing, **as directed**.
2. Mullions: Formed of hot-rolled **OR** cold-formed, **as directed**, steel matching window units; with anchors for support to structure and for installation of window units and having sufficient strength to withstand design pressure indicated. Provide mullions of profile indicated and with cover plates. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections.
3. Subframes and Operable Ventilators: Formed of hot-rolled **OR** cold-formed, **as directed**, steel of profile indicated. Miter or cope corners, and mechanically fasten and seal joints **OR** weld and dress joints smooth, **as directed**.
4. Provide weep holes and internal water passages to conduct infiltrating water to the exterior.
5. Provide water-shed members above casement **OR** horizontal-sliding, **as directed**, ventilators.
6. Glazing Stops: Provide screw-applied **OR** snap-on, **as directed**, glazing stops; coordinate with Division 08 Section "Glazing" and with glazing system indicated. Provide glazing stops to match panel frames. Finish glazing stops to match window units if fabricated of steel; otherwise, provide manufacturer's standard finish.
7. Glazing Clips: Where face glazing (without glazing stops) is indicated, furnish glazing clips for concealment in glazing compound.

I. Metallic-Coated Steel Sheet Finishes
1. Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and apply galvanizing repair paint complying with SSPC-Paint 20 and ASTM A 780.
2. Factory Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
3. Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat. Comply with coating

manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).

J. Steel Finishes
1. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning" **OR** SSPC-SP 8, "Pickling", **as directed**. After cleaning, apply a conversion coating suited to the organic coating to be applied over it, **as directed**.
2. Galvanized Finish: Hot-dip galvanize per ASTM A 123.
3. Steel and Galvanized-Steel Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
4. Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).
5. High-Performance Organic Finish: Two-coat fluoropolymer finish containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1.3 EXECUTION

A. Examination
1. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Verify rough opening dimensions, levelness of sill plate, accurate locations of connections to building electrical system, **as directed**, and operational clearances. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure a coordinated, weathertight window installation.
   a. Masonry Surfaces: Visibly dry and free of excess mortar, sand, and other construction debris.
   b. Wood Frame Walls: Dry, clean, sound, well nailed, free of voids, and without offsets at joints. Ensure that nail heads are driven flush with surfaces in opening and within 3 inches (76 mm) of opening.
   c. Metal Surfaces: Dry, clean, and free of grease, oil, dirt, rust, corrosion, and welding slag; without sharp edges or offsets at joints.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation
1. Comply with manufacturer's written instructions for installing windows, hardware, operators, accessories, and other components.
2. Install windows level, plumb, square, true to line, without distortion or impediment to thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction.
3. Set sill members in bed of sealant or with gaskets, as indicated, to provide weathertight construction.
4. Install windows and components to drain condensation, water-penetrating joints, and moisture migrating within windows to the exterior.
5. Separate corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials according to ASTM E 2112, Section 5.12 "Dissimilar Materials."

C. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Tests and Inspections:

a. Testing Methodology: Testing of windows for air-penetration resistance and water resistance will be performed according to AAMA 502, Test Method A **OR** B, **as directed**, by applying same test pressures required for performance.
b. Testing Extent: Three windows as selected by the Owner and a qualified independent testing and inspecting agency. Windows shall be tested immediately after installation.
3. Window will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports according to AAMA 502. Testing agency will interpret test results and state in each report whether tested work complies with or deviates from requirements.

D. Adjusting, Cleaning, And Protection
1. Adjust operating sashes and ventilators, screens, hardware, operators, **as directed**, and accessories for a tight fit at contact points and weather stripping for smooth operation and weathertight closure. Lubricate hardware and moving parts.
2. Clean factory-finished steel surfaces immediately after installing windows. Comply with manufacturer's written recommendations for final cleaning and maintenance. Avoid damaging protective coatings and finishes.
3. Clean glass immediately after installing windows. Comply with manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels, and clean surfaces.
4. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.
5. Protect window surfaces from contact with contaminating substances resulting from construction operations. Remove contaminants immediately according to manufacturer's written recommendations.
6. Refinish or replace windows with damaged finish.

E. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain group window operating system for steel windows.

END OF SECTION 08 51 23 00

SECTION 08 51 69 00 - ALUMINUM STORM WINDOWS

DESCRIPTION OF WORK

This specification covers the furnishing and installation of materials for aluminum storm windows. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

GENERAL

Definitions

1. Aluminum Storm Window Configuration and Performance Classes: ANSI/AAMA 1002.10:
    a. VWE (15): Vertically operating insulating storm window for external application, Performance Class 15.
    b. VWE (45): Vertically operating insulating storm window for external application, Performance Class 45.
    c. HWE (15): Horizontally operating insulating storm window for external application, Performance Class 15.
    d. FWE (15): Fixed removable insulating storm window for exterior application, Performance Class 15
    e. FWI (15): Fixed removable insulation window for internal application, Performance Class 15.
    f. HWI (15): Horizontally operating insulating window for internal application, Performance Class 15.
2. Type of Stainless Steel Screens (Frames and Screening): Medium, and Heavy Types: As defined by and comply with requirements of ANSI/SMA 6001.
3. Supply and Delivery Only: Include supply and delivery to site(s) FOB destination Freight prepaid. Unless otherwise specified or scheduled, unloading and handling at site is by the Owner.

System Desription

4. Performance Requirements: Comply with following:
    a. Storm Windows: HUD UM 39a.
    b. Storm Windows: ANSI/SMA 6001.
        1) Exterior Mounted Aluminum storm Windows for Normal Usage: Specification FWE, HWE, or VWE as applicable and Performance Class 15.
        2) Interior Mounted Aluminum Storm Windows for Normal Usage: Specification FWI, HWI, or VWI as applicable and Performance Class 15.
        3) High Rise Storm Windows: Specification VWE and Performance Class 45.

Submittals

5. Product Data.
6. Shop Drawings:
    a. Indicate fabrication of parts, metal thickness. installation details, fastening and sealing.
    b. Include sections of typical members and details of latching devices.
7. Samples: Submit full set of finish color samples for color selection.
    a. For Supply and Deliver Only Contract: Submit one full size sample of each type of storm window with specified finish for acceptance.
8. Quality Assurance/Control Submittals:
    a. Certificates: Manufacturer's written third party certification that storm windows meet or exceed HUD UM 39a, ANSI/AAMA 1102.10, and other specified requirements.
    b. Manufacturer's installation instructions.

9. Closeout Submittals:
    a. Operation and maintenance data.
    b. Special warranty.

Quality Assurance

10. Regulatory Requirements:
    a. Glazing Materials: Comply with CPSC 16 CFR 1201 or ANSI Z97.1.
    b. Egress Requirements: Comply with applicable codes and regulations.
    c. Provide emergency egress, single point locking release, and bit key lock fire entry from exterior as and where required by applicable codes and regulations.
    d. Accessibility:
        1) Architectural Barriers Act of 1968 as amended (42 USC 4152-4157) and HUD implementing regulations (24 CFR Part 40).
            a) Uniform Federal Accessibility Standards (UFAS).
        2) Section 504 of the Rehabilitation Act of 1973 as amended (29 USC 794) and HUD implementing regulations 24 CFR Part 8.
        3) Fair Housing Accessibility Guidelines (24 CFR Chapter 1).
        4) Americans with Disabilities Act of 1990 (ADA) (28 CFR Part 35).
11. Certifications: Comply with HUD UM 39a, ANSI Z34.1, and HUD 24 CFR 200.935.
12. Mock-ups: For Supply and Install Contract: Install one full size mock-up of each type of storm window with specified finish for acceptance.
    a. Location: As directed.
    b. Approved Mock-up: Standard for rest of work.
    c. Approved Mock-up: May remain part of completed project.

Delivery, Storage, And Handling

13. Packing, Shipping, Handling, and Unloading: Pack materials at manufacturing plant to prevent damage during shipping.
    a. Aluminum Storm Windows: Label in accordance with HUD UM 39a attached signifying compliance with ANSI/AAMA 1002.10 performance requirements.
14. Acceptance at Site: Inspect storm windows upon delivery. Replace damaged or defective materials before installation.
15. Storage and Protection: Store storm windows in manner to protect from weather and other damage.

Project Conditions

16. Field Measurements: Field measure openings for storm windows before start of fabrication.

Scheduling And Sequencing

17. Scheduling and Completion: Comply with requirements of Detailed Scope of Work.

Warranty

18. Special Warranty: Provide one year written covering materials and installation for storm windows.
    a. Warranty: Include coverage of inserts, hardware, and latches.
        1) Screening and glazing riot included.
        2) Defects resulting from vandalism not included.
    b. For Supply and Delivery Only Contract:
        1) Contractor: Agrees to supply and deliver to the Owner, free of charge, any required replacement parts that can be readily installed by the Owner without special tools.
        2) Contractor: Agrees to supply and deliver free of charge, complete replacement window, when defective part or parts cannot be installed without use of special tools.
    c. For Supply and Install Contract:
        1) Contractor: Agrees to supply and install, free of charge, any required replacement parts or complete replacement window.

PRODUCTS

Aluminum Storm Windows

19. General: Type(s) and size(s) indicated, specified, or scheduled with necessary hardware. anchors, and equipment.
20. Materials: ANSI/AAMA 1002.10.
    a. Extruded Aluminum: ASTM B 221, Alloy 60630-TS or stronger.
    b. Carbon Steel (reinforcing members): ASTM A 36, zinc coated in accordance with ASTM B 633 or cadmium coated in accordance with ASTM B 766.
    c. Stainless Steel: ASTM A 167, Type 302.
    d. Anti-galling Devices: Manufacturers standard non-corrosive material compatible with aluminum.
    e. Channel Gaskets: Manufacturer's standard flexible vinyl.
    f. Welding Filler Rods: AWS A5.3.
21. Glazing Materials: Comply with CPSC 16 CFR 1201 or ANSI Z97.1.
    a. Glass: ASTM C 1036, Type 1. Class 1, Glazing B Quality.
    b. Tempered Glass: ASTM C 1048, Kind FT, Condition A, Type 1, Class 1, Glazing B Quality.
    c. Plastic: Extruded polycarbonate clear sheets, minimum 4.5 mm (0.177 inch) thick with following characteristics:
        1) Impact Resistance: ASTM D 256, Method A, 12-18 foot-pound per inch.
        2) Elongation/Modulus of Elasticity: ASTM D 638, 110 percent maximum/340,000 PSI.
        3) Heat Deflection: ASTM D 648, 132.2 degrees C (270 degrees F) at 264 PSI.
        4) Abrasion Resistance: Coated on both surfaces to produce abrasion resistance of 3-19 percent maximum haze increase for 500 revolutions of CS-1 OF wheel per ASTM D 1044.
    d. Glass Thickness: Determined in accordance with ANSI/AAMA 1002.10 Appendix, minimum 3 mm (1/8 inch) (DS).
        1) Design Wind Pressures: Determined in accordance with applicable codes and regulations.
    e. Glass: Labeled to show name of manufacturer and type.
22. Insert Insect Screens: Provide storm windows with Screens as indicated, specified, or scheduled in manufacturer's standard approved design, applicable to specific storm windows.
    a. Screen Frames: Roll form aluminum frames of suitable alloy and of sufficient rigidity, crossbraces, as required, to lie flat against window and to prevent excessive bow in frame members and sag in screening.
        1) Frame Comers: Firmly joined in secured and rigid manner.
    b. Screening: One of following as indicated, specified, or scheduled:
        1) Vinyl Coated Fibrous Glass Yam: ASTM D 3656, Class 1, 18 by 16 mesh, 0.29 mm (0.0115 inch) diameter yam.
        2) Polyvinylidene Chloride or Polypropylene Filament: FS L-S-12513, Type I or III, Class 1 or 2, 18 by 18 mesh, 0.31 mm (0.012 inch) or 0.38 mm (0.015 inch) diameter filament.
        3) Aluminum: FS RR-W-365, Type VII, 18 x 16 or 18 by 18 regular, 0.28 mm (0.011 inch) diameter wire.
        4) Stainless Steel Medium: ANSI/SMA 6001 Medium Type, 12 x 12 mesh type 304 stainless steel 0.58 mm (0.023 inch) diameter wire.
        5) Stainless Steel Heavy: ANSI/SMA 6001 Heavy Type, 12 x 12 mesh type 304 high tensile strength stainless steel 0.71 mm (0.028 inch) diameter wire.
    c. Screening: Fastened to frame in manner to permit replacement of screening.
    d. Screens: Provide with fastening devices, suited particularly for application to specific window made of aluminum or materials compatible with aluminum and of sufficient strength to perform satisfactorily.
    e. Screens: Comply with applicable fire codes for egress and fireman access.
        1) Provide single point release as and where required by applicable codes and regulations.

2) Provide bit key lock fire entry from exterior if required by applicable codes and regulations.

f. Window Screens: Include warning label indicating that screen will not stop child from failing out of window in accordance with SMA 7001.

Accessories

23. Joint Sealant: AAMA 800, Type 808.3 Exterior Perimeter Sealing Compound.

Fabrication

24. General:
    a. Storm Windows: Conform to approved Shop Drawings.
    b. Storm Windows: Assembled securely to assure neat, weather resistant construction.
    c. Glazed Sash: Fabricated to permit reglazing without special tools.
    d. Remove flux and grind welds, flush with exposed surfaces, and polish to blend with ad surfaces.
    e. Sills: Provide weep holes to provide means for water to flow to exterior.
    f. Inserts:
        1) Removable to inside.
        2) Not operable or removable from outside when in closed and latched position.
        3) Glass Inserts: Weatherstripped to prevent metal-to-metal contact with main frame.
    g. Storm Windows: Comply with applicable fire codes for egress.
25. Vertically Sliding Storm Windows: Provide following features:
    a. Aluminum two-track or triple-track, self-storing, vertical-sliding combination storm and screen units with two glass insert panels and one screen insert panel, and two-track storm windows.
    b. Master Frame: Afford clearance for operation of prime window hardware.
    c. Equip units over 1 143 mm (45 inches) wide, 2 032 mm (80 inches) high or 3 175 mm (125 united inches) with extruded aluminum tie bar to ensure rigidity to main frame.
    d. Provide self-activating locks or latches designed to hold sash secure in locked and ventilating positions.
26. Horizontally Operating Storm Windows: Provide following features:
    a. Aluminum triple track, self-storing, horizontally operating, combination storm and screen unit.
    b. Glass Insert Panels: Operable and slide on rollers, rigid PVC or nylon glides.
    c. Equip with security lock to latch closed when in locked position.
    d. Master Frame: Afford clearance for operation of prime window hardware.
    e. Fixed Aluminum Vertical Tie Bar at Meeting Rails of Inserts: Ensure rigidity to main frame.
27. Fixed Picture Storm Windows: Provide following features:
    a. Divider on Storm Windows: Locate over meeting rail or prime window.
    b. When window is larger than 1500 mm (60 inches) in height or width, separate glass area into sections with one or more aluminum muntins to join pieces of glass.
    c. Picture Windows: Fixed but removable inserts either from inside or from outside.
        1) Glazing: Wrapped around marine type vinyl or drop in.

Finishes

28. Finish:
    a. Aluminum Finish: Provide one of following as specified or scheduled:
        1) Factory applied pigmented organic coating. AAMA 603-8.
            a) Color: As selected from manufacturer's standard colors.
        2) Clear Anodized: Factory applied anodic coating, AAMA 607.1, Class 1.
    b. Exposed Surfaces of Aluminum Members: Clean and free from serious surface blemishes.
    c. Dress and finish exposed welded joints.

Source Quality Control

29. Testing: Performed under Third Party Administrator who is in compliance with HUD UM 39a, ANSI Z34.1, and HUD 24 CFR 200.935.

EXECUTION

Examination

30. Site Verification of Conditions: indicated on Shop Drawings.
    a. Field Measurements: Verify field measurements are as
    b. Existing Conditions: Examine openings before beginning installation.
    c. Verify that surfaces to receive storm windows are clean.
    d. Do not proceed with installation until conditions are satisfactory.

Preparation

31. Protection: Protect adjacent elements from damage and disfiguration in accordance with Detailed Scope of Work.
    a. Contractor: Responsible for damage to grounds, plantings, buildings and any other facilities or property caused by construction operations.
    b. Repair or replace damaged elements in accordance with Detailed Scope of Work.
32. Existing Storm Widows: Remove existing storm windows and debris from site in accordance with Detailed Scope of Work.
33. Preparation: Prepare openings and existing frames in accordance with ASTM E 737.
    a. Prime Window Jambs of Existing Prime Windows: Prepare as necessary to provide for straight, plumb, level, tight and aesthetically appealing installation of new storm windows.
    b. Preparatory Work: Include, but not limited to repair of jambs, filling holes and/or dents, removing peeling and scaling paint, etc.

Installation

34. General: Install in accordance with ASTM E 737, manufacturer's recommendations, Reference Standards, and approved Shop Drawings.
    a. Securely fasten storm windows in place to straight, plumb and level condition, without distortion of window or window frame, and make final adjustments for proper operation and satisfactory weatherstrip contact and seal.
    b. Comply with applicable codes and regulations regarding egress requirements and fireman entry.
35. Joint Sealants: Apply in accordance with manufacturers recommendations.
    a. Surfaces to be Sealed: Clean, dry and free of any foreign matter that would degrade adhesion. Remove existing calking and joint sealants from areas to receive new joint sealant.
    b. Prime cleaned surfaces in accordance with sealant manufacturers recommendations.
    c. Protect surfaces adjacent to joints by masking tape before applying sealant. Remove tape upon finishing sealing work.
    d. Seal joints between perimeter of window frame and underlying or surrounding construction with joint sealant to accomplish weather-tight installation.
    e. Maximum Width of Sealed Joint: 13 mm (1/2 Inch).
36. Dissimilar Materials: Isolate materials from incompatible materials as necessary to prevent deterioration.
    a. Separate dissimilar metals with bituminous paint, suitable sealant, nonabsorptive plastic or elastomeric tape, or gasket between surfaces.
    b. Coat aluminum in direct contact with concrete, masonry, steel, or other non-compatible materials with bituminous paint, zinc chromate primer, or other suitable insulating material.

Adjusting And Cleaning

37. Adjusting: At completion of job, check, adjust, and lubricate hardware as required and leave storm windows and hardware in proper operating condition.
38. Cleaning: Comply with requirements of Detailed Scope of Work.

a. Clean storm windows after installation is completed to remove foreign matter and surface blemishes.

b. Scratched or Abraded Surfaces: Touch-up with rust inhibitor primer and enamel paint compatible with factory finish.

Protection

39. Installed Work: Protect storm windows from damage after installation

END OF SECTION 08 51 69 00

Task	Specification	Specification Description
08 51 69 00	08 11 63 13a	Security Window Screens and Doors
08 51 69 00	08 51 13 00	Aluminum Windows
08 52 11 00	08 01 52 61	Wood Windows
08 52 13 00	08 01 52 61	Wood Windows
08 52 16 00	08 01 52 61	Wood Windows
08 52 66 00	08 01 52 61	Wood Windows

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SECTION 08 53 13 00 - VINYL WINDOWS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of material for fixed and operable vinyl framed windows. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes fixed and operable vinyl-framed windows.

C. Definitions
   1. Performance class designations according to AAMA/WDMA 101/I.S.2/NAFS:
      a. AW: Architectural.
      b. HC: Heavy Commercial.
      c. C: Commercial.
      d. LC: Light Commercial.
      e. R: Residential.
   2. Performance grade number according to AAMA/WDMA 101/I.S.2/NAFS:
      a. Design pressure number in pounds force per square foot (pascals) used to determine the structural test pressure and water test pressure.
   3. Structural Test Pressure: For uniform load structural test, is equivalent to 150 percent of the design pressure.
   4. Minimum Test Size: Smallest size permitted for performance class (gateway test size). Products must be tested at minimum test size or at a size larger than minimum test size to comply with requirements for performance class.

D. Performance Requirements
   1. General: Provide vinyl windows capable of complying with performance requirements indicated, based on testing manufacturer's windows that are representative of those specified, and that are of test size indicated below:
      a. Size required by AAMA/WDMA 101/I.S.2/NAFS for gateway performance **OR** optional performance grade, **as directed**.
      b. Size indicated on Drawings **OR** in a schedule, **as directed**.
   2. Structural Performance: Provide vinyl windows capable of withstanding the effects of the following loads, based on testing units representative of those indicated for Project that pass AAMA/WDMA 101/I.S.2/NAFS, Uniform Load Structural Test:
      a. Design Wind Loads: Determine design wind loads applicable to Project from basic wind speed indicated in miles per hour (meters per second) at 33 feet (10 m) above grade, according to ASCE 7, Section 6.5, "Method 2-Analytical Procedure," based on mean roof heights above grade indicated on Drawings.
         1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s), **as directed**.
         2) Importance Factor.
         3) Exposure Category: A **OR** B **OR** C **OR** D, **as directed**.
   3. Windborne-Debris Resistance: Provide glazed windows capable of resisting impact from windborne debris, based on the pass/fail criteria as determined from testing glazed windows identical to those specified, according to ASTM E 1886 and testing information in ASTM E 1996 or AAMA 506 and requirements of authorities having jurisdiction.

E. Submittals
   1. Product Data: For each type of vinyl window indicated.

2. Shop Drawings: Include plans, elevations, sections, details, hardware, attachments to other work, operational clearances, and installation details.
3. Samples: For each exposed finish.
4. Product Schedule: Use same designations indicated on Drawings.
5. Product test reports.
6. Maintenance data.
7. Warranty: Special warranty specified in this Section.

F. Quality Assurance
1. Installer: A qualified installer, approved by manufacturer to install manufacturer's products.
2. Fenestration Standard: Comply with AAMA/WDMA 101/I.S.2/NAFS, "North American Fenestration Standard Voluntary Performance Specification for Windows, Skylights and Glass Doors," for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.
    a. Provide AAMA **OR** WDMA, **as directed**,-certified vinyl windows with an attached label.
3. Glazing Publications: Comply with published recommendations of glass manufacturers and with GANA's "Glazing Manual" unless more stringent requirements are indicated.
4. Preinstallation Conference: Conduct conference at Project site.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace vinyl windows that fail in materials or workmanship within specified warranty period.
    a. Failures include, but are not limited to, the following:
        1) Failure to meet performance requirements.
        2) Structural failures including excessive deflection, water leakage, air infiltration, or condensation.
        3) Faulty operation of movable sash and hardware.
        4) Deterioration of vinyl, other materials, and finishes beyond normal weathering.
        5) Failure of insulating glass.
    b. Warranty Period:
        1) Window: Two **OR** Three **OR** 10, **as dirtected**, years from date of Final Completion.
        2) Glazing: Five **OR** 10, **as directed**, years from date of Final Completion.
        3) Vinyl Finish: Five years from date of Final Completion.

1.2 PRODUCTS

A. Materials
1. Vinyl Extrusions: Rigid (unplasticized) hollow PVC extrusions, formulated and extruded for exterior applications, complying with AAMA/WDMA 101/I.S.2/NAFS and the following:
    a. PVC Resins: 100 percent virgin resin.
    b. PVC Formulation: High impact, low heat buildup, lead free, nonchalking, and color and UV stabilized.
    c. Extrusion Wall Thickness: Not less than 0.060 inch (1.5 mm) **OR** 0.090 inch (2.3 mm) **OR** 0.125 inch (3.2 mm), **as directed**.
    d. Multichamber Extrusions: Profile designed with two chambers **OR** three chambers **OR** multichambers, **as directed**, between interior and exterior faces of the extrusions.
2. Vinyl Trim and Glazing Stops: Material and finish to match frame members.
3. Fasteners: Aluminum, nonmagnetic stainless steel, epoxy adhesive, or other materials warranted by manufacturer to be noncorrosive and compatible with vinyl window members, cladding, trim, hardware, anchors, and other components.
    a. Exposed Fasteners: Unless unavoidable for applying hardware, do not use exposed fasteners. For application of hardware, use fasteners that match finish of member or hardware being fastened, as appropriate.

4. Anchors, Clips, and Accessories: Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.
5. Reinforcing Members: Aluminum, or nonmagnetic stainless steel, or nickel/chrome-plated steel complying with ASTM B 456 for Type SC 3 severe service conditions, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.
6. Compression-Type Weather Stripping: Provide compressible weather stripping designed for permanently resilient sealing under bumper or wiper action, and for complete concealment when vinyl window is closed.
   a. Weather-Stripping Material: Elastomeric cellular preformed gaskets complying with ASTM C 509.
   b. Weather-Stripping Material: Dense elastomeric gaskets complying with ASTM C 864.
   c. Weather-Stripping Material: Manufacturer's standard system and materials complying with AAMA/WDMA 101/I.S.2/NAFS.
7. Sliding-Type Weather Stripping: Provide woven-pile weather stripping of wool, polypropylene, or nylon pile and resin-impregnated backing fabric. Comply with AAMA 701/702.
   a. Weather Seals: Provide weather stripping with integral barrier fin or fins of semirigid, polypropylene sheet or polypropylene-coated material. Comply with AAMA 701/702.
8. Replaceable Weather Seals: Comply with AAMA 701/702.

B. Window
1. Window Type: Casement **OR** Double hung **OR** Fixed **OR** Horizontal sliding **OR** Projected awning **OR** Single hung **OR** Bay **OR** Bow **OR** Specialty product **OR** As indicated on Drawings **OR** As indicated on a schedule, **as directed**.
2. AAMA/WDMA Performance Requirements: Provide vinyl windows of performance indicated that comply with AAMA/WDMA 101/I.S.2/NAFS unless more stringent performance requirements are indicated.
   a. Performance Class and Grade: R15 **OR** R20 **OR** R25, **as directed**.
   b. Performance Class and Grade: LC25 **OR** LC30 **OR** LC35, **as directed**.
   c. Performance Class and Grade: C30 **OR** C35 **OR** C40, **as directed**.
   d. Performance Class and Grade: HC40 **OR** HC45 **OR** HC50, **as directed**.
   e. Performance Class and Grade: AW40 **OR** AW45 **OR** AW50, **as directed**.
   f. Performance Class and Grade: As indicated.
   g. Performance Class (if test performance method is selected for specifying windows and designating a performance class does not conflict with basic wind speed and performance testing indicated): R **OR** LC **OR** C **OR** HC **OR** AW, **as directed**.
3. Condensation-Resistance Factor (CRF): Provide vinyl windows tested for thermal performance according to AAMA 1503, showing a CRF of 45 **OR** 52 **OR** 65, **as directed**.
4. Thermal Transmittance: Provide vinyl windows with a whole-window, U-factor maximum indicated at 15-mph (24-km/h) exterior wind velocity and winter condition temperatures when tested according to AAMA 1503 **OR** ASTM E 1423 **OR** NFRC 100, **as directed**.
   a. U-Factor: 0.35 Btu/sq. ft. x h x deg F (2.0 W/sq. m x K) **OR** 0.40 Btu/sq. ft. x h x deg F (2.3 W/sq. m x K) **OR** 0.43 Btu/sq. ft. x h x deg F (2.5 W/sq. m x K) **OR** 0.60 Btu/sq. ft. x h x deg F (3.4 W/sq. m x K), **as directed**, or less.
5. Solar Heat-Gain Coefficient (SHGC): Provide vinyl windows with a whole-window SHGC maximum of 0.40 **OR** 0.50 **OR** 0.55, **as directed**, determined according to NFRC 200 procedures.
6. Sound Transmission Class (STC): Provide glazed windows rated for not less than 26 **OR** 30 **OR** 35, **as directed**, STC when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 413.
7. AAMA/WDMA 101/I.S.2/NAFS, Air Infiltration Test.
   a. Maximum Rate: 0.3 cfm/sq. ft. (5 cu. m/h x sq. m) of area at an inward test pressure of 1.57 lbf/sq. ft. (75 Pa) which is equivalent to 25-mph (40-km/h) wind speed and is typically used to test R, C, and LC performance classes.

b. Maximum Rate: 0.3 cfm/sq. ft. (5 cu. m/h x sq. m) of area at an inward test pressure of 6.24 lbf/sq. ft. (300 Pa) which is equivalent to a 50-mph (80-km/h) wind speed and is typically used to test HC and AW performance classes.

8. Water Resistance: No water leakage as defined in AAMA/WDMA referenced test methods at a water test pressure equaling that indicated, when tested according to AAMA/WDMA 101/I.S.2/NAFS, Water Resistance Test.
   a. Test Pressure: 15 percent of positive design pressure, but not less than 2.86 lbf/sq. ft. (140 Pa) or more than 15 lbf/sq. ft. (720 Pa).
   b. Test Pressure: 20 percent of positive design pressure, but not more than 15 lbf/sq. ft. (720 Pa).
9. Forced-Entry Resistance: Comply with Performance Grade 10 **OR** 20 **OR** 30 **OR** 40, **as directed**, requirements when tested according to ASTM F 588.
10. Life-Cycle Testing: Test according to AAMA 910 and comply with AAMA/WDMA 101/I.S.2/NAFS.
11. Operating Force and Auxiliary (Durability) Tests: Comply with AAMA/WDMA 101/I.S.2/NAFS for operating window types indicated.

C. Glazing
1. Glass: Clear, insulating-glass units **OR** Clear, insulating-glass units, with low-E coating pyrolytic on second surface or sputtered on second or third surface, **OR** Clear, insulating-glass units, argon gas filled, with low-E coating pyrolytic on second surface or sputtered on second or third surface, **as directed**, complying with Division 08 Section "Glazing".
2. Glazing System: Manufacturer's standard factory-glazing system that produces weathertight seal **OR** Manufacturer's standard factory-glazing system that produces weathertight seal and complies with requirements for windborne-debris resistance **OR** Manufacturer's standard factory-glazing system as indicated in Division 08 Section "Glazing", **as directed**.

D. Hardware
1. General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with vinyl; designed to smoothly operate, tightly close, and securely lock vinyl windows, and sized to accommodate sash or ventilator weight and dimensions. Do not use aluminum in frictional contact with other metals. Where exposed, provide solid bronze **OR** extruded, cast, or wrought aluminum **OR** die-cast zinc with special coating finish **OR** nonmagnetic stainless steel, **as directed**.
2. Counterbalancing Mechanism: Comply with AAMA 902.
   a. Sash-Balance Type: Concealed, tape-spring **OR** spiral-tube **OR** spring-loaded, block-and-tackle, **as directed**, type, of size and capacity to hold sash stationary at any open position.
3. Sill Cap/Track: Extruded-aluminum track with natural anodized finish **OR** Rigid PVC or other weather-resistant plastic track with manufacturer's standard integral color, **as directed**, of thickness, dimensions, and profile indicated; designed to comply with performance requirements indicated and to drain to the exterior.
4. Locks and Latches: Designed to allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only. Provide custodial locks, **as directed**.
5. Roller Assemblies: Low-friction design.
6. Push-Bar Operators: Provide telescoping-type, push-bar operator designed to open and close ventilators with fixed screens.
7. Gear-Type Rotary Operators: Comply with AAMA 901 when tested according to ASTM E 405, Method A.
   a. Operation Function: All ventilators move simultaneously and securely close at both jambs without using additional manually controlled locking devices.
8. Four- or Six-Bar Friction Hinges: Comply with AAMA 904.
   a. Locking mechanism and handles for manual operation.
   b. Friction Shoes: Provide friction shoes of nylon or other nonabrasive, nonstaining, noncorrosive, durable material.

9. Limit Devices: Provide concealed friction adjustor, adjustable stay bar **OR** concealed support arms with adjustable, limited, hold-open, **as directed**, limit devices designed to restrict sash or ventilator opening.
   a. Safety Devices: Limit clear opening to 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, for ventilation; with custodial key release.
10. Pole Operators: Tubular-shaped anodized aluminum; with rubber-capped lower end and standard push-pull hook at top to match hardware design; of sufficient length to operate window without reaching more than 60 inches (1500 mm) above floor; 1 pole operator and pole hanger per room that has operable windows more than 72 inches (1800 mm) above floor.

E. Insect Screens
1. General: Design windows and hardware to accommodate screens in a tight-fitting, removable arrangement, with a minimum of exposed fasteners and latches. Fabricate insect screens to fully integrate with window frame. Locate screens on inside **OR** outside, **as directed**, of window and provide for each operable exterior sash or ventilator.
   a. Aluminum Tubular Frame Screens: Comply with SMA 1004, "Specifications for Aluminum Tubular Frame Screens for Windows," Residential R-20 **OR** Architectural C-24 **OR** Monumental M-32, **as directed**, class.
2. Aluminum Insect Screen Frames: Manufacturer's standard aluminum alloy complying with SMA 1004. Fabricate frames with mitered or coped joints or corner extrusions, concealed fasteners, adjustable rollers, **as directed**, and removable PVC spline/anchor concealing edge of frame.
   a. Aluminum Tubular Framing Sections and Cross Braces: Roll formed from aluminum sheet with minimum wall thickness as required for class indicated.
   b. Finish: Anodized aluminum **OR** Baked-on organic coating, **as directed**, in manufacturer's standard color.
   c. Finish: Anodized aluminum **OR** Baked-on organic coating, **as directed**, in color selected from manufacturer's full range.
   d. Finish: Manufacturer's standard.
3. Glass-Fiber Mesh Fabric: 18-by-14 (1.1-by-1.4-mm) or 18-by-16 (1.0-by-1.1-mm) **OR** 20-by-20 (0.85-by-0.85-mm) or 20-by-30 (0.85-by-0.42-mm), **as directed**, mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration, in the following color. Comply with ASTM D 3656.
   a. Mesh Color: Charcoal gray **OR** Silver gray **OR** Aquamarine, **as directed**.
4. Aluminum Wire Fabric: 18-by-16 (1.1-by-1.3-mm) mesh of 0.011-inch- (0.28-mm-) diameter, coated aluminum wire.
   a. Wire-Fabric Finish: Natural bright **OR** Charcoal gray **OR** Black, **as directed**.
5. Wickets: Provide sliding **OR** hinged, **as directed**, wickets, framed and trimmed for a tight fit and for durability during handling.

F. Accessories
1. Dividers (False Muntins): Provide dividers in designs indicated for each sash lite, one per sash, removable from the exposed surface of interior lite of the sash **OR** two per sash, removable from the exposed surfaces of interior and exterior lites of the sash **OR** one permanently located between glazing lites in the airspace, **as directed**.
   a. Material: Extruded, rigid PVC **OR** Aluminum, **as directed**.
   b. Design: Rectangular **OR** Diamond, **as directed**.
   c. Color: White **OR** Beige, **as directed**.

G. Fabrication
1. Fabricate vinyl windows in sizes indicated. Include a complete system for assembling components and anchoring windows.
   a. Welded Frame and Sash/Ventilator Corners: Miter-cut and fusion **OR** chemically, **as directed**, welded.
   b. Mechanically Fastened Frame and Sash/Ventilator Corners: Double-butt coped and fastened with concealed screws, **as directed**.

2. Fabricate vinyl windows that are reglazable without dismantling sash or ventilator framing.
3. Weather Stripping: Provide full-perimeter weather stripping for each operable sash and ventilator, unless otherwise indicated.
   a. Double-Hung Windows: Provide weather stripping only at horizontal rails of operable sash.
4. Mullions: Provide mullions and cover plates as shown, compatible with window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections, as indicated. Provide mullions and cover plates capable of withstanding design loads of window units. Provide manufacturer's standard finish to match window units.
5. Subframes: Provide subframes with anchors for window units as shown, of profile and dimensions indicated but not less than 0.062-inch- (1.6-mm-) thick extruded aluminum. Miter or cope corners, and weld and dress smooth with concealed mechanical joint fasteners. Provide manufacturer's standard finish to match window units. Provide subframes capable of withstanding design loads of window units.
6. Factory-Glazed Fabrication: Except for light sizes in excess of 100 united inches (2500 mm width plus length), glaze vinyl windows in the factory where practical and possible for applications indicated. Comply with requirements in Division 08 Section "Glazing" and with AAMA/WDMA 101/I.S.2/NAFS.
7. Glazing Stops: Provide nailed or snap-on glazing stops coordinated with Division 08 Section "Glazing" and glazing system indicated. Provide glazing stops to match sash and ventilator frames.
8. Hardware: Mount hardware through double walls of vinyl extrusions or provide corrosion-resistant steel reinforcement complying with requirements for reinforcing members, or do both.
9. Bow **OR** Bay, **as directed**, Windows: Provide vinyl windows in configuration indicated. Provide window frames, fixed and operating sash, operating hardware, and other trim and components necessary for a complete, secure, and weathertight installation, including the following:
   a. Angled mullion posts with interior and exterior trim.
   b. Angled interior and exterior extension and trim.
   c. Clear pine head and seat boards.
   d. Top and bottom plywood platforms.
   e. Exterior head and sill casings and trim.
   f. Support brackets.
10. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation. Allow for scribing, trimming, and fitting at Project site.

H. Vinyl Finishes
1. Integral Finish and Color: Uniform, solid, homogeneous white **OR** beige, **as directed**, interior and exterior.
2. Organic Pigmented Finish: Manufacturer's standard finish, interior and exterior, complying with AAMA 613 **OR** AAMA 615, **as directed**, and paint manufacturer's written specifications for cleaning and painting.
   a. Color: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.

1.3 EXECUTION

A. Installation
1. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing windows, hardware, accessories, and other components.
2. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction.
3. Set sill members in bed of sealant or with gaskets, as indicated, for weathertight construction.

4. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

B. Adjusting, Cleaning, And Protection
  1. Adjust operating sashes and ventilators, screens, hardware, and accessories for a tight fit at contact points and weather stripping for smooth operation and weathertight closure. Lubricate hardware and moving parts.
  2. Clean exposed surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.
  3. Clean factory-glazed glass immediately after installing windows. Comply with manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels, and clean surfaces.
  4. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.
  5. Protect window surfaces from contact with contaminating substances resulting from construction operations. In addition, monitor window surfaces adjacent to and below exterior concrete and masonry surfaces during construction for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written recommendations.

END OF SECTION 08 53 13 00

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Task	Specification	Specification Description
08 53 66 00	08 53 13 00	Vinyl Windows
08 54 13 00	08 53 13 00	Vinyl Windows
08 54 66 00	08 53 13 00	Vinyl Windows

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SECTION 08 56 19 00 - SECURITY WINDOWS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of material for security windows. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Vision security windows.
   b. Fixed, transaction security windows.
   c. Sliding, transaction security windows.

C. Performance Requirements

1. Ballistics-Resistance Performance: Provide units identical to those tested for compliance with requirements indicated, and as follows:
   a. Listed and labeled as bullet resisting according to UL 752.
   b. Tested for ballistics resistance according to UL 752 **OR** ASTM F 1233 **OR** HPW-TP-0500.03 **OR** NIJ STD-0108.01, **as directed**, by a testing agency acceptable to authorities having jurisdiction.
   c. Certified as complying with SD-STD-01.01, by the U.S. State Department, for ballistics resistance when tested by a qualified testing agency.
2. Forced-Entry-Resistance Performance: Provide units identical to those tested for compliance with requirements indicated, and as follows:
   a. Tested for forced-entry resistance according to HPW-TP-0500.03 **OR** ASTM F 1233, **as directed**, by a testing agency acceptable to authorities having jurisdiction.
   b. For Federal Government Work: Certified as complying with SD-STD-01.01, by the U.S. State Department, for forced-entry resistance when tested by a qualified testing agency.
3. Windborne-Debris-Impact-Resistance-Test Performance: Provide automatic entrances that pass large missile-impact and cyclic-pressure tests of ASTM E 1996 according to the IBC.
4. Structural Performance: Security windows shall withstand the effects of wind loads determined as follows, with no permanent deformation or breakage within window assembly when tested according to ASTM E 330:
   a. Basic Wind Speed: As indicated in miles per hour (meters per second) at 33 feet (10 m) above grade. Determine wind loads and resulting design pressures applicable to Project according to SEI/ASCE 7, "Minimum Design Loads for Buildings and Other Structures," Section 6.4.2, "Analytic Procedure," based on mean roof heights above grade as indicated on Drawings.
5. Air Infiltration for Operable Windows: Not more than 0.370 cfm/ft. (0.573 L/s per m) **OR** 0.500 cfm/ft. (0.774 L/s per m), **as directed**, of operable sash joint at an inward test pressure of 1.56 lbf/sq. ft. (75 Pa) when tested according to ASTM E 283.
6. Air Infiltration for Fixed Windows: Not more than 0.010 cfm/ft. (0.015 L/s per m) **OR** 0.060 cfm/ft. (0.093 L/s per m), **as directed**, of crack length at an inward test pressure of 1.56 lbf/sq. ft. (75 Pa) when tested according to ASTM E 283.
7. Water Penetration: No water penetration as defined in test method at an inward test pressure of 1.56 lbf/sq. ft. (75 Pa) **OR** 2.86 lbf/sq. ft. (137 Pa) **OR** 6.24 lbf/sq. ft. (300 Pa), **as directed**, when tested according to ASTM E 331.

D. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings.

3. Samples: For each type of exposed finish required.
4. Welding certificates.
5. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of security window and accessory indicated as ballistics **OR** forced-entry, **as directed**, resistant.
6. Configuration Disclosure Drawing: For each type of forced-entry-resistant security window, complying with ASTM F 1233.
7. Warranty: Sample of special warranty.

E. Quality Assurance
1. Testing Agency Qualifications: Qualified according to ASTM E 699 and experienced in ballistics- and forced-entry-resistance testing.
2. Welding Qualifications: Qualify procedures and personnel according to the following:
    a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
    b. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
    c. AWS D1.3, "Structural Welding Code - Sheet Steel."
    d. AWS D1.6, "Structural Welding Code - Stainless Steel."
3. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Pack security windows in wood crates for shipment. Crate glazing separate from frames unless factory glazed.
2. Label security window packaging with location in Project **OR** drawing designation, **as directed**.
3. Store crated security windows on raised blocks to prevent moisture damage.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace security windows that fail in materials or workmanship within three years from date of Final Completion.

1.2 PRODUCTS

A. Materials
1. Aluminum Extrusions: ASTM B 221 (ASTM B 221M). Provide alloy and temper recommended by manufacturer for strength, corrosion resistance, and application of required finish, but not less than 22,000-psi (150-MPa) ultimate tensile strength and not less than 0.125 inch (3.2 mm) thick at any location for main frame and sash members.
2. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
3. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, CS (Commercial Steel), Type B; free of scale, pitting, or surface defects; pickled and oiled.
4. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, CS (Commercial Steel), Type B.
5. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, CS (Commercial Steel), Type B; with G60 (Z180) zinc (galvanized) or A60 (ZF180) zinc-iron-alloy (galvannealed) coating designation.
6. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 240/A 240M or ASTM A 666, austenitic stainless steel, Type 304 **OR** Type 316, **as directed**, stretcher-leveled standard of flatness.
7. Concealed Bolts: ASTM A 307, Grade A unless otherwise indicated.
8. Cast-in-Place Anchors in Concrete: Fabricated from corrosion-resistant materials capable of sustaining, without failure, a load equal to four times the load imposed, as determined by testing per ASTM E 488, conducted by a qualified testing agency.
    a. Threaded or wedge type; galvanized ferrous castings, either ASTM A 27/A 27M cast steel or ASTM A 47/A 47M malleable iron. Provide bolts, washers, and shims as required; hot-dip galvanized per ASTM A 153/A 153M or ASTM F 2329.

9. Embedded Plate Anchors: Fabricated from steel shapes and plates, minimum 3/16 inch (4.8 mm) thick; with minimum 1/2-inch- (12.7-mm-) diameter, headed studs welded to back of plate.
10. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
11. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos; formulated for 30-mil (0.76-mm) thickness per coat.
12. Sealants: For sealants required within fabricated security windows, provide type recommended by manufacturer for joint size and movement. Sealant shall remain permanently elastic, nonshrinking, and nonmigrating.

B. Window Components
1. Glazing: Comply with requirements in Division 08 Section "Security Glazing" for performance indicated.
   a. Comply with requirements of UL listing for ballistics-resistance level.
2. Compression-Type Glazing Strips and Weather Stripping: Unless otherwise indicated, provide compressible stripping for glazing and weather stripping, such as molded EPDM or neoprene gaskets complying with ASTM D 2000, Designations 2BC415 to 3BC620; molded PVC gaskets complying with ASTM D 2287; or molded, expanded EPDM or neoprene gaskets complying with ASTM C 509, Grade 4.
3. Miscellaneous Glazing Materials: Provide material, size, and shape complying with requirements of glass manufacturers, and with a proven record of compatibility with surfaces contacted in installation.
   a. Cleaners, Primers, and Sealers: Type recommended by sealant or gasket manufacturer.
   b. Setting Blocks: Elastomeric material with a Type A Shore durometer hardness of 85, plus or minus 5.
   c. Spacers: Elastomeric blocks or continuous extrusions with a Type A Shore durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
   d. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
4. Anchors, Clips, and Window Accessories: Stainless steel; hot-dip, zinc-coated steel or iron, complying with ASTM B 633; provide sufficient strength to withstand design pressure indicated.

C. Vision Security Windows
1. Vision Security Windows: Provide fixed vision security windows with framing on four sides and no operable sash or ventilator.
2. Ballistics Resistance:
   a. Level 1 **OR** Level 2 **OR** Level 3 **OR** Level 4 **OR** Level 5 **OR** Level 6 **OR** Level 7 **OR** Level 8, **as directed**, when tested according to UL 752.
   b. HG1 **OR** HG2 **OR** HG3 **OR** HG4 **OR** SMG **OR** R1 **OR** R2 **OR** R3 **OR** R4-AP **OR** SH1 **OR** SH2, **as directed**, when tested according to ASTM F 1233.
   c. A **OR** B **OR** C **OR** D **OR** E, **as directed**, when tested according to HPW-TP-0500.03.
   d. S **OR** R **OR** AP **OR** SH, **as directed**, when tested according to SD-STD-01.01.
   e. Level I **OR** Level IIA **OR** Level II **OR** Level IIIA **OR** Level III **OR** Level IV, **as directed**, when tested according to NIJ STD-0108.01.
3. Forced-Entry Resistance:
   a. Level I **OR** Level II **OR** Level III **OR** Level IV **OR** Level V, **as directed**, when tested according to HPW-TP-0500.03.
   b. Class I **OR** Class II **OR** Class III **OR** Class IV **OR** Class V, **as directed**, when tested according to ASTM F 1233.
   c. Five **OR** 15 **OR** 60, **as directed**,-minute protection level when tested according to SD-STD-01.01.
4. Framing: Fabricate perimeter framing, mullions, and glazing stops from metal sheet as follows:
   a. Material:
      1) Cold-rolled steel sheet, factory primed for field-painted finish **OR** with baked-enamel finish, **as directed**.

2) Galvanized-steel sheet, factory primed for field-painted finish.
3) Stainless-steel sheet with No. 4 finish.
4) Aluminum-clad steel sheet with Class I, clear anodized **OR** Class II, clear anodized **OR** Class I, color anodized **OR** Class II, color anodized **OR** baked-enamel, **as directed**, finish.
5) Material: Extruded aluminum with Class I, clear anodized **OR** Class II, clear anodized **OR** Class I, color anodized **OR** Class II, color anodized **OR** baked-enamel, **as directed**, finish.

b. Profile: Manufacturer's standard **OR** Narrow, **as directed**, with minimum face dimension indicated.
c. Minimum Face Dimension: 2 inches (50 mm) **OR** 1-1/4 inches (32 mm) **OR** As indicated on Drawings, **as directed**.
d. Framing Depth:
1) Manufacturer's standard.
2) Adjustable for varying wall thicknesses by use of a two-piece, split frame that is attached to wall by clamping action induced by tightening screws.
3) As indicated on Drawings.

e. Framing Orientation: Vertical **OR** Incline subframe 5 degrees to vertical, with top of frame slanted away from protected side of window, **as directed**.

D. Fixed, Transaction Security Windows
1. Fixed, Transaction Security Windows: Provide fixed, framed transaction windows with operable sash or ventilator capable of allowing transfer of currency and documents.
2. Configuration: One fixed-glazed panel **OR** Multiple fixed-glazed panels **OR** As indicated on Drawings, **as directed**.
3. Ballistics Resistance:
a. Level 1 **OR** Level 2 **OR** Level 3 **OR** Level 4Level 5 **OR** Level 6 **OR** Level 7 **OR** Level 8, **as directed**, when tested according to UL 752.
b. HG1 **OR** HG2 **OR** HG3 **OR** HG4 **OR** SMG **OR** R1 **OR** R2 **OR** R3 **OR** R4-AP **OR** SH1 **OR** SH2, **as directed**, when tested according to ASTM F 1233.
c. A **OR** B **OR** C **OR** D **OR** E, **as directed**, when tested according to HPW-TP-0500.03.
d. S **OR** R **OR** AP **OR** SH, **as directed**, when tested according to SD-STD-01.01.
e. Level I **OR** Level IIA **OR** Level II **OR** Level IIIA **OR** Level III **OR** Level IV, **as directed**, when tested according to NIJ STD-0108.01.

4. Forced-Entry Resistance:
a. Level I **OR** Level II **OR** Level III **OR** Level IV **OR** Level V, **as directed**, when tested according to HPW-TP-0500.03.
b. Class I **OR** Class II **OR** Class III **OR** Class IV **OR** Class V, **as directed**, when tested according to ASTM F 1233.
c. Five **OR** 15 **OR** 60, **as directed**,-minute protection level when tested according to SD-STD-01.01.

5. Framing: Fabricate perimeter framing, mullions, and glazing stops from metal sheet as follows:
a. Material:
1) Cold-rolled steel sheet, factory primed for field-painted finish **OR** with baked-enamel finish, **as directed**.
2) Stainless-steel sheet with No. 4 finish.
3) Aluminum-clad steel sheet with Class I, clear anodized **OR** Class II, clear anodized **OR** Class I, color anodized **OR** Class II, color anodized **OR** baked-enamel, **as directed**, finish.
4) Extruded aluminum with Class I, clear anodized **OR** Class II, clear anodized **OR** Class I, color anodized **OR** Class II, color anodized **OR** baked-enamel, **as directed**, finish.

b. Profile: Manufacturer's standard **OR** Narrow, **as directed**, with minimum face dimension indicated.

c. Minimum Face Dimension: 2 inches (50 mm) **OR** 1-1/4 inches (32 mm) **OR** As indicated on Drawings, **as directed**.
d. Framing Depth:
1) Manufacturer's standard.
2) Adjustable for varying wall thicknesses by use of a two-piece, split frame that is attached to wall by clamping action induced by tightening screws.
3) As indicated on Drawings.
e. Provide thermally improved construction for aluminum framing.

6. Head and Jamb Framing: Designed for sealant glazing **OR** gasket glazing **OR** voice communication by speech at normal volume, **as directed**.
7. Channel-Frame Sill: Formed from stainless steel and designed for sealant glazing.
a. Transaction Counter: Stainless steel, 12 inches (305 mm) **OR** 18 inches (457 mm), **as directed**, deep by width of security window, with integral deal tray centered in opening **OR** as indicated on Drawings, **as directed**.
b. Transaction Counter: Stainless steel, 21 inches (533 mm) deep by width of security window, with operable deal tray centered in opening **OR** as indicated on Drawings, **as directed**.
8. Voice-Communication-Type Sill: Formed from stainless steel and designed to allow passage of speech at normal speaking volume without distortion.
a. Sill Depth: 12 inches (305 mm) deep **OR** 18 inches (457 mm) deep with 6-inch (152-mm) deep projection on nonsecure side **OR** 21 inches (533 mm) deep with 6-inch (152-mm) deep projection on both sides, **as directed**.
b. Transaction Counter: Stainless steel, 12 inches (305 mm) **OR** 18 inches (457 mm), **as directed**, deep by width of security window, with integral deal tray centered in opening **OR** as indicated on Drawings, **as directed**.
c. Integral Transaction-Drawer Sill: Formed from stainless steel **OR** framing to match head and jamb framing, **as directed**; with transaction drawer integrated into framing and contained in a stainless-steel housing that forms a transaction counter on secure side **OR** nonsecure side **OR** both sides, **as directed**, of opening. Drawer front shall be flush with housing when drawer is closed.

E. Sliding, Transaction Security Windows
1. Sliding, Transaction Security Windows: Provide horizontal-sliding, transaction security windows.
2. Configuration: One fixed-glazed panel and one horizontal-sliding glazed panel **OR** Two glazed panels that slide horizontally and meet at center of security window **OR** As indicated on Drawings, **as directed**.
3. Ballistics Resistance:
a. Level 1 **OR** Level 2 **OR** Level 3 **OR** Level 4 **OR** Level 5 **OR** Level 6 **OR** Level 7 **OR** Level 8, **as directed**, when tested according to UL 752.
b. HG1 **OR** HG2 **OR** HG3 **OR** HG4 **OR** SMG **OR** R1 **OR** R2 **OR** R3 **OR** R4-AP **OR** SH1 **OR** SH2, **as directed**, when tested according to ASTM F 1233.
c. A **OR** B **OR** C **OR** D **OR** E, **as directed**, when tested according to HPW-TP-0500.03.
d. S **OR** R **OR** AP **OR** SH, **as directed**, when tested according to SD-STD-01.01.
e. Level I **OR** Level IIA **OR** Level II **OR** Level IIIA **OR** Level III **OR** Level IV, **as directed**, when tested according to NIJ STD-0108.01.
4. Forced-Entry Resistance:
a. Level I **OR** Level II **OR** Level III **OR** Level IV **OR** Level V, **as directed**, when tested according to HPW-TP-0500.03.
b. Class I **OR** Class II **OR** Class III **OR** Class IV **OR** Class V, **as directed**, when tested according to ASTM F 1233.
c. Five **OR** 15 **OR** 60, **as directed**,-minute protection level when tested according to SD-STD-01.01.
5. Framing: Fabricate perimeter framing, mullions, and glazing stops from metal sheet as follows:
a. Material:
1) Cold-rolled steel sheet, factory primed for field-painted finish **OR** with baked-enamel finish, **as directed**.

2) Material: Stainless-steel sheet with No. 4 finish.
3) Material: Aluminum-clad steel sheet with Class I, clear anodized **OR** Class II, clear anodized **OR** Class I, color anodized **OR** Class II, color anodized **OR** baked-enamel, **as directed**, finish.
4) Material: Extruded aluminum with Class I, clear anodized **OR** Class II, clear anodized **OR** Class I, color anodized **OR** Class II, color anodized **OR** baked-enamel, **as directed**, finish.

b. Profile: Manufacturer's standard **OR** Narrow, **as directed**, with minimum face dimension indicated.
c. Minimum Face Dimension: 2 inches (50 mm) **OR** 1-1/4 inches (32 mm) **OR** As indicated on Drawings, **as directed**.
d. Framing Depth:
1) Manufacturer's standard.
2) Adjustable for varying wall thicknesses by use of a two-piece, split frame that is attached to wall by clamping action induced by tightening screws.
3) As indicated on Drawings.

e. Provide thermally improved construction for aluminum framing.

6. Head and Jamb Framing: Designed for sealant **OR** gasket, **as directed**, glazing.
7. Glazing Meeting Edges: Polished glazing.
8. Sill: Stainless-steel channel frame designed for sealant **OR** gasket, **as directed**, glazing.
a. Shelf: Stainless steel, 12 inches (305 mm) **OR** 18 inches (457 mm), **as directed**, deep by width of security window, with integral deal tray.
9. Sliding Window Hardware: Provide roller track designed for overhead support of two- or four-wheel carriage supporting horizontal-sliding glazed panel. Provide manufacturer's standard pull and lock with two keys for each horizontal-sliding glazed panel.
a. Provide weather stripping for exterior horizontal-sliding, transaction security windows.

F. Accessories
1. Recessed Deal Trays: Formed from stainless steel with sliding stainless-steel cover, **as directed**; fabricated in curved shape with exposed flanges for recessed installation into horizontal surface.
a. Clear Opening Size: 12 inches wide by 8 inches deep by 1-1/2 inches high (305 mm wide by 203 mm deep by 38 mm high) **OR** 12 inches wide by 11 inches deep by 1-1/2 inches high (305 mm wide by 279 mm deep by 38 mm high) **OR** 16 inches wide by 11 inches deep by 1-1/2 inches high (406 mm wide by 279 mm deep by 38 mm high), **as directed**.
2. Recessed, Nonricochet Deal Trays: Formed from stainless steel; fabricated with recessed bullet trap to ricochet bullets away from secure side, with exposed flanges for recessed installation into horizontal surface, and with sliding stainless-steel cover, **as directed**.
a. Clear Opening Size: 10 inches wide by 7 inches deep by 1-1/2 inches high (254 mm wide by 178 mm deep by 38 mm high) **OR** 12 inches wide by 8 inches deep by 1-1/2 inches high (305 mm wide by 203 mm deep by 38 mm high) **OR** 12 inches wide by 11 inches deep by 1-1/2 inches high (305 mm wide by 279 mm deep by 38 mm high) **OR** 16 inches wide by 11 inches deep by 1-1/2 inches high (406 mm wide by 279 mm deep by 38 mm high), **as directed**.
b. Bullet Trap Location: Secure side **OR** Both sides, **as directed**.
c. Ballistics Resistance: UL Level 1 **OR** UL Level 3 **OR** Same as security window, **as directed**.
d. Listed and labeled as bullet resisting according to UL 752.
3. Rotating Deal Trays: Formed from stainless steel, with rotating recessed deal tray on each side of secure opening and with handle that rotates deal trays 180 degrees.
a. Mounting: Drop in **OR** Countertop, **as directed**.
b. Ballistics Resistance: UL Level 1 **OR** UL Level 3 **OR** Same as security window, **as directed**.
c. Listed and labeled as bullet resisting according to UL 752.

4. Transaction Drawers: Formed from stainless steel **OR** steel **OR** bullet-resistant armoring, **as directed**; with ball-bearing, telescoping sliding mechanism; with cover on secure side of top of drawer that automatically closes when drawer is extended to nonsecure side.
   a. Inside Dimensions: 15-3/8 inches wide by 8-1/2 inches deep by 4-3/8 inches high (390 mm wide by 216 mm deep by 111 mm high) **OR** 13 inches wide by 22 inches deep by 6-1/2 inches high (330 mm wide by 559 mm deep by 165 mm high), **as directed**.
   b. Operation:
      1) Manual.
      2) Electric, with sliding handle for emergency manual operation during lack of power. Provide individual switches for power and drawer movement on secure side and call button on nonsecure side.
   c. Ballistics Resistance: UL Level 1 **OR** UL Level 3 **OR** Same as security window, **as directed**.
   d. Listed and labeled as bullet resisting according to UL 752.
5. Speaking Apertures: Fabricate from stainless steel **OR** security glazing, **as directed**, designed to allow passage of speech at normal speaking volume without distortion.
   a. Shape: Circular **OR** Square, **as directed**.
   b. Ballistics Resistance: UL Level 1 **OR** UL Level 3 **OR** Same as security window, **as directed**.
   c. Listed and labeled as bullet resisting according to UL 752.

G. Fabrication
1. General: Fabricate security windows to provide a complete system for assembly of components and anchorage of window units.
   a. Provide units that are reglazable from the secure side without dismantling the nonsecure side of framing.
   b. Prepare security windows for glazing unless preglazing at the factory is indicated.
2. Provide weep holes and internal water passages for exterior security windows to conduct infiltrating water to the exterior.
3. Framing: Miter or cope corners the full depth of framing; weld and dress smooth.
   a. Fabricate framing with manufacturer's standard, internal opaque armoring in thicknesses required for security windows to comply with ballistics-resistance performance indicated.
4. Glazing Stops: Finish glazing stops to match security window framing.
   a. Secure-Side (Exterior) Glazing Stops: Welded or integral to framing.
   b. Nonsecure-Side (Interior) Glazing Stops: Removable, coordinated with glazing indicated.
5. Welding: Weld components to comply with referenced AWS standard. To greatest extent possible, weld before finishing and in concealed locations to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
6. Metal Protection: Separate dissimilar metals to protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
7. Factory-cut openings in glazing for speaking apertures.
8. Preglazed Fabrication: Preglaze window units at factory, where required for applications indicated. Comply with requirements in Division 08 Section "Security Glazing".
9. Weather Stripping: Factory applied.

H. Aluminum Finishes
1. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
2. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black, **as directed**.
3. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

a. Color and Gloss: As selected from manufacturer's full range.

I. Metallic-Coated Steel Sheet Finishes
1. Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and apply galvanizing repair paint, complying with SSPC-Paint 20, to comply with ASTM A 780.
2. Factory Prime Finish: Apply an air-dried primer, complying with SSPC-Paint 5, immediately after cleaning and pretreating.
3. Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard 2-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).
   a. Color and Gloss: As selected from manufacturer's full range.

J. Stainless-Steel Finishes
1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
   a. Run grain of directional finishes with long dimension of each piece.
   b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
   c. Directional Satin Finish: No. 4.

1.3 EXECUTION

A. Installation
1. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing security windows to in-place construction. Include threaded fasteners for concrete and masonry inserts, security fasteners, and other connectors.
   a. Install an attached or integral flange to secure side of security windows extending over rough-in opening gap so that gap has same forced-entry-resistance and ballistics-resistance performance as security window.
2. Voice-Communication-Type Framing: Attach removable glass spacers to jambs and head of glazing, located not more than 6 inches (152 mm) from each corner and spaced not more than 12 inches (305 mm) o.c.
3. Glazed Framing: Provide sealant **OR** gasket, **as directed**,-glazed framing. Comply with installation requirements in Division 08 Section "Security Glazing".
4. Removable Glazing Stops and Trim: Fasten components with security fasteners.
5. Fasteners: Install security windows using fasteners recommended by manufacturer with head style appropriate for installation requirements, strength, and finish of adjacent materials. Provide stainless-steel fasteners in stainless-steel materials, **as directed**.
6. Sealants: Comply with requirements in Division 07 Section "Joint Sealants" for installing sealants, fillers, and gaskets.
   a. Set continuous sill members and flashing in a full sealant bed to provide weathertight construction unless otherwise indicated.
   b. Seal frame perimeter with sealant to provide weathertight construction unless otherwise indicated.
7. Metal Protection: Where dissimilar metals will contact each other, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended in writing by manufacturer for this purpose. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

B. Adjusting

1. Adjust horizontal-sliding, transaction security windows to provide a tight fit at contact points for smooth operation and a secure enclosure.
2. Adjust transaction drawers to provide a tight fit at contact points and weather stripping for smooth operation and weathertight and secure enclosure.
3. Remove and replace defective work, including security windows that are warped, bowed, or otherwise unacceptable.

C. Cleaning And Protection
1. Clean surfaces promptly after installation of security windows. Take care to avoid damaging the finish. Remove excess glazing and sealant compounds, dirt, and other substances.
   a. Lubricate sliding security window hardware.
   b. Lubricate transaction drawer hardware.
2. Clean glass of preglazed security windows promptly after installation. Comply with requirements in Division 08 Section "Security Glazing" for cleaning and maintenance.
3. Provide temporary protection to ensure that security windows are without damage at time of Final Completion.

END OF SECTION 08 56 19 00

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Task	Specification	Specification Description
08 56 56 00	08 11 63 13a	Security Window Screens and Doors
08 56 56 00	08 34 53 00a	Security Grilles
08 56 59 00	01 22 16 00	No Specification Required

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SECTION 08 62 00 00 - ROOF WINDOWS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of material for roof windows. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Fixed (nonoperable) roof windows for exterior locations with aluminum-clad, copper-clad and fiberglass-clad exterior exposed surfaces and wood interior exposed surfaces.
   b. Venting (with operable sash) roof windows for exterior locations with aluminum-clad, copper-clad and fiberglass-clad exterior exposed surfaces and wood interior exposed surfaces.

C. Performance Requirements

1. Structural Performance: Provide roof windows capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   a. Wind Loads: Compliance is based on testing units representative of those indicated for Project that pass AAMA/WDMA/CSA 101/I.S.2/A440, Uniform Load Structural Test.
      1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s), **as directed**.
      2) Importance Factor.
      3) Exposure Category: B **OR** C **OR** D, **as directed**.
   b. Deflection Limits: Design glass framing system to limit lateral deflections of glass edges to less than 1/175 of glass-edge length or 3/4 inch (19 mm), whichever is less, at design pressure based on testing performed according to AAMA/WDMA/CSA 101/I.S.2/A440, Uniform Load Deflection Test, or structural computations.
   c. Snow Loads.
2. Windborne-Debris Resistance: Provide glazed roof windows capable of resisting impact from windborne debris, based on the pass/fail criteria as determined from testing glazed roof windows identical to those specified, according to ASTM E 1886 and testing information in ASTM E 1996 **OR** AAMA 506, **as directed**, and requirements of authorities having jurisdiction.

D. Submittals

1. Product Data: For each type of product indicated. Include construction details, material descriptions, fabrication methods, dimensions of individual components and profiles, hardware, finishes, and operating instructions.
   a. Motors: Show nameplate data, ratings, characteristics, and mounting arrangements.
2. Shop Drawings: Include plans, elevations, sections, details, hardware, attachments to other work, operational clearances, installation details, and the following:
   a. Mullion details, including reinforcement and stiffeners.
   b. Joinery details.
   c. Expansion provisions.
   d. Flashing and drainage details.
   e. Weather-stripping details.
   f. Glazing details.
   g. Accessories.
   h. Window cleaning provisions.
   i. Window System Operators: Show locations, mounting, and details for installing operator components and controls.

j. Window System Operators: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
k. Wiring Diagrams: Power, signal, and control wiring.

3. Samples: For roof windows and components required, prepared on Samples of size indicated below.
   a. Main Framing Member: 12-inch- (300-mm-) long section with weather stripping, **as directed**, glazing bead and factory-applied color finish.
   b. Hardware: Full-size units with factory-applied finish.
4. Delegated-Design Submittal: For roof windows indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation and used to determine the following:
   a. Structural test pressures and design pressures from loads indicated.
   b. Deflection limitations of glass framing systems.
5. Qualification Data: For qualified Installer, manufacturer and professional engineer.
6. Product Test Reports: Based on evaluation of comprehensive tests performed within the last four years by a qualified testing agency, for each class, grade, and size of roof window.
7. Maintenance Data: For weather stripping, operable sash, operating hardware, and finishes to include in maintenance manuals.
8. Warranties: Sample of special warranties.

E. Quality Assurance
1. Manufacturer Qualifications: A manufacturer capable of fabricating roof windows that meet or exceed performance requirements indicated and of documenting this performance by inclusion in lists and by labels, test reports, and calculations.
2. Installer Qualifications: An installer acceptable to roof window manufacturer for installation of units required for this Project.
   a. Installer's responsibilities include providing professional engineering services needed to assume engineering responsibility including preparation of data for roof windows, including Shop Drawings and Designated Design Submittal, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
3. Fenestration Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440, "Standard/Specification for Windows, Doors, and Unit Skylights," for minimum standards of performance, materials, components, accessories, and fabrication. Comply with more stringent requirements if indicated.
   a. Provide WDMA-certified units with an attached label.
4. Glazing Publication: Comply with published recommendations of glass manufacturers and with GANA's "Glazing Manual" unless more stringent requirements are indicated.

F. Delivery, Storage, And Handling
1. Protect roof windows during transit, storage, and handling to prevent damage, soiling, and deterioration. Store off ground and covered in a clean, dry, well-ventilated, protected space. Comply with manufacturer's written instructions.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace roof windows that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Failure to meet performance requirements.
      2) Structural failures including excessive deflection.
      3) Water leakage or air infiltration.
      4) Faulty operation of movable panels and hardware.
      5) Deterioration of wood, metals, vinyl, other materials, and finishes beyond normal weathering.

6) Deterioration of insulating glass and laminated glass, **as directed**, as defined in Division 08 Section "Glazing".

b. Warranty Period:
   1) Roof Window: Five **OR** 10, **as directed**, years from date of Final Completion.
   2) Glazing: 10 **OR** 20, **as directed**, years from date of Final Completion.
   3) Exterior Finish: Five years from date of Final Completion.

1.2 PRODUCTS

A. Materials
1. Wood: Clear fir or pine or another suitable fine-grained lumber; kiln-dried to a moisture content of 6 to 12 percent at time of fabrication; free of visible finger joints, blue stain, knots, pitch pockets, and surface checks larger than 1/32 inch (0.8 mm) deep by 2 inches (51 mm) wide; water-repellent preservative treated.
   a. Finish: Unfinished **OR** Manufacturer's standard transparent finish **OR** Manufacturer's standard prime-painted finish complying with WDMA T.M. 11 **OR** Manufacturer's standard opaque finish complying with WDMA T.M. 12, **as directed**.
2. Aluminum: Manufacturer's standard formed sheet or extruded aluminum. Provide aluminum alloy and temper recommended by roof window manufacturer for strength, corrosion resistance, and application of required finish.
   a. Baked-Enamel Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
      1) Color and Gloss: White **OR** Bronze **OR** Brown **OR** As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   b. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 620 **OR** AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      1) Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
3. Copper: ASTM B 370; Temper H00, cold rolled unless Temper 060, soft is required for forming; not less than 16 oz./sq. ft. (0.55 mm thick).
   a. Finish: Manufacturer's standard **OR** As selected from manufacturer's full range, **as directed**.
4. Reinforced Thermoset Fiberglass: AAMA 305 with manufacturer's standard finish.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
5. Trim and Glazing Stops: Material and finish to match wood frame members.
6. Fasteners: Aluminum, nonmagnetic stainless steel, or other materials warranted by manufacturer to be noncorrosive for SC 3 severe service conditions and compatible with roof window members, cladding, trim, hardware, anchors, and other components.
   a. Exposed Fasteners: Unless unavoidable for applying hardware, do not use exposed fasteners. For application of hardware, use fasteners that match finish of member or hardware being fastened, as appropriate.
7. Anchors, Clips, Mounting Brackets, and Accessories: Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B 456 or ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.
8. Mullions: Provide mullions and mullion casing and cover plates as shown, matching roof window units, complete with anchors for support to structure and installation of roof window units. Allow for erection tolerances and provide for movement of roof window units due to thermal expansion and building deflections, as indicated. Provide mullions and cover plates capable of withstanding design loads of roof window units.

9. Reinforcing Members: Aluminum, nonmagnetic stainless steel, nickel/chrome-plated steel complying with ASTM B 456 or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.
10. Compression-Type Weather Stripping: Provide compressible weather stripping designed for permanently resilient sealing under bumper or wiper action, and completely concealed when roof window is closed.
    a. Weather-Stripping Material: Closed-cell elastomeric, preformed gaskets complying with ASTM C 509.
       OR
       Weather-Stripping Material: Dense elastomeric gaskets complying with ASTM C 864.
       OR
       Weather-Stripping Material: Manufacturer's standard system and materials complying with AAMA/WDMA/CSA 101/I.S.2/A440.
11. Flashing: Manufacturer's standard flashing system for application indicated.
    a. Material: Aluminum **OR** Copper **OR** Flexible EPDM flashing, **as directed**.
    b. Rigid aluminum **OR** copper, **as directed**, nailing flange formed into frame.
    c. Auxiliary Water Diverter: Provide at roof window head as back flashing.

B. Roof Window
1. AAMA/WDMA/CSA Performance Requirements: Provide roof windows of performance indicated that comply with AAMA/WDMA/CSA 101/I.S.2/A440 unless more stringent performance requirements are indicated.
    a. Performance Class and Grade: R15 **OR** 20 **OR** 25, **as directed**.
    b. Performance Class and Grade: C30 **OR** 35 **OR** 40, **as directed**.
    c. Performance Class and Grade: As indicated.
2. Thermal Transmittance: Provide roof windows with a whole fenestration product U-factor maximum indicated, when tested according to AAMA 1503 **OR** determined according to ASTM E 1423 **OR** determined according to NFRC 100, **as directed**.
    a. U-Factor: 0.35 **OR** 0.40 **OR** 0.65, **as directed**, Btu/sq. ft. x h x deg F (W/sq. m x K).
    b. U-Factor: 0.60 Btu/sq. ft. x h x deg F (W/sq. m x K) (this is the maximum U-factor allowed by the IECC 2006 for skylights in all but climate zones 1 to 3).
3. Solar Heat-Gain Coefficient (SHGC): Provide roof windows with a whole-window SHGC maximum of 0.40 **OR** 0.50 **OR** 0.55, **as directed**, determined according to NFRC 200.
4. Air-Leakage Resistance: Maximum rate not more than indicated when tested according to AAMA/WDMA/CSA 101/I.S.2/A440, Air Leakage Resistance Test.
    a. Maximum Rate: 0.3 cfm/sq. ft. (1.5 L/s x sq. m) of area at an inward test pressure of 1.6 lbf/sq. ft. (75 Pa) (equivalent to 25-mph (40-km/h) wind speed and typically used to test R and C performance classes).
5. Water-Penetration Resistance: No water leakage as defined in AAMA/WDMA/CSA referenced test methods at a water test pressure equaling that indicated, when tested according to AAMA/WDMA/CSA 101/I.S.2/A440, Water Penetration Resistance Test.
    a. Test Pressure: 15 percent of positive design pressure, but not less than 2.9 lbf/sq. ft. (140 Pa) or more than 12 lbf/sq. ft. (580 Pa).
6. Forced-Entry Resistance: Comply with Performance Grade 10 (lowest recognized by ASTM F 588 and is mandatory if AAMA/WDMA/CSA 101/I.S.2/A440 is the method selected for specifying roof window performance) requirements when tested according to ASTM F 588.
7. Operating Force and Auxiliary (Durability) Tests: According to and complying with AAMA/WDMA/CSA 101/I.S.2/A440.

C. Glazing
1. Glass and Glazing System: Comply with Division 08 Section "Glazing" for glass, insulating-glass units, laminated glass, and glazing requirements applicable to glazed roof windows.

D. Hardware
1. Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for fixed skylights.

2. General: Provide manufacturer's standard hardware, fabricated from a corrosion-resistant material compatible with wood and aluminum cladding **OR** and copper cladding, **as directed**, complying with AAMA 907; designed to smoothly operate, tightly close, and securely lock sliding wood-framed roof windows; and sized to accommodate sash weight and dimensions. Do not use aluminum in frictional contact with other metals.
   a. Hardware Finish: Manufacturer's standard **OR** Match cladding appearance, **as directed**.
3. Gear-Type Rotary Operators: Comply with AAMA 901 when tested according to ASTM E 405, Method A.
4. Pole Operator: Manufacturer's standard manual **OR** motorized, **as directed**, pole for operating venting units that are more than 72 inches (1800 mm) above floor.
5. Motor Operator: Manufacturer's standard electric motor and remote control for operating venting units that are more than 72 inches (1800 mm) above floor.
   a. Provide rain sensor that automatically closes venting unit when water is detected.
      OR
      Provide motor operator with wireless remote-control device.
6. Roof Window Operation:
   a. Operator and Control: Gear-type rotary operator with plastic or metal cable that uncoils and stiffens to open sash; with locking mechanism.
      1) Operation: Crank handle **OR** Pole, **as directed**, for manual operation.
      2) Operation: Electric.
      OR
      Operator and Control: Gear-type rotary operator with arm(s) that scissors or swings to open sash; with locking mechanism.
      1) Operation: Crank handle **OR** Pole, **as directed**, for manual operation.
      2) Operation: Electric.
      OR
      Operator and Control: Spring-assisted, counter-balanced operator that allows sash to remain open in any position; with lever-handle-operated latches and lock for manual operation.
   b. Hinge: Continuous.
      OR
      Hinges: Pivot **OR** Manufacturer's standard, **as directed**; two per operable sash.

E. Accessories
1. Insect Screens: Manufacturer's standard removable screen; aluminum or vinyl frame with mitered or coped joints and with ASTM D 3656 mesh of plastic-coated glass-fiber threads. Provide frame in manufacturer's standard finish and mesh in manufacturer's standard color.
2. Shades: Manufacturer's standard of type indicated and in color and pattern selected from manufacturer's full range.
   a. Type: Pleated **OR** Venetian blind **OR** Roll up, **as directed**.
   b. Pole Operation: Provide manual **OR** motorized, **as directed**, pole for operating shades that are more than 72 inches (1800 mm) above floor.
      OR
      Motorized Operation: Provide manufacturer's standard electric motor and remote control for operating shades with wireless remote-control device, **as directed**.

F. Fabrication
1. Fabricate roof windows in sizes indicated. Include a complete system for assembling components and anchoring and flashing windows.
2. Fabricate roof windows that are reglazable without dismantling sash framing.
3. Weather Stripping: Provide full-perimeter weather stripping for each operable sash.
4. Provide condensation gutter or other means to hold condensed moisture or drain it to exterior.
5. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation. Allow for scribing, trimming, and fitting at Project site.

6. Factory-Glazed Fabrication: Glaze roof windows in the factory. Comply with requirements in Division 08 Section "Glazing" and with AAMA/WDMA/CSA 101/I.S.2/A440.

1.3 EXECUTION

A. Examination

1. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work. Verify rough opening dimensions, slope of roof construction, and operational clearances. Examine roof decks, vapor retarders, water and weather barriers, and other built-in components to ensure a coordinated, weathertight roof window installation.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation

1. Comply with manufacturer's written installation instructions for installing roof windows, hardware, **as directed**, motor operators, **as directed**, accessories, and other components.
2. Install roof windows square, true, and without distortion, warp, or rack of frames and sash. Securely anchor windows to structural support without impeding thermal movement and in proper relation to adjacent construction.
3. Install flashing to provide a watertight and weathertight seal.
4. Separate aluminum, copper, and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials according to recommendations in ASTM E 2112.

C. Adjusting, Cleaning, And Protection

1. Lubricate hardware and moving parts.
2. Adjust operating sash, operators, **as directed**, screens, and accessories for a tight fit at contact points and for smooth operation and weathertight closure.
3. Adjust hardware for proper alignment, smooth operation, and proper latching without unnecessary force or excessive clearance.
4. Adjust shades to hang true to line without rack. Provide unencumbered operation.
5. Clean frame surfaces immediately after installing roof windows. Comply with manufacturer's written instructions for final cleaning and maintenance. Avoid damaging protective coatings and finishes.
6. Inspect drainage holes for blockage. Clean and free holes of any obstructions to allow drainage.
7. Clean glass immediately after installing roof windows. Comply with manufacturer's written instructions for final cleaning and maintenance. Remove nonpermanent labels and clean surfaces.
8. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.
9. Protect roof window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances contact roof window surfaces, remove contaminants immediately according to manufacturer's written instructions.
10. Refinish or replace roof windows that have damaged finishes.
11. Replace damaged components.

END OF SECTION 08 62 00 00

Task	Specification	Specification Description
08 62 23 00	08 62 00 00	Roof Windows
08 63 13 00	08 62 00 00	Roof Windows
08 66 00 00	08 45 23 00	Unit Skylights

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SECTION 08 71 11 00 - DETENTION DOOR HARDWARE

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for detention door hardware. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Detention door hardware for the following:
1) Swinging detention doors.
2) Sliding detention doors.
b. Detention cylinders for doors specified in other Sections.

C. Performance Requirements
1. Swinging Detention Door Assemblies: Provide detention door hardware as part of a detention door assembly that complies with security grade indicated, when tested according to ASTM F 1450, based on testing manufacturer's standard units in assemblies similar to those indicated for this Project.
a. Bullet Resistance: Comply with Level 3 rating when tested according to UL 752; where indicated.
1) Listed and labeled as bullet resisting by a testing agency acceptable to authorities having jurisdiction.
b. Tool-Attack Resistance: Comply with small-tool-attack-resistance rating when tested according to UL 1034 and UL 437.
2. Detention Door Hardware Functional Performance: Provide detention door hardware with features, functions, and internal equipment required to perform control and monitoring functions indicated in Division 28 Section "Plc Electronic Detention Monitoring And Control Systems".

D. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: For each type of detention door hardware.
a. Wiring Diagrams: For power, signal, and control wiring; differentiate between manufacturer-installed and field-installed wiring for electrified and pneumatic, **as directed**, detention door hardware.
b. Compressed-Air System Diagrams: For compressed-air piping for door control systems; differentiate between manufacturer-installed and field-installed piping for pneumatic detention door hardware.
c. Detail interface between electrified detention door hardware and perimeter security, detention monitoring and control, fire-alarm, and building control, **as directed**, system.
d. Detail interface between pneumatic detention door hardware and perimeter security, detention monitoring and control, fire-alarm, and building control, **as directed**, system.
3. Other Action Submittals:
a. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with detention doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
1) Integrate detention door hardware indicated in "Detention Door Hardware Sets" Article into the Door Hardware Schedule, and indicate complete designations of every item required for each door and opening.

b. Keying Schedule: Comply with requirements specified in Division 08 Section "Door Hardware". Coordinate detention keying with other door hardware in the final Keying Schedule.
   1) Indicate each lock and type of key using the following prefixes: "P" for paracentric, "M" for mogul, "HS" for high security, and "C" for commercial.

c. Operation and Maintenance Data: For electrified and pneumatic, **as applicable**, detention door hardware to include in emergency, operation, and maintenance manuals.

4. Warranties: Sample of special warranties.

E. Quality Assurance
1. Installer Qualifications: An employer of workers trained and approved by manufacturer and an authorized representative of detention door hardware manufacturer for installation and maintenance of units required for this Project.
2. Supplier Qualifications: Detention door hardware supplier with warehousing facilities in Project's vicinity and who is or employs a qualified Architectural Hardware Consultant, available during the course of the Work to consult with Contractor, Architect, and the Owner about detention door hardware and keying.
   a. Detention Door Hardware Supplier Qualifications: An experienced detention door hardware supplier who has completed projects with electrified and pneumatic, **as directed**, detention door hardware similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance, and who is acceptable to manufacturer of primary materials.
      1) Engineering Responsibility: Prepare data for electrified and pneumatic, **as directed**, detention door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
   b. Scheduling Responsibility: Preparation of door hardware and keying schedules.
3. Architectural Hardware Consultant Qualifications: A person who is currently certified by DHI as an Architectural Hardware Consultant **OR** one who meets the requirements necessary for certification, **as directed,** and who is experienced in providing consulting services for detention door hardware installations that are comparable in material, design, and extent to that indicated for this Project.
   a. Detention Door Hardware Consultant Qualifications: Experienced in providing consulting services for electrified and pneumatic, **as directed**, detention door hardware installations.
4. Source Limitations for Detention Door Hardware: Obtain each type of detention door hardware from single source from single manufacturer.
   a. Provide electrified and pneumatic, **as directed**, detention door hardware from same manufacturer as mechanical detention door hardware unless otherwise indicated.
5. Regulatory Requirements: Comply with provisions of the following:
   a. Where indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1, **as directed**, as follows:
      1) Handles, Pulls, Latches, Locks, and other Operating Devices: Shape that is easy to grasp with one hand and does not require tight grasping, tight pinching, or twisting of the wrist.
      2) Security Door Closers: Comply with the following maximum opening-force requirements indicated:
         a) Interior Hinged Doors: 5 lbf (22 N) applied perpendicular to door.
         b) Sliding Doors: 5 lbf (22 N) applied parallel to door at latch.
         c) Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
   b. NFPA 101: Comply with the following for means-of-egress doors:
      1) Latches and Locks: Not more than 15 lbf (67 N) to release the latch.
      2) Security Door Closers: Not more than 30 lbf (133 N) to set door in motion and not more than 15 lbf (67 N) to open door to minimum required width.

3) Sliding Detention Door Devices: Not more than 50 lbf (222 N) to slide door to its fully open position with a perpendicular force of 50 lbf (222 N) against door.

c. Electrified and Pneumatic, **as directed**, Door Hardware: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

6. Fire-Rated Detention Door Assemblies: Provide detention door hardware for assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure **OR** as close to neutral pressure as possible, **as directed**, according to NFPA 252 **OR** UBC Standard 7-2 **OR** UL 10B **OR** UL 10C, **as directed**.
7. Keying Conference: Conduct conference at Project site Incorporate keying conference decisions into the final Keying Schedule after reviewing detention door hardware keying system including, but not limited to, the following:
   a. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
   b. Preliminary key system schematic diagram.
   c. Requirements for key-control system including key exclusivity and duplication control.
   d. Address for delivery of keys.
8. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling

1. Inventory detention door hardware on receipt and provide secure lockup for detention door hardware delivered to Project site.
2. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
3. Deliver keys to the Owner by registered mail or overnight package service**.**

G. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of detention door hardware that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Structural failures including excessive deflection, cracking, or breakage.
      2) Faulty operation of operators and detention door hardware.
      3) Deterioration of metals, metal finishes, and other materials beyond normal weathering or detention use.
2. Warranty Period: Three years from date of Final Completion.
3. Warranty Period for Continuous-Pin Detention Hinges: 10 years from date of Final Completion.
4. Warranty Period for Security Door Closers: 10 years from date of Final Completion.

H. Maintenance Service

1. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for the Owner's continued adjustment, maintenance, and removal and replacement of detention door hardware.
2. Initial Maintenance Service: Beginning at Final Completion, provide three **OR** six **OR** nine **OR** 12, **as directed**, months' full maintenance by skilled employees of detention door hardware Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper detention door hardware operation. Provide parts and supplies the same as those used in the manufacture and installation of original equipment.

1.2 PRODUCTS

A. Security Fasteners

1. General: Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive-system type, head style, material, and protective coating as required for assembly, installation, and strength, and as follows:
   a. Drive-System Types: Pinned Torx-Plus **OR** Pinned Torx, **as directed**.
   b. Fastener Strength: 120,000 psi (827 MPa).
   c. Socket Button Head Fasteners:
      1) Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
      2) Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.
   d. Socket Flat Countersunk Head Fasteners:
      1) Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
      2) Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.
   e. Socket Head Cap Fasteners:
      1) Heat-treated alloy steel, ASTM A 574 (ASTM A 574M).
      2) Stainless steel, ASTM F 837 (ASTM F 837M), Group 1 CW.
   f. Protective Coatings for Heat-Treated Alloy Steel:
      1) Zinc and clear trivalent chromium where indicated.
      2) Zinc phosphate with oil, ASTM F 1137, Grade I, or black oxide unless otherwise indicated.

B. Detention Hinges, General
1. Standard for Electric Detention Hinges: UL 634.
2. Quantity: Provide the following unless otherwise indicated:
   a. Two Detention Hinges: For detention doors with heights up to 60 inches (1524 mm).
   b. Three Detention Hinges: For detention doors with heights 61 to 90 inches (1549 to 2286 mm).
   c. Four Detention Hinges: For detention doors with heights 91 to 120 inches (2311 to 3048 mm).
   d. For detention doors with heights more than 120 inches (3048 mm), provide four detention hinges, plus one detention hinge for every 30 inches (762 mm) of detention door height greater than 120 inches (3048 mm).
3. Size: Provide the following, unless otherwise indicated, with detention hinge widths sized for 2-inch (51-mm) detention door thickness and clearances required:
   a. Doors up to 42 Inches (1067 mm) Wide: Minimum 4-1/2 inches (114 mm) wide by 0.180 inches (4.6 mm) thick or 5 inches (127 mm) wide by 0.190 inches (4.8 mm) thick.
   b. Doors Greater Than 42 Inches (1067 mm) Wide: Minimum 6 inches (152 mm) wide by 0.203 inches (5.2 mm) thick.
4. Detention Doors with Security Closers: Unless otherwise indicated, provide antifriction-bearing detention hinges.
5. Detention Hinge Base Metal: Unless otherwise indicated, provide the following:
   a. Exterior Detention Hinges: Stainless steel, with stainless-steel pin.
   b. Interior Detention Hinges: Steel, with steel pin **OR** Stainless steel, with stainless-steel pin, **as directed**.
   c. Detention Hinges for Fire-Rated Assemblies: Steel, with steel pin **OR** Stainless steel, with stainless-steel pin, **as directed**.
6. Electrified Functions for Detention Hinges: Comply with the following:
   a. Electrical Contact: Exposed electrical contacts for transfer of power.
   b. Power Transfer: Concealed PTFE-jacketed wires, secured at each leaf and continuous through detention hinge knuckle.
   c. Monitoring: Concealed electrical monitoring switch.
7. Fastening: Comply with the following:
   a. Welding: Where indicated, weld hinges to detention doors and frames with continuous fillet weld around three sides of hinge perimeter.
   b. Security Fasteners: Provide socket flat countersunk head machine screws; finish screw heads to match surface of detention hinges. Install into drilled and tapped holes.

C. Detention Hinges

1. Utility-Door Detention Hinges DH-1: Heavy weight, plain bearing; fabricated from cast iron or steel; 3/8-inch- (9.5-mm-) diameter, case-hardened, fully welded, **as directed**, steel hinge pin; full surface.
   a. Leaves: Drilled for countersunk security fasteners **OR** Solid, **as directed**.
   b. Size: Minimum 3 by 4 inches by 0.200 inch (75 by 100 by 5 mm).
   c. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**, according to ASTM F 1758.
   d. Finish: BHMA 600.
2. Food-Pass Detention Hinges DH-2: Heavy weight, plain bearing; fabricated from cast iron or steel; 3/8-inch- (9.5-mm-) diameter, case-hardened, fully welded, **as directed**, steel hinge pin; with applied stop preventing door from opening more than 90 degrees and supporting door in horizontal position as a shelf; full surface.
   a. Leaves: Drilled for countersunk security fasteners **OR** Solid, **as directed**.
   b. Size: Minimum 3 by 4 inches by 0.200 inch (75 by 100 by 5 mm).
   c. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**, according to ASTM F 1758.
   d. Finish: BHMA 600.
3. Full-Surface Detention Hinges DH-3: Extra heavy weight; two heavy-duty thrust bearings with hardened-steel ball bearings; fabricated from steel plate; 3/4-inch- (19-mm-) diameter, case-hardened, fully welded, steel hinge pin.
   a. Leaves: Drilled for countersunk security fasteners **OR** Solid, **as directed**.
   b. Size: Minimum 5 by 5-1/4 inches by 1/2 inch (127 by 133 by 13 mm).
   c. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**, according to ASTM F 1758.
   d. Finish: BHMA 600.
4. Half-Surface Detention Hinges DH-4: Extra heavy weight; two heavy-duty thrust bearings with hardened-steel ball bearings; fabricated from steel plate; 3/4-inch- (19-mm-) diameter, case-hardened, fully welded, steel hinge pin.
   a. Leaves: Drilled for countersunk security fasteners **OR** Solid, **as directed**.
   b. Size: Minimum 5 by 5-1/4 inches by 1/2 inch (127 by 133 by 13 mm).
   c. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**, according to ASTM F 1758.
   d. Finish: BHMA 600.
5. Gap-Mounted Detention Hinges DH-5: Extra heavy weight; two heavy-duty thrust bearings with hardened-steel ball bearings; fabricated from steel plate; 3/4-inch- (19-mm-) diameter, case-hardened, fully welded, steel hinge pin.
   a. Leaves: Drilled for countersunk security fasteners **OR** Solid, **as directed**.
   b. Size: Minimum 5 by 6 inches by 1/2 inch (127 by 152 by 13 mm).
   c. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**, according to ASTM F 1758.
   d. Finish: BHMA 600.
6. Continuous-Pin Detention Hinges DH-6: Minimum 0.109-inch- (2.78-mm-) thick, stainless-steel hinge leaves with minimum overall width of 4 inches (100 mm); with 1/4-inch- (6-mm-) diameter continuous pin; fabricated to full height of detention door and frame. Finish components after milling and drilling are complete. Fabricate continuous-pin detention hinges to template screw locations.
   a. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**, according to ASTM F 1758.

D. Detention Locks And Latches, General

1. Swinging Detention Door Lock and Latch Performance: Provide detention door locks and latches that comply with security grade indicated, when tested according to ASTM F 1577, based on testing manufacturer's standard units in assemblies similar to those indicated for this Project.
2. Detention Lock Functions: Provide function numbers and descriptions indicated in detention door hardware sets complying with ASTM F 1577.
3. Detention Lock Construction: Fabricate detention lock case and cover plate from steel plate. Fabricate bolts from solid sections; laminated construction unacceptable.
4. Detention Lock Throw: Comply with testing requirements for length of bolts to comply with labeled fire door requirements, and as follows:
   a. Latchbolts for Detention Food Pass **OR** Security Access Doors, **as directed**: Minimum 5/8-inch (16-mm) latchbolt throw.

b. Latchbolts: Minimum 3/4-inch (19-mm) latchbolt throw.
c. Deadbolts: Minimum 1-inch (25-mm) bolt throw.

5. Detention Lock Trim:
   a. Levers: Solid stainless steel.
   b. Knobs: Stainless steel **OR** Brass, **as directed**.
   c. Escutcheons for Paracentric Locks: 0.125-inch- (3.18-mm-) thick, 3-inch- (75-mm-) diameter stainless steel with BHMA 626 **OR** brass with BHMA 606, **as directed**, finish. Attach with security fasteners.
      1) Style: Single wing **OR** Double wing **OR** Single or double wing as required by lock function **OR** As indicated, **as directed**.
      2) Provide escutcheons unless otherwise **OR** where, **as directed**, indicated.
   d. Cylinder Shields for Paracentric Locks: 0.125-inch- (3.18-mm-) thick, 3-inch- (75-mm-) diameter stainless steel with BHMA 626 **OR** brass with BHMA 606, **as directed**, finish and swinging cover to protect keyhole. Attach with security fasteners.
      1) Style: Single wing **OR** Double wing **OR** Single or double wing as required by lock function **OR** As indicated, **as directed**.
      2) Provide cylinder shields unless otherwise **OR** where, **as directed**, indicated.
6. Pneumatic Detention Locks and Latches: Operate when supplied with air between 40 psig (275 kPa) minimum and 100 psig (690 kPa) maximum. Factory install quick-connect air fitting and factory-wired plug connector with 6-inch (150-mm) wire pigtail.
   a. Provide security ring for installation of pneumatic detention lock in hollow-metal detention frame, welded to frame or access cover unless otherwise **OR** where, **as directed**, indicated.

E. Mechanical Detention Locks And Latches
1. General: Provide mechanical detention lock mountings as follows:
   a. Hollow-Metal Detention Doors: Mount detention lock to back of 0.179-inch (4.56-mm) nominal-thickness steel **OR** 0.183-inch (4.65-mm) nominal-thickness galvanized-steel, **as directed**, cover plate for installation in lock pocket fabricated into detention door. Attach cover plate to hollow-metal detention door with security fasteners.
   b. Bar-Grille Detention Doors: Mount detention lock to back of galvanized, **as directed**, steel enclosure welded to flat horizontal bars of bar-grille detention door; cover with 0.179-inch (4.56-mm) nominal-thickness steel **OR** 0.183-inch (4.65-mm) nominal-thickness galvanized-steel, **as directed**, plate. Attach plate with security fasteners.
   c. Steel-Plate Detention Doors: Mount detention lock to inside surface of 0.179-inch (4.56-mm) nominal-thickness steel **OR** 0.134-inch (3.42-mm) nominal-thickness steel **OR** 0.183-inch (4.65-mm) nominal-thickness galvanized-steel **OR** 0.138-inch (3.50-mm) nominal-thickness galvanized-steel, **as directed**, enclosure with integrally formed mounting flanges. Attach enclosure to steel-plate detention door with security fasteners **OR** rivets, **as directed**.
2. Utility-Door Mechanical Deadlocks, Paracentric ML-1: For use on small swinging doors, such as access panels, plumbing space doors, electric panel doors, and hatches that are infrequently used.
   a. Function: Lockbolt retracted and extended by five **OR** six, **as directed**,-tumbler paracentric cylinder; keyed one side **OR** two sides, **as directed**.
   b. Lockbolt: 1-1/2 inches high by 3/4 inch (38 mm high by 19 mm) thick; 5/8-inch (16-mm) throw.
   c. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
3. Utility-Door Mechanical Deadlocks, Mogul ML-2: For use on small swinging doors, such as access panels, plumbing space doors, electric panel doors, and hatches that are infrequently used.
   a. Function: Lockbolt retracted and extended by mogul cylinder; keyed one side **OR** two sides, **as directed**.
   b. Lockbolt: 1-1/2 inches high by 3/4 inch (38 mm high by 19 mm) thick; 5/8-inch (16-mm) throw.

c. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.

4. Mechanical Snaplatches, Paracentric ML-3: For use on small swinging doors, such as food-pass doors, observation panels, gun locker doors, and other small doors where snaplocking is needed and deadlocking is not required.
   a. Function: Automatic snaplatch when door is closed; latchbolt retracted by five **OR** six, **as directed**,-tumbler paracentric cylinder; keyed one side **OR** two sides, **as directed**.
   b. Latchbolt: 1 inch high by 7/16 inch (25 mm high by 11 mm) thick; 5/16-inch (8-mm) throw.
   c. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
5. Mechanical Snaplatches, Mogul ML-4: For use on small swinging doors, such as food-pass doors, observation panels, gun locker doors, and other small doors where snaplocking is needed and deadlocking is not required
   a. Function: Automatic snaplatch when door is closed; latchbolt retracted by mogul cylinder; keyed one side **OR** two sides, **as directed**.
   b. Latchbolt: 1 inch high by 7/16 inch (25 mm high by 11 mm) thick; 5/16-inch (8-mm) throw.
   c. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
6. Mechanical Concealed Snaplatches ML-5: For use on small swinging doors, such as observation panels, wickets, covers, and other small doors.
   a. Function: Automatic snaplatch when door is closed; latchbolt retracted by five-tumbler paracentric cylinder; keyed one side. When closed, latch is concealed within lock case.
   b. Latchbolt: 1 inch high by 7/16 inch (25 mm high by 11 mm) thick; 7/16-inch (11-mm) throw.
   c. Provide angled strike.
   d. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
7. Sliding Door Mechanical Deadlatches ML-6: For use on sliding doors, such as entrance, safety vestibule, and corridor doors.
   a. Function: Hookbolt snaplatches and automatically deadlocks through action of plunger pin when door is closed (slam locking); hookbolt raised by five **OR** six, **as directed**,-tumbler paracentric cylinder; keyed one side **OR** two sides, **as directed**.
   b. Hookbolt: 1/2-inch- (13-mm-) thick, case-hardened steel; 5/8-inch (16-mm) lift.
   c. Provide case-hardened-steel deadlock plunger pin.
   d. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
8. Sliding Door Mechanical Deadlocks ML-7: For use on sliding doors, such as entrance, safety vestibule, corridor, and inmate cell doors.
   a. Function: Hookbolt raised and lowered by five **OR** six, **as directed**,-tumbler paracentric cylinder (no slam locking); keyed one side **OR** two sides, **as directed**.
   b. Hookbolt: 1/2-inch- (13-mm-) thick, case-hardened steel; 5/8-inch (16-mm) lift.
   c. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
9. Mechanical Snaplatches ML-8: For use on swinging doors, such as corridor, dining room, and recreational area doors.
   a. Function: Automatic snaplatch when door is closed (slam locking); latchbolt retracted by half turn and extended by full turn in opposite direction of five **OR** six, **as directed**,-tumbler paracentric cylinder; keyed one side **OR** two sides, **as directed**.
      1) Knob operation retracts latchbolt unless deadlocked. Locate knobs on one side **OR** two sides, **as directed**.
   b. Latchbolt: 2-inch-high by 3/4-inch- (50-mm-high by 19-mm-) thick steel, with two case-hardened-steel insert pins; 3/4-inch (19-mm) throw; 1/2-inch (13-mm) **OR** 1-1/4-inch (32-mm), **as directed**, bolt projection when retracted.
   c. Listed and labeled for use on fire doors.
   d. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
10. Mechanical Deadlatches/Deadlocks ML-9: For use on swinging doors, such as day room, dining room, and recreational area doors.
    a. Function: Automatic snaplatch and automatic deadlock through action of actuator when door is closed (slam locking); latchbolt retracted by five **OR** six, **as directed**,-tumbler paracentric cylinder; keyed one side **OR** two sides, **as directed**.
    b. Latchbolt: 2-inch-high by 3/4-inch- (50-mm-high by 19-mm-) thick steel, with two case-hardened-steel insert pins; 3/4-inch (19-mm) throw; 1/2-inch (13-mm) **OR** 1-1/4-inch (32-mm), **as directed**, bolt projection when retracted.

c. Deadlock Actuator: 3/4-inch-high by 3/4-inch- (19-mm-high by 19-mm-) thick steel; 1/2-inch (13-mm) throw.
d. Listed and labeled for use on fire doors.
e. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.

11. Mechanical Deadlocks ML-10: For use on swinging doors where slam locking is not required, such as holding cell, segregation cell, control room, armory, key cabinet, storage, utility, and hollow-metal access doors.
    a. Function: Deadlocked in both locked and unlocked position; latchbolt retracted and extended by five **OR** six, **as directed**,-tumbler paracentric cylinder; keyed one side **OR** two sides, **as directed**.
    b. Latchbolt: 2-inch-high by 3/4-inch- (50-mm-high by 19-mm-) thick steel, with two case-hardened-steel insert pins; 3/4-inch (19-mm) throw; 1/2-inch (13-mm) **OR** 1-1/4-inch (32-mm), **as directed**, bolt projection when retracted.
    c. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
12. Cremone Bolt Mechanical Snaplatches ML-11: For use on swinging doors or active leaf of pairs of swinging doors where slam locking is needed.
    a. Function: Automatic snaplatch and deadlocking when door is closed (slam locking); latchbolt retracted and extended by five-tumbler paracentric cylinder; keyed one side **OR** two sides, **as directed**. Lever operation one side **OR** two sides, **as directed**, retracts head and foot rods, unless deadlocked, for three-point locking.
    b. Latchbolt: 2-inch-high by 3/4-inch- (50-mm-high by 19-mm-) thick steel, with two case-hardened-steel insert pins; 3/4-inch (19-mm) throw.
    c. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
13. Cremone Bolt Mechanical Deadlocks, Paracentric ML-12: For use on swinging doors or active leaf of pairs of swinging doors where doors may be subject to mass attack. Delete inactive leaf for single door.
    a. Function: Active leaf deadlocks when door is closed (no slam locking); active-leaf deadbolt retracted and extended by five **OR** six, **as directed**,-tumbler paracentric cylinder; keyed one side **OR** two sides, **as directed**. Active-leaf lever operation one side **OR** two sides, **as directed**, retracts active-leaf head and foot bolts unless deadlocked.
        1) Inactive Leaf: Head and foot bolts deadlocked by five **OR** six, **as directed**,-tumbler, inactive-leaf paracentric cylinder. Inactive-leaf lever operation one side **OR** two sides, **as directed**, retracts inactive-leaf head and foot bolts unless deadlocked.
    b. Deadbolt: 2-inch-high by 3/4-inch- (50-mm-high by 19-mm-) thick steel, with two case-hardened-steel insert pins; 3/4-inch (19-mm) throw.
    c. Head and Foot Bolts: 7/8-inch (22-mm) diameter; 3/4-inch (19-mm) throw.
    d. Provide foot bolt receptacle(s).
    e. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
14. Mechanical Head and Foot Bolts ML-14: For use on the inactive leaf of pairs of swinging doors.
    a. Function: Bolt retracted and extended by spanner-type key **OR** five-tumbler paracentric cylinder, **as directed**; enclosed in iron or steel case with steel cover (not applicable for hollow-metal doors).
    b. Latchbolt: 1-inch- (25-mm-) diameter steel; 3/4-inch (19-mm) throw.
    c. Footbolt Receptacle: Spring-loaded mechanism; brass.
    d. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.

F. Electromechanical Detention Locks And Latches
1. General: Provide electromechanical detention locks and latches with factory-wired plug connector with 6-inch (152-mm) wire pigtail.
    a. Provide security ring for installation of electromechanical detention lock in hollow-metal detention frame, welded to frame or access cover, unless otherwise **OR** where, **as directed**, indicated.
    b. Equip direct-current solenoid-operated detention locks and latches with diode transient voltage protection at each locking device.

2. Solenoid-Operated Deadlatches, Paracentric EL-1: For use on swinging doors, such as entrance, sally port, corridor, and inmate cell doors, that are to be unlocked from remote locations.
   a. Function: Remote switch activates electric solenoid that retracts latchbolt; automatic latching and deadlocking when door is closed (slam locking). Latchbolt can be mechanically retracted by five **OR** six, **as directed**,-tumbler paracentric cylinder; keyed one side **OR** two sides, **as directed**; if latchbolt is retracted by key, it remains retracted until relocked by key.
      1) Latchback: Latchbolt remains retracted until door is opened 2 inches (50 mm), then releases **OR** as long as control switch is activated; latchbolt extends when power is discontinued, **as directed**.
      2) If power fails, latchbolt automatically deadlocks (fail secure).
   b. Latchbolt: 2-inch-high by 3/4-inch- (50-mm-high by 19-mm-) thick hardened steel; 3/4-inch (19-mm) throw.
   c. Provide internal deadlock indicator switch.
   d. Provide roller-type deadlock actuator.
   e. Voltage: 120-V ac.
   f. Listed and labeled for use on fire doors.
   g. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
3. Motor-Operated Deadlatches, Paracentric EL-2: For use on swinging doors, such as entrance, sally port, corridor, and inmate cell doors, that are to be unlocked from remote locations.
   a. Function: Remote switch activates electric motor that retracts latchbolt; automatic latching and deadlocking when door is closed (slam locking). Latchbolt can be mechanically retracted by five **OR** six, **as directed**,-tumbler paracentric cylinder; keyed one side **OR** two sides, **as directed**; if latchbolt is retracted by key, it remains retracted until relocked by key.
      1) Latchback: Latchbolt remains retracted until door is opened 2 inches (50 mm), then releases **OR** as long as control switch is activated; latchbolt extends when power is discontinued, **as directed**.
      2) If power fails, latchbolt automatically deadlocks (fail-secure).
   b. Latchbolt: 2-inch-high by 3/4-inch- (50-mm-high by 19-mm-) thick hardened steel; 3/4-inch (19-mm) throw.
   c. Provide internal deadlock indicator switch.
   d. Provide roller-type deadlock actuator.
   e. Voltage: 120-V ac **OR** 24-V dc, **as directed**.
   f. Listed and labeled for use on fire doors.
   g. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
4. Sliding Door Motor-Operated Deadlatches EL-3: For use on sliding doors, such as entrance, sally port, corridor, and inmate cell doors, that are to be unlocked from remote locations.
   a. Function: Remote switch activates electric motor that raises hookbolt; spring-loaded actuator pin pushes door open 1 to 3 inches (25 to 75 mm); automatic latching and deadlocking when door is closed (slam locking). Hookbolt can be mechanically raised by five **OR** six, **as directed**,-tumbler paracentric cylinder; keyed one side **OR** two sides, **as directed**; if hookbolt is raised by key, it remains raised until relocked by key.
      1) Latchback: Hookbolt remains raised until door is opened 2 inches (50 mm), then lowers **OR** as long as control switch is in open position; hookbolt lowers when control switch is moved to locked position, **as directed**.
      2) If power fails, hookbolt automatically deadlocks (fail-secure).
   b. Hookbolt: 1-3/4- by 1/2-inch- (44- by 13-mm-) thick, case-hardened steel; 3/4-inch (19-mm) throw.
   c. Provide internal deadlock indicator switch.
   d. Provide case-hardened-steel deadlock actuator.
   e. Voltage: 120-V ac.
   f. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
5. Solenoid-Operated Deadlatches, Mogul EL-4: For use on swinging doors, such as entrance, sally port, corridor, and inmate cell doors, that are to be unlocked from remote locations.

a. Function: Remote switch activates electric solenoid that retracts latchbolt; automatic latching and deadlocking when door is closed (slam locking). Latchbolt can be mechanically retracted by mogul cylinder; keyed one side **OR** two sides, **as directed**.
   1) Latchback: Latchbolt remains retracted until door is opened 2 inches (50 mm), then releases **OR** as long as control switch is activated; latchbolt extends when power is discontinued, **as directed**.
   2) Local Electric Key (LEK): Inmate key operates lock electrically when enabled; staff key always operates lock manually and electrically; where indicated.
   3) Key Holdback: If latchbolt is retracted by key, it remains retracted until relocked by key (listing for use on fire doors is not available).
   4) Knob operation retracts latchbolt; always active.
   5) If power fails, latchbolt automatically deadlocks (fail-secure).
b. Latchbolt: 1-1/2-inch-high by 3/4-inch- (38-mm-high by 19-mm-) thick hardened steel; 1-inch (25-mm) throw.
c. Provide internal deadlock indicator switch.
d. Provide roller-type deadlock actuator.
e. Voltage: 120-V ac.
f. Listed and labeled for use on fire doors.
g. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.

6. Motor-Operated Deadlatches, Mogul EL-5: for use on swinging doors, such as entrance, sally port, corridor, and inmate cell doors, that are to be unlocked from remote locations.
   a. Function: Remote switch activates electric motor that retracts latchbolt; automatic latching and deadlocking when door is closed (slam locking). Latchbolt can be mechanically retracted by mogul cylinder; keyed one side **OR** two sides, **as directed**.
      1) Latchback: Latchbolt remains retracted until door is opened 2 inches (50 mm), then releases **OR** as long as control switch is in open position; latchbolt extends when control switch is moved to locked position, **as directed**.
      2) Local Electric Key (LEK): Inmate key operates lock electrically when enabled; staff key always operates lock manually and electrically; where indicated.
      3) Key Holdback: If latchbolt is retracted by key, it remains retracted until relocked by key (listing for use on fire doors is not available).
      4) Knob operation retracts latchbolt; always active.
      5) If power fails, latchbolt automatically deadlocks (fail-secure).
   b. Latchbolt: 1-1/2-inch-high by 3/4-inch- (38-mm-high by 19-mm-) thick hardened steel; 1-inch (25-mm) throw.
   c. Provide internal deadlock indicator switch.
   d. Provide roller-type deadlock actuator.
   e. Voltage: 120-V ac **OR** 24-V dc, **as directed**.
   f. Listed and labeled for use on fire doors.
   g. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.

7. Solenoid-Operated Deadlatches, Commercial EL-6: For use on swinging doors, hung in standard 2-inch (50-mm) hollow-metal frames, that are to be unlocked from remote locations.
   a. Function: Remote switch activates electric solenoid that retracts latchbolt; automatic latching and deadlocking when door is closed (slam locking). Latchbolt can be mechanically retracted by high-security, **as directed**, commercial cylinder; keyed one side **OR** two sides, **as directed**.
      1) Latchback: Latchbolt remains retracted until door is opened 2 inches (50 mm), then releases **OR** as long as control switch is activated; latchbolt extends when power is discontinued, **as directed**.
      2) Local Electric Key (LEK): Inmate key operates lock electrically when enabled; staff key always operates lock manually and electrically; where indicated.
      3) If power fails, latchbolt automatically deadlocks (fail-secure).
   b. Latchbolt: 1-1/2-inch-high by 5/8-inch- (38-mm-high by 16-mm-) thick hardened steel; 3/4-inch (19-mm) throw.
   c. Provide internal deadlock indicator switch.

d. Deadlock Actuator: Stainless steel.
e. Strike: Stainless steel.
f. Voltage: 24-V dc.
g. Listed and labeled for use on fire doors.
h. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.

8. Motor-Operated Deadlatches, Commercial EL-7: For use on swinging doors, hung in standard 2-inch (50-mm) hollow-metal frames, that are to be unlocked from remote locations.
   a. Function: Remote switch activates electric motor that retracts latchbolt; automatic latching and deadlocking when door is closed (slam locking). Latchbolt can be mechanically retracted by high-security, **as directed**, commercial cylinder; keyed one side **OR** two sides, **as directed**.
      1) Latchback: Latchbolt remains retracted until door is opened 2 inches (50 mm), then releases **OR** as long as control switch is in open position; latchbolt extends when control switch is moved to locked position, **as directed**.
      2) Local Electric Key (LEK): Inmate key operates lock electrically when enabled; staff key always operates lock manually and electrically; where indicated.
      3) If power fails, latchbolt automatically deadlocks (fail-secure).
   b. Latchbolt: 1-1/2-inch-high by 5/8-inch- (38-mm-high by 16-mm-) thick hardened steel; 3/4-inch (19-mm) throw.
   c. Provide internal deadlock indicator switch.
   d. Deadlock Actuator: Stainless steel.
   e. Strike: Stainless steel.
   f. Voltage: 24-V dc.
   g. Listed and labeled for use on fire doors.
   h. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
9. Solenoid-Operated Gate Locks, Paracentric EL-8: For use on swinging and sliding gates that are to be unlocked from remote locations.
   a. Function: Remote switch activates electric solenoid that raises an internal bolt; automatic deadlocking when gate is closed. Bolt can be mechanically retracted by five **OR** six, **as directed**,-tumbler paracentric cylinder; keyed one side **OR** two sides, **as directed**.
      1) Latchback: Bolt remains raised until gate is closed.
      2) If power fails, latchbolt automatically deadlocks (fail-secure).
   b. Bolt: 5/8-inch- (16-mm-) diameter stainless steel; 1-inch (25-mm) throw.
   c. Provide internal deadlock indicator switch.
   d. Voltage: 120-V ac.
   e. Finish: Galvanized.
   f. Mounting: Mount lock to gate post; mount locking tongue to gate frame.
   g. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.

G. Pneumatic Detention Locks And Latches
1. General: Provide pneumatic detention locks and latches that operate when supplied with air between 40 psig (275 kPa) minimum and 100 psig (690 kPa) maximum.
2. Factory install quick-connect air fitting and factory-wired plug connector with 6-inch (150-mm) wire pigtail.
   a. Provide security ring for installation of pneumatic detention lock in hollow-metal detention frame, welded to frame or access cover, unless otherwise **OR** where, **as directed**, indicated.
3. Pneumatic Deadlatches, Paracentric PL-1: For use on swinging doors, such as entrance, sally port, corridor, and inmate cell doors, that are to be unlocked from remote locations.
   a. Function: Remote switch activates pneumatic cylinder that retracts latchbolt; latchbolt remains retracted until door is opened 2 inches (50 mm), then releases **OR** as long as control switch is activated, **as directed**; automatic latching and deadlocking when door is closed (slam locking). Latchbolt can be mechanically retracted by five **OR** six, **as directed**,-tumbler paracentric cylinder; keyed one side **OR** two sides, **as directed**.
      1) If power fails or compressed-air system fails, latchbolt automatically deadlocks (fail-secure).

b. Latchbolt: 2-inch-high by 3/4-inch- (50-mm-high by 19-mm-) thick hardened steel; 3/4-inch (19-mm) throw.
c. Provide internal deadlock indicator switch.
d. Provide roller-type deadlock actuator.
e. Voltage: 24-V dc.
f. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.

4. Pneumatic Deadlatches, Mogul PL-2: For use on swinging doors, such as entrance, sally port, corridor, and inmate cell doors, that are to be unlocked from remote locations.
   a. Function: Remote switch activates pneumatic cylinder that retracts latchbolt; latchbolt remains retracted until door is opened 2 inches (50 mm), then releases **OR** as long as control switch is activated, **as directed**; automatic latching and deadlocking when door is closed (slam locking). Latchbolt can be mechanically retracted by mogul cylinder; keyed one side **OR** two sides, **as directed**.
      1) Local Electric Key (LEK): Inmate key operates lock electrically when enabled; staff key always operates lock manually and electrically; where indicated.
      2) Knob on opposite side of cylinder retracts latchbolt.
      3) If power fails or compressed-air system fails, latchbolt automatically deadlocks (fail-secure).
   b. Latchbolt: 1-1/2-inch-high by 3/4-inch- (38-mm-high by 19-mm-) thick hardened steel; 1-inch (25-mm) throw.
   c. Provide internal deadlock indicator switch.
   d. Provide roller-type deadlock actuator.
   e. Voltage: 24-V dc.
   f. Listed and labeled for use on fire doors.
   g. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
5. Pneumatic Deadlatches, Commercial PL-3: For use on swinging doors, hung in standard 2-inch (50-mm) hollow-metal frames, that are to be unlocked from remote locations.
   a. Function: Remote switch activates pneumatic cylinder that retracts latchbolt; latchbolt remains retracted until door is opened 2 inches (50 mm), then releases **OR** as long as control switch is activated, **as directed**; automatic latching and deadlocking when door is closed (slam locking). Latchbolt can be mechanically retracted by high-security, **as directed**, commercial cylinder; keyed one side **OR** two sides, **as directed**.
      1) Local Electric Key (LEK): Inmate key operates lock electrically when enabled; staff key always operates lock manually and electrically; where indicated.
      2) If power fails or compressed-air system fails, latchbolt automatically deadlocks (fail-secure).
   b. Latchbolt: 1-1/2-inch-high by 5/8-inch- (38-mm-high by 16-mm-) thick hardened steel; 3/4-inch (19-mm) throw.
   c. Faceplate: Stainless steel.
   d. Provide internal deadlock indicator switch.
   e. Provide roller-type deadlock actuator.
   f. Voltage: 24-V dc.
   g. Listed and labeled for use on fire doors.
   h. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.

H. Cylinders And Keying
1. General: Subject to compliance with requirements, provide cylinders and keying for paracentric and mogul cylinders by the same manufacturer as for detention locks and latches.
2. Commercial (Builders' Hardware) Cylinders: As specified in Division 08 Section "Door Hardware".
3. Paracentric Cylinders: Manufacturer's standard lever-tumbler type, constructed from one-piece spring-tempered brass; with tumblers activated by phosphor bronze springs; five tumblers per lock unless otherwise indicated.

4. Mogul Cylinders: Manufacturer's standard pin-tumbler type, minimum 2-inch (50-mm) diameter; body constructed from brass or bronze, stainless steel, or nickel silver; with stainless-steel tumblers and engaging cylinder balls; complying with the following:
   a. Number of Pins: Five **OR** Six **OR** Seven, **as directed**.
   b. Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.
      1) High-Security Grade: Listed and labeled as complying with pick- and drill-resistant testing requirements in UL 437 (Suffix A); where indicated.
   c. Finish: BHMA 606 **OR** BHMA 626, **as directed**.
5. Keying System: Unless otherwise indicated, provide a factory-registered keying system complying with the following requirements:
   a. Paracentric cylinders operated by change keys only.
   b. No Master Key System: Mogul cylinders operated by change keys only.
      OR
      Master Key System: Mogul cylinders operated by a change key and a master key.
      OR
      Grand Master Key System: Mogul cylinders operated by a change key, a master key, and a grand master key.
      OR
      Great-Grand Master Key System: Mogul cylinders operated by a change key, a master key, a grand master key, and a great-grand master key.
   c. Existing System: Master key or grand master key mogul-cylinder locks to the Owner's existing system.
   d. Existing System: Re-key the Owner's existing master key system for mogul-cylinder locks into new keying system.
6. Keys: Provide cast silicon-bronze copper alloy keys complying with the following:
   a. Stamping: Permanently inscribe each key with a visual key-control number and include the following notation:
      1) Notation: "DO NOT DUPLICATE" **OR** Information to be furnished by the Owner, **as directed**.
   b. Quantity: In addition to one extra blank key for each lock, provide the following:
      1) Cylinder Change Keys: Three.
         OR
         Master Key(s): One.
         OR
         Grand Master Key(s): One.
         OR
         Great-Grand Master Key(s): One.

I. Switches
1. General: Provide switches configured with type of contacts required for functions indicated, including multiple circuiting where required by functional performance of Division 28 Section "Plc Electronic Detention Monitoring And Control Systems".
2. Concealed, Magnetic Door Position Switches: Consisting of actuating magnet mortised into detention door and switch mortised into frame; with stainless-steel faceplates; 24-V dc, factory wired with plug connector. Wire in series with lock monitors. Attach with security fasteners.
3. Concealed, Mechanical Door Position Switches: Consisting of metal track mortised into head of detention door connected by steel actuator arm to steel actuator mortised into frame; switch fully concealed when door is in closed position; with stainless-steel faceplate; 120-V ac; factory wired with plug connector. Action of door mechanically activates switch. Wire in series with lock monitors. Attach with security fasteners.
4. Surface-Mounted Door Position Switches: Switch enclosed in 0.134-inch (3.42-mm) nominal-thickness steel enclosure, factory primed for painting; 120-V ac; factory wired with plug connector. Wire in series with lock monitors. Attach with security fasteners.
   a. Galvanize enclosure for exterior locations and where indicated.

5. Strike Indicator Switches: Designed to be mortised behind strike and to indicate whether door is locked or unlocked; enclosed in metal strike box. Wire in series with door position switches. Attach with security fasteners.
   a. Voltage: 120-V dc **OR** 240-V ac **OR** As indicated, **as directed**.
   b. Locations: At doors with mechanical detention lock **OR** Where indicated, **as directed**.
   c. Manufacturer: Same as detention lock.
6. Inmate Door Control Switches, as directed: Momentary **OR** Maintained-contact, **as directed**, push-button switch with metal faceplate. Attach with security fasteners.
   a. Material and Finish: Brass with BHMA 606 **OR** Brass with BHMA 626 **OR** Stainless steel with BHMA 630, **as directed**, finish.
   b. Operation: When activated from remote location, switch allows inmate operation of electric cell door lock.
7. Push-Button, Inmate Door Control Switches, as directed: Momentary **OR** Maintained-contact, **as directed**, push-button switch for installation without faceplate. Attach with security fasteners.
   a. Material and Finish: Brass with BHMA 606 **OR** Brass with BHMA 626 **OR** Stainless steel with BHMA 630, **as directed**, finish.
   b. Operation: When activated from remote location, switch allows inmate operation of electric cell door lock.

J. Detention Operating Trim
1. Standard: BHMA A156.6, Grade 1.
2. Surface-Mounted Door Pulls (not typically used inside cells): 8-3/4-inch (222-mm) overall length and 2-1/4-inch (57-mm) projection; attach to door with two security fasteners.
   a. Material: Cast bronze with BHMA 606 **OR** BHMA 626, **as directed**, finish.
   b. Material: Cast stainless steel with BHMA 630 finish.
3. Round, Surface-Mounted Door Pulls (not typically used inside cells): 7-inch (178-mm) overall length by 1-inch- (25-mm-) diameter solid bar, with 2-1/4-inch (57-mm) projection; attach to door with two security through fasteners.
   a. Material: Cast or extruded bronze with BHMA 606 **OR** BHMA 626, **as directed**, finish.
   b. Material: Cast stainless steel with BHMA 630 finish.
4. Flush Door Pulls: 5 inches high by 4 inches wide by 1 inch deep (127 mm high by 102 mm wide by 25 mm deep), with 1/8-inch- (3-mm-) thick faceplate; attach to door with four security fasteners.
   a. Material: Formed, wrought, or cast brass/bronze with BHMA 606 **OR** BHMA 626, **as directed**, finish.
   b. Material: Formed or cast stainless steel with BHMA 630 finish.
5. Knob Pulls: 2-inch (50-mm) diameter; fabricated from solid brass with BHMA 606 **OR** BHMA 626, **as directed**, finish. Attach with security fasteners.
6. Lever-Handle Guides: Guide track and escutcheon, **as directed**, that provides selective stopping of lever handle by use of an adjustable stop; fabricated from steel with BHMA 633 **OR** stainless steel with BHMA 630, **as directed**, finish. Attach with security fasteners.

K. Security Door Closers
1. Standard: BHMA A156.4, Grade 1.
   a. Certified Products: Provide security door closers listed in BHMA's "Directory of Certified Products."
2. Surface-Mounted Security Door Closers:
   a. Arms: Minimum 3/8-inch- (9.5-mm-) thick by 1-1/8-inch- (29-mm-) wide, rectangular steel main arm; 5/16-inch- (8-mm-) thick by 1-inch- (25-mm-) wide, rectangular steel secondary arm; full rack-and-pinion type; fabricated with orbital-riveted, pinned, or welded elbow and arm shoe/soffit plate joints designed to prevent disassembly with ordinary hand tools.
   b. Cover: Heavy-duty metal, attached with four security fasteners.
   c. Mounting: Attach security door closer with security fasteners.
3. Concealed Security Door Closers:

a. Construction: Forged-steel arm; security roller; with track concealed in head of detention door, designed to eject foreign objects during opening and closing; fabricated with joints designed to prevent disassembly with ordinary hand tools. Closer arm and track fully concealed when door is closed.
b. Cover Plates: Heavy-duty metal, attached with security fasteners.
c. Provide door position switch integral to closer.

4. Unit Size: Unless otherwise indicated, comply with manufacturer's written recommendations for size of security door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

L. Detention Door Stops
1. Detention Floor Stops: 1-1/2-inch-high by 2-inch- (38-mm-high by 50-mm-) diameter rubber bumper mounted on steel lag bolt; BHMA A156.16; install in floor with nonshrink grout; for detention doors unless wall or other type stops are indicated. Do not mount floor stops where they will impede traffic.
2. Silencers for Detention Door Frames: BHMA A156.16, Grade 1; neoprene or rubber, minimum 1/2-inch (13-mm) diameter; fabricated for drilled-in application to detention door frame. Attach with security fasteners.

M. Sliding Detention Door Device Assemblies
1. Performance Requirements: Provide sliding detention door device assemblies, including locking device, receiver, overhead door hanger, bottom door guide, lock column, and enclosure, as a complete assembly, complying with Grade 1 **OR** Grade 2, **as directed**, according to ASTM F 1643, as determined by testing manufacturers' standard units representing those indicated for Project.
2. Assembly Construction: As follows:
   a. Enclosure: Fabricated from 0.179-inch (4.56-mm) nominal-thickness steel plate, with 0.134-inch (3.42-mm) nominal-thickness steel removable **OR** hinged, **as directed**, cover. Baffle openings in enclosure. Provide closures for ends of housings.
      1) Provide sloping-top housings. Flat-top housings may be provided for operators mounted to ceiling, **as directed**.
   b. Lock Column: Vertical tube enclosure fabricated from 0.134-inch (3.42-mm) nominal-thickness steel, providing mechanical locking control of detention sliding door at door location; operated by paracentric key. Doors shall be capable of being locked at top and bottom, at rear of door, in both open and closed positions, with no components projecting into door opening.
   c. Receiver: Fabricated from 0.134-inch (3.42-mm) nominal-thickness steel plate.
   d. Hanger Assembly: Extend steel carrier full width of door and door travel required for clear door opening. Provide antifriction ball-bearing steel rollers with hardened members and grease shield.
   e. Finish: Factory prime painted.
3. Mechanical-Locking, Manual-Door-Movement, Sliding Door Device Assemblies SDA-1: Doors are manually opened and closed and mechanically locked by means of jamb-mounted mechanical detention lock specified elsewhere in this Section.
4. Electromechanical-Locking, Manual-Door-Movement, Sliding Door Device Assemblies SDA-2: Operated from remote-control panel that activates electric motors to unlock sliding doors. Doors spring open a small distance after unlocking and are manually opened and closed. Locks automatically deadlock when doors are moved to fully open or fully closed position. Provide factory-wired cable harness with plug connectors for each motor unit.
   a. Single-Door Function: In an emergency or if power fails, individual doors can be unlocked using a manual-release tool and manually moved; doors relock in either fully open or fully closed position.
   b. Multiple-Door Function: Each door can be individually unlocked locally or from a remote panel, or unlocked from a remote panel with other doors as a group. In an emergency or if power fails, door group can be manually operated from mechanical-release cabinet at end

of cell line **OR** pilaster release adjacent to receiving jamb of each door operated by paracentric key, **as directed**; doors shall not relock in any position.

c. Electric Key Switch: Operated by paracentric **OR** mogul, **as directed**, key and providing electric control of detention sliding door operation at door location; where indicated.

5. Electromechanical-Locking, Electromechanical-Door-Movement, Sliding Door Device Assemblies SDA-3: Operated from remote-control panel that activates electric motors to unlock sliding doors and motorized rack-and-pinion drive mechanisms to open and close doors. Doors lock in open position and deadlock when closed. Provide factory-wired cable harness with plug connectors for each motor unit.

NOTE: Paragraph above describes Southern Folger's "Southern Steel Model 3150LX" and "Southern Steel Model 3165LX." Only the 3150LX system offers multiple door functions, such as for cell doors; the 3165LX system is for individual doors, such as for vestibules, day rooms, and corridors.

1) Single-Door Function: In an emergency or if power fails, individual doors can be unlocked using a manual-release tool and manually moved; doors relock in either fully open or fully closed position.

2) Multiple-Door Function: Each door can be individually unlocked locally or from a remote panel, or unlocked from a remote panel with other doors as a group. In an emergency or if power fails, door group can be manually operated from mechanical-release cabinet at end of cell line **OR** pilaster release adjacent to receiving jamb of each door operated by paracentric key, **as directed**; doors shall not relock in any position.

b. Electric Key Switch: Operated by paracentric **OR** mogul, **as directed**, key and providing electric control of detention sliding door operation at door location; where indicated.

6. Electromechanical-Locking, Pneumatic-Door-Movement, Sliding Door Device Assemblies SDA-4 (for individual doors, such as for vestibules, day rooms, and corridors): Operated from remote-control panel that activates electric motors to unlock sliding doors and pneumatic system to open and close doors. Doors lock in open position and deadlock when closed. Factory install quick-connect air fitting and factory-wired cable harness with plug connectors for each motor unit; 24-V dc.

a. Single-Door Function: In an emergency or if pneumatic systems or electric power fails, individual doors can be unlocked using a manual-release tool and manually moved; doors relock in either fully open or fully closed position.

1) Lock Control at Door: Mechanical key release adjacent to receiving jamb of each door, contained in pilaster and operated by paracentric key; where indicated.

7. Pneumatic-Locking, Manual-Door-Movement, Sliding Door Device Assemblies SDA-5: Operated from remote-control panel that activates pneumatic cylinders to unlock doors. Doors spring open a small distance after unlocking and are manually opened and closed. Locks automatically deadlock when doors are moved to fully open or fully closed position. Factory install quick-connect air fitting and factory-wired cable harness with plug connectors for each motor unit.

a. Single-Door Function: In an emergency or if pneumatic systems or electric power fails, individual doors can be unlocked using a manual-release tool and manually moved; doors relock in either fully open or fully closed position.

1) Lock Control at Door: Mechanical key release adjacent to receiving jamb of each door, contained in pilaster and operated by paracentric key; where indicated.

b. Multiple-Door Function: Each door can be individually unlocked locally or from a remote panel, or unlocked from a remote panel with other doors as a group. In an emergency or if pneumatic systems or electric power fails, door group can be operated from remotely located auxiliary pneumatic-release system **OR** pilaster release adjacent to receiving jamb of each door operated by paracentric key, **as directed**; doors shall not relock in any position.

c. Electric Key Switch: Operated by paracentric **OR** mogul, **as directed**, key and providing electric control of detention sliding door operation at door location; where indicated.

8. Pneumatic-Locking, Pneumatic-Door-Movement, Sliding Door Device Assemblies SDA-6 (Paragraph below describes Southern Folger's "Southern Steel Model 8050L" and "Southern

Steel Model 8065L." Only the 8050L system offers multiple door functions, such as for cell doors; the 8065L system is for individual doors, such as for vestibules, day rooms, and corridors.): Operated from remote-control panel that activates pneumatic cylinder to unlock sliding doors and open and close doors. Doors lock in open position and deadlock when closed. Factory install quick-connect air fitting and factory-wired cable harness with plug connectors for each motor unit; 24-V dc.

a. Single-Door Function: In an emergency or if pneumatic systems or electric power fails, individual doors can be unlocked using a manual-release tool and manually moved; doors relock in either fully open or fully closed position.
b. Multiple-Door Function: Each door can be individually unlocked locally or from a remote panel, or unlocked from a remote panel with other doors as a group. In an emergency or if pneumatic systems or electric power fails, door group can be operated from remotely located auxiliary pneumatic-release system **OR** pilaster release adjacent to receiving jamb of each door operated by paracentric key, **as directed**; doors shall not relock in any position.
c. Electric Key Switch: Operated by paracentric **OR** mogul, **as directed**, key and providing electric control of detention sliding door operation at door location; where indicated.
d. Provide security ring for installation of pneumatic detention lock in hollow-metal detention frame, welded to frame or access cover, unless otherwise **OR** where, **as directed**, indicated.

N. Fabrication

1. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location (omit removable nameplates) except in conjunction with required fire-rated labels and as otherwise approved.
2. Base Metals: Produce detention door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified detention door hardware units and BHMA A156.18 finishes. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.
3. Fasteners: Provide flat-head security fasteners with finished heads to match surface of detention door hardware unless otherwise indicated.
   a. Security Fasteners: Fabricate detention door hardware using security fasteners with head style appropriate for fabrication requirements, strength, and finish of adjacent materials. Provide stainless-steel security fasteners in stainless-steel materials, **as directed**.
   b. Concealed Fasteners: For detention door hardware units that are exposed when detention door is closed except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching detention door hardware. Where through bolts are used on hollow-metal detention door and frame construction, provide sleeves for each through bolt.
   c. Steel Machine Screws (for fire-rated detention door assemblies. NFPA 80 requires locks, latches, and surface-mounted top and bottom bolts to be secured with machine screws or through bolts.): For the following fire-rated applications:
      1) Mortise detention hinges to detention doors.
      2) Strike plates to detention frames.
      3) Security door closers to detention doors and frames.
   d. Steel Through Bolts (for fire-rated detention door assemblies. NFPA 80 requires locks, latches, and surface-mounted top and bottom bolts to be secured with machine screws or through bolts.): For the following fire-rated applications unless door blocking is provided:
      1) Surface detention hinges to detention doors.
      2) Security door closers to detention doors and frames.
   e. Spacers or Sex Bolts: For through bolting of hollow-metal detention doors.
   f. Fasteners for Wood Detention Doors: Comply with DHI WDHS.2.

O. Finishes
  1. Standard: Comply with BHMA A156.18.
  2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
  3. BHMA Designations: Comply with base material and finish requirements indicated by the following:
     a. BHMA 600: Primed for painting, over steel base metal.
     b. BHMA 606: Satin brass, clear coated, over brass base metal.
     c. BHMA 626: Satin chromium plated over nickel, over brass or bronze base metal.
     d. BHMA 630: Stainless steel, satin, over stainless-steel base metal.
     e. BHMA 652: Satin chromium plated over nickel, over steel base metal.

1.3 EXECUTION

A. Preparation
  1. Steel Detention Doors and Frames: Comply with ANSI/DHI A115 Series.
     a. Surface-Applied Detention Door Hardware: Drill and tap detention doors and frames according to ANSI/SDI A250.6.
  2. Wood Detention Doors: Comply with DHI A115-W Series.

B. Installation
  1. Mounting Heights: Mount detention door hardware units at heights indicated in the following applicable publications unless specifically indicated or required to comply with governing regulations:
     a. Steel Detention Doors and Frames: DHI's "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames."
     b. Wood Detention Doors: DHI WDHS.3.
  2. Install each detention door hardware item to comply with Shop Drawings and manufacturer's written instructions. Where cutting and fitting are required to install detention door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09. Do not install surface-mounted items until finishes have been completed on substrates involved.
     a. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
     b. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
  3. Install interconnecting wiring and connectors between detention door hardware devices. Terminate device wiring for detention door hardware installed in swinging doors at a plug-type connector located in lock pocket or door frame junction box and for sliding doors at a junction box in door frame.
  4. Security Fasteners: Install detention door hardware using security fasteners with head style appropriate for installation requirements, strength, and finish of adjacent materials.

C. Field Quality Control
  1. Inspect installed products to verify compliance with requirements. Prepare inspection reports and indicate compliance with and deviations from the Contract Documents.
  2. Perform the following field tests and inspections and prepare test reports:
     a. After installing electrified and pneumatic, **as directed**, detention door hardware and after electrical circuitry has been energized and compressed-air system is functional, **as directed**, test detention door hardware for compliance with requirements.
        1) Test: Operate lock of each door and group of doors in normal remote, normal local, and emergency operating modes. Verify that remote controls operate correct door locks and in correct sequence.

b. Verify that lock bolts engage strikes with required bolt projection.
c. Verify that detention door hardware is installed, connected, and adjusted according to the Contract Documents.
d. Verify that electrical wiring installation complies with manufacturer's submittal and written installation requirements.

3. Remove and replace detention work if inspections indicate that work does not comply with specified requirements. Remove malfunctioning units, replace with new units, and retest as specified above.
4. Perform additional inspections to determine compliance of replaced or additional work. Prepare inspection reports.
5. Prepare field quality-control certification endorsed by Detention Specialist, **as directed**, that states installed products and their installation comply with requirements in the Contract Documents.

D. Adjusting

1. Adjust and check each operating item of detention door hardware and each detention door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust detention door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
   a. Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
   b. Security Door Closers: Adjust sweep period so that, from an open position of 90 degrees, detention door will take at least five seconds to move to a position of 12 degrees.

E. Cleaning And Protection

1. Clean adjacent surfaces soiled by detention door hardware installation.
2. Clean operating items as necessary to restore proper function and finish.
3. Provide final protection and maintain conditions that ensure that detention door hardware is without damage or deterioration at time of Final Completion.

1.4 Detention Door Hardware Sets

Note 1: Hanging devices below include detention hinges and sliding detention door device assemblies. Indicate whether detention hinges are attached to detention doors and frames by security fasteners or by welding.
Note 2: Securing devices (inactive leaf) below include door position switches and strike indicator switches.
Note 3: Securing devices (active leaf) below include detention locksets and latchsets, cylinders, door position switches, strike indicator switches, and inmate door control switches.\
Note 4: Operating trim below includes detention door pulls, flush pulls, knob pulls, and lever-handle guides.
Note 5: Closing devices below include security door closers.
Note 6: Stops below include detention floor stops and door silencers if not specified with steel detention doors and frames.
Note 7: Miscellaneous items that could be inserted at end of detention door hardware sets include key-control cabinets, software if not included in Division 08 Section "Door Hardware", and detention door hardware not otherwise listed.

A. General: Provide detention door hardware for each detention door to comply with requirements in this Section and detention door hardware sets indicated in a door and frame schedule **OR** and detention door hardware sets indicated below, **as directed**.

Detention Door Hardware Set No. [**#**]
Single Door No. [**#**]; each to have the following:

*	Hanging Devices	**<Insert description.>**	**<Insert manufacturer.>**	**<Insert finish.>**
[**#**]	Securing Devices	**<Insert description.>**	**<Insert manufacturer.>**	**<Insert finish.>**

	(inactive leaf)			
<#>	Securing Devices (active leaf)	**<Insert description.>**	**<Insert manufacturer.>**	**<Insert finish.>**
[#]	Operating Trim	**<Insert description.>**	**<Insert manufacturer.>**	**<Insert finish.>**
[#]	Closing Devices	**<Insert description.>**	**<Insert manufacturer.>**	**<Insert finish.>**
[#]	Stops	**<Insert description.>**	**<Insert manufacturer.>**	**<Insert finish.>**
*	Number of Hinges, as specified.			

Note 8: Insert additional requirements and sequence of operation in schedule above for electrified and pneumatic detention door hardware if required.

END OF SECTION 08 71 11 00

Task	Specification	Specification Description
08 71 11 00	01 22 16 00	No Specification Required
08 71 11 00	06 01 40 91	Door Hardware

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SECTION 08 71 13 00 - AUTOMATIC DOOR OPERATORS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of material for automatic door operators. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Power door operators for swinging doors.
      b. Low-energy door operators for swinging doors.
      c. Power-assist door operators for swinging doors.

C. Definitions
   1. Double Egress Doors: A pair of doors that simultaneously swing with the two doors moving in opposite directions with no mullion between them.
   2. Double Swing Doors: A pair of doors that swing with the two doors moving in opposite directions with a mullion between them; each door functioning as a single swing door.

D. Submittals
   1. Product Data: For each type of product indicated.
   2. Shop Drawings: For automatic door operators. Include plans, elevations, sections, details, and attachments to other work.
   3. Samples: For each exposed product and for each color and texture specified.
   4. Product certificates
   5. Field quality-control reports.
   6. Maintenance data.
   7. Warranty: Sample of special warranty.

E. Quality Assurance
   1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation and maintenance of units required for this Project and who employs a certified inspector, **as directed**.
   2. Certified Inspector Qualifications: Certified by the AAADM.
   3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended location and application.
   4. Exit-Door Requirements: Comply with requirements of authorities having jurisdiction for doors with automatic door operators serving as a component of a required means of egress.
   5. Preinstallation Conference: Conduct conference at Project site.

F. Warranty
   1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of automatic door operators that fail in materials or workmanship within two years from date of Final Completion.

1.2 PRODUCTS

A. Materials
   1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated, complying with standards indicated below:

a. Sheet: ASTM B 209 (ASTM B 209M).
b. Extrusions: ASTM B 221 (ASTM B 221M).

2. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304, stretcher-leveled standard of flatness, in manufacturer's standard thickness.
3. Brass Sheet: ASTM B 36/B 36M, Alloy UNS No. C26000 (cartridge brass, 70 percent copper), in manufacturer's standard thickness.
4. Bronze Sheet: ASTM B 36/B 36M, Alloy UNS No. C28000 (muntz metal, 60 percent copper) or Alloy UNS No. C23000 (red brass, 85 percent copper), in manufacturer's standard thickness.
5. Expanded Aluminum Mesh: Manufacturer's standard expanded **OR** expanded and flattened, **as directed**, aluminum sheet in accordance with the geometry of ASTM F 1267.
6. Polycarbonate: Manufacturer's standard monolithic polycarbonate sheet manufactured by extrusion process, with an average impact strength of 12 to 16 ft-lbf/in. (640 to 854 J/m) of width when tested according to ASTM D 256, Method A.
7. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

B. Automatic Door Operators, General

1. General: Provide operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; for long-term, maintenance-free operation under normal traffic load for type of occupancy indicated; and complying with UL 325. Coordinate operator mechanisms with door operation, hinges, and activation and safety devices.
   a. Emergency Breakaway: Where indicated for center-pivoted doors, provide emergency breakaway feature for reverse swing of doors. Equip system to discontinue power to automatic door operator when door is in emergency breakaway position, and to return to closed position after breakaway and automatically reset.
   b. Fire-Rated Doors: Provide door operators for fire-rated door assemblies that comply with NFPA 80 for fire-rated door components and are listed and labeled by a qualified testing agency.
   c. Wind Load: Provide door operators on exterior doors that will open and close doors and maintain them in fully closed position when subjected to wind load of <**Insert wind load**>.
2. Electromechanical Operating System: Self-contained unit powered by permanent-magnet dc motor; with closing speed controlled mechanically by gear train and dynamically by braking action of electric motor, connections for power and activation- and safety-device wiring, and manual operation including spring closing when power is off.
3. Electrohydraulic Operating System: Self-contained low-pressure unit; with separate cylinders for power and checking, connections for power and activation- and safety-device wiring, manual operation including spring closing when power is off.
4. Pneumatic Operating System: Pneumatic operator, air opened and spring closed, checking in both cycles, with doors manually operable when power is off.
   a. Power Unit: Manufacturer's standard remote compressor unit, complete with tank, compressor, motor, regulator, safety valve, pressure cutoff switch, and automatic air-line filter drain.
      OR
      Power Unit: As specified in Division 22 Section(s) "General-service Compressed-air Piping" AND "General-service Packaged Air Compressors And Receivers".
5. Hinges: See Division 08 Section "Door Hardware" for type of hinge for each door that door operator shall accommodate.
6. Housing for Overhead Concealed Operators: Fabricated from minimum 0.125-inch- (3.2-mm-) thick, extruded or formed aluminum and extending full width of door opening including door jambs to conceal door operators and controls. Provide hinged or removable access panels for service and adjustment of door operators and controls. Secure panels to prevent unauthorized access.
7. Cover for Surface-Mounted Operators: Fabricated from 0.125-inch- (3.2-mm-) thick extruded or formed aluminum; manufacturer's standard width; **OR** continuous over full width of operator-controlled door opening; **OR** continuous over full width of door opening including door jambs, **as**

directed; with enclosed end caps, provision for maintenance access, and fasteners concealed when door is in closed position.

8. Brackets and Reinforcements: Manufacturer's standard, fabricated from aluminum with nonstaining, nonferrous shims for aligning system components.
9. Fire-Door Package: Consisting of UL-listed latch mechanism, power-reset box, and caution signage for fire-rated doors. Latch mechanism shall allow door to swing free during automatic operation; when fire is detected, latch actuator shall cause exit hardware to latch when door closes. Provide latch actuators with fail-secure design.

C. Power Door Operators
1. Standard: BHMA A156.10.
2. Performance Requirements:
   a. Opening Force:
      1) Power-Operated Doors: Not more than 50 lbf (222 N) required to manually set door in motion if power fails; not more than 15 lbf (67 N) required to open door to minimum required width.
         OR
         Power-Operated Swinging Doors: Not more than 30 lbf (133 N) required to manually open door if power fails.
      2) Breakaway Device for Power-Operated Doors: Not more than 50 lbf (222 N) required for a door to open.
   b. Entrapment Protection: Not more than 40 lbf (178 N) required to prevent stopped door in the last 10 degrees of opening from moving in the direction of opening; not more than 30 lbf (133 N) required to prevent stopped door from moving in direction of closing.
3. Configuration: Operator to control single swinging door **OR** pair of swinging doors, **as directed**.
   a. Traffic Pattern: One way **OR** Two way **OR** Double swing **OR** Double egress, **as directed**.
   b. Operator Mounting: Surface **OR** Overhead concealed, **as directed**.
4. Operation: Power opening and power-assisted, **as directed**, spring closing. Provide time delay for door to remain open before initiating closing cycle as required by BHMA A156.10.
5. Operating System: Electromechanical **OR** Electrohydraulic **OR** Pneumatic, **as directed**.
6. Microprocessor Control Unit: Solid-state controls.
7. Features:
   a. Adjustable opening **OR** closing **OR** opening and closing, **as directed**, speed.
   b. Adjustable opening **OR** closing, **as directed**, force.
   c. Adjustable backcheck.
   d. Adjustable hold-open time from zero to 30 seconds.
   e. Adjustable time delay.
   f. Adjustable acceleration.
   g. Adjustable limit switch.
   h. Obstruction recycle.
   i. On-off/hold-open switch to control electric power to operator; key operated, **as directed**.
8. Exposed Finish: Finish exposed components with Class I, clear anodic finish **OR** Class II, clear anodic finish **OR** Class I, color anodic finish **OR** Class II, color anodic finish **OR** baked-enamel or powder coat **OR** metal cladding **OR** finish matching door and frame **OR** finish matching door hardware, **as directed**.
   a. Color: As selected from full range of industry colors and color densities.
   b. Metal Cladding: No. 4 directional-satin-finish stainless steel **OR** No. 8 mirrorlike reflective, nondirectional-polish-finish stainless steel **OR** Satin brass **OR** Polished brass **OR** Satin bronze **OR** Polished bronze, **as directed**.

D. Low-Energy Door Operators
1. Standard: BHMA A156.19.
2. Performance Requirements:
   a. Opening Force if Power Fails: Not more than 15 lbf (67 N) required to release a latch if provided, not more than 30 lbf (133 N) required to manually set door in motion, and not more than 15 lbf (67 N) required to fully open door.

b. Entrapment Protection: Not more than 15 lbf (67 N) required to prevent stopped door from closing or opening.

3. Configuration: Operator to control single swinging door **OR** pair of swinging doors, **as directed**.
   a. Traffic Pattern: One way **OR** Two way **OR** Double swing **OR** Double egress, **as directed**.
   b. Operator Mounting: Surface **OR** Overhead concealed, **as directed**.
4. Operation: Power opening and power-assisted, **as directed**, spring closing. Provide time delay for door to remain open before initiating closing cycle as required by BHMA A156.19. When not in automatic mode, door operator shall function as manual door closer, with or without electrical power.
5. Operating System: Electromechanical **OR** Electrohydraulic **OR** Pneumatic, **as directed**.
6. Microprocessor Control Unit: Solid-state controls.
7. Features:
   a. Adjustable opening **OR** closing **OR** opening and closing, **as directed**, speed.
   b. Adjustable opening **OR** closing, **as directed**, force.
   c. Adjustable backcheck.
   d. Adjustable hold-open time from zero to 30 seconds.
   e. Adjustable time delay.
   f. Adjustable acceleration.
   g. Obstruction recycle.
   h. On-off/hold-open switch to control electric power to operator; key operated, **as directed**.
8. Exposed Finish: Finish exposed components with Class I, clear anodic finish **OR** Class II, clear anodic finish **OR** Class I, color anodic finish **OR** Class II, color anodic finish **OR** baked-enamel or powder coat **OR** metal cladding **OR** finish matching door and frame **OR** finish matching door hardware, **as directed**.
   a. Color: As selected from full range of industry colors and color densities.
   b. Metal Cladding: No. 4 directional-satin-finish stainless steel **OR** No. 8 mirrorlike reflective, nondirectional-polish-finish stainless steel **OR** Satin brass **OR** Polished brass **OR** Satin bronze **OR** Polished bronze, **as directed**.

E. Power-Assist Door Operators
1. Standard: BHMA A156.19.
2. Performance Requirements:
   a. Opening Force:
      1) If Power Fails: Not more than 15 lbf (67 N) required to release a latch if provided, not more than 30 lbf (133 N) required to manually set door in motion, and not more than 15 lbf (67 N) required to fully open door.
      2) Accessible Interior Doors: Not more than 5 lbf (22 N) to fully open door.
   b. Entrapment Protection: Not more than 15 lbf (67 N) required to prevent stopped door from closing or opening.
3. Configuration: Operator to control single swinging door **OR** pair of swinging doors, **as directed**.
   a. Traffic Pattern: One way **OR** Two way **OR** Double swing **OR** Double egress, **as directed**.
   b. Operator Mounting: Surface **OR** Overhead concealed, **as directed**.
4. Operation: Power-assisted opening that reduces force to open door and power-assisted, **as directed**, spring closing. Pushing or pulling on door activates the operator. Provide time delay for door to remain open before initiating closing cycle as required by BHMA A156.19. When not in automatic mode, door operator shall function as manual door closer, with or without electrical power.
5. Operating System: Electromechanical **OR** Electrohydraulic **OR** Pneumatic, **as directed**.
6. Microprocessor Control Unit: Solid-state controls.
7. Features:
   a. Adjustable opening **OR** closing **OR** opening and closing, **as directed**, speed.
   b. Adjustable opening **OR** closing, **as directed**, force.
   c. Adjustable backcheck.
   d. Adjustable latch speed.
   e. Adjustable hold-open time from zero to 30 seconds.

f. Adjustable time delay.
g. Adjustable acceleration.
h. Obstruction recycle.
i. On-off/hold-open switch to control electric power to operator; key operated, **as directed**.

8. Exposed Finish: Finish exposed components with Class I, clear anodic finish **OR** Class II, clear anodic finish **OR** Class I, color anodic finish **OR** Class II, color anodic finish **OR** baked-enamel or powder coat **OR** metal cladding **OR** finish matching door and frame **OR** finish matching door hardware, **as directed**.
   a. Color: As selected from full range of industry colors and color densities.
   b. Metal Cladding: No. 4 directional-satin-finish stainless steel **OR** No. 8 mirrorlike reflective, nondirectional-polish-finish stainless steel **OR** Satin brass **OR** Polished brass **OR** Satin bronze **OR** Polished bronze, **as directed**.

F. Activation And Safety Devices
1. General: Provide activation and safety devices in accordance with BHMA standards, for condition of exposure and for long-term, maintenance-free operation under normal traffic load for type of occupancy indicated. Coordinate activation and safety devices with door operation and door operator mechanisms.
2. Motion Sensors: Self-contained, K-band-frequency, microwave-scanner units; adjustable to provide detection field sizes and functions required by BHMA A156.10.
   a. Provide capability for switching between bidirectional and unidirectional detection.
   b. For one-way traffic, sensor on egress side shall not be active when doors are fully closed.
3. Presence Sensors: Self-contained, infrared-scanner units; adjustable to provide detection field sizes and functions required by BHMA A156.10. Sensors shall remain active at all times.
4. Combination Motion/Presence Sensors: Self-contained units consisting of both motion and presence sensors in a single housing; adjustable to provide detection field sizes and functions required by BHMA A156.10.
   a. Motion Sensor: K-band-frequency, microwave-scanner units.
      1) Provide capability for switching between bidirectional and unidirectional detection.
      2) For one-way traffic, sensor on egress side shall not be active when doors are fully closed.
   b. Presence Sensor: Infrared-scanner units that remain active at all times.
5. Photoelectric Beams: Pulsed infrared, sender-receiver assembly for recessed mounting. Beams shall not be active when doors are fully closed.
6. Control Mats: 1/2-inch- (13-mm-) thick, synthetic-rubber or flexible-plastic mat in safety-ribbed surface pattern, with extruded-aluminum frame; with pressure switches for low-voltage control wiring; and complying with performance requirements in BHMA A156.10.
   a. Frame: Recessed to fit flush with floor, with concealed anchors **OR** Surface mounted, with tapered safety edge, **as directed**.
   b. Size: As indicated, but not smaller than required by BHMA A156.10 including Appendix A.
   c. Color: As selected from full range of industry colors and color densities.
7. Push-Plate Switch: Momentary-contact door control switch with flat push-plate actuator with contrasting-colored, engraved message, **as directed**.
   a. Configuration: Round **OR** Square, **as directed**, push plate with 4-by-4-inch (100-by-100-mm) junction box.
      1) Mounting: Recess mounted, semiflush in wall **OR** Surface mounted on wall **OR** As indicated on Drawings, **as directed**.
   b. Configuration: Rectangular push plate with 2-by-4-inch (50-by-100-mm) junction box.
      1) Mounting: Recess mounted, semiflush in wall **OR** Recess mounted in door jamb **OR** Surface mounted on wall **OR** Surface mounted on post **OR** Surface mounted on guide rail **OR** As indicated on Drawings, **as directed**.
   c. Push-Plate Material: Stainless steel **OR** Plastic, **as directed**, as selected from manufacturer's full range.
   d. Message: Plain face with no message **OR** "Push to Open" **OR** International symbol of accessibility **OR** International symbol of accessibility and "Push to Open", **as directed**.

8. Push-Button Switch: Momentary-contact door control switch with one red-button actuator; enclosed in nominal 2-by-4-inch (50-by-100-mm) **OR** 4-by-4-inch (100-by-100-mm), **as directed**, junction box.
   a. Provide faceplate engraved with "Press to Open" text and international symbol of accessibility, **as directed**, in contrasting color.
   b. Provide blue plastic cover engraved with "Press Button to Open" in white text and international symbol of accessibility.
   c. Mounting: Surface mounted on wall **OR** Surface mounted on post **OR** Surface mounted on guide rail **OR** Recess mounted in wall **OR** As indicated on Drawings, **as directed**.
   d. Faceplate Material: Stainless steel **OR** Painted metal, **as directed**, as selected from manufacturer's full range.
9. Key Switch: Recess-mounted, door control switch with key-controlled actuator; enclosed in 2-by-4-inch (50-by-100-mm) junction box. Provide faceplate engraved with text indicating switch functions.
   a. Faceplate Material: Stainless steel **OR** Painted metal, **as directed**, as selected from manufacturer's full range.
   b. Functions: On-off, momentary contact **OR** On-off, maintained contact **OR** Two-way automatic, hold open, one-way exit, and off **OR** Two-way automatic, hold open, one-way exit, off, full open, and partial open, **as directed**.
   c. Mounting: Recess mounted, semiflush in wall **OR** Recess mounted in door jamb **OR** Surface mounted on wall **OR** Surface mounted on post **OR** As indicated on Drawings, **as directed**.
10. Wireless or Remote Radio-Control Switch: Manufacturer's standard radio-control system consisting of header-mounted receiver and wall-mounted **OR** hand-held, battery-operated, **as directed**, transmitter switch.
    a. Wall-Mounted Transmitter Switch: One red-button, momentary-contact actuator enclosed in 4-by-4-inch (100-by-100-mm) junction box. Provide blue plastic cover engraved with "Press Button to Open" in white text and international symbol of accessibility.
11. Electrical Interlocks: Unless units are equipped with self-protecting devices or circuits, provide electrical interlocks to prevent activation of operator when door is locked, latched, or bolted.

G. Fabrication
1. Factory fabricate automatic door operators to comply with indicated standards.
2. Fabricate exterior components to drain water passing joints and condensation and moisture occurring or migrating within operator enclosure to the exterior.
3. Form aluminum shapes before finishing.
4. Use concealed fasteners to greatest extent possible. Where exposed fasteners are required, use countersunk Phillips flat-head machine screws, finished to match operator.
5. Provide metal cladding, completely cladding visible surfaces before shipment to Project site. Fabricate cladding with concealed fasteners and connection devices, with accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion, and with allowance for thermal expansion at exterior doors.

H. Accessories
1. Signage: As required by cited BHMA standard for the type of operator.
   a. Application Process: Decals **OR** Silk-screened **OR** Door manufacturer's standard process, **as directed**.
   b. Provide sign materials with instructions for field application when operators are installed.
2. Guide Rails: Anodized aluminum **OR** Baked-enamel or powder-coated aluminum **OR** Stainless steel, **as directed**, fabricated from bars **OR** tubing, **as directed**, minimum 30 inches (762 mm) high, and finished to match doors unless otherwise indicated; positioned and projecting from face of door jamb for distance as indicated, but not less than that required by BHMA A156.10 for type of door and direction of travel; with filler panel.
   a. Filler Panel: Expanded aluminum mesh **OR** Polycarbonate plastic, **as directed**.

1) Orient expanded aluminum mesh with long dimension of diamonds parallel to top rail **OR** perpendicular to top rail **OR** horizontal **OR** vertical, **as directed**.
2) Color: As selected from manufacturer's full range.

b. Provide intermediate guide rail suitable for supporting photoelectric beams.
c. Mounting: Jamb and floor **OR** Floor, freestanding, **as directed**.

OR

Guide Rails: See Division 05 Section(s) "Metal Fabrications" OR "Pipe And Tube Railings" OR "Decorative Metal", **as directed**.

I. General Finish Requirements

1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.
4. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

J. Aluminum Finishes

1. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
2. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
3. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, application, and baking.

1.3 EXECUTION

A. Installation

1. General: Install complete automatic door operators according to manufacturer's written instructions, including activation and safety devices, control wiring, and remote power units if any; connection to the building's power supply; and signage.
   a. Do not install damaged components. Fit joints to produce hairline joints free of burrs and distortion.
   b. Install operators true in alignment with established lines and door geometry without warp or rack. Anchor securely in place.
   c. Power Door Operator Installation Standard: BHMA A156.10.
   d. Low-Energy Door Operator Installation Standard: BHMA A156.19.
2. Power Connection: See Division 26 for connection to electrical power distribution system and see Division 22 for connection to compressed-air distribution piping, **as directed**.
3. Activation and Safety Devices: Install devices and wiring according to manufacturer's written instructions and cited BHMA standard for type of operator and direction of pedestrian travel. Connect activation- and safety-device wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
4. Access-Control System: Connect operators to access-control system as specified in Division 28 Section "Access Control".
5. Signage: Apply on both sides of each door as required by cited BHMA standard for type of door operator and direction of pedestrian travel.
6. Guide Rails: Install according to BHMA A156.10 including Appendix A and manufacturer's written instructions unless otherwise indicated.

B. Field Quality Control

1. Inspection: Engage Installer's certified inspector to test and inspect automatic door operators and prepare test and inspection reports.

a. Certified inspector shall test and inspect each automatic door operator to determine compliance of installed systems with applicable BHMA standards.
b. Inspection Report: Certified inspector shall submit report in writing to the Owner and Contractor within 24 hours after inspection.
2. Work will be considered defective if it does not pass tests and inspections.

C. Adjusting
1. Adjust automatic door operators to function smoothly, and lubricate as recommended by manufacturer; comply with requirements of applicable BHMA standards.
   a. Adjust operators on exterior doors for weathertight closure.
2. After completing installation of exposed, factory-finished automatic door operators, inspect exposed finishes on doors and operators. Repair damaged finish to match original finish.
3. Readjust automatic door operators after repeated operation of completed installation equivalent to three days' use by normal traffic (100 to 300 cycles).
4. Occupancy Adjustment: When requested within 12 months of date of Final Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION 08 71 13 00

Task	Specification	Specification Description
08 72 33 00	06 48 13 00	Wood Doors
08 72 33 00	08 05 13 00	Flush Wood Doors
08 72 33 00	06 01 40 91	Door Hardware
08 72 43 00	06 01 40 91	Door Hardware
08 75 13 00	06 01 40 91	Door Hardware
08 75 13 00	08 71 13 00	Automatic Door Operators
08 78 00 00	08 71 11 00	Detention Door Hardware
08 81 23 13	07 42 13 19	Glazing
08 81 23 23	07 42 13 19	Glazing

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SECTION 08 83 13 00 - MIRRORS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for mirrors. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes the following types of silvered flat glass mirrors:
   a. Annealed monolithic glass mirrors.
   b. Film-backed, Laminated and Tempered glass mirrors qualifying as safety glazing.

C. Submittals
1. Product Data: For each type of product indicated.
   a. Mirrors. Include description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality-control provisions.
2. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachments to other work.
3. Samples: For each type of the following products:
   a. Mirrors: 12 inches (300 mm) square, including edge treatment on two adjoining edges.
   b. Mirror Clips: Full size.
   c. Mirror Trim: 12 inches (300 mm) long.
4. Qualification Data: For qualified Installer.
5. Product Certificates: For each type of mirror and mirror mastic, from manufacturer.
6. Preconstruction Test Reports: From mirror manufacturer indicating that mirror mastic was tested for compatibility and adhesion with mirror backing paint **OR** film, **as directed**, and substrates on which mirrors are installed.
7. Maintenance Data: For mirrors to include in maintenance manuals.
8. Warranty: Sample of special warranty.

D. Quality Assurance
1. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
2. Source Limitations for Mirrors: Obtain mirrors from single source from single manufacturer.
3. Source Limitations for Mirror Accessories: Obtain mirror glazing accessories from single source.
4. Glazing Publications: Comply with the following published recommendations:
   a. GANA's "Glazing Manual" unless more stringent requirements are indicated. Refer to this publication for definitions of glass and glazing terms not otherwise defined in this Section or in referenced standards.
   b. GANA Mirror Division's "Mirrors, Handle with Extreme Care: Tips for the Professional on the Care and Handling of Mirrors."
5. Safety Glazing Products: For film-backed, laminated and tempered mirrors, provide products complying with testing requirements in 16 CFR 1201 for Category II materials.
6. Preconstruction Mirror Mastic Compatibility Test: Submit mirror mastic products to mirror manufacturer for testing to determine compatibility of mastic with mirror backing paint **OR** film, **as directed**, and substrates on which mirrors are installed.

E. Delivery, Storage, And Handling

1. Protect mirrors according to mirror manufacturer's written instructions and as needed to prevent damage to mirrors from moisture, condensation, temperature changes, direct exposure to sun, or other causes.
2. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors.

F. Project Conditions
1. Environmental Limitations: Do not install mirrors until ambient temperature and humidity conditions are maintained at levels indicated for final occupancy.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which mirror manufacturer agrees to replace mirrors that deteriorate within specified warranty period. Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.
    a. Warranty Period: Five years from date of Final Completion.

1.2 PRODUCTS

A. Silvered Flat Glass Mirrors
1. Glass Mirrors, General: ASTM C 1503; manufactured using copper-free, low-lead mirror coating process, **as directed**.
2. Clear Glass: Mirror Select **OR** Glazing, **as directed**, Quality; ultraclear (low-iron) float glass with a minimum 91 percent visible light transmission, **as directed**.
    a. Nominal Thickness: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
3. Tinted Glass: Mirror Glazing Quality.
    a. Nominal Thickness: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
    b. Tint Color: Blue **OR** Black **OR** Bronze **OR** Gold **OR** Gray **OR** Green **OR** Peach **OR** Pink, **as directed**.
4. Tempered Clear **OR** Tinted, **as directed**, Glass: Mirror Glazing Quality, for blemish requirements; and comply with ASTM C 1048 for Kind FT, Condition A, tempered float glass before silver coating is applied.
    a. Nominal Thickness: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
    b. Tint Color: Blue **OR** Black **OR** Bronze **OR** Gold **OR** Gray **OR** Green **OR** Peach **OR** Pink, **as directed**.
5. Laminated Mirrors: ASTM C 1172, Kind LM.
    a. Clear Glass for Outer Lite: Mirror Select **OR** Glazing, **as directed**, Quality; ultraclear (low-iron) float glass with a minimum 91 percent visible light transmission, **as directed**.
    b. Tinted Glass for Outer Lite: Mirror Glazing Quality.
        1) Tint Color: Blue **OR** Black **OR** Bronze **OR** Gold **OR** Gray **OR** Green **OR** Peach **OR** Pink, **as directed**.
    c. Nominal Thickness for Outer Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
    d. Glass for Inner Lite: Annealed float glass; ASTM C 1036, Type I (transparent flat glass), Quality-Q3; Class 1 (clear).
    OR
    Glass for Inner Lite: Heat-treated float glass; ASTM C 1048 Type I; Quality-Q3; Class I (clear) Kind HS, Condition A.
    OR

Glass for Inner Lite: Tempered float glass; ASTM C 1048 Type I; Quality-Q3; Class I (clear), Kind FT, Condition A.

e. Nominal Thickness for Inner Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.

f. Interlayer: Mirror manufacturer's standard 0.030-inch- (0.76-mm-) thick, clear polyvinyl-butyral interlayer with a proven record of showing no tendency to delaminate from, or cause damage to, silver coating.

B. Miscellaneous Materials

1. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
2. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.
3. Mirror Mastic: An adhesive setting compound, asbestos-free, produced specifically for setting mirrors and certified by both mirror manufacturer and mastic manufacturer as compatible with glass coating and substrates on which mirrors will be installed.
4. Film Backing for Safety Mirrors: Film backing and pressure-sensitive adhesive; both compatible with mirror backing paint as certified by mirror manufacturer.

C. Mirror Hardware

1. Top and Bottom Aluminum J-Channels: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover bottom and top edges of each mirror in a single piece.
   a. Bottom Trim: J-channels formed with front leg and back leg not less than 3/8 and 7/8 inch (9.5 and 22 mm) in height, respectively, and a thickness of not less than 0.04 inch (1.0 mm) **OR** 0.05 inch (1.3 mm), **as directed**.
   b. Top Trim: J-channels formed with front leg and back leg not less than 5/8 and 1 inch (16 and 25 mm) in height, respectively, and a thickness of not less than 0.04 inch (1.0 mm) **OR** 0.062 inch (1.57 mm), **as directed**.
   c. Finish: Clear **OR** Gold, **as directed**, bright anodized.
2. Top Channel/Cleat and Bottom Aluminum J-Channels: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover bottom and top edges of each mirror in a single piece.
   a. Bottom Trim: J-channels formed with front leg and back leg not less than 5/16 and 3/4 inch (7.9 and 19 mm) in height, respectively.
   b. Top Trim: Formed with front leg with a height of 5/16 inch (7.9 mm) and back leg designed to fit into the pocket created by wall-mounted aluminum cleat.
   c. Finish: Clear **OR** Gold, **as directed**, bright anodized.
3. Mirror Bottom Clips: As indicated.
4. Mirror Top Clips: As indicated.
5. Plated Steel Hardware: Formed-steel shapes with plated finish indicated.
   a. Profile: As indicated.
   b. Finish: Selected from manufacturer’s standards.
6. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color and texture where fasteners are exposed.
7. Anchors and Inserts: Provide devices as required for mirror hardware installation. Provide toothed or lead-shield expansion-bolt devices for drilled-in-place anchors. Provide galvanized anchors and inserts for applications on inside face of exterior walls and where indicated.

D. Fabrication

1. Mirror Sizes: To suit Project conditions, and before tempering, **as directed**, cut mirrors to final sizes and shapes.
2. Cutouts: Fabricate cutouts before tempering, **as directed**, for notches and holes in mirrors without marring visible surfaces. Locate and size cutouts so they fit closely around penetrations in mirrors.

3. Mirror Edge Treatment: Flat polished **OR** Rounded polished **OR** Flat high-polished **OR** Rounded high-polished **OR** Beveled polished edge of width shown, **as directed**.
    a. Seal edges of mirrors with edge sealer after edge treatment to prevent chemical or atmospheric penetration of glass coating.
    b. Require mirror manufacturer to perform edge treatment and sealing in factory immediately after cutting to final sizes.
4. Film-Backed Safety Mirrors: Apply film backing with adhesive coating over mirror backing paint as recommended in writing by film-backing manufacturer to produce a surface free of bubbles, blisters, and other imperfections.

1.3 EXECUTION

A. Examination
1. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance of the Work.
2. Verify compatibility with and suitability of substrates, including compatibility of mirror mastic with existing finishes or primers.
3. Proceed with installation only after unsatisfactory conditions have been corrected and surfaces are dry.

B. Preparation
1. Comply with mastic manufacturer's written installation instructions for preparation of substrates, including coating substrates with mastic manufacturer's special bond coating where applicable.

C. Installation
1. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced GANA publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.
2. Provide a minimum air space of 1/8 inch (3 mm) between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.
3. Wall-Mounted Mirrors: Install mirrors with mirror hardware **OR** mastic and mirror hardware, **as directed**. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.
    a. Top and Bottom Aluminum J-Channels: Provide setting blocks 1/8 inch (3 mm) thick by 4 inches (100 mm) long at quarter points. To prevent trapping water, provide, between setting blocks, two slotted weeps not less than 1/4 inch (6.4 mm) wide by 3/8 inch (9.5 mm) long at bottom channel.
    b. Top Channel/Cleat and Bottom Aluminum J-Channels: Fasten J-channel directly to wall and attach top trim to continuous cleat fastened directly to wall.
    c. Mirror Clips: Place a felt or plastic pad between mirror and each clip to prevent spalling of mirror edges. Locate clips where indicated **OR** so they are symmetrically placed and evenly spaced, **as directed**.
    d. Install mastic as follows:
        1) Apply barrier coat to mirror backing where approved in writing by manufacturers of mirrors and backing material.
        2) Apply mastic to comply with mastic manufacturer's written instructions for coverage and to allow air circulation between back of mirrors and face of mounting surface.
        3) After mastic is applied, align mirrors and press into place while maintaining a minimum air space of 1/8 inch (3 mm) between back of mirrors and mounting surface.

D. Cleaning And Protection

1. Protect mirrors from breakage and contaminating substances resulting from construction operations.
2. Do not permit edges of mirrors to be exposed to standing water.
3. Maintain environmental conditions that will prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.
4. Wash exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Final Completion. Wash mirrors as recommended in writing by mirror manufacturer.

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Task	Specification	Specification Description
08 83 13 00	07 42 13 19	Glazing

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SECTION 08 84 00 00 - PLASTIC GLAZING

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of material for plastic glazing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Monolithic acrylic glazing.
      b. Monolithic polycarbonate glazing.
      c. Multiwalled structured polycarbonate glazing.

C. Performance Requirements
   1. Provide plastic glazing sheets and glazing materials capable of withstanding normal temperature changes, wind, and impact loads without failure, including loss or breakage of plastic sheets attributable to the following: failure of sealants or gaskets to remain watertight and airtight, deterioration of plastic sheet and glazing materials, or other defects in materials and installation.
   2. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on plastic glazing and glazing framing members.
      a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

D. Preconstruction Testing
   1. Preconstruction Adhesion and Compatibility Testing: Test each plastic glazing type, tape sealant, gasket, glazing accessory, and glazing-framing member for adhesion to and compatibility with elastomeric glazing sealants.
      a. Testing will not be required if data are submitted based on previous testing of current sealant products and plastic glazing matching those submitted.
      b. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glazing, tape sealants, gaskets, and glazing channel substrates.
      c. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
      d. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
      e. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.

E. Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittal:
      a. Product Data for Credit EQ 4.1: For glazing sealants used inside the weatherproofing system, including printed statement of VOC content.
   3. Plastic Glazing Samples: For each color and finish of plastic glazing indicated, 12 inches (300 mm) square and of same thickness indicated for final Work.
   4. Glazing Accessory Samples: For gaskets and sealants, in 12-inch (300-mm) lengths. Install sealant Samples between two strips of material representative in color of the adjoining framing system, **as directed**.
   5. Plastic Glazing Schedule: List plastic glazing types and thicknesses for each size opening and location. Use same designations indicated on Drawings. Indicate coordinated dimensions of

plastic glazing and construction that receives plastic glazing, including clearances and glazing channel dimensions.
6. Qualification Data: For installers, plastic glazing testing agency and sealant testing agency.
7. Product Certificates: For plastic glazing and glazing products, from manufacturer.
8. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for plastic glazing, glazing sealants and glazing gaskets.
   a. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.
9. Preconstruction adhesion and compatibility test report.
10. Research/Evaluation Reports: For plastic glazing.
11. Maintenance Data: For plastic glazing to include in maintenance manuals.
12. Warranty: Sample of special warranty.

F. Quality Assurance
1. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
2. Source Limitations: Obtain plastic glazing from single source from single manufacturer. Obtain sealants and gaskets from single source from single manufacturer for each product and installation method.
3. Glazing Publication: Comply with published recommendations of plastic glazing manufacturers and with GANA's "Glazing Manual" unless more stringent requirements are indicated. Refer to this publication for definitions of glazing terms not otherwise defined in this Section or in other referenced standards.
4. Plastic Glazing Labeling: Identify plastic sheets with appropriate markings of applicable testing and inspecting agency, indicating compliance with required fire-test-response characteristics.
5. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of a certification agency acceptable to authorities having jurisdiction or manufacturer. Label shall indicate manufacturer's name, type of plastic glazing, thickness, and safety glazing standard with which glass complies.

G. Delivery, Storage, And Handling
1. Protect plastic glazing materials according to manufacturer's written instructions. Prevent damage to plastic glazing and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
2. Maintain protective coverings on plastic glazing to avoid exposures to abrasive substances, excessive heat, and other sources of possible deterioration.

H. Project Conditions
1. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
   a. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below 40 deg F (4.4 deg C).

I. Coordination
1. Coordinate dimensions of plastic glazing with dimensions of construction that receives plastic glazing to ensure that glazing channels provide adequate face and edge clearance, bite, and allowance for expansion.

J. Warranty
1. Manufacturer's Special Warranty for Abrasion- and UV-Resistant, Monolithic **OR** Multiwalled Structured, **as directed**, Polycarbonate: Manufacturer's standard form, made out to the Owner and signed by polycarbonate manufacturer, in which manufacturer agrees to replace polycarbonate products that break or develop defects from normal use that are attributable to manufacturing process and not to practices for maintaining and cleaning plastic glazing contrary

to manufacturer's written instructions. Defects include coating delamination, haze, excessive yellowing, and loss of light transmission beyond the limits stated in plastic glazing manufacturer's standard form.

a. Warranty Period: Five years from date of Final Completion.

1.2 PRODUCTS

A. Plastic Glazing, General

1. Sizes: Fabricate plastic glazing to sizes required for openings indicated. Allow for thermal expansion and contraction of plastic glazing without restraint and without withdrawal of edges from frames, with edge clearances and tolerances complying with plastic glazing manufacturer's written instructions.
2. Fire-Test-Response Characteristics of Plastic Glazing: As determined by testing plastic glazing by a qualified testing agency acceptable to authorities having jurisdiction.
   a. Self-ignition temperature of 650 deg F (343 deg C) or higher when tested according to ASTM D 1929 on plastic sheets in thicknesses indicated for the Work.
   b. Smoke-developed index of 450 or less when tested according to ASTM E 84, or smoke density of 75 or less when tested according to ASTM D 2843 on plastic sheets in thicknesses indicated for the Work.
   c. Burning extent of 1 inch (25 mm) or less when tested according to ASTM D 635 at a nominal thickness of 0.060 inch (1.52 mm) or thickness indicated for the Work, where Class CC1 is indicated.
   d. Burning rate of 2.5 in./min. (1.06 mm/s) or less when tested according to ASTM D 635 at a nominal thickness of 0.060 inch (1.52 mm) or thickness indicated for the Work, where Class CC2 is indicated.
   e. Flame-spread index not less than that indicated when tested according to ASTM E 84.
3. Windborne-Debris-Impact Resistance: Provide exterior plastic glazing that passes basic **OR** enhanced, **as directed**,-protection testing requirements in ASTM E 1996 for Wind Zone 1 **OR** Wind Zone 2 **OR** Wind Zone 3 **OR** Wind Zone 4, **as directed**, when tested according to ASTM E 1886. Test specimens shall be no smaller in width and length than plastic glazing indicated for use on Project and shall be installed in same manner as indicated for use on Project.
   a. Large-Missile Test: For plastic glazing located within 30 feet (9.1 m) of grade.
   b. Small-Missile Test: For plastic glazing located more than 30 feet (9.1 m) above grade.
   OR
   Large-Missile Test: For all plastic glazing, regardless of height above grade.

B. Monolithic Acrylic Glazing

1. Plastic Glazing: Transparent acrylic sheet; ASTM D 4802, Category A-1 (cell cast) **OR** Category A-2 (continuously cast) **OR** Category B-1 (continuously manufactured), **as directed**, Finish 1 (smooth or polished), Type UVF (UV filtering).
   a. Nominal Thickness: 0.093 inch (2.5 mm) **OR** 0.118 inch (3 mm) **OR** 0.177 inch (4.5 mm) **OR** 0.236 inch (6 mm), **as directed**.
   b. Color: Colorless **OR** As selected from manufacturer's full range, **as directed**.
   c. Combustibility Class: CC2.
   d. Provide safety glazing labeling.
2. Plastic Glazing: Coated, transparent acrylic sheet; ASTM D 4802, Category A-1 (cell cast) **OR** Category B-1 (continuously manufactured), **as directed**, Finish 3 (abrasion-resistant coating) with coating on one side **OR** both sides, **as directed**, Type UVF (UV filtering).
   a. Nominal Thickness: 0.093 inch (2.5 mm) **OR** 0.118 inch (3 mm) **OR** 0.177 inch (4.5 mm) **OR** 0.236 inch (6 mm), **as directed**.
   b. Color: Colorless **OR** As selected from manufacturer's full range, **as directed**.
   c. Combustibility Class: CC2.
   d. Provide safety glazing labeling.

3. Plastic Glazing: Translucent acrylic sheet; ASTM D 4802, Category A-1 (cell cast) **OR** Category B-1 (continuously manufactured), **as directed**, Finish 1 (smooth or polished), Type UVF (UV filtering).
   a. Nominal Thickness: 0.093 inch (2.5 mm) **OR** 0.118 inch (3 mm) **OR** 0.177 inch (4.5 mm) **OR** 0.236 inch (6 mm), **as directed**.
   b. Color: White, with visible light transmittance of not more than 50 percent for 0.117-inch- (2.9-mm-) thick sheet, measured according to ASTM D 1003 **OR** As selected from manufacturer's full range, **as directed**.
   c. Combustibility Class: CC2.
   d. Provide safety glazing labeling.
4. Plastic Glazing: Patterned acrylic sheet; ASTM D 4802, Category A-1 (cell cast), Finish 2 (patterned), Type UVF (UV filtering).
   a. Nominal Thickness: 0.093 inch (2.5 mm) **OR** 0.118 inch (3 mm) **OR** 0.177 inch (4.5 mm) **OR** 0.236 inch (6 mm), **as directed**.
   b. Pattern: Matte finish **OR** As selected from manufacturer's full range, **as directed**.
   c. Color: Transparent colorless **OR** Translucent white **OR** As selected from manufacturer's full range, **as directed**.
   d. Combustibility Class: CC2.
   e. Provide safety glazing labeling.

C. Monolithic Polycarbonate Glazing
1. Plastic Glazing: Polycarbonate sheet; ASTM C 1349, Appendix X1, Type I (standard, UV stabilized), with a polished finish.
   a. Nominal Thickness: 0.093 inch (2.5 mm) **OR** 0.118 inch (3 mm) **OR** 0.177 inch (4.5 mm) **OR** 0.236 inch (6 mm), **as directed**.
   b. Color: Transparent colorless **OR** As selected from manufacturer's full range, **as directed**.
   c. Combustibility Class: CC1.
   d. Flame-Spread Index: 25 **OR** 75 **OR** 200, **as directed**, or less.
   e. Provide safety glazing labeling.
2. Plastic Glazing: Coated polycarbonate sheet; ASTM C 1349, Appendix X1, Type II (coated mar-resistant, UV stabilized), with coating on both sides.
   a. Nominal Thickness: 0.093 inch (2.5 mm) **OR** 0.118 inch (3 mm) **OR** 0.177 inch (4.5 mm) **OR** 0.236 inch (6 mm), **as directed**.
   b. Color: Transparent colorless **OR** As selected from manufacturer's full range, **as directed**.
   c. Combustibility Class: CC1.
   d. Flame-Spread Index: 25 **OR** 75 **OR** 200, **as directed**, or less.
   e. Provide safety glazing labeling.

D. Multiwalled Structured Polycarbonate Glazing
1. Multiwalled Structured Polycarbonate Sheet: Manufacturer's standard polycarbonate extruded shape with smooth, flat exterior surfaces and internal ribbing.
   a. Nominal Thickness: 5/16 inch (8 mm) **OR** 3/8 inch (10 mm) **OR** 5/8 inch (16 mm) **OR** 3/4 inch (20 mm) **OR** 1 inch (25 mm), **as directed**.
   b. Color: Transparent colorless **OR** As selected from manufacturer's full range, **as directed**.
   c. Combustibility Class: CC1 **OR** CC2, **as directed**.
   d. Flame-Spread Index: 25 **OR** 75 **OR** 200, **as directed**, or less.

E. Glazing Gaskets
1. Dense Compression Gaskets: Molded or extruded gaskets, EPDM, ASTM C 864 or silicone, ASTM C 1115; and of profile and hardness required to maintain watertight seal.
2. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned EPDM or silicone gaskets complying with ASTM C 509, Type II, black; and of profile and hardness required to maintain watertight seal.

F. Glazing Sealants

1. General:
   a. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including plastic glazing products and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
   b. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
   c. VOC Content: For sealants used inside the weatherproofing system, not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   d. Colors of Exposed Glazing Sealants: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
2. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.
   OR
   Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT.
   OR
   Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT.
   OR
   Glazing Sealant: Acid-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT.

G. Glazing Tapes
1. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
   a. AAMA 804.3 tape, where indicated.
   b. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
   c. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
2. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
   a. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
   b. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

H. Miscellaneous Glazing Materials
1. Compatibility: Provide products of material, size, and shape complying with requirements of manufacturers of plastic glazing and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
2. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
3. Setting Blocks: EPDM or silicone as required for compatibility with glazing sealant and plastic glazing, and of hardness recommended by plastic glazing manufacturer for application indicated.
4. Compressible Filler Rods: Closed cell of waterproof-jacketed rod stock of synthetic rubber or plastic foam, flexible and resilient, with 5- to 10-psi (35- to 70-kPa) compression strength for 25 percent deflection.

1.3 EXECUTION

A. Examination
1. Examine plastic glazing framing, with glazing Installer present, for compliance with the following:

a. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
b. Minimum required face or edge clearances.
c. Effective sealing between joints of plastic glazing framing members.
2. Proceed with glazing only after unsatisfactory conditions have been corrected.

B. Preparation
1. Clean glazing channels and other framing members immediately before glazing. Remove coatings not firmly bonded to substrates. Remove lacquer from metal surfaces where elastomeric sealants are indicated for use.

C. Glazing, General
1. Comply with combined written instructions of manufacturers of plastic glazing materials, sealants, gaskets, and other glazing materials unless more stringent requirements are indicated, including those in referenced glazing publication.
2. Glazing channel dimensions indicated on Drawings are designed to provide the necessary bite on plastic glazing, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust plastic glazing lites during installation to ensure that bite is equal on all sides.
3. Sand or scrape cut edges of plastic glazing to provide smooth edges, free of chips and hairline cracks.
4. Remove burrs and other projections from glazing channel surfaces.
5. Protect plastic glazing surfaces from abrasion and other damage during handling and installation, according to the following requirements:
a. Retain plastic glazing manufacturer's protective covering or protect by other methods according to plastic glazing manufacturer's written instructions.
b. Remove covering at border of each piece before glazing; remove remainder of covering immediately after installation where plastic glazing will be exposed to sunlight or where other conditions make later removal difficult.
c. Remove damaged plastic glazing sheets from Project site and legally dispose of off-site. Damaged plastic glazing sheets are those containing imperfections that, when installed, result in weakened glazing and impaired performance and appearance.
6. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.
7. Install elastomeric setting blocks in sill channels, sized and located to comply with referenced glazing publication, unless otherwise instructed by plastic glazing manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
8. Provide edge blocking to comply with referenced glazing publication unless otherwise instructed by plastic glazing manufacturer.
9. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
10. Square cut wedge-shaped gaskets at corners and install gaskets as recommended in writing by gasket manufacturer to prevent corners from pulling away; seal corner and butt joints with sealant recommended by gasket manufacturer.

D. Tape Glazing
1. Install tapes continuously, but not in one continuous length. Do not stretch tapes to make them fit opening.
2. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
3. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant recommended by tape manufacturer.
4. Do not remove release paper from tape until immediately before each lite is installed.
5. Apply heel bead of glazing sealant.

6. Center plastic glazing lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
7. Apply cap bead of glazing sealant over exposed edge of tape.

E. Gasket Glazing (Dry)
1. Fabricate compression gaskets in lengths recommended in writing by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
2. Insert soft compression gasket between plastic glazing and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
3. Center plastic glazing lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in plastic glazing. Seal gasket joints with sealant recommended by gasket manufacturer.
4. Install gaskets so they protrude past face of glazing stops.

F. Sealant Glazing (Wet)
1. Install continuous spacers between plastic glazing lites and glazing stops to maintain plastic glazing face clearances and to prevent sealant from extruding into glazing channel weep systems until sealants cure. Secure spacers in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
2. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to plastic glazing and channel surfaces.
3. Tool exposed surfaces of sealants to provide a substantial wash away from plastic glazing.

G. Protecting And Cleaning
1. Protect plastic glazing from contact with contaminating substances from construction operations. If, despite such protection, contaminating substances do come into contact with plastic glazing, remove immediately and wash plastic glazing according to plastic glazing manufacturer's written instructions.
2. Remove and replace plastic glazing that is broken, chipped, cracked, abraded, or damaged in other ways during construction period, including natural causes, accidents, and vandalism.
3. Wash plastic glazing on both faces before date scheduled for inspections intended to establish date of Final Completion in each area of Project. Wash plastic glazing according to plastic glazing manufacturer's written instructions.

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Task	Specification	Specification Description
08 85 00 00	08 44 13 00	Glazed Aluminum Curtain Walls
08 85 00 00	08 44 13 00a	Structural-Sealant-Glazed Curtain Walls
08 85 00 00	08 44 13 00b	Sloped Glazing Assemblies
08 87 13 00	07 42 13 19	Glazing

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SECTION 08 87 23 16 - FRAGMENT RETENTION FILM FOR GLASS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of fragment retention film for glass. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. Product Data: For each type of product indicated.
   2. Samples: For each type of product indicated.
   3. Test Reports: Certified test reports including analysis and interpretation of test results. Each report shall identify the manufacturer, the specific product name, the film thickness, the adhesive type and thickness, and the glass type and thickness. Test reports shall clearly identify the methods used and shall include the results recorded.
   4. Certificates: On applications where the film will contact the glazing beads or gaskets, a certificate from the Contractor stating that the glazing compounds and gaskets are compatible with the fragment retention film and adhesive.

C. Delivery, Storage, And Handling
   1. Deliver, store, and handle in accordance with the manufacturer's recommendations. Glass, including glass in windows or doors, that has the film factory applied shall be stored in a dry location free of dust, water, and other contaminants. Glass with factory applied film shall be delivered, stored, and handled so that the film is not damaged, scratched, or abraded and shall be stored in a manner which permits easy access for inspection and handling. Each roll of film shall have a tamperproof label containing full details of the roll and the batch number.

D. Warranty
   1. Provide a 5 year warranty for fragment retention film material. The warranty shall provide for replacement of film if cracking, crazing, peeling, or inadequate adhesion occurs.

1.2 PRODUCTS

A. Standard Products: Fragment retention film shall be the standard product of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

B. Fragment Retention Film: Fragment retention film shall be polyester, polyethylene terephthalate, or a composite. Fragment retention film shall be optically clear and free of waves, distortions, impurities, and adhesive lines. The film may be a single layer or laminated. Lamination of the film shall only occur at the factory of the fragment retention film manufacturer. The film shall include an abrasion resistant coating on the surface that does not receive the film adhesive. Fragment retention film shall be a minimum thickness of 0.004 inch (0.10 mm), as required to meet Project requirements, and shall be clear **OR** tinted, **OR** reflective, **as directed**. The film shall be supplied with an optically clear weatherable pressure sensitive adhesive. The adhesive shall contain ultraviolet inhibitors to protect the film for its required life and shall limit ultraviolet transmission to not more than 8 percent of the radiation between 300 and 380 nanometers. The adhesive shall not be water activated.
   1. Impact Performance: Test fragment retention film for impact in accordance with ANSI Z97.1 or 16 CFR 1201.

2. Tensile Strength: The fragment retention film samples tested shall exhibit a minimum tensile strength at break of 25,000 psi (172.4 MPa) when tested in accordance with ASTM D882, Method A.
3. Peel Strength: The fragment retention film shall exhibit a minimum peel strength of 5.3 pounds/inch (930 N/m) for 0.004 inch (0.10 mm) thick film when tested in accordance with ASTM D3330, Method A.
4. Surface Abrasion: The fragment retention film shall exhibit a change in haze not to exceed 3.2 percent following 100 turns, using 500-gram weights on a CS 10F abrasive wheel when tested in accordance with ASTM D1044.
5. Flame Spread and Smoke Density: The fragment retention film shall exhibit a flame spread index not exceeding 25 and a smoke density index not exceeding 100 when tested in accordance with ASTM E84.

1.3 EXECUTION

A. Surface Preparation: The glass surface to which the fragment retention film is to be applied shall be cleaned of paint, foreign compounds, smears, and spatters. After the initial cleaning, the surface to receive the film shall be further cleaned in accordance with the film manufacturer's instructions.

B. Application: Provide fragment retention film on window and door glass where indicated. After surface preparation, apply the fragment retention film in accordance with the manufacturer's recommendations and instructions. Apply film to the interior (room) side of the glass for both single and double glazed sheets, unless otherwise indicated. Multiple applications of film to achieve specified thicknesses will not be allowed. The film shall not be applied if there are visible dust particles in the air, if there is frost on the glazing, or if any room condition such as temperature and humidity do not meet the manufacturer's instructions. After film application, maintain room conditions as required by the manufacturer's instructions to allow for proper curing of the adhesive.
1. Application to New Glass Before Glazing: Apply fragment retention film so that it extends edge to edge of the glass sheet. Set the film reinforced glass into the frame with glazing compounds or gaskets as specified in Division 08 Section "Glazing". When contact between the glazing compounds and/or gaskets and the film occurs, the Contractor shall ensure compatibility. The Contractor shall be responsible for delivery of the fragment retention film to the appropriate location for application. Coordinate fragment retention film application and curing with the glass supplier and window or door manufacturer prior to glazing installation.
2. Application to Existing Glass Involving Dismantlement: Remove the existing glazing compound, gaskets, and/or stops as required to expose the existing glass pane. If necessary, remove the glass so that the film can be applied. Apply the film so that it extends edge to edge of the glass sheet. Install existing gaskets and/or stops and replace any removed glazing compounds with new glazing compounds. Scrap removed glazing compounds. Glazing compounds shall be in accordance with GANA Sealant Manual. Glazing methods shall be in accordance with GANA Glazing Manual. When contact between the glazing compounds and/or gaskets and the film occurs, the Contractor shall ensure compatibility. Replace and reinstall any damaged or broken glazing and gaskets in kind.
3. Application to Existing Glass Without Dismantlement: Apply fragment retention film so that it extends to within 1/16-inch (1.6 mm), with a maximum of 1/8 inch (3 mm), of the edge of the visible glass area.
4. Application to Existing Glass and Frame Without Dismantlement: Apply fragment retention film past the edge of the visible glass and extend onto the frame. Amount of film overlap, edge connection to the frame, and adhesive for adhering film to frame shall be as recommended by the film manufacturer. When contact between the glazing compounds and/or gaskets and the film occurs, the Contractor shall ensure compatibility.
5. Splicing: Splices or seams in fragment retention film shall be permitted only when a sheet of glass has a dimension exceeding 58 inches (1.475 m) in both directions. All seams shall be

applied with a minimum overlap of 1/4 inch (6 mm) unless submitted test reports indicate impact performance is not diminished when seam is applied with a different overlap or a gap.

C. Cleaning: Clean the fragment retention film in accordance with the manufacturer's instructions.

END OF SECTION 08 87 23 16

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SECTION 08 88 53 00 - SECURITY GLAZING

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of material for security glazing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section includes glazing for the following products and applications and of the following types:
    a. Products and applications specified in other Sections where glazing requirements are specified by reference to this Section:
        1) Steel detention and Steel doors.
        2) Glazed entrances.
        3) Storefront framing.
        4) Interior borrowed lites.
        5) Glazed curtain walls.
        6) Sloped glazing.
        7) Security, Detention, Aluminum and Steel windows.
    b. Security Glazing Types:
        1) Monolithic polycarbonate.
        2) Laminated glass.
        3) Laminated polycarbonate.
        4) Glass-clad polycarbonate.
        5) Laminated glass and polycarbonate.
        6) Insulating security glazing.
        7) Air-gap security glazing.

C. Definitions

1. Glazing Manufacturers: Firms that produce primary glass, monolithic plastic glazing, or fabricated security glazing, as defined in referenced glazing publications.
2. Interspace: Space between lites of air-gap security glazing or insulating security glazing.

D. Performance Requirements

1. General:
    a. Installed security glazing shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing; or other defects in construction.
    b. Installed security glazing shall withstand security-related loads and forces without damage to the glazing beyond that allowed by referenced standards.
2. Delegated Design: Design security glazing, including comprehensive engineering analysis by a qualified professional engineer.
    a. Design Procedure for Glass: Design according to ASTM E 1300 **OR** ICC's 2003 International Building Code, **as directed**.
    b. Design Wind Pressures: As indicated on Drawings.
       OR
       Design Wind Pressures: Determine design wind pressures applicable to Project according to ASCE/SEI 7, based on heights above grade indicated on Drawings.
        1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s) **OR** 100 mph (44 m/s) **OR** 110 mph (49 m/s), **as directed**.
        2) Importance Factor.

3) Exposure Category: B **OR** C **OR** D, **as directed**.

c. Design Snow Loads: As indicated on Drawings **OR as directed**.

d. Vertical Glazing: For glass surfaces sloped 15 degrees or less from vertical, design glass to resist design wind pressure based on glass type factors for short-duration load.

e. Sloped Glazing: For glass surfaces sloped more than 15 degrees from vertical, design glass to resist each of the following combinations of loads:

1) Outward design wind pressure minus the weight of the glass. Base design on glass type factors for short-duration load.

2) Inward design wind pressure plus the weight of the glass plus half of the design snow load. Base design on glass type factors for short-duration load.

3) Half of the inward design wind pressure plus the weight of the glass plus the design snow load. Base design on glass type factors for long-duration load.

f. Probability of Breakage for Sloped Glazing: For glass surfaces sloped more than 15 degrees from vertical, design glass for a probability of breakage not greater than 0.001.

g. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch (25 mm), whichever is less.

3. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glazing framing members and glazing components.

a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

E. Preconstruction Testing

1. Preconstruction Adhesion and Compatibility Testing: Test each security glazing type, tape sealant, gasket, glazing accessory, and glazing-framing member for adhesion to and compatibility with elastomeric glazing sealants.

a. Testing will not be required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.

b. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to security glazing, tape sealants, gaskets, and glazing channel substrates.

c. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.

d. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.

e. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.

F. Submittals

1. Product Data: For each type of product indicated.

2. LEED Submittal:

a. Product Data for Credit EQ 4.1: For glazing sealants used inside of the weatherproofing system, including printed statement of VOC content.

3. Security Glazing Samples: For each type of security glazing; 12 inches (300 mm) square.

4. Glazing Accessory Samples: For gaskets, sealants and colored spacers, in 12-inch (300-mm) lengths. Install sealant Samples between two strips of material representative in color of the adjoining framing system, **as directed**.

5. Security Glazing Schedule: List security glazing types and thicknesses for each size opening and location. Use same designations indicated on Drawings. Indicate coordinated dimensions of security glazing and construction that receives security glazing, including clearances and glazing channel dimensions.

6. Delegated-Design Submittal: For security glazing indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

7. Qualification Data: For installers, manufacturers of insulating security glazing with sputter-coated, low-e coatings, glazing testing agency and sealant testing agency.

8. Product Certificates: For each type of product indicated, from manufacturer.
9. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of security glazing, glazing sealant and glazing gasket.
   a. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.
10. Preconstruction adhesion and compatibility test reports.
11. Warranties: Sample of special warranties.

G. Quality Assurance
1. Manufacturer Qualifications for Insulating Security Glazing Units with Sputter-Coated, Low-E Coatings: A qualified insulating glazing manufacturer who is approved and certified, **as directed**, by coated-glass manufacturer.
2. Installer Qualifications: A qualified installer who employs glazing installers for this Project who are certified under the National Glass Association Glazier Certification Program.
3. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
4. Source Limitations for Security Glazing: Obtain security glazing from single source from single manufacturer using the same type of lites, plies, interlayers, and spacers for each security glazing type indicated.
   a. Source Limitations for Tinted Glass: Obtain tinted glass from single source from single primary glass manufacturer for each tint color indicated.
5. Source Limitations for Glazing Sealants and Gaskets: Obtain from single source from single manufacturer for each product and installation method.
6. Glazing Publications: Comply with published recommendations of security glazing and glazing material manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
   a. GANA Publications: GANA's "Laminated Glazing Reference Manual" and GANA's "Glazing Manual."
   b. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR-A7, "Sloped Glazing Guidelines."
   c. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."
   d. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
7. Plastic Glazing Labeling: Identify plastic sheets with appropriate markings of applicable testing and inspecting agency, indicating compliance with required fire-test-response characteristics.
8. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of the SGCC **OR** another certification agency acceptable to authorities having jurisdiction **OR** manufacturer, **as directed**. Label shall indicate manufacturer's name, type of glazing, thickness, and safety glazing standard with which glazing complies.
9. Insulating Glazing Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
10. Preinstallation Conference: Conduct conference at Project site.

H. Delivery, Storage, And Handling
1. Protect security glazing and glazing materials according to manufacturer's written instructions. Prevent damage from condensation, temperature changes, direct exposure to sun, or other causes.
2. Comply with insulating security glazing and with air-gap security glazing manufacturers' written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

I. Project Conditions
1. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

a. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below 40 deg F (4.4 deg C).

J. Coordination
1. Coordinate dimensions, including thickness, of security glazing with dimensions of construction that receives security glazing.

K. Warranty
1. Manufacturer's Special Warranty for Coated Glass: Manufacturer's standard form in which coated-glass manufacturer agrees to replace coated glass that deteriorates within specified warranty period. Deterioration is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
   a. Warranty Period: 10 years from date of Final Completion.
2. Manufacturer's Special Warranty on Laminated Glass: Manufacturer's standard form in which laminated-glass manufacturer agrees to replace laminated glass that deteriorates within specified warranty period. Deterioration is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
   a. Warranty Period: Five **OR** 10, **as directed**, years from date of Final Completion.
3. Manufacturer's Special Warranty for Polycarbonate Sheet: Manufacturer's standard form in which glazing manufacturer agrees to replace polycarbonate sheet that deteriorates within specified warranty period. Deterioration is defined as defects developed from normal use that are not attributed to maintaining and cleaning polycarbonate sheet contrary to manufacturer's written instructions. Defects include yellowing and loss of light transmission.
   a. Warranty Period: 10 years from date of Final Completion.
4. Manufacturer's Special Warranty for Laminated Polycarbonate: Manufacturer's standard form in which laminated polycarbonate manufacturer agrees to replace laminated polycarbonate that deteriorates within specified warranty period. Deterioration is defined as defects developed from normal use that are not attributed to maintaining and cleaning laminated polycarbonate contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glazing, blemishes exceeding those allowed by referenced standard, yellowing, and loss of light transmission.
   a. Warranty Period: Five **OR** 10, **as directed**, years from date of Final Completion.
5. Manufacturer's Special Warranty for Glass-Clad Polycarbonate: Manufacturer's standard form in which glass-clad polycarbonate manufacturer agrees to replace glass-clad polycarbonate that deteriorates within specified warranty period. Deterioration is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning glass-clad polycarbonate contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glazing, blemishes exceeding those allowed by referenced glass-clad polycarbonate standard, yellowing, and loss of light transmission.
   a. Warranty Period: Five **OR** 10, **as directed**, years from date of Final Completion.
6. Manufacturer's Special Warranty for Laminated Glass and Polycarbonate: Manufacturer's standard form in which laminated-glass-and-polycarbonate manufacturer agrees to replace laminated glass and polycarbonate that deteriorates within specified warranty period. Deterioration is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass and polycarbonate contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glazing, blemishes exceeding those allowed by referenced glass-clad polycarbonate standard, yellowing, and loss of light transmission.
   a. Warranty Period: Five **OR** 10, **as directed**, years from date of Final Completion.

7. Manufacturer's Special Warranty on Insulating Security Glazing: Manufacturer's standard form in which insulating security glazing manufacturer agrees to replace insulating security glazing that deteriorates within specified warranty period. Deterioration is defined as defects in individual lites developed from normal use or failure of hermetic seal under normal use. Deterioration does not include defects in individual lites or failure of hermetic seal that is attributed to glass breakage or to maintaining and cleaning insulating security glazing contrary to manufacturer's written instructions.
   a. Defects in coated glass lites include peeling, cracking, and other indications of deterioration in coating.
   b. Defects in laminated-glass lites include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
   c. Defects in glass-clad polycarbonate lites include edge separation, delamination materially obstructing vision through glazing, blemishes exceeding those allowed by referenced glass-clad polycarbonate standard, yellowing, and loss of light transmission.
   d. Evidence of hermetic seal failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glazing.
   e. Warranty Period: Five **OR** 10, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Security Glazing, General
1. Thickness: Where thickness is indicated, it is a minimum. Provide security glazing in thicknesses as needed to comply with requirements indicated.
2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.
3. Fire-Test-Response Characteristics of Plastic Sheets: As determined by testing plastic sheets identical to those used in security glazing products by a qualified testing agency acceptable to authorities having jurisdiction.
   a. Self-ignition temperature of 650 deg F (343 deg C) or more when tested per ASTM D 1929 on plastic sheets in thicknesses indicated for the Work.
   b. Smoke-developed index of 450 or less when tested according to ASTM E 84, or smoke density of 75 or less when tested per ASTM D 2843 on plastic sheets in thicknesses indicated for the Work.
   c. Burning extent of 1 inch (25 mm) **OR** rate of 2.5 in./min. (1.06 mm/s), **as directed**, or less when tested per ASTM D 635 at a nominal thickness of 0.060 inch (1.52 mm) or thickness indicated for the Work.
4. Windborne-Debris-Impact Resistance: Provide exterior security glazing that passes basic **OR** enhanced, **as directed**,-protection testing requirements in ASTM E 1996 for Wind Zone 1 **OR** Wind Zone 2 **OR** Wind Zone 3 **OR** Wind Zone 4, **as directed**, when tested according to ASTM E 1886. Test specimens shall be no smaller in width and length than security glazing indicated for use on the Project and shall be installed in same manner as indicated for use on the Project.
   a. Large-Missile Test: For security glazing located within 30 feet (9.1 m) of grade.
   b. Small-Missile Test: For security glazing located more than 30 feet (9.1 m) above grade.
      OR
      Large-Missile Test: For all security glazing, regardless of height above grade.
5. Thermal and Optical Performance Properties: Provide security glazing with performance properties specified, as indicated in manufacturer's published test data, based on products of construction indicated and on procedures indicated below:
   a. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
   b. Solar-Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
   c. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

B. Glass Products

1. Float Glass: ASTM C 1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated.
2. Heat-Treated Float Glass: ASTM C 1048; Type I; Quality-Q3; Class I (clear) unless otherwise indicated; of kind and condition indicated.
    a. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
    b. For heat-strengthened float glass, comply with requirements for Kind HS.
    c. For fully tempered float glass, comply with requirements for Kind FT.
    d. For uncoated glass, comply with requirements for Condition A.
    e. For coated vision glass, comply with requirements for Condition C (other coated glass).
3. Chemically Strengthened Glass: Annealed float glass chemically strengthened to comply with ASTM C 1422, Surface Compression Level 1 **OR** Level 2 **OR** Level 3 **OR** Level 4 **OR** Level 5, **as directed**, and Case Depth Level A **OR** Level B **OR** Level C **OR** Level D **OR** Level E **OR** Level F, **as directed**.
4. Reflective-Coated Vision Glass: ASTM C 1376, Kind CV (coated vision glass), coated by pyrolytic process **OR** vacuum deposition (sputter-coating) process, **as directed**, and complying with other requirements specified.

C. Laminated Glass

1. Laminated Glass: ASTM C 1172, and complying with testing requirements in 16 CFR 1201 for Category II materials, and with other requirements specified. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
    a. Construction: Laminate glass with polyvinyl butyral interlayer or cast-in-place and cured-transparent-resin interlayer to comply with interlayer manufacturer's written recommendations.
    b. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
    c. Interlayer Color: Clear unless otherwise indicated.
2. Windborne-Debris-Impact-Resistant Laminated Glass: ASTM C 1172, and complying with testing requirements in 16 CFR 1201 for Category II materials, with "Windborne-Debris-Impact Resistance" Paragraph, and with other requirements specified.
    a. Construction: Laminate glass with one of the following to comply with interlayer manufacturer's written recommendations:
        1) Polyvinyl butyral interlayer.
        2) Polyvinyl butyral interlayers reinforced with polyethylene terephthalate film.
        3) Ionoplast interlayer.
        4) Cast-in-place and cured-transparent-resin interlayer.
        5) Cast-in-place and cured-transparent-resin interlayer reinforced with polyethylene terephthalate film.
    b. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
    c. Interlayer Color: Clear unless otherwise indicated.

D. Polycarbonate Security Glazing

1. Polycarbonate Sheet: ASTM C 1349, Appendix X1, Type II, coated, mar-resistant, UV-stabilized polycarbonate with coating on exposed surfaces and Type I, standard, UV-stabilized polycarbonate where no surfaces are exposed.
2. Laminated Polycarbonate: Polycarbonate sheets laminated with clear urethane interlayer that complies with ASTM C 1349, Appendix X2, and has a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation. Provide laminated units that comply with requirements of ASTM C 1349 for maximum allowable laminating process blemishes and haze.
3. Glass-Clad Polycarbonate: ASTM C 1349, and other requirements specified.

a. Provide glass-clad polycarbonate that complies with testing requirements in 16 CFR 1201 for Category II materials, and with other requirements specified.

4. Laminated Glass and Polycarbonate: ASTM C 1349, and other requirements specified.
   a. Provide laminated glass and polycarbonate that complies with testing requirements in 16 CFR 1201 for Category II materials, and with other requirements specified.

E. Spall-Resistant Film
   1. Spall-Resistant Film: Composite of clear polyvinyl butyral film and clear abrasion-resistant polyester film.
   2. Laminating Process: Laminate spall-resistant film to glazing assemblies in factory to produce laminated lites free of foreign substances, air, and glass pockets.

F. Insulating Security Glazing
   1. Insulating Security Glazing: Factory-assembled units consisting of sealed lites separated by a dehydrated interspace, qualified according to ASTM E 2190, and complying with other requirements specified.
      a. Sealing System: Dual seal, with manufacturer's standard **OR** polyisobutylene and polysulfide **OR** polyisobutylene and silicone **OR** polyisobutylene and hot-melt butyl **OR** polyisobutylene and polyurethane, **as directed**, primary and secondary.
      b. Spacer: Manufacturer's standard spacer material and construction **OR** Aluminum with mill or clear anodic finish **OR** Aluminum with black, color anodic finish **OR** Aluminum with bronze, color anodic finish **OR** Aluminum with powdered metal paint finish in color selected **OR** Galvanized steel **OR** Stainless steel **OR** Polypropylene-covered stainless steel in color selected **OR** Thermally broken aluminum **OR** Nonmetallic laminate **OR** Nonmetallic tube, **as directed**.
      c. Desiccant: Molecular sieve or silica gel, or blend of both.

G. Air-Gap Security Glazing
   1. Air-Gap Security Glazing: Factory-assembled units consisting of sealed lites separated by a dehydrated interspace and complying with other requirements specified.
      a. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
      b. Spacer Specifications: Manufacturer's standard rigid, **as directed**, spacer material and construction.

H. Glazing Gaskets
   1. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:
      a. Neoprene complying with ASTM C 864.
      b. EPDM complying with ASTM C 864.
      c. Silicone complying with ASTM C 1115.
      d. Thermoplastic polyolefin rubber complying with ASTM C 1115.
   2. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned neoprene, EPDM, silicone or thermoplastic polyolefin rubber gaskets complying with ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.
      a. Application: Use where soft compression gaskets will be compressed by inserting dense compression gaskets on opposite side of glazing or pressure applied by means of pressure-glazing stops on opposite side of glazing.

I. Glazing Sealants
   1. General:
      a. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including security glazing, seals of insulating security glazing and air-gap security glazing, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

b. Suitability: Comply with sealant and security glazing manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
c. VOC Content: For sealants used inside of the weatherproofing system, not more than 250 g/L when calculated according to 40 CFR 59, Subpart D.
d. Colors of Exposed Glazing Sealants: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
2. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.
3. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT.
4. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT.
5. Glazing Sealant: Acid-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT.

J. Glazing Tapes
1. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and security glazing manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
a. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
b. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
2. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
a. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
b. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

K. Miscellaneous Glazing Materials
1. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of security glazing and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
2. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
3. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
4. Spacers: Elastomeric blocks or continuous extrusions of hardness required by security glazing manufacturer to maintain security glazing lites in place for installation indicated.
5. Edge Blocks: Elastomeric material of hardness needed to limit security glazing lateral movement (side walking).
6. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

L. Fabrication Of Security Glazing
1. Fabricate security glazing in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

M. Laminated-Glass Security Glazing Types
1. Security Glazing: Clear laminated glass **OR** Tinted laminated glass **OR** Clear reflective-coated laminated glass **OR** Tinted reflective-coated laminated glass, **as directed**.

a. Forced-Entry Resistance: Class I **OR** Class II **OR** Class III **OR** Class IV **OR** Class V, **as directed**, per ASTM F 1233.
OR
Forced-Entry Resistance: Level I **OR** Level II **OR** Level III **OR** Level IV **OR** Level V, **as directed**, per HPW-TP-0500.03.

b. Ballistic Resistance: Class/Level HG1 **OR** Class/Level HG2 **OR** Class/Level HG3 **OR** Class/Level HG4 **OR** Class/Level SMG **OR** Class/Level R1 **OR** Class/Level R2 **OR** Class/Level R3 **OR** Class/Level R4-AP **OR** Class/Level SH1 **OR** Class/Level SH2, **as directed**, per ASTM F 1233.
OR
Ballistic Resistance: Level 1 **OR** Level 2 **OR** Level 3 **OR** Level 4 **OR** Level 5 **OR** Level 6 **OR** Level 7 **OR** Level 8 **OR** Level 1-SG **OR** Level 2-SG **OR** Level 3-SG **OR** Level 4-SG **OR** Level 5-SG **OR** Level 6-SG **OR** Level 7-SG **OR** Level 8-SG, **as directed**, per UL 752.

c. Blast Resistance:
   1) Hazard Rating: No hazard **OR** Minimal hazard **OR** Very low hazard **OR** Low hazard **OR** High hazard, **as directed**, per ASTM F 1642.
   OR
   Performance Condition: 1 **OR** 2 **OR** 3a **OR** 3b **OR** 4 **OR** 5, **as directed**, per GSA-TS01.
   2) Peak Pressure: as directed by the Owner.
   3) Positive Phase Impulse: as directed by the Owner.

d. Number of Plies: Two **OR** Three, **as directed**.

e. Overall Unit Thickness: as directed by the Owner.

f. Outer Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, float glass **OR** heat-strengthened float glass **OR** fully tempered float glass **OR** chemically strengthened float glass, **as directed**.

g. Core Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, float glass **OR** heat-strengthened float glass **OR** fully tempered float glass **OR** chemically strengthened float glass, **as directed**.

h. Inner Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, float glass **OR** heat-strengthened float glass **OR** fully tempered float glass **OR** chemically strengthened float glass, **as directed**.

i. Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.3 mm)\, **as directed**.

j. Glass Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray **as directed**.

k. Tinted Glass Location: Outer ply.

l. Coating Color: Gold **OR** Pewter **OR** Silver, **as directed**.

m. Coating Location: Second **OR** Third **OR** Fifth, **as directed**, surface.

n. Overall Visible Light Transmittance: as directed by the Owner.

o. Outdoor Visible Reflectance: as directed by the Owner. Winter Nighttime U-Factor: as directed by the Owner.

p. Summer Daytime U-Factor: as directed by the Owner.

q. Solar Heat-Gain Coefficient: as directed by the Owner.

r. Provide safety glazing labeling.

2. Security Glazing: Tinted reflective-coated, **as directed**, laminated glass with clear glass and tinted interlayer.

a. Forced-Entry Resistance: Class I **OR** Class II **OR** Class III **OR** Class IV **OR** Class V, **as directed**, per ASTM F 1233.
OR
Forced-Entry Resistance: Level I **OR** Level II **OR** Level III **OR** Level IV **OR** Level V, **as directed**, per HPW-TP-0500.03.

b. Ballistic Resistance: Class/Level HG1 **OR** Class/Level HG2 **OR** Class/Level HG3 **OR** Class/Level HG4 **OR** Class/Level SMG **OR** Class/Level R1 **OR** Class/Level R2 **OR** Class/Level R3 **OR** Class/Level R4-AP **OR** Class/Level SH1 **OR** Class/Level SH2, **as directed**, per ASTM F 1233.
OR
Ballistic Resistance: Level 1 **OR** Level 2 **OR** Level 3 **OR** Level 4 **OR** Level 5 **OR** Level 6 **OR** Level 7 **OR** Level 8 **OR** Level 1-SG **OR** Level 2-SG **OR** Level 3-SG **OR** Level 4-SG **OR** Level 5-SG **OR** Level 6-SG **OR** Level 7-SG **OR** Level 8-SG, **as directed**, per UL 752.

c. Blast Resistance:
   1) Hazard Rating: No hazard **OR** Minimal hazard **OR** Very low hazard **OR** Low hazard **OR** High hazard, **as directed**, per ASTM F 1642.
      OR
      Performance Condition: 1 **OR** 2 **OR** 3a **OR** 3b **OR** 4 **OR** 5, **as directed**, per GSA-TS01.
   2) Peak Pressure: as directed by the Owner.
   3) Positive Phase Impulse: as directed by the Owner.
d. Number of Plies: Two **OR** Three, **as directed**.
e. Overall Unit Thickness: as directed by the Owner.
f. Outer Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, float glass **OR** heat-strengthened float glass **OR** fully tempered float glass **OR** chemically strengthened float glass, **as directed**.
g. Core Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, float glass **OR** heat-strengthened float glass **OR** fully tempered float glass **OR** chemically strengthened float glass, **as directed**.
h. Inner Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, float glass **OR** heat-strengthened float glass **OR** fully tempered float glass **OR** chemically strengthened float glass, **as directed**.
i. Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.3 mm), **as directed**.
j. Interlayer Color: Clear **OR** Blue-green **OR** Bronze light **OR** Gray, **as directed**.
k. Coating Color: Gold **OR** Pewter **OR** Silver, **as directed**.
l. Coating Location: Second **OR** Third **OR** Fifth, **as directed**, surface.
m. Overall Visible Light Transmittance: as directed by the Owner.
n. Outdoor Visible Reflectance: as directed by the Owner. Winter Nighttime U-Factor: as directed by the Owner.
o. Summer Daytime U-Factor: as directed by the Owner.
p. Solar Heat-Gain Coefficient: as directed by the Owner. Provide safety glazing labeling.

N. Monolithic Polycarbonate Security Glazing Types
1. Security Glazing: Monolithic polycarbonate with mar-resistant coating on both surfaces.
   a. Detention Security Grade: Grade 4 per ASTM F 1915 cold-temperature impact test **OR** warm-temperature impact test **OR** torch and small blunt impactor test, **as directed**.
      OR
      Thickness: 3/8 inch (9.25 mm) **OR** 1/2 inch (12.7 mm), **as directed**.

O. Laminated-Polycarbonate Security Glazing Types
1. Security Glazing: Laminated polycarbonate.
   a. Detention Security Grade: Grade 1 **OR** Grade 2 **OR** Grade 3 **OR** Grade 4, **as directed**, per ASTM F 1915 cold-temperature impact test **OR** warm-temperature impact test **OR** torch and small blunt impactor test, **as directed**.
   b. Forced-Entry Resistance: Class I **OR** Class II **OR** Class III **OR** Class IV **OR** Class V, **as directed**, per ASTM F 1233.
      OR
      Forced-Entry Resistance: Level I **OR** Level II **OR** Level III **OR** Level IV **OR** Level V, **as directed**, per HPW-TP-0500.03.
   c. Blast Resistance:
      1) Hazard Rating: No hazard **OR** Minimal hazard **OR** Very low hazard **OR** Low hazard **OR** High hazard, **as directed**, per ASTM F 1642.
         OR
         Performance Condition: 1 **OR** 2 **OR** 3a **OR** 3b **OR** 4 **OR** 5, **as directed**, per GSA-TS01.
      2) Peak Pressure: as directed by the Owner.
      3) Positive Phase Impulse: as directed by the Owner.
   d. Number of Plies: Two **OR** Three **OR** Four, **as directed**.
   e. Overall Unit Thickness: as directed by the Owner.

f. Outer and Inner Plies: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
g. Core Ply **OR** Core Plies, **as directed**: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
h. Interlayer Thicknesses: 0.025 inch (0.635 mm).

P. Glass-Clad Polycarbonate Security Glazing Types
1. Security Glazing: Clear symmetrical glass-clad polycarbonate **OR** Tinted symmetrical glass-clad polycarbonate **OR** Clear reflective-coated symmetrical glass-clad polycarbonate **OR** Tinted reflective-coated symmetrical glass-clad polycarbonate, **as directed**.
a. Detention Security Grade: Grade 1 **OR** Grade 2 **OR** Grade 3 **OR** Grade 4, **as directed**, per ASTM F 1915 cold-temperature impact test **OR** warm-temperature impact test **OR** torch and small blunt impactor test, **as directed**.
b. Forced-Entry Resistance: Class I **OR** Class II **OR** Class III **OR** Class IV **OR** Class V, **as directed**, per ASTM F 1233.
OR
Forced-Entry Resistance: Level I **OR** Level II **OR** Level III **OR** Level IV **OR** Level V, **as directed**, per HPW-TP-0500.03.
c. Ballistic Resistance: Class/Level HG1 **OR** Class/Level HG2 **OR** Class/Level HG3 **OR** Class/Level HG4 **OR** Class/Level SMG **OR** Class/Level R1 **OR** Class/Level R2 **OR** Class/Level R3 **OR** Class/Level R4-AP **OR** Class/Level SH1 **OR** Class/Level SH2, **as directed**, per ASTM F 1233.
OR
Ballistic Resistance: Level 1 **OR** Level 2 **OR** Level 3 **OR** Level 4 **OR** Level 5 **OR** Level 6 **OR** Level 7 **OR** Level 8 **OR** Level 1-SG **OR** Level 2-SG **OR** Level 3-SG **OR** Level 4-SG **OR** Level 5-SG **OR** Level 6-SG **OR** Level 7-SG **OR** Level 8-SG, **as directed**, per UL 752.
d. Blast Resistance:
1) Hazard Rating: No hazard **OR** Minimal hazard **OR** Very low hazard **OR** Low hazard **OR** High hazard, **as directed**, per ASTM F 1642.
OR
Performance Condition: 1 **OR** 2 **OR** 3a **OR** 3b **OR** 4 **OR** 5, **as directed**, per GSA-TS01.
2) Peak Pressure: as directed by the Owner.
3) Positive Phase Impulse: as directed by the Owner.
e. Overall Unit Thickness: as directed by the Owner. Outer Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, heat-strengthened **OR** chemically strengthened, **as directed**, float glass.
f. Single Core: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
OR
Multiple Core:
1) Outer Core Ply: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
2) Single Inner Core Ply **OR** Double Inner Core Plies, **as directed**: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
g. Inner Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, heat-strengthened **OR** chemically strengthened, **as directed**, float glass.
h. Interlayer Thickness: 0.025 inch (0.635 mm) **OR** 0.050 inch (0.127 mm), **as directed**.
i. Glass Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
j. Tinted Glass Location: Outer ply.
k. Coating Color: Gold **OR** Pewter **OR** Silver, **as directed**.
l. Coating Location: Second **OR** Third **OR** Fifth, **as directed**, surface.
m. Overall Visible Light Transmittance: as directed by the Owner.
n. Outdoor Visible Reflectance: as directed by the Owner.
o. Winter Nighttime U-Factor: as directed by the Owner.
p. Summer Daytime U-Factor: as directed by the Owner.

q. Solar Heat-Gain Coefficient: as directed by the Owner.
r. Provide safety glazing labeling.

Q. Laminated-Glass-And-Polycarbonate Security Glazing Types
1. Security Glazing: Nonsymmetrical clear **OR** tinted **OR** reflective-coated, **as directed**, laminated glass and polycarbonate with glass plies on the attack or threat side and polycarbonate plies on the witness side.
a. Detention Security Grade: Grade 1 **OR** Grade 2 **OR** Grade 3 **OR** Grade 4, **as directed**, per ASTM F 1915 cold-temperature impact test **OR** warm-temperature impact test **OR** torch and small blunt impactor test, **as directed**.
b. Forced-Entry Resistance: Class I **OR** Class II **OR** Class III **OR** Class IV **OR** Class V, **as directed**, per ASTM F 1233.
OR
Forced-Entry Resistance: Level I **OR** Level II **OR** Level III **OR** Level IV **OR** Level V, **as directed**, per HPW-TP-0500.03.
c. Ballistic Resistance: Class/Level HG1 **OR** Class/Level HG2 **OR** Class/Level HG3 **OR** Class/Level HG4 **OR** Class/Level SMG **OR** Class/Level R1 **OR** Class/Level R2 **OR** Class/Level R3 **OR** Class/Level R4-AP **OR** Class/Level SH1 **OR** Class/Level SH2, **as directed**, per ASTM F 1233.
OR
Ballistic Resistance: Level 1 **OR** Level 2 **OR** Level 3 **OR** Level 4 **OR** Level 5 **OR** Level 6 **OR** Level 7 **OR** Level 8 **OR** Level 1-SG **OR** Level 2-SG **OR** Level 3-SG **OR** Level 4-SG **OR** Level 5-SG **OR** Level 6-SG **OR** Level 7-SG **OR** Level 8-SG, **a directed**, per UL 752.
d. Blast Resistance:
1) Hazard Rating: No hazard **OR** Minimal hazard **OR** Very low hazard **OR** Low hazard **OR** High hazard, **as directed**, per ASTM F 1642.
OR
Performance Condition: 1 **OR** 2 **OR** 3a **OR** 3b **OR** 4 **OR** 5, **as directed**, per GSA-TS01.
2) Peak Pressure: as directed by the Owner.
3) Positive Phase Impulse: as directed by the Owner.
e. Overall Unit Thickness: as directed by the Owner.
f. Makeup:
1) Outer Glass Ply: 3-mm heat-strengthened float glass.
2) Interlayer Thickness: 0.025 inch (0.635 mm) **OR** 0.050 inch (0.127 mm), **as directed**.
3) First Inner Glass Ply: 12-mm, **as directed**, float glass.
4) Interlayer Thickness: 0.025 inch (0.635 mm) **OR** 0.050 inch (0.127 mm), **as directed**.
5) Second Inner Glass Ply: 10-mm, **as directed**, float glass.
6) Interlayer Thickness: 0.025 inch (0.635 mm) **OR** 0.050 inch (0.127 mm), **as directed**.
7) Inner Polycarbonate Ply: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, Type I (standard, UV-stabilized) polycarbonate.
8) Interlayer Thickness: 0.025 inch (0.635 mm) **OR** 0.050 inch (0.127 mm), **as directed**.
9) Outer Polycarbonate Ply: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, Type II (coated, mar-resistant, UV-stabilized) polycarbonate.
g. Glass Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed.**
h. Tinted Glass Location: Outer glass ply.
i. Coating Color: Gold **OR** Pewter **OR** Silver, **as directed.**
j. Coating Location: Second **OR** Third **OR** Fifth, **as directed**, surface.
k. Overall Visible Light Transmittance: as directed by the Owner.
l. Outdoor Visible Reflectance: as directed by the Owner.

m. Winter Nighttime U-Factor: as directed by the Owner.
n. Summer Daytime U-Factor: as directed by the Owner.
o. Solar Heat-Gain Coefficient: as directed by the Owner.
p. Provide safety glazing labeling.

R. Insulating Security Glazing Types

1. Security Glazing: Clear insulating security glazing **OR** Tinted insulating security glazing **OR** Reflective-coated, clear insulating security glazing **OR** Reflective-coated, tinted insulating security glazing, **as directed.** Outdoor lite is monolithic glass and indoor lite is glass-clad polycarbonate.
   a. Detention Security Grade: Grade 1 **OR** Grade 2 **OR** Grade 3 **OR** Grade 4, **as directed**, per ASTM F 1915 cold-temperature impact test **OR** warm-temperature impact test **OR** torch and small blunt impactor test, **as directed**.
   b. Overall Unit Thickness: as directed by the Owner.
   c. Outdoor Lite: Float glass **OR** Heat-strengthened float glass **OR** Fully tempered float glass, **as directed**.
   d. Indoor Lite: Glass-clad polycarbonate.
      1) Outer Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, heat-strengthened **OR** chemically strengthened **OR** fully tempered, **as directed**, float glass.
      2) Single Core: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
         OR
         Multiple Core:
         a) Outer Core Ply: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
         b) Single Inner Core Ply **OR** Double Inner Core Plies, **as directed**: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
      3) Inner Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, heat-strengthened **OR** chemically strengthened **OR** fully tempered, **as directed**, float glass.
   e. Interspace Content: Air **OR** Argon, **as directed**.
   f. Interspace Dimension: as directed by the Owner.
   g. Glass Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
   h. Tinted Glass Location: Outdoor lite.
   i. Coating Color: Gold **OR** Pewter **OR** Silver, **as directed**.
   j. Coating Location: Second **OR** Third **OR** Fifth, **as directed**, surface.
   k. Overall Visible Light Transmittance: as directed by the Owner.
   l. Outdoor Visible Reflectance: as directed by the Owner.
   m. Winter Nighttime U-Factor: as directed by the Owner.
   n. Summer Daytime U-Factor: as directed by the Owner.
   o. Solar Heat-Gain Coefficient: as directed by the Owner.
   p. Provide safety glazing labeling.
2. Security Glazing: Low-e-coated, clear insulating security glazing **OR** Low-e-coated, tinted insulating security glazing, **as directed.** Outdoor lite is monolithic glass and indoor lite is glass-clad polycarbonate.
   a. Detention Security Grade: Grade 1 **OR** Grade 2 **OR** Grade 3 **OR** Grade 4, **as directed**, per ASTM F 1915 cold-temperature impact test **OR** warm-temperature impact test **OR** torch and small blunt impactor test, **as directed**.
   b. Overall Unit Thickness: as directed by the Owner.
   c. Outdoor Lite: Float glass **OR** Heat-strengthened float glass **OR** Fully tempered float glass, **as directed**.
   d. Indoor Lite: Glass-clad polycarbonate.
      1) Outer Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, heat-strengthened **OR** chemically strengthened **OR** fully tempered, **as directed**, float glass.
      2) Single Core: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
         OR

Multiple Core:

a) Outer Core Ply: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.

b) Single Inner Core Ply **OR** Double Inner Core Plies, **as directed**: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.

3) Inner Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, heat-strengthened **OR** chemically strengthened **OR** fully tempered, **as directed**, float glass.

e. Interspace Content: Air **OR** Argon, **as directed**.

f. Interspace Dimension: as directed by the Owner.

g. Glass Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.

h. Tinted Glass Location: Outer lite.

i. Low-E Coating: Pyrolytic on second surface **OR** Pyrolytic on third surface **OR** Sputtered on second surface **OR** Sputtered on third surface, **as directed**.

j. Overall Visible Light Transmittance: as directed by the Owner.

k. Winter Nighttime U-Factor: as directed by the Owner.

l. Summer Daytime U-Factor: as directed by the Owner.

m. Solar Heat-Gain Coefficient: as directed by the Owner..

n. Provide safety glazing labeling.

3. Security Glazing: Clear insulating security glazing **OR** Tinted insulating security glazing **OR** Reflective-coated, clear insulating security glazing **OR** Reflective-coated, tinted insulating security glazing, **as directed**. Outdoor lite is laminated glass and indoor lite is glass-clad polycarbonate with spall-resistant film on inside face.

a. Detention Security Grade: Grade 1 **OR** Grade 2 **OR** Grade 3 **OR** Grade 4, **as directed**, per ASTM F 1915 cold-temperature impact test **OR** warm-temperature impact test **OR** torch and small blunt impactor test, **as directed**.

b. Forced-Entry Resistance: Class I **OR** Class II **OR** Class III **OR** Class IV **OR** Class V, **as directed**, per ASTM F 1233.

OR

Forced-Entry Resistance: Level I **OR** Level II **OR** Level III **OR** Level IV **OR** Level V, **as directed**, per HPW-TP-0500.03.

c. Ballistic Resistance: Class/Level HG1 **OR** Class/Level HG2 **OR** Class/Level HG3 **OR** Class/Level HG4 **OR** Class/Level SMG **OR** Class/Level R1 **OR** Class/Level R2 **OR** Class/Level R3 **OR** Class/Level R4-AP **OR** Class/Level SH1 **OR** Class/Level SH2, **as directed**, per ASTM F 1233.

OR

Ballistic Resistance: Level 1 **OR** Level 2 **OR** Level 3 **OR** Level 4 **OR** Level 5 **OR** Level 6 **OR** Level 7 **OR** Level 8 **OR** Level 1-SG **OR** Level 2-SG **OR** Level 3-SG **OR** Level 4-SG **OR** Level 5-SG **OR** Level 6-SG **OR** Level 7-SG **OR** Level 8-SG, **as directed**, per UL 752.

d. Blast Resistance:

1) Hazard Rating: No hazard **OR** Minimal hazard **OR** Very low hazard **OR** Low hazard **OR** High hazard, **as directed**, per ASTM F 1642.

OR

Performance Condition: 1 **OR** 2 **OR** 3a **OR** 3b **OR** 4 **OR** 5, **as directed**, per GSA-TS01.

2) Peak Pressure: as directed by the Owner.

3) Positive Phase Impulse: as directed by the Owner.

e. Overall Unit Thickness: as directed by the Owner.

f. Outdoor Lite: Laminated glass with two plies of heat-strengthened float glass **OR** three plies of heat-strengthened float glass **OR** two outer plies of heat-strengthened float glass and two inner plies of annealed float glass, **as directed**.

1) Outer Ply Thickness: 3 mm **OR** 5 mm **OR** 6 mm, **as directed**.

2) Core Ply Thickness: 3 mm **OR** 5 mm **OR** 6 mm, **as directed**.

3) Inner Ply Thickness: 3 mm **OR** 5 mm **OR** 6 mm, **as directed**.

4) Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.3 mm), **as directed**.

g. Indoor Lite: Glass-clad polycarbonate faced with a 0.037-inch- (0.94-mm-) thick, spall-resistant polyester film laminated to indoor face.

1) Outer Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, heat-strengthened **OR** chemically strengthened, **as directed**, float glass.

2) Single Core: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.

OR

Multiple Core:

a) Outer Core Ply: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.

b) Single Inner Core Ply **OR** Double Inner Core Plies, **as directed**: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.

3) Inner Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, heat-strengthened **OR** chemically strengthened, **as directed**, float glass.

h. Interspace Content: Air **OR** Argon, **as directed**.

i. Interspace Dimension: as directed by the Owner.

j. Glass Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.

k. Tinted Glass Location: Outer **OR** Inner, **as directed**, ply of outdoor lite.

l. Coating Color: Gold **OR** Pewter **OR** Silver, **as directed**.

m. Coating Location: Second **OR** Third **OR** Fifth, **as directed**, surface.

n. Overall Visible Light Transmittance: as directed by the Owner.

o. Outdoor Visible Reflectance: as directed by the Owner.

p. Winter Nighttime U-Factor: as directed by the Owner.

q. Summer Daytime U-Factor: as directed by the Owner.

r. Solar Heat-Gain Coefficient: as directed by the Owner.

s. Provide safety glazing labeling.

4. Security Glazing: Low-e-coated, clear insulating security glazing **OR** Low-e-coated, tinted insulating security glazing, **as directed**. Outdoor lite is laminated glass and indoor lite is glass-clad polycarbonate with spall-resistant film on inside face.

a. Detention Security Grade: Grade 1 **OR** Grade 2 **OR** Grade 3 **OR** Grade 4, **as directed**, per ASTM F 1915 cold-temperature impact test **OR** warm-temperature impact test **OR** torch and small blunt impactor test, **as directed**.

b. Forced-Entry Resistance: Class I **OR** Class II **OR** Class III **OR** Class IV **OR** Class V, **as directed**, per ASTM F 1233.

OR

Forced-Entry Resistance: Level I **OR** Level II **OR** Level III **OR** Level IV **OR** Level V, **as directed**, per HPW-TP-0500.03.

c. Ballistic Resistance: Class/Level HG1 **OR** Class/Level HG2 **OR** Class/Level HG3 **OR** Class/Level HG4 **OR** Class/Level SMG **OR** Class/Level R1 **OR** Class/Level R2 **OR** Class/Level R3 **OR** Class/Level R4-AP **OR** Class/Level SH1 **OR** Class/Level SH2, **as directed**, per ASTM F 1233.

OR

Ballistic Resistance: Level 1 **OR** Level 2 **OR** Level 3 **OR** Level 4 **OR** Level 5 **OR** Level 6 **OR** Level 7 **OR** Level 8 **OR** Level 1-SG **OR** Level 2-SG **OR** Level 3-SG **OR** Level 4-SG **OR** Level 5-SG **OR** Level 6-SG **OR** Level 7-SG **OR** Level 8-SG, **as directed**, per UL 752.

d. Blast Resistance:

1) Hazard Rating: No hazard **OR** Minimal hazard **OR** Very low hazard **OR** Low hazard **OR** High hazard, **as directed**, per ASTM F 1642.

OR

Performance Condition: 1 **OR** 2 **OR** 3a **OR** 3b **OR** 4 **OR** 5, **as directed**, per GSA-TS01.

2) Peak Pressure: as directed by the Owner.

3) Positive Phase Impulse: as directed by the Owner.

e. Overall Unit Thickness: as directed by the Owner.

f. Outdoor Lite: Laminated glass with two plies of heat-strengthened float glass **OR** three plies of heat-strengthened float glass **OR** two outer plies of heat-strengthened float glass and two inner plies of annealed float glass, **as directed**.

1) Outer Ply Thickness: 3 mm **OR** 5 mm **OR** 6 mm, **as directed**.
2) Core Ply Thickness: 3 mm **OR** 5 mm **OR** 6 mm, **as directed**.
3) Inner Ply Thickness: 3 mm **OR** 5 mm **OR** 6 mm, **as directed**.
4) Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.3 mm), **as directed**.

g. Indoor Lite: Glass-clad polycarbonate faced with a 0.037-inch- (0.94-mm-) thick, spall-resistant polyester film laminated to indoor face.

1) Outer Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, heat-strengthened **OR** chemically strengthened, **as directed**, float glass.
2) Inner Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, heat-strengthened **OR** chemically strengthened, **as directed**, float glass.
3) Single Core: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
   OR
   Multiple Core:
   a) Outer Core Ply: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
   b) Single Inner Core Ply **OR** Double Inner Core Plies, **as directed**: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
4) Inner Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, heat-strengthened **OR** chemically strengthened, **as directed**, float glass.

h. Interspace Content: Air **OR** Argon, **as directed**.

i. Interspace Dimension: as directed by the Owner.

j. Glass Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.

k. Tinted Glass Location: Outer lite.

l. Low-E Coating: Pyrolytic on second surface **OR** Pyrolytic on third surface **OR** Sputtered on second surface **OR** Sputtered on third surface, **as directed**.

m. Overall Visible Light Transmittance: as directed by the Owner.

n. Winter Nighttime U-Factor: as directed by the Owner.

o. Summer Daytime U-Factor: as directed by the Owner.

p. Solar Heat-Gain Coefficient: as directed by the Owner. Provide safety glazing labeling.

S. Air-Gap Security Glazing Types

1. Security Glazing: Clear air-gap security glazing **OR** Tinted air-gap security glazing **OR** Clear reflective-coated air-gap security glazing **OR** Tinted reflective-coated air-gap security glazing, **as directed**. Outdoor lite is laminated glass and indoor lite is laminated polycarbonate.

a. Forced-Entry Resistance: Class I **OR** Class II **OR** Class III **OR** Class IV **OR** Class V, **as directed**, per ASTM F 1233.
   OR
   Forced-Entry Resistance: Level I **OR** Level II **OR** Level III **OR** Level IV **OR** Level V, **as directed**, per HPW-TP-0500.03.

b. Ballistic Resistance: Class/Level HG1 **OR** Class/Level HG2 **OR** Class/Level HG3 **OR** Class/Level HG4 **OR** Class/Level SMG **OR** Class/Level R1 **OR** Class/Level R2 **OR** Class/Level R3 **OR** Class/Level R4-AP **OR** Class/Level SH1 **OR** Class/Level SH2, **as directed**, per ASTM F 1233.
   OR
   Ballistic Resistance: Level 1 **OR** Level 2 **OR** Level 3 **OR** Level 4 **OR** Level 5 **OR** Level 6 **OR** Level 7 **OR** Level 8 **OR** Level 1-SG **OR** Level 2-SG **OR** Level 3-SG **OR** Level 4-SG **OR** Level 5-SG **OR** Level 6-SG **OR** Level 7-SG **OR** Level 8-SG, **as directed**, per UL 752.

c. Blast Resistance:

1) Hazard Rating: No hazard **OR** Minimal hazard **OR** Very low hazard **OR** Low hazard **OR** High hazard, **as directed**, per ASTM F 1642.
OR
Performance Condition: 1 **OR** 2 **OR** 3a **OR** 3b **OR** 4 **OR** 5, **as directed**, per GSA-TS01.
2) Peak Pressure: as directed by the Owner.
3) Positive Phase Impulse: as directed by the Owner.

d. Overall Unit Thickness: as directed by the Owner.

e. Outdoor Lite: Laminated glass with two **OR** three, **as directed**, plies of float glass **OR** heat-strengthened float glass **OR** fully tempered float glass **OR** chemically strengthened float glass, **as directed**.
1) Outer Ply Thickness: 3 mm **OR** 5 mm **OR** 6 mm, **as directed**.
2) Core Ply Thickness: 3 mm **OR** 5 mm **OR** 6 mm, **as directed**.
3) Inner Ply Thickness: 3 mm **OR** 5 mm **OR** 6 mm, **as directed**.
4) Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.3 mm), **as directed**.

f. Indoor Lite: Laminated polycarbonate with two **OR** three **OR** four, **as directed**, polycarbonate plies.
1) Overall Unit Thickness: as directed by the Owner.
2) Outer and Inner Plies: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
3) Core Ply **OR** Core Plies, **as directed**: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
4) Interlayer Thicknesses: 0.025 inch (0.635 mm).

g. Air-Gap Dimension: as directed by the Owner.
h. Glass Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
i. Tinted Glass Location: Outer **OR** Inner, **as directed**, ply of outdoor lite.
j. Coating Color: Gold **OR** Pewter **OR** Silver, **as directed**.
k. Coating Location: Second **OR** Third **OR** Fifth, **as directed**, surface.
l. Overall Visible Light Transmittance: as directed by the Owner..
m. Outdoor Visible Reflectance: as directed by the Owner.
n. Winter Nighttime U-Factor: as directed by the Owner.
o. Summer Daytime U-Factor: as directed by the Owner.
p. Solar Heat-Gain Coefficient: as directed by the Owner.
q. Provide safety glazing labeling.

2. Security Glazing: Low-e-coated, clear air-gap security glazing **OR** Low-e-coated, tinted air-gap security glazing, **as directed**. Outdoor lite is laminated glass and indoor lite is laminated polycarbonate.

a. Forced-Entry Resistance: Class I **OR** Class II **OR** Class III **OR** Class IV **OR** Class V, **as directed**, per ASTM F 1233.
OR
Forced-Entry Resistance: Level I **OR** Level II **OR** Level III **OR** Level IV **OR** Level V, **as directed**, per HPW-TP-0500.03.

b. Ballistic Resistance: Class/Level HG1 **OR** Class/Level HG2 **OR** Class/Level HG3 **OR** Class/Level HG4 **OR** Class/Level SMG **OR** Class/Level R1 **OR** Class/Level R2 **OR** Class/Level R3 **OR** Class/Level R4-AP **OR** Class/Level SH1 **OR** Class/Level SH2, **as directed**, per ASTM F 1233.
OR
Ballistic Resistance: Level 1 **OR** Level 2 **OR** Level 3 **OR** Level 4 **OR** Level 5 **OR** Level 6 **OR** Level 7 **OR** Level 8 **OR** Level 1-SG **OR** Level 2-SG **OR** Level 3-SG **OR** Level 4-SG **OR** Level 5-SG **OR** Level 6-SG **OR** Level 7-SG **OR** Level 8-SG, **as directed**, per UL 752.

c. Blast Resistance:
1) Hazard Rating: No hazard **OR** Minimal hazard **OR** Very low hazard **OR** Low hazard **OR** High hazard, **as directed**, per ASTM F 1642.
OR

Performance Condition: 1 **OR** 2 **OR** 3a **OR** 3b **OR** 4 **OR** 5, **as directed**, per GSA-TS01.
2) Peak Pressure: as directed by the Owner.
3) Positive Phase Impulse: as directed by the Owner.

d. Overall Unit Thickness: as directed by the Owner.

e. Outdoor Lite: Laminated glass with two **OR** three, **as directed**, plies of float glass **OR** heat-strengthened float glass **OR** fully tempered float glass **OR** chemically strengthened float glass, **as directed**.
1) Outer Ply Thickness: 3 mm **OR** 5 mm **OR** 6 mm, **as directed**.
2) Core Ply Thickness: 3 mm **OR** 5 mm **OR** 6 mm, **as directed**.
3) Inner Ply Thickness: 3 mm **OR** 5 mm **OR** 6 mm, **as directed**.
4) Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.3 mm), **as directed**.

f. Indoor Lite: Laminated polycarbonate with two **OR** three **OR** four, **as directed**, polycarbonate plies.
1) Overall Unit Thickness: as directed by the Owner.
2) Outer and Inner Plies: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
3) Core Ply **OR** Core Plies, **as directed**: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
4) Interlayer Thicknesses: 0.025 inch (0.635 mm).

g. Air-Gap Dimension: as directed by the Owner.

h. Glass Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.

i. Tinted Glass Location: Outer **OR** Inner, **as directed**, ply of outdoor lite.

j. Low-E Coating: Pyrolytic on second surface **OR** Pyrolytic on third surface **OR** Sputtered on second surface **OR** Sputtered on third surface, **as directed**.

k. Overall Visible Light Transmittance: as directed by the Owner.

l. Winter Nighttime U-Factor: as directed by the Owner.

m. Summer Daytime U-Factor: as directed by the Owner.

n. Solar Heat-Gain Coefficient: as directed by the Owner.

o. Provide safety glazing labeling.

1.3 EXECUTION

A. Examination

1. Examine framing for security glazing, with Installer present, for compliance with the following:
   a. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
   b. Presence and functioning of weep system.
   c. Minimum required face or edge clearances.
   d. Effective sealing between joints of framing members.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation

1. Clean glazing channels and other framing members receiving security glazing immediately before glazing. Remove coatings not firmly bonded to substrates.

C. Glazing, General

1. Comply with combined written instructions of manufacturers of security glazing, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
2. Protect edges of security glazing from damage during handling and installation. Remove damaged security glazing from Project site and legally dispose of off Project site. Damaged

security glazing includes units with edge or face damage or other imperfections that, when installed, could weaken security glazing, impair performance, or impair appearance.

3. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
4. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications unless otherwise required by glazing unit manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
5. Do not exceed edge pressures stipulated by security glazing manufacturers for installing lites.
6. Provide spacers for security glazing lites where the length plus width is larger than 50 inches (1270 mm).
   a. Locate spacers directly opposite each other on both inside and outside faces of security glazing. Install correct size and spacing to preserve required face clearances unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with performance requirements.
   b. Provide 1/8-inch (3-mm) minimum bite of spacers on glazing lites and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
7. Provide edge blocking where indicated or needed to prevent security glazing from moving sideways in glazing channel, as recommended in writing by security glazing manufacturer and according to requirements in referenced glazing publications.
8. Set security glazing in each series with uniform pattern, draw, bow, and similar characteristics.
9. Set coated security glazing with proper orientation so that coatings face exterior or interior as specified.
10. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
11. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

D. Tape Glazing
1. Position tapes on fixed stops so that, when compressed by security glazing, their exposed edges are flush with or protrude slightly above sightline of stops.
2. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
3. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
4. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
5. Do not remove release paper from tape until just before each glazing unit is installed.
6. Apply heel bead of elastomeric sealant.
7. Center security glazing in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
8. Apply cap bead of elastomeric sealant over exposed edge of tape.

E. Gasket Glazing (Dry)
1. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
2. Insert soft compression gasket securely in place between glazing unit and frame or fixed stop, with joints miter cut and bonded together at corners.
3. Installation with Drive-in Wedge Gaskets: Center security glazing in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal

without developing bending stresses in security glazing. Seal gasket joints with sealant recommended by gasket manufacturer.

4. Installation with Pressure-Glazing Stops: Center security glazing in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in security glazing. Seal gasket joints with sealant recommended by gasket manufacturer.
5. Install gaskets so they protrude past face of glazing stops.

F. Sealant Glazing (Wet)

1. Install continuous spacers, or spacers combined with cylindrical sealant backing, between security glazing and glazing stops to maintain face clearances and to prevent sealant from extruding into glazing channel and blocking weep systems. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
2. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to security glazing and channel surfaces.
3. Tool exposed surfaces of sealants to provide a substantial wash away from security glazing.

G. Protection And Cleaning

1. Protect exterior security glazing from damage immediately after installation by attaching crossed streamers to framing held away from glazing unit. Do not apply markers to security glazing surfaces. Remove nonpermanent labels, and clean surfaces.
2. Protect security glazing from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with security glazing, remove substances immediately as recommended in writing by security glazing manufacturer.
3. Examine security glazing surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by security glazing manufacturer.
4. Remove and replace security glazing that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, or vandalism during construction period.
5. Wash security glazing on exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Final Completion. Wash security glazing as recommended in writing by security glazing manufacturer.

END OF SECTION 08 88 53 00

Task	Specification	Specification Description
08 88 53 00	07 42 13 19	Glazing

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SECTION 08 90 00 00 - LOUVERS AND VENTS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for louvers and vents. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Fixed, extruded-aluminum and formed-metal louvers.
      b. Adjustable, extruded-aluminum and formed-metal louvers.
      c. Adjustable, extruded-aluminum and formed-metal insulated louvers.
      d. Fixed, formed-metal acoustical louvers.
      e. Wall vents (brick vents).

C. Definitions
   1. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
   2. Horizontal Louver: Louver with horizontal blades; i.e., the axes of the blades are horizontal.
   3. Vertical Louver: Louver with vertical blades; i.e., the axes of the blades are vertical.
   4. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.
   5. Storm-Resistant Louver: Louver that provides specified wind-driven rain performance, as determined by testing according to AMCA 500-L.

D. Performance Requirements
   1. Delegated Design: Design louvers, including comprehensive engineering analysis by a qualified professional engineer, using structural and seismic performance requirements and design criteria indicated.
   2. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors.
      a. Wind Loads:
         1) Determine loads based on pressures as indicated on Drawings.
            OR
            Determine loads based on a uniform pressure of 20 lbf/sq. ft. (957 Pa) **OR** 30 lbf/sq. ft. (1436 Pa), **as directed**, acting inward or outward.
   3. Seismic Performance: Louvers, including attachments to other construction, shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
      a. Design earthquake spectral response acceleration, short period (Sds) for Project is **as directed.**
      b. Component Importance Factor is 1.5 **OR** 1.0, **as directed**.
   4. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.
      a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
   5. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

6. Acoustic Performance: Provide acoustical louvers complying with ratings specified, as demonstrated by testing manufacturer's stock units identical to those specified, except for length and width for airborne sound-transmission loss according to ASTM E 90 **OR** outdoor-indoor sound-transmission loss according to ASTM E 966, **as directed**.

E. Submittals
1. Product Data: For each type of product indicated.
   a. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
2. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
3. Samples: For each type of metal finish required.
4. Delegated-Design Submittal: For louvers indicated to comply with structural and seismic performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
5. Product Test Reports: Based on tests performed according to AMCA 500-L.

F. Quality Assurance
1. Welding: Qualify procedures and personnel according to the following:
   a. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   b. AWS D1.3, "Structural Welding Code - Sheet Steel."
   c. AWS D1.6, "Structural Welding Code - Stainless Steel."
2. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.
3. UL and NEMA Compliance: Provide motors and related components for motor-operated louvers that are listed and labeled by UL and comply with applicable NEMA standards.

1.2 PRODUCTS

A. Materials
1. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T5, T-52, or T6.
2. Aluminum Sheet: ASTM B 209 (ASTM B 209M), Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.
3. Aluminum Castings: ASTM B 26/B 26M, Alloy 319.
4. Galvanized-Steel Sheet: ASTM A 653/A 653M, G60 (Z180) **OR** G90 (Z275), **as directed**, zinc coating, mill phosphatized.
5. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, No. 2B finish **OR** No. 2D finish **OR** No. 4 finish, with grain running parallel to length of blades and frame members **OR** No. 4 finish, with grain running perpendicular to length of blades and frame members **OR** No. 4 finish, with grain running perpendicular to length of blades and parallel to length of frame members **OR** No. 6 finish, **as directed**.
6. Fasteners: Use types and sizes to suit unit installation conditions.
   a. Use Phillips flat-head **OR** hex-head or Phillips pan-head **OR** tamper-resistant, **as directed**, screws for exposed fasteners unless otherwise indicated.
   b. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
   c. For fastening galvanized steel, use hot-dip-galvanized steel or 300 series stainless-steel fasteners.
   d. For fastening stainless steel, use 300 series stainless-steel fasteners.
   e. For color-finished louvers, use fasteners with heads that match color of louvers.
7. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
8. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

B. Fabrication, General
1. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
2. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.
   a. Continuous Vertical Assemblies: Fabricate units without interrupting blade-spacing pattern unless horizontal mullions are indicated **OR** where indicated, **as directed**.
   b. Horizontal Mullions: Provide horizontal mullions at joints unless continuous vertical assemblies are indicated **OR** where indicated, **as directed**.
3. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, **as directed**, to produce uniform appearance.
4. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
   a. Frame Type: Channel **OR** Exterior flange **OR** Interior flange, **as directed**, unless otherwise indicated.
5. Include supports, anchorages, and accessories required for complete assembly.
6. Provide vertical mullions of type and at spacings indicated, but not more than recommended by manufacturer, or 72 inches (1830 mm) o.c., whichever is less.
   a. Fully Recessed Mullions: Where indicated, provide mullions fully recessed behind louver blades. Where length of louver exceeds fabrication and handling limitations, fabricate with close-fitting blade splices designed to permit expansion and contraction.
   b. Semirecessed Mullions: Where indicated, provide mullions partly recessed behind louver blades so louver blades appear continuous. Where length of louver exceeds fabrication and handling limitations, fabricate with interlocking split mullions and close-fitting blade splices designed to permit expansion and contraction.
   c. Exposed Mullions: Where indicated, provide units with exposed mullions of same width and depth as louver frame. Where length of louver exceeds fabrication and handling limitations, provide interlocking split mullions designed to permit expansion and contraction.
   d. Exterior Corners: Prefabricated corner units with mitered and welded blades **OR** blades with concealed close-fitting splices, **as directed**, and with fully recessed **OR** semirecessed, **as directed**, mullions at corners.
7. Provide subsills made of same material as louvers **OR** extended sills, **as directed**, for recessed louvers.
8. Join frame members to each other and to fixed louver blades with fillet welds concealed from view **OR** welds, threaded fasteners, or both, as standard with louver manufacturer, **as directed**, unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

C. Fixed, Extruded-Aluminum Louvers
1. Horizontal Storm-Resistant Louver:
   a. Louver Depth: 4 inches (100 mm) **OR** 5 inches (125 mm) **OR** 7 inches (175 mm) **OR** 8 inches (200 mm) **OR** 9 inches (225 mm), **as directed**.
   b. Frame and Blade Nominal Thickness: Not less than 0.080 inch (2.03 mm) **OR** 0.060 inch (1.52 mm) for blades and 0.080 inch (2.03 mm) for frames, **as directed**.
   c. Louver Performance Ratings:
      1) Free Area: Not less than 5.0 sq. ft. (0.46 sq. m) **OR** 6.0 sq. ft. (0.56 sq. m) **OR** 7.0 sq. ft. (0.65 sq. m), **as directed**, for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
      2) Air Performance: Not more than 0.10-inch wg (25-Pa) static pressure drop at 600-fpm (3.0-m/s) **OR** 700-fpm (3.6-m/s) **OR** 800-fpm (4.1-m/s), **as directed**, free-area exhaust **OR** intake, **as directed**, velocity.

3) Wind-Driven Rain Performance: Not less than 99 **OR** 95 **OR** 80, **as directed**, percent effectiveness when subjected to a rainfall rate of 3 inches (75 mm) per hour and a wind speed of 29 mph (13 m/s) **OR** 8 inches (200 mm) per hour and a wind speed of 50 mph (22.4 m/s), **as directed**, at a core-area intake velocity of 300 fpm (1.5 m/s) **OR** 400 fpm (2.0 m/s) **OR** 500 fpm (2.5 m/s), **as directed**.

d. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2. Vertical Storm-Resistant Louver:
   a. Louver Depth: 4 inches (100 mm) **OR** 6 inches (150 mm) **OR** 8 inches (200 mm) **OR** 9 inches (225 mm) **OR** 12 inches (300 mm), **as directed**.
   b. Frame and Blade Nominal Thickness: Not less than 0.080 inch (2.03 mm) **OR** 0.060 inch (1.52 mm) for blades and 0.080 inch (2.03 mm) for frames, **as directed**.
   c. Louver Performance Ratings:
      1) Free Area: Not less than 5.0 sq. ft. (0.46 sq. m) **OR** 6.0 sq. ft. (0.56 sq. m) **OR** 7.0 sq. ft. (0.65 sq. m) **as directed**, for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
      2) Air Performance: Not more than 0.10-inch wg (25-Pa) static pressure drop at 600-fpm (3.0-m/s) **OR** 700-fpm (3.6-m/s) **OR** 800-fpm (4.1-m/s), **as directed**, free-area exhaust **OR** intake, **as directed**, velocity.
      3) Wind-Driven Rain Performance: Not less than 99 percent effectiveness when subjected to a rainfall rate of 3 inches (75 mm) per hour and a wind speed of 29 mph (13 m/s) **OR** 8 inches (200 mm) per hour and a wind speed of 50 mph (22.4 m/s), **as directed**, at a core-area intake velocity of 300 fpm (1.5 m/s) **OR** 400 fpm (2.0 m/s) **OR** 500 fpm (2.5 m/s), **as directed**.
   d. AMCA Seal: Mark units with AMCA Certified Ratings Seal.
3. Horizontal, Drainable-Blade Louver:
   a. Louver Depth: 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**.
   b. Frame and Blade Nominal Thickness: Not less than 0.080 inch (2.03 mm) **OR** 0.060 inch (1.52 mm) for blades and 0.080 inch (2.03 mm) for frames, **as directed**.
   c. Mullion Type: Exposed.
   d. Louver Performance Ratings:
      1) Free Area: Not less than 7.0 sq. ft. (0.65 sq. m) **OR** 7.5 sq. ft. (0.70 sq. m) **OR** 8.0 sq. ft. (0.74 sq. m) **OR** 8.5 sq. ft. (0.79 sq. m), **as directed**, for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
      2) Point of Beginning Water Penetration: Not less than 900 fpm (4.6 m/s) **OR** 950 fpm (4.8 m/s) **OR** 1000 fpm (5.1 m/s) **OR** 1050 fpm (5.3 m/s) **OR** 1100 fpm (5.6 m/s), **as directed**.
      3) Air Performance: Not more than 0.10-inch wg (25-Pa) static pressure drop at 700-fpm (3.6-m/s) **OR** 750-fpm (3.8-m/s) **OR** 800-fpm (4.1-m/s) **OR** 850-fpm (4.3-m/s), **as directed**, free-area exhaust **OR** intake, **as directed**, velocity.
      4) Air Performance: Not more than 0.15-inch wg (37-Pa) static pressure drop at 900-fpm (4.6-m/s) **OR** 950-fpm (4.8-m/s) **OR** 1000-fpm (5.1-m/s), **as directed**, free-area exhaust **OR** intake, **as directed**, velocity.
   e. AMCA Seal: Mark units with AMCA Certified Ratings Seal.
4. Horizontal, Continuous-Line, Drainable-Blade Louver: Drainable-blade louver with blade gutters (drains) in rear two-thirds of blades only and with semirecessed mullions capable of collecting and draining water from blades.
   a. Louver Depth: 6 inches (150 mm).
   b. Frame and Blade Nominal Thickness: Not less than 0.080 inch (2.03 mm).
   c. Louver Performance Ratings:
      1) Free Area: Not less than 7.8 sq. ft. (0.72 sq. m) for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
      2) Point of Beginning Water Penetration: Not less than 850 fpm (4.3 m/s).
      3) Air Performance: Not more than 0.10-inch wg (25-Pa) static pressure drop at 800-fpm (4.1-m/s) free-area exhaust **OR** intake, **as directed**, velocity.
5. Horizontal, Sightproof, Drainable-Blade Louver:

a. Louver Depth: 5 inches (125 mm).
b. Frame and Blade Nominal Thickness: Not less than 0.080 inch (2.03 mm) **OR** 0.060 inch (1.52 mm) for blades and 0.080 inch (2.03 mm) for frames, **as directed**.
c. Mullion Type: Exposed.
d. Louver Performance Ratings:
1) Free Area: Not less than 8.3 sq. ft. (0.77 sq. m) for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
2) Point of Beginning Water Penetration: Not less than 750 fpm (3.8 m/s) **OR** 950 fpm (4.8 m/s), **as directed**.
3) Air Performance: Not more than 0.10-inch wg (25-Pa) static pressure drop at 550-fpm (2.8-m/s) free-area exhaust **OR** intake, **as directed**, velocity.

6. Horizontal, Nondrainable-Blade Louver:
a. Louver Depth: 2 inches (50 mm) **OR** 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**.
b. Blade Profile: Plain blade without **OR** Blade with, **as directed**, center baffle.
c. Frame and Blade Nominal Thickness: Not less than 0.080 inch (2.03 mm) **OR** 0.060 inch (1.52 mm) for blades and 0.080 inch (2.03 mm) for frames, **as directed**.
d. Mullion Type: Exposed **OR** Semirecessed **OR** Fully recessed, **as directed**.
e. Louver Performance Ratings:
1) Free Area: Not less than 7.5 sq. ft. (0.70 sq. m) **OR** 8.0 sq. ft. (0.74 sq. m) **OR** 8.5 sq. ft. (0.79 sq. m), **as directed**, for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
2) Point of Beginning Water Penetration: Not less than 700 fpm (3.6 m/s) **OR** 750 fpm (3.8 m/s) **OR** 800 fpm (4.1 m/s) **OR** 850 fpm (4.3 m/s) **OR** 900 fpm (4.6 m/s) **OR** 950 fpm (4.8 m/s), **as directed**.
3) Air Performance: Not more than 0.10-inch wg (25-Pa) static pressure drop at 650-fpm (3.3-m/s) **OR** 700-fpm (3.6-m/s) **OR** 750-fpm (3.8-m/s), **as directed**, free-area exhaust **OR** intake, **as directed**, velocity.

7. Vertical, Sightproof, Louver:
a. Louver Depth: 4 inches (100 mm).
b. Blade Profile: Chevron **OR** Y **OR** Labyrinth, **as directed**,-shaped blade.
c. Frame and Blade Nominal Thickness: Not less than 0.080 inch (2.03 mm) **OR** 0.060 inch (1.52 mm) for blades and 0.080 inch (2.03 mm) for frames, **as directed**.
d. Blade Spacing: 2 inches (50 mm) **OR** 4 inches (100 mm), **as directed**, o.c.
e. Mullion Type: Exposed **OR** Semirecessed **OR** Fully recessed, **as directed**.

D. Fixed, Formed-Metal Louvers
1. Horizontal, Drainable-Blade Louver:
a. Louver Depth: 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**.
b. Frame and Blade Material and Nominal Thickness: Galvanized-steel sheet, not less than 0.052 inch (1.32 mm) for frames and 0.040 inch (1.02 mm) for blades **OR** 0.052 inch (1.32 mm) **OR** 0.064 inch (1.63 mm), **as directed**.
c. Frame and Blade Material and Nominal Thickness: Stainless-steel sheet, not less than 0.050 inch (1.27 mm) **OR** 0.062 inch (1.59 mm), **as directed**.
d. Mullion Type: Exposed.
e. Louver Performance Ratings:
1) Free Area: Not less than 7.0 sq. ft. (0.65 sq. m) **OR** 7.5 sq. ft. (0.70 sq. m) **OR** 8.0 sq. ft. (0.74 sq. m) **OR** 8.5 sq. ft. (0.79 sq. m), **as directed**, for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
2) Point of Beginning Water Penetration: Not less than 800 fpm (4.1 m/s) **OR** 850 fpm (4.3 m/s) **OR** 900 fpm (4.6 m/s) **OR** 950 fpm (4.8 m/s) **OR** 1000 fpm (5.1 m/s), **as directed**.
3) Air Performance: Not more than 0.10-inch wg (25-Pa) static pressure drop at 700-fpm (3.6-m/s) **OR** 750-fpm (3.8-m/s) **OR** 800-fpm (4.1-m/s) **OR** 850-fpm (4.3-m/s), **as directed**, free-area exhaust **OR** intake, **as directed**, velocity.

4) Air Performance: Not more than 0.15-inch wg (37-Pa) static pressure drop at 900-fpm (4.6-m/s) **OR** 950-fpm (4.8-m/s) **OR** 1000-fpm (5.1-m/s), **as directed**, free-area velocity.

f. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2. Horizontal, Nondrainable-Blade Louver:
   a. Louver Depth: 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**.
   b. Blade Profile: Plain blade without **OR** Blade with, **as directed**, center baffle.
   c. Frame and Blade Material and Nominal Thickness: Galvanized-steel sheet, not less than 0.052 inch (1.32 mm) for frames and 0.040 inch (1.02 mm) for blades **OR** 0.052 inch (1.32 mm) **OR** 0.064 inch (1.63 mm), **as directed**.
   d. Frame and Blade Material and Nominal Thickness: Stainless-steel sheet, not less than 0.050 inch (1.27 mm) **OR** 0.062 inch (1.59 mm), **as directed**.
   e. Mullion Type: Exposed **OR** Semirecessed **OR** Fully recessed, **as directed**.
   f. Louver Performance Ratings:
      1) Free Area: Not less than 6.5 sq. ft. (0.60 sq. m) **OR** 7.0 sq. ft. (0.65 sq. m) **OR** 7.5 sq. ft. (0.70 sq. m) **OR** 8.0 sq. ft. (0.74 sq. m), **as directed**, for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
      2) Point of Beginning Water Penetration: Not less than 550 fpm (2.8 m/s) **OR** 600 fpm (3.0 m/s) **OR** 650 fpm (3.3 m/s) **OR** 700 fpm (3.6 m/s), **as directed**.
      3) Air Performance: Not more than 0.10-inch wg (25-Pa) static pressure drop at 550-fpm (2.8-m/s) **OR** 600-fpm (3.0-m/s) **OR** 650-fpm (3.3-m/s) **OR** 700-fpm (3.6-m/s), **as directed**, free-area exhaust **OR** intake, **as directed**, velocity.

E. Adjustable, Extruded-Aluminum Louvers

1. Louver Construction and Operation: Provide adjustable louvers with extruded-aluminum frames and blades not less than 0.080-inch (2.03-mm) nominal thickness, and with operating mechanisms to suit louver sizes.
   a. Hand operation with push bars.
   b. Crank operation with removable-crank operator in sill or jamb.
   c. Chain operation with tension spring, wall clip, pull chain, and 160 deg F (71 deg C) fusible link.
   d. Motor operation with 2-position, spring-return application (with power on, motor opens louver; with power off, spring closes louver); 110-V, 60-Hz motor and limit switch **OR** 2-direction, 110-V, 60-Hz motor and limit switches, **as directed**; equipped with frame-mounted switch **OR** remote-mounted switch with indicator light **OR** terminals for controlling devices, **as directed**.
   e. Pneumatic piston operation for use with 80- to 100-psi (550- to 690-kPa) compressed air for 2-position **OR** modulating, **as directed**, operation; power open, power close with spring-return fail-safe, **as directed**.
2. Dual-Blade, Drainable-Blade, Adjustable Louver: Fixed drainable blades and adjustable plain blades combined in single frame.
   a. Louver Depth: 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, overall.
   b. Louver Performance Ratings:
      1) Free Area: Not less than 6.0 sq. ft. (0.56 sq. m) **OR** 6.5 sq. ft. (0.60 sq. m) **OR** 7.0 sq. ft. (0.65 sq. m) **OR** 7.5 sq. ft. (0.70 sq. m) **OR** 8.0 sq. ft. (0.74 sq. m), **as directed**, for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
      2) Point of Beginning Water Penetration: Not less than 750 fpm (3.8 m/s) **OR** 800 fpm (4.1 m/s) **OR** 850 fpm (4.3 m/s) **OR** 900 fpm (4.6 m/s) **OR** 950 fpm (4.8 m/s) **OR** 1000 fpm (5.1 m/s), **as directed**.
      3) Air Performance: Not more than 0.10-inch wg (25-Pa) static pressure drop at 750-fpm (3.8-m/s) **OR** 800-fpm (4.1-m/s) **OR** 850-fpm (4.3-m/s) **OR** 900-fpm (4.6-m/s), **as directed**, free-area exhaust **OR** intake, **as directed**, velocity.
      4) Air Leakage: Not more than 1.5 cfm/sq. ft. (7.6 L/s per sq. m) of louver gross area at a differential static pressure of 0.15-inch wg (37 Pa) with adjustable louver blades closed.

c. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

3. Single-Blade, Adjustable Louver:
   a. Louver Depth: 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**.
   b. Blade Type: Drainable **OR** Plain, **as directed**.
   c. Accessories: Equip louvers as follows:
      1) Vinyl blade-edge gaskets for each louver blade.
      2) Stainless-steel jamb seals **OR** vinyl blade-end gaskets, **as directed**.
   d. Louver Performance Ratings:
      1) Free Area: Not less than 6.5 sq. ft. (0.60 sq. m) **OR** 7.0 sq. ft. (0.65 sq. m) **OR** 7.5 sq. ft. (0.70 sq. m) **OR** 8.0 sq. ft. (0.74 sq. m), **as directed**, for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
      2) Point of Beginning Water Penetration: Not less than 500 fpm (2.5 m/s) **OR** 600 fpm (3.0 m/s) **OR** 700 fpm (3.6 m/s) **OR** 800 fpm (4.1 m/s) **OR** 900 fpm (4.6 m/s) **OR** 1000 fpm (5.1 m/s), **as directed**.
      3) Air Performance: Not more than 0.10-inch wg (25-Pa) static pressure drop at 500-fpm (2.5-m/s) **OR** 600-fpm (3.0-m/s) **OR** 700-fpm (3.6-m/s) **OR** 800-fpm (4.1-m/s) **OR** 900-fpm (4.6-m/s), **as directed**, free-area exhaust **OR** intake, **as directed**, velocity.
      4) Air Leakage: Not more than 3.5 cfm/sq. ft. (17.8 L/s per sq. m) of louver gross area at a differential static pressure of 0.15-inch wg (37 Pa) with adjustable louver blades closed.
   e. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

F. Adjustable, Formed-Metal Louvers
1. Louver Operation: Provide adjustable louvers with operating mechanisms to suit louver sizes.
   a. Hand operation with push bars.
   b. Crank operation with removable-crank operator in sill or jamb.
   c. Chain operation with tension spring, wall clip, pull chain, and 160 deg F (71 deg C) fusible link.
   d. Motor operation with 2-position, spring-return application (with power on, motor opens louver; with power off, spring closes louver); 110-V, 60-Hz motor and limit switch **OR** 2-direction, 110-V, 60-Hz motor and limit switches, **as directed**; equipped with frame-mounted switch **OR** remote-mounted switch with indicator light **OR** terminals for controlling devices, **as directed**.
   e. Pneumatic piston operation for use with 80- to 100-psi (550- to 690-kPa) compressed air for 2-position **OR** modulating, **as directed**, operation; power open, power close with spring-return fail-safe, **as directed**.
2. Dual-Blade, Drainable-Blade, Adjustable Louver: Fixed drainable blades and adjustable plain blades combined in single frame.
   a. Louver Depth: 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, overall.
   b. Frame and Blade Material and Nominal Thickness: Galvanized-steel sheet, not less than 0.052 inch (1.32 mm) for frames and 0.040 inch (1.02 mm) for blades **OR** 0.052 inch (1.32 mm) **OR** 0.064 inch (1.63 mm), **as directed**.
   c. Frame and Blade Material and Nominal Thickness: Stainless-steel sheet, not less than 0.050 inch (1.27 mm) **OR** 0.062 inch (1.59 mm), **as directed**.
   d. Louver Performance Ratings:
      1) Air Leakage: Not more than 1.5 cfm/sq. ft. (7.6 L/s per sq. m) of louver gross area at a differential static pressure of 0.15-inch wg (37 Pa) with adjustable louver blades closed.
   e. AMCA Seal: Mark units with AMCA Certified Ratings Seal.
3. Single-Blade, Adjustable Louver:
   a. Louver Depth: 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**.
   b. Blade Type: Drainable **OR** Plain, **as directed**.
   c. Frame and Blade Material and Nominal Thickness: Galvanized-steel sheet, not less than 0.052 inch (1.32 mm) for frames and 0.040 inch (1.02 mm) for blades **OR** 0.052 inch (1.32 mm) **OR** 0.064 inch (1.63 mm), **as directed**.

d. Frame and Blade Material and Nominal Thickness: Stainless-steel sheet, not less than 0.050 inch (1.27 mm) **OR** 0.062 inch (1.59 mm), **as directed**.
e. Accessories: Equip louvers as follows:
   1) Vinyl blade-edge gaskets for each louver blade.
   2) Stainless-steel jamb seals **OR** vinyl blade-end gaskets, **as directed**.
f. Louver Performance Ratings:
   1) Free Area: Not less than 6.5 sq. ft. (0.60 sq. m) **OR** 7.0 sq. ft. (0.65 sq. m) **OR** 7.5 sq. ft. (0.70 sq. m) **OR** 8.0 sq. ft. (0.74 sq. m), **as directed**, for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
   2) Point of Beginning Water Penetration: Not less than 500 fpm (2.5 m/s) **OR** 600 fpm (3.0 m/s) **OR** 700 fpm (3.6 m/s) **OR** 800 fpm (4.1 m/s) **OR** 900 fpm (4.6 m/s) **OR** 1000 fpm (5.1 m/s), **as directed**.
   3) Air Performance: Not more than 0.10-inch wg (25-Pa) static pressure drop at 500-fpm (2.5-m/s) **OR** 600-fpm (3.0-m/s) **OR** 700-fpm (3.6-m/s) **OR** 800-fpm (4.1-m/s) **OR** 900-fpm (4.6-m/s), **as directed**, free-area exhaust **OR** intake, **as directed**, velocity.
   4) Air Leakage: Not more than 3.5 cfm/sq. ft. (17.8 L/s per sq. m) of louver gross area at a differential static pressure of 0.15-inch wg (37 Pa) with adjustable louver blades closed.
g. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

G. Adjustable, Insulated Louvers
1. Louver Operation: Provide adjustable louvers with operating mechanisms to suit louver sizes.
   a. Hand operation with push bars.
   b. Crank operation with removable-crank operator in sill or jamb.
   c. Chain operation with tension spring, wall clip, pull chain, and 160 deg F (71 deg C) fusible link.
   d. Motor operation with 2-position, spring-return application (with power on, motor opens louver; with power off, spring closes louver); 110-V, 60-Hz motor and limit switch **OR** 2-direction, 110-V, 60-Hz motor and limit switches, **as directed**; equipped with frame-mounted switch **OR** remote-mounted switch with indicator light **OR** terminals for controlling devices, **as directed**.
   e. Pneumatic piston operation for use with 80- to 100-psi (550- to 690-kPa) compressed air for 2-position **OR** modulating, **as directed**, operation; power open, power close with spring-return fail-safe, **as directed**.
2. Adjustable, Insulated, Extruded-Aluminum Louver: Single-blade, adjustable louver with gasketed, insulated blades. Frames and blade frames have urethane thermal break. Frames are extruded aluminum, not less than 0.080-inch (2.03-mm) nominal thickness. Blade facings are aluminum sheet, not less than 0.032-inch (0.81-mm) nominal thickness.
   a. Louver Depth: 6 inches (150 mm) **OR** 9 inches (225 mm), **as directed**.
   b. Insulation: Extruded-polystyrene foam, 2 inches (50 mm) thick **OR** Foamed-in-place polyurethane, **as directed**.
3. Adjustable, Insulated, Formed-Metal Louver: Single-blade, adjustable louver with gasketed, insulated blades.
   a. Louver Depth: 6 inches (150 mm) **OR** 8 inches (200 mm), **as directed**.
   b. Frame Material and Nominal Thickness: Galvanized-steel sheet, not less than 0.052 inch (1.32 mm) **OR** 0.064 inch (1.63 mm), **as directed**.
   c. Frame Material and Nominal Thickness: Stainless-steel sheet, not less than 0.050 inch (1.27 mm) **OR** 0.062 inch (1.59 mm), **as directed**.
   d. Blade Material and Nominal Thickness: Galvanized-steel sheet, not less than 0.028 inch (0.71 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.052 inch (1.32 mm) **OR** 0.064 inch (1.63 mm), **as directed**.
   e. Blade Material and Nominal Thickness: Stainless-steel sheet, not less than 0.025 inch (0.64 mm) **OR** 0.038 inch (0.95 mm) **OR** 0.050 inch (1.27 mm) **OR** 0.062 inch (1.59 mm), **as directed**.

f. Insulation: Extruded-polystyrene foam, 1 inch (25 mm) thick **OR** Rigid, glass-fiber-board insulation, 1 inch (25 mm) thick **OR** Foamed-in-place polyurethane, 1/2 inch (13 mm) thick, **as directed**.

H. Fixed, Acoustical Louvers
1. Fixed, Formed-Metal Acoustical Louver: Louver with formed-metal blades filled on interior with mineral-fiber, rigid-board, acoustical insulation retained by perforated metal sheet of same material and finish as blade.
a. Louver Depth: 6 inches (150 mm) **OR** 8 inches (200 mm) **OR** 12 inches (300 mm), **as directed**.
b. Frame Material: Extruded-aluminum or aluminum sheet, not less than 0.080-inch (2.03-mm) nominal thickness.
c. Frame Material: Galvanized-steel sheet, not less than 0.052-inch (1.32-mm) **OR** 0.064-inch (1.63-mm), **as directed**, nominal thickness.
d. Blade Material: Aluminum sheet, not less than 0.063-inch (1.60-mm) **OR** 0.080-inch (2.03-mm), **as directed**, nominal thickness.
e. Blade Material: Galvanized-steel sheet, not less than 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
f. Blade Shape: Straight **OR** Airfoil **OR** Chevron, **as directed**.
g. Blade Angle: 45 degrees unless otherwise indicated.
h. Blade Spacing: 6 inches (150 mm) o.c. for 6-inch- (150-mm-) deep louvers.
i. Blade Spacing: 6 inches (150 mm) **OR** 8 inches (200 mm), **as directed**, o.c. for 8-inch- (200-mm-) deep louvers.
j. Blade Spacing: 9 inches (225 mm) **OR** 12 inches (300 mm), **as directed**, o.c. for 12-inch- (300-mm-) deep louvers.
k. Free Area: Not less than 4 sq. ft. (0.37 sq. m) for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
l. Airborne Sound-Transmission Loss: STC 10 per ASTM E 413, determined by testing per ASTM E 90.
m. Outdoor-Indoor Sound-Transmission Loss: OITC 10 per ASTM E 1332, determined by testing per ASTM E 966.

I. Louver Screens
1. General: Provide screen at each exterior louver **OR** louvers indicated, **as directed**.
a. Screen Location for Fixed Louvers: Interior face.
b. Screen Location for Adjustable Louvers: Interior **OR** Exterior, **as directed**, face unless otherwise indicated.
c. Screening Type: Bird screening **OR** Bird screening except where insect screening is indicated **OR** Insect screening, **as directed**.
2. Secure screen frames to louver frames with stainless-steel machine screws **OR** machine screws with heads finished to match louver, **as directed**, spaced a maximum of 6 inches (150 mm) from each corner and at 12 inches (300 mm) o.c.
3. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.
a. Metal: Same kind and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips, **as directed**.
b. Finish: Same finish as louver frames to which louver screens are attached **OR** Mill finish unless otherwise indicated, **as directed**.
c. Type: Rewirable frames with a driven spline or insert **OR** Non-rewirable, U-shaped frames, **as directed**.
4. Louver Screening for Aluminum Louvers:
a. Bird Screening: Aluminum, 1/2-inch- (13-mm-) square mesh, 0.063-inch (1.60-mm) wire.
b. Bird Screening: Stainless steel, 1/2-inch- (13-mm-) square mesh, 0.047-inch (1.19-mm) wire.
c. Bird Screening: Flattened, expanded aluminum, 3/4 by 0.050 inch (19 by 1.27 mm) thick.
d. Insect Screening: Aluminum, 18-by-16 (1.4-by-1.6-mm) mesh, 0.012-inch (0.30-mm) wire.

e. Insect Screening: Stainless steel, 18-by-18 (1.4-by-1.4-mm) mesh, 0.009-inch (0.23-mm) wire.

5. Louver Screening for Galvanized-Steel Louvers:
   a. Bird Screening: Galvanized steel, 1/2-inch- (13-mm-) square mesh, 0.041-inch (1.04-mm) wire.
   b. Bird Screening: Stainless steel, 1/2-inch- (13-mm-) square mesh, 0.047-inch (1.19-mm) wire.
   c. Insect Screening: Galvanized steel, 18-by-14 (1.4-by-1.8-mm) mesh, 0.011-inch (0.28-mm) wire.
   d. Insect Screening: Stainless steel, 18-by-18 (1.4-by-1.4-mm) mesh, 0.009-inch (0.23-mm) wire.
6. Louver Screening for Stainless-Steel Louvers:
   a. Bird Screening: Stainless steel, 1/2-inch- (13-mm-) square mesh, 0.047-inch (1.19-mm) wire.
   b. Insect Screening: Stainless steel, 18-by-18 (1.4-by-1.4-mm) mesh, 0.009-inch (0.23-mm) wire.

J. Blank-Off Panels
1. Uninsulated, Blank-Off Panels: Metal sheet attached to back of louver.
   a. Aluminum sheet for aluminum louvers, not less than 0.050-inch (1.27-mm) nominal thickness.
   b. Galvanized-steel sheet for galvanized-steel louvers, not less than 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
   c. Stainless-steel sheet for stainless-steel louvers, not less than 0.038-inch (0.95-mm) **OR** 0.050-inch (1.27-mm), **as directed**, nominal thickness, with grain running in same direction as grain of louver blades.
   d. Panel Finish: Same finish applied to louvers **OR** Same type of finish applied to louvers, but black color, **as directed**.
   e. Attach blank-off panels with clips **OR** sheet metal screws, **as directed**.
2. Insulated, Blank-Off Panels: Laminated panels consisting of insulating core surfaced on back and front with metal sheets and attached to back of louver.
   a. Thickness: 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**.
   b. Metal Facing Sheets: Aluminum sheet, not less than 0.032-inch (0.81-mm) nominal thickness.
   c. Metal Facing Sheets: Galvanized-steel sheet, not less than 0.028-inch (0.71-mm) nominal thickness.
   d. Metal Facing Sheets: Stainless-steel sheet, not less than 0.031-inch (0.79-mm) nominal thickness.
   e. Insulating Core: Rigid, glass-fiber-board insulation **OR** extruded-polystyrene foam, **as directed**.
   f. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard extruded-aluminum-channel frames, not less than 0.080-inch (2.03-mm) nominal thickness **OR** channel frames, **as directed**, with corners mitered and with same finish as panels.
   g. Seal perimeter joints between panel faces and louver frames with gaskets or sealant.
   h. Panel Finish: Same finish applied to louvers **OR** Same type of finish applied to louvers, but black color, **as directed**.
   i. Attach blank-off panels with clips **OR** sheet metal screws, **as directed**.

K. Wall Vents (Brick Vents)
1. Extruded-Aluminum Wall Vents:
   a. Extruded-aluminum louvers and frames, not less than 0.125-inch (3.18-mm) nominal thickness, assembled by welding; with 18-by-14- (1.4-by-1.8-mm-) mesh, aluminum insect screening on inside face; incorporating weep holes, continuous drip at sill, and integral waterstop on inside edge of sill; of load-bearing design and construction.

b. Dampers: Aluminum blades and frames mounted on inside of wall vents; operated from exterior with Allen wrench in socket-head cap screw. Fabricate operating mechanism from Type 304 stainless-steel components.
c. Finish: Mill finish.
2. Cast-Aluminum Wall Vents:
a. One-piece, cast-aluminum louvers and frames; with 18-by-14- (1.4-by-1.8-mm-) mesh, aluminum insect screening on inside face; incorporating integral waterstop on inside edge of sill; of load-bearing design and construction.
b. Dampers: Aluminum blades and frames mounted on inside of wall vents; operated from exterior with Allen wrench in socket-head cap screw. Fabricate operating mechanism from Type 304 stainless-steel components.
c. Finish: Mill finish.

L. Finishes, General
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

M. Aluminum Finishes
1. Finish louvers after assembly.
2. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
3. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
a. Color: As selected from full range of industry colors and color densities.
4. Conversion-Coated Finish: AA-C12C42 (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating).
5. Conversion-Coated and Factory-Primed Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below).
a. Organic Coating: Air-dried primer of not less than 2-mil (0.05-mm) dry film thickness.
6. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
7. High-Performance Organic Finish: 2-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
8. High-Performance Organic Finish: 3 **OR** 4, **as directed**,-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

N. Galvanized-Steel Sheet Finishes
1. Finish louvers after assembly.
2. Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and repair according to ASTM A 780.
3. Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard 2-coat, baked-on finish consisting of prime coat and thermosetting

topcoat, with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).

a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

O. Stainless-Steel Sheet Finishes

1. Repair sheet finish by grinding and polishing irregularities, weld spatter, scratches, and forming marks to match surrounding finish.

1.3 EXECUTION

A. Installation

1. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.
2. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
3. Form closely fitted joints with exposed connections accurately located and secured.
4. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
5. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.
6. Protect unpainted galvanized and nonferrous-metal surfaces that will be in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.
7. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Division 07 Section "Joint Sealants" for sealants applied during louver installation.

B. Adjusting And Cleaning

1. Test operation of adjustable louvers and adjust as needed to produce fully functioning units that comply with requirements.
2. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.
3. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
4. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by the Owner, remove damaged units and replace with new units.
   a. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 08 90 00 00

Task	Specification	Specification Description
08 91 16 00	08 90 00 00	Louvers And Vents
08 95 13 00	01 22 16 00	No Specification Required
08 95 16 00	01 22 16 00	No Specification Required
08 95 16 00	05 50 00 00	Metal Fabrications
08 95 16 00	05 73 23 00	Miscellaneous Ornamental Metals

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SECTION 09 01 30 91 - CERAMIC TILE

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for ceramic tile. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Ceramic tile.
b. Porcelain tile.
c. Stone thresholds.
d. Waterproof membrane.
e. Crack isolation membrane.
f. Tile backing panels.
g. Metal edge strips.

C. Definitions
1. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
2. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1A, ANSI A108.1B, ANSI A108.1C, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in "American National Standard Specifications for Installation of Ceramic Tile."
3. Module Size: Actual tile size plus joint width indicated.
4. Face Size: Actual tile size, excluding spacer lugs.

D. Performance Requirements
1. Static Coefficient of Friction: For tile installed on walkway surfaces, provide products with the following values as determined by testing identical products per ASTM C 1028:
a. Level Surfaces: Minimum 0.6.
b. Step Treads: Minimum 0.6.
c. Ramp Surfaces: Minimum 0.8.

E. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
a. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
4. Samples:
a. Full-size units of each type and composition of tile and for each color and finish required. For ceramic mosaic tile in color blend patterns, provide full sheets of each color blend.
OR
Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required. Make samples at least 12 inches

(300 mm) square, but not fewer than 4 tiles. Use grout of type and in color or colors approved for completed Work.
b. Full-size units of each type of trim and accessory for each color and finish required.
c. Stone thresholds in 6-inch (150-mm) lengths.
d. Metal edge strips in 6-inch (150-mm) lengths.
5. Qualification Data: For qualified Installer.
6. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.
7. Product Certificates: For each type of product, signed by product manufacturer. Certification: Porcelain tile certified by the Porcelain Tile Certification Agency.
8. Material Test Reports: For each tile-setting and -grouting product, special purpose tile and certified porcelain tile.

F. Quality Assurance
1. Source Limitations for Tile: Obtain tile of each type and color or finish **OR** tile of each type **OR** tile of each color or finish **OR** tile, **as directed**, from one source or producer.
a. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.
2. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from one manufacturer and each aggregate from one source or producer.
3. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer for each product:
a. Stone thresholds.
b. Waterproof membrane.
c. Crack isolation membrane.
d. Joint sealants.
e. Cementitious backer units.
f. Metal edge strips.
4. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
2. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
3. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
4. Store liquid materials in unopened containers and protected from freezing.
5. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

H. Project Conditions
1. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

1.2 PRODUCTS

A. Products, General
1. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
a. Provide tile complying with Standard grade requirements unless otherwise indicated.

2. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 1.2 articles, ANSI standards referenced by TCA installation methods specified in tile installation schedules, and other requirements specified.
3. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.
4. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.
   a. Where tile is indicated for installation in swimming pools, on exteriors or in wet areas, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.
5. Factory-Applied Temporary Protective Coating: Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by precoating with continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

B. Tile Products
1. Tile Type: Factory-mounted unglazed **OR** glazed, **as directed**, ceramic mosaic tile.
   a. Composition: Porcelain **OR** Impervious natural clay or porcelain **OR** Vitreous or impervious natural clay or porcelain, **as directed**.
   b. Module Size: 1 by 1 inch (25.4 by 25.4 mm) **OR** 1 by 2 inches (25.4 by 50.8 mm) **OR** 2 by 2 inches (50.8 by 50.8 mm), **as directed**.
   c. Thickness: 1/4 inch (6.35 mm).
   d. Face: Plain **OR** Pattern of design indicated, **as directed**, with cushion edges.
   e. Surface (for unglazed tile): Smooth, without **OR** Slip-resistant, with, **as directed**, abrasive admixture.
   f. Finish (for glazed tile): Bright, opaque **OR** Bright, clear **OR** Mat, opaque **OR** Mat, clear **OR** Semimat, opaque **OR** Semimat, clear **OR** Vellum, opaque **OR** Vellum, clear **OR** Crystalline, **as directed**, glaze.
   g. Tile Color and Pattern: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   h. Grout Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   i. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile, **as directed**. Provide shapes as follows, selected from manufacturer's standard shapes:
      1) Base Cove: Cove, module size 1 by 1 inch (25.4 by 25.4 mm) **OR** 2 by 1 inch (50.8 by 25.4 mm), **as directed**.
      2) Base Cap for Portland Cement Mortar Installations: Bead (bullnose), module size 1 by 1 inch (25.4 by 25.4 mm) **OR** 2 by 1 inch (50.8 by 25.4 mm), **as directed**.
      3) Base Cap for Thin-Set Mortar Installations: Surface bullnose, module size 1 by 1 inch (25.4 by 25.4 mm) **OR** 2 by 1 inch (50.8 by 25.4 mm) **OR** 2 by 2 inches (50.8 by 50.8 mm), **as directed**.
      4) Wainscot Cap for Portland Cement Mortar Installations: Bead (bullnose), module size 1 by 1 inch (25.4 by 25.4 mm) **OR** 2 by 1 inch (50.8 by 25.4 mm), **as directed**.
      5) Wainscot Cap for Thin-Set Mortar Installations: Surface bullnose, module size 1 by 1 inch (25.4 by 25.4 mm) **OR** 2 by 1 inch (50.8 by 25.4 mm) **OR** 2 by 2 inches (50.8 by 50.8 mm), **as directed**.
      6) Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it, same size as adjoining flat tile.
      7) External Corners for Portland Cement Mortar Installations: Bead (bullnose), module size 1 by 1 inch (25.4 by 25.4 mm) **OR** 2 by 1 inch (50.8 by 25.4 mm), **as directed**.
      8) External Corners for Thin-Set Mortar Installations: Surface bullnose, module size 1 by 1 inch (25.4 by 25.4 mm) **OR** 2 by 1 inch (50.8 by 25.4 mm) **OR** 2 by 2 inches (50.8 by 50.8 mm), **as directed**.

9) Internal Corners: Cove, module size 1 by 1 inch (25.4 by 25.4 mm) **OR** 2 by 1 inch (50.8 by 25.4 mm), **as directed**.
OR
Internal Corners: Field-butted square corners. For coved base and cap, use angle pieces designed to fit with stretcher shapes.
10) Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide reduction in thickness from 1/2 to 1/4 inch (12.7 to 6.35 mm) across nominal 4-inch (100-mm) dimension.

2. Tile Type: Unglazed **OR** Glazed, **as directed**, square-edged quarry tile.
a. Face Size: 3 by 3 inches (76 by 76 mm) **OR** 4 by 4 inches (102 by 102 mm) **OR** 6 by 3 inches (152 by 76 mm) **OR** 6 by 6 inches (152 by 152 mm) **OR** 8 by 3-7/8 inches (203 by 98 mm) **OR** 8 by 8 inches (203 by 203 mm), **as directed**.
b. Thickness: 3/8 inch (9.5 mm) **OR** 1/2 inch (12.7 mm) **OR** 3/4 inch (19 mm), **as directed**.
c. Wearing Surface (for unglazed tile): Nonabrasive, smooth **OR** Abrasive aggregate embedded in surface, **as directed**.
d. Finish (for glazed tile): Bright, opaque **OR** Bright, clear **OR** Mat, opaque **OR** Mat, clear **OR** Semimat, opaque **OR** Semimat, clear **OR** Vellum, opaque **OR** Vellum, clear **OR** Crystalline, **as directed**, glaze.
e. Tile Color and Pattern: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
f. Grout Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
g. For furan-grouted quarry tile, precoat with temporary protective coating.
h. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile, **as directed**. Provide shapes as follows, selected from manufacturer's standard shapes:
1) Base: Coved with surface bullnose top edge, **as directed**, face size 6 by 6 inches (152 by 152 mm) **OR** 8 by 3-7/8 inches (203 by 98 mm), **as directed**.
2) Wainscot Cap: Surface bullnose, face size 6 by 6 inches (152 by 152 mm) **OR** 8 by 3-7/8 inches (203 by 98 mm), **as directed**.
3) Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it, same size as adjoining flat tile.

3. Tile Type: Unglazed **OR** Glazed, **as directed**, paver tile.
a. Composition: Porcelain **OR** Impervious natural clay or porcelain **OR** Vitreous or impervious natural clay or porcelain **OR** Natural clay or porcelain, **as directed**.
b. Face Size: 3 by 3 inches (76 by 76 mm) **OR** 4 by 4 inches (102 by 102 mm) **OR** 6 by 6 inches (152 by 152 mm) **OR** 7-3/4 by 3-7/8 inches (197 by 98 mm) **OR** 7-7/8 by 7-7/8 inches (200 by 200 mm) **OR** 11-13/16 by 11-13/16 inches (300 by 300 mm) **OR** 165 by 333 mm **OR** 200 by 250 mm **OR** 250 by 250 mm **OR** 165 by 333 mm **OR** 333 by 333 mm **OR** 400 by 400 mm, **as directed**.
c. Thickness: 1/4 inch (6.35 mm) **OR** 3/8 inch (9.5 mm) **OR** 1/2 inch (12.7 mm), **as directed**.
d. Face: Plain with square or cushion edges **OR** Plain with square edges **OR** Plain with cushion edges **OR** Pattern of design indicated, with square or cushion edges **OR** As indicated, **as directed**.
e. Finish (for glazed tile): Bright, opaque **OR** Bright, clear **OR** Mat, opaque **OR** Mat, clear **OR** Semimat, opaque **OR** Semimat, clear **OR** Vellum, opaque **OR** Vellum, clear **OR** Crystalline, **as directed**, glaze.
f. Tile Color and Pattern: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
g. Grout Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

4. Tile Type: Glazed wall tile **OR** Decorative thin wall tile, **as directed**.

a. Module Size: 4-1/4 by 4-1/4 inches (108 by 108 mm) **OR** 6 by 4-1/4 inches (152 by 108 mm) **OR** 6 by 6 inches (152 by 152 mm) **OR** 200 by 200 mm **OR** 250 by 250 mm **OR** 200 by 300 mm, **as directed**.
b. Thickness: 5/16 inch (8 mm).
c. Face: Plain with modified square edges or cushion edges **OR** Plain with modified square edges **OR** Plain with cushion edges **OR** Pattern of design indicated, with manufacturer's standard edges, **as directed**.
d. Finish: Bright, opaque **OR** Bright, clear **OR** Mat, opaque **OR** Mat, clear **OR** Semimat, opaque **OR** Semimat, clear **OR** Vellum, opaque **OR** Vellum, clear **OR** Crystalline, **as directed**, glaze.
e. Tile Color and Pattern: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
f. Grout Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
g. Mounting: Factory, back mounted.
h. Mounting: Pregrouted sheets of tiles factory assembled and grouted with manufacturer's standard white silicone rubber.
i. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile, **as directed**. Provide shapes as follows, selected from manufacturer's standard shapes:
1) Base for Portland Cement Mortar Installations: Coved, module size 4-1/4 by 4-1/4 inches (108 by 108 mm) **OR** 6 by 6 inches (152 by 152 mm) **OR** 6 by 3-3/4 inches (152 by 95 mm), **as directed**.
2) Base for Thin-Set Mortar Installations: Straight, module size 4-1/4 by 4-1/4 inches (108 by 108 mm) **OR** 6 by 6 inches (152 by 152 mm) **OR** 6 by 2 inches (152 by 51 mm), **as directed**.
3) Wainscot Cap for Portland Cement Mortar Installations: Bullnose cap, module size 4-1/4 by 4-1/4 inches (108 by 108 mm) **OR** 6 by 6 inches (152 by 152 mm) **OR** 6 by 2 inches (152 by 51 mm), **as directed**.
4) Wainscot Cap for Thin-Set Mortar Installations: Surface bullnose, module size 4-1/4 by 4-1/4 inches (108 by 108 mm) **OR** 6 by 6 inches (152 by 152 mm) **OR** 6 by 2 inches (152 by 51 mm), **as directed**.
5) Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it, same size as adjoining flat tile.
6) External Corners for Portland Cement Mortar Installations: Bullnose shape with radius of at least 3/4 inch (19 mm) unless otherwise indicated.
7) External Corners for Thin-Set Mortar Installations: Surface bullnose, same size as adjoining flat tile.
8) Internal Corners: Field-butted square corners. For coved base and cap use angle pieces designed to fit with stretcher shapes.

5. Accessories: Provide vitreous china accessories of type and size indicated, suitable for installing by same method as adjoining wall tile.
a. One soap holder with grab handle, **as directed**, for each shower and tub indicated.
b. One paper holder at each water closet.
c. Color and Finish: Match adjoining glazed wall tile **OR** As indicated by manufacturer's designations **OR** As selected from manufacturer's full range **OR** White, bright glaze, **as directed**.

C. Thresholds
1. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.
a. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to 1/16 inch (1.5 mm) above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to 1/2 inch (12.7 mm) or less above adjacent floor surface.
2. Granite Thresholds: ASTM C 615, with polished **OR** honed, **as directed**, finish.

a. Description: Uniform, fine **OR** medium, **as directed**,-grained, white **OR** gray **OR** black, **as directed**, stone without veining.
OR
Description: Match sample.

3. Marble Thresholds: ASTM C 503, with a minimum abrasion resistance of 10 **OR** 12, **as directed**, per ASTM C 1353 or ASTM C 241 and with honed finish.
   a. Description: Uniform, fine- to medium-grained white stone with gray veining.
   OR
   Description: Match sample.
4. Slate Thresholds: ASTM C 629, Classification I Exterior **OR** II Interior, **as directed**, with fine, even grain and honed finish.
   a. Description: Uniform, black **OR** blue-black **OR** gray **OR** blue-gray **OR** green, **as directed**, stone and unfading.
   OR
   Description: Match sample.

D. Tile Backing Panels
1. Cementitious Backer Units: ANSI A118.9 or ASTM C 1325, in maximum lengths available to minimize end-to-end butt joints.
   a. Thickness: 1/4 inch (6.4 mm) **OR** 1/2 inch (12.7 mm) **OR** 5/8 inch (15.9 mm) **OR** As indicated, **as directed**.
2. Fiber-Cement Underlayment: ASTM C 1288, in maximum lengths available to minimize end-to-end butt joints.
   a. Thickness: 1/4 inch (6.4 mm) **OR** 1/2 inch (12.7 mm) **OR** As indicated, **as directed**.

E. Waterproof Membrane
1. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
2. Chlorinated Polyethylene Sheet: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; 0.030-inch (0.76-mm) nominal thickness.
3. PVC Sheet: Two layers of PVC sheet heat-fused together and to facings of nonwoven polyester; 0.040-inch (1.01-mm) nominal thickness.
4. Polyethylene Sheet: Polyethylene faced on both sides with fleece webbing; 0.008-inch (0.203-mm) nominal thickness.
5. Fabric-Reinforced, Modified-Bituminous Sheet: Self-adhering, SBS-modified-bituminous sheet with woven reinforcement facing; 0.040-inch (1.01-mm) nominal thickness.
6. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and continuous fabric reinforcement.
7. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.
8. Latex-Portland Cement: Flexible mortar consisting of cement-based mix and latex additive.
9. Urethane Waterproofing and Tile-Setting Adhesive: One-part, liquid-applied urethane, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), in a consistency suitable for trowel application and intended for use as both waterproofing and tile-setting adhesive in a two-step process.

F. Crack Isolation Membrane
1. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.12 for standard **OR** high, **as directed**, performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
2. Chlorinated Polyethylene Sheet: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; 0.030-inch (0.76-mm) nominal thickness.
3. PVC Sheet: Two layers of PVC sheet heat-fused together and to facings of nonwoven polyester; 0.040-inch (1.01-mm) nominal thickness.

4. Polyethylene Sheet: Polyethylene faced on both sides with fleece webbing; 0.008-inch (0.203-mm) nominal thickness.
5. Corrugated Polyethylene: Corrugated polyethylene with dovetail-shaped corrugations and with anchoring webbing on the underside; 3/16-inch (4-mm) nominal thickness.
6. Fabric-Reinforced, Modified-Bituminous Sheet: Self-adhering, modified-bituminous sheet with fabric reinforcement facing; 0.040-inch (1.01-mm) nominal thickness.
7. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and fabric reinforcement.
8. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.
9. Latex-Portland Cement: Flexible mortar consisting of cement-based mix and latex additive.
10. Urethane Crack Isolation Membrane and Tile-Setting Adhesive: One-part, liquid-applied urethane, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), in a consistency suitable for trowel application and intended for use as both waterproofing and tile-setting adhesive in a two-step process.

G. Setting Materials
1. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.02.
   a. Cleavage Membrane: Asphalt felt, ASTM D 226, Type I (No. 15); or polyethylene sheeting, ASTM D 4397, 4.0 mils (0.1 mm) thick.
   b. Reinforcing Wire Fabric: Galvanized, welded wire fabric, 2 by 2 inches (50.8 by 50.8 mm) by 0.062-inch (1.57-mm) diameter; comply with ASTM A 1064 and ASTM A 82 except for minimum wire size.
   c. Expanded Metal Lath: Diamond-mesh lath complying with ASTM C 847.
      1) Base Metal and Finish for Interior Applications: Uncoated or zinc-coated (galvanized) steel sheet, with uncoated steel sheet painted after fabrication into lath.
      2) Base Metal and Finish for Exterior Applications: Zinc-coated (galvanized) steel sheet.
      3) Configuration over Studs and Furring: Flat.
      4) Configuration over Solid Surfaces: Self furring.
      5) Weight: 2.5 lb/sq. yd. (1.4 kg/sq. m) **OR** 3.4 lb/sq. yd. (1.8 kg/sq. m), **as directed**.
   d. Latex Additive: Manufacturer's standard, acrylic resin or styrene-butadiene-rubber water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed.
2. Dry-Set Portland Cement Mortar (Thin Set): ANSI A118.1.
   a. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.1.
3. Latex-Portland Cement Mortar (Thin Set): ANSI A118.4.
   a. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
      OR
      Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.
   b. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.
4. Medium-Bed, Latex-Portland Cement Mortar: Comply with requirements in ANSI A118.4. Provide product that is approved by manufacturer for application thickness of 5/8 inch (16 mm).
   a. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
      OR
      Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.
5. EGP (Exterior Glue Plywood) Latex-Portland Cement Mortar (Thin Set): ANSI A118.11.
   a. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.

b. Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.

6. Water-Cleanable, Tile-Setting Epoxy: ANSI A118.3, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   a. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 deg F (60 deg C) and 212 deg F (100 deg C), respectively, and certified by manufacturer for intended use.
7. Chemical-Resistant Furan Mortar: ANSI A118.5, with carbon filler.
8. Organic Adhesive: ANSI A136.1, Type I, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

H. Grout Materials
1. Sand-Portland Cement Grout: ANSI A108.10, composed of white or gray cement and white or colored aggregate as required to produce color indicated.
2. Standard Cement Grout: ANSI A118.6.
3. Polymer-Modified Tile Grout: ANSI A118.7.
   a. Polymer Type: Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.
   OR
   Polymer Type: Acrylic resin or styrene-butadiene rubber in liquid-latex form for addition to prepackaged dry-grout mix.
4. Water-Cleanable Epoxy Grout: ANSI A118.3.
   a. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 deg F (60 deg C) and 212 deg F (100 deg C), respectively, and certified by manufacturer for intended use.
5. Chemical-Resistant Furan Grout: ANSI A118.5, with carbon filler.
6. Grout for Pregrouted Tile Sheets: Same product used in factory to pregrout tile sheets.

I. Elastomeric Sealants
1. General: Provide sealants, primers, backer rods, and other sealant accessories that comply with the following requirements and with the applicable requirements in Division 7 Section "Joint Sealants."
   a. Use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. Use primers, backer rods, and sealant accessories recommended by sealant manufacturer.
2. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints unless otherwise indicated.
3. One-Part, Mildew-Resistant Silicone Sealant: ASTM C 920; Type S; Grade NS; Class 25; Uses NT, G, A, and, as applicable to nonporous joint substrates indicated, O; formulated with fungicide, intended for sealing interior ceramic tile joints and other nonporous substrates that are subject to in-service exposures of high humidity and extreme temperatures.
4. Multipart, Pourable Urethane Sealant for Use T: ASTM C 920; Type M; Grade P; Class 25; Uses T, M, A, and, as applicable to joint substrates indicated, O.
5. Chemical-Resistant Sealants: For chemical-resistant floors, provide chemical-resistant elastomeric sealant of type recommended and produced by chemical-resistant mortar and grout manufacturer for type of application indicated, with proven service record and compatibility with tile and other setting materials, and with chemical resistance equivalent to mortar/grout.

J. Miscellaneous Materials
1. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
2. Metal Edge Strips: Angle or L-shape, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications;

half-hard brass **OR** white zinc alloy **OR** nickel silver **OR** stainless-steel, ASTM A 666, 300 Series, **as directed**, exposed-edge material.

3. Temporary Protective Coating: Either product indicated below that is formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products; and easily removable after grouting is completed without damaging grout or tile.
   a. Petroleum paraffin wax, fully refined and odorless, containing at least 0.5 percent oil with a melting point of 120 to 140 deg F (49 to 60 deg C) per ASTM D 87.
   b. Grout release in form of manufacturer's standard proprietary liquid coating that is specially formulated and recommended for use as temporary protective coating for tile.
4. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.
5. Grout Sealer: Manufacturer's standard silicone product for sealing grout joints and that does not change color or appearance of grout.

K. Mixing Mortars And Grout
   1. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
   2. Add materials, water, and additives in accurate proportions.
   3. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

1.3 EXECUTION

A. Examination
   1. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
      a. Verify that substrates for setting tile are firm, dry, clean, free of coatings that are incompatible with tile-setting materials including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
      b. Verify that concrete substrates for tile floors installed with adhesives, bonded mortar bed or thin-set mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
         1) Verify that surfaces that received a steel trowel finish have been mechanically scarified.
         2) Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
      c. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
      d. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
   2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
   1. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with adhesives or thin-set mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
   2. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot (1:50) toward drains.
   3. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from

other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

4. Field-Applied Temporary Protective Coating: If indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

C. Tile Installation

1. Comply with TCA's "Handbook for Ceramic Tile Installation" for TCA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 Series "Specifications for Installation of Ceramic Tile" that are referenced in TCA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
   a. For the following installations, follow procedures in the ANSI A108 Series of tile installation standards for providing 95 percent mortar coverage:
      1) Exterior tile floors.
      2) Tile floors in wet areas.
      3) Tile swimming pool decks.
      4) Tile floors in laundries.
      5) Tile floors composed of tiles 8 by 8 inches (200 by 200 mm) or larger.
      6) Tile floors composed of rib-backed tiles.
2. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
3. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
4. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
   a. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
   b. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
   c. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.
5. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
   a. Ceramic Mosaic Tile: 1/16 inch (1.6 mm).
   b. Porcelain Tile: 1/4 inch (6.4 mm) **OR** 3/8 inch (9.5 mm)**, as directed.**
   c. Quarry Tile: 1/4 inch (6.35 mm) **OR** 3/8 inch (9.5 mm), **as directed**.
   d. Paver Tile: 1/4 inch (6.35 mm) **OR** 3/8 inch (9.5 mm), **as directed**.
   e. Glazed Wall Tile: 1/16 inch (1.6 mm).
   f. Decorative Thin Wall Tile: 1/16 inch (1.6 mm).
6. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.
7. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
   a. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
   b. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants".
8. Stone Thresholds: Install stone thresholds in same type of setting bed as adjacent floor unless otherwise indicated.
   a. At locations where mortar bed (thickset) would otherwise be exposed above adjacent floor finishes, set thresholds in latex-portland cement mortar (thin set).

b. Do not extend cleavage membrane, waterproofing or crack isolation membrane under thresholds set in dry-set portland cement or latex-portland cement mortar. Fill joints between such thresholds and adjoining tile set on cleavage membrane, waterproofing or crack isolation membrane with elastomeric sealant.

9. Metal Edge Strips: Install at locations indicated **OR** where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with top of tile **OR** where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with or below top of tile and no threshold is indicated, **as directed**.
10. Grout Sealer: Apply grout sealer to cementitious grout joints in tile floors according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

D. Tile Backing Panel Installation

1. Install cementitious backer units and fiber-cement underlayment and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated. Use latex-portland cement mortar for bonding material unless otherwise directed in manufacturer's written instructions.

E. Waterproofing Installation

1. Install waterproofing to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness and bonded securely to substrate.
2. Do not install tile or setting materials over waterproofing until waterproofing has cured and been tested to determine that it is watertight.

F. Crack Isolation Membrane Installation

1. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness and bonded securely to substrate.
2. Do not install tile or setting materials over crack isolation membrane until membrane has cured.

G. Cleaning And Protecting

1. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
   a. Remove epoxy and latex-portland cement grout residue from tile as soon as possible.
   b. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.
   c. Remove temporary protective coating by method recommended by coating manufacturer and that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent drain clogging.
2. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
3. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
4. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

H. Exterior Tile Installation Schedule

1. Exterior Floor Installations:
   a. Tile Installation F101: Cement mortar bed (thickset) bonded to concrete **OR** over waterproof membrane on concrete **OR** over waterproof membrane on concrete where indicated and bonded to concrete where membrane is not indicated, **as directed**; TCA F101 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
      1) Tile Type: as directed by the Owner.

2) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

b. Tile Installation F102: Thin-set mortar on concrete **OR** over waterproof membrane on concrete **OR** over waterproof membrane on concrete where indicated and on concrete where membrane is not indicated, **as directed**; TCA F102.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **directed**, portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

2. Exterior Wall Installations, Masonry or Concrete:

a. Tile Installation W201: Cement mortar bed (thickset) on metal lath over waterproof membrane; TCA W201 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
1) Tile Type: as directed by the Owner.
2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed,** portland cement mortar.
4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

b. Tile Installation W202: Thin-set mortar; TCA W202.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

I. Interior Tile Installation Schedule

1. Interior Floor Installations, Concrete Subfloor:

a. Tile Installation F111: Cement mortar bed (thickset) with cleavage membrane; TCA F111 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

b. Tile Installation F112: Cement mortar bed (thickset) bonded to concrete; TCA F112 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

c. Tile Installation F113: Thin-set mortar; TCA F113.
1) Tile Type: as directed by the Owner.

2) Thin-Set Mortar: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

d. Tile Installation F114: Cement mortar bed (thickset) with cleavage membrane; epoxy **OR** furan, **as directed**, grout; TCA F114 and ANSI A108.1B.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
3) Grout: Water-cleanable epoxy **OR** Chemical-resistant furan, **s directed**, grout.

e. Tile Installation F115: Thin-set mortar; epoxy **OR** furan, **as directed**, grout; TCA F115.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
3) Grout: Water-cleanable epoxy **OR** Chemical-resistant furan, **as directed**, grout.

f. Tile Installation F116: Organic adhesive **OR** Water-cleanable, tile-setting epoxy, **as directed**; TCA F116.
1) Tile Type: as directed by the Owner.
2) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

g. Tile Installation F121: Cement mortar bed (thickset) on waterproof membrane; TCA F121 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

h. Tile Installation F122: Thin-set mortar on waterproof membrane; TCA F122.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar: Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
3) Grout: Polymer-modified sanded **OR** unsanded, **as directed**, grout.

i. Tile Installation F125A: Thin-set mortar on crack isolation membrane; TCA F125A.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar: Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
3) Grout: Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

j. Tile Installation F131: Water-cleanable, tile-setting epoxy; epoxy grout; TCA F131.
1) Tile Type: as directed by the Owner.
2) Grout: Water-cleanable epoxy grout.

k. Tile Installation F132: Water-cleanable, tile-setting epoxy on cured cement mortar bed bonded to concrete subfloor **OR** installed over cleavage membrane, **as directed**; epoxy grout; TCA F132.
1) Tile Type: as directed by the Owner.
2) Grout: Water-cleanable epoxy grout.

l. Tile Installation F133: Chemical-resistant furan mortar **OR** Water-cleanable, tile-setting epoxy, **as directed**; furan grout. TCA F133 except use water-cleanable, tile-setting epoxy instead of chemical-resistant furan mortar for setting tile.
1) Tile Type: as directed by the Owner.
2) Grout: Chemical-resistant furan grout.

2. Interior Floor Installations, Wood Subfloor:

a. Tile Installation F121: Cement mortar bed (thickset) on waterproof membrane; TCA F121 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
   1) Tile Type: as directed by the Owner.
   2) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
   3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
b. Tile Installation F141: Cement mortar bed (thickset) with cleavage membrane; TCA F141 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
   1) Tile Type: as directed by the Owner.
   2) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
   3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
c. Tile Installation F142: Organic adhesive; TCA F142.
   1) Tile Type: as directed by the Owner.
   2) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
d. Tile Installation F143: Water-cleanable, tile-setting epoxy; epoxy grout; TCA F143.
   1) Tile Type: as directed by the Owner.
   2) Grout: Water-cleanable epoxy grout.
e. Tile Installation F144: Thin-set mortar on cementitious backer units or fiber cement underlayment; TCA F144.
   1) Tile Type: as directed by the Owner.
   2) Thin-Set Mortar: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
   3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
f. Tile Installation F150/160: Thin-set mortar on exterior-glue plywood; TCA F150 or TCA F160.
   1) Tile Type: as directed by the Owner.
   2) Thin-Set Mortar: EGP latex-portland cement mortar.
   3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

3. Interior Radiant Heat Floor Installations, Concrete Subfloor:
   a. Tile Installation RH110: Thin-set mortar on crack isolation membrane; hydronic piping installed in concrete; TCA RH110.
      1) Tile Type: as directed by the Owner.
      2) Thin-Set Mortar: Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
      3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
   b. Tile Installation RH115: Thin-set mortar; electric radiant system encapsulated in thin-set mortar; TCA RH115.
      1) Tile Type: as directed by the Owner.
      2) Thin-Set Mortar: Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.

3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

c. Tile Installation RH116: Thin-set mortar on crack isolation membrane; electric radiant system encapsulated in cementitious self-leveling underlayment; TCA RH116.
   1) Tile Type: as directed by the Owner.
   2) Cementitious Self-Leveling Underlayment: Specified in Division 03 Section "Hydraulic Cement Underlayment".
   3) Thin-Set Mortar: Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
   4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

4. Interior Radiant Heat Floor Installations, Wood Subfloor:
   a. Tile Installation RH130: Thin-set mortar on exterior-glue plywood; electric radiant system encapsulated in thin-set mortar; TCA RH130.
      1) Tile Type: as directed by the Owner.
      2) Thin-Set Mortar: EGP latex-portland cement mortar.
      3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
   b. Tile Installation RH135: Thin-set mortar on cementitious backer units or fiber cement underlayment; electric radiant system encapsulated in thin-set mortar; TCA RH135.
      1) Tile Type: as directed by the Owner.
      2) Thin-Set Mortar: Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
      3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
   c. Tile Installation RH140: Thin-set mortar on crack isolation membrane; electric radiant system encapsulated in cementitious self-leveling underlayment; TCA RH140.
      1) Tile Type: as directed by the Owner.
      2) Cementitious Self-Leveling Underlayment: Specified in Division 03 Section "Hydraulic Cement Underlayment".
      3) Thin-Set Mortar: Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
      4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

5. Interior Wall Installations, Masonry or Concrete:
   a. Tile Installation W202: Thin-set mortar; TCA W202.
      1) Tile Type: as directed by the Owner.
      2) Thin-Set Mortar: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
      3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
   b. Tile Installation W211: Cement mortar bed (thickset) bonded to substrate; TCA W211 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
      1) Tile Type: as directed by the Owner.
      2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
      3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.

4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

c. Tile Installation W221: Cement mortar bed (thickset) on metal lath over waterproof membrane, **as directed**; TCA W221 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
1) Tile Type: as directed by the Owner.
2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

d. Tile Installation W222: One-coat cement mortar bed (thickset) on metal lath over waterproof membrane, **as directed**; TCA W222 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
1) Tile Type: as directed by the Owner.
2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

e. Tile Installation W223: Organic adhesive; TCA W223.
1) Tile Type: as directed by the Owner.
2) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

6. Interior Wall Installations, Wood Studs or Furring:

a. Tile Installation W221: Cement mortar bed (thickset) over waterproof membrane, **as directed**, on solid backing; TCA W221 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
1) Tile Type: as directed by the Owner.
2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

b. Tile Installation W222: One-coat cement mortar bed (thickset) over waterproof membrane, **as directed**, on solid backing; TCA W222 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
1) Tile Type: as directed by the Owner.
2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

c. Tile Installation W223: Organic adhesive on solid backing; TCA W223.
1) Tile Type: as directed by the Owner.

2) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

d. Tile Installation W231: Cement mortar bed (thickset); TCA W231 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
   1) Tile Type: as directed by the Owner.
   2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
   3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
   4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

e. Tile Installation W243: Thin-set mortar on gypsum board; TCA W243.
   1) Tile Type: as directed by the Owner.
   2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
   3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

f. Tile Installation W244: Thin-set mortar on cementitious backer units or fiber cement underlayment over cleavage membrane, **as directed**; TCA W244.
   1) Tile Type: as directed by the Owner.
   2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
   3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

g. Tile Installation W245: Thin-set mortar **OR** Organic adhesive, **as directed**, on coated glass-mat, water-resistant gypsum backer board; TCA W245.
   1) Tile Type: as directed by the Owner.
   2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
   3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

7. Interior Wall Installations, Metal Studs or Furring:
   a. Tile Installation W221: Cement mortar bed (thickset) over waterproof membrane, **as directed**, on solid backing; TCA W221 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
      1) Tile Type: as directed by the Owner.
      2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
      3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
      4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
   b. Tile Installation W222: One-coat cement mortar bed (thickset) over waterproof membrane, **as directed**, on solid backing; TCA W222 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
      1) Tile Type: as directed by the Owner.
      2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
      3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
      4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

c. Tile Installation W223: Organic adhesive on solid backing; TCA W223.
   1) Tile Type: as directed by the Owner.
   2) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
d. Tile Installation W241: Cement mortar bed (thickset); TCA W241 and ANSI A108.1B.
   1) Tile Type: as directed by the Owner.
   2) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
   3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
e. Tile Installation W242: Organic adhesive on gypsum board; TCA W242.
   1) Tile Type: as directed by the Owner.
   2) Grout: Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
f. Tile Installation W243: Thin-set mortar on gypsum board; TCA W243.
   1) Tile Type: as directed by the Owner.
   2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
   3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
g. Tile Installation W244: Thin-set mortar on cementitious backer units or fiber cement underlayment over cleavage membrane, **as directed**; TCA W244.
   1) Tile Type: as directed by the Owner.
   2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
   3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
h. Tile Installation W245: Thin-set mortar **OR** Organic adhesive, **as directed**, on coated glass-mat, water-resistant gypsum backer board; TCA W245.
   1) Tile Type: as directed by the Owner.
   2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
   3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

8. Bathtub Wall Installations, Wood **OR** Metal, **as directed**, Studs or Furring:
   a. Tile Installation B413: Thin-set mortar **OR** Organic adhesive, **as directed**, on water-resistant gypsum board; TCA B413.
      1) Tile Type: as directed by the Owner.
      2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
      3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
9. Bathtub/Shower Wall Installations, Wood **OR** Metal, **as directed**, Studs or Furring:
   a. Tile Installation B411: Cement mortar bed (thickset); TCA B411 and ANSI A108.1A.
      1) Tile Type: as directed by the Owner.
      2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **s drected**, portland cement mortar.
      3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
   b. Tile Installation B412: Thin-set mortar on cementitious backer units or fiber cement underlayment; TCA B412.
      1) Tile Type: as directed by the Owner.

2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

c. Tile Installation B419: Thin-set mortar **OR** Organic adhesive, **as directed**, on coated glass-mat, water-resistant backer board; TCA B419.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

10. Shower Receptor and Wall Installations, Concrete or Masonry:

a. Tile Installation B414: Cement mortar bed (thickset); TCA B414 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
1) Tile Type: as directed by the Owner.
2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

b. Tile Installation B421: Thin-set mortar on waterproof membrane; TCA B421.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar: Latex-portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

c. Tile Installation B422: Thin-set mortar on waterproof membrane with integrated bonding flange for bonded membranes; TCA B422.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

11. Shower Receptor and Wall Installations, Wood **OR** Metal, **as directed**, Studs or Furring:

a. Tile Installation B414: Cement mortar bed (thickset); TCA B414 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
1) Tile Type: as directed by the Owner.
2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

b. Tile Installation B415: Thin-set mortar on cementitious backer units or fiber cement underlayment; TCA B415.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

c. Tile Installation B420: Thin-set mortar on coated glass-mat, water-resistant backer board; TCA B420.
1) Tile Type: as directed by the Owner.

2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

d. Tile Installation B421: Thin-set mortar on waterproof membrane over cementitious backer units or fiber cement underlayment; TCA B421.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar: Latex-portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

e. Tile Installation B422: Thin-set mortar on waterproof membrane over cementitious backer units or fiber cement underlayment with integrated bonding flange for bonded membranes; TCA B422.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar: Latex-portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

END OF SECTION 09 01 30 91

SECTION 09 01 60 91 - PORTLAND CEMENT TERRAZZO FLOORING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for portland cement terrazzo flooring. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Poured-in-place portland cement terrazzo flooring and base.
b. Poured-in-place rustic terrazzo flooring.
c. Precast terrazzo units.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For marble chips, aggregates, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
1) Include statement that indicates cost for each product having recycled content.
b. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
3. Shop Drawings: Include terrazzo installation requirements. Include plans, elevations, sections, component details, and attachments to other work.
4. Samples: For each type, material, color, and pattern of terrazzo and accessory required showing the full range of color, texture, and pattern variations expected
5. Qualification data.
6. Material certificates.
7. Maintenance data.

D. Quality Assurance
1. Installer Qualifications: An installer who is a contractor member of NTMA.
2. NTMA Standards: Comply with NTMA's "Terrazzo Specifications and Design Guide" and with written recommendations for terrazzo type indicated unless more stringent requirements are specified.
3. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
1. Deliver materials to Project site in supplier's original wrappings and containers, labeled with source's or manufacturer's name, material or product brand name, and lot number if any.
2. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

F. Project Conditions
1. Environmental Limitations: Maintain temperature above 50 deg F (10 deg C) for 48 hours before and during terrazzo installation.
2. Weather Limitations: Proceed with rustic terrazzo installation only when forecasted weather conditions permit work to be performed according to NTMA's written recommendations and temperatures remain above 45 deg F (7.2 deg C).
3. Field Measurements: Verify actual dimensions of construction contiguous with precast terrazzo by field measurements before fabrication.

4. Control and collect dust produced by grinding operations. Protect adjacent construction from detrimental effects of grinding operations.
    a. Provide dustproof partitions and temporary enclosures to limit dust migration and to isolate areas from noise.

1.2 PRODUCTS

A. Portland Cement Terrazzo
1. Portland Cement Terrazzo Type: Sand cushion **OR** Structural **OR** Bonded **OR** Monolithic **OR** Installed over metal deck, **as directed**.
2. Materials:
    a. Portland Cement: ASTM C 150, Type 1.
        1) Color for Exposed Matrix: As required by mix indicated **OR** White **OR** Gray, **as directed**.
    b. Water: Potable.
    c. Sand: ASTM C 33.
    d. Marble Chips **OR** Aggregates, **as directed**: Complying with NTMA gradation standards for mix indicated and containing no deleterious or foreign matter.
        1) Abrasion and Impact Resistance: Less than 40 percent loss per ASTM C 131 and ASTM C 535, **as directed**.
        2) 24-Hour Absorption Rate: Less than 0.75 percent.
        3) Dust Content: Less than 1.0 percent by weight.
    e. Matrix Pigments: Pure mineral or synthetic pigments, alkali resistant, durable under exposure to sunlight, and compatible with terrazzo matrix.
    f. Bonding Agent: Neat portland cement or epoxy or acrylic bonding agents formulated for use with topping indicated.
    g. Underbed Reinforcement: Galvanized welded-wire reinforcement, 2 by 2 inches (51 by 51 mm) by 0.062-inch- (1.57-mm-) diameter wire, complying with ASTM A 1064 and ASTM A 82, except for minimum wire size.
    h. Isolation Membrane: Polyethylene sheeting, ASTM D 2103, Type 13300, 4 mils (0.1 mm) thick; or unperforated asphalt felt, ASTM D 226, Type I (No. 15).
3. Mixes:
    a. Underbed (for structural portland cement terrazzo or portland cement terrazzo installed over metal deck): Structural-concrete underbed as specified in Division 03 Section "Cast-in-place Concrete".
    b. Underbed (for sand-cushion or bonded portland cement terrazzo): Comply with NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated for component proportions and mixing.
    c. Portland Cement Terrazzo (below for NTMA-formulated design mixes): Comply with NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated for matrix and marble-chip proportions and mixing.
        1) Formulated Mix Color and Pattern: As selected from NTMA standard-terrazzo plates **OR** As selected from NTMA Venetian-terrazzo plates, **as directed**.
    d. Portland Cement Terrazzo (for custom design mixes): Comply with NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated for matrix and marble-chip **OR** aggregate, **as directed**, proportions and mixing.
        1) Custom Mix Color and Pattern: Match sample **OR** Match existing, **as directed**.

B. Rustic Terrazzo
1. Rustic Terrazzo Type: Structural **OR** Bonded **OR** Monolithic **OR** Unbonded, **as directed**.
2. Materials:
    a. Portland Cement: ASTM C 150, Type 1.
        1) Color for Exposed Matrix: As required by mix indicated.
    b. Water: Potable.

c. Sand: ASTM C 33.
d. Marble Chips **OR** Aggregates, **as directed**: As required for mix indicated, sizes complying with NTMA gradation standards, 0.25 percent maximum 24-hour absorption rate, and containing no deleterious or foreign matter.
e. Matrix Pigments: Pure mineral or synthetic pigments, alkali resistant, durable under exposure to sunlight and weather, and compatible with matrix binder.
f. Air-Entraining Agent (for underbed of structural, bonded, or unbonded rustic terrazzo): Complying with NTMA's written recommendations and recommended by supplier for intended use.
g. Underbed Bonding Agent (for bonded rustic terrazzo): Neat portland cement.
h. Topping Bonding Agent (for monolithic rustic terrazzo): Neat portland cement, or epoxy or acrylic bonding agents formulated for use with topping indicated.
i. Isolation Membrane (for unbonded rustic terrazzo): Polyethylene sheeting, ASTM D 2103, Type 13300, 4 mils (0.1 mm) thick.

3. Mixes:
a. Underbed (for structural or unbonded rustic terrazzo): Structural-concrete underbed as specified in Division 03 Section "Cast-in-place Concrete".
b. Underbed (for bonded rustic terrazzo): Comply with NTMA's "Terrazzo Specifications and Design Guide" for component proportions and mixing.
1) Exterior Applications: Provide air-entraining agent.
c. Rustic Terrazzo (for NTMA-formulated design mixes): Comply with NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated for matrix and marble-chip proportions and mixing.
1) Formulated Mix Color and Pattern: As selected from NTMA rustic-terrazzo plates.
d. Rustic Terrazzo (for custom design mixes): Comply with NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated for matrix and marble-chip **OR** aggregate, **as directed**, proportions and mixing.
1) Custom Mix Color and Pattern: Match sample **OR** Match existing, **as directed**.

C. Strip Materials
1. Standard Divider Strips: One-piece, flat-type strips for grouting into sawed joints prepared in concrete slab or underbed.
a. Material: As indicated **OR** White-zinc alloy **OR** Brass, **as directed**.
b. Depth: As indicated **OR** 3/4 inch (19 mm) **OR** 1-1/4 inches (32 mm) **OR** 2 inches (51 mm), **as directed**.
c. Width: As indicated **OR** 0.05 inch (1.27 mm) **OR** 1/8 inch (3.2 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
2. Heavy-Top Divider Strips: One-piece, flat-type strips for grouting into sawed joints prepared in concrete slab or underbed.
a. Base-Section Material: As indicated **OR** White-zinc alloy **OR** Galvanized steel, **as directed**.
b. Top-Section Material: As indicated **OR** White-zinc alloy **OR** Brass **OR** Plastic, in color selected from manufacturer's full range, **as directed**.
c. Depth: As indicated **OR** 3/4 inch (19 mm) **OR** 1-1/4 inches (32 mm) **OR** 2 inches (51 mm), **as directed**.
d. Top-Section Width: As indicated **OR** 1/8 inch (3.2 mm) **OR** 1/4 inch (6.4 mm) **OR** 1/2 inch (12.7 mm), **as directed**.
3. Heavy-Top Angle Divider Strips: One-piece, L-type angle strips with anchoring device and in depth required for topping thickness indicated.
a. Material: As indicated **OR** White-zinc alloy **OR** Brass **OR** Plastic, in color selected from manufacturer's full range, **as directed**.
b. Top-Section Width: As indicated **OR** 1/8 inch (3.2 mm) **OR** 1/4 inch (6.4 mm) **OR** 3/8 inch (9.5 mm) **OR** 1/2 inch (12.7 mm), **as directed**.
4. Control-Joint Strips: Separate, double L-type angles, positioned back to back, that match material, thickness, and color of divider strips and in depth required for topping thickness indicated.

5. Expansion-Joint Strips (for structural portland cement terrazzo or for any type of rustic terrazzo): Brass **OR** Plastic strips in color selected from manufacturer's full range, **as directed**, with removable zip-strip top for installing sealant; in width indicated **OR** minimum 1/2 inch (12.7 mm) wide, **as directed**.
6. Accessory Strips: Match divider strip width, material, and color unless otherwise indicated. Use the following types of accessory strips as required to provide a complete installation:
   a. Base-bead strips for exposed top edge of terrazzo base.
   b. Edge-bead strips for exposed edges of terrazzo.
   c. Nosings for terrazzo stair treads and landings.
7. Abrasive Strips (for terrazzo stair treads and landings): Silicon carbide or aluminum oxide, or combination of both, in epoxy-resin binder and set in channel.
   a. Width: 1/2 inch (12.7 mm).
   b. Depth: As required by terrazzo thickness.
   c. Length: 4 inches (100 mm) less than stair width **OR** As indicated, **as directed**.
   d. Color: As selected from manufacturer's full range.

D. Miscellaneous Accessories
1. Strip Adhesive: Adhesive recommended by manufacturer for this use.
   a. Use adhesives that have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Anchoring Devices:
   a. Strips: Provide mechanical anchoring devices for strip materials as required for secure attachment to substrate.
   b. Precast Terrazzo: Provide mechanical anchoring devices as recommended by fabricator for proper anchorage and support of units for conditions of installation and support.
3. Isolation and Expansion-Joint Material: Closed-cell polyethylene foam, nonabsorbent to liquid water and gas, and nonoutgassing in unruptured state; butyl rubber; rubber; or cork; in width indicated **OR** minimum 1/2 inch (12.7 mm) wide, **as directed**.
4. Portland Cement Terrazzo Cleaner: Chemically neutral cleaner with pH factor between 7 and 10 that is biodegradable, phosphate free, and recommended by cleaner manufacturer for use on terrazzo type indicated.
5. Rustic Terrazzo Cleaner: Solution of muriatic acid and water for use on terrazzo type indicated.
6. Sealer: Slip- and stain-resistant, penetrating-type sealer that is chemically neutral with pH factor between 7 and 10; does not affect color or physical properties of terrazzo; is recommended by sealer manufacturer; and complies with NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated.
   a. Rustic Terrazzo: Use solvent acrylic-type sealer.

E. Precast Terrazzo
1. Precast Terrazzo Base Units: Minimum 3/4-inch- (19-mm-) thick, reinforced portland cement terrazzo units cast in maximum lengths possible, but not less than 36 inches (900 mm).
   a. Type: As indicated **OR** Coved with minimum 3/4-inch (19-mm) radius **OR** Straight **OR** Splayed, **as directed**.
   b. Top Edge: Straight, unfinished if top edge is concealed **OR** Beveled with polished top surface **OR** Radius edge with polished top surface, **as directed**.
   c. Metal Toe Strip (for coved-toe bases): Zinc **OR** Brass, **as directed**.
   d. Outside Corner Units: With finished returned edges at outside corner.
   e. Color, Pattern, and Finish: As selected from manufacturer's full range **OR** Match sample **OR** Match adjacent poured-in-place terrazzo flooring, **as directed**.
2. Precast Terrazzo Units for Stair Treads, Thresholds, Sills, Benches and Planters: Comply with NTMA's written recommendations for fabricating precast terrazzo units in sizes and profiles indicated. Reinforce units as required by unit sizes, profiles, and thicknesses and as recommended by manufacturer.
   a. Stair Treads: Three-line **OR** Two-line **OR** One-line **OR** Abrasive nosing strip and two-line, **as directed**, abrasive inserts at nosings.

b. Color, Pattern, and Finish: As selected from manufacturer's full range **OR** Match sample **OR** Match adjacent poured-in-place terrazzo flooring, **as directed**.

3. Precast Terrazzo Finishing (for custom precast terrazzo components):
   a. Finish exposed-to-view edges or reveals to match face finish.
   b. Ease exposed edges to 1/8-inch (3-mm) radius.

1.3 EXECUTION

A. Preparation

1. Clean substrates to produce clean, dry, and neutral substrate for terrazzo application.
   a. Remove substances, including oil, grease, and curing compounds, that might impair bond of terrazzo system.
   b. Roughen concrete substrates before installing terrazzo system according to NTMA's written recommendations.
2. Protect other work from dust generated by grinding operations. Control dust to prevent air pollution and comply with environmental protection regulations.
   a. Erect and maintain temporary enclosures and other suitable methods to limit dust migration and to ensure adequate ambient temperatures and ventilation conditions during installation.

B. Installation, General

1. Comply with NTMA's written recommendations for terrazzo and accessory installation.
2. Installation Tolerance: Limit variation in terrazzo surface from level to 1/4 inch in 10 feet (6 mm in 3 m); noncumulative.
3. Structural Portland Cement **OR** Structural Rustic **OR** Bonded Rustic **OR** Monolithic Rustic **OR** Unbonded Rustic, **as directed**, Terrazzo: Install isolation and expansion material where terrazzo and underbed abut **OR** terrazzo abuts, **as directed**, adjacent construction and directly above substrate expansion joints.
4. Underbed (for structural portland cement terrazzo or portland cement terrazzo installed over metal deck, or for structural or unbonded rustic terrazzo): Install structural-concrete underbed according to requirements specified in Division 03 Section "Cast-in-place Concrete".
5. Underbed (for sand-cushion or bonded portland cement terrazzo or for bonded rustic terrazzo):
   a. Comply with NTMA's "Terrazzo Specifications and Design Guide" for underbed installation.
   b. For sand-cushion portland cement terrazzo only:
      1) Cover entire surface to receive terrazzo with dusting of sand.
      2) Install isolation membrane over sand, overlapping ends and edges a minimum of 3 inches (75 mm).
      3) Install welded wire reinforcement, overlapping at edges and ends at least two squares. Stop mesh a minimum of 1 inch (25 mm) short of expansion joints.
   c. Place underbed and screed to elevation indicated below finished floor elevation.
6. Strip Materials:
   a. Divider and Control-Joint Strips:
      1) Locate divider strips over each edge of steel beams and girders **OR** centered over steel beams and joists **OR** directly over control joints, breaks, and saw cuts in concrete slabs **OR** in locations indicated, **as directed**.
      2) Install control-joint strips back to back and directly above concrete-slab control joints **OR** in locations indicated, **as directed**.
      3) Install control-joint strips with 1/4-inch (6.4-mm) gap between strips, and install sealant in gap.
      4) Install strips in adhesive setting bed without voids below strips, or mechanically anchor strips as required to attach strips to substrate, as recommended by strip manufacturer.
   b. Expansion-Joint Strips (for structural portland cement terrazzo or for any type of rustic terrazzo): Form expansion joints using divider strips and install directly above concrete-slab expansion joints.

c. Accessory Strips: Install accessory strips as required to provide a complete installation.
d. Abrasive Strips: Install with surface of abrasive strip positioned 1/16 inch (1.6 mm) **OR** 1/32 inch (0.8 mm), **as directed**, higher than terrazzo surface.

7. Repair: Cut out and replace terrazzo areas that evidence lack of bond with substrate or underbed, including areas that emit a "hollow" sound if tapped. Cut out terrazzo areas in panels defined by strips and replace to match adjacent terrazzo, or repair panels according to NTMA's written recommendations, as approved by the Owner.

C. Portland Cement Terrazzo Installation
1. Pour in place, cure, and finish portland cement terrazzo according to NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated.
2. Terrazzo Topping Thickness: As indicated.
3. Finishing:
a. Seed additional marble chips **OR** aggregates, **as directed**, in matrix to uniformly distribute granular material on surface.
b. Delay fine grinding until heavy trade work is complete and construction traffic through area is restricted.
c. Fine Grinding: Grind with stones 120 grit or finer until all grout is removed from surface. Repeat rough grinding, grout coat, and fine grinding if large voids exist after initial fine grinding. Produce surface with a minimum of 70 percent aggregate exposure.

D. Rustic Terrazzo Installation
1. Pour in place, cure, and finish rustic terrazzo according to NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated.
2. Terrazzo Topping Thickness: As indicated.
3. Finishing:
a. Seed additional marble chips **OR** aggregates, **as directed**, in matrix to uniformly distribute granular material on surface.

E. Precast Terrazzo Installation
1. Install precast terrazzo units using method recommended by NTMA and manufacturer unless otherwise indicated.
2. Installation Tolerance: Set units with alignment level and true to dimensions, varying 1/8 inch (3.2 mm) maximum in length, height, or width; noncumulative.
3. Do not install units that are chipped, cracked, discolored, or improperly finished.
4. Seal joints between units with cement grout matching precast terrazzo matrix **OR** joint sealant, **as directed**.

F. Cleaning And Protection
1. Portland Cement Terrazzo and Precast Terrazzo Cleaning:
a. Remove grinding dust from installation and adjacent areas.
b. Wash surfaces with cleaner immediately after grouting precast terrazzo units and final cleaning of terrazzo flooring.
c. Wash surfaces with cleaner according to NTMA's written recommendations and manufacturer's written instructions; rinse surfaces with water and allow to dry thoroughly.
2. Rustic Terrazzo Cleaning: Clean surfaces with 1:10 solution of muriatic acid in water. Legally contain and dispose of runoff from cleaning operations. Rinse surfaces with water and allow to dry thoroughly.
3. Sealing:
a. Seal surfaces according to NTMA's written recommendations.
b. Apply sealer according to sealer manufacturer's written instructions.
4. Protection: Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure that terrazzo is without damage or deterioration at time of Final Completion.

END OF SECTION 09 01 60 91

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Task	Specification	Specification Description
09 01 60 91	01 22 16 00	No Specification Required
09 01 60 91	07 91 23 00	Joint Sealants
09 01 60 91	09 68 16 00	Carpet
09 01 60 91	09 68 13 00	Carpet Tile
09 01 90 52	03 01 30 71	Concrete Rehabilitation
09 05 71 00	09 01 30 91	Ceramic Tile

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SECTION 09 22 13 13 - GYPSUM PLASTER

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for gypsum plaster. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Gypsum plasterwork on expanded-metal lath, unit masonry and monolithic concrete.
   b. Solid-plaster partitions.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
      1) Include statement indicating costs for each product having recycled content.
   b. Product Data for Credit EQ 4.1: For sealants, including printed statement of VOC content.
3. Shop Drawings: Show locations and installation of control and expansion joints including plans, elevations, sections, details of components, and attachments to other work.

D. Quality Assurance
1. Fire-Resistance Ratings: Where indicated, provide gypsum plaster assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   a. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
2. Sound Transmission Characteristics: Where indicated, provide gypsum plaster assemblies identical to those of assemblies tested for STC ratings per ASTM E 90 and classified according to ASTM E 413 by a qualified testing agency.

E. Delivery, Storage, And Handling
1. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.

F. Project Conditions
1. Comply with ASTM C 842 requirements or gypsum plaster manufacturer's written recommendations, whichever are more stringent.
2. Room Temperatures: Maintain temperatures at not less than 55 deg F (13 deg C) or greater than 80 deg F (27 deg C) for at least seven days before application of gypsum plaster, continuously during application, and for seven days after plaster has set or until plaster has dried.
3. Avoid conditions that result in gypsum plaster drying out too quickly.
   a. Distribute heat evenly; prevent concentrated or uneven heat on plaster.
   b. Maintain relative humidity levels for prevailing ambient temperature that produce normal drying conditions.
   c. Ventilate building spaces in a manner that prevents drafts of air from contacting surfaces during plaster application and until plaster is dry.

1.2 PRODUCTS

A. Steel Framing For Solid-Plaster Partitions
1. Components, General: Comply with ASTM C 841. For steel sheet components not included in ASTM C 841, comply with ASTM C 645 requirements for metal unless otherwise indicated.
2. Channel Studs: Cold-rolled channels, 3/4 inch (19.1 mm) **OR** 1-1/2 inches (38.1 mm), **as directed**, deep.
3. Runners: L-runners with perforated or plain legs to suit lath attachment requirements, in 0.033-inch (0.84-mm) base-metal thickness where attached to overhead support and in 0.043-inch (1.1-mm) base-metal thickness where attached to floor.

B. Expanded-Metal Lath
1. Expanded-Metal Lath: ASTM C 847, cold-rolled carbon-steel sheet, ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coated.
a. Recycled Content: Provide steel products with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
b. Paper Backing: Kraft paper factory bonded to back of lath.
c. Diamond-Mesh Lath: Flat **OR** Self-furring, **as directed**, 2.5 lb/sq. yd. (1.4 kg/sq. m) **OR** 3.4 lb/sq. yd. (1.8 kg/sq. m), **as directed**.
d. Flat Rib Lath: Rib depth of not more than 1/8 inch (3.1 mm), 2.75 lb/sq. yd. (1.5 kg/sq. m) **OR** 3.4 lb/sq. yd. (1.8 kg/sq. m), **as directed**.
e. 3/8-Inch (9.5-mm) Rib Lath: 3.4 lb/sq. yd. (1.8 kg/sq. m) **OR** 4 lb/sq. yd. (2.2 kg/sq. m), **as directed**.

C. Accessories
1. General: Comply with ASTM C 841 and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.
2. Metal Accessories:
a. Cornerite: Fabricated from expanded-metal lath with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.
b. Striplath: Fabricated from expanded-metal lath with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.
c. Cornerbeads: Fabricated from zinc or zinc-coated (galvanized) steel.
1) Small nose cornerbead with expanded flanges; use unless otherwise indicated.
2) Small nose cornerbead with perforated flanges; use on curved corners.
3) Small nose cornerbead with expanded flanges reinforced by perforated stiffening rib; use on columns and for finishing unit masonry corners.
4) Bull nose cornerbead, radius 3/4 inch (19.1 mm) minimum, with expanded flanges; use at locations indicated on Drawings.
d. Casing Beads: Fabricated from zinc or zinc-coated (galvanized) steel; square-edged style; with expanded flanges.
e. Control Joints: Fabricated from zinc or zinc-coated (galvanized) steel; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.
f. Expansion Joints: Fabricated from zinc or zinc-coated (galvanized) steel; folded pair of unperforated screeds in M-shaped configuration; with expanded flanges.
g. Two-Piece Expansion Joints: Fabricated from zinc or zinc-coated (galvanized) steel; formed to produce slip-joint and square-edged reveal that is adjustable from 1/4 to 5/8 inch (6 to 16 mm) wide; with perforated flanges.
3. Plastic Accessories: Fabricated from high-impact PVC.
a. Cornerbeads: With perforated flanges.
1) Small nose cornerbead; use unless otherwise indicated.
2) Bull nose cornerbead, radius 3/4 inch (19.1 mm) minimum; use at locations indicated on Drawings.

b. Casing Beads: With perforated flanges in depth required to suit plaster bases indicated and flange length required to suit applications indicated.
1) Square-edge style; use unless otherwise indicated.
2) Bull-nose style, radius 3/4 inch (19.1 mm) minimum; use at locations indicated on Drawings.
c. Control Joints: One-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.
d. Expansion Joints: Two-piece type, formed to produce slip-joint and square-edged 1/2-inch- (13-mm-) **OR** 1-inch- (25.4-mm-) **OR** 1-1/2-inch- (38.1-mm-), **as directed**, wide reveal; with perforated concealed flanges.
4. Aluminum Trim: Extruded accessories of profiles and dimensions indicated on Drawings.
a. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221 (ASTM B 221M), Alloy 6063-T5.
b. Finish: Mill **OR** Chemical-conversion coating, ASTM D 1730, Type B, compatible with field-applied finish coatings specified, **as directed**.

D. Miscellaneous Materials
1. Water for Mixing and Finishing Plaster: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.
2. Bonding Compound: ASTM C 631.
3. Steel Drill Screws: For metal-to-metal fastening, ASTM C 1002 or ASTM C 954, as required by thickness of metal being fastened; with pan head that is suitable for application; in lengths required to achieve penetration through joined materials of no fewer than three exposed threads.
4. Fasteners for Attaching Metal Lath to Substrates: Complying with ASTM C 841.
5. Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, not less than 0.0475-inch (1.21-mm) diameter, unless otherwise indicated.
6. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
a. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of rated assembly.
b. Recycled Content: Provide blankets with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 25 percent by weight.
7. Acoustical Sealant: As specified in Division 7 Section "Joint Sealants."
a. Provide sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Base-Coat Plaster Materials
1. Base-Coat Plasters, General: ASTM C 28/C 28M.
2. Lightweight Gypsum Ready-Mixed Plaster: With mill-mixed perlite aggregate.
3. Gypsum Neat Plaster: For use with job-mixed aggregates.
4. Gypsum Wood-Fibered Plaster:
5. High-Strength Gypsum Neat Plaster: With a minimum, average, dry compressive strength of 2800 psi (19 MPa) per ASTM C 472 for a mix of 100 lb (45 kg) of plaster and 2 cu. ft. (0.06 cu. m) of sand.
6. Aggregates for Base-Coat Plasters: ASTM C 35, sand and perlite.

F. Finish-Coat Plaster Materials
1. Gypsum Gaging Plaster: ASTM C 28/C 28M.
2. Gypsum Ready-Mixed Finish Plaster: Manufacturer's standard, mill-mixed, gaged, interior finish.
3. High-Strength Gypsum Gaging Plaster: ASTM C 28/C 28M, with a minimum, average, dry compressive strength of 5000 psi (34 MPa) per ASTM C 472 for a neat mix.
4. Gypsum Keene's Cement: ASTM C 61/C 61M.
5. Lime: ASTM C 206, Type S, special finishing hydrated lime.

6. Lime: ASTM C 206, Type N, normal finishing hydrated lime.
7. Aggregates for Float Finishes: ASTM C 35, sand **OR** perlite, **as directed**; graded per ASTM C 842.

G. Plaster Mixes
1. Mixing: Comply with ASTM C 842 and manufacturer's written instructions for applications indicated.

1.3 EXECUTION

A. Examination
1. Examine nonstructural and structural metal framing, substrates, and hollow-metal frames, for compliance with requirements and other conditions affecting performance of the Work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.

C. Installation, General
1. Fire-Resistance-Rated Assemblies: Install components according to requirements for design designations from listing organization and publication indicated on Drawings.
2. STC-Rated Assemblies: Install components according to requirements for design designations from listing organization and publication indicated on Drawings.
   a. Seal construction at perimeters, behind control and expansion joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations.
   b. Comply with ASTM C 919 and manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
3. Sound Attenuation Blankets: Where required, install blankets before installing lath unless blankets are readily installed after lath has been installed on one side.
4. Acoustical Sealant: Where required, seal joints between edges of plasterwork and abutting construction with acoustical sealant.

D. Installing Steel Framing For Solid-Plaster Partitions
1. Install according to ASTM C 841.
2. Framing for Solid-Plaster Partitions: Provide channel stud to support expanded-metal lath construction.
   a. Space channel studs at 16 inches (406 mm) **OR** 24 inches (610 mm), **as directed**, o.c. unless otherwise indicated.
3. Framing for Studless Solid-Plaster Partition: Provide top and bottom L-track runners to support expanded-metal lath.

E. Installing Expanded-Metal Lath
1. Expanded-Metal Lath: Install according to ASTM C 841.
   a. Partition Framing and Vertical Furring: Install flat diamond-mesh **OR** flat rib, **as directed**, lath.
   b. Flat-Ceiling and Horizontal Framing: Install flat diamond-mesh **OR** flat rib, **as directed**, lath.
   c. Curved-Ceiling Framing: Install flat diamond-mesh lath.
   d. On Solid Surfaces, Not Otherwise Furred: Install self-furring, diamond-mesh lath.
   e. Solid-Plaster Partitions: Where supported by channel studs, install flat rib **OR** flat diamond-mesh, **as directed**, lath.

f. Studless Solid-Plaster Partitions: Install 3/8-inch (9.5-mm) rib lath.

F. Installing Accessories
1. General: Install according to ASTM C 841.
2. Cornerbeads: Install at external corners.
3. Casing Beads: Install at terminations of plasterwork, except where plaster passes behind and is concealed by other work and where metal screeds, bases, or frames act as casing beads.
4. Control Joints: Install control joints at locations indicated on Drawings **OR** with spacing between joints in either direction not exceeding the following and in specific locations approved by Architect for visual effect, **as directed**:
a. Partitions: 30 feet (9 m).
b. Ceilings: 50 feet (15 m) **OR** 30 feet (9 m), **as directed**.

G. Plaster Application
1. General: Comply with ASTM C 842.
a. Do not deviate more than plus or minus 1/8 inch in 10 feet (3.1 mm in 3 m) from a true plane in finished plaster surfaces, as measured by a 10-foot (3-m) straightedge placed on surface.
b. Grout hollow-metal frames, bases, and similar work occurring in plastered areas, with base-coat plaster material, before lathing where necessary. Except where full grouting is indicated or required for fire-resistance rating, grout at least 6 inches (152 mm) at each jamb anchor.
c. Finish plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, cut base coat free from metal frame before plaster sets and groove finish coat at junctures with metal.
d. Provide plaster surfaces that are ready to receive field-applied finishes indicated.
2. Bonding Compound: Apply on unit masonry and concrete plaster bases.
3. Base Coats:
a. Base Coats over Expanded-Metal Lath: High-strength gypsum **OR** Gypsum neat, **as directed**, plaster with job-mixed sand for scratch and brown coats.
b. Base Coats over Expanded-Metal Lath:
1) Scratch Coat: Gypsum wood-fibered plaster; neat or with job-mixed sand.
2) Brown Coat: Gypsum wood-fibered plaster with job-mixed sand **OR** neat plaster with job-mixed sand **OR** lightweight ready-mixed plaster **OR** neat plaster with job-mixed perlite, **as directed**.
c. Base Coats over Unit Masonry: Gypsum wood-fibered plaster with job-mixed sand **OR** neat plaster with job-mixed sand **OR** lightweight ready-mixed plaster, **as directed**.
d. Base-Coat Mix over Monolithic Concrete: Gypsum neat plaster with job-mixed sand.
4. Finish Coats:
a. Finish-Coat Mix for Smooth-Troweled Finishes: Gypsum gaging plaster **OR** Gypsum ready-mixed finish plaster **OR** High-strength gypsum gaging plaster **OR** Gypsum Keene's cement, **as directed**.
b. Finish-Coat Mix for Float Finishes: Gypsum gaging plaster **OR** Gypsum Keene's cement, **as directed**.
c. Finish-Coat Mix for Sprayed Finishes: Gypsum ready-mixed finish plaster.
d. Finish-Coat Mix for Textured Finishes: Gypsum ready-mixed finish plaster.
5. Plaster Finishes:
a. Provide troweled finish unless otherwise indicated **OR** where indicated, **as directed**.
b. Provide float finish unless otherwise indicated **OR** where indicated, **as directed**.
c. Provide sprayed finish unless otherwise indicated **OR** where indicated, **as directed**.
1) Sprayed Finish: Match sample.
d. Provide textured finish where indicated.
1) Textured Finish: Match sample.
6. Concealed Plaster:

a. Where plaster application will be concealed behind built-in cabinets, similar furnishings, and equipment, apply finish coat.
b. Where plaster application will be concealed above suspended ceilings and in similar locations, finish coat may be omitted.
c. Where plaster application will be used as a base for adhesive application of tile and similar finishes, finish coat may be omitted.

H. Plaster Repairs
1. Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

I. Cleaning And Protection
1. Remove temporary protection and enclosure of other work. Promptly remove plaster from door frames, windows, and other surfaces not indicated to be plastered. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.

END OF SECTION 09 22 13 13

SECTION 09 22 13 13a - GYPSUM VENEER PLASTER

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for gypsum veneer plastering. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Gypsum veneer plaster and gypsum base for veneer plaster.
      b. Gypsum veneer plaster over cementitious backer units.
      c. Gypsum veneer plaster over masonry surfaces.
      d. Gypsum veneer plaster over monolithic concrete surfaces.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. Shop Drawings: Show locations, fabrication, and installation of control joints, and reveals and trim; include plans, elevations, sections, details of components, and attachments to other work.
   3. Samples: For the following products:
      a. Trim Accessories: Full-size Sample in 12-inch (300-mm) length for each trim accessory.
      b. Textured Finishes: Manufacturer's standard size for each textured finish and on rigid backing.
   4. LEED Submittals:
      a. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
      b. Product Data for Credit MR 4.1 and MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
         1) Include statement indicating costs for each product having recycled content.

D. Quality Assurance
   1. Source Limitations: Obtain gypsum veneer plaster products, including gypsum base for veneer plaster, **OR** cementitious base units, **as directed**, joint reinforcing tape, and embedding material, from a single manufacturer.
   2. Fire-Resistance-Rated Assemblies: Provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by a testing and inspecting agency.
   3. STC-Rated Assemblies: Provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by a testing and inspecting agency.

E. Delivery, Storage, And Handling
   1. Deliver materials in original packages, containers, and bundles bearing brand name and identification of manufacturer or supplier.
   2. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.
   3. Stack panels flat on leveled supports off floor or slab to prevent sagging.

F. Project Conditions
   1. Environmental Limitations: Comply with ASTM C 843 requirements or gypsum veneer plaster manufacturer's written recommendations, whichever are more stringent.

2. Room Temperatures: Maintain not less than 55 deg F (13 deg C) or more than 80 deg F (27 deg C) for 7 days before application of gypsum base and gypsum veneer plaster, continuously during application, and after application until veneer plaster is dry.
3. Avoid conditions that result in gypsum veneer plaster drying too rapidly.
   a. Distribute heat evenly; prevent concentrated or uneven heat on veneer plaster.
   b. Maintain relative humidity levels, for prevailing ambient temperature, that produce normal drying conditions.
   c. Ventilate building spaces in a manner that prevents drafts of air from contacting surfaces during veneer plaster application until it is dry.
4. Do not install panels that are wet, moisture damaged, or mold damaged.
   a. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
   b. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

1.2 PRODUCTS

A. Gypsum Veneer Plaster Materials
1. One-Component Gypsum Veneer Plaster: ASTM C 587, formulated for application directly over substrate without use of separate base-coat material.
2. High-Strength, One-Component Gypsum Veneer Plaster: ASTM C 587, ready-mixed, smooth, finish-coat veneer plaster containing mill-mixed, fine silica sand; with a compressive strength of 3000 psi (20 MPa) when tested according to ASTM C 472; and formulated for application directly over substrate without use of separate base-coat material.
3. Two-Component Gypsum Veneer Plaster: ASTM C 587, with separate formulations; one for base-coat and one for finish-coat application over substrates.
4. High-Strength, Two-Component Gypsum Veneer Plaster: ASTM C 587, ready-mixed, base-coat plaster and smooth finish-coat veneer plaster containing mill-mixed, fine silica sand; with a compressive strength of 3000 psi (20 MPa) when tested according to ASTM C 472.
5. Radiant-Heat, Two-Component Gypsum Veneer Plaster: ASTM C 587, and approved in writing by gypsum veneer plaster manufacturer for application with embedded electric heating cables.
   a. Provide ready-mixed **OR** job-aggregated, **as directed**, components, as standard for manufacturer, to comply with manufacturer's written recommendations.
   b. Aggregate: For job-aggregated base coat and texture finish coat, provide white silica sand passing a No. 30 (0.6-mm) sieve.

B. Panel Products
1. Recycled Content: Provide gypsum panel products with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 25 percent by weight.
2. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.
3. Gypsum Base for Veneer Plaster: ASTM C 588/C 588M.
   a. Regular Type: In thickness indicated **OR** 1/2 inch (13 mm) thick, unless otherwise indicated, **as directed**.
   b. Type X: In thickness indicated **OR** 5/8 inch (16 mm) thick, **as directed**.
   c. Foil-Backed, Regular-Type Core: In thickness indicated **OR** 1/2 inch (13 mm) thick, unless otherwise indicated, **as directed**.
   d. Type C: In thickness indicated **OR** 5/8 inch (16 mm) thick **OR** 1/2 inch (13 mm) thick, **as directed**.
   e. Abuse-Resistant Base: With specially reinforced core for greater resistance to surface indentation, 5/8-inch (16-mm) thick, Type X core **OR** 1/2-inch (13-mm) thick, regular-type core, **as directed**.

f. High-Impact Base: With Type X core, plastic film laminated to back side for greater resistance to through-penetration (impact resistance), and in thickness indicated **OR** 5/8 inch (16 mm) thick, **as directed**.
   1) Plastic-Film Thickness: 0.010 inch (0.254 mm) **OR** 0.020 inch (0.508 mm) **OR** 0.030 inch (0.762 mm) **OR** 0.081 inch (2.057 mm), **as directed**.
g. Moisture- and Mold-Resistant Base: With moisture- and mold-resistant core, glass-mat facing on both sides of panel, and in thickness indicated **OR** 5/8-inch (16-mm) thick, Type X core **OR** 1/2-inch (13-mm) thick, regular-type core, **as directed**.
   1) Mold Resistance: ASTM D 3273; no mold growth after four weeks' exposure.

4. Backing Panels for Multilayer Applications: ASTM C 588/C 588M gypsum base or ASTM C 36/C 36M gypsum board, as recommended by gypsum veneer plaster manufacturer, for application method and thicknesses indicated.
   a. Core: Matching face layer, unless otherwise indicated.
   b. Thickness: Matching face layer, unless otherwise indicated.
5. Cementitious Backer Units: ANSI A118.9, in thickness indicated **OR** 1/2 inch (13 mm) thick, **as directed**.

C. Trim Accessories
1. Standard Trim: ASTM C 1047, provided or approved by manufacturer for use in gypsum veneer plaster applications indicated.
   a. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet **OR** Galvanized or aluminum-coated steel sheet or rolled zinc **OR** Plastic **OR** Paper-faced galvanized steel sheet, **as directed**.
   b. Shapes:
      1) Cornerbead.
      2) Bullnose bead.
      3) LC-Bead: J-shaped; exposed long flange receives joint compound.
      4) L-Bead: L-shaped; exposed long flange receives joint compound.
      5) U-Bead: J-shaped; exposed short flange does not receive joint compound.
      6) Curved-Edge Cornerbead: With notched or flexible flanges.
      7) Control joints.
2. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
   a. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221 (ASTM B 221M), Alloy 6063-T5.
   b. Finish: Manufacturer's standard Architectural Class II, Clear Anodic Finish AA-M12C22A31, complying with AAMA 611 **OR** chemical conversion coat finish **OR** prime paint finish, **as directed**.

D. Joint Reinforcing Materials
1. General: Comply with joint strength requirements in ASTM C 587 and with gypsum veneer plaster manufacturer's written recommendations for each application indicated.
2. Joint Tape:
   a. Gypsum Base for Veneer Plaster: As recommended by gypsum veneer plaster manufacturer for applications indicated **OR** Paper **OR** Open-mesh, glass fiber, **as directed**.
   b. Cementitious Backer Units: As recommended by cementitious backer unit manufacturer.
3. Embedding Material for Joint Tape:
   a. Gypsum Base for Veneer Plaster: As recommended by gypsum veneer plaster manufacturer for use with joint-tape material and gypsum veneer plaster applications indicated.
   b. Cementitious Backer Units: As recommended by cementitious backer unit manufacturer for applications indicated.

E. Auxiliary Materials
1. General: Provide auxiliary materials that comply with referenced product standards and manufacturer's written recommendations.

2. Bonding Agent: ASTM C 631, polyvinyl acetate.
3. Laminating Adhesive: Adhesive or joint compound recommended by manufacturer for directly adhering gypsum base face-layer panels to backing-layer panels in multilayer construction.
    a. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
4. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
    a. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
5. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
6. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing), produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
    a. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
    b. Recycled Content: Provide blankets with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 25 percent by weight.
7. Acoustical Sealant: As specified in Division 07 Section "Thermal Insulation".
    a. Provide sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
8. Patching Mortar: Dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 (1.18-mm) sieve, using only enough water for handling and placing.

F. Gypsum Veneer Plaster Mixes
1. Mechanically mix gypsum veneer plaster materials to comply with ASTM C 843 and with gypsum veneer plaster manufacturer's written recommendations.

1.3 EXECUTION

A. Preparation
1. Monolithic Concrete Substrates: Prepare according to gypsum veneer plaster manufacturer's written recommendations and as follows:
    a. Clean surfaces to remove dust, loose particles, grease, oil, incompatible curing compounds, form-release agents, and other foreign matter and deposits that could impair bond with gypsum veneer plaster.
    b. Remove ridges and protrusions greater than 1/8 inch (3 mm) and fill depressions greater than 1/4 inch (6 mm) with patching mortar. Allow to set and dry.
    c. Apply bonding agent on dry and cured concrete substrates.
2. Masonry Substrates: Prepare according to gypsum veneer plaster manufacturer's written recommendations and as follows:
    a. Clean surfaces to remove dirt, grease, oil, and other foreign matter and deposits that could impair bond with gypsum veneer plaster.
    b. Apply bonding agent on dry masonry substrates.

B. Installing Panels, General
1. Gypsum Base for Veneer Plaster: Apply according to ASTM C 844 unless manufacturer's written recommendations are more stringent.
    a. Do not allow gypsum base to degrade from exposure to sunlight as evidenced by fading of paper facing.
    b. Erection Tolerance: No more than 1/16-inch (1.6-mm) offsets between planes of gypsum base panels, and 1/8 inch in 8 feet (3 mm in 2.4 m) noncumulative, for level, plumb, warp, and bow.

2. Install sound attenuation blankets before installing gypsum base for veneer plaster unless blankets are readily installed after panels have been installed on one side.
3. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
4. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.6 mm) of open space between panels. Do not force into place.
5. Locate edge and end joints over supports except in ceiling applications where intermediate supports or back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints, other than control joints, at corners of framed openings.
6. Attach panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
7. Attach panels to framing provided at openings and cutouts.
8. Form control joints with space between edges of adjoining panels.
9. Cover both sides of steel stud partition framing with panels in concealed spaces, including above ceilings, except in internally braced chases.
   a. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.74 sq. m) in area.
   b. Fit panels around ducts, pipes, and conduits.
   c. Where partitions intersect open concrete coffers, concrete joists, and other structural members projecting below underside of floor/roof slabs and decks, cut panels to fit profile formed by coffers, joists, and other structural members; allow 1/4- to 3/8-inch- (6.4- to 9.5-mm-) wide joints; seal joints with acoustical sealant.
10. Wood Framing: Install panels over wood framing, with "floating" internal corner construction. Do not attach panels across the flat grain of wide-dimension lumber, including floor joists and headers. "Float" panels over these members or provide control joints to counteract wood shrinkage.
11. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
12. Fastener Spacing: Comply with ASTM C 844, manufacturer's written recommendations, and fire-resistance-rating requirements.
   a. Space screws a maximum of 12 inches (305 mm) o.c. along framing members for wall or ceiling application.
   b. Space fasteners in cementitious backer units a maximum of 8 inches (200 mm) o.c. along framing members for wall applications and 6 inches (150 mm) o.c. along framing members for ceiling applications.

C. Installing Panels
1. Install gypsum base panels for veneer plaster in the following locations:
   a. Regular Type: As indicated on Drawings **OR** Vertical surfaces, unless otherwise indicated, **as directed**.
   b. Ceiling Type: As indicated on Drawings **OR** Ceiling surfaces, **as directed**.
   c. Type X: As indicated on Drawings **OR** Where required for fire-resistance-rated assembly **OR** Vertical surfaces, unless otherwise indicated, **as directed**.
   d. Type C: As indicated on Drawings **OR** Where required for specific fire-resistance-rated assembly indicated, **as directed**.
   e. Foil-Backed, Regular-Type Core: As indicated on Drawings **OR as directed**.
   f. Abuse-Resistant Base: As indicated on Drawings **OR as directed**.
   g. High-Impact Base: As indicated on Drawings **OR as directed**.
   h. Moisture- and Mold-Resistant Base: As indicated on Drawings **OR as directed**.
2. Single-Layer Application:

a. On ceilings, apply gypsum base panels before wall panels, to the greatest extent possible and at right angles to framing, unless otherwise indicated.
b. On walls, apply gypsum base panels vertically and parallel **OR** horizontally and perpendicular, **as directed**, to framing, unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 1) Stagger abutting end joints not less than one framing member in alternate courses of panels.
 2) At stairwells and other walls higher than 30 feet (9.0 m), install gypsum base panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
c. On Z-furring, apply gypsum base panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.

3. Multilayer Application on Ceilings: Apply backing panels for ceilings before applying backing panels for partitions; apply gypsum-base face layers in same sequence. Apply backing panels at right angles to framing members and offset gypsum-base face-layer joints a minimum of 16 inches (400 mm) from parallel backing panel joints, unless otherwise required by fire-resistance-rated assembly.
4. Multilayer Application on Partitions: Apply backing panels indicated and gypsum-base face layers vertically (parallel to framing) with joints of backing panels located over stud or furring members and gypsum-base face-layer joints offset at least one stud or furring member from backing-panel joints, unless otherwise required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
 a. Z-Furring: Apply backing panels vertically (parallel to framing) and gypsum-base face layer either vertically or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of backing panels over furring members.
5. Single-Layer Fastening Methods: Apply gypsum base panels to supports with steel drill screws.
6. Multilayer Fastening Methods: Fasten backing panels and gypsum-base face layers separately to supports with screws **OR** with screws; fasten gypsum-base face layers with adhesive and supplementary fasteners, **as directed**.
7. Curved Partitions: Comply with gypsum base manufacturer's written installation recommendations.
8. Cementitious Backer Units: Install according to ANSI A108.11.
 a. Where cementitious backer units abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

D. Installing Trim Accessories
1. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
2. Control Joints: Install at locations indicated on Drawings **OR** according to ASTM C 844 and in specific locations approved by the Owner, **as directed**.
3. Trim: Install in the following locations:
 a. Cornerbead: Use at outside corners, unless otherwise indicated.
 b. Bullnose Bead: Use at outside corners **OR** where indicated, **as directed**.
 c. LC-Bead: Use at exposed panel edges.
 d. L-Bead: Use where indicated.
 e. U-Bead: Use at exposed panel edges **OR** where indicated, **as directed**.
 f. Curved-Edge Cornerbead: Use at curved openings.
4. Aluminum Trim:
 a. Install aluminum trim according to manufacturer's written recommendations.
 b. Apply and embed joint tape over flanges of aluminum trim accessories if recommended by trim manufacturer.

E. Installing Joint Reinforcement

1. Gypsum Base for Veneer Plaster: Reinforce interior angles and flat joints with joint tape and embedding material to comply with ASTM C 843 and with gypsum veneer plaster manufacturer's written recommendations.
2. Abuse-Resistant Base: Reinforce joints between abuse-resistant panels with joint tape and embedding material according to panel manufacturer's written recommendations.
3. Impact-Resistant Base: Reinforce joints between impact-resistant panels with joint tape and embedding material according to panel manufacturer's written recommendations.
4. Moisture- and Mold-Resistant Base: Reinforce joints between moisture- and mold-resistant panels with joint tape and embedding material according to panel manufacturer's written recommendations.
5. Cementitious Backer Units: Reinforce joints between cementitious backer units with joint tape and embedding material according to unit manufacturer's written recommendations.

F. Gypsum Veneer Plastering
1. Bonding Agent: Apply bonding agent on dry monolithic concrete **OR** masonry **OR** abuse-resistant base panels **OR** cementitious backer units, **as directed**, according to gypsum veneer plaster manufacturer's written recommendations.
2. Gypsum Veneer Plaster Application: Comply with ASTM C 843 and with veneer plaster manufacturer's written recommendations.
   a. One-Component Gypsum Veneer Plaster: Trowel apply base coat over substrate to uniform thickness of 1/16 to 3/32 inch (1.6 to 2.4 mm). Fill all voids and imperfections. Allow plaster to set, then scratch and immediately double back with gypsum veneer plaster to uniform total thickness of 3/16 inch (4.8 mm).
   b. Two-Component Gypsum Veneer Plaster:
      1) Base Coat: Trowel apply base coat over substrate to uniform thickness of 1/16 to 3/32 inch (1.6 to 2.4 mm). Fill all voids and imperfections.
      2) Finish Coat: Trowel apply finish-coat plaster over base-coat plaster to uniform thickness of 1/16 to 3/32 inch (1.6 to 2.4 mm).
   c. Where gypsum veneer plaster abuts only metal door frames, windows, and other units, groove finish coat to eliminate spalling.
   d. Do not apply veneer plaster to gypsum base if paper facing has degraded from exposure to sunlight. Before applying veneer plaster, use remedial methods to restore bonding capability to degraded paper facing according to manufacturer's written recommendations and as approved by the Owner.
3. Radiant-Heat, Two-Component Gypsum Veneer Plaster Ceilings: Comply with ASTM C 843 and with radiant-heat veneer plaster manufacturer's written recommendations.
   a. Base Coat: Apply plaster base coat to sufficiently cover electric heating cables. Trowel plaster parallel in direction of cables to uniform thickness of 3/16 inch (4.8 mm). Completely cover cables.
   b. Finish Coat: After base coat has developed sufficient bond, apply finish coat. Trowel plaster to uniform thickness of 1/16 to 3/32 inch (1.6 to 2.4 mm).
4. Concealed Surfaces: Do not omit gypsum veneer plaster behind cabinets, furniture, furnishings, and similar removable items. Omit veneer plaster in the following areas where it will be concealed from view in the completed Work unless otherwise indicated or required to maintain fire-resistance and STC ratings:
   a. Above suspended ceilings.
   b. Behind wood paneling.
5. Gypsum Veneer Plaster Finish: Smooth-troweled finish, unless otherwise indicated **OR** Textured finish matching the Owner's sample, **as directed**.

G. Protection
1. Protect installed gypsum veneer plaster from damage from weather, condensation, construction, and other causes during remainder of the construction period.
2. Remove and replace gypsum veneer plaster and gypsum base panels that are wet, moisture damaged, or mold damaged.

a. Indications that gypsum base panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
b. Indications that gypsum base panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09 22 13 13a

SECTION 09 22 13 13b - PORTLAND CEMENT PLASTER

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for portland cement plaster. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Interior portland cement plasterwork on metal lath, unit masonry and monolithic concrete.
      b. Exterior portland cement plasterwork (stucco) on metal lath, unit masonry and monolithic concrete.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittals:
      a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
         1) Include statement indicating costs for each product having recycled content.
      b. Product Data for Credit EQ 4.1: For sealants, including printed statement of VOC content.
   3. Shop Drawings: Show locations and installation of control and expansion joints including plans, elevations, sections, details of components, and attachments to other work.
   4. Samples: For each type of factory-prepared, colored or textured finish coat indicated; 12 by 12 inches (305 by 305 mm), and prepared on rigid backing.

D. Quality Assurance
   1. Fire-Resistance Ratings: Where indicated, provide portland cement plaster assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
      a. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
   2. Sound-Transmission Characteristics: Where indicated, provide portland cement plaster assemblies identical to those of assemblies tested for STC ratings per ASTM E 90 and classified according to ASTM E 413 by a qualified testing agency.
   3. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
   1. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.

F. Project Conditions
   1. Comply with ASTM C 926 requirements.
   2. Interior Plasterwork: Maintain room temperatures at greater than 40 deg F (4.4 deg C) for at least 48 hours before plaster application, and continuously during and after application.
      a. Avoid conditions that result in plaster drying out during curing period. Distribute heat evenly; prevent concentrated or uneven heat on plaster.
      b. Ventilate building spaces as required to remove water in excess of that required for hydrating plaster in a manner that prevents drafts of air from contacting surfaces during plaster application and until plaster is dry.
   3. Exterior Plasterwork:

a. Apply and cure plaster to prevent plaster drying out during curing period. Use procedures required by climatic conditions, including moist curing, providing coverings, and providing barriers to deflect sunlight and wind.
b. Apply plaster when ambient temperature is greater than 40 deg F (4.4 deg C).
c. Protect plaster coats from freezing for not less than 48 hours after set of plaster coat has occurred.

4. Factory-Prepared Finishes: Comply with manufacturer's written recommendations for environmental conditions for applying finishes.

1.2 PRODUCTS

A. Metal Lath
1. Expanded-Metal Lath: ASTM C 847 with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.
   a. Recycled Content: Provide steel products with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
   b. Diamond-Mesh Lath: Flat **OR** Self-furring, **as directed**, 2.5 lb/sq. yd. (1.4 kg/sq. m) **OR** 3.4 lb/sq. yd. (1.8 kg/sq. m), **as directed**.
   c. Flat Rib Lath: Rib depth of not more than 1/8 inch (3.1 mm), 2.75 lb/sq. yd. (1.5 kg/sq. m) **OR** 3.4 lb/sq. yd. (1.8 kg/sq. m), **as directed**.
   d. 3/8-Inch (9.5-mm) Rib Lath: 3.4 lb/sq. yd. (1.8 kg/sq. m) **OR** 4 lb/sq. yd. (2.2 kg/sq. m), **as directed**.
2. Wire-Fabric Lath:
   a. Welded-Wire Lath: ASTM C 933; self-furring, 1.4 lb/sq. yd. (0.8 kg/sq. m) **OR** 1.95 lb/sq. yd. (1.1 kg/sq. m), **as directed**.
   b. Woven-Wire Lath: ASTM C 1032; self-furring, with stiffener wire backing, 1.1 lb/sq. yd. (0.6 kg/sq. m) **OR** 1.4 lb/sq. yd. (0.8 kg/sq. m), **as directed**.
3. Paper Backing: FS UU-B-790, Type I, Grade D, Style 2 vapor-permeable paper **OR** Grade B, Style 1a vapor-retardant paper, **as directed**.
   a. Provide paper-backed lath unless otherwise indicated **OR** at exterior locations **OR** in locations indicated on Drawings, **as directed**.

B. Accessories
1. General: Comply with ASTM C 1063 and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.
2. Metal Accessories:
   a. Foundation Weep Screed: Fabricated from hot-dip galvanized-steel sheet, ASTM A 653/A 653M, G60 (Z180) zinc coating.
   b. Cornerite: Fabricated from metal lath with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.
   c. External-Corner Reinforcement: Fabricated from metal lath with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.
   d. Cornerbeads: Fabricated from zinc or zinc-coated (galvanized) steel.
      1) Small nose cornerbead with expanded flanges; use unless otherwise indicated.
      2) Small nose cornerbead with perforated flanges; use on curved corners.
      3) Small nose cornerbead with expanded flanges reinforced by perforated stiffening rib; use on columns and for finishing masonry corners.
      4) Bull nose cornerbead, radius 3/4 inch (19.1 mm) minimum, with expanded flanges; use at locations indicated on Drawings.
   e. Casing Beads: Fabricated from zinc or zinc-coated (galvanized) steel; square-edged style; with expanded flanges.

f. Control Joints: Fabricated from zinc or zinc-coated (galvanized) steel; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.
g. Expansion Joints: Fabricated from zinc or zinc-coated (galvanized) steel; folded pair of unperforated screeds in M-shaped configuration; with expanded flanges.
h. Two-Piece Expansion Joints: Fabricated from zinc or zinc-coated (galvanized) steel; formed to produce slip-joint and square-edged reveal that is adjustable from 1/4 to 5/8 inch (6.34 to 16 mm) wide; with perforated flanges.

3. Plastic Accessories: Fabricated from high-impact PVC.
   a. Cornerbeads: With perforated flanges.
      1) Small nose cornerbead; use unless otherwise indicated.
      2) Bull nose cornerbead, radius 3/4 inch (19.1 mm) minimum; use at locations indicated on Drawings.
   b. Casing Beads: With perforated flanges in depth required to suit plaster bases indicated and flange length required to suit applications indicated.
      1) Square-edge style; use unless otherwise indicated.
      2) Bull-nose style, radius 3/4 inch (19.1 mm) minimum; use at locations indicated on Drawings.
   c. Control Joints: One-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.
   d. Expansion Joints: Two-piece type, formed to produce slip-joint and square-edged 1/2-inch- (13-mm-) **OR** 1-inch- (25-mm-) **OR** 1-1/2-inch- (38-mm-), **as directed**, wide reveal; with perforated concealed flanges.

C. Miscellaneous Materials
1. Water for Mixing: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.
2. Fiber for Base Coat: Alkaline-resistant glass or polypropylene fibers, 1/2 inch (13 mm) long, free of contaminants, manufactured for use in portland cement plaster.
3. Bonding Compound: ASTM C 932.
4. Steel Drill Screws: For metal-to-metal fastening, ASTM C 1002 or ASTM C 954, as required by thickness of metal being fastened; with pan head that is suitable for application; in lengths required to achieve penetration through joined materials of no fewer than three exposed threads.
5. Fasteners for Attaching Metal Lath to Substrates: Complying with ASTM C 1063.
6. Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, not less than 0.0475-inch (1.21-mm) diameter, unless otherwise indicated.
7. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
   a. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
   b. Recycled Content: Provide blankets with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 25 percent by weight.
8. Acoustical Sealant: As specified in Division 7 Section "Joint Sealants".
   a. Provide sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Plaster Materials
1. Portland Cement: ASTM C 150, Type I **OR** Type II, **as directed**.
   a. Color for Finish Coats: White **OR** Gray, **as directed**.
2. Masonry Cement: ASTM C 91, Type N.
   a. Color for Finish Coats: White **OR** Gray, **as directed**.
3. Plastic Cement: ASTM C 1328.
4. Colorants for Job-Mixed Finish Coats: Colorfast mineral pigments that produce finish plaster color to match sample.

5. Lime: ASTM C 206, Type S; or ASTM C 207, Type S.
6. Sand Aggregate: ASTM C 897.
   a. Color for Job-Mixed Finish Coats: White **OR** In color matching sample, **as directed**.
7. Perlite Aggregate: ASTM C 35.
8. Exposed Aggregates for Finish Coats: For marblecrete finish, clean, sound, crushed marble matching color and size gradation of sample.
9. Ready-Mixed Finish-Coat Plaster: Mill-mixed portland cement, aggregates, coloring agents, and proprietary ingredients.
   a. Color: As selected from manufacturer's full range.
10. Acrylic-Based Finish Coatings: Factory-mixed acrylic-emulsion coating systems, formulated with colorfast mineral pigments and fine aggregates; for use over portland cement plaster base coats. Include manufacturer's recommended primers and sealing topcoats for acrylic-based finishes.
    a. Color: As selected from manufacturer's full range.

E. Plaster Mixes
1. General: Comply with ASTM C 926 for applications indicated.
   a. Fiber Content: Add fiber to base-coat mixes after ingredients have mixed at least two minutes. Comply with fiber manufacturer's written instructions for fiber quantities in mixes, but do not exceed 1 lb of fiber/cu. yd. (0.6 kg of fiber/cu. m) of cementitious materials.
2. Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork as follows:
   a. Portland Cement Mixes:
      1) Scratch Coat: For cementitious material, mix 1 part portland cement and 0 to 3/4 **OR** 3/4 to 1-1/2, **as directed**, parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
      2) Brown Coat: For cementitious material, mix 1 part portland cement and 0 to 3/4 **OR** 3/4 to 1-1/2, **as directed**, parts lime. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.
   b. Masonry Cement Mixes:
      1) Scratch Coat: 1 part masonry cement and 2-1/2 to 4 parts aggregate.
      2) Brown Coat: 1 part masonry cement and 3 to 5 parts aggregate, but not less than volume of aggregate used in scratch coat.
   c. Portland and Masonry Cement Mixes:
      1) Scratch Coat: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
      2) Brown Coat: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.
   d. Plastic Cement Mixes:
      1) Scratch Coat: 1 part plastic cement and 2-1/2 to 4 parts aggregate.
      2) Brown Coat: 1 part plastic cement and 3 to 5 parts aggregate, but not less than volume of aggregate used in scratch coat.
   e. Portland and Plastic Cement Mixes:
      1) Scratch Coat: For cementitious material, mix 1 part plastic cement and 1 part portland cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
      2) Brown Coat: For cementitious material, mix 1 part plastic cement and 1 part portland cement. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.
3. Base-Coat Mixes: Single base coats for two-coat plasterwork as follows:
   a. Portland Cement Mix: For cementitious material, mix 1 part portland cement and 0 to 3/4 part lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
   b. Portland and Masonry Cement Mix: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
   c. Plastic Cement Mix: Use 1 part plastic cement and 2-1/2 to 4 parts aggregate.

4. Base-Coat Mixes: Single base coats for two-coat plasterwork as follows:
   a. Portland Cement Mix: For cementitious material, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
   b. Masonry Cement Mix: Use 1 part masonry cement and 2-1/2 to 4 parts aggregate.
   c. Plastic Cement Mix: Use 1 part plastic cement and 2-1/2 to 4 parts aggregate.
5. Job-Mixed Finish-Coat Mixes:
   a. Portland Cement Mix: For cementitious materials, mix 1 part portland cement and 3/4 to 1-1/2 **OR** 1-1/2 to 2, **as directed**, parts lime. Use 1-1/2 to 3 parts aggregate per part of cementitious material.
   b. Masonry Cement Mix: 1 part masonry cement and 1-1/2 to 3 parts aggregate.
   c. Portland and Masonry Cement Mix: For cementitious materials, mix 1 part portland cement and 1 part masonry cement. Use 1-1/2 to 3 parts aggregate per part of cementitious material.
   d. Plastic Cement Mix: 1 part plastic cement and 1-1/2 to 3 parts aggregate.
6. Factory-Prepared Finish-Coat Mixes: For ready-mixed finish-coat plasters or acrylic-based finish coatings, comply with manufacturer's written instructions.

1.3 EXECUTION

A. Examination
   1. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
   2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
   1. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.
   2. Prepare solid substrates for plaster that are smooth or that do not have the suction capability required to bond with plaster according to ASTM C 926.

C. Installation, General
   1. Fire-Resistance-Rated Assemblies: Install components according to requirements for design designations from listing organization and publication indicated on Drawings.
   2. Sound Attenuation Blankets: Where required, install blankets before installing lath unless blankets are readily installed after lath has been installed on one side.
   3. Acoustical Sealant: Where required, seal joints between edges of plasterwork and abutting construction with acoustical sealant.

D. Installing Metal Lath
   1. Expanded-Metal Lath: Install according to ASTM C 1063.
      a. Partition Framing and Vertical Furring: Install flat diamond-mesh **OR** flat rib **OR** welded-wire **OR** woven-wire, **as directed**, lath.
      b. Flat-Ceiling and Horizontal Framing: Install flat diamond-mesh **OR** flat rib **OR** 3/8-inch (9.5-mm) rib lath **OR** welded-wire **OR** woven-wire, **as directed**, lath.
      c. Curved-Ceiling Framing: Install flat diamond-mesh **OR** welded-wire **OR** flat woven-wire, **as directed**, lath.
      d. On Solid Surfaces, Not Otherwise Furred: Install self-furring, diamond-mesh **OR** welded-wire **OR** woven-wire, **as directed**, lath.

E. Installing Accessories
   1. Install according to ASTM C 1063 and at locations indicated on Drawings.
   2. Reinforcement for External Corners:
      a. Install lath-type, external-corner reinforcement at exterior locations.
      b. Install cornerbead at interior and exterior, **as directed**, locations.

3. Control Joints: Install control joints at locations indicated on Drawings **OR** in specific locations approved for visual effect as follows, **as directed**:
   a. As required to delineate plasterwork into areas (panels) of the following maximum sizes:
      1) Vertical Surfaces: 144 sq. ft. (13.4 sq. m).
      2) Horizontal and other Nonvertical Surfaces: 100 sq. ft. (9.3 sq. m).
   b. At distances between control joints of not greater than 18 feet (5.5 m) o.c.
   c. As required to delineate plasterwork into areas (panels) with length-to-width ratios of not greater than 2-1/2:1.
   d. Where control joints occur in surface of construction directly behind plaster.
   e. Where plasterwork areas change dimensions, to delineate rectangular-shaped areas (panels) and to relieve the stress that occurs at the corner formed by the dimension change.

F. Plaster Application
1. General: Comply with ASTM C 926.
   a. Do not deviate more than plus or minus 1/4 inch in 10 feet (6.4 mm in 3 m) from a true plane in finished plaster surfaces, as measured by a 10-foot (3-m) straightedge placed on surface.
   b. Finish plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, cut base coat free from metal frame before plaster sets and groove finish coat at junctures with metal.
   c. Provide plaster surfaces that are ready to receive field-applied finishes indicated.
2. Bonding Compound: Apply on unit masonry and concrete plaster bases.
3. Walls; Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork, on masonry or on concrete; 3/4-inch (19-mm) thickness.
   a. Portland cement mixes.
   b. Masonry cement mixes.
   c. Portland and masonry cement mixes.
   d. Plastic cement mixes.
   e. Portland and plastic cement mixes.
4. Ceilings; Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork; 1/2 inch (13 mm) thick **OR** 3/4 inch (19 mm) thick on concrete, **as directed**.
   a. Portland cement mixes.
   b. Masonry cement mixes.
   c. Portland and masonry cement mixes.
   d. Plastic cement mixes.
   e. Portland and plastic cement mixes.
5. Walls; Base-Coat Mix: Scratch coat for two-coat plasterwork, 3/8 inch (10 mm) thick on concrete masonry **OR** 1/4 inch (6 mm) thick on concrete, **as directed**.
   a. Portland cement mixes.
   b. Masonry cement mixes.
   c. Portland and masonry cement mixes.
   d. Plastic cement mixes.
   e. Portland and plastic cement mixes.
6. Ceilings; Base-Coat Mix: Scratch coat for two-coat plasterwork, 1/4 inch (6 mm) thick on concrete.
   a. Portland cement mixes.
   b. Masonry cement mixes.
   c. Portland and masonry cement mixes.
   d. Plastic cement mixes.
   e. Portland and plastic cement mixes.
7. Plaster Finish Coats: Apply to provide float **OR** dash **OR** scraped trowel-textured **OR** skip trowel-textured **OR** brocade (knock-down dash) **OR** trowel sweep **OR** combed **OR** sacked (California mission) **OR** English **OR** marblecrete, **as directed**, finish to match sample.

8. Acrylic-Based Finish Coatings: Apply coating system, including primers, finish coats, and sealing topcoats, according to manufacturer's written instructions.
9. Concealed Exterior Plasterwork: Where plaster application will be used as a base for adhered finishes, omit finish coat.
10. Concealed Interior Plasterwork:
    a. Where plaster application will be concealed behind built-in cabinets, similar furnishings, and equipment, apply finish coat.
    b. Where plaster application will be concealed above suspended ceilings and in similar locations, finish coat may be omitted.
    c. Where plaster application will be used as a base for adhesive application of tile and similar finishes, omit finish coat.

G. Plaster Repairs
1. Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

H. Protection
1. Remove temporary protection and enclosure of other work. Promptly remove plaster from door frames, windows, and other surfaces not indicated to be plastered. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.

END OF SECTION 09 22 13 13b

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Task	Specification	Specification Description
09 22 13 23	09 22 13 13	Gypsum Plaster
09 22 13 23	09 22 13 13a	Gypsum Veneer Plaster
09 22 13 23	09 22 13 13b	Portland Cement Plaster

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SECTION 09 22 16 13 - NON-LOAD-BEARING STEEL FRAMING

1.1 GENERAL

A. Description Of Work
  1. This specification covers the furnishing and installation of materials for non-load bearing steel framing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
  1. This Section includes non-load-bearing steel framing members for the following applications:
    a. Interior framing systems (e.g., supports for partition walls, framed soffits, furring, etc.).
    b. Interior suspension systems (e.g., supports for ceilings, suspended soffits, etc.).

C. Submittals
  1. Product Data: For each type of product indicated.
  2. LEED Submittal:
    a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
      1) Include statement indicating costs for each product having recycled content.

D. Quality Assurance
  1. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
  2. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

1.2 PRODUCTS

A. Non-Load-Bearing Steel Framing, General
  1. Recycled Content of Steel Products: Provide products with average recycled content of steel products such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
  2. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
    a. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.
    b. Protective Coating: ASTM A 653/A 653M, G40 (Z120) **OR** ASTM A 653/A 653M, G60 (Z180) **OR** Coating with equivalent corrosion resistance of ASTM A 653/A 653M, G40 (Z120), **as directed**, hot-dip galvanized, unless otherwise indicated.

B. Suspension System Components
  1. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- (1.59-mm-) diameter wire, or double strand of 0.0475-inch- (1.21-mm-) diameter wire.
  2. Hanger Attachments to Concrete:
    a. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.

1) Type: Cast-in-place anchor, designed for attachment to concrete forms **OR** Postinstalled, chemical anchor **OR** Postinstalled, expansion anchor, **as directed**.

b. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.

3. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch (4.12-mm) diameter.
4. Flat Hangers: Steel sheet, in size indicated on Drawings **OR** 1 by 3/16 inch (25.4 by 4.76 mm) by length indicated, **as directed**.
5. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch (1.37 mm) and minimum 1/2-inch- (12.7-mm-) wide flanges.
   a. Depth: As indicated on Drawings **OR** 2-1/2 inches (64 mm) **OR** 2 inches (51 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
6. Furring Channels (Furring Members):
   a. Cold-Rolled Channels: 0.0538-inch (1.37-mm) bare-steel thickness, with minimum 1/2-inch- (12.7-mm-) wide flanges, 3/4 inch (19.1 mm) deep.
   b. Steel Studs: ASTM C 645.
      1) Minimum Base-Metal Thickness: As indicated on Drawings **OR** 0.0179 inch (0.45 mm) **OR** 0.0312 inch (0.79 mm), **as directed**.
      2) Depth: As indicated on Drawings **OR** 1-5/8 inches (41.3 mm) **OR** 2-1/2 inches (63.5 mm) **OR** 3-5/8 inches (92.1 mm), **as directed**.
   c. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch (22.2 mm) deep.
      1) Minimum Base Metal Thickness: As indicated on Drawings **OR** 0.0179 inch (0.45 mm) **OR** 0.0312 inch (0.79 mm), **as directed**.
   d. Resilient Furring Channels: 1/2-inch- (12.7-mm-) deep members designed to reduce sound transmission.
      1) Configuration: Asymmetrical **OR** Hat shaped, **as directed**.
7. Grid Suspension System for Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.

C. Steel Framing For Framed Assemblies

1. Steel Studs and Runners: ASTM C 645.
   a. Minimum Base-Metal Thickness: As indicated on Drawings **OR** 0.0179 inch (0.45 mm) **OR** 0.027 inch (0.7 mm) **OR** 0.0312 inch (0.79 mm), **as directed**.
   b. Depth: As indicated on Drawings **OR** 3-5/8 inches (92.1 mm) **OR** 6 inches (152.4 mm) **OR** 4 inches (101.6 mm) **OR** 2-1/2 inches (63.5 mm) **OR** 1-5/8 inches (41.3 mm), **as directed**.
2. Slip-Type Head Joints: Where indicated, provide one of the following:
   a. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch- (50.8-mm-) deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches (305 mm) of the top of studs to provide lateral bracing.
   b. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch- (50.8-mm-) deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
   c. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
3. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
4. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
   a. Minimum Base-Metal Thickness: As indicated on Drawings **OR** 0.0179 inch (0.45 mm) **OR** 0.027 inch (0.7 mm) **OR** 0.0312 inch (0.79 mm), **as directed**.

5. Cold-Rolled Channel Bridging: 0.0538-inch (1.37-mm) bare-steel thickness, with minimum 1/2-inch- (12.7-mm-) wide flanges.
   a. Depth: As indicated on Drawings **OR** 1-1/2 inches (38.1 mm), **as directed**.
   b. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38.1 by 38.1 mm), 0.068-inch- (1.73-mm-) thick, galvanized steel.
6. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
   a. Minimum Base Metal Thickness: As indicated on Drawings **OR** 0.0179 inch (0.45 mm) **OR** 0.0312 inch (0.79 mm), **as directed**.
   b. Depth: As indicated on Drawings **OR** 7/8 inch (22.2 mm) **OR** 1-1/2 inches (38.1 mm), **as directed**.
7. Resilient Furring Channels: 1/2-inch- (12.7-mm-) deep, steel sheet members designed to reduce sound transmission.
   a. Configuration: Asymmetrical **OR** Hat shaped, **as directed**.
8. Cold-Rolled Furring Channels: 0.0538-inch (1.37-mm) bare-steel thickness, with minimum 1/2-inch- (12.7-mm-) wide flanges.
   a. Depth: As indicated on Drawings **OR** 3/4 inch (19.1 mm), **as directed**.
   b. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum bare-steel thickness of 0.0312 inch (0.79 mm).
   c. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- (1.59-mm-) diameter wire, or double strand of 0.0475-inch- (1.21-mm-) diameter wire.
9. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (31.8 mm), wall attachment flange of 7/8 inch (22.2 mm), minimum bare-metal thickness of 0.0179 inch (0.45 mm), and depth required to fit insulation thickness indicated.

D. Auxiliary Materials
1. General: Provide auxiliary materials that comply with referenced installation standards.
   a. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
2. Isolation Strip at Exterior Walls: Provide one of the following:
   a. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.
   b. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch (3.2 mm) thick, in width to suit steel stud size.

1.3 EXECUTION

A. Preparation
1. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
   a. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.
2. Coordination with Sprayed Fire-Resistive Materials:
   a. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches (600 mm) o.c.
   b. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

B. Installation, General
1. Installation Standard: ASTM C 754, except comply with framing sizes and spacing indicated.

a. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.
b. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
c. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
d. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

2. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
3. Install bracing at terminations in assemblies.
4. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

C. Installing Suspension Systems

1. Install suspension system components in sizes and spacings indicated on Drawings, but not less than those required by referenced installation standards for assembly types and other assembly components indicated.
2. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
3. Suspend hangers from building structure as follows:
   a. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
      1) Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   b. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
      1) Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
   c. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
   d. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
   e. Do not attach hangers to steel roof deck.
   f. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
   g. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
   h. Do not connect or suspend steel framing from ducts, pipes, or conduit.
4. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
5. Seismic Bracing: Sway-brace suspension systems with hangers used for support.
6. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
7. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

D. Installing Framed Assemblies

1. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

2. Install studs so flanges within framing system point in same direction.
    a. Space studs as follows:
        1) Single-Layer Application: 16 inches (406 mm) **OR** 24 inches (610 mm) **OR** 400 mm **OR** 600 mm, **as directed**, o.c., unless otherwise indicated.
        2) Multilayer Application: 16 inches (406 mm) **OR** 24 inches (610 mm) **OR** 400 mm **OR** 600 mm, **as directed**, o.c., unless otherwise indicated.
        3) Tile backing panels: 16 inches (406 mm) **OR** 400 mm, **as directed**, o.c., unless otherwise indicated.
3. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
    a. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
    b. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
        1) Install two studs at each jamb, unless otherwise indicated.
        2) Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (12.7-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
        3) Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
    c. Other Framed Openings: Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
    d. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
        1) Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
    e. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
    f. Curved Partitions:
        1) Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
        2) Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of not less than 2 studs at ends of arcs, place studs 6 inches (150 mm) o.c.
4. Direct Furring:
    a. Screw to wood framing.
    b. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.
5. Z-Furring Members:
    a. Erect insulation (specified in Division 7 Section "Building Insulation") vertically and hold in place with Z-furring members spaced 24 inches (610 mm) **OR** 600 mm, **as directed**, o.c.
    b. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (600 mm) o.c.
    c. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches (300 mm) from corner and cut insulation to fit.
6. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

END OF SECTION 09 22 16 13

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Task	Specification	Specification Description
09 22 36 13	09 22 13 13	Gypsum Plaster
09 22 36 13	09 22 13 13a	Gypsum Veneer Plaster
09 22 36 13	09 22 13 13b	Portland Cement Plaster

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SECTION 09 22 36 23 - LATH AND PLASTER RENOVATION

GENERAL

Description Of Work

1. This specification covers the furnishing and installation of materials for lath and plaster renovation. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

Quality Assurance

2. Regulatory Requirements:
   a. Plaster Partitions: Listed and labeled for fire-protective ratings as indicated or scheduled.
   b. Plaster Floor/Ceilings and Roof/Ceiling Assemblies: Listed and labeled for fire-protective ratings as indicated or scheduled.
   c. Fire Rated Assemblies: Comply with UL 05, FM P8016, or GA 600 for required fire-rated assembly.

Submittals

3. Product Data: Submit in accordance with Detailed Scope of Work. Include each type of plaster material, metal lath. and lathing accessories to be installed.

Delivery, Storage, And Handling

4. General:
   a. Plastering Materials: Deliver in original unopened containers and store off ground and under cover.
   b. Metal Lath and Accessories: Protect from rusting during storage.
   c. Rusted or Water Damaged Materials: Subject to rejection before or after installation.

Project Conditions

5. Environmental Requirements: Comply with Detailed Scope of Work.
   a. Cold-Weather Protection: Do not apply plaster if ambient temperature is less than 4 degrees C (40 degrees F) or more than 26 degrees C (80 degrees F). Maintain this temperature range in all areas 7 days prior to application, during application, and for 7 days after plaster is set.
   b. Hot-Weather Protection: Protect plaster against uneven or excessive evaporation during dry, hot weather and from strong blasts of dry air, either natural or artificial.
   c. Ventilation: Ventilate building spaces as required to remove water in excess of that required for hydration of plaster. Begin ventilation immediately after plaster is applied and continue until it sets.
6. Existing Conditions: See Division 1 Section “Summary of Work”. Do not interfere with use of occupied buildings or portions of buildings. Maintain free and safe passage to and from occupied areas.
7. Protection: Protect grounds, plantings, buildings, and any other facilities or property from damage caused by construction operations.

Scheduling And Sequencing

8. Scheduling and Completion: Comply with Detailed Scope of Work.
   a. Sequence plaster application with installation and protection of other work so that neither will be damaged by installation of other.

PRODUCTS

Materials

9. Materials for Patching, Extending, and Matching:
    a. Provide same products or types of construction as existing structure, as needed to patch, extend, or match existing work.
        1) Generally, Contract Documents will not define products or standards of workmanship present in existing construction. Determine products by inspection and any necessary testing, and workmanship by use of existing as sample of comparison.
        2) Patching, extending, and matching of existing work and systems shall result in complete, finished system.
    b. Presence of product, finish, or type of construction, requires that patching, extending, or matching shall be performed as necessary to make work complete and consistent.
10. Partition Metals: ASTM C 645, galvanized steel:
    a. Interior Steel Studs: Minimum 0.46 mm (25 gage), provide sizes and gages to match existing, or as indicated.
        1) Provide minimum of 0.84 mm (20 gage) studs both sides of hollow metal frames.
    b. Steel Stud Runners: Match studs. Provide long leg runners for slip joint at structure above to allow for deflection.
    c. Furring Channels: Hat-shaped furring channels, minimum 0.46 mm (25 gage).
    d. Sheet Metal Reinforcement (Alternate to Wood Blocking): 1.52 mm (16 gage) minimum.
11. Suspended Ceiling Metals:
    a. Main Runners (Primary Members): ASTM C 754 cold-rolled steel channels with rust-inhibitive finish.
        1) 50 mm (2 inches) deep, 88 kg per 100 m (590 pounds per 1,000 LF).
        2) 38 mm (1-1/2 inch) deep, 70 kg per 100 m (475 pounds per 1,000 LF).
        3) 19 mm (3/4 inch) deep, 45 kg per 100 m (300 pounds per 1,000 LF).
    b. Cross Furring (Furring Channels): Hat-shaped galvanized steel furring channels, minimum 0.46 mm (25 gage).
    c. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft temper.
        1) Hanger Wire: Minimum 4.1 mm (8 gage).
        2) Tie Wire: 6 mm (16 gage).
12. Lath:
    a. Metal Lath: ASTM C 847, galvanized expanded metal.
        1) Weight: In compliance with ASTM C 841 for conditions and spacing of supports.
    b. Gypsum Lath: ASTM C 37, plain. Provide Type X at fire-rated assemblies.
        1) Thickness: As indicated or specified and in compliance with ASTM C 841 for conditions and spacing of supports.
13. Fasteners:
    a. Screws: ASTM C 1002, corrosion-resistant. Provide types as recommended by manufacturer for each application.
        1) To Metal Framing: Minimum 25 mm (1 inch), Type S.
        2) To Wood Framing: Minimum 32 mm (1-1/4 inch), Type W bugle head.
14. Accessories: ASTM C 841, galvanized steel.
    a. Comer Beads: Small nose with expanded flanges, unless otherwise indicated.
    b. Casing Beads: Square-edged style. with short or expanded flanges to suit kinds of plaster bases indicated.
    c. Control Joints: Prefabricated folded pair of non-perforated screeds in M-shaped configuration, with expanded or perforated flanges.
        1) Provide removable protective tape on plaster face of control joints.
    d. Cornerite: Galvanized expanded metal lath in accordance with ASTM C 841.
15. Gypsum Plaster Materials: ASTM C 28.
    a. Base Coat Plasters: One of following:
        1) Gypsum ready-mixed plaster with mill-mixed perlite aggregate.
        2) Gypsum wood-fibered plaster, ASTM C 28, Type N.
    b. Finish Coat Plasters: One of following:

1) Gypsum ready-mixed finished plaster, manufacturers standard mill-mixed gauged interior finish.
2) Gypsum Gauging Plaster: ASTM C 28, Type G.

c. Quicklime: ASTM C 5.
d. Sand: ASTM C 35.
e. Finishing Hydrated Limes: ASTM C 206, Type S, special hydrated lime for finishing purposes.
f. Bonding Compound for Gypsum Plaster: ASTM C 631.
g. Water: Clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or substances that may be deleterious to plaster or metals in contact with plaster.

16. Sound-Isolation Materials:
    a. Sound Insulation: ASTM C 665, Type I (unfaced) mineral-fiber blankets, 12 to 16 kg per cu m (0.75 to 1 PCF), thickness as indicated or scheduled, or required by fire-rated assembly.
    b. Acoustical Sealant:
        1) Concealed: ASTM C 919 nondrying, non-hardening, non-skinning, non-bleeding, and non-staining.
        2) Exposed: ASTM C 919 non-oxidizing and skinning, permanently elastic, and paintable.
    c. Ductwork Penetrations Packing: Low-density fiberglass.
17. Gypsum Plaster Mixes: As recommended by manufacturer:
    a. Scratch Coat:
        1) Over Metal Lath: Gypsum wood-fibered plaster, neat or with job-mixed sand.
        2) Over Gypsum Lath: Gypsum neat plaster with job-mixed sand.
        3) Over Unit Masonry: Gypsum wood-fibered plaster, neat or with job-mixed sand.
    b. Brown Coat:
        1) Over Metal Lath: Gypsum wood-fibered plaster, with job-mixed sand.
        2) Over Gypsum Lath: Gypsum neat plaster with job-mixed sand.
        3) Over Unit Masonry: Gypsum wood-fibered plaster with job-mixed sand.
    c. Finish Coat: Proportion materials for finish coats to comply with ASTM C 842 for each type of finish coat and texture indicated.
        1) Gypsum Gauging Plaster 1 part plaster and 2 parts lime.
            a) Over lightweight aggregate base coats, add 15 L (1/2 cubic foot) of perlite fines or 23 kg (50 pounds) of No. 1 white silica sand per 45 kg (100 pounds) of plaster.
        2) Gypsum Ready-mixed Finish Plaster Neat.
    d. Mechanically mix cementitious and aggregate materials for plasters to comply with applicable referenced application standard and with recommendations of plaster manufacturer.

EXECUTION

Examination

18. Units, Spaces, and Areas to be renovated: Comply with Detailed Scope of Work.
    a. Verify that surfaces to receive rough carpentry are prepared to required grades and dimensions.

Preparation

19. Dust Protection: Comply with Detailed Scope of Work.
20. Building Occupation: Carry out demolition and renovation work to cause as little inconvenience to occupants as possible. See Detailed Scope of Work.
21. Protection: Comply with Detailed Scope of Work.
    a. Protection: Provide drapes and drop cloths necessary to protect walls, floors, ductwork and piping, electrical work, etc. during plastering operations.
22. Selective Demolition: Comply with Detailed Scope of Work.

23. Surface Preparation: Clean projections, dust, loose particles, grease, bond breakers, and foreign matter from surfaces to receive plaster.
    a. Do not apply plaster directly to surfaces (1) of masonry or concrete that have been coated with bituminous compound or other waterproofing agents, or (2) that have been painted or previously plastered.
    b. Before plaster work is started, wet masonry and concrete surfaces thoroughly with fine fog spray of clean water to produce uniformly moist surface.
    c. Do not apply plaster to surfaces containing frost.

Laying-Out Work

24. Discrepancies: Verify dimensions and elevations indicated in layout of existing work.
    a. Prior to commencing work, carefully compare and check Drawings (if any) for discrepancies in locations or elevations of work to be executed.
    b. Refer discrepancies among Drawings (if any), Specifications, and existing conditions to the Owner for adjustment before work affected is performed.
        1) Failure to make such notification shall place responsibility on Contractor to carry out work in satisfactory, workmanlike manner.
25. Contractor: Responsible for location and elevation of construction contemplated by Construction Documents.

Performance

26. Patching: Patch and extend existing work using skilled mechanics who are capable of matching existing quality of workmanship.
    a. Quality of Patched or Extended Work: Not less than specified for new work. If similar new work is not specified, equal to existing work.
27. Damaged Surfaces: Comply with Detailed Scope of Work.
28. Transitions from Existing to New Work: Comply with Detailed Scope of Work.
29. Isolation: Where lathing and metal support system abuts building structure horizontally and where partition/wall work abuts overhead structure, isolate work from structural movement sufficiently to prevent transfer of loads to work from building structure. Install slip or cushion-type joints to absorb deflections but maintain lateral support.
    a. Frame both sides of control and expansion joints independently, and do not bridge joints with furring and lathing or accessories.

Installation Of Suspended Steel Framing

30. General: Construct ceilings of lath and plaster on suspended steel framing system in accordance with manufacturer's recommendations and Reference Standards.
31. Hanger Installation: Attach hangers to structure above ceiling to comply with NAAMM ML/SFA 920.
32. Ceiling Suspension System Components: Install In sizes and at spacings indicated but not in smaller sizes or greater spacings than those required by ASTM C 841 and NAAMM ML/SFA 920.
    a. Wire Hangers: Space and install wire hangers In accordance with ASTM C 841 and within 150 mm (6 inches) of channel ends, unless closer spacing indicated or required for fire-resistance rated assembly.
    b. Main Runners (Primary Members): Space and install channels in accordance with ASTM C 841, unless closer spacing indicated or required for fire-resistance rated assembly.
    c. Cross Furring (Furring Channels): Space and install furring channels in accordance with ASTM C 841, unless closer spacing indicated or required for fire-resistance rated assembly.
33. Framing Around Openings: Frame channels and lath on suspended soffits and ceilings and at furring to receive electric lights, etc. as indicated or as necessary to complete work. Furnish and install in furring, plaster rings or access panels furnished under other sections.

Installation Of Steel Stud Partitions

34. General: Install steel stud partition support systems in accordance with manufacturer's recommendations and Reference Standards.
35. Steel Stud Systems: Comply with ASTM C 754.
    a. To Receive Metal Lath: Space studs in accordance with ASTM C 841 and NAAMM ML/SFA 920.
    b. To Receive Gypsum Lath: Space studs in accordance with ASTM C 841.
36. Extend partition support systems to finish ceilings and attach to ceiling suspension members, unless otherwise indicated.

Metal Furring

37. General: Install in accordance with ASTM C 841 and NAAMM ML/SFA 920.
    a. Install supplementary framing, blocking, and bracing at terminations in work and for support of fixtures, equipment services, heavy trim, grab bars, bath accessories, furnishings, and similar work to comply with manufacturer's recommendations.
38. Metal Furring to Receive Gypsum Lath: Space furring channels in accordance with ASTM C 841.
39. Metal Furring Systems:
    a. To Receive Metal Lath: Space furring in accordance with ASTM C 841 and NAAMM ML/SFA 920.
    b. To Receive Gypsum Lath: Space furring in accordance with ASTM C 841.
40. Isolation: Where lathing and metal support system abuts building structure horizontally and where partition/wall work abuts overhead structure, isolate work from structural movement sufficiently to prevent transfer of loads to work from building structure. Install slip or cushion-type joints to absorb deflections but maintain lateral support.
    a. Frame both sides of control and expansion joints independently, and do not bridge joints with furring and lathing or accessories.

Installation Of Suspended Steel Framing

41. General: Construct ceilings of lath and plaster on suspended steel framing system in accordance with manufacturer's recommendations and Reference Standards.
42. Hanger Installation: Attach hangers to structure above ceiling to comply with NAAMM ML/SFA 920.
43. Ceiling Suspension System Components: Install In sizes and at spacings indicated but not in smaller sizes or greater spacings than those required by ASTM C 841 and NAAMM ML/SFA 920.
    a. Wire Hangers: Space and install wire hangers in accordance with ASTM C 841 and within 150 mm (6 inches) of channel ends, unless closer spacing indicated or required for fire-resistance rated assembly.
    b. Main Runners (Primary Members): Space and install channels in accordance with ASTM C 841, unless closer spacing indicated or required for fire-resistance rated assembly.
    c. Cross Furring (Furring Channels): Space and install furring channels in accordance with ASTM C 841, unless closer spacing indicated or required for fire-resistance rated assembly.
44. Framing Around Openings: Frame channels and lath on suspended soffits and ceilings and at furring to receive electric lights, etc. as indicated or as necessary to complete work. Furnish and install in furring, plaster rings or access panels furnished under other sections.

Installation Of Steel Stud Partitions

45. General: Install steel stud partition support systems in accordance with manufacturer's recommendations and Reference Standards.
46. Steel Stud Systems: Comply with ASTM C 754.
    a. To Receive Metal Lath: Space studs in accordance with ASTM C 841 and NAAMM ML/SFA 920.
    b. To Receive Gypsum Lath: Space studs in accordance with ASTM C 841.
47. Extend partition support systems to finish ceilings and attach to ceiling suspension members, unless otherwise indicated.

Metal Furring

48. General: Install in accordance with ASTM C 841 and NAAMM ML/SFA 920.
    a. Install supplementary framing, blocking, and bracing at terminations in work and for support of fixtures, equipment services, heavy trim, grab bars, bath accessories, furnishings, and similar work to comply with manufacturer's recommendations.
49. Metal Furring to Receive Gypsum Lath: Space furring channels in accordance with ASTM C 841.
50. Metal Furring Systems:
    a. To Receive Metal Lath: Space furring in accordance with ASTM C 841 and NAAMM ML/SFA 920.
    b. To Receive Gypsum Lath: Space furring in accordance with ASTM C 841.

Lathing

51. Metal Lathing: Install in accordance with ASTM C 841 and NAAMM ML/SFA 920.
    a. At Metal Framing: Attach metal lath to furring channels with long dimension of sheet at right angles to furring channels with gage wire ties spaced not over 150 mm (6 inches) apart.
    b. At Wood Framing: Nail metal lath to wood framing with long dimension of sheet at right angles to framing member.
    c. Place ties where sides of sheets laps at supports and at side laps of sheets between supports. Lap metal lath not less than 13 mm (112 inch) at sides of sheets and 25 mm (1 inch) at ends of sheets.
    d. Suspended and Furred Ceilings: Use 1.8 kg/sq m (3.4 pounds/SY) minimum weight diamond mesh lath.
    e. Ceramic Tile Setting Beds: Use 1.8 kg/sq m (3.4 pounds/SY) minimum weight diamond mesh lath.
52. Gypsum Lath: Install in accordance with ASTM C 841.
    a. Wood Framing and Furrlng: Install lath as follows:
        1) With screws to comply with lath manufacturer's directions.
        2) With nails.
        3) Provide floating angle construction.
    b. Suspended and Furred Ceilings: Install lath to furring members with clips.
    c. Vertical Metal Framing and Furring: Install lath as follows:
        1) With screws.
        2) With clips, supplemented by screws where required by lath manufacturer.
        3) Where sound-rated partitions are indicated, attach lath with resilient clips.

Installation Of Accessories

53. Accessories: Install as required to repair area of work to match existing. Install in accordance with ASTM C 841. Miter or cope accessories at comers; Install with tight joints and in alignment. Attach accessories securely to plaster bases to hold accessories In place and alignment during plastering.
54. Interior Corners: Apply cornerite.
55. Corner Beads: Install corner beads tightly secured to lath at exposed exterior corners.
56. Casing Beads: Install at terminations of plaster work, except where plaster passes behind and is concealed by other work and where metal screeds, bases, or metal frames act as casing beads.
57. Control Joints: Install at locations indicated or, if not indicated, at spacings and locations required by Reference Standards. Coordinate specific locations with the Owner.
58. Access Panels: Provide access panels as required for maintenance of concealed plumbing work in coordination with Division 15 Section "Plumbing." Tiled Areas: Coordinate with Division 9 Section "Ceramic Tile."
59. Sound-Rated Plaster Work: Where sound-rated plaster work is indicated by STC ratings or other notation:
    a. Acoustical Sealant: Seal work at perimeters, control joints, openings, and penetrations with continuous bead of acoustical sealant. Comply with ASTM C 919 and plastering manufacturer's recommendations for location of sealant beads.

b. Sound Insulation: Install insulation blankets within stud cavities of sound-rated partition assemblies where incated.

Plastering

60. Plastering: Comply with ASTM C 842 in thickness to match existing.
    a. Preparation: Remove loose, fractured, or separated plaster to face of substrate. repairing lath at substrate to ensure repair area bounded by solid and sound existing plaster construction.
        1) Prepare monolithic surfaces for bonded base coats and use bonding compound to comply with Reference Standards for conditioning of monolithic surfaces.
    b. Grout hollow metal frames, bases, and similar work with base-mat plaster material, and prior to lathing where necessary. Except where full grouting is indicated or required for fire-resistance rating, grout at least 150 mm (6 inches) at each jamb anchor dip.
    c. Plaster flush with metal frames and other built-in metal items or accessories that act as plaster ground, unless otherwise indicated. Where plaster is not terminated at metal by casing beads, cut base coat free from metal before plaster sets and groove finish coat at junctures with metal.
61. Preparation: Check metal grounds, comer beads, screeds, and other accessories carefully for alignment before starting plaster application. Check expansion and control joints and supporting metal structures to ensure that expansion and control joints can move unrestrained.
62. Plaster: Apply In accordance with ASTM C 842 in thickness to match existing:
    a. Use three-coat work over following plaster bases:
        1) Metal lath.
        2) Gypsum lath attached to ceiling supports by clips.
        3) Gypsum lath attached to ceiling supports spaced over 400 mm (16 inches) OC.
        4) Gypsum lath, 9.5 mm (3/8 inch) thick, with separate vapor retarder behind.
    b. Use two-coat work over following bases.
        1) Gypsum lath except for installations requiring three-coat work.
        2) Unit masonry.
        3) Concrete, cast-in-place or precast when surface condition complies with ASTM C 842 for plaster bonded to solid base.
    c. First Coat: Apply first coat of plaster with such force to secure good key.
    d. Finish Coats: Apply troweled finish coats unless otherwise indicated.
63. Workmanship: Perform work true to line, straight, and plumb.
    a. Finished Surfaces: Free from waves, dents, bumps, cracks, pits. checks, streaks, catfaces, blisters, or other defects. Cutout and property replace defective areas.
    b. Execute work to avoid any irregularity occurring at point or place where one section is joined to another.
    c. Arises and Angles: True and sharp.
64. Tolerances: Plaster surface plane within plus/minus 3 mm in 3 000 mm (1/8 inch in 10 feet).

Integrating Existing Work

65. Protection: Comply with Detailed Scope of Work.

Adjustments

66. Partition Removal: Comply with Detailed Scope of Work.

Dust Control

67. Dust: Comply with Detailed Scope of Work.

Patching And Cleaning

68. Cutting and Patching: Do necessary cutting, patching, and repairing and pointing up of plastering after other work is in place to restore defective areas. Repair or replace work to eliminate blisters, buckles, excessive crazing and check-cracking, dry outs, efflorescence, sweat-outs, and similar defects and where bond to substrate has failed.
    a. Sand smooth-troweled finishes lightly to remove trowel marks and arises.

69. Cleaning: As rapidly as plastering is completed in each space, clean up rubbish, utensils, and surplus material, sweep floor and leave in neat condition for work of others.
    a. When general plastering is concluded, remove plastering rubbish, equipment, and surplus materials from premises.
    b. Clean surfaces splattered with plaster.

END OF SECTION 09 22 36 23

Task	Specification	Specification Description
09 22 36 23	09 22 13 13	Gypsum Plaster
09 22 36 23	09 22 13 13a	Gypsum Veneer Plaster
09 22 36 23	09 22 13 13b	Portland Cement Plaster
09 22 36 33	09 22 13 13	Gypsum Plaster
09 22 36 33	09 22 13 13a	Gypsum Veneer Plaster
09 22 36 33	09 22 13 13b	Portland Cement Plaster
09 22 36 33	09 22 36 23	Lath and Plaster Renovation

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SECTION 09 23 13 00 - GYPSUM BOARD RENOVATION

GENERAL

Description Of Work

1. This specification covers the furnishing and installation of materials for gypsum board renovation. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

Submittals

2. Quality Assurance/Control Submittals
   a. Certificates: Manufacturer's written certification that gypsum products meet or exceed specified requirements.

Quality Assurance

3. Regulatory Requirements:
   a. Gypsum Board Partitions: Listed and labeled for fire-protective ratings as indicated or scheduled.
   b. Gypsum Board Floor/Ceilings and Roof/Ceiling Assemblies: Listed and labeled for fire protective ratings as indicated or scheduled.
   c. Fire-Rated Assemblies: Comply with UL 05, FM P8016, or GA 600 for required fire-rated assembly.

Delivery, Storage, And Handling

4. Storage and Protection: Store wallboard off ground to protect it from weather and damage due to moisture damage.
   a. Wallboard: Dry, free of warpage, and have bundling tape intact immediatly prior to use.

Project Conditions

5. Environmental Requirements: Comply with Detailed Scope of Work.
   a. During gypsum-panel application and finishing, maintain indoor temperatures within range of 13 degrees C (55 degrees F) to 21 degrees C (70 degrees F). Provide adequate ventilation to carry off excess moisture.
6. Existing Conditions: See Division 1 Section “Summary of Work”. Do not interfere with use of occupied buildings or portions of buildings. Maintain free and safe passage to and from occupied areas.
7. Protection: Protect grounds, plantings, buildings and any other facilities or property from damage caused by construction operations.

Scheduling And Sequencing

8. Scheduling and Completion: Comply with Detailed Scope of Work.

PRODUCTS

Materials

9. Materials for Patching, Extending, and Matching:

a. Provide same products or types of construction as in existing structure, as needed to patch, extend, or match existing work.
    1) Generally, Contract Documents will not define products present in existing construction. Determine products by Inspection and any necessary testing.
    2) Patching, extending, and matching of existing work and systems shall result in a complete, finished system.
b. Presence of product, finish, or type of construction requires that patching, extending, or matching be performed as necessary to make work complete and consistent.

Metals

10. Partition Metals: ASTM C 645, galvanized steel:
    a. Interior Steel Studs: Minimum 0.46 mm (25 gage), provide sizes and gages to match existing or as indicated.
        1) Provide minimum of 0.84 mm (20 gage) studs both sides of hollow metal frames.
    b. Steel Stud Runners: Match studs. Provide long leg runners for slip joint at structure above to allow for deflection.
    c. Furring Channels: Hat-shaped furring channels, minimum 0.46 mm (25 gage).
    d. Resilient Furring Channels: Manufacturer's standard product designed to reduce sound transmission by resilient attachment of gypsum board, 13 mm (1/2 inch) deep.
    e. Sheet-Metal Reinforcement (Altemate to Wood Blocking): 1.52 mm (16 gage) minimum.
11. Suspended Coiling Metals:
    a. Runner Channels: ASTM C 754 cold-rolled steel channels with rust-inhibitive finish.
        1) 50 mm (2 Inches) deep, 88 kg per 100 m (590 pounds per 1,000 LF).
        2) 38 mm (1-1/2 inch) deep, 70 kg per 100 m (475 pounds per 1,000 LF).
        3) 19 mm (3/4 Inch) deep, 45 kg per 100 m (300 pounds per 1,000 LF).
    b. Furring Channels: Hat-shaped galvanized-steel furring channels, minimum 0.46 mm (25 gage).
    c. Steel Studs: Galvanized steel as specified above, minimum 0.46 mm (25 gage).
    d. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft temper.
        1) Hanger Wire: Minimum 4.1 mm (8 gage).
        2) Tie Wire: 6 mm (16 gage).

Gypsum Board And Related Materials

12. Gypsum Board: GA216 and ASTM C 36
    a. Size: 12.7 mm and 15.9 mm (1/2 inch and 5/8 inch) thick to match existing, as indicated or scheduled. Provide boards 1 200 mm (48 inches) wide by length required to minimize cross joints.
    b. Regular Tapered-edge gypsum panels.
        1) Provide Type X gypsum panels at fire-rated assemblies.
    c. Water-Resistant: ASTM C 630, paintable, tapered-edge gypsum panels.
        1) Provide Type X water-resistant gypsum panels at fire-rated assemblies.
13. Cementitious Backer Units (CBU): ANSI A118.9, nailable/screwable backer board composed of stable portland cement, aggregates, and reinforcements with ability to remain unaffected by prolonged exposure to moisture, 12.7 mm (112 inch) thick.
14. Fasteners:
    a. Screws: ASTM C 1002, drywall screws, corrosion resistant. Provide types as recommended by manufacturer for each application.
        1) Wallboard to Metal Framing: Minimum 25 mm (1 inch), Type S.
        2) Wall board to Wood Framing: Minimum 32 mm (1-1/4 inch) Type W bugle head.

    3) Wall board to Wallboard: Type G.
  b. Nails: ASTM C 514.

15. Accessories: GA 216 and ASTM C 1047, galvanized steel.
  a. Comer Bead: GA 216 Type CB-114 x 114.
  b. Metal Trim (Casing Beads): GA 216 Type L, in depth to match gypsum-board thickness.
  c. Control Joint: V-shaped control joint.
  d. Adhesive: ASTM C 557 multi-purpose adhesive.

16. Finishing Materials: ASTM C 475.
  a. Joint Tape: Provide type as recommended by panel manufacturer.
  b. Joint Treatment: Joint compound, adhesive, water, and fasteners.

17. Sound-Isolation Materials:
  a. Sound Insulation: ASTM C 665, Type I (unfaced) mineral fiber blankets, 3.7 to 4.9 kg per sq m (3/4 to 1 PCF), thickness as indicated, scheduled, or required by fire-rated assembly.
  b. Acoustical Sealant:
    1) Concealed: ASTM C 919 nondrying, non-hardening, and non-skinning; non-bleeding; and non-staining.
    2) Exposed: ASTM C 919 non-oxidizing and skinning; permanently elastic; and paintable.
  c. Ductwork Penetrations Packing: Low-density fiberglass.

EXECUTION

Examination

18. Units, Spaces, and Areas to be Renovated: Comply with Detailed Scope of Work.
  a. Existing Conditions: Before beginning installation, examine substrates and framing to receive gypsum board for defects or conditions adversely affecting quality and execution of installation.

Preparation

19. Dust Protection: Comply with Detailed Scope of Work.
20. Building Occupation: Carry out demolition and renovation work to cause as little inconvenience to occupants as possible. See Detailed Scope of Work.
21. Protection: Comply with Detailed Scope of Work.
  a. Protection: Provide drapes and drop cloths necessary to protect walls, floors, ductwork and piping, electrical work, etc. during drywall finishing operations.
22. Selective Demolition: Comply with Detailed Scope of Work.

Laying Out Work

23. Discrepancies: Verity dimensions and elevations indicated in layout of existing work.
  a. Prior to commencing work, carefully compare and check Drawings (if any) for discrepancies in locations or elevations of work to be executed.
  b. Refer discrepancies among Drawings (if any), Specifications, and existing conditions to the Owner or adjustment before work affected is performed.
    1) Failure to make such notification shall place responsibility on Contractor to carry out work in satisfactory, workmanlike mariner.
  c. Contractor: Responsible for location and elevation of construction indicated by Construction Documents.

Performance

24. Patching: Patch and extend existing work using skilled mechanics capable of matching existing quality of workmanship.
    a. Quality of Patched or Extended Work: Not less than specified for new work. If similar new work is not specified, equal to existing work.
25. Damaged Surfaces: Comply with Detailed Scope of Work.
26. Transitions from Existing to New Work: Comply with Detailed Scope of Work.

Erection Of Drywall Stud Partitions

27. Reference Standard: Erect steel framing in accordance with ASTM C 754.
28. Layouts: Align partition studs accurately according to partition layout.
29. Anchoring: Anchor runner channels to concrete slabs with concrete stub nails or power-driven anchors at 600 mm (24 inches) OC. Anchor runner channels to coiling grid, where applicable, with stove bolts. Where studs extend above ceiling system, install headers where required to receive runners.
30. Studs: Position studs vertically in runners. Where studs are located adjacent to openings or partition intersections and comers. anchor studs to runners with manufacturer’s metal lock fastener or with 13 mm (1/2 inch) Type S pan-head screws.
    a. Space studs at 400 mm (16 Inches) and 600 mm (24 inches) OC as indicated or scheduled.
        1) Cementitious Backer Units (CBU): Space studs at maximum of 400 mm (16 inches) OC.
        2) Limiting Heights: Comply with ASTM C 754 for transverse load of 240 Pa (5 lb-force/SF) without exceeding either allowable stress or deflection of L/240. Comers and Intersections: Locate studs no more than 50 mm (2 inches) from abutting partitions, comers, etc.
    b. Openings: Locate studs not more than 50 mm (2 inches) from opening frames. Anchor studs to frame anchor clips by bolt or screw attachment. Install headers over openings as recommended by the manufacturer.
        1) Solid-Core Wood Doors and Hollow Metal Doors: Provide two full-height studs at jambs fastened together back to back.
        2) Fire-Rated Openings: Comply with GA 219.
31. Bracing: Provide diagonal bracing at head of studs that terminate above the ceiling level. Bracing shall consist of metal studs bent to V-shape and extending at 45 degrees from partition head to structure above. Locate bracing 1 200 mm (48 inches) maximum OC.
32. Wood Blocking or Metal Reinforcement:
    a. Wood Blocking: See Division 6 Section “Rough Carpentry.”
    b. Install metal reinforcement of size required for support of toilet and bath accessories, hardware, cabinets, shelving, counters, and other wall-mounted items.
    c. Set true to line, level, or plumb well-secured in stud wall and flush with back of drywall or other wall finish.
    d. Coordinate exact locations with other sections.

Miscellaneous Framing And Furring

33. General: Provide necessary framing and furring for special framing at recesses, offsets, specialty Items, and at wall-mounted casework, shelving, and equipment.
34. Furring Channels: Install furring channels over back-up material. Position channels vertically at 600 mm (24 inches) OC. Use power-activated fasteners or stub nails at 600 mm (24 Inches) OC along alternating flanges. Shim channels level as required.
    a. Cementitious Backer Units (CBU): Space furring at maximum of 400 mm (16 inches) OC.

35. Resilient Furring Channels: Screw-attach In accordance with manufacturer's recommendations.
    a. Spacing: 600 mm (24 inches) OC for framing at 16 inches OC and 400 mm (16 inches) OC for framing at 24 Inches OC.

Ceiling Grillage Erection

36. Reference Standard: Erect steel framing In accordance with ASTM C 754.
37. Hangers: Install wire hangers spaced not over 1 200 mm (48 inches) OC in direction of 38 mm (1-1/2 inch) main runner channels and within 150 mm (6 inches) of ends of main runners or interruptions of ceiling continuity. Hang from structure above.
38. Runners: Place main runners not over 1 200 mm (48 inches) OC. Provide, position, and level hangers with hangers saddle-tied along runners. Space furring channels at 600 mm (24 inches) OC at right angles to runner channels and secure with furring channel clips.
39. Reinforcement: At light troffers or other openings, reinforce grillage with 19 mm (314 inch) cold-rolled channels wired atop and parallel to main runner channels.
    a. Provide lateral seismic bracing as required by code.
40. Special Shapes: Provide necessary framing and suspension for off sets, verticals, etc.

Insulation

41. Sound Insulation: Place sound Insulation blankets in partitions tight within spaces, around cut openings. behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
    a. Ductwork Penetrations: Provide one-inch wide clearance around ductwork and pack with fiberglass ready for joint sealers.

Installation Of Gypsum Drywall

42. Reference Standards: Apply and finish gypsum board in accordance with GA 216 and ASTM C 840.
43. Partition Gypsum Board Layout: Apply gypsum wallboard panels vertically with abutting ends and edges occurring over stud flanges or furring.
    a. Joints on Opposite Sides of Partitions: Stagger; joints shall not occur over same stud.
    b. Two Layer Construction: Stagger Joints between layers.
44. Ceiling Gypsum Board: Apply gypsum board of maximum practical length with long dimensions at right angles to furring channels. End and edge joints shall occur over furring channels with end joints staggered. Properly support gypsum board around cutouts and openings.
45. Fasteners: Apply board to studs or furring with drywall screws spaced 300 mm (12 inches) OC in field of board and 200 mm (8 inches) OC staggered along abutting edges.
46. Water-Resistant: Apply gypsum wallboard manufacturer's recommended sealant to raw cut edges and screw heads.
47. Cementitious Backer Units (CBU): Install in accordance with ANSI A108.11 and manufacturer's recommendations.
48. Accessories:
    a. Comer Bead: Apply as recommended by manufacturer at exposed outer corners.
    b. Trim (Casing Beads): Apply as recomrnended by manufacturer, where gypsum board abuts other materials, and as indicated.
    c. Control Joints: Comply with GA 216.
        1) Walls: Install at not more than 9 m (30 feet) OC.
        2) Ceilings: Install at not more than 15 m (50 feet) OC and where framing changes direction.
        3) Coordinate locations with the Owner.
49. Access Panels: Securely install access panels furnished under other sections. Set plumb and square to align with finish surface.

50. Acoustical Sealant: Seal perimeter and penetrations on both sides of sound-rated partitions and partitions with sound-attenuation blankets with minimum of single 6 mm (1/4 inch) bead of sealant
    a. Locations:
        1) Seal around gypsum-board perimeter in angle formed by gypsum-board panels and abutting dissimilar materials.
        2) Seal intersections of gypsum board with dissimilar materials.
        3) Seal pipe. conduit, ductwork, penetrations, etc.
        4) Seal around cutouts for lights, cabinets, pipes, ductwork, electrical boxes, etc.
        5) Seal gypsum board panel terminations in door and window frarnes.
        6) Seal control-joint locations before installing control Joints to panels.
    b. Installation: Comply with ASTM C 919 and requirements of indicated sound-rated assembly. Provide number and positions of beads to comply with sound rating of assembly.
51. Tolerances: Gypsum-board surface plane within plus or minus 3 mm in 3 000 mm (1/8 inch in 10 feet).
52. Finishing: Finish in accordance with GA 214.
    a. Concealed Locations (Not Exposed to View in Rooms): Level 1
    b. Beneath Tile: Level 2.
    c. Other Finished Areas: Level 4. Finish joints, trim, and fastener dimples. Sand smooth.
    d. Cementitious Backer Units (CBU): Treat joints in accordance with ANSI A108.11 and manufacturer's recommendations.

END OF SECTION 09 23 13 00

Task	Specification	Specification Description
09 23 13 00	09 22 13 13	Gypsum Plaster
09 23 13 00	09 22 13 13a	Gypsum Veneer Plaster
09 23 13 00	09 22 13 13b	Portland Cement Plaster
09 23 13 00	09 22 36 23	Lath and Plaster Renovation
09 24 13 00	09 22 13 13	Gypsum Plaster
09 24 13 00	09 22 13 13a	Gypsum Veneer Plaster
09 24 33 00	01 22 16 00	No Specification Required

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SECTION 09 28 13 00 - GYPSUM BOARD

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for gypsum board. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Interior gypsum board.
b. Exterior gypsum board for ceilings and soffits.
c. Tile backing panels.

C. Submittals
1. Product Data: For each type of product indicated.
2. Samples: For the following products:
a. Trim Accessories: Full-size Sample in 12-inch- (300-mm-) long length for each trim accessory indicated.
b. Textured Finishes: Manufacturer's standard size for each textured finish indicated and on same backing indicated for Work.
3. LEED Submittals:
a. Product Data for Credit MR 4.1 and MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
1) Include statement indicating costs for each product having recycled content.
b. Product Data for Credit EQ 4.1: For adhesives used to laminate gypsum board panels to substrates, including printed statement of VOC content.

D. Quality Assurance
1. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
2. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

E. Storage And Handling
1. Store materials inside under cover and keep them dry and protected against damage from weather, condensation, direct sunlight, construction traffic, and other causes. Stack panels flat to prevent sagging.

F. Project Conditions
1. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.
2. Do not install interior products until installation areas are enclosed and conditioned.
3. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.
a. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
b. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

1.2 PRODUCTS

A. Panels, General
1. Recycled Content: Provide gypsum panel products with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 25 percent by weight.
2. Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

B. Interior Gypsum Board
1. General: Complying with ASTM C 36/C 36M or ASTM C 1396/C 1396M, as applicable to type of gypsum board indicated and whichever is more stringent.
2. Regular Type:
   a. Thickness: 1/2 inch (12.7 mm).
   b. Long Edges: Tapered **OR** Tapered and featured (rounded or beveled) for prefilling, **as directed**.
3. Type X:
   a. Thickness: 5/8 inch (15.9 mm).
   b. Long Edges: Tapered **OR** Tapered and featured (rounded or beveled) for prefilling, **as directed**.
4. Type C:
   a. Thickness: As required by fire-resistance-rated assembly indicated on Drawings.
   b. Long Edges: Tapered.
5. Flexible Type: Manufactured to bend to fit radii and to be more flexible than standard regular-type gypsum board of same thickness.
   a. Thickness: 1/4 inch (6.4 mm).
   b. Long Edges: Tapered.
6. Ceiling Type: Manufactured to have more sag resistance than regular-type gypsum board.
   a. Thickness: 1/2 inch (12.7 mm).
   b. Long Edges: Tapered.
7. Foil-Backed Type:
   a. Core: As indicated on Drawings **OR** 3/8 inch (9.5 mm), regular type **OR** 1/2 inch (12.7 mm), regular type **OR** 5/8 inch (15.9 mm), Type X **OR** Type C as required by fire-resistance-rated assembly indicated on Drawings, **as directed**.
   b. Long Edges: Tapered **OR** Tapered and featured (rounded or beveled) for prefilling, **as directed**.
8. Abuse-Resistant Type: Manufactured to produce greater resistance to surface indentation, through-penetration (impact resistance), and abrasion than standard, regular-type and Type X gypsum board.
   a. Core: As indicated on Drawings **OR** 1/2 inch (12.7 mm), regular type **OR** 5/8 inch (15.9 mm), Type X, **as directed**.
   b. Long Edges: Tapered.
9. High-Impact Type: Manufactured with Type X core, plastic film laminated to back side for greater resistance to through-penetration (impact resistance).
   a. Core: As indicated on Drawings **OR** 5/8 inch (15.9 mm) thick, **as directed**.
   b. Plastic-Film Thickness: 0.010 inch (0.254 mm) **OR** 0.020 inch (0.508 mm) **OR** 0.030 inch (0.762 mm) **OR** 0.081 inch (2.057 mm), **as directed**.
10. Moisture- and Mold-Resistant Type: With moisture- and mold-resistant core and surfaces.
   a. Core: 5/8 inch (15.9 mm), Type X.
   b. Long Edges: Tapered.

C. Exterior Gypsum Board For Ceilings And Soffits
1. Exterior Gypsum Soffit Board: ASTM C 931/C 931M or ASTM C 1396/C 1396M, with manufacturer's standard edges.

1) Core: As indicated **OR** 1/2 inch (12.7 mm), regular type **OR** 5/8 inch (15.9 mm), Type X, **as directed**.

2. Glass-Mat Gypsum Sheathing Board: ASTM C 1177/C 1177M.
   a. Core: As indicated **OR** 1/2 inch (12.7 mm), regular type **OR** 5/8 inch (15.9 mm), Type X, **as directed**.

D. Tile Backing Panels
1. Water-Resistant Gypsum Backing Board: ASTM C 630/C 630M or ASTM C 1396/C 1396M.
   a. Core: As indicated on Drawings **OR** 1/2 inch (12.7 mm), regular type **OR** 5/8 inch (15.9 mm), Type X **OR** Type C as required by fire-resistance-rated assembly indicated on Drawings, **as directed**.
2. Glass-Mat, Water-Resistant Backing Board:
   a. Complying with ASTM C 1178/C 1178M.
   b. Complying with ASTM C1177/C 1177M.
   c. Core: As indicated on Drawings **OR** 1/2 inch (12.7 mm), regular type **OR** 5/8 inch (15.9 mm), Type X, **as directed**.
3. Cementitious Backer Units: ANSI A118.9.
   a. Thickness: As indicated on Drawings **OR** 1/2 inch (12.7 mm), **as directed**.

E. Trim Accessories
1. Interior Trim: ASTM C 1047.
   a. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet **OR** Galvanized or aluminum-coated steel sheet or rolled zinc **OR** Plastic **OR** Paper-faced galvanized steel sheet, **as directed**.
   b. Shapes:
      1) Cornerbead.
      2) Bullnose bead.
      3) LC-Bead: J-shaped; exposed long flange receives joint compound.
      4) L-Bead: L-shaped; exposed long flange receives joint compound.
      5) U-Bead: J-shaped; exposed short flange does not receive joint compound.
      6) Expansion (control) joint.
      7) Curved-Edge Cornerbead: With notched or flexible flanges.
2. Exterior Trim: ASTM C 1047.
   a. Material: Hot-dip galvanized steel sheet, plastic, or rolled zinc.
   b. Shapes:
      1) Cornerbead.
      2) LC-Bead: J-shaped; exposed long flange receives joint compound.
      3) Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening.
3. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
   a. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221 (ASTM B 221M), Alloy 6063-T5.
   b. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

F. Joint Treatment Materials
1. General: Comply with ASTM C 475/C 475M.
2. Joint Tape:
   a. Interior Gypsum Wallboard: Paper.
   b. Exterior Gypsum Soffit Board: Paper.
   c. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
   d. Tile Backing Panels: As recommended by panel manufacturer.
3. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
   a. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.

b. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping **OR** drying-type, all-purpose, **as directed**, compound.
   1) Use setting-type compound for installing paper-faced metal trim accessories.
c. Fill Coat: For second coat, use setting-type, sandable topping **OR** drying-type, all-purpose, **as directed**, compound.
d. Finish Coat: For third coat, use setting-type, sandable topping **OR** drying-type, all-purpose, **as directed**, compound.
e. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound **OR** drying-type, all-purpose compound **OR** high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish, **as directed**.

4. Joint Compound for Exterior Applications:
   a. Exterior Gypsum Soffit Board: Use setting-type taping compound and setting-type, sandable topping compound.
   b. Glass-Mat Gypsum Sheathing Board: As recommended by sheathing board manufacturer.
5. Joint Compound for Tile Backing Panels:
   a. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.
   b. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.
   c. Cementitious Backer Units: As recommended by backer unit manufacturer.

G. Auxiliary Materials
1. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
2. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
   a. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
   a. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
   b. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
4. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
   a. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
   b. Recycled Content: Provide blankets with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 25 percent by weight.
5. Acoustical Sealant: As specified in Division 07 Section "Joint Sealants".
   a. Provide sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Thermal Insulation: As specified in Division 07 Section "Thermal Insulation".
7. Vapor Retarder: As specified in Division 07 Section "Thermal Insulation".

H. Texture Finishes
1. Primer: As recommended by textured finish manufacturer.
2. Polystyrene Aggregate Ceiling Finish: Water-based, job-mixed, polystyrene aggregate finish with flame-spread and smoke-developed indexes of not more than 25 when tested according to ASTM E 84.
   a. Texture: Fine **OR** Medium **OR** Coarse, **as directed**.
3. Aggregate Finish: Water-based, job-mixed, aggregated, drying-type texture finish for spray application.

a. Texture: Light spatter **OR** Spatter knock-down, **as directed**.

4. Acoustical Finish: Water-based, chemical-setting or drying-type, job-mixed texture finish for spray application.
   a. Application Thickness: 1/2 inch (12.7 mm).
   b. Fire-Test-Response Characteristics: Indices when tested according to ASTM E 84 as follows:
      1) Flame Spread: Less than 25.
      2) Smoke Developed: Less than 450.
   c. NRC: 0.55 according to ASTM C 423.

1.3 EXECUTION

A. Examination

1. Examine areas and substrates, with Installer present, and including welded hollow-metal frames and framing, for compliance with requirements and other conditions affecting performance.
2. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Applying And Finishing Panels, General

1. Comply with ASTM C 840.
2. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
3. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.
4. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
5. Form control and expansion joints with space between edges of adjoining gypsum panels.
6. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
   a. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
   b. Fit gypsum panels around ducts, pipes, and conduits.
   c. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- (6.4- to 9.5-mm-) wide joints to install sealant.
7. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations, and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
8. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
9. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members, or provide control joints to counteract wood shrinkage.
10. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

11. Install sound attenuation blankets before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side.

C. Applying Interior Gypsum Board
1. Install interior gypsum board in the following locations:
   a. Regular Type: As indicated on Drawings **OR** Vertical surfaces, unless otherwise indicated, **as directed**.
   b. Type X: As indicated on Drawings **OR** Where required for fire-resistance-rated assembly **OR** Vertical surfaces, unless otherwise indicated, **as directed**.
   c. Type C: As indicated on Drawings **OR** Where required for specific fire-resistance-rated assembly indicated, **as directed**.
   d. Flexible Type: As indicated on Drawings **OR** Apply in double layer at curved assemblies, **as directed**.
   e. Ceiling Type: As indicated on Drawings **OR** Ceiling surfaces, **as directed**.
   f. Foil-Backed Type: As indicated on Drawings **OR as directed**.
   g. Abuse-Resistant Type: As indicated on Drawings **OR as directed**.
   h. High-Impact Type: As indicated on Drawings **OR as directed**.
   i. Moisture- and Mold-Resistant Type: As indicated on Drawings **OR as directed**.
2. Single-Layer Application:
   a. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing, unless otherwise indicated.
   b. On partitions/walls, apply gypsum panels vertically (parallel to framing) **OR** horizontally (perpendicular to framing), **as directed**, unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
      1) Stagger abutting end joints not less than one framing member in alternate courses of panels.
      2) At stairwells and other high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly.
   c. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
   d. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
3. Multilayer Application:
   a. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints 1 framing member, 16 inches (400 mm) minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
   b. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
   c. On Z-furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
   d. Fastening Methods: Fasten base layers and face layers separately to supports with screws **OR** Fasten base layers with screws; fasten face layers with adhesive and supplementary fasteners, **as directed**.
4. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.
5. Curved Surfaces:

a. Install panels horizontally (perpendicular to supports) and unbroken, to extent possible, across curved surface plus 12-inch- (300-mm-) long straight sections at ends of curves and tangent to them.
b. For double-layer construction, fasten base layer to studs with screws 16 inches (400 mm) o.c. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced 12 inches (300 mm) o.c.

D. Applying Exterior Gypsum Panels For Ceilings And Soffits
1. Apply panels perpendicular to supports, with end joints staggered and located over supports.
a. Install with 1/4-inch (6.4-mm) open space where panels abut other construction or structural penetrations.
b. Fasten with corrosion-resistant screws.

E. Applying Tile Backing Panels
1. Water-Resistant Gypsum Backing Board: Install at showers, tubs, and where indicated. Install with 1/4-inch (6.4-mm) gap where panels abut other construction or penetrations.
2. Glass-Mat, Water-Resistant Backing Panel: Comply with manufacturer's written installation instructions and install at showers, tubs, and where indicated **OR** locations indicated to receive tile, **as directed**. Install with 1/4-inch (6.4-mm) gap where panels abut other construction or penetrations.
3. Cementitious Backer Units: ANSI A108.11, at showers, tubs, and where indicated **OR** locations indicated to receive tile, **as directed**.
4. Areas Not Subject to Wetting: Install regular-type gypsum wallboard panels to produce a flat surface except at showers, tubs, and other locations indicated to receive water-resistant panels.
5. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

F. Installing Trim Accessories
1. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
2. Control Joints: Install control joints at locations indicated on Drawings **OR** according to ASTM C 840 and in specific locations approved by the Owner for visual effect, **as directed**.
3. Interior Trim: Install in the following locations:
a. Cornerbead: Use at outside corners, unless otherwise indicated.
b. Bullnose Bead: Use at outside corners **OR** where indicated, **as directed**.
c. LC-Bead: Use at exposed panel edges.
d. L-Bead: Use where indicated.
e. U-Bead: Use at exposed panel edges **OR** where indicated, **as directed**.
f. Curved-Edge Cornerbead: Use at curved openings.
4. Exterior Trim: Install in the following locations:
a. Cornerbead: Use at outside corners.
b. LC-Bead: Use at exposed panel edges.
5. Aluminum Trim: Install in locations indicated on Drawings.

G. Finishing Gypsum Board
1. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
2. Prefill open joints, rounded or beveled edges, and damaged surface areas.
3. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
4. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
a. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
b. Level 2: Panels that are substrate for tile **OR** Panels that are substrate for acoustical tile **OR** Where indicated on Drawings, **as directed**.

c. Level 3: For surfaces receiving medium- or heavy-textured finishes before painting or heavy wallcoverings where lighting conditions are not critical **OR** Where indicated on Drawings, **as directed**.

d. Level 4: For surfaces receiving light-textured finishes, wallcoverings, and flat paints **OR** At panel surfaces that will be exposed to view, unless otherwise indicated, **as directed**. This is generally the standard exposed finish. Gloss and semi-gloss enamel paints are not usually recommended over this level of finish. ASTM C 840 requires application of "drywall primer" on surfaces before final decoration

   1) Primer and its application to surfaces are specified in other Division 07.

e. Level 5: For surfaces receiving gloss and semigloss enamels and other surfaces subject to severe lighting **OR** Where indicated on Drawings, **as directed**.

   1) Primer and its application to surfaces are specified in other Division 07.

f. Glass-Mat Gypsum Sheathing Board: Finish according to manufacturer's written instructions for use as exposed soffit board.

g. Glass-Mat, Water-Resistant Backing Panels: Finish according to manufacturer's written instructions.

h. Cementitious Backer Units: Finish according to manufacturer's written instructions.

H. Applying Texture Finishes

1. Surface Preparation and Primer: Prepare and apply primer to gypsum panels and other surfaces receiving texture finishes. Apply primer to surfaces that are clean, dry, and smooth.
2. Texture Finish Application: Mix and apply finish using powered spray equipment, to produce a uniform texture free of starved spots or other evidence of thin application or of application patterns.
3. Prevent texture finishes from coming into contact with surfaces not indicated to receive texture finish by covering them with masking agents, polyethylene film, or other means. If, despite these precautions, texture finishes contact these surfaces, immediately remove droppings and overspray to prevent damage according to texture-finish manufacturer's written recommendations.

I. Protection

1. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
2. Remove and replace panels that are wet, moisture damaged, and mold damaged.
   a. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
   b. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09 28 13 00

SECTION 09 28 13 00a - GYPSUM BOARD SHAFT-WALL ASSEMBLIES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for gypsum board shaft-wall assemblies. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes gypsum board shaft-wall assemblies for the following:
      a. Shaft-wall enclosures.
      b. Chase enclosures.
      c. Stair enclosures.
      d. Horizontal enclosures.

C. Submittals
   1. Product Data: For each gypsum board shaft-wall assembly indicated.
   2. LEED Submittals:
      a. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
      b. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
         1) Include statement indicating costs for each product having recycled content.

D. Quality Assurance
   1. Fire-Resistance Ratings: Provide materials and construction identical to those of assemblies with fire-resistance ratings determined according to ASTM E 119 by a testing and inspecting agency.
   2. STC-Rated Assemblies: Provide materials and construction identical to those of assemblies tested according to ASTM E 90 and classified according to ASTM E 413 by a testing and inspecting agency.
   3. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
   1. Deliver materials in original packages, containers, and bundles bearing brand name and identification of manufacturer or supplier.
   2. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.
   3. Stack panels flat on leveled supports off floor or slab to prevent sagging.

F. Project Conditions
   1. Environmental Limitations: Comply with ASTM C 840 requirements or with gypsum board manufacturer's written recommendations, whichever are more stringent.
   2. Do not install interior products until installation areas are enclosed and conditioned.
   3. Do not install panels that are wet, moisture damaged, or mold damaged.
      a. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
      b. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

A. Gypsum Board Shaft-Wall Assemblies, General
   1. Provide materials and components complying with requirements of fire-resistance-rated assemblies indicated.
      a. Provide panels in maximum lengths available to eliminate or minimize end-to-end butt joints.
      b. Provide auxiliary materials complying with gypsum board shaft-wall assembly manufacturer's written recommendations.

B. Panel Products
   1. Recycled Content: Provide gypsum panel products with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 25 percent by weight.
   2. Gypsum Liner Panels: Comply with ASTM C 442/C 442M.
      a. Type X: Manufacturer's proprietary liner panels with moisture-resistant paper faces.
         1) Core: 1 inch (25.4 mm) thick.
         2) Long Edges: Double bevel.
      b. Moisture- and Mold-Resistant Type X: Manufacturer's proprietary liner panels with moisture- and mold-resistant core and surfaces; comply with ASTM D 3273.
         1) Core: 1 inch (25.4 mm) thick.
         2) Long Edges: Double bevel.
   3. Gypsum Base for Gypsum Veneer Plaster: As specified in Division 09 Section "Gypsum Veneer Plastering".
   4. Gypsum Board: As specified in Division 09 Section "Gypsum Board".
   5. Water-Resistant Gypsum Backing Board: As specified in Division 09 Section "Gypsum Board".
   6. Cementitious Backer Units: As specified in Division 09 Section "Tiling".

C. Non-Load-Bearing Steel Framing
   1. Framing Members: Comply with ASTM C 754 for conditions indicated.
   2. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.
      a. Recycled Content: Provide steel sheet with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
      b. Protective Coating: ASTM A 653/A 653M, G40 (Z120) **OR** ASTM A 653/A 653M, G60 (Z180) **OR** Coating with equivalent corrosion resistance of ASTM A 653/A 653M, G40 (Z120), **as directed**, hot-dip galvanized, unless otherwise indicated.

D. Auxiliary Materials
   1. General: Provide auxiliary materials that comply with referenced product standards and manufacturer's written recommendations.
   2. Trim Accessories: Cornerbead, edge trim, and control joints of material and shapes specified in Division 09 Section(s) "Gypsum Veneer Plastering" OR "Gypsum Board", **as directed**, that comply with gypsum board shaft-wall assembly manufacturer's written recommendations for application indicated.
   3. Gypsum Base Joint-Reinforcing Materials: As specified in Division 09 Section "Gypsum Veneer Plastering".
   4. Gypsum Veneer Plaster: As specified in Division 09 Section "Gypsum Veneer Plastering".
   5. Gypsum Board Joint-Treatment Materials: As specified in Division 09 Section "Gypsum Board".
   6. Laminating Adhesive: Adhesive or joint compound recommended by manufacturer for directly adhering gypsum face-layer panels and gypsum-base face-layer panels to backing-layer panels in multilayer construction.
      a. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
   a. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
8. Track Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on shaft-wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.
   a. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 conducted by a qualified testing agency.
   b. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.
9. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing), produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
   a. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
   b. Recycled Content: Provide blankets with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 25 percent by weight.
10. Acoustical Sealant: As specified in Division 07 Section "Thermal Insulation".
   a. Provide sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Gypsum Board Shaft-Wall Assemblies
1. Basis-of-Design Product: As indicated on Drawings by design designation of a qualified testing agency.
2. Fire-Resistance Rating: As indicated **OR** 1 hour **OR** 2 hours **OR** 3 hours **OR** 4 hours, **as directed**.
3. STC Rating: As indicated **OR** 51, minimum, **as directed**.
4. Studs: Manufacturer's standard profile for repetitive members, corner and end members, and fire-resistance-rated assembly indicated.
   a. Depth: As indicated **OR** 2-1/2 inches (64 mm) **OR** 4 inches (102 mm) **OR** 6 inches (152 mm), **as directed**.
   b. Minimum Base-Metal Thickness: As indicated **OR** 0.0179 inch (0.45 mm) **OR** 0.0220 inch (0.55 mm) **OR** 0.0329 inch (0.84 mm), **as directed**.
5. Runner Tracks: Manufacturer's standard J-profile track with long-leg length as standard with manufacturer, but at least 2 inches (51 mm) long and in depth matching studs.
   a. Minimum Base-Metal Thickness: As indicated **OR** Matching steel studs **OR** 0.0179 inch (0.45 mm) **OR** 0.0220 inch (0.55 mm) **OR** 0.0329 inch (0.84 mm), **as directed**.
6. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
7. Jamb Struts: Manufacturer's standard J-profile strut with long-leg length of 3 inches (76 mm), in depth matching studs, and not less than 0.0329 inch (0.84 mm) thick.
8. Room-Side Finish: As indicated **OR** Gypsum board **OR** Gypsum veneer plaster **OR** Cementitious backer units, **as directed**.
9. Shaft-Side Finish: As indicated **OR** As indicated by fire-resistance-rated assembly design designation, **as directed**.
10. Insulation: Sound attenuation blankets.

2.2 EXECUTION

A. Preparation

1. Sprayed Fire-Resistive Materials: Coordinate with gypsum board shaft-wall assemblies so both elements of Work remain complete and undamaged. Patch or replace sprayed fire-resistive materials removed or damaged during installation of shaft-wall assemblies to comply with requirements specified in Division 07 Section "Applied Fireproofing".
   a. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runner tracks to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches (610 mm) o.c.
2. After sprayed fire-resistive materials are applied, remove only to extent necessary for installation of gypsum board shaft-wall assemblies and without reducing the fire-resistive material thickness below that which is required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

B. Installation
1. General: Install gypsum board shaft-wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated, manufacturer's written installation instructions, and the following:
   a. ASTM C 754 for installing steel framing except comply with framing spacing indicated.
   b. Division 09 Section(s) "Gypsum Veneer Plastering" OR "Gypsum Board", **as directed**, for applying and finishing panels.
   c. Division 09 Section "Tiling" for cementitious backer units.
2. Do not bridge architectural or building expansion joints with shaft-wall assemblies; frame both sides of expansion joints with furring and other support.
3. Install supplementary framing in gypsum board shaft-wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, and similar items that cannot be supported directly by shaft-wall assembly framing.
   a. At elevator hoistway entrance door frames, provide jamb struts on each side of door frame.
   b. Where handrails directly attach to gypsum board shaft-wall assemblies, provide galvanized steel reinforcing strip with 0.0312-inch (0.79-mm) minimum thickness of base (uncoated) metal, accurately positioned and secured behind at least 1 gypsum base for veneer plaster **OR** gypsum board **OR** cementitious backer unit, **as directed**, face-layer panel.
4. Integrate stair hanger rods with gypsum board shaft-wall assemblies by locating cavity of assemblies where required to enclose rods.
5. At penetrations in shaft wall, maintain fire-resistance rating of shaft-wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.
6. Isolate perimeter of gypsum panels from building structure to prevent cracking of panels, while maintaining continuity of fire-rated construction.
7. Firestop Tracks: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
8. Control Joints: Install control joints at locations indicated on Drawings **OR** according to ASTM C 840 and in specific locations approved by the Owner, **as directed**, while maintaining fire-resistance rating of gypsum board shaft-wall assemblies.
9. Seal gypsum board shaft walls with acoustical sealant at perimeter of each assembly where it abuts other work and at joints and penetrations within each assembly. Install acoustical sealant to withstand dislocation by air-pressure differential between shaft and external spaces; maintain an airtight and smoke-tight seal; and comply with ASTM C 919 requirements or with manufacturer's written instructions, whichever are more stringent.
10. In elevator shafts where gypsum board shaft-wall assemblies cannot be positioned within 4 inches (102 mm) of the shaft face of structural beams, floor edges, and similar projections into shaft, install 1/2- or 5/8-inch- (13- or 16-mm-) thick, gypsum board cants covering tops of projections. No recesses allowed (at steel beams especially).

a. Slope cant panels at least 75 degrees from horizontal. Set base edge of panels in adhesive and secure top edges to shaft walls at 24 inches (610 mm) o.c. with screws fastened to shaft-wall framing.
b. Where steel framing is required to support gypsum board cants, install framing at 24 inches (610 mm) o.c. and extend studs from the projection to shaft-wall framing.

11. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3mm) from the plane formed by faces of adjacent framing.

C. Protection
1. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
2. Remove and replace panels that are wet, moisture damaged, or mold damaged.
   a. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
   b. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09 28 13 00a

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Task	Specification	Specification Description
09 28 13 00	09 22 13 13a	Gypsum Veneer Plaster
09 28 13 00	09 01 30 91	Ceramic Tile
09 29 10 00	01 22 16 00	No Specification Required
09 29 10 00	09 28 13 00	Gypsum Board
09 29 10 00	09 23 13 00	Gypsum Board Renovation
09 29 10 00	09 28 13 00a	Gypsum Board Shaft-Wall Assemblies
09 29 82 00	09 28 13 00	Gypsum Board
09 29 82 00	09 28 13 00a	Gypsum Board Shaft-Wall Assemblies
09 30 13 00	09 01 30 91	Ceramic Tile
09 30 16 00	09 01 30 91	Ceramic Tile
09 34 00 00	09 01 30 91	Ceramic Tile
09 39 00 00	01 22 16 00	No Specification Required
09 39 00 00	09 01 30 91	Ceramic Tile

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SECTION 09 51 13 00 - ACOUSTICAL PANEL CEILINGS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for acoustical panel ceilings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes acoustical panels and exposed suspension systems for ceilings.
2. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete at ceilings.

C. Definitions
1. AC: Articulation Class.
2. CAC: Ceiling Attenuation Class.
3. LR: Light Reflectance coefficient.
4. NRC: Noise Reduction Coefficient.

D. Submittals
1. Product Data: For each type of product indicated.
2. Coordination Drawings: Drawn to scale and coordinating acoustical panel ceiling installation with hanger attachment to building structure and ceiling mounted items:
3. Samples: For each exposed finish.
4. LEED Submittals:
   a. Product Data for Credit MR 4.1 and MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
      1) Include statement indicating costs for each product having recycled content.
   b. Product Data for Credit EQ 4.1: For sealants, including printed statement of VOC content.
5. Product test reports.
6. Research/evaluation reports.
7. Maintenance data.

E. Quality Assurance
1. Acoustical Testing Agency Qualifications: An independent testing laboratory, or an NVLAP-accredited laboratory, with the experience and capability to conduct the testing indicated. NVLAP-accredited laboratories must document accreditation, based on a "Certificate of Accreditation" and a "Scope of Accreditation" listing the test methods specified.
2. Fire-Test-Response Characteristics
   a. Fire-Resistance Characteristics: Where indicated, provide acoustical panel ceilings identical to those of assemblies tested for fire resistance per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
      1) Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
      2) Identify materials with appropriate markings of applicable testing and inspecting agency.
   b. Surface-Burning Characteristics: Provide acoustical panels with the following surface-burning characteristics complying with ASTM E 1264 for Class A **OR** B **OR** C, **as directed**, materials as determined by testing identical products per ASTM E 84:
      1) Smoke-Developed Index: 450 or less.

3. Seismic Standard: Provide acoustical panel ceilings designed and installed to withstand the effects of earthquake motions according to the following:
   a. Standard for Ceiling Suspension Systems Requiring Seismic Restraint: Comply with ASTM E 580.
   b. CISCA's Recommendations for Acoustical Ceilings: Comply with CISCA's "Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings--Seismic Zones 0-2."
   c. CISCA's Guidelines for Systems Requiring Seismic Restraint: Comply with CISCA's "Guidelines for Seismic Restraint of Direct-Hung Suspended Ceiling Assemblies--Seismic Zones 3 & 4."
   d. IBC Standard for Metal Suspension Systems for Acoustical Tile and for Lay-in Panel Ceilings.
   e. ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."
4. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Deliver acoustical panels, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
2. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.
3. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.2 PRODUCTS

A. Acoustical Panels, General
1. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.
   a. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from test surface per ASTM E 795.
2. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.
   a. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by the Owner from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.
3. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.
4. Antimicrobial Fungicide Treatment: Provide acoustical panels with face and back surfaces coated with antimicrobial treatment consisting of manufacturer's standard formulation with fungicide added to inhibit growth of mold and mildew and showing no mold or mildew growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

B. Acoustical Panels For Acoustical Panel Ceiling
1. Classification: Provide fire-resistance-rated, **as directed**, panels complying with ASTM E 1264 for type, form, and pattern as follows:

a. Type and Form: Type III, mineral base with painted finish; Form 1, nodular **OR** 2, water felted **OR** 4, cast or molded, **as directed**.
b. Type and Form: Type IV, mineral base with membrane-faced overlay; Form 1, nodular; with glass-fiber cloth **OR** washable vinyl-film, **as directed**, overlay.
c. Type and Form: Type IV, mineral base with membrane-faced overlay; Form 2, water felted; with vinyl overlay on face **OR** vinyl overlay on face and back **OR** vinyl overlay on face, back, and sealed edges **OR** fiberglass-fabric overlay on face, **as directed**.
d. Type and Form: Type XII, glass-fiber base with membrane-faced overlay; Form 1, plastic **OR** 2, cloth **OR** 3, other, **as directed**.
e. Type and Form: Type XX, other types; described as high-density, ceramic- and mineral-base panels with scrubbable finish, resistant to heat, moisture, and corrosive fumes.
f. Pattern: C (perforated, small holes) **OR** CD (perforated, small holes and fissured) **OR** CE (perforated, small holes and lightly textured) **OR** D (fissured) **OR** E (lightly textured) **OR** F (heavily textured) **OR** G (smooth) **OR** GH (smooth and printed) **OR** I (embossed) **OR** J (embossed-in-register) **OR** K (surface scored) **OR** Z (other patterns as described) **OR** As indicated by manufacturer's designation, **as directed**.

2. Color: White **OR** As selected from manufacturer's full range **OR** Match sample **OR** As indicated by manufacturer's designation **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
3. LR: Not less than 0.65 **OR** 0.70 **OR** 0.75 **OR** 0.80 **OR** 0.85 **OR** 0.90, **as directed**.
4. NRC: Not less than 0.10 **OR** 0.35 **OR** 0.40 **OR** 0.50 **OR** 0.55 **OR** 0.60 **OR** 0.65 **OR** 0.70 **OR** 0.75 **OR** 0.80 **OR** 0.85 **OR** 0.90 **OR** 0.95 **OR** 1.00, **as directed**.
5. CAC: Not less than 20 **OR** 25 **OR** 30 **OR** 35 **OR** 40, **as directed**.
6. AC: Not less than 170 **OR** 180 **OR** 190 **OR** 200 **OR** 210, **as directed**.
7. Edge/Joint Detail: Square **OR** Reveal sized to fit flange of exposed suspension system members **OR** Flush reveal sized to fit flange of exposed suspension system members **OR** Beveled, kerfed and rabbeted long edges and square, butt-on short edges, **as directed**.
8. Thickness: 5/8 inch (15 mm) **OR** 3/4 inch (19 mm) **OR** 7/8 inch (22 mm) **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
9. Thickness (For glass-fiber-based panels): 1/8 inch (3 mm) **OR** 9/16 inch (15 mm) **OR** 5/8 inch (15 mm) **OR** 7/16 inch (22 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (51 mm) **OR** 3 inches (76 mm) **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
10. Modular Size: 24 by 24 inches (610 by 610 mm) **OR** 24 by 48 inches (610 by 1220 mm) **OR** 600 by 600 mm **OR** 600 by 1200 mm **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
11. Antimicrobial Treatment: Broad spectrum fungicide and bactericide **OR** Fungicide, **as directed**, based.

C. Metal Suspension Systems, General
1. Recycled Content: Provide products made from steel sheet with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
2. Metal Suspension System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.
3. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.
a. High-Humidity Finish: Comply with ASTM C 635 requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.
4. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
a. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing per

ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.

1) Type: Cast-in-place **OR** Postinstalled expansion **OR** Postinstalled bonded, **as directed**, anchors.
2) Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.
3) Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchor.
4) Corrosion Protection: Components fabricated from nickel-copper-alloy rods complying with ASTM B 164 for UNS No. N04400 alloy.

b. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E 1190, conducted by a qualified testing and inspecting agency.

5. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
   a. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
      OR
      Stainless-Steel Wire: ASTM A 580/A 580M, Type 304, nonmagnetic.
      OR
      Nickel-Copper-Alloy Wire: ASTM B 164, nickel-copper-alloy UNS No. N04400.
   b. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- (2.69-mm-) **OR** 0.135-inch- (3.5-mm-), **as directed**, diameter wire.
6. Hanger Rods **OR** Flat Hangers, **as directed**: Mild steel, zinc coated or protected with rust-inhibitive paint.
7. Angle Hangers: Angles with legs not less than 7/8 inch (22 mm) wide; formed with 0.04-inch- (1-mm-) thick, galvanized steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation; with bolted connections and 5/16-inch- (8-mm-) diameter bolts.
8. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.
9. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.
10. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical panels in-place.
11. Hold-Down Clips: Where indicated, provide manufacturer's standard hold-down clips spaced 24 inches (610 mm) o.c. on all cross tees.
12. Impact Clips: Where indicated, provide manufacturer's standard impact-clip system designed to absorb impact forces against acoustical panels.
13. Clean-Room Gasket System: Where indicated, provide manufacturer's standard system, including manufacturer's standard **OR** closed-cell PVC **OR** neoprene **OR** antimicrobial, **as directed**, gasket and related adhesives, tapes, seals, and retention clips, designed to seal out foreign material from and maintain positive pressure in clean room.

D. Metal Suspension System For Acoustical Panel Ceiling

1. Wide-Face, Capped, Double-Web, Fire-Rated, **as directed**, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 (Z90) coating designation, with prefinished 15/16-inch- (24-mm-) wide metal caps on flanges.
   a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
   b. End Condition of Cross Runners: Override (stepped) **OR** Butt-edge, **as directed**, type.
   c. Face Design: Flat, flush.
   d. Cap Material: Steel **OR** Aluminum, **as directed**, cold-rolled sheet.
   e. Cap Finish: Painted white **OR** Painted in color as selected from manufacturer's full range **OR** Painted to match color indicated by manufacturer's designation **OR** Painted to match

color of acoustical unit **OR** Plated with metallic finish, as selected from manufacturer's full range **OR** Plated with metallic finish indicated by manufacturer's designation **OR** Natural finish for aluminum, **as directed**.

2. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 (Z90) coating designation, with prefinished 9/16-inch- (15-mm-) wide metal caps on flanges.
   a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
   b. End Condition of Cross Runners: Override (stepped) **OR** Butt-edge, **as directed**, type.
   c. Face Design: Flat, flush **OR** Flanges formed with an integral center reveal, **as directed**.
   d. Cap Material: Steel **OR** Aluminum, **as directed**, cold-rolled sheet.
   e. Cap Finish: Painted white **OR** Painted in color as selected from manufacturer's full range **OR** Painted to match color indicated by manufacturer's designation **OR** Painted to match color of acoustical unit **OR** Plated with metallic finish, as selected from manufacturer's full range **OR** Plated with metallic finish indicated by manufacturer's designation **OR** Natural finish for aluminum, **as directed**.
3. Narrow-Face, Steel-Capped, Double-Web, Fire-Rated Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 (Z90) coating designation, with prefinished, cold-rolled, 9/16-inch- (15-mm-) wide metal caps on flanges.
   a. Structural Classification: Intermediate-duty system.
   b. Face Design: Flat, flush.
   c. Cap Finish: Painted white **OR** Painted in color as selected from manufacturer's full range **OR** Painted to match color indicated by manufacturer's designation **OR** Painted to match color of acoustical unit **OR** Plated with metallic finish, as selected from manufacturer's full range **OR** Plated with metallic finish indicated by manufacturer's designation **OR** Natural finish for aluminum, **as directed**.
4. Narrow-Face, Uncapped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized, to produce structural members with 9/16-inch- (15-mm-) wide faces.
   a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
   b. Face Design: With 1/8-inch- (3.2-mm-) wide, slotted, box-shaped flange **OR** With 1/4-inch- (6.35-mm-) wide, slotted, box-shaped flange **OR** Flanges formed in stepped design with a center protrusion projecting 19/64 inch (7.54 mm) below flange surfaces supporting panel faces and forming 3/16-inch- (4.76-mm-) wide reveals between edges of protrusion and those of panels, **as directed**.
   c. Face Finish: Painted white **OR** in color as selected from manufacturer's full range **OR** to match color indicated by manufacturer's designation **OR** to match color of acoustical unit, **as directed**.
   d. Reveal Finish: Painted to match flange color **OR** white **OR** black **OR** in color other than flange color as selected from manufacturer's full range of contrasting reveal colors, **as directed**.
5. Wide-Face, Capped, Double-Web, Fire-Rated, **as directed**, Hot-Dip Galvanized, G60 (Z180), Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, hot-dip galvanized according to ASTM A 653/A 653M, G60 (Z180) coating designation, with prefinished, cold-rolled, 15/16-inch- (24-mm-) wide, aluminum caps on flanges.
   a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
   b. Face Design: Flat, flush.
   c. Face Finish: Painted white **OR** Painted to match color indicated by manufacturer's designation **OR** Painted to match color of acoustical unit **OR** Natural finish, **as directed**.
6. Wide-Face, Single-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet electrolytically zinc coated, with prefinished flanges of width indicated.
   a. Structural Classification: Heavy-duty system.
   b. Face Finish: Painted white **OR** black, **as directed**.

7. Wide-Face, Capped, Double-Web, Stainless-Steel Suspension System: Main and cross runners roll formed from Type 304 or 316, stainless-steel sheet, with prefinished 15/16-inch- (24-mm-) wide, stainless-steel caps on flanges.
   a. Structural Classification: Intermediate-duty system.
   b. Face Design: Flat, flush.
8. Narrow-Face, Single-Web, Extruded-Aluminum Suspension System: Main and cross runners formed from extruded aluminum to produce structural members with 9/16-inch- (15-mm-) wide faces.
   a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
   b. Face Design: Screw-slot profile.
   c. Face Finish: Painted white **OR** Satin anodized per AA-M12C22A31 and AAMA 611, **as directed**.
   d. Reveal Finish: Match face finish **OR** Painted white **OR** Painted black, **as directed**.
9. Extra-Wide-Face, Double-Web **OR** Single-Web, **as directed**, Metal Suspension System: Main and cross runners formed from extruded aluminum **OR** aluminum-capped steel **OR** steel-capped steel, **as directed**, to produce structural members with 1-1/2-inch- (50-mm-) **OR** 2-inch- (50-mm-), **as directed**, wide flanges.
   a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
   b. Face Design: Flat, flush.
   c. Face Finish: Painted white **OR** Satin anodized per AA-M12C22A31 and AAMA 611, **as directed**.
   d. Gasket System: Clean-room type.

E. Metal Edge Moldings And Trim
1. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.
   a. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners, unless otherwise indicated.
   b. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
   c. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
2. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements and the following:
   a. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of aluminum extrusions complying with ASTM B 221 (ASTM B 221M) for Alloy and Temper 6063-T5.
   b. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.
   c. Conversion-Coated Finish: AA-M12C42 (Chemical Finish: cleaned with inhibited chemicals; acid-chromate-fluoride-phosphate conversion coating).
   d. Conversion-Coated and Factory-Primed Finish: AA-M12C42R1x (Chemical Finish: cleaned with inhibited chemicals; acid-chromate-fluoride-phosphate conversion coating; organic coating as follows):
      1) Manufacturer's standard, factory-applied prime-coat finish ready for field painting.
   e. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.

f. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; organic coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.
   1) Organic Coating: Thermosetting, primer/topcoat system with a minimum dry film thickness of 0.8 to 1.2 mils (0.02 to 0.03 mm).

F. Acoustical Sealant
   1. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex sealant, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
   2. Acoustical Sealant for Concealed Joints: Manufacturer's standard nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), recommended for sealing interior concealed joints to reduce airborne sound transmission.

1.3 EXECUTION

A. Preparation
   1. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

B. Installation
   1. General: Install acoustical panel ceilings to comply with ASTM C 636 **OR** IBC Standard, **as directed**, and seismic design requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
      a. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.
   2. Suspend ceiling hangers from building's structural members and as follows:
      a. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
      b. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
      c. Splay hangers only where required and, if permitted with fire-resistance-rated ceilings, to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
      d. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
      e. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
      f. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
      g. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.

h. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.

i. Do not attach hangers to steel deck tabs.

j. Do not attach hangers to steel roof deck. Attach hangers to structural members.

k. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.

l. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

3. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

4. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

a. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.

b. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.

c. Do not use exposed fasteners, including pop rivets, on moldings and trim.

5. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

6. Install acoustical panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.

a. Arrange directionally patterned acoustical panels as follows:

1) As indicated on reflected ceiling plans.

OR

Install panels with pattern running in one direction parallel to long **OR** short, **as directed**, axis of space.

OR

Install panels in a basket-weave pattern.

b. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension system runners and moldings.

c. For reveal-edged panels on suspension system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.

d. For reveal-edged panels on suspension system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension system surfaces and panel faces flush with bottom face of runners.

e. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.

f. Install hold-down clips in areas indicated, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space as recommended by panel manufacturer's written instructions, unless otherwise indicated.

g. Install clean-room gasket system in areas indicated, sealing each panel and fixture as recommended by panel manufacturer's written instructions.

h. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

C. Field Quality Control

1. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

2. Tests and Inspections: Testing and inspecting of completed installations of acoustical panel ceiling hangers and anchors and fasteners shall take place in successive stages, in areas of extent and using methods as follows. Do not proceed with installations of acoustical panel ceiling hangers for the next area until test results for previously completed installations of acoustical panel ceiling hangers show compliance with requirements.
   a. Extent of Each Test Area: When installation of ceiling suspension systems on each floor has reached 20 percent completion but no panels have been installed.
      1) Within each test area, testing agency will select 1 of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 200 lbf (890 N) of tension; it will also select one of every 2 postinstalled anchors used to attach bracing wires to concrete and will test them for 440 lbf (1957 N) of tension.
      2) When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.
3. Remove and replace acoustical panel ceiling hangers and anchors and fasteners that do not pass tests and inspections and retest as specified above.

D. Cleaning
   1. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

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SECTION 09 51 23 00 - ACOUSTICAL TILE CEILINGS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for acoustical tile ceilings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes acoustical tiles for ceilings and the following:
   a. Concealed suspension systems.
   b. Direct attachment of tiles to substrates with adhesive.
   c. Direct attachment of tiles to substrates with staples.
2. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete at ceilings.

C. Definitions
1. AC: Articulation Class.
2. CAC: Ceiling Attenuation Class.
3. LR: Light-Reflectance coefficient.
4. NRC: Noise Reduction Coefficient.

D. Submittals
1. Product Data: For each type of product indicated.
2. Coordination Drawings: Drawn to scale and coordinating acoustical tile ceiling installation with hanger attachment to building structure and ceiling mounted items. Show size and location of initial access modules.
3. Samples: For each exposed finish.
4. LEED Submittals:
   a. Product Data for Credit MR 4.1 and MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
      1) Include statement indicating costs for each product having recycled content.
   b. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
5. Field quality-control test reports.
6. Product test reports.
7. Research/evaluation reports.
8. Maintenance data.

E. Quality Assurance
1. Acoustical Testing Agency Qualifications: An independent testing laboratory, or an NVLAP-accredited laboratory, with the experience and capability to conduct the testing indicated. NVLAP-accredited laboratories must document accreditation, based on a "Certificate of Accreditation" and a "Scope of Accreditation" listing the test methods specified.
2. Fire-Test-Response Characteristics: Provide acoustical tile ceilings that comply with the following requirements:
   a. Fire-Resistance Characteristics: Where indicated, provide acoustical tile ceilings identical to those of assemblies tested for fire resistance per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
      1) Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.

2) Identify materials with appropriate markings of applicable testing and inspecting agency.

b. Surface-Burning Characteristics: Provide acoustical tiles with the following surface-burning characteristics complying with ASTM E 1264 for Class A **OR** B **OR** C, **as directed**, materials as determined by testing identical products per ASTM E 84:

1) Smoke-Developed Index: 450 or less.

3. Seismic Standard: Provide acoustical tile ceilings designed and installed to withstand the effects of earthquake motions according to the following:

a. Standard for Ceiling Suspension Systems Requiring Seismic Restraint: Comply with ASTM E 580.

b. CISCA's Recommendations for Acoustical Ceilings: Comply with CISCA's "Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings--Seismic Zones 0-2."

c. CISCA's Guidelines for Systems Requiring Seismic Restraint: Comply with CISCA's "Guidelines for Seismic Restraint of Direct-Hung Suspended Ceiling Assemblies--Seismic Zones 3 & 4."

d. IBC Standard for Metal Suspension Systems for Acoustical Tile and for Lay-in Panel Ceilings.

e. ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

4. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling

1. Deliver acoustical tiles, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

2. Before installing acoustical tiles, permit them to reach room temperature and a stabilized moisture content.

3. Handle acoustical tiles carefully to avoid chipping edges or damaging units in any way.

1.2 PRODUCTS

A. Acoustical Tiles, General

1. Acoustical Tile Standard: Provide manufacturer's standard tiles of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.

a. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from test surface per ASTM E 795.

2. Acoustical Tile Colors and Patterns: Match appearance characteristics indicated for each product type.

a. Where appearance characteristics of acoustical tiles are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by the Owner from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

3. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical tiles treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

4. Antimicrobial Fungicide Treatment: Provide acoustical tiles with face and back surfaces coated with antimicrobial treatment consisting of manufacturer's standard formulation with fungicide

added to inhibit growth of mold and mildew and showing no mold or mildew growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

B. Acoustical Tiles For Acoustical Tile Ceiling
1. Classification: Provide fire-resistance-rated, **as directed**, tiles complying with ASTM E 1264 for type, form, and pattern as follows:
a. Type III, mineral base with painted finish; Form 1, nodular **OR** 2, water felted **OR** 4, cast or molded, **as directed**.
b. Pattern: C (perforated, small holes) **OR** CD (perforated, small holes and fissured) **OR** CE (perforated, small holes and lightly textured) **OR** D (fissured) **OR** E (lightly textured) **OR** F (heavily textured) **OR** G (smooth) **OR** I (embossed) **OR** J (embossed-in-register) **OR** As indicated by manufacturer's designation, **as directed**.
2. Color: White **OR** As selected from manufacturer's full range **OR** Match sample **OR** As indicated by manufacturer's designation **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
3. LR: Not less than 0.65 **OR** 0.70 **OR** 0.75 **OR** 0.80, **as directed**.
4. NRC: Not less than 0.50 **OR** 0.55 **OR** 0.60 **OR** 0.65 **OR** 0.70, **as directed**.
5. CAC: Not less than 20 **OR** 25 **OR** 30 **OR** 35 **OR** 40, **as directed**.
6. AC: Not less than 170 **OR** 180 **OR** 190 **OR** 200 **OR** 210, **as directed**.
7. Edge/Joint Detail: Square, kerfed and rabbeted, or tongue and grooved, or butt **OR** Beveled, kerfed and rabbeted, or tongue and grooved, or butt **OR** Beveled, kerfed and rabbeted long edges and square, butt on short edges, **as directed**.
8. Thickness: 5/8 inch (15 mm) **OR** 3/4 inch (19 mm) **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
9. Modular Size: 12 by 12 inches (305 by 305 mm) **OR** 300 by 300 mm **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
10. Antimicrobial Treatment: Broad spectrum fungicide and bactericide **OR** Fungicide, **as directed**, based.

C. Metal Suspension Systems, General
1. Recycled Content: Provide products made from steel sheet with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
2. Metal Suspension System Standard: Provide manufacturer's standard metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.
3. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.
4. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
a. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing per ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
1) Type: Cast-in-place **OR** Postinstalled expansion **OR** Postinstalled bonded, **as directed**, anchors.
2) Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.
3) Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchors.
b. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without

failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E 1190, conducted by a qualified testing and inspecting agency.

5. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
   a. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
   b. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- (2.69-mm-) **OR** 0.135-inch- (3.5-mm-), **as directed**, diameter wire.
6. Hanger Rods **OR** Flat Hangers, **as directed**: Mild steel, zinc coated or protected with rust-inhibitive paint.
7. Angle Hangers: Angles with legs not less than 7/8 inch (22 mm) wide; formed with 0.04-inch- (1-mm-) thick, galvanized steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation; with bolted connections and 5/16-inch- (8-mm-) diameter bolts.
8. Seismic Struts: Manufacturer's standard compression struts designed to accommodate lateral forces.
9. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical tiles in-place.

D. Metal Suspension System For Acoustical Tile Ceiling

1. Direct-Hung, Double-Web, Fire-Rated, **as directed**, Suspension System: Main and cross runners roll formed from and capped with cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, G30 (Z90) coating designation.
   a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
   b. Access: Upward **OR** Downward, **as directed**, and end pivoted, **OR** side pivoted, **as directed**, with initial access openings of size indicated below and located throughout ceiling within each module formed by main and cross runners, with additional access available by progressively removing remaining acoustical tiles.
2. Indirect-Hung, Fire-Rated, **as directed**, Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, G30 (Z90) coating designation.
   a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
   b. Carrying Channels: Cold-rolled steel, 0.059850-inch- (1.52-mm-) minimum base (uncoated) metal thickness, not less than 3/16-inch- (4.7-mm-) wide flanges by 1-1/2-inch- (38-mm-) deep steel channels, 475 lb/1000 feet (0.707 kg/m), with rust-inhibitive paint finish **OR** hot-dip galvanized according to ASTM A 653/A 653M, G60 (Z180) coating designation, **as directed**.
   c. Access: Where access is indicated, provide special cross runners or split splines to allow for removal of acoustical units in indicated access areas. Identify access tile with manufacturer's standard unobtrusive markers for each access unit.

E. Metal Edge Moldings And Trim

1. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.
   a. Provide manufacturer's standard edge moldings that fit acoustical tile edge details and suspension systems indicated and that match width and configuration of exposed runners, unless otherwise indicated.
   b. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
2. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements and the following:
   a. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability

properties of aluminum extrusions complying with ASTM B 221 (ASTM B 221M) for Alloy and Temper 6063-T5.

b. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.

c. Conversion-Coated Finish: AA-M12C42 (Chemical Finish: cleaned with inhibited chemicals; acid-chromate-fluoride-phosphate conversion coating).

d. Conversion-Coated and Factory-Primed Finish: AA-M12C42R1x (Chemical Finish: cleaned with inhibited chemicals; acid-chromate-fluoride-phosphate conversion coating; organic coating as follows):

1) Manufacturer's standard factory-applied prime-coat finish ready for field painting.

e. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.

f. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; organic coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.

1) Organic Coating: Thermosetting, enamel primer/topcoat system with a minimum dry film thickness of 0.8 to 1.2 mils (0.02 to 0.03 mm).

F. Acoustical Sealant

1. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex sealant, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

2. Acoustical Sealant for Concealed Joints: Manufacturer's standard nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), recommended for sealing interior concealed joints to reduce airborne sound transmission.

G. Miscellaneous Materials

1. Tile Adhesive: Type recommended by tile manufacturer, bearing UL label for Class 0-25 flame spread.

a. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Staples: 5/16-inch- (8-mm-) long, divergent-point staples.

1.3 EXECUTION

A. Preparation

1. Testing Substrates: Before installing adhesively applied tiles on wet-placed substrates such as cast-in-place concrete or plaster, test and verify that moisture level is below tile manufacturer's recommended limits.

2. Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders, and comply with layout shown on reflected ceiling plans.

B. Installation, Suspended Acoustical Tile Ceilings

1. General: Install acoustical tile ceilings to comply with ASTM C 636 **OR** IBC Standard, **as directed**, and seismic design requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

a. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.

2. Suspend ceiling hangers from building's structural members and as follows:

a. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
b. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
OR
Splay hangers only where required and, if permitted with fire-resistance-rated ceilings, to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
c. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
d. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
OR
Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
e. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
f. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
g. Do not attach hangers to steel deck tabs.
h. Do not attach hangers to steel roof deck. Attach hangers to structural members.
i. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
j. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

3. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
4. Install edge moldings and trim of type indicated at perimeter of acoustical tile ceiling area and where necessary to conceal edges of acoustical tiles.
a. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
b. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.
c. Do not use exposed fasteners, including pop rivets, on moldings and trim.
5. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
6. Arrange directionally patterned acoustical tiles as follows:
a. As indicated on reflected ceiling plans.
OR
Install tiles with pattern running in one direction parallel to long **OR** short, **as directed**, axis of space.
OR

Install tiles in a basket-weave pattern.

7. Install acoustical tiles in coordination with suspension system and exposed moldings and trim. Place splines or suspension system flanges into kerfed edges so tile-to-tile joints are closed by double lap of material.
   a. Fit adjoining tile to form flush, tight joints. Scribe and cut tile for accurate fit at borders and around penetrations through tile.
   b. Hold tile field in compression by inserting leaf-type, spring-steel spacers between tile and moldings, spaced 12 inches (305 mm) o.c.
   c. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

C. Installation, Directly Attached Acoustical Tile Ceilings
1. Adhesive Installation: Install acoustical tile by bonding to substrate, using amount of adhesive and procedure recommended in writing by tile manufacturer and as follows:
   a. Remove loose dust from backs of tiles by brushing and prime them with a thin coat of adhesive.
   b. Install splines in joints between tiles; maintain level of bottom surface of tiles to a tolerance of 1/8 inch in 12 feet (3 mm in 3.6 m) and not exceeding 1/4 inch (6.35 mm) cumulatively.
   c. Maintain tight butt joints, aligned in both directions and coordinated with ceiling fixtures.
2. Stapled Installation: Fasten acoustical tile to substrate using a minimum of two staples per tile that are installed in flanges of tile and as follows:
   a. Form double-lapped joint between tiles by securely pressing tile tongues into corresponding tile grooves.
   b. Maintain level of bottom surface of tiles to a tolerance of 1/8 inch in 12 feet (3 mm in 3.6 m) and not exceeding 1/4 inch (6.35 mm) cumulatively. Shim tile or correct substrate as required to maintain tolerance.
   c. Maintain tight butt joints, aligned in both directions and coordinated with ceiling fixtures.
3. Install edge moldings and trim of type indicated at perimeter of acoustical tile ceiling area and where necessary to conceal edges of acoustical units.
4. Arrange directionally patterned acoustical tiles as follows:
   a. As indicated on reflected ceiling plans.
      OR
      Install tiles with pattern running in one direction parallel to long axis of space.
      OR
      Install tiles with pattern running in one direction parallel to short axis of space.
      OR
      Install tiles in a basket-weave pattern.

D. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
2. Tests and Inspections: Testing and inspecting of completed installations of acoustical tile ceiling hangers and anchors and fasteners shall take place in successive stages, in areas of extent and using methods as follows. Do not proceed with installations of acoustical tile ceiling hangers for the next area until test results for previously completed installations of acoustical tile ceiling hangers show compliance with requirements.
   a. Extent of Each Test Area: When installation of ceiling suspension systems on each floor has reached 20 percent completion but no tiles have been installed.
      1) Within each test area, testing agency will select 1 of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 200 lbf (890 N) of tension; it will also select one of every 2 postinstalled anchors used to attach bracing wires to concrete and will test them for 440 lbf (1957 N) of tension.
      2) When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.

3. Remove and replace acoustical tile ceiling hangers and anchors and fasteners that do not pass tests and inspections and retest as specified above.

E. Cleaning

1. Clean exposed surfaces of acoustical tile ceilings, including trim and edge moldings. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace tiles and other ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 09 51 23 00

Task	Specification	Specification Description
09 53 23 00	09 51 13 00	Acoustical Panel Ceilings

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SECTION 09 54 23 00 - ACOUSTICAL METAL PAN CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Acoustical metal pans and associated suspension system for interior ceilings.

B. Related Requirements:

1. Section 095113 "Acoustical Panel Ceilings" for ceilings consisting of mineral-base and glass-fiber-base acoustical panels and exposed suspension systems.
2. Section 095123 "Acoustical Tile Ceilings" for ceilings consisting of mineral-base acoustical tiles used with concealed suspension systems, stapling, or adhesive bonding.
3. Section 095423 "Linear Metal Ceilings."
4. Section 095436 "Suspended Decorative Grids."
5. Section 095753 "Security Ceiling Assemblies" for downward-locking panel and plank ceilings for use in security or detention facilities.

C. Products furnished, but not installed, under this Section include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**>.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include procedure for cutting metal pans.

B. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for recycled content.>
2. <Double click to insert sustainable design text for adhesives and sealants.>
3. <Double click to insert sustainable design text for ceilings.>
4. <Double click to insert sustainable design text for insulation.>
5. <Double click to insert sustainable design text for regional materials.>
6. <Double click to insert sustainable design text for EPDs and HPDs.>

C. Samples: For each exposed product and for each color and texture specified, 6 inches (150 mm) in size.

D. Samples for Initial Selection: For units with factory-applied finishes.

E. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below:

1. Metal Pans: Set of [**full-size**] [**6-inch- (150-mm-) square**] Samples of each type, finish, color, pattern, and texture. Show pan edge profile.

2. Exposed Suspension-System Members, Moldings, and Trim: Set of 6-inch- (150-mm-) long Samples of each type, finish, and color.
3. Sound Absorber: Sample of each type matching size of Sample metal pan.

F. Delegated Design Submittals: For design of [**seismic restraints and**]attachment devices.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which suspension systems will be attached.
3. Size and location of access modules for acoustical panels.
4. Items penetrating finished ceiling including the following:

   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Access panels.
   f. <**Insert item**>.

5. Perimeter moldings.

B. Qualification Data: For testing agency.

C. Product Test Reports: For each acoustical metal pan ceiling, for tests performed by [**manufacturer and witnessed by a qualified testing agency**] [**a qualified testing agency**].

D. Evaluation Reports: For each acoustical metal pan ceiling suspension system[**and anchor and fastener type**].

E. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Acoustical Metal Pans[**with Sound Absorber**]: Full-size units equal to [**2**] <**Insert number**> percent of quantity installed.
2. Suspension-System Components: Quantity of each grid, exposed molding, and trim equal to [**2**] <**Insert number**> percent of quantity installed.
3. Hold-Down Clips: [**Equal to 2 percent of quantity installed**] <**Insert number**>.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to NVLAP for testing indicated.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup of typical ceiling area as indicated on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical metal pans, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they are protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Handle acoustical metal pans, suspension-system components, and accessories carefully to avoid damaging units and finishes in any way.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design [**seismic restraints and**]attachment devices.

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Comply with ASTM E1264 for [**Class A**] [**Class B**] [**Class C**] materials.
2. Smoke-Developed Index: [**50**] [**450**] <**Insert value**> or less.

2.2 ACOUSTICAL METAL PANS, GENERAL

A. Source Limitations: Obtain each type of acoustical metal ceiling pan and supporting suspension system from single source from single manufacturer.

B. <Double click to insert sustainable design text for recycled content.>

C. <Double click to insert sustainable design text for recycled content of aluminum.>

D. <Double click to insert sustainable design text for recycled content of insulation.>

E. <Double click to insert sustainable design text for insulation.>

F. <Double click to insert sustainable design text for regional materials.>

G. Acoustical Panel Standard: Provide manufacturer's standard pans of configuration indicated that comply with ASTM E1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.

1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from test surface according to ASTM E795.

H. Sheet Metal Characteristics: For metal components exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, roughness, stains, or discolorations.

1. Aluminum Sheet: Rolled aluminum sheet, complying with ASTM B209 (ASTM B209M); alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
2. Steel Sheet: Commercial-quality, cold-rolled, carbon-steel sheet; stretcher leveled; with protective coating complying with ASTM C635/C635M.

a. Painted Finishes: Electrolytic zinc-coated steel complying with ASTM A879/A879M, 13Z (40G) coating, surface treatment as recommended by finish manufacturer for type of use and finish indicated.
b. Chemical/Mechanical Finishes: Uncoated steel sheet complying with ASTM A1008/A1008M with luster or bright finish as required by finisher for applying electroplating or other metallic-finishing processes.

3. Stainless Steel Sheet: Complying with ASTM A240/A240M or ASTM A666, [**Type 304**] [**Type 430**] <**Insert type**>.

I. Sound-Absorbent Fabric Layer: Provide fabric layer, sized to fit concealed surface of pan, and consisting of black, nonwoven, nonflammable, sound-absorbent material with surface-burning characteristics for flame-spread index of 25 or less and smoke-developed index of 50 or less, as determined by testing according to ASTM E84.

1. Bond fabric layer to panels in the factory with manufacturer's standard nonflammable adhesive.

J. Sound-Absorbent Pads: Provide width and length to completely fill concealed surface of pan, with surface-burning characteristics for flame-spread index of 25 or less and smoke-developed index of 50 or less, as determined by testing according to ASTM E84, and to comply with the following requirements:

1. Plastic Sheet-Wrapped, Mineral-Fiber Insulation: Pads consisting of nonrigid, PVC plastic sheet encapsulating unfaced mineral-fiber insulation complying with ASTM C553, Type I, Type II, or Type III, and as follows:

a. Mineral-Fiber Type and Thickness: Glass fiber; [**1 inch (25 mm)**] [**1-1/2 inches (38 mm)**] [**3 inches (76 mm)**] <**Insert dimension**>.
b. Mineral-Fiber Density: [**3/4 lb/cu. ft. (12 kg/cu. m)**] [**1 lb/cu. ft. (16 kg/cu. m)**] [**1-1/2 lb/cu. ft. (24 kg/cu. m)**] <**Insert value**>.
c. Plastic Sheet Thickness and Color: Not less than 0.003 inch (0.076 mm); [**clear**] [**flat black**] [**white**].

2. Unwrapped, Glass-Fiber Insulation: Black coated, unfaced, complying with ASTM C553, Type I, Type II, or Type III; treated to be nondusting; [**1 inch (25 mm)**] [**1-1/2 inches (38 mm)**] <**Insert dimension**> thick.
3. Spacer Grids: Provide manufacturer's standard [**aluminum**] [**galvanized-steel**] grid units that provide an air cushion between metal pans and insulation pads and that act to improve sound absorption.

K. Sound Attenuation Panels: Provide manufacturer's standard [**aluminum**] [**galvanized-steel**] unperforated metal backing unit that acts as a sound attenuation pan to reduce sound travel through ceiling plenum into adjoining rooms.

1. Sound-Absorbent Pads: Provide secondary sound-absorbent pads, [**same as specified for primary sound-absorbent pads**] <**Insert requirements**>, for placement over sound attenuation pan to reduce plenum sound.

L. Adhesive: Manufacturer's standard nonflammable adhesive for sound-absorbent [**fabric**] [**and**] [**pads**].

1. <u><Double click to insert sustainable design text for VOC content of adhesive.></u>
2. <u><Double click to insert sustainable design text for low emitting adhesives.></u>

2.3 ALUMINUM PANS FOR ACOUSTICAL METAL PAN CEILING <**Insert drawing designation**>

A. <u><Double click here to find, evaluate, and insert list of manufacturers and products.></u>

B. Classification: Units complying with ASTM E1264 for [**Type VII, perforated aluminum facing (pan) with mineral- or glass-fiber-base backing**] [**Type XX, other types described as perforated aluminum facing (pan) units with sound-absorbent fabric backing**] [**Type XX, other types described as unperforated aluminum facing (pan) units**] <**Insert Type XX description**>.

1. Pattern A: (Perforated, regularly spaced large holes), arranged in [**diagonal**] [**parallel**] alignment to pan edge with uniform perforations of dimension, holes per square foot or inch, and percent open area as [**indicated by product designation**] [**selected from manufacturer's full range**].
2. Pattern B: (Perforated, small holes) regularly spaced, with uniform perforations of dimension, holes per square foot or inch, and percent open area as [**specified by product designation**] [**selected from manufacturer's full range**].
3. Pattern: <**Insert pattern designation for perforated pans and any requirements for perforation alignment, hole shape and size, holes per square foot or inch, percent open area, and border requirements**>.

C. Pan Fabrication: Manufacturer's standard units of size, profile, and edge treatment indicated, formed from metal indicated and finished to comply with requirements indicated.

1. Lay-in Pans: Formed to set in exposed suspension grid.
2. Clip-in Pans: Designed to clip in and be securely retained in exposed suspension grid by formed edges or accessory clips provided by manufacturer.
3. Snap-in Pans: Designed with dimples or continuous beads on flanges for snap-in, secure engagement with concealed suspension system.
4. Torsion-Spring-Hinged Pans: Designed to be securely retained in preslotted, exposed suspension grid by torsion springs provided by manufacturer.
5. <**Insert type and description**>.

D. Pan Thickness: Not less than [**0.019 inch (0.5 mm)**] [**0.025 inch (0.6 mm)**] [**0.032 inch (0.8 mm)**] [**0.040 inch (1.0 mm)**] <**Insert dimension**>.

E. Pan Edge Detail: [**Square**] [**Beveled**] [**Reveal**] [**Manufacturer's standard edge detail**].

F. Pan Joint Detail: [**Butt**] [**Wide reveal, not less than 15/16 inch (24 mm) wide**] [**Narrow reveal, not greater than 9/16 inch (15 mm) wide**] [**Flush narrow reveal, not greater than 9/16 inch (15 mm) wide**] <**Insert description**>.

G. Pan Size: [**12 by 12 inches (305 by 305 mm)**] [**12 by 24 inches (305 by 610 mm)**] [**12 by 36 inches (305 by 915 mm)**] [**24 by 24 inches (610 by 610 mm)**] [**24 by 48 inches (610 by 1220 mm)**] [**24 by 60**

inches (610 by 1525 mm)] [**30 by 30 inches (760 by 760 mm)**] [**30 by 60 inches (760 by 1525 mm)**] [**As indicated on Drawings**] <**Insert dimensions**>.

H. Scoring: Score pans at intervals to appear as [**12-by-12-inch (305-by-305-mm)**] <**Insert dimensions**> ceiling units.

I. Pan Face Finish: [**Mill**] [**Lacquered mill**] [**Clear anodized**] [**Clear mirror anodized**] [**Painted white**] [**Painted to match color indicated by product designation**] [**Painted to match Architect's sample**] [**Painted in color selected from manufacturer's full range**] [**Bright-reflective metallic finish selected from manufacturer's full range**] <**Insert finish**>.

J. Light Reflectance Coefficient: Not less than [**0.70**] [**0.75**] <**Insert number**>.

K. NRC: Not less than [**0.60**] [**0.65**] [**0.70**] [**0.75**] [**0.80**] [**0.85**] [**0.90**] [**0.95**] <**Insert number**>.

L. Ceiling Attenuation Class: Not less than [**35**] [**40**] [**45**] <**Insert number**>.

2.4 STEEL PANS FOR ACOUSTICAL METAL PAN CEILING <**Insert drawing designation**>

A. <u><Double click here to find, evaluate, and insert list of manufacturers and products.></u>

B. Classification: Units complying with ASTM E1264 for [**Type V, perforated steel facing (pan) with mineral- or glass-fiber-base backing**] [**Type XX, other types described as perforated steel facing (pan) units with sound-absorbent fabric backing**] [**Type XX, other types described as unperforated steel facing (pan) units**] <**Insert Type XX description**>.

1. Pattern A: (Perforated, regularly spaced large holes), arranged in [**diagonal**] [**parallel**] alignment to pan edge with uniform perforations of dimension, holes per square foot or inch, and percent open area as [**indicated by product designation**] [**selected from manufacturer's full range**].
2. Pattern B: (Perforated, small holes) regularly spaced, with uniform perforations of dimension, holes per square foot or inch, and percent open area as [**specified by product designation**] [**selected from manufacturer's full range**].
3. Pattern: <**Insert pattern designation for perforated pans and any requirements for perforation alignment, hole shape and size, holes per square foot or inch, and percent open area**>.

C. Pan Fabrication: Manufacturer's standard units of size, profile, and edge treatment indicated, formed from metal indicated and finished to comply with requirements indicated.

1. Lay-in Pans: Formed to set in exposed suspension grid.
2. Clip-in Pans: Designed to clip in and be securely retained in exposed suspension grid by formed edges or accessory clips provided by manufacturer.
3. Snap-in Pans: Designed with dimples or continuous beads on flanges for snap-in, secure engagement with concealed suspension system.
4. Torsion-Spring-Hinged Pans: Designed to be securely retained in preslotted, exposed suspension grid by torsion springs provided by manufacturer.
5. <**Insert type and description**>.

D. Pan Thickness: Not less than [**0.010 inch (0.25 mm)**] [**0.019 inch (0.5 mm)**] [**0.025 inch (0.6 mm)**] [**0.030 inch (0.75 mm)**] [**0.036 inch (0.9 mm)**] <**Insert dimension**>.

E. Pan Edge Detail: [**Square**] [**Beveled**] [**Reveal**] [**Manufacturer's standard edge detail**].

F. Pan Joint Detail: [**Butt**] [**Wide reveal, not less than 15/16 inch (24 mm) wide**] [**Narrow reveal, not greater than 9/16 inch (15 mm) wide**] [**Flush narrow reveal, not greater than 9/16 inch (15 mm) wide**] <**Insert description**>.

G. Pan Size: [**12 by 12 inches (305 by 305 mm)**] [**12 by 24 inches (305 by 610 mm)**] [**12 by 36 inches (305 by 915 mm)**] [**24 by 24 inches (610 by 610 mm)**] [**24 by 48 inches (610 by 1220 mm)**] [**24 by 60 inches (610 by 1525 mm)**] [**30 by 30 inches (760 by 760 mm)**] [**30 by 60 inches (760 by 1525 mm)**] [**As indicated on Drawings**] <**Insert dimensions**>.

H. Scoring: Score pans at intervals to appear as [**12-by-12-inch (305-by-305-mm)**] <**Insert dimensions**> ceiling units.

I. Pan Face Finish: [**Painted white**] [**Painted to match color indicated by product designation**] [**Painted to match Architect's sample**] [**Painted in color selected from manufacturer's full range**] [**Plated with metallic finish, as selected from manufacturer's full range**] [**Bright-reflective metallic finish selected from manufacturer's full range**] <**Insert finish**>.

J. Light Reflectance Coefficient: Not less than [**0.70**] [**0.75**] <**Insert number**>.

K. NRC: Not less than [**0.60**] [**0.65**] [**0.70**] [**0.75**] [**0.80**] [**0.85**] [**0.90**] [**0.95**] <**Insert number**>.

L. Ceiling Attenuation Class: Not less than [**35**] [**40**] [**45**] <**Insert number**>.

2.5 STAINLESS STEEL PANS FOR ACOUSTICAL METAL PAN CEILING <**Insert drawing designation**>

A. <u><Double click here to find, evaluate, and insert list of manufacturers and products.></u>

B. Classification: Units complying with ASTM E1264 for [**Type VI, perforated stainless steel facing (pan) with mineral- or glass-fiber-base backing**] [**Type XX, other types described as perforated stainless steel facing (pan) units with sound-absorbent fabric backing**] [**Type XX, other types described as unperforated stainless steel facing (pan) units**] <**Insert Type XX description**>.

1. Pattern A: (Perforated, regularly spaced large holes), arranged in parallel alignment to pan edge with uniform perforations of 0.109-inch (2.8-mm) diameter, 1800 holes/sq. ft. or inch, and 11.8 percent open area.
2. Pattern: <**Insert pattern designation for perforated pans and any requirements for perforation alignment, hole shape and size, holes per square foot or inch, and percent open area**>.

C. Pan Fabrication: Manufacturer's standard units of size, profile, and edge treatment indicated, formed from metal indicated and finished to comply with requirements indicated.

1. Lay-in Pans: Formed to set in exposed suspension grid.
2. Clip-in Pans: Designed to clip in and be securely retained in exposed suspension grid by formed edges or accessory clips provided by manufacturer.
3. Snap-in Pans: Designed with dimples or continuous beads on flanges for snap-in, secure engagement with concealed suspension system.
4. Torsion-Spring-Hinged Pans: Designed to be securely retained in preslotted, exposed suspension grid by torsion springs provided by manufacturer.
5. <**Insert type and description**>.

D. Pan Thickness: Not less than [**0.019 inch (0.5 mm)**] [**0.025 inch (0.6 mm)**] [**0.030 inch (0.76 mm)**] <**Insert dimension**>.

E. Pan Edge Detail: [**Square**] [**Beveled**] [**Reveal**] [**Manufacturer's standard edge detail**].

F. Pan Joint Detail: [**Butt**] [**Wide reveal, not less than 15/16 inch (24 mm) wide**] [**Narrow reveal, not greater than 9/16 inch (15 mm) wide**] [**Flush narrow reveal, not greater than 9/16 inch (15 mm) wide**] <**Insert description**>.

G. Pan Size: [**12 by 12 inches (305 by 305 mm)**] [**12 by 24 inches (305 by 610 mm)**] [**12 by 36 inches (305 by 915 mm)**] [**24 by 24 inches (610 by 610 mm)**] [**24 by 48 inches (610 by 1220 mm)**] [**30 by 30 inches (760 by 760 mm)**] [**As indicated on Drawings**] <**Insert dimensions**>.

H. Scoring: Score pans at intervals to appear as [**12-by-12-inch (305-by-305-mm)**] <**Insert dimensions**> ceiling units.

I. Pan Face Finish: [**Directional Satin Finish: ASTM A480/A480M No. 4**] [**Dull Satin Finish: ASTM A480/A480M No. 6**] [**Mirrorlike Reflective, Nondirectional Polish: ASTM A480/A480M No. 8**] <**Insert finish**>.

J. NRC: Not less than [**0.60**] [**0.65**] [**0.70**] [**0.75**] [**0.80**] [**0.85**] [**0.90**] [**0.95**] <**Insert number**>.

K. Ceiling Attenuation Class: Not less than [**35**] [**40**] [**45**] <**Insert number**>.

2.6 METAL SUSPENSION SYSTEMS, GENERAL

A. <Double click to insert sustainable design text for recycled content.>

B. <Double click to insert sustainable design text for regional materials.>

C. Metal Suspension System Standard: Provide manufacturer's standard metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable ASTM C635/C635M requirements.

D. Suspension Systems: Provide systems complete with carriers, runners, splice sections, connector clips, alignment clips, leveling clips, hangers, molding, trim, retention clips, load-resisting struts, and other suspension components required to support ceiling units and other ceiling-supported construction.

E. Attachment Devices: Size for 5 times the design load indicated in ASTM C635/C635M, Table 1, Direct Hung, unless otherwise indicated. Comply with seismic design requirements.

F. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E488/E488M conducted by a qualified testing agency.

G. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E1190 conducted by a qualified testing agency.

H. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
2. Stainless Steel Wire: ASTM A580/A580M, Type 304, nonmagnetic.
3. Nickel-Copper-Alloy Wire: ASTM B164, nickel copper alloy for UNS No. N04400 alloy.

4. Size: Select wire diameter so its stress at 3 times the hanger design load indicated in ASTM C635/C635M, Table 1, Direct Hung, is less than yield stress of wire, but provide not less than [**0.106-inch- (2.69-mm-)**] [**0.135-inch- (3.5-mm-)**] <**Insert dimension**> diameter wire.

I. [**Hanger Rods**] [**Flat Hangers**]: Mild steel, zinc coated or protected with rust-inhibitive paint.

J. Angle Hangers: Angles with legs not less than 7/8 inch (22 mm) wide; formed with 0.04-inch- (1.0-mm-) thick, galvanized-steel sheet complying with ASTM A653/A653M, G90 (Z275) coating designation; with bolted connections and 5/16-inch- (8-mm-) diameter bolts.

K. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.

L. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

M. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical metal pans in place.

N. Hold-Down Clips: Manufacturer's standard hold-down clips spaced to secure acoustical metal pans in place [**to molding and trim at perimeter**] [**at each pan**] <**Insert requirements**>.

O. Exposed Metal Edge Moldings and Trim: Provide exposed members as indicated or as required to comply with seismic requirements of authorities having jurisdiction, to conceal edges of and penetrations through ceiling, to conceal edges of pans and runners, for fixture trim and adapters, for fasciae at changes in ceiling height, and for other conditions; of metal and finish matching acoustical metal pan ceiling units unless otherwise indicated.

1. For Circular Penetrations of Ceiling: Fabricate edge moldings to diameter required to fit penetration exactly.

2.7 METAL SUSPENSION SYSTEM FOR ACOUSTICAL, STANDARD-GRID METAL PAN CEILING <**Insert drawing designation**>

A. <u><Double click here to find, evaluate, and insert list of manufacturers and products.></u>

B. Suspension System: For [**clip-in**] [**lay-in**] [**torsion-spring-hinged**] <**Insert type**> pans.

1. Wide-Face, Capped, Double-Web, Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytic zinc-coated or hot-dip galvanized according to ASTM A653/A653M, G30 (Z90) coating designation, with prefinished, cold-rolled, 15/16-inch- (24-mm-) wide, sheet metal caps on flanges.

a. Structural Classification: [**Intermediate**] [**Heavy**]-duty system.
b. End Condition of Cross Runners: [**Override (stepped)**] [**or**] [**butt-edge**] type.
c. Face Design: Flat, flush.
d. Cap Material: [**Steel**] [**or**] [**aluminum**] cold-rolled sheet.
e. Cap Finish: [**Painted white**] [**Painted in color as selected from manufacturer's full range**] [**Painted to match color indicated by manufacturer's designation**] [**Painted to match color of metal pan**] [**Plated with metallic finish, as selected from manufacturer's full range**] [**Plated with metallic finish indicated by manufacturer's designation**] [**Natural finish for aluminum**].

2. Narrow-Face, Capped, Double-Web, Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytic zinc-coated or hot-dip galvanized according

to ASTM A653/653M, G30 (Z90) coating designation, with prefinished, cold-rolled, 9/16-inch- (15-mm-) wide, sheet metal caps on flanges.

a. Structural Classification: [**Intermediate**] [**Heavy**]-duty system.
b. End Condition of Cross Runners: [**Override (stepped)**] [**or**] [**butt-edge**] type.
c. Face Design: [**Flat, flush**] [**Flanges formed with an integral center reveal**].
d. Cap Material: [**Steel**] [**or**] [**aluminum**] cold-rolled sheet.
e. Cap Finish: [**Painted white**] [**Painted in color as selected from manufacturer's full range**] [**Painted to match color indicated by manufacturer's designation**] [**Painted to match color of metal pan**] [**Plated with metallic finish, as selected from manufacturer's full range**] [**Plated with metallic finish indicated by manufacturer's designation**] [**Natural finish for aluminum**].

3. Narrow-Face, Uncapped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytic zinc-coated or hot-dip galvanized, to produce structural members with 9/16-inch- (15-mm-) wide faces.

a. Structural Classification: [**Intermediate**] [**Heavy**]-duty system.
b. Face Design: With [**1/8-inch- (3.2-mm-)**] [**1/4-inch- (6.35-mm-)**] wide, slotted, box-shaped flange.
c. Face Finish: Painted [**white**] [**in color as selected from manufacturer's full range**] [**to match color indicated by manufacturer's designation**] [**to match color of metal pan**].

4. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, hot-dip galvanized according to ASTM A653/A653M, G60 (Z180) coating designation, with prefinished, cold-rolled, 15/16-inch- (24-mm-) wide, aluminum caps on flanges.

a. Structural Classification: [**Intermediate**] [**Heavy**]-duty system.
b. Face Design: Flat, flush.
c. Face Finish: [**Painted white**] [**Painted to match color indicated by manufacturer's designation**] [**Painted to match color of acoustical unit**] [**Natural finish**].

5. Wide-Face, Capped, Double-Web, Stainless Steel Suspension System: Main and cross runners roll formed from and capped with Type 304 or Type 316 stainless steel sheet, with prefinished, cold-rolled, 15/16-inch- (24-mm-) wide, stainless steel caps on flanges.

a. Structural Classification: Intermediate-duty system.
b. Face Design: Flat, flush.
c. Finish: [**Directional Satin Finish: ASTM A480/A480M No. 4**] [**Dull Satin Finish: ASTM A480/A480M No. 6**] [**Mirrorlike Reflective, Nondirectional Polish: ASTM A480/A480M No. 8**] <**Insert finish**>.

6. Suspension System for Torsion-Spring-Hinged Metal Pans: Provide runners with factory-cut slots fabricated to accept torsion-spring-hinged attachment.

2.8 METAL SUSPENSION SYSTEM FOR ACOUSTICAL SNAP-IN METAL PAN CEILING <**Insert drawing designation**>

A. Manufacturers: Subject to compliance with requirements, provide products by snap-in metal pan ceiling manufacturer.

B. Indirect-Hung, Snap-[**Tee**] [**Bar**] System: Designed to support metal pans that snap into main runners, consisting of main runners connected to carrying channels that are attached by hangers to building structure, and complying with the following requirements:

1. Main Runners: Formed from the following metal:

a. Aluminum Sheet: Alloy and temper recommended by aluminum producer and finisher for type of use indicated and manufacturer's standard finish, complying with ASTM B209 (ASTM B209M).
b. Electrolytic Zinc-Coated Steel Sheet: ASTM A879/A879M, with not less than [**08Z (24G)**] <**Insert coating designation**> zinc coating.
c. Hot-Dip Galvanized Steel: ASTM A653/A653M, with not less than [**G60 (Z180)**] <**Insert coating designation**> zinc coating.
d. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 302 or Type 304, stretcher leveled, with cold-rolled mill finish.
e. Metal Sheet: Metal as standard with ceiling system manufacturer, with factory-applied protective finish complying with ASTM C635/C635M.

2. Carrying Channels:

a. Same member and metal as indicated for main runners.
b. Cold-rolled steel, not less than 0.060-inch (1.5-mm) nominal thickness of base (uncoated) metal and 7/16-inch- (11-mm-) wide flanges, [**protected with rust-inhibitive paint**] [**hot-dip galvanized according to ASTM A653/A653M, G60 (Z180) coating designation**], and as follows:

1) Depth and Weight: [**1-1/2 inches and 475 lb/1000 feet (38 mm and 215 kg/305 m)**] [**2 inches and 590 lb/1000 feet (51 mm and 268 kg/305 m)**].

C. Direct-Hung, Snap-[**Tee**] [**Bar**] System: Designed to support metal pans that snap into main runners, consisting of main runners supported by hangers attached directly to building structure, and complying with the following requirements:

1. Hangers: Angles or channels, as standard with ceiling system manufacturer, formed from same metal as main runners.
2. Main Runners: Rolled aluminum sheet; alloy and temper recommended by aluminum producer and finisher for type of use indicated and manufacturer's standard finish, complying with ASTM B209 (ASTM B209M).

D. Access Panels: For access at locations indicated, provide acoustical snap-in metal pan ceiling units, accessible by [**key or tool**] [**two access knobs; place one access knob at each end of panel near corners**].

1. Access Key or Tool: Provide manufacturer's standard key or tool for opening access panels; [**one**] [**two**] <**Insert number**>.

2.9 ACOUSTICAL SEALANT

A. Acoustical Sealant for Exposed and Concealed Joints:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Acoustical Sealant for Concealed Joints:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

C. Acoustical Sealant: Manufacturer's standard sealant complying with ASTM C834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E90.

1. Exposed and Concealed Joints: Nonsag, paintable, nonstaining latex sealant.
2. Concealed Joints: Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant.
3. <Double click to insert sustainable design text for sealants.>
4. <Double click to insert sustainable design text for sealants.>

2.10 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. High-Humidity Finish: Comply with ASTM C635/C635M requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.

2.11 ALUMINUM FINISHES

A. Mill Finish: AA-M10C10 (Mechanical Finish: as fabricated, unspecified; Chemical Finish: chemically cleaned).

B. Lacquered Mill Finish: AA-M10C10R1x (Mechanical Finish: as fabricated, unspecified; Chemical Finish: chemically cleaned; Organic Coating: as specified below).

1. Organic Coating: Manufacturer's standard clear organic coating.

C. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

D. Clear Mirror Anodic Finish: AA-M21C12A212, 0.005 mm or thicker.

E. Color-Coated Finish: Manufacturer's standard[**powder-coat**] baked paint complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.

F. Bright-Reflective Finish: Manufacturer's standard chemical/mechanical bright-reflective metallic finish complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, protective coating, and minimum thickness to produce a finish uniform in appearance and free of blisters, pits, roughness, nodules, burning, cracks, unfinished areas, and other visible defects.

2.12 METALLIC-COATED STEEL SHEET FINISHES

A. Color-Coated Finish: Manufacturer's standard[**powder-coat**] baked paint complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.

2.13 STEEL SHEET FINISHES

A. Electroplated Finish: Electroplating process complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, and minimum thickness to produce a coating uniform in appearance and free of blisters, pits, roughness, nodules, burning, cracks, unplated areas, and other visible defects.

B. Bright-Reflective Finish: Manufacturer's standard chemical/mechanical bright-reflective metallic finish complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, protective coating, and minimum thickness to produce a finish uniform in appearance and free of blisters, pits, roughness, nodules, burning, cracks, unfinished areas, and other visible defects.

2.14 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical metal pan ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical metal pan ceilings.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical metal pans to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width pans at borders, and comply with layout shown on reflected ceiling plans and coordination drawings.

3.3 INSTALLATION

A. General: Install acoustical metal pan ceiling assemblies to comply with ASTM C636/C636M[**, seismic design requirements,**] and manufacturer's written instructions.

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.

2. Splay hangers only where required[**and, if permitted with fire-resistance-rated ceilings,**] to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
4. Secure wire hangers to ceiling suspension members[**or carrying channels**] and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that do not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Secure flat, angle, channel, and rod hangers to ceiling suspension members[**or carrying channels**] and to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that does not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
8. Do not attach hangers to steel deck tabs.
9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
10. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

C. Secure bracing wires to ceiling suspension members[**or carrying channels**] and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical metal pans.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Cut acoustical metal pan units for accurate fit at borders and at interruptions and penetrations by other work through ceilings. Stiffen edges of cut units as required to eliminate evidence of buckling or variations in flatness exceeding referenced standards for stretcher-leveled metal sheet. Cut and treat edges to comply with manufacturer's written instructions.

G. Install acoustical metal pans in coordination with suspension system and exposed moldings and trim. Comply with manufacturer's installation tolerances.

1. For lay-in, square-edge pans, install pans with edges fully hidden from view by flanges of suspension-system runners and moldings.
2. For lay-in, reveal-edge pans on suspension-system runners, install pans with bottom of reveal in firm contact with top surface of runner flanges.
3. For lay-in, reveal-edge pans on suspension-system members with box-shaped flanges, install pans with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom face of runners.
4. For [**clip-in**] [**torsion-spring-hinged**] pans, position pans according to manufacturer's written instructions.
5. For snap-in pans, fit adjoining units to form flush, tight joints.
6. Align joints in adjacent courses to form uniform, straight joints parallel to room axis in both directions unless otherwise indicated.
7. Fit adjoining units to form flush, tight joints.
8. Install directionally patterned or textured metal pans in directions indicated.
9. Install sound-absorbent fabric layers in, and bond to, perforated metal pans.
10. Install sound-absorbent pads in perforated metal pans[**over metal spacer grids**].

H. Install sound attenuation panels in areas indicated by reflected ceiling plans or room finish schedules. Lay panels directly on ceiling system and close major openings to form complete coverage in required areas. Lay second sound-absorbent pads on sound attenuation panels.

I. Install hold-down clips where indicated.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: [**Owner will engage**] [**Engage**] a qualified special inspector to perform the following special inspections:

1. Seismic design compliance.

B. Testing Agency: [**Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.

C. Perform the following tests and inspections of completed installations of acoustical metal panel ceiling hangers, anchors, and fasteners in successive stages. Do not proceed with installations of acoustical metal panel ceiling hangers for the next area until test results for previously completed installations show compliance with requirements.

1. Extent of Each Test Area: When installation of ceiling suspension systems on each floor has reached 20 percent completion, but no panels have been installed.

   a. Within each test area, testing agency selects one of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and tests them for 200 lbf (890 N) of tension; it also selects one of every two postinstalled anchors used to attach bracing wires to concrete and tests them for 440 lbf (1957 N) of tension.
   b. When tested fasteners and anchors do not comply with requirements, testing agency tests those fasteners and anchors not previously tested until 20 pass consecutively and then resumes initial testing frequency.

D. Acoustical metal panel ceiling hangers, anchors, and fasteners will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 CLEANING

A. Clean exposed surfaces of acoustical metal pan ceilings, including trim and edge moldings, after removing strippable, temporary protective covering, if any. Comply with manufacturer's written instructions for stripping of temporary protective covering, cleaning, and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage, including dented and bent units.

END OF SECTION 09 54 23 00

SECTION 09 54 23 00a - LINEAR METAL CEILINGS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for linear metal ceilings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes strip linear metal pans and suspension systems for ceilings.

C. Definitions
1. LR: Light Reflectance coefficient.
2. NRC: Noise Reduction Coefficient.

D. Performance Requirements
1. Structural Performance: Exterior linear metal ceilings shall withstand exterior exposure and the effects of gravity loads and the following loads and stresses without showing permanent deformation of ceiling system components including pans and suspension system; noise or metal fatigue caused by vibration, deflection, and displacement of ceiling units; or permanent damage to fasteners and anchors.
   a. Wind Load: Uniform pressure of 20 lbf/sq. ft. (960 Pa) **OR** of 30 lbf/sq. ft. (1436 Pa) **OR** as indicated on Drawings, **as directed**, acting inward or outward.
2. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), **as directed**, material surfaces.

E. Submittals
1. Product Data: For each type of product indicated.
2. Performance Data: For installed products indicated to comply with design loads and other criteria, include structural analysis and other analytical data signed and sealed by the qualified professional engineer responsible for their preparation.
3. Samples: For each exposed finish.
4. Coordination Drawings: Drawn to scale and coordinating and showing the following:
   a. Linear pattern.
   b. Joint pattern.
   c. Ceiling suspension members.
   d. Method of attaching hangers to building structure.
   e. Ceiling-mounted items.
   f. Ceiling perimeter and penetrations through ceiling; trim and moldings.
5. Product test reports.
6. Evaluation reports.
7. Maintenance data.

F. Quality Assurance
1. Acoustical Testing Agency Qualifications: An independent testing laboratory or an NVLAP-accredited laboratory.
2. Surface-Burning Characteristics: Complying with ASTM E 1264 for Class A materials, as determined by testing identical products according to ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.

3. Seismic Standard: Comply with the following:
   a. Standard for Ceiling Suspension Systems Requiring Seismic Restraint: Comply with ASTM E 580.
   b. CISCA's Recommendations for Acoustical Ceilings: Comply with CISCA's "Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings - Seismic Zones 0-2."
   c. CISCA's Guidelines for Systems Requiring Seismic Restraint: Comply with CISCA's "Guidelines for Seismic Restraint of Direct-Hung Suspended Ceiling Assemblies - Seismic Zones 3 & 4."
   d. IBC Standard for Metal Suspension Systems for Acoustical Tile and for Lay-in Panel Ceilings.
   e. SEI/ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

G. Delivery, Storage, And Handling
1. Deliver linear metal pans, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
2. Handle linear metal pans, suspension system components, and accessories carefully to avoid damaging units and finishes in any way.

1.2 PRODUCTS

A. Linear Metal Ceiling Pans
1. Acoustical Metal Pan Standard: Provide manufacturer's standard linear metal pans of configuration indicated that comply with ASTM E 1264.
   a. Mounting Method for Measuring NRC: Type E-400.
2. Sheet Metal Characteristics: For metal components exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, roughness, stains, or discolorations.
   a. Aluminum Sheet: Roll-formed aluminum sheet, complying with ASTM B 209 (ASTM B 209M); alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
   b. Steel Sheet: Commercial-quality, cold-rolled, carbon-steel sheet; stretcher leveled; with protective coating complying with ASTM C 635.
   c. Steel Sheet: Commercial-quality, cold-rolled, carbon-steel sheet; stretcher leveled and ASTM A 591/A 591M, 40Z (12G) coating for painted finish **OR** ASTM A 1008/A 1008M for electroplating, **as directed**; with protective coating complying with ASTM C 635 and recommended by finisher for finish indicated.
   d. Stainless-Steel Sheet: Complying with ASTM A 240/A 240M, Type 304 **OR** Type 430, **as directed**.
3. Pan Fabrication: Manufacturer's standard units of size, profile, and edge treatment indicated, formed from metal indicated to snap on and be securely retained on carriers without separate fasteners, and finished to comply with requirements indicated.
4. Pan Splices: Construction same as pans, in lengths 8 to 12 inches (200 to 300 mm); with manufacturer's standard finish.
5. End Caps: Metal matching pans **OR** Plastic **OR** Manufacturer's standard material, **as directed**; fabricated to fit and conceal exposed ends of pans.
6. Filler Strips: Metal matching pans **OR** Plastic **OR** Manufacturer's standard material, **as directed**; fabricated to uninterruptedly close voids between pans.
7. Moldings and Trim: Provide manufacturer's standard moldings and trim for exposed members, and as indicated or required, for edges and penetrations of ceiling, around fixtures, at changes in ceiling height, and for other conditions; of same metal and finish as linear metal ceiling pans.

8. Sound-Absorbent Fabric Layer: Provide fabric layer, sized to fit concealed surface of pan, and consisting of black, nonwoven, nonflammable, sound-absorbent material with surface-burning characteristics for flame-spread index of 25 or less and smoke-developed index of 50 or less, as determined by testing per ASTM E 84.
   a. Bond fabric layer to pan in the factory with manufacturer's standard nonflammable adhesive.
9. Sound-Absorbent Pads: Provide width and length to completely fill between carriers, joined at center of panel, with surface-burning characteristics for flame-spread index of 25 or less and smoke-developed index of 50 or less, as determined by testing per ASTM E 84, and to comply with the following requirements:
   a. Plastic Sheet-Wrapped Mineral-Fiber Insulation: Pads consisting of nonrigid, PVC plastic sheet encapsulating unfaced mineral-fiber insulation complying with ASTM C 553, Type I, II, or III, and as follows:
      1) Mineral-Fiber Type and Thickness: Glass fiber; 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 3 inches (76 mm), **as directed**.
      2) Mineral-Fiber Density: 3/4 lb/cu. ft. (12 kg/cu. m) **OR** 1 lb/cu. ft. (16 kg/cu. m) **OR** 1-1/2 lb/cu. ft. (24 kg/cu. m), **as directed**.
      3) Plastic Sheet Thickness and Color: Not less than 0.003 inch (0.076 mm); clear **OR** flat black **OR** white, **as directed**.
   b. Unwrapped, Glass-Fiber Insulation: Black-coated, unfaced, glass-fiber insulation complying with ASTM C 553, Type I, II, or III, not less than 1-lb/cu. ft. (16-kg/cu. m) density, treated to be nondusting, and as follows:
      1) Thickness: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**.

B. Metal Suspension Systems
1. Metal Suspension Systems Standard: Provide ceiling manufacturer's standard metal suspension systems of types and finishes indicated that comply with applicable ASTM C 635 requirements.
2. Suspension Systems: Provide systems complete with carriers, splice sections, connector clips, alignment clips, leveling clips, hangers, molding, trim, retention clips, load-resisting struts, fixture adapters, and other suspension components required to support ceiling units and other ceiling-supported construction.
3. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, Direct Hung, unless otherwise indicated.
   a. Cast-in-Place and Postinstalled Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing per ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
      1) Type: Cast-in-place **OR** Postinstalled expansion **OR** Postinstalled bonded, **as directed**, anchors.
      2) Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC service condition (mild).
      3) Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchors.
      4) Corrosion Protection: Components fabricated from nickel-copper-alloy rods complying with ASTM B 164 for UNS No. N04400 alloy.
   b. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E 1190, conducted by a qualified testing and inspecting agency.
4. Wire Hangers, Braces, and Ties: Provide wire complying with the following requirements:
   a. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
   b. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304, nonmagnetic.
   c. Nickel-Copper-Alloy Wire: ASTM B 164, nickel-copper-alloy UNS No. N04400.

d. Size: Select wire diameter so its stress at 3 times the hanger design load indicated in ASTM C 635, Table 1, Direct Hung will be less than yield stress of wire, but provide not less than 0.106-inch- (2.69-mm-) **OR** 0.135-inch- (3.5-mm-), **as directed**, diameter wire.

5. Hanger Rods **OR** Flat Hangers, **as directed**: Mild steel, zinc coated or protected with rust-inhibitive paint.
6. Angle Hangers: Angles with legs not less than 7/8 inch (22 mm) wide; formed from 0.04-inch- (1.0-mm-) thick, galvanized-steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation; with bolted connections and 5/16-inch- (8-mm-) diameter bolts.
7. Carriers: Factory finished with matte-black baked finish, **as directed**.
   a. Main Carriers: Aluminum, not less than 0.240-inch (6.0-mm) rolled sheet, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, complying with ASTM B 209 (ASTM B 209M).
   b. Main Carriers: Steel, not less than 0.0209-inch (0.53-mm) nominal thickness, cold-rolled sheet, with factory-applied protective coating, complying with ASTM C 635.
      1) Electrolytic Zinc-Coated Steel: ASTM A 591/A 591M, not less than 80Z (24G), **as directed**, zinc coating.
      2) Hot-Dip Galvanized Steel: ASTM A 653/A 653M, not less than G60 (Z180), **as directed**, zinc coating.
   c. Adaptable Carriers: Manufacturer's standard carriers for direct attachment to existing suspended tees.
   d. Flexible Radial Carriers: Manufacturer's standard radial carriers.
   e. Expansion Carriers: Manufacturer's standard carriers allowing for irregularities or other unusual space conditions.
8. Carrier Splices: Same metal, profile, and finish as indicated for carriers.
9. Stabilizer Channels, Tees, and Bars: Manufacturer's standard components for stabilizing main carriers at regular intervals and at light fixtures, air-distribution equipment, access doors, and other equipment; spaced as standard with manufacturer for use indicated; and factory finished with matte-black baked finish.
10. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.
11. Exterior Bracing Channels and Angles: Cold-rolled steel, hot-dip galvanized to comply with ASTM A 653/A 653M, G60 (Z180) coating designation; size and profile as required to withstand wind load.
12. Hold-Down Clips: Manufacturer's standard hold-down clips spaced as standard with manufacturer.
13. Edge Moldings and Trim: Provide exposed members as indicated or required to comply with seismic requirements of authorities having jurisdiction, to conceal edges of penetrations through ceiling, to conceal ends of pans and carriers, for fixture trim and adapters, for fasciae at changes in ceiling height, and for other conditions; of metal and finish matching linear metal pans or extruded plastic unless otherwise indicated.
   a. For Circular Penetrations of Ceiling: Fabricate edge moldings to diameter required to fit penetration exactly.

C. Aluminum Pans And Suspension System For Linear Metal Ceiling
1. Aluminum Pans and Suspension System:
2. Classification: Units complying with ASTM E 1264 for Type XIII, aluminum strips with mineral- or glass-fiber-base backing; Form 1, perforated **OR** Type XIII, aluminum strips with mineral- or glass-fiber-base backing; Form 2, unperforated **OR** Type XX, other types described as perforated aluminum strips with sound-absorbent fabric backing, **as directed**.
3. Pan Thickness: Not less than 0.018 inch (0.46 mm) **OR** 0.022 inch (0.56 mm) **OR** 0.024 inch (0.6 mm) **OR** 0.025 inch (0.65 mm) **OR** 0.027 inch (0.7 mm) **OR** 0.032 inch (0.8 mm) **OR** 0.040 inch (1.0 mm), **as directed**.
4. Pan Edge Detail: Beveled **OR** Square **OR** Round **OR** Manufacturer's standard edge detail, **as directed**.

5. Linear Module Width and Pan Face Width: 2-inch (51-mm) module width and 1-1/4-inch (32-mm) face width **OR** 4-inch (102-mm) module width and 3-1/4-inch (83-mm) face width **OR** 6-inch (152-mm) module width and 5-1/4-inch (133-mm) face width **OR** 8-inch (203-mm) module width and 7-1/4-inch (184-mm) face width **OR** 100-mm module width and 80-mm face width **OR** 200-mm module width and 180-mm face width **OR** 300-mm module width and 280-mm face width **OR** As indicated on Drawings, **as directed**.
6. Pan Depth: 5/8 inch (16 mm) deep **OR** 3/4 inch (19 mm) deep **OR** Not less than 1 to 1-1/2 inches (25 to 38 mm) deep **OR** 15 mm deep **OR** As indicated, **as directed**.
7. Pan Face Finish: Mill **OR** Lacquered mill **OR** Clear anodized **OR** Clear mirror-anodized **OR** Painted white **OR** Painted to match color indicated by product designation **OR** Painted to match sample **OR** Painted in color selected from manufacturer's full range **OR** High-performance organic coating in color selected from manufacturer's full range **OR** Bright-reflective finish selected from manufacturer's full range, **as directed**.
8. End Cap, Finish of Exposed Portions: Matte black **OR** To match pan **OR** Manufacturer's standard finish, **as directed**.
9. Filler Strip Design: Recessed **OR** Flush **OR** An integral extension of pan profile **OR** Expansion, for use with expansion carriers **OR** Slotted, for air diffusion, **as directed**.
10. Filler Strip, Finish of Exposed Portions: Matte black **OR** To match pan, **as directed**.
11. LR: Not less than 0.70 **OR** 0.75, **as directed**.
12. NRC: Not less than 0.65 **OR** 0.75 **OR** 0.95, **as directed**.
13. Suspension-System Main-Carrier Material: Aluminum **OR** Electrolytic zinc-coated steel **OR** Hot-dip galvanized steel **OR** Manufacturer's standard material and protective finish, **as directed**.

D. Steel Pans And Suspension System For Linear Metal Ceiling
1. Steel Pans and Suspension System:
2. Classification: Units complying with ASTM E 1264 for Type XIII, steel strips with mineral- or glass-fiber-base backing; Form 1, perforated **OR** Type XIII, steel strips with mineral- or glass-fiber-base backing; Form 2, unperforated **OR** Type XX, other types described as perforated steel strips with sound-absorbent fabric backing, **as directed**.
3. Pan Thickness: Not less than 0.015 inch (0.4 mm) **OR** 0.020 inch (0.5 mm) **OR** 0.024 inch (0.6 mm) **OR** 0.030 inch (0.75 mm), **as directed**.
4. Pan Edge Detail: Beveled **OR** Square **OR** Round **OR** Manufacturer's standard edge detail, **as directed**.
5. Linear Module Width and Pan Face Width: 2-inch (51-mm) module width and 1-1/4-inch (32-mm) face width **OR** 4-inch (102-mm) module width and 3-1/4-inch (83-mm) face width **OR** 6-inch (152-mm) module width and 5-1/4-inch (133-mm) face width **OR** 8-inch (203-mm) module width and 7-1/4-inch (184-mm) face width **OR** As indicated on Drawings, **as directed**.
6. Pan Depth: 5/8 inch (16 mm) deep **OR** 3/4 inch (19 mm) deep **OR** Not less than 1 to 1-1/2 inches (25 to 38 mm) deep **OR** 15 mm deep **OR** As indicated, **as directed**.
7. Pan Face Finish: Painted white **OR** Painted to match color indicated by product designation **OR** Painted to match sample **OR** Painted in color selected from manufacturer's full range **OR** Electroplated finish selected from manufacturer's full range, **as directed**.
8. End Cap, Finish of Exposed Portions: Matte black **OR** To match pan **OR** Manufacturer's standard finish, **as directed**.
9. Filler Strip Design: Recessed **OR** Flush **OR** An integral extension of pan profile **OR** Expansion, for use with expansion carriers **OR** Slotted, for air diffusion, **as directed**.
10. Filler Strip, Finish of Exposed Portions: Matte black **OR** To match pan, **as directed**.
11. LR: Not less than 0.70 **OR** 0.75, **as directed**.
12. NRC: Not less than 0.65 **OR** 0.75 **OR** 0.95, **as directed**.
13. Suspension-System Main-Carrier Material: Aluminum **OR** Electrolytic zinc-coated steel **OR** Hot-dip galvanized steel **OR** Manufacturer's standard material and protective finish, **as directed**.

E. Stainless-Steel Pans And Suspension System For Linear Metal Ceiling
1. Stainless-Steel Pans and Suspension System:
2. Classification: Units complying with ASTM E 1264 for Type XIII, stainless-steel strips with mineral- or glass-fiber-base backing; Form 1, perforated **OR** Type XIII, stainless-steel strips with

mineral- or glass-fiber-base backing; Form 2, unperforated **OR** Type XX, other types described as perforated stainless-steel strips with sound-absorbent fabric backing, **as directed**.

3. Pan Thickness: Not less than 0.016 inch (0.396 mm) **OR** 0.019 inch (0.475 mm), **as directed**.
4. Pan Edge Detail: Manufacturer's standard edge detail, **as directed**.
5. Linear Module Width and Pan Face Width: 2-inch (51-mm) module width and 1-1/4-inch (32-mm) face width **OR** 4-inch (102-mm) module width and 3-1/4-inch (83-mm) face width **OR** 6-inch (152-mm) module width and 5-1/4-inch (133-mm) face width **OR** 8-inch (203-mm) module width and 7-1/4-inch (184-mm) face width **OR** As indicated on Drawings, **as directed**.
6. Pan Depth: 5/8 inch (16 mm) deep **OR** As indicated, **as directed**.
7. Pan Face Finish: Brushed, directional polish **OR** Satin, directional polish **OR** Mirrorlike reflective, nondirectional polish, **as directed**.
8. End Cap, Finish of Exposed Portions: Matte black **OR** To match pan **OR** Manufacturer's standard finish, **as directed**.
9. Filler Strip Design: Recessed **OR** Flush **OR** An integral extension of pan profile **OR** Expansion, for use with expansion carriers **OR** Slotted, for air diffusion, **as directed**.
10. Filler Strip, Finish of Exposed Portions: Matte black **OR** To match pan, **as directed**.
11. NRC: Not less than 0.65 **OR** 0.75 **OR** 0.95, **as directed**.
12. Suspension-System Main-Carrier Material: Aluminum **OR** Electrolytic zinc-coated steel **OR** Hot-dip galvanized steel **OR** Manufacturer's standard material and protective finish, **as directed**.

F. Accessories

1. Access Panels: For access at locations indicated, provide door hinge assembly, retainer clip, and retainer bar, assembled with ceiling panels and carrier sections into access doors of required size, permitting upward or downward opening.

G. General Finish Requirements

1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

H. Aluminum Finishes

1. Mill Finish: AA-M10C10.
2. Lacquered Mill Finish: AA-M10C10R1x with manufacturer's standard clear, organic coating.
3. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
4. Clear Mirror Anodic Finish: AA-M21C12A212, 0.005 mm or thicker.
5. Color-Coated Finish: Manufacturer's standard powder-coat baked paint finish complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.
6. High-Performance Organic Finish: 2-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
7. Bright-Reflective Finish: Manufacturer's standard chemical/mechanical bright-reflective metallic finish complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, protective coating, and minimum thickness to produce a finish uniform in appearance and free of blisters, pits, roughness, nodules, burning, cracks, unfinished areas, and other visible defects.

I. Galvanized-Steel Sheet Finishes

1. Color-Coated Finish: Manufacturer's standard powder-coat baked paint finish complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.

J. Steel Sheet Finishes
1. Electroplated Finish: Electroplating process complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, and minimum thickness to produce a coating uniform in appearance and free of blisters, pits, roughness, nodules, burning, cracks, unplated areas, and other visible defects.
2. Bright-Reflective Finish: Manufacturer's standard chemical/mechanical bright-reflective metallic finish complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, protective coating, and minimum thickness to produce a finish uniform in appearance and free of blisters, pits, roughness, nodules, burning, cracks, unfinished areas, and other visible defects.

K. Stainless-Steel Finishes
1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
a. Run grain of directional finishes with long dimension of each piece.
b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

1.3 EXECUTION

A. Installation
1. Comply with ASTM C 636 **OR** IBC Standard, **as directed**, and seismic requirement indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
2. Suspend ceiling hangers from building's structural members and as follows:
a. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
b. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
c. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
d. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate to which hangers are attached and for type of hanger involved.
e. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
f. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
g. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
h. Do not attach hangers to steel deck tabs.
i. Do not attach hangers to steel roof deck. Attach hangers to structural members.
j. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.

k. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

3. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers but without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
4. Install edge moldings and trim of type indicated at perimeter of linear metal ceiling area and where necessary to conceal edges and ends of linear metal pans.
   a. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.
   b. Do not use exposed fasteners, including pop rivets, on moldings and trim.
5. Install suspension system carriers so they are aligned and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
6. Cut linear metal pans for accurate fit at borders and at interruptions and penetrations by other work through ceilings. Stiffen edges of cut units as required to eliminate evidence of buckling or variations in flatness exceeding referenced standards for stretcher-leveled metal sheet.
7. Install linear metal pans in coordination with suspension system and exposed moldings and trim.
   a. Align joints in adjacent courses to form uniform, straight joints parallel to room axis in both directions unless otherwise indicated.
   b. Fit adjoining units to form flush, tight joints. Scribe and cut units for accurate fit at borders and around construction penetrating ceiling.
   c. Install pans with butt joints using internal pan splices.
      1) Joint Configuration: Aligned **OR** Aligned, every other panel length **OR** Staggered a minimum of 12 inches (300 mm) **OR** Random **OR** As indicated**, as directed**.
   d. Install directionally textured metal pans in directions indicated.
   e. Where metal pan ends are visible, install end caps unless trim is indicated.
   f. Install filler strips where indicated.
   g. Install sound-absorbent fabric layers in perforated metal pans.
   h. Install sound-absorbent pads at right angle to perforated metal pans so pads do not hang unsupported.
8. Install hold-down clips where indicated.

B. Cleaning
1. Clean exposed surfaces of linear metal ceilings, including trim and edge moldings after removing strippable, temporary protective covering if any. Comply with manufacturer's written instructions for stripping of temporary protective covering, cleaning, and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage, including dented and bent units.

END OF SECTION 09 54 23 00a

SECTION 09 63 13 00 - BRICK FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Brick flooring set on thickset mortar bed.
2. Brick flooring set in thinset mortar directly on concrete.

B. Related Requirements:

1. [**Section 071326 "Self-Adhering Sheet Waterproofing"**] [**Section 071353 "Elastomeric Sheet Waterproofing"**] [**Section 071354 "Thermoplastic Sheet Waterproofing"**] [**Section 071413 "Hot Fluid-Applied Rubberized Asphalt Waterproofing"**] [**Section 071416 "Cold Fluid-Applied Waterproofing"**] for waterproofing under brick flooring.
2. Section 079200 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in brick flooring.
3. Section 096313.35 "Chemical-Resistant Brick Flooring" for brick flooring set with chemical-resistant materials.
4. Section 321400 "Unit Paving" for brick pavers installed in pavement applications (exterior) rather than as flooring (interior).

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**>.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For materials other than water and aggregates.
2. For the following:

   a. Brick.
   b. Packaged mortar mixes.
   c. Packaged grout mixes.
   d. Mortar and grout additives.
   e. Sealer.
   f. Floor polish.

B. Sustainable Design Submittals:

1. <u><Double click to insert sustainable design text for regional materials.></u>
2. <u><Double click to insert sustainable design text for flooring.></u>

C. Samples for Initial Selection: For each type of brick[**and for grout and accessories involving color selection**].

D. Samples for Verification: Full-size units of each type of brick[**with joints grouted and cured**].

1. Seal and polish Samples on one-half of exposed traffic surface.

1.4 INFORMATIONAL SUBMITTALS

A. Adhesion and Compatibility Test Reports: From latex-additive manufacturer for mortar and grout containing latex additives.

1.5 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Apply sealer and floor polish over one-half of mockup's traffic surface.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Submit to latex-additive manufacturer, for testing as indicated below, samples of flooring materials that will contact or affect mortar and grout that contain latex additives.

1. Use manufacturer's standard test methods to determine whether mortar and grout materials will obtain optimum adhesion with, and will be nonstaining to, installed brick and other materials constituting brick flooring installation.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store bricks on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

B. Deliver, store, and handle bricks that have temporary protective coating, with coated surfaces placed against other coated surfaces. Do not allow coated surfaces to come in contact with uncoated surfaces.

C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

D. Store aggregates where grading and other required characteristics can be maintained and where contamination can be avoided.

E. Store liquids in tightly closed containers protected from freezing.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not set brick flooring when air temperature or material temperature is below 40 deg F (4.4 deg C). Maintain minimum ambient temperature of 40 deg F (4.4 deg C) during installation and for 48 hours after completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of brick and joint material from single source from single manufacturer or producer.

2.2 BRICK PAVERS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Brick Pavers: Light-traffic paving brick complying with ASTM C902, [**Class SX**] [**Class MX**] [**Class NX**], [**Type I**] [**Type II**] [**Type III**], [**Application PS**] [**Application PX**] [**Application PA**], without frogs or cores in surfaces exposed to view in the completed Work.

C. <Double click to insert sustainable design text for brick.>

D. Size: [**As indicated.**] [**Actual dimensions as follows:**]

1. Thickness: [**1-1/4 inches (32 mm)**] [**1-5/8 inches (41 mm)**] [**2-1/4 inches (57 mm)**].
2. Face Dimensions: [**3-5/8 by 7-5/8 inches (92 by 194 mm)**] [**4 by 8 inches (102 by 203 mm)**] [**3-5/8 by 11-5/8 inches (92 by 295 mm)**] [**7-5/8 by 7-5/8 inches (194 by 194 mm)**].

E. Colors and Textures: [**As indicated by manufacturer's designations**] [**Match Architect's samples**] [**As selected by Architect from manufacturer's full range**].

F. Temporary Protective Coating: Precoat exposed surfaces of brick pavers[**at factory**] with a continuous film of a temporary protective coating that is compatible with brick, mortar, and grout products and can be removed without damaging grout or brick. Do not coat unexposed brick surfaces; handle brick to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.

2.3 MORTAR SETTING-BED MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or II.

B. Hydrated Lime: ASTM C207, Type S.

C. Aggregate: ASTM C144.

D. Latex Additive: [**Manufacturer's standard**] [**acrylic resin**] [**or**] [**styrene-butadiene-rubber**] water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed, and not containing a retarder.

E. Cleavage Membrane: Asphalt-saturated felt, ASTM D226/D226M, Type I (No. 15); or polyethylene sheeting, ASTM D4397, 4.0 mils (0.1 mm) thick.

F. Reinforcing Wire Fabric: Galvanized, welded-wire fabric, 2 by 2 inches (50.8 by 50.8 mm) by 0.062 inch (1.57 mm) in diameter; in compliance with ASTM A1064/A1064M.

G. Thinset Mortar: Latex-portland-cement mortar complying with ANSI A118.4.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
3. Provide prepackaged, dry-mortar mix combined with [**acrylic resin**] [**or**] [**styrene-butadiene-rubber**] liquid-latex additive at Project site.
4. Provide product that is approved by manufacturer for application thickness of [**5/8 inch (16 mm)**] <**Insert value**>.

2.4 GROUT MATERIALS

A. Sand-Portland-Cement Grout: ANSI A108.10, composed of white or gray cement and white or colored aggregate as required to produce color indicated.

1. Colored Mortar Pigments for Grout: Natural and synthetic iron and chromium oxides, compounded for use in mortar and grout mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in portland-cement grout.

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Standard Cement Grout: ANSI A118.6, sanded.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

C. High-Performance Tile Grout: ANSI A118.7, sanded.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Polymer Type:

a. Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.
b. [**Acrylic resin**] [**or**] [**styrene-butadiene rubber**] in liquid-latex form for addition to prepackaged dry-grout mix.

D. Colors: [**As indicated by manufacturer's designations**] [**Match Architect's samples**] [**As selected by Architect from manufacturer's full range**].

E. Water: Potable.

2.5 MISCELLANEOUS MATERIALS

A. Expansion- and Control-Joint-Filler Strips: ASTM D1752, cork or self-expanding cork.

B. Sealer: Colorless, stain- and slip-resistant sealer, not affecting color or physical properties of brick and grout surfaces and specifically recommended by sealer manufacturer for use indicated.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for floor treatment products.>

C. Floor Polish: ASTM D4078, formulated for use over sealer indicated, acceptable to sealer manufacturer, and specifically recommended by floor-polish manufacturer for use indicated.

1. Slip Resistance: Floor polish to have a static coefficient of friction of at least 0.5 when tested according to ASTM D2047.
2. <u><Double click to insert sustainable design text for floor treatment products.></u>

2.6 MIXES

A. General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing times, and other procedures needed to produce setting-bed and joint materials of uniform quality and with optimum performance characteristics. Discard mortars and grout when they have reached their initial set.

B. Portland-Cement-Lime Setting-Bed Mortar: ASTM C270, [**Type S**] [**Type N**], Proportion Specification.

C. Latex-Modified Portland-Cement Setting-Bed Mortar: Proportion and mix according to written instructions of liquid-latex manufacturer and as necessary to produce stiff mixture with a moist surface when bed is ready to receive brick.

D. Mortar-Bed Bond Coat: Mix neat cement and [**latex additive**] [**water**] to a creamy consistency.

E. Thinset Mortar Bond Coat: Proportion and mix according to manufacturer's written instructions.

F. Portland-Cement Bond Coat: Mix neat cement and water to a creamy consistency.

G. Thinset Mortar: Proportion and mix according to manufacturer's written instructions.

H. Job-Mixed Grout: Proportion and mix portland cement and aggregate grout to match setting-bed mortar, except omit hydrated lime and use enough water to produce a pourable mixture.

1. Pigmented Grout: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1 to 10, by weight.
2. Colored-Aggregate Grout: Produce color required by combining colored aggregates with portland cement of selected color.

I. Packaged Grout: Proportion and mix according to grout manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces indicated to receive brick flooring, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION OF SUBFLOOR

A. Sweep subfloor to remove dirt, dust, debris, and loose particles.

B. Remove substances from subfloor that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.

3.3 INSTALLATION, GENERAL

A. Do not use bricks with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in the finished Work.

B. Mix bricks from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C. Cut bricks with motor-driven masonry saw to provide clean, sharp, unchipped edges. Hammer cutting is not acceptable. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible.

D. Joint Pattern: [**Running bond**] [**Herringbone**] [**Basket weave**] [**As indicated**] [**Match existing brick flooring joint pattern**].

E. Hand-Tight Joints: Set brick with hand-tight joints[**where indicated**].

F. Spaced Joint Widths: Provide nominal [**3/8-inch (10-mm)**] [**1/2-inch (13-mm)**] joint width with variations not exceeding plus or minus [**1/16 inch (1.6 mm)**] [**1/8 inch (3 mm)**] [**unless otherwise indicated**].

G. Finished-Surface Tolerances:

1. Do not exceed 1/32-inch (1-mm) brick-to-brick offset from flush (lippage) or 1/8 inch in 10 feet (3 mm in 3 m) from level, or indicated slope, for finished surface of brick flooring.
2. Do not exceed 1/16-inch (1.5-mm) brick-to-brick offset from flush (lippage) nor 1/8 inch in 24 inches (3 mm in 600 mm) and 1/4 inch in 10 feet (6 mm in 3 m) from level, or indicated slope, for finished surface of brick flooring.

H. Expansion and Control Joints: Provide for sealant-filled joints at locations and of widths indicated. Provide joint filler as backing for sealant-filled joints where indicated. Install joint filler before setting brick flooring. Sealant materials and installation are specified in Section 079200 "Joint Sealants."

3.4 THICKSET BRICK FLOORING

A. Apply mortar bed to concrete subfloors to comply with the following requirements:

1. Saturate concrete subfloor with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.
2. Apply mortar-bed bond coat over surface of concrete subfloor about 15 minutes before placing mortar bed. Do not exceed 1/16-inch (1.6-mm) thickness. Limit area of mortar-bed bond coat to avoid its drying out before placing setting bed.
3. Place reinforcing wire fabric over mortar-bed bond coat, lapped at joints by at least one full mesh and supported so mesh becomes embedded in the middle of setting bed. Hold edges back from vertical surfaces approximately 1/2 inch (13 mm).
4. Apply mortar bed immediately after applying mortar-bed bond coat. Spread and screed setting bed to uniform thickness at elevations required for accurate setting of brick to finished elevations indicated.
5. Brick Wet Set on Workable Mortar Bed: Mix and place only that amount of mortar bed that can be covered with brick before initial set. Cut back, bevel edge, and discard setting-bed material that has reached initial set before placing brick.
6. Brick Set on Cured Mortar Bed: Cure mortar bed for not less than 20 hours at 70 deg F (21 deg C).

B. Apply mortar bed over [**cleavage membrane**] [**waterproofing**] to comply with the following requirements:

1. Place cleavage membrane over subfloor surfaces indicated to receive brick flooring, lapped at least 4 inches (100 mm) at joints.
2. Place reinforcing wire fabric over membrane, lapped at joints by at least one full mesh and supported so mesh becomes embedded in the middle of setting bed. Hold edges back from vertical surfaces approximately 1/2 inch (13 mm).
3. Place mortar bed over cleavage membrane with reinforcing wire fabric fully embedded in middle of setting bed. Spread and screed setting bed to uniform thickness at elevations required for accurate setting of brick to finished elevations indicated.
4. Brick Wet Set on Workable Mortar Bed: Mix and place only that amount of mortar bed that can be covered with brick before initial set. Cut back, bevel edge, and discard setting-bed material that has reached initial set before placing brick.
5. Brick Set on Cured Mortar Bed: Cure mortar bed for not less than 20 hours at 70 deg F (21 deg C).

C. Install brick either in workable mortar bed or over cured mortar bed at Contractor's option.

D. Install brick in workable mortar bed to comply with the following requirements:

1. Wet brick before laying if the initial rate of absorption exceeds 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested according to ASTM C67. Allow brick to absorb the water so it is damp but not wet at the time of laying.
2. Place brick before initial set of mortar takes place. Immediately before placing brick on setting bed, apply uniform 1/16-inch- (1.6-mm-) thick bond coat to mortar bed or to back of each brick with a flat trowel.
3. Tamp or beat brick with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each brick in a single operation before initial set of mortar; do not return to areas already set and disturb bricks for purposes of realigning finished surfaces or adjusting joints.

E. Install brick over cured mortar bed to comply with the following requirements:

1. Wet brick before laying if the initial rate of absorption exceeds 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested according to ASTM C67. Allow brick to absorb the water so it is damp but not wet at the time of laying.
2. Apply thinset mortar to setting bed with notched trowel complying with manufacturer's specifications for notch depth and configuration and in heavy enough layer to provide a minimum mortar-bed thickness of 3/32 to 1/8 inch (2.5 to 3 mm) after bricks are fully embedded. Key the mortar into setting bed with flat side of trowel and comb with notched side of trowel in one direction. Apply only as much mortar as can be covered with brick before initial set (15 to 30 minutes).
3. Place brick while thinset mortar is still tacky and before initial set takes place. Immediately before placing brick on setting bed, apply skim coat of thinset mortar to back of brick. Place brick by sliding in direction perpendicular to combed ridges, and tamp or beat brick with a small beating block to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances; do not return to areas already set and disturb bricks for purposes of realigning finished surfaces or adjusting joints.

3.5 THINSET BRICK FLOORING

A. Install brick flooring on concrete subfloor with thinset mortar to comply with the following requirements:

1. Wet brick before laying if the initial rate of absorption exceeds 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested according to ASTM C67. Allow brick to absorb the water, so it is damp but not wet at the time of laying.
2. Apply thinset mortar to subfloor with notched trowel complying with manufacturer's specifications for notch depth and configuration and in heavy enough layer to provide a minimum mortar-bed thickness of 3/32 to 1/8 inch (2.5 to 3 mm) after bricks are fully embedded. Key the mortar into substrate with flat side of trowel and comb with notched side of trowel in one direction. Apply only as much mortar as can be covered with brick before initial set (15 to 30 minutes).
3. Place brick while mortar is still tacky and before initial set takes place. Immediately before placing brick, apply skim coat of thinset mortar to back of brick. Place brick by sliding in direction perpendicular to combed ridges, and tamp or beat brick with a small beating block to obtain full contact with mortar and to bring finished surfaces within indicated tolerances; do not return to areas already set and disturb bricks for purposes of realigning finished surfaces or adjusting joints.

3.6 JOINT TREATMENT

A. Hand-Tight Joints: Sweep dry mixture of portland cement and sand into joints, then fog surface with water to set mixture.

B. Grouted Joints: Grout brick joints complying with ANSI A108.10.

C. Grout joints as soon as possible after initial set of setting bed. Force grout into joints, taking care not to smear grout on adjoining brick and other surfaces. After initial set of grout, finish joints by tooling to produce a slightly concave polished joint, free from drying cracks.

D. Cure grout by maintaining it in a damp condition for seven days unless otherwise recommended by grout manufacturer.

E. Movement Joints: Provide expansion, control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and brick. Do not saw-cut joints after installing brick flooring. Keep joint free of mortar and other rigid materials.

1. Where joints occur in concrete substrates, locate joints in brick flooring directly above them.

3.7 REPAIR, POINTING, CLEANING, AND PROTECTION

A. Remove and replace bricks that are loose or damaged or that do not match other bricks. Provide new bricks to match adjoining bricks and install in same manner as original bricks, with same joint treatment and with no evidence of replacement.

B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point up joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.

C. Cleaning: Remove excess mortar and grout from exposed brick surfaces; wash and scrub clean.

1. Remove temporary protective coating as recommended by coating manufacturer and as acceptable to brick and grout manufacturers. Trap and remove coating to prevent it from clogging drains.

D. Sealing and Polishing: After floor has been cleaned and is thoroughly dry, seal and polish traffic surface of brick flooring in a manner that results in a clear, uniform appearance. Apply sealer and floor polish in the number of coats and by application methods that comply with written directions of manufacturer of each product. Do not apply floor polish until sealer has dried.

END OF SECTION 09 63 13 00

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Task	Specification	Specification Description
09 63 43 00	09 67 16 00	Resinous Flooring

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SECTION 09 64 00 00 - WOOD FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Field-finished wood flooring.
2. Factory-finished wood flooring.
3. Sound control underlayment.

B. Related Requirements:

1. Section 096466 "Wood Athletic Flooring" for wood resilient systems used in sports-activity areas.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for recycled content.>
2. <Double click to insert sustainable design text for certified wood.>
3. <Double click to insert sustainable design text for certified wood.>
4. <Double click to insert sustainable design text for adhesives.>
5. <Double click to insert sustainable design text for coatings.>
6. <Double click to insert sustainable design text for flooring.>
7. <Double click to insert sustainable design text for composite wood.>

C. Shop Drawings: For each type of floor assembly and accessory. Include plans, sections, and attachment details. Include expansion provisions and trim details.

D. Samples: For each exposed product and for each color and texture specified, approximately [**12 inches (300 mm) long**] <**Insert dimension**> and of same thickness and material indicated for the Work and showing the full range of normal color and texture variations expected.

E. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors and finishes available for wood flooring.

1. Include Samples of accessories involving color and finish selection.

F. Samples for Verification: For each type of wood flooring and accessory, with stain color and finish required, approximately [**12 inches (300 mm) long**] <**Insert dimension**> and of same thickness and material indicated for the Work and showing the full range of normal color and texture variations expected.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Wood Flooring: Equal to [**1**] <**Insert number**> percent of amount installed for each type, color, and finish of wood flooring indicated.

1.4 QUALITY ASSURANCE

A. <Double click to insert sustainable design text for manufacturer qualifications.>

B. <Double click to insert sustainable design text for vendor qualifications.>

1.5 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver wood flooring materials in unopened cartons or bundles.

B. Protect wood flooring from exposure to moisture. Do not deliver wood flooring until after concrete, masonry, plaster, ceramic tile, and similar wet-work is complete and dry.

C. Store wood flooring materials in a dry, warm, ventilated, weathertight location.

1.7 FIELD CONDITIONS

A. Conditioning period begins not less than seven days before wood flooring installation, is continuous through installation, and continues not less than seven days after wood flooring installation.

1. Environmental Conditioning: Maintain ambient temperature between 65 and 75 deg F (18 and 24 deg C) and relative humidity planned for building occupants in spaces to receive wood flooring during the conditioning period.
2. Wood Flooring Conditioning: Move wood flooring into spaces where it will be installed, no later than the beginning of the conditioning period.

   a. Do not install flooring until it adjusts to relative humidity of, and is at same temperature as, space where it is to be installed.
   b. Open sealed packages to allow wood flooring to acclimatize immediately on moving flooring into spaces in which it will be installed.

B. After conditioning period, maintain relative humidity and ambient temperature planned for building occupants.

C. Install factory-finished wood flooring after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. <Double click to insert sustainable design text for flooring.>

B. <Double click to insert sustainable design text for certified wood.>

C. <Double click to insert sustainable design text for composite wood products.>

D. Hardwood Flooring: Comply with NWFA A500 for species, grade, and cut.

1. Certification: Provide flooring that carries NWFA grade stamp on each bundle or piece.

E. Maple Flooring: Comply with applicable MFMA grading rules for species, grade, and cut.

1. Certification: Provide flooring that carries MFMA mark on each bundle or piece.

F. Softwood Flooring: Comply with WCLIB No. 17 grading rules for species, grade, and cut.

2.2 FIELD-FINISHED WOOD FLOORING

A. Solid-Wood Flooring, Field-Finished: Kiln dried to 6 to 9 percent maximum moisture content; tongue and groove and end matched; with backs channeled.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Grade and Species: [**Clear red oak**] [**Select red oak**] [**No. 1 Common red oak**] [**No. 2 Common red oak**] [**MFMA-RL First Grade hard maple**] [**MFMA-RL Second and Better Grade hard maple**] [**Grade C & BTR - Flooring Douglas fir**] [**Grade D - Flooring Douglas fir**] <**Insert grade and species**>.
3. Cut: [**Plain sawn**] [**Quarter/rift sawn**] [**Edge grain**] [**Vertical grain**] <**Insert description**>.
4. Thickness: [**25/32 inch (20 mm)**] [**3/4 inch (19 mm)**] <**Insert dimension**>.
5. Face Width: [**2-1/4 inches (57 mm)**] [**3-1/8 inches (79 mm)**] [**5-1/8 inches (130 mm)**] <**Insert dimension**>.
6. Lengths: [**Manufacturer's standard**] [**Random-length strips complying with applicable grading rules**] [**Lengths required to form pattern indicated**] <**Insert requirements**>.
7. Simulated Wood Pegs: Contrasting wood pegs at ends of flooring pieces.

B. Solid-Wood Parquet Flooring, Field-Finished: Kiln dried to 6 to 9 percent maximum moisture content.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Species: [**Red oak**] [**White oak**] [**Ash**] [**Maple**] [**Black cherry**] <**Insert species**>.
3. Grade: <**Insert grade**>.
4. Thickness: [**5/16 inch (8 mm)**] [**11/16 inch (17 mm)**] [**1/4 inch (6 mm)**] <**Insert dimension**>.
5. Pattern: <**Insert description**>.
6. Size: <**Insert dimension**>.

C. Engineered-Wood Flooring, Field-Finished: HPVA EF[**, complying with requirements for composite wood products**].

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Species: [**Red oak**] [**White oak**] [**Ash**] [**Beech**] [**Maple**] [**Black cherry**] <**Insert species**>.
3. Grade: <**Insert grade**>.
4. Thickness: [**1/2 inch (13 mm)**] [**3/8 inch (10 mm)**] <**Insert dimension**>.
5. Construction: [**Five**] [**Three**] ply.
6. Face Width: [**2-1/4 inches (57 mm)**] [**3 inches (76 mm)**] <**Insert dimension**>.
7. Length: Manufacturer's standard.

D. Urethane Finish System: Complete [**solvent-based, oil-modified**] [**water-based**] system of compatible components that is recommended by finish manufacturer for application indicated.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for coating.>
3. <Double click to insert sustainable design text for floor treatment products.>
4. Stain: Penetrating and nonfading type.

   a. Color: [**Match sample**] [**As selected by Architect from manufacturer's full range**] <**Insert color**>.

5. Floor Sealer: Pliable, penetrating type.
6. Finish Coats: Formulated for multicoat application on wood flooring.

E. Wood Filler: Compatible with finish system components and recommended by filler and finish manufacturers for use indicated. If required to match approved Samples, provide pigmented filler.

2.3 FACTORY-FINISHED WOOD FLOORING

A. Solid-Wood Flooring, Factory-Finished: Kiln dried to 6 to 9 percent maximum moisture content; tongue and groove and end matched; with backs channeled.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Species: [**Red oak**] [**White oak**] [**Ash**] [**Birch**] [**Maple**] [**Black cherry**] [**Hickory**] [**Walnut**] <**Insert species**>.
3. Grade: <**Insert grade**>.
4. Cut: [**Plain sawn**] [**Quarter/rift sawn**] [**Edge grain**] [**Vertical grain**] <**Insert description**>.
5. Thickness: [**3/4 inch (19 mm)**] [**25/32 inch (20 mm)**] <**Insert dimension**>.
6. Face Width: [**2-1/4 inches (57 mm)**] [**3-1/8 inches (79 mm)**] [**5-1/8 inches (130 mm)**] <**Insert dimension**>.
7. Lengths: [**Random-length strips complying with applicable grading rules**] [**Lengths required to form pattern indicated**] <**Insert requirements**>.
8. Edge Style: [**Square**] [**Beveled (eased)**] <**Insert style**>.
9. Finish: UV urethane.

   a. Color: [**As selected by Architect from manufacturer's full range**] <**Insert color**>.

B. Solid-Wood Parquet Flooring, Factory-Finished: Kiln dried to 6 to 9 percent maximum moisture content.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Species: [**Red oak**] <**Insert species**>.
3. Grade: <**Insert grade**>.
4. Thickness: [**5/16 inch (8 mm)**] [**11/16 inch (17 mm)**] [**1/4 inch (6 mm)**] <**Insert dimension**>.

5. Edge Style: <**Insert style**>.
6. Pattern: <**Insert description**>.
7. Size: <**Insert dimension**>.
8. Finish: [**UV urethane**] [**Acrylic impregnated**].

   a. Color: [**As selected by Architect from manufacturer's full range**] <**Insert color**>.

C. Engineered-Wood Flooring, Factory-Finished: HPVA EF[**, complying with requirements for composite wood products**].

1. <u><Double click here to find, evaluate, and insert list of manufacturers and products.></u>
2. Species: [**Red oak**] [**White oak**] [**Ash**] [**Beech**] [**Birch**] [**Maple**] [**Black cherry**] [**Hickory**] [**Walnut**] <**Insert species**>.
3. Grade: <**Insert grade**>.
4. Thickness: [**1/2 inch (13 mm)**] [**3/8 inch (10 mm)**] <**Insert dimension**>.
5. Construction: [**Five**] [**Three**] ply.
6. Face Width: [**2-1/4 inches (57 mm)**] [**3 inches (76 mm)**] <**Insert dimension**>.
7. Length: Manufacturer's standard.
8. Edge Style: [**Square**] [**Beveled (eased)**] <**Insert style**>.
9. Finish: [**UV urethane**] [**Acrylic impregnated**].

   a. Color: [**As selected by Architect in manufacturer's full range**] <**Insert color**>.

D. Engineered-Wood Parquet Flooring, Factory-Finished: HPVA EF[**, complying with requirements for composite wood products**].

1. <u><Double click here to find, evaluate, and insert list of manufacturers and products.></u>
2. Species: [**Red oak**] [**Ash**] [**Beech**] [**Maple**] [**Walnut**] <**Insert species**>.
3. Grade: <**Insert grade**>.
4. Thickness: [**3/8 inch (10 mm)**] [**1/2 inch (13 mm)**] <**Insert dimension**>.
5. Construction: [**Five**] [**Three**] ply.
6. Edge Style: <**Insert style**>.
7. Pattern: <**Insert description**>.
8. Size: <**Insert dimension**>.
9. Finish: UV urethane.

   a. Color: [**As selected by Architect from manufacturer's full range**] <**Insert color**>.

2.4 SOUND CONTROL UNDERLAYMENT

A. Sound Control Underlayment: Sound reducing underlayment consisting of impact-absorbing materials. Minimum Impact Insulation Class (IIC) of [**50**] [**55**] <**Insert value**> when tested according to ASTM E492.

1. Material: [**Recycled rubber**] [**Polyurethane foam**] [**Wood fiber**] [**Wood fiber complying with requirements for composite wood products**] <**Insert material**>.
2. <u><Double click to insert sustainable design text for recycled content.></u>
3. Thickness: [**3/4 inch (19 mm)**] [**1/2 inch (13 mm)**] [**3/8 inch (10 mm)**] [**1/4 inch (6 mm)**] [**5/32 inch (4 mm)**] <**Insert dimension**>.

2.5 ACCESSORY MATERIALS

A. Wood Sleepers and Subfloor: [**As specified in Section 061000 "Rough Carpentry" and Section 061600 "Sheathing."**] <**Insert requirements.**>

B. Wood Underlayment: [**As specified in Section 061600 "Sheathing."**] <**Insert requirements.**>

C. Vapor Retarder: ASTM D4397, polyethylene sheet not less than [**6.0 mils (0.15 mm)**] [**8.0 mils (0.2 mm)**] thick.

D. Asphalt-Saturated Felt: ASTM D4869/D4869M, Type II.

E. Wood Flooring Adhesive: Mastic recommended by flooring and adhesive manufacturers for application indicated.

1. <Double click to insert sustainable design text for VOC content of adhesive.>
2. <Double click to insert sustainable design text for adhesives.>

F. Trowelable Leveling and Patching Compound: Latex-modified, hydraulic-cement-based formulation approved by wood flooring manufacturer.

G. Fasteners: As recommended by manufacturer, but not less than that recommended in [**NWFA's "Installation Guidelines."**] <**Insert standard or publication.**>

H. Thresholds and Saddles: To match wood flooring. Tapered on each side.

I. Reducer Strips: To match wood flooring. [**2 inches (51 mm)**] <**Insert dimension**> wide, tapered, and in thickness required to match height of flooring.

J. Cork Expansion Strip: Composition cork strip.

K. Feature Strips: [**2-inch- (51-mm-) wide, square-edged walnut strips**] <**Insert description**>, furnished in lengths as long as practical and in thickness to match wood flooring.

L. Metal Feature Strips: [**1/8-by-1/8-inch (3-by-3-mm) solid-brass strips**] <**Insert description**>, designed for inlaying into routed reveal in wood flooring surface.

M. Wood Air Vents and Grilles: To match wood flooring and in sizes and design indicated on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances, and other conditions affecting performance of wood flooring.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Concrete Slabs: Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.

1. Moisture Testing: Perform tests so that each test area does not exceed [**200 sq. ft. (18.6 sq. m)**] [**1000 sq. ft. (304.8 sq. m)**] <**Insert area**>, and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of [**3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m)**] [**4.5 lb of water/1000 sq. ft. (2.04 kg of water/92.9 sq. m)**] <**Insert emission**> in 24 hours.
b. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum [**80**] [**75**] <**Insert number**> percent relative humidity level measurement.
c. Perform additional moisture tests recommended by manufacturer. Proceed with installation only after substrates pass testing.

3.2 PREPARATION

A. Concrete Slabs:

1. Grind high spots and fill low spots to produce a maximum 1/8-inch (3-mm) deviation in any direction when checked with a 10-foot (3-m) straight edge.
2. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, and depressions in substrates.
3. Remove coatings, including curing compounds, and other substances on substrates that are incompatible with installation adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.

B. Broom or vacuum clean substrates to be covered immediately before product installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Comply with flooring manufacturer's written installation instructions, but not less than applicable recommendations in [**NWFA's "Installation Guidelines."**] <**Insert standard or publication.**>

B. Wood Sleepers and Subfloor: [**Install according to requirements in Section 061000 "Rough Carpentry" and Section 061600 "Sheathing."**] <**Insert requirements.**>

C. Wood Underlayment: [**Install according to requirements in Section 061600 "Sheathing."**] <**Insert requirements.**>

D. Provide expansion space at walls and other obstructions and terminations of flooring [**as indicated on Drawings**] [**of not less than 3/4 inch (19 mm)**] <**Insert requirements**>.

E. Vapor Retarder: Comply with the following for vapor retarder installation:

1. Wood Flooring Nailed to Wood Subfloor: Install flooring over a layer of asphalt-saturated felt.
2. Wood Flooring Nailed to Sleepers over Concrete: Install flooring over a layer of polyethylene sheet with edges overlapped over sleepers and turned up behind baseboards.
3. Wood Flooring Installed Directly on Concrete: Install a layer of polyethylene sheet according to flooring manufacturer's written instructions.

F. Sound Control Underlayment: Install over vapor retarder according to manufacturer's written instructions.

G. Solid-Wood Flooring: Blind nail or staple flooring to substrate.

1. Plank Flooring: For flooring of face width more than 3 inches (76 mm):

a. Hardwood: Install countersunk screws at each end of each piece in addition to blind nailing. Cover screw heads with wood plugs glued flush with flooring.
b. Softwood: Install no fewer than two countersunk nails at each end of each piece, spaced not more than 16 inches (406 mm) along length of each piece, in addition to blind nailing. Fill holes with matching wood filler.

H. Solid-Wood Parquet Flooring: Set in adhesive in pattern indicated on Drawings.

I. Engineered-Wood Flooring: [**Set in adhesive**] [**Nail or staple**] [**Install floating floor**].

3.4 FIELD FINISHING

A. Machine-sand flooring to remove offsets, ridges, cups, and sanding-machine marks that are noticeable after finishing. Vacuum and tack with a clean cloth immediately before applying finish.

1. Comply with applicable recommendations in [**NWFA's "Installation Guidelines."**] <**Insert standard or publication.**>

B. Fill [**open-grained hardwood**] <**Insert description of wood to be filled**>.

C. Fill and repair wood flooring defects.

D. Apply floor-finish materials in number of coats recommended by finish manufacturer for application indicated, but not less than one coat of floor sealer and [**three**] <**Insert number**> finish coats.

1. Apply stains to achieve an even color distribution matching approved Samples.
2. For water-based finishes, use finishing methods recommended by finish manufacturer to minimize grain raise.

E. Cover wood flooring before finishing.

F. Do not cover wood flooring after finishing until finish reaches full cure, and not before seven days after applying last finish coat.

3.5 PROTECTION

A. Protect installed wood flooring during remainder of construction period with covering of heavy kraft paper or other suitable material. Do not use plastic sheet or film that might cause condensation.

1. Do not move heavy and sharp objects directly over kraft-paper-covered wood flooring. Protect flooring with plywood or hardboard panels to prevent damage from storing or moving objects over flooring.

END OF SECTION 09 64 00 00

Task	Specification	Specification Description
09 64 13 00	09 64 00 00	Wood Flooring

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SECTION 09 64 23 00 - WOOD SPORTS-FLOOR ASSEMBLIES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for wood sports-floor assemblies. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes wood sports-floor assemblies.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. Shop Drawings: Show installation details including location and layout of each type of floor assembly and accessory. Include the following:
      a. Expansion provisions and trim details.
      b. Layout, colors, widths, and dimensions of game lines and markers.
      c. Locations of floor inserts for athletic equipment installed through flooring assembly.
   3. Samples: For each exposed finish.
   4. LEED Submittals:
      a. Product Data for Credit EQ 4.1: For wood sports-floor assembly installation adhesives, including printed statement of VOC content.
      b. Product Data for Credit EQ 4.2: For field-applied finishes and game-line and marker paints, including printed statement of VOC content.
      c. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood flooring complies with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
         1) Include statement indicating costs for each certified wood product.
   5. Maintenance data.

D. Quality Assurance
   1. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
   2. Installer Responsibilities: Include installation and field finishing of sports-floor assembly components and accessories, and application of game lines and markers.
   3. Forest Certification: Provide wood components produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
   4. Maple Flooring: Comply with MFMA grading rules for species, grade, and cut.
      a. Certification: Provide flooring that carries MFMA mark on each bundle or piece.

E. Delivery, Storage, And Handling
   1. Deliver assembly materials in unopened cartons or bundles.
   2. Protect wood from exposure to moisture. Do not deliver wood components until after concrete, masonry, plaster, ceramic tile, and similar wet work is complete and dry.
   3. Store wood components in a dry, warm, well-ventilated, weathertight location and in a horizontal position.

F. Field Conditions
   1. Conditioning period begins not less than seven days before sports-floor assembly installation, is continuous through installation, and continues not less than seven days after sports-floor installation.

a. Environmental Conditioning: Maintain an ambient temperature between 65 and 75 deg F (18 and 24 deg C) and relative humidity planned for building occupants, but not less than 35 percent or more than 50 percent, in spaces to receive sports-floor assemblies during the conditioning period.
b. Wood Conditioning: Move wood components into spaces where they will be installed, no later than beginning of the conditioning period.
   1) Do not install sports-floor assemblies until wood components adjust to relative humidity of, and are at same temperature as, spaces where they are to be installed.
   2) Open sealed packages to allow wood components to acclimatize immediately on moving wood components into spaces in which they will be installed.
c. After conditioning period, maintain relative humidity and ambient temperature planned for building occupants.
d. Install sports-floor assemblies after other finishing operations, including painting, have been completed.

1.2 PRODUCTS

A. Description
1. System Type: Floating **OR** Fixed **OR** Anchored resilient **OR** Portable, as directed.
2. Overall System Height: 2-1/8 inches (54 mm) **OR** 2-1/4 inches (57 mm) **OR** 2-1/2 inches (64 mm), **as directed.**

B. Performance
1. Provide wood athletic flooring systems tested by a qualified testing agency according to DIN V 18032-2 and shown to meet the following requirements:
   a. Shock Absorption: Minimum 53 percent.
   b. Vertical Deflection: Minimum 0.09 inch (2.3 mm).
   c. Area of Deflection: Maximum 15 percent.
   d. Ball Bounce: Minimum **90** percent.
   e. Surface Friction: Not less than 0.5 or more than 0.7.
   f. Rolling Loads: No damage when subjected to 337 lbf (1500 N) applied through a single wheel.

C. Flooring Material
1. Random-Length Strip Flooring: Northern hard maple (Acer saccharum), kiln dried, random length, tongue and groove, and end matched.
   a. Grade: MFMA-RL First **OR** Second and Better **OR** Third and Better, **as directed**.
      1) Exception: For areas under stacked portion of telescoping bleachers that are normally concealed from view, provide Third and Better Grade.
   b. Cut: Edge **OR** Flat, **as directed**.
   c. Thickness: 25/32 inch (20 mm) **OR** 33/32 inch (26 mm), **as directed**.
   d. Face Width: 2-1/4 inches (57 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
2. Finger-Jointed Strip Flooring: Northern hard maple (Acer saccharum), kiln dried, random length, tongue and groove, and end matched.
   a. Grade: MFMA-RL First **OR** Second and Better **OR** Third and Better, **as directed**.
      1) Exception: For areas under stacked portion of telescoping bleachers that are normally concealed from view, provide Third and Better Grade.
   b. Cut: Edge **OR** Flat, **as directed**.
   c. Thickness: 25/32 inch (20 mm) **OR** 33/32 inch (26 mm), **as directed**.
   d. Face Width: 2-1/4 inches (57 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
3. Parquet Flooring: Northern hard maple (Acer saccharum), kiln dried, edge grain, and square edge.
   a. Grade: MFMA-PQ Second and Better **OR** Third and Better, **as directed**.

b. Thickness: Not less than 5/16 inch (8 mm) **OR** 3/8 inch (10 mm) **OR** 7/16 inch (11 mm) **OR** 1/2 inch (13 mm) **OR** 11/16 inch (17 mm), **as directed**.
c. Picket Dimensions:
   1) Width: 7/8 inch (22 mm) or 1-1/8 inches (29 mm) **OR** 7/8 inch (22 mm) **OR** 1-1/8 inches (29 mm), **as directed**.
   2) Length: 6 inches (152 mm) **OR** 9 inches (229 mm), **as directed**.

D. Subfloor Materials
1. Board Underlayment: Nominal 1-by-6-inch (25-by-150-mm) graded boards; of SPIB No. 2 Southern pine, WCLIB Construction grade (any species), or WWPA No. 3 (any species), dried to 15 percent moisture content.
2. Plywood Underlayment: APA rated, C-D Plugged, exterior glue, tongue and groove, 15/32 inch (12 mm) **OR** 23/32 inch (18 mm), **as directed**, thick.
3. Wood Sleepers: Standard grade; 48 inches (1200 mm) long; kiln-dried Eastern hemlock, fir, pine, or spruce.
   a. Size: Nominal 2 by 3 inches (50 by 75 mm) **OR** 2 by 4 inches (50 by 100 mm), **as directed**.
   b. Sleeper Anchors: Manufacturer's standard, but not less than steel drive pins recommended by anchor manufacturer to achieve minimum 900-lbf (4000-N) pullout strength.
   c. Sleeper Shims: In size and type recommended in writing by flooring manufacturer for application indicated.
   d. Asphalt Primer: ASTM D 41.
   e. Asphalt Mastic: ASTM D 312, Type I, cold-applied dead-level asphalt or Type III, hot-applied steep asphalt, as recommended in writing by manufacturer.
4. Channels: Manufacturer's standard as indicated by product designation above.
   a. Channel Anchors: Manufacturer's standard but not less than modified steel drive pins recommended by anchor manufacturer to achieve minimum 900-lbf (4000-N) pullout strength.
   b. Clips: Manufacturer's standard as indicated by product designation above.
5. Resilient Pads: With air voids for resiliency and installed at manufacturer's standard spacing for product designation indicated above.
   a. Material: PVC **OR** Rubber **OR** Neoprene, **as directed**.
   b. Thickness: 3/8 inch (10 mm) **OR** 7/16 inch (11 mm) **OR** 5/8 inch (16 mm) **OR** 3/4 inch (19 mm), **as directed**.
6. Resilient Underlayment: Flexible, multicellular, closed-cell, expanded polyethylene-foam sheet; 1/2 inch (13 mm) thick; nominal 2-lb/cu. ft. (32-kg/cu. m) density, **as directed**.

E. Finishes
1. Floor-Finish System: System of compatible components recommended in writing by flooring manufacturer, and MFMA approved.
   a. Floor-Sealer Formulation: Pliable, penetrating type. MFMA Group 1, Sealers.
   b. Finish-Coat Formulation: Formulated for gloss finish indicated and multicoat application.
      1) Type: MFMA Group 3, Gymnasium-Type Surface Finishes **OR** MFMA Group 5, Water-Based Finishes, **as directed.**
   c. Game-Line and Marker Paint: Industrial enamel compatible with finish coats and recommended in writing by manufacturers of finish coats, and paint for this use.
   d. VOC Content: Provide products that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
      1) Floor Sealers and Finish Coats: VOC content of not more than 350 g/L.
      2) Game-Line and Marker Paint: VOC content of not more than 150 g/L.
   e. VOC Emissions: Provide products that comply with the maximum allowable concentrations of VOCs when tested according to California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. Accessories
1. Vapor Retarder: ASTM D 4397, polyethylene sheet not less than 6 mils (0.15 mm) thick.
2. Resilient Wall Base: Molded, vented, rubber or vinyl cove base; 4 by 3 by 48 inches (100 by 75 by 1200 mm); with premolded outside corners.
   a. Color: Black **OR** Brown, **as directed**.
3. Wood Wall Base: Nominal 1-by-3-inch (25-by-75-mm) wood base **OR** Built-up wood base as indicated on Drawings, **as directed**, matching species, grade, and cut of wood flooring.
4. Thresholds: As specified in Division 08 Section "Door Hardware".
5. Fasteners: Type and size recommended by manufacturer, but not less than those recommended by MFMA for application indicated.
6. Trowelable Leveling and Patching Compound: Latex-modified, hydraulic-cement-based formulation approved by sports-floor manufacturer.
7. Adhesives: Manufacturer's standard for application indicated.
   a. Concrete Primers: Manufacturer's standard for application indicated.
   b. Use adhesive and primer, if any, that have a VOC content of 100 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
8. Floor-Finish System: System of compatible components recommended in writing by flooring manufacturer and MFMA approved.
   a. Type: MFMA Group 3, Gymnasium Type (Surface) Finishes; urethane-oil type **OR** Group 5, Water Based Finishes; polyurethane, **as directed**.
   b. Floor-Sealer Formulation: Pliable, penetrating type.
   c. Finish-Coat Formulation: Formulated for gloss finish and multicoat application.
   d. Game-Line and Marker Paint: Industrial enamel compatible with finish coats and recommended in writing by manufacturers of finish coats, and paint for this use.
   e. VOC content: Provide products that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
      1) Floor Sealers and Finish Coats: VOC content of not more than 350 g/L.
      2) Game-Line and Marker Paint: VOC content of not more than 150 g/L.

1.3 EXECUTION

A. Preparation
1. Grind high spots and fill low spots on concrete substrates to produce a maximum 1/8-inch (3-mm) deviation in any direction when checked with a 10-foot (3-m) straight edge.
   a. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, and depressions in substrates.
2. Remove coatings including curing compounds and other substances on substrates that are incompatible with installation adhesives and that contain soap, wax, oil, or silicone; use mechanical methods recommended by manufacturer. Do not use solvents.
3. Broom and vacuum clean substrates to be covered immediately before product installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation
1. General: Comply with sports-floor assembly manufacturer's written instructions, but not less than written recommendations of MFMA applicable to flooring type indicated.
2. Pattern: Lay flooring parallel with long dimension of space to be floored, unless otherwise indicated.
3. Expansion Spaces: Provide as indicated, but not less than that required by manufacturer's written instructions and MFMA's written recommendations at walls and other obstructions, and at interruptions and terminations of flooring.
   a. Cover expansion spaces with base molding, trim, and saddles, as indicated on Drawings.
4. Vapor Retarder: Install with joints lapped a minimum of 6 inches (150 mm) and sealed.

5. Underlayment: Install perpendicular to direction of flooring, staggering end joints in adjacent rows.
6. Sleepers:
   a. Install perpendicular to direction of flooring, staggering end joints a minimum of 24 inches (610 mm).
   b. Space at spacing recommended by manufacturer for system components indicated **OR** 12 inches (305 mm) o.c. **OR** 9 inches (229 mm) o.c. **OR** 8 inches (203 mm) o.c., **as directed**.
   c. Shim and level sleepers and install anchors at spacing recommended by manufacturer, but not less than 30 inches (760 mm) o.c.
   d. Anchor predrilled sleepers through resilient pads.
7. Channels: Anchor channels to substrate according to manufacturer's written instructions.
   a. Install wood strip flooring across channels.
   b. Insert steel clip at each intersection of a flooring strip with a channel.
8. Strip Flooring: Mechanically fasten perpendicular to supports.
9. Parquet Flooring: Adhere to substrates according to manufacturer's written instructions.
10. Installation Tolerances: 1/8 inch in 10 feet (3 mm in 3 m) of variance from level.

C. Sanding And Finishing
1. Follow applicable recommendations in MFMA's "Industry Recommendations for Sanding, Sealing, Court Lining, Finishing, and Resurfacing of Maple Gym Floors."
2. Allow installed flooring to acclimate to ambient conditions for at least 10 days before sanding.
3. Machine sand with coarse, medium, and fine grades of sandpaper to achieve a level, smooth, uniform surface without ridges or cups. Remove sanding dust by tack or vacuum.
4. Finish: Apply seal and finish coats of finish system according to finish manufacturer's written instructions. Provide not less than four coats total and not less than two finish coats.
   a. Water-Based Finishes: Use finishing methods recommended by finish manufacturer to reduce grain raise and sidebonding effect.
   b. Game Lines and Markers: Apply game-line and marker paint between final seal coat and first finish coat according to paint manufacturer's written instructions.
      1) Mask flooring at game lines and markers, and apply paint to produce lines and markers with sharp edges.
      2) Where game lines cross, break minor game line at intersection; do not overlap lines.
      3) Apply game lines and markers in widths and colors according to requirements indicated on Drawings.
      4) Apply finish coats after game-line and marker paint is fully cured.

D. Protection
1. Protect sports floors during remainder of construction period to allow finish to cure and to ensure that flooring and finish are without damage or deterioration at time of Final Completion.
   a. Do not cover sports floors after finishing until finish reaches full cure, and not before seven days after applying last finish coat.
   b. Do not move heavy and sharp objects directly over sports floors. Protect fully cured floor finishes and surfaces with plywood or hardboard panels to prevent damage from storing or moving objects over sports floors.

END OF SECTION 09 64 23 00

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Task	Specification	Specification Description
09 64 23 00	09 64 00 00	Wood Flooring
09 64 29 00	09 64 00 00	Wood Flooring
09 64 29 00	09 64 23 00	Wood Sports-Floor Assemblies
09 64 66 00	09 64 00 00	Wood Flooring
09 64 66 00	09 64 23 00	Wood Sports-Floor Assemblies

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SECTION 09 65 13 13 - CORK FLOORING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for cork flooring. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Cork floor tile.
   b. Engineered cork floor tile.
   c. Cork rubber floor tile.
   d. Cork floating floor system.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Product Data for Credit MR 6.0: For cork flooring, including printed statement of costs for each rapidly renewable material.
   b. Product Data for Credit EQ 4.1: For adhesive, including printed statement of VOC content.
   c. Product Data for Credit EQ 4.2: For field-applied sealer and finish coatings, including printed statement of VOC content.
   d. Product Data for Credit EQ 4.4: For cork flooring and MDF, including printed statement indicating that the bonding agent and adhesive contain no urea-formaldehyde resins.
3. Shop Drawings: For each type of cork flooring. Include cork flooring layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
4. Samples: Full-size units of each shade and finish **OR** shade, pattern, and finish **OR** color and pattern, **as directed**, of cork flooring required.
5. Maintenance Data: For each type of cork flooring to include in maintenance manuals.

D. Quality Assurance
1. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
   a. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm **OR** Class II, not less than 0.22 W/sq. cm, **as directed**.
2. Product Certificates: For cork floating floor system, from manufacturer, certifying that MDF core contains no urea-formaldehyde resins.

E. Delivery, Storage, And Handling
1. Store cork flooring and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C). Store cork flooring on flat surfaces.

F. Project Conditions
1. Maintain ambient temperatures within range recommended by manufacturer, but not less than 65 deg F (18 deg C) or more than 75 deg F (24 deg C) where relative humidity is between 45 and 65 percent, in spaces to receive cork flooring during the following time periods:
   a. 72 hours before installation.
   b. During installation.
   c. 72 hours after installation.

2. Until Final Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 65 deg F (18 deg C) or more than 75 deg F (24 deg C).
3. Close spaces to traffic during cork flooring installation.
4. Close spaces to traffic for 72 hours after cork flooring installation.
5. Install cork flooring after other finishing operations, including painting, have been completed.

1.2 PRODUCTS

A. Cork Floor Tile
1. Cork Floor Tile: Composed of 100 percent natural cork bark and recycled cork granules and set in a natural or synthetic, flexible resin matrix; homogeneous and uniform in composition throughout the tile thickness.
2. Provide cork floor tile made with adhesives and binders that do not contain urea-formaldehyde resins.
3. Minimum Density: 30 lb/cu. ft. (480 kg/cu. m) **OR** 34 lb/cu. ft. (544 kg/cu. m) **OR** 37 lb/cu. ft. (592 kg/cu. m), **as directed**.
4. Thickness: Nominal 0.180 inch (4.8 mm) **OR** Nominal 0.312 inch (8.0 mm), **as directed**.
5. Size: 12 by 12 inches (305 by 305 mm) **OR** 12 by 24 inches (305 by 610 mm) **OR** 24 by 24 inches (610 by 610 mm), **as directed**.
6. Shade: Light **OR** Medium **OR** Dark **OR** As indicated by manufacturer's designations **OR** Match sample, **as directed**.
7. Finish: Sanded or unfinished **OR** Waxed **OR** Polyurethane **OR** Polyurethane containing UV inhibitors **OR** Acrylic **OR** As indicated by manufacturer's designations **OR** Match sample, **as directed**.

B. Engineered Cork Floor Tile
1. Engineered Cork Floor Tile: Composed of 100 percent natural cork bark and recycled cork granules with laminated, patterned cork veneers and set in a natural or synthetic, flexible resin matrix; homogeneous and uniform in composition throughout the tile thickness.
2. Provide cork floor tile made with adhesives and binders that do not contain urea-formaldehyde resins.
3. Minimum Density: 30 lb/cu. ft. (480 kg/cu. m) **OR** 34 lb/cu. ft. (544 kg/cu. m) **OR** 37 lb/cu. ft. (592 kg/cu. m), **as directed**.
4. Thickness: Nominal 0.180 inch (4.8 mm) **OR** Nominal 0.312 inch (8.0 mm), **as directed**.
5. Size: 12 by 12 inches (305 by 305 mm) **OR** 12 by 24 inches (305 by 610 mm) **OR** 24 by 24 inches (610 by 610 mm), **as directed**.
6. Shade: Light **OR** Medium **OR** Dark **OR** As indicated by manufacturer's designations **OR** Match sample, **as directed**.
7. Pattern: As indicated by manufacturer's designations **OR** Match sample, **as directed**.
8. Finish: Sanded or unfinished **OR** Waxed **OR** Polyurethane **OR** Polyurethane containing UV inhibitors **OR** Acrylic **OR** As indicated by manufacturer's designations **OR** Match sample, **as directed**.

C. Cork Rubber Floor Tile
1. Cork Rubber Floor Tile: Composed of 70 percent natural cork granules and 30 percent rubber granules combined with fade-resistant pigments; homogeneous and uniform in composition throughout the tile thickness.
2. Provide cork rubber floor tile made with adhesives and binders that do not contain urea-formaldehyde resins.
3. Physical Characteristics:
   a. Minimum Density: 78 lb/cu. ft. (1249 kg/cu. m).
   b. Minimum Tensile Strength: 700 psi (4.8 MPa).
4. Thickness: Nominal 0.125 inch (3.2 mm).
5. Size: 18 by 18 inches (450 by 450 mm).

6. Texture: Lightly textured wear surface.
7. Colors and Patterns: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from full range of industry colors, **as directed**.

D. Cork Floating Floor System
1. Cork Floating Floor System: Laminated planks made of two cork layers, top and bottom, sandwiched around an MDF core and containing no urea-formaldehyde resins.
2. Plank Density:
   a. Cork Top Layer: 28 lb/cu. ft. (448 kg/cu. m) **OR** Manufacturer's standard density, **as directed**.
   b. Interlocking MDF Core: 45 lb/cu. ft. (720 kg/cu. m) **OR** Manufacturer's standard density, **as directed**.
   c. Cork Underlayment Layer: 13 lb/cu. ft. (208 kg/cu. m) **OR** Manufacturer's standard density, **as directed**.
3. Plank Thickness: Nominal 0.450-inch (11.4-mm) overall thickness made up as follows:
   a. Cork Top Layer: Nominal 0.125 inch (3.2 mm) **OR** Manufacturer's standard dimension, **as directed**.
   b. Interlocking MDF Core: Nominal 0.250 inch (6.3 mm) **OR** Manufacturer's standard dimension, **as directed**.
   c. Cork Underlayment Layer: Nominal 0.078 inch (2.0 mm) **OR** Manufacturer's standard dimension, **as directed**.
4. Plank Size: 18 by 18 inches (450 by 450 mm) **OR** 36 by 12 inches (900 by 305 mm), **as directed**.
5. Plank Edge: Tongue-and-groove type **OR** Manufacturer's standard interlock, **as directed**.
6. Shade: Light **OR** Medium **OR** Dark **OR** As indicated by manufacturer's designations **OR** Match sample, **as directed**.
7. Pattern: As indicated by manufacturer's designations **OR** Match sample, **as directed**.
8. Finish: Sanded or unfinished **OR** Waxed **OR** Polyurethane **OR** Polyurethane containing UV inhibitors **OR** Acrylic **OR** As indicated by manufacturer's designations **OR** Match sample, **as directed**.

E. Installation Materials
1. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement-based or blended hydraulic-cement-based formulation provided or approved by cork flooring manufacturer for applications indicated.
2. Vapor Retarder: ASTM D 4397, polyethylene sheet not less than 6.0 mils (0.15 mm) **OR** 8.0 mils (0.2 mm), **as directed**, thick.
3. Adhesive: Water-resistant products as recommended by manufacturer to suit cork flooring and substrate conditions indicated.
   a. Use adhesives that have a VOC content of not more than 50 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. Field-Applied Finishes
1. Cork Sealer: Product as recommended by cork flooring manufacturer.
   a. Use sealers that have a VOC content of not more than 350 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Paste Wax: Products as recommended by cork flooring manufacturer.
3. Finish Coatings: Products containing UV inhibitors as recommended by cork flooring manufacturer.
   a. Use finish coatings that have a VOC content of not more than 350 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
4. Cork Rubber Tile Sealer: Product as recommended by cork rubber floor tile manufacturer.
   a. Use sealers that have a VOC content of not more than 350 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1.3 EXECUTION

A. Preparation

1. Prepare substrates according to cork flooring manufacturer's written instructions to ensure adhesion of cork flooring.
2. Concrete Substrates: Prepare according to ASTM F 710.
    a. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
    b. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
    c. Alkalinity and Adhesion Testing: Perform tests recommended by cork flooring manufacturer. Proceed with installation only after substrates pass testing.
    d. Moisture Testing: Perform tests recommended by cork flooring manufacturer and as follows. Proceed with installation only after substrates pass testing.
        1) Perform anhydrous calcium chloride test according to ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
        2) Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
3. Access Flooring Panels: Remove protective film of oil or other coating using method recommended by access flooring manufacturer.
4. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
5. Do not install cork flooring until materials are same temperature as space where they are to be installed.
    a. Move cork flooring products and installation materials into spaces where they will be installed at least 72 hours in advance of installation.
6. Immediately before installation, sweep and vacuum clean substrates to be covered by cork flooring products.

B. Floor Tile Installation

1. Comply with cork flooring manufacturer's written instructions for installing cork flooring.
2. Mix floor tiles from each carton together to ensure uniform distribution of shade.
3. Discard broken, cracked, chipped, or deformed floor tiles.
4. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
5. Lay floor tiles square with room axis **OR** at a 45-degree angle with room axis **OR** in ashlar or staggered joint pattern **OR** in pattern indicated, **as directed**.
6. Apply adhesive to substrate and set floor tiles in adhesive.
7. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
8. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
9. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.
10. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in finished floor areas. Maintain overall continuity of shade and finish **OR** shade, pattern, and finish **OR** color and pattern, **as directed**, between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.

C. Cork Floating Floor System Installation

1. Comply with manufacturer's written instructions for installing cork floating floor system.
2. Install continuous vapor retarder over substrate, taping side and end laps.
3. Mix floor planks from several cartons to ensure uniform distribution of shade.
4. Discard broken, cracked, chipped, or deformed floor planks.
5. Do not attach floor planks to substrate.
6. Tightly interlock and adhere plank edges with adhesive. Remove excess adhesive from top surface of planks.
7. Lay floor planks in pattern indicated.
8. Use spacers to keep planks from shifting as subsequent rows are added. Remove spacers after installing cork floating floor system.
9. Maintain expansion space at walls and other obstructions and terminations of flooring as indicated on Drawings **OR** of not less than 3/8 inch (9.5 mm), **as directed**.
10. Extend floor planks into toe spaces, door reveals, closets, and similar openings. Extend floor planks to center of door openings.
11. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor planks as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.

D. Field-Applied Finishes
1. Apply finishes according to cork flooring manufacturer's written instructions.
2. Cork Sealer: Apply one **OR** two, **as directed**, coat(s).
3. Paste Wax: Apply one **OR** two **OR** three, **as directed**, coat(s).
4. Finish Coatings: Apply two **OR** three, **as directed**, coat(s).
5. Cork Rubber Tile Sealer: Apply one **OR** two, **as directed**, coat(s).

E. Cleaning And Protection
1. Comply with manufacturer's written instructions for cleaning and protecting cork flooring.
2. Remove adhesive and other blemishes from exposed surfaces.
3. Sweep and vacuum surfaces thoroughly.
4. Damp-mop surfaces to remove marks and soil.
5. Protect cork flooring products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
6. Cover cork flooring until Final Completion.

END OF SECTION 09 65 13 13

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SECTION 09 65 13 13a - RESILIENT WALL BASE AND ACCESSORIES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for resilient wall base and accessories. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Resilient base.
      b. Resilient stair accessories.
      c. Resilient molding accessories.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittals:
      a. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
   3. Samples: For each type of product indicated, in manufacturer's standard-size Samples but not less than 12 inches (300 mm) long, of each resilient product color, texture, and pattern required.

D. Quality Assurance
   1. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
      a. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

E. Delivery, Storage, And Handling
   1. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C).

F. Project Conditions
   1. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive resilient products during the following time periods:
      a. 48 hours before installation.
      b. During installation.
      c. 48 hours after installation.
   2. Until Final Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).
   3. Install resilient products after other finishing operations, including painting, have been completed.

1.2 PRODUCTS

A. Resilient Base
   1. Resilient Base Standard: ASTM F 1861.
      a. Material Requirement: Type TV (vinyl, thermoplastic) **OR** Type TS (rubber, vulcanized thermoset) **OR** Type TP (rubber, thermoplastic), **as directed**.
      b. Manufacturing Method: Group I (solid, homogeneous) **OR** Group II (layered), **as directed**.

c. Style: Cove (base with toe) **OR** Straight (flat or toeless) **OR** Butt to (fit-to-floor), **as directed**.
2. Minimum Thickness: 0.125 inch (3.2 mm) **OR** 0.080 inch (2.0 mm), **as directed**.
3. Height: 2-1/2 inches (64 mm) **OR** 4 inches (102 mm) **OR** 6 inches (152 mm) **OR** As indicated on Drawings, **as directed**.
4. Lengths: Cut lengths, 48 inches (1219 mm) long **OR** Coils in manufacturer's standard length, **as directed**.
5. Outside Corners: Job formed **OR** Preformed, **as directed**.
6. Inside Corners: Job formed **OR** Preformed, **as directed**.
7. Finish: Satin **OR** Matte **OR** Low luster **OR** As selected from manufacturer's full range, **as directed**.
8. Colors and Patterns: As selected from full range of industry colors.

B. Resilient Stair Accessories
1. Resilient Stair Treads Standard: ASTM F 2169.
   a. Material Requirement: Type TV (vinyl, thermoplastic) **OR** Type TS (rubber, vulcanized thermoset) **OR** Type TP (rubber, thermoplastic), **as directed**.
   b. Surface Design:
      1) Class 1, Smooth (flat).
      2) Class 2, Pattern: Raised-disc design **OR** Raised-square design **OR** Raised-chevron design **OR** Raised-diamond design **OR** Raised-rib design **OR** Raised-rib design with abrasive strips, **as directed**.
   c. Manufacturing Method: Group 1, tread with embedded abrasive strips **OR** Group 2, tread with contrasting color for the visually impaired, **as directed**.
2. Nosing Style: Square, adjustable to cover angles between 60 and 90 degrees **OR** Square **OR** Round, **as directed**.
3. Nosing Height: 1-1/2 inches (38 mm) **OR** 2 inches (51 mm) **OR** 2-3/16 inches (56 mm), **as directed**.
4. Thickness: 1/4 inch (6 mm) and tapered to back edge.
5. Size: Lengths and depths to fit each stair tread in one piece **OR** one piece or, for treads exceeding maximum lengths manufactured, in equal-length units, **as directed**.
6. Risers: Smooth, flat, coved-toe, 7 inches (178 mm) high by length matching treads **OR** toeless, height and length to cover risers, **as directed**; produced by same manufacturer as treads and recommended by manufacturer for installation with treads.
   a. Thickness: 0.125 inch (3.2 mm) **OR** 0.080 inch (2.0 mm), **as directed**.
7. Stringers: Of same thickness as risers, height and length after cutting to fit risers and treads and to cover stair stringers; produced by same manufacturer as treads and recommended by manufacturer for installation with treads.
8. Colors and Patterns: As selected from full range of industry colors.

C. Resilient Molding Accessory
1. Description: Cap for cove carpet **OR** Cap for cove resilient floor covering **OR** Carpet bar for tackless installations **OR** Carpet edge for glue-down applications **OR** Nosing for carpet **OR** Nosing for resilient floor covering **OR** Reducer strip for resilient floor covering **OR** Joiner for tile and carpet **OR** Transition strips, **as directed**.
2. Material: Vinyl **OR** Rubber, **as directed**.
3. Profile and Dimensions: As indicated.
4. Colors and Patterns: As selected from full range of industry colors.

D. Installation Materials
1. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
2. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.

a. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   1) Cove Base Adhesives: Not more than 50 g/L.
   2) Rubber Floor Adhesives: Not more than 60 g/L.
3. Stair-Tread-Nose Filler: Two-part epoxy compound recommended by resilient tread manufacturer to fill nosing substrates that do not conform to tread contours.
4. Metal Edge Strips: Extruded aluminum with mill finish of width shown, of height required to protect exposed edges of tiles, and in maximum available lengths to minimize running joints.
5. Floor Polish: Provide protective liquid floor polish products as recommended by resilient stair tread manufacturer.

1.3 EXECUTION

A. Preparation
1. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
2. Concrete Substrates for Resilient Stair Treads and Accessories: Prepare according to ASTM F 710.
   a. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
   b. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
   c. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer.
   d. Moisture Testing: Perform tests recommended by manufacturer and as follows. Proceed with installation only after substrates pass testing.
      1) Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
      2) Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have maximum 75 percent relative humidity level measurement.
3. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
4. Do not install resilient products until they are same temperature as the space where they are to be installed.
   a. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
5. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

B. Resilient Base Installation
1. Comply with manufacturer's written instructions for installing resilient base.
2. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
3. Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.
4. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
5. Do not stretch resilient base during installation.
6. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
7. Preformed Corners: Install preformed corners before installing straight pieces.
8. Job-Formed Corners:
   a. Outside Corners: Use straight pieces of maximum lengths possible. Form without producing discoloration (whitening) at bends.

b. Inside Corners: Use straight pieces of maximum lengths possible.

C. Resilient Accessory Installation
1. Comply with manufacturer's written instructions for installing resilient accessories.
2. Resilient Stair Accessories:
a. Use stair-tread-nose filler to fill nosing substrates that do not conform to tread contours.
b. Tightly adhere to substrates throughout length of each piece.
c. For treads installed as separate, equal-length units, install to produce a flush joint between units.
3. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of carpet **OR** resilient floor covering, **as directed**, that would otherwise be exposed.

D. Cleaning And Protection
1. Comply with manufacturer's written instructions for cleaning and protection of resilient products.
2. Perform the following operations immediately after completing resilient product installation:
a. Remove adhesive and other blemishes from exposed surfaces.
b. Sweep and vacuum surfaces thoroughly.
c. Damp-mop surfaces to remove marks and soil.
3. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
4. Floor Polish: Remove soil, visible adhesive, and surface blemishes from resilient stair treads before applying liquid floor polish.
a. Apply one **OR** two **OR** three, **as directed**, coat(s).
5. Cover resilient products until Final Completion.

END OF SECTION 09 65 13 13a

Task	Specification	Specification Description
09 65 13 23	09 65 13 13	Cork Flooring

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SECTION 09 65 13 33 - RESILIENT FLOOR TILE

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for resilient floor tile. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Solid vinyl floor tile.
b. Rubber floor tile.
c. Vinyl composition floor tile.
d. Resilient terrazzo floor tile.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
a. Product Data for Credit EQ 4.1: For adhesives, sealants and chemical-bonding compounds, including printed statement of VOC content.
3. Shop Drawings: For each type of floor tile. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
a. Show details of special patterns.
4. Samples: Full-size units of each color and pattern of floor tile required.
5. Seam Samples: For seamless-installation technique indicated and for each flooring product, color, and pattern required; with seam running lengthwise and in center of 6-by-9-inch (150-by-230-mm) Sample applied to a rigid backing and prepared by Installer for this Project.
6. Maintenance data.

D. Quality Assurance
1. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
a. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
2. Preconstruction Testing: Use manufacturer's standard test methods to determine whether materials will obtain optimum adhesion with installed flooring material.

E. Delivery, Storage, And Handling
1. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C). Store floor tiles on flat surfaces.

F. Project Conditions
1. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive floor tile during the following time periods:
a. 48 hours before installation.
b. During installation.
c. 48 hours after installation.
2. Until Final Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).
3. Close spaces to traffic during floor tile installation.
4. Close spaces to traffic for 48 hours after floor tile installation.

5. Install floor tile after other finishing operations, including painting, have been completed.

1.2 PRODUCTS

A. Solid Vinyl Floor Tile
1. Tile Standard: ASTM F 1700.
   a. Class: As indicated by product designations **OR** Class I, monolithic vinyl tile **OR** Class II, surface-decorated vinyl tile **OR** Class III, printed film vinyl tile, **as directed**.
   b. Type: Type A, smooth surface **OR** Type B, embossed surface, **as directed**.
2. Thickness: 0.080 inch (2.0 mm) **OR** 0.100 inch (2.5 mm) **OR** 0.120 inch (3.0 mm) **OR** 0.125 inch (3.2 mm), **as directed**.
3. Size: 12 by 12 inches (305 by 305 mm) **OR** 18 by 18 inches (457 by 457 mm) **OR** 24 by 24 inches (610 by 610 mm) **OR** 36 by 36 inches (914 by 914 mm) **OR** 3 by 36 inches (76 by 914 mm), **as directed**.
4. Seaming Method: Heat welded **OR** Chemically bonded **OR** Standard, **as directed**.
5. Colors and Patterns: As selected from full range of industry colors.

B. Rubber Floor Tile
1. Tile Standard: ASTM F 1344, Class I-A, homogeneous rubber tile, solid color **OR** Class I-B, homogeneous rubber tile, through mottled **OR** Class II-A, laminated rubber tile, solid-color wear layer **OR** Class II-B, laminated rubber tile, mottled wear layer, **as directed**.
2. Hardness: Not less than 85 as required by ASTM F 1344, measured using Shore, Type A durometer per ASTM D 2240 **OR** Manufacturer's standard hardness, **as directed**.
3. Wearing Surface: Smooth **OR** Textured **OR** Molded pattern, **as directed**.
   a. Molded-Pattern Figure: Raised discs **OR** Raised squares, **as directed**.
4. Thickness: 0.125 inch (3.2 mm).
5. Size: 12 by 12 inches (305 by 305 mm) **OR** 24 by 24 inches (610 by 610 mm), **as directed**.
6. Seaming Method: Heat welded **OR** Chemically bonded **OR** Standard, **as directed**.
7. Colors and Patterns: As selected from full range of industry colors.

C. Vinyl Composition Floor Tile
1. Tile Standard: ASTM F 1066, Class 1, solid-color tile **OR** Class 2, through-pattern tile **OR** Class 3, surface-pattern tile, **as directed**.
2. Wearing Surface: Smooth **OR** Embossed, **as directed**.
3. Thickness: 0.125 inch (3.2 mm).
4. Size: 12 by 12 inches (305 by 305 mm).
5. Colors and Patterns: As selected from full range of industry colors.

D. Resilient Terrazzo Floor Tile
1. Resilient Terrazzo Floor Tile: Marble or granite chips embedded in flexible, thermoset-polyester-resin matrix; electrically nonconductive and chemical, oil, and corrosion resistive, with smooth wearing surface and manufacturer's standard factory-applied, protective urethane coating.
2. Thickness: 1/8 inch (3.0 mm) **OR** 3/16 inch (4.8 mm), **as directed**.
3. Size: 12 by 12 inches (305 by 305 mm).
4. Performance Characteristics:
   a. Compressive Strength: 2900 to 5000 psi (20 to 34.5 MPa), ASTM C 109/C 109M or ASTM D 695.
   b. Abrasion Resistance: Maximum 0.0196 cubic centimeters volume loss, ASTM F 510, Taber abrader, S-39 wheels, at 500 cycles with 1000-gram load.
   c. Static Load Limit: 0.0007-inch (0.0177-mm) maximum indentation, ASTM F 970 at 125 lb (57 kg).
   d. Resin Matrix Hardness: Not less than 78, as measured using Shore, Type D durometer per ASTM D 2240.
5. Colors and Patterns: As selected from full range of industry colors.

E. Installation Materials
1. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
2. Adhesives: Water-resistant type recommended by manufacturer to suit floor tile and substrate conditions indicated.
    a. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
        1) VCT and Asphalt Tile Adhesives: Not more than 50 g/L.
        2) Rubber Floor Adhesives: Not more than 60 g/L.
3. Seamless-Installation Accessories:
    a. Heat-Welding Bead: Manufacturer's solid-strand product for heat welding seams.
        1) Color: As selected from manufacturer's full range to contrast with floor tile **OR** Match floor tile, **as directed**.
    b. Chemical-Bonding Compound: Manufacturer's product for chemically bonding seams.
        1) Use chemical-bonding compound that has a VOC content of 350 **OR** 510, **as directed**, g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
4. Floor Polish: Provide protective liquid floor polish products as recommended by manufacturer.
5. Joint Sealant for Resilient Terrazzo Floor Tile: Silicone sealant of type and grade as recommended in writing by manufacturer to suit resilient terrazzo floor tile.
    a. Use sealant that has a VOC content of not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    b. Joint-Sealant Color: White **OR** As selected from manufacturer's full range to match floor tile **OR** Match floor tile, **as directed**.
6. Sealers and Finish Coats for Resilient Terrazzo Floor Tile: Premium-type products as recommended by manufacturer for resilient terrazzo floor tile.

1.3 EXECUTION

A. Preparation
1. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
2. Concrete Substrates: Prepare according to ASTM F 710.
    a. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
    b. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
    c. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
    d. Moisture Testing: Perform tests recommended by manufacturer and as follows. Proceed with installation only after substrates pass testing.
        1) Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
        2) Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75% relative humidity level measurement.
3. Access Flooring Panels: Remove protective film of oil or other coating using method recommended by access flooring manufacturer.
4. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
5. Do not install floor tiles until they are same temperature as space where they are to be installed.
    a. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

6. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

B. Floor Tile Installation
1. Comply with manufacturer's written instructions for installing floor tile.
2. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
   a. Lay tiles square with room axis **OR** at a 45-degree angle with room axis **OR** in pattern indicated, **as directed**.
3. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
   a. Lay tiles with grain running in one direction **OR** with grain direction alternating in adjacent tiles (basket-weave pattern) **OR** in pattern of colors and sizes indicated, **as directed**.
4. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
5. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
6. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.
7. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in finished floor areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.
8. Adhere floor tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
9. Seamless Installation:
   a. Heat-Welded Seams: Comply with ASTM F 1516. Rout joints and heat weld with welding bead to permanently fuse sections into a seamless floor covering. Prepare, weld, and finish seams to produce surfaces flush with adjoining floor covering surfaces.
   b. Chemically Bonded Seams: Bond seams with chemical-bonding compound to permanently fuse sections into a seamless floor covering. Prepare seams and apply compound to produce tightly fitted seams without gaps, overlays, or excess bonding compound on floor covering surfaces.

C. Cleaning And Protection
1. Comply with manufacturer's written instructions for cleaning and protection of floor tile.
2. Perform the following operations immediately after completing floor tile installation:
   a. Remove adhesive and other blemishes from exposed surfaces.
   b. Sweep and vacuum surfaces thoroughly.
   c. Damp-mop surfaces to remove marks and soil.
3. Protect floor tile products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
4. Floor Polish: Remove soil, visible adhesive, and surface blemishes from floor tile surfaces before applying liquid floor polish.
   a. Apply one **OR** two **OR** three, **as directed**, coat(s).
5. Joint Sealant: Apply sealant to resilient terrazzo floor tile perimeter and around columns, at door frames, and at other joints and penetrations.
6. Sealers and Finish Coats: Remove soil, visible adhesive, and surface blemishes from resilient terrazzo floor tile surfaces before applying liquid cleaners, sealers, and finish products.
   a. Sealer: Apply two base coats of liquid sealer.
   b. Finish: Apply two **OR** three, **as directed**, coats of liquid floor finish.

7. Cover floor tile until Final Completion.

END OF SECTION 09 65 13 33

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SECTION 09 65 13 33a - LINOLEUM FLOOR COVERINGS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for linoleum floor coverings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Linoleum floor tile **OR** sheet flooring, **as directed**.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
a. Product Data for Credit MR 6.0: For linoleum flooring, including printed statement of costs for each rapidly renewable material.
b. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
3. Shop Drawings: For each type of floor covering. Include floor covering layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
4. Samples for Verification: In manufacturer's standard size, but not less than 6-by-9-inch (152-by-230-mm) sections of each color and pattern of floor covering required.
a. Heat-Welding Bead: Include manufacturer's standard-size Samples, but not less than 9 inches (230 mm) long, of each color required.
5. Heat-Welded Seam Samples: For each floor covering product and welding bead color and pattern combination required; with seam running lengthwise and in center of 6-by-9-inch (152-by-230-mm) Sample applied to rigid backing and prepared by Installer for this Project.
6. Maintenance data.

D. Quality Assurance
1. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
a. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

E. Delivery, Storage, And Handling
1. Store floor coverings and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 65 deg F (18 deg C) or more than 90 deg F (32 deg C).
a. Floor Tile: Store on flat surfaces.
b. Sheet Flooring: Store rolls upright.

F. Project Conditions
1. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive floor coverings during the following time periods:
a. 72 hours before installation.
b. During installation.
c. 72 hours after installation.
2. Until Final Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).
3. Close spaces to traffic during floor covering installation.

4. Close spaces to traffic for 72 hours after floor covering installation.
5. Install floor coverings after other finishing operations, including painting, have been completed.

1.2 PRODUCTS

A. Linoleum Floor Covering
1. Floor Tile: ASTM F 2195, Type I, linoleum floor tile with fibrous backing **OR** Type II, linoleum floor tile with special backing **OR** Type III, linoleum floor tile without backing, **as directed**.
   a. Nominal Floor Tile Size: Manufacturer's standard **OR** 12 by 12 inches (300 by 300 mm) **OR** 18 by 18 inches (460 by 460 mm) **OR** 20 by 20 inches (500 by 500 mm) **OR** 24 by 24 inches (600 by 600 mm), **as directed**.
2. Sheet Flooring: ASTM F 2034, Type I, linoleum sheet with backing **OR** Type III, linoleum sheet with special backing, **as directed**.
   a. Roll Size: In manufacturer's standard length by not less than 78 inches (1980 mm) wide.
3. Seaming Method: Standard **OR** Heat welded, **as directed**.
4. Thickness: 0.08 inch (2.0 mm) **OR** 0.10 inch (2.5 mm) **OR** 0.13 inch (3.2 mm) **OR** 0.16 inch (4.0 mm) **OR** 0.18 inch (4.5 mm), **as directed**.
5. Colors and Patterns: As selected from full range of industry colors.

B. Installation Materials
1. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
2. Adhesives: Water-resistant type recommended by manufacturer to suit products and substrate conditions indicated.
   a. Use adhesives that have a VOC content of not more than 50 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Heat-Welding Bead: Solid-strand product of linoleum floor covering manufacturer.
   a. As selected from manufacturer's full range to contrast with linoleum floor covering **OR** Match linoleum floor covering, **as directed**.
4. Integral-Flash-Cove-Base Accessories:
   a. Cove Strip: 1-inch (25.4-mm) radius provided or approved by manufacturer.
   b. Cove-Base Cap Strip: Square metal, vinyl, or rubber cap provided or approved by manufacturer.
5. Floor Polish: Provide protective liquid floor polish products as recommended by manufacturer.

1.3 EXECUTION

A. Preparation
1. Prepare substrates according to manufacturer's written instructions to ensure adhesion of floor coverings.
2. Concrete Substrates: Prepare according to ASTM F 710.
   a. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
   b. Remove substrate coatings and other substances that are incompatible with floor covering adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
   c. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
   d. Moisture Testing: Perform tests recommended by manufacturer and as follows. Proceed with installation only after substrates pass testing.
      1) Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.

2) Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have maximum 75 percent relative humidity level measurement.

3. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
4. Do not install floor coverings until they are same temperature as space where they are to be installed.
   a. Move floor coverings and installation materials into spaces where they will be installed at least 72 hours in advance of installation.
5. Sweep and vacuum clean substrates to be covered by floor coverings immediately before installation.

B. Installation, General
1. Comply with manufacturer's written instructions for installing floor coverings.
2. Scribe and cut floor coverings to butt neatly and tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings.
3. Extend floor coverings into toe spaces, door reveals, closets, and similar openings.
4. Maintain reference markers, holes, or openings that are in place or marked for future cutting by repeating on floor coverings as marked on subfloor. Use chalk or other nonpermanent marking device.
5. Install floor coverings on covers for telephone and electrical ducts and similar items in finished floor areas. Maintain overall continuity of color and pattern between pieces of floor covering installed on covers and adjoining floor covering. Tightly adhere floor covering edges to substrates that abut covers and to cover perimeters.
6. Adhere floor coverings to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
7. Heat-Welded Seams: Comply with ASTM F 1516. Rout joints and use welding bead to permanently fuse sections into a seamless floor covering. Prepare, weld, and finish seams to produce surfaces flush with adjoining floor covering surfaces.

C. Linoleum Floor Tile Installation
1. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so floor tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
   a. Lay floor tiles square with room axis **OR** at a 45-degree angle with room axis **OR** in pattern indicated, **as directed**.
2. Match floor tiles for color and pattern by selecting tiles from cartons in same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed floor tiles.
   a. Lay floor tiles with grain running in one direction **OR** with grain direction alternating in adjacent floor tiles (basket-weave pattern) **OR** in pattern of colors and sizes indicated, **as directed**.

D. Linoleum Sheet Flooring Installation
1. Unroll sheet floorings and allow them to stabilize before cutting and fitting.
2. Lay out sheet floorings as follows:
   a. Maintain uniformity of floor covering direction.
   b. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches (152 mm) away from parallel joints in floor covering substrates.
   c. Match edges of floor coverings for color shading at seams.
   d. Avoid cross seams.
   e. Eliminate deformations that result from hanging method used during drying process (stove bar marks).

3. Integral-Flash-Cove Base: Cove linoleum floor covering 6 inches (152 mm) **OR** dimension indicated, **as directed**, up vertical surfaces. Support floor covering at horizontal and vertical junction with cove strip. Butt at top against cap strip.

E. Cleaning And Protection
1. Comply with manufacturer's written instructions for cleaning and protection of floor coverings.
2. Perform the following operations immediately after completing floor covering installation:
   a. Remove adhesive and other blemishes from exposed surfaces.
   b. Sweep and vacuum surfaces thoroughly.
   c. Damp-mop surfaces to remove marks and soil.
3. Protect floor coverings from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
4. Floor Polish: Remove soil, visible adhesive, and surface blemishes from floor coverings before applying liquid floor polish.
   a. Apply two **OR** three, **as directed**, coat(s).
5. After allowing drying room film (yellow film caused by linseed oil oxidation) to disappear, cover floor coverings until Final Completion.

END OF SECTION 09 65 13 33a

Task	Specification	Specification Description
09 65 13 33	01 22 16 00	No Specification Required
09 65 13 33	09 65 13 13	Cork Flooring
09 65 13 33	09 65 23 00	Resilient Sheet Flooring
09 65 13 33	09 65 13 13a	Resilient Wall Base And Accessories
09 65 13 36	09 65 13 13	Cork Flooring
09 65 13 36	09 65 13 13a	Resilient Wall Base And Accessories
09 65 16 23	09 65 13 13	Cork Flooring
09 65 16 23	09 65 23 00	Resilient Sheet Flooring
09 65 19 19	09 65 13 13	Cork Flooring
09 65 19 19	09 65 13 33	Resilient Floor Tile
09 65 19 23	09 65 13 13	Cork Flooring
09 65 19 23	09 65 13 33	Resilient Floor Tile
09 65 19 33	09 65 13 13	Cork Flooring
09 65 19 33	09 65 13 33	Resilient Floor Tile
09 65 19 43	09 65 13 13	Cork Flooring
09 65 19 43	09 65 13 33	Resilient Floor Tile

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SECTION 09 65 23 00 - RESILIENT SHEET FLOORING

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for resilient sheet floor flooring. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Vinyl sheet floor covering, with and without backing.
      b. Rubber sheet floor covering, with and without backing.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittals:
      a. Product Data for Credit EQ 4.1: For adhesives and chemical-bonding compounds, including printed statement of VOC content.
   3. Shop Drawings: For each type of floor covering. Include floor covering layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
      a. Show details of special patterns.
   4. Samples: In manufacturer's standard size, but not less than 6-by-9-inch (150-by-230-mm) sections of each different color and pattern of floor covering required.
      a. For heat-welding bead, manufacturer's standard-size Samples, but not less than 9 inches (230 mm) long, of each color required.
   5. Seam Samples: For seamless-installation technique indicated and for each floor covering product, color, and pattern required; with seam running lengthwise and in center of 6-by-9-inch (150-by-230-mm) Sample applied to a rigid backing and prepared by Installer for this Project.
   6. Maintenance data.

D. Quality Assurance
   1. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
      a. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

E. Delivery, Storage, And Handling
   1. Store floor coverings and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C). Store rolls upright.

F. Project Conditions
   1. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 85 deg F (29 deg C), in spaces to receive floor coverings during the following time periods:
      a. 48 hours before installation.
      b. During installation.
      c. 48 hours after installation.
   2. Until Final Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).
   3. Close spaces to traffic during floor covering installation.
   4. Close spaces to traffic for 48 hours after floor covering installation.
   5. Install floor coverings after other finishing operations, including painting, have been completed.

1.2 PRODUCTS

A. Vinyl Sheet Floor Covering
1. Unbacked Vinyl Sheet Floor Covering: ASTM F 1913, 0.080 inch (2.0 mm) thick.
2. Vinyl Sheet Floor Covering with Backing: ASTM F 1303.
a. Type (Binder Content): Type I, minimum binder content of 90 percent **OR** Type II, minimum binder content of 34 percent, **as directed**.
b. Wear-Layer Thickness: Grade 1.
c. Overall Thickness: As standard with manufacturer.
d. Interlayer Material: Foamed plastic **OR** None, **as directed**.
e. Backing Class: Class A (fibrous) **OR** Class B (nonfoamed plastic) **OR** Class C (foamed plastic), **as directed**.
3. Wearing Surface: Smooth **OR** Embossed **OR** Smooth with embedded abrasives **OR** Embossed with embedded abrasives, **as directed**.
4. Sheet Width: As standard with manufacturer **OR** 4.9 feet (1.5 m) **OR** 6 feet (1.8 m) **OR** 6.5 feet (1.98 m) **OR** 6.6 feet (2.0 m) **OR** 9 feet (2.7 m) **OR** 12 feet (3.6 m), **as directed**.
5. Seaming Method: Heat welded **OR** Chemically bonded **OR** Standard, **as directed**.
6. Colors and Patterns: As selected from full range of industry colors.

B. Rubber Sheet Floor Covering
1. Unbacked Rubber Sheet Floor Covering: ASTM F 1859.
a. Type: Type I (homogeneous rubber sheet) **OR** Type II (layered rubber sheet), **as directed**.
b. Thickness: As standard with manufacturer.
2. Rubber Sheet Floor Covering with Backing: ASTM F 1860.
a. Type: Type I, homogeneous rubber sheet with backing **OR** Type II, layered rubber sheet with backing, **as directed**.
b. Wear-Layer Thickness: As standard with manufacturer.
c. Overall Thickness: As standard with manufacturer.
d. Interlayer Material: As standard with manufacturer **OR** None, **as directed**.
e. Backing Type: Fibrous **OR** Foamed rubber, **as directed**.
3. Hardness: Not less than required by ASTM F 1859 **OR** Not less than required by ASTM F 1860 **OR** Manufacturer's standard hardness, measured using Shore, Type A durometer per ASTM D 2240, **as directed**.
4. Wearing Surface: Smooth **OR** Textured **OR** Molded pattern, **as directed**.
a. Molded-Pattern Figure: Raised discs **OR** Raised squares, **as directed**.
5. Sheet Width: As standard with manufacturer **OR** 4.9 feet (1.5 m) **OR** 6 feet (1.8 m) **OR** 6.5 feet (1.98 m) **OR** 6.6 feet (2.0 m) **OR** 9 feet (2.7 m) **OR** 12 feet (3.6 m), **as directed**.
6. Seaming Method: Heat welded **OR** Chemically bonded **OR** Standard, **as directed**.
7. Colors and Patterns: As selected from full range of industry colors.

C. Installation Materials
1. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
2. Adhesives: Water-resistant type recommended by manufacturer to suit floor covering and substrate conditions indicated.
a. Use adhesives that have a VOC content of not more than 50 g/L **OR** 60 g/L, **as directed**, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Seamless-Installation Accessories:
a. Heat-Welding Bead: Manufacturer's solid-strand product for heat welding seams.
1) Color: As selected from manufacturer's full range to contrast with floor covering **OR** Match floor covering, **as directed**.
b. Chemical-Bonding Compound: Manufacturer's product for chemically bonding seams.

1) VOC Content: Not more than 510 g/L. when calculated according to 40 CFR 59, Subpart D (EPA method 24).

4. Integral-Flash-Cove-Base Accessories:
   a. Cove Strip: 1-inch (25-mm) radius provided or approved by manufacturer.
   b. Cap Strip: Square metal, vinyl, or rubber cap **OR** Tapered vinyl cap, **as directed**, provided or approved by manufacturer.
   c. Corners: Metal inside and outside corners and end stops provided or approved by manufacturer.
5. Floor Polish: Provide protective liquid floor polish products as recommended by manufacturer.

1.3 EXECUTION

A. Preparation
1. Prepare substrates according to manufacturer's written instructions to ensure adhesion of floor coverings.
2. Concrete Substrates: Prepare according to ASTM F 710.
   a. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
   b. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
   c. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
   d. Moisture Testing: Perform tests recommended by manufacturer and as follows. Proceed with installation only after substrates pass testing.
      1) Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
      2) Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
3. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
4. Do not install floor coverings until they are same temperature as space where they are to be installed.
   a. Move floor coverings and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
5. Sweep and vacuum clean substrates to be covered by floor coverings immediately before installation.

B. Floor Covering Installation
1. Comply with manufacturer's written instructions for installing floor coverings.
2. Unroll floor coverings and allow them to stabilize before cutting and fitting.
3. Lay out floor coverings as follows:
   a. Maintain uniformity of floor covering direction.
   b. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches (152 mm) away from parallel joints in floor covering substrates.
   c. Match edges of floor coverings for color shading at seams.
   d. Avoid cross seams.
4. Scribe and cut floor coverings to butt neatly and tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, and door frames.
5. Extend floor coverings into toe spaces, door reveals, closets, and similar openings.
6. Maintain reference markers, holes, or openings that are in place or marked for future cutting by repeating on floor coverings as marked on substrates. Use chalk or other nonpermanent marking device.

7. Install floor coverings on covers for telephone and electrical ducts and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of floor coverings installed on covers and adjoining floor covering. Tightly adhere floor covering edges to substrates that abut covers and to cover perimeters.
8. Adhere floor coverings to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
9. Seamless Installation:
   a. Heat-Welded Seams: Comply with ASTM F 1516. Rout joints and use welding bead to permanently fuse sections into a seamless floor covering. Prepare, weld, and finish seams to produce surfaces flush with adjoining floor covering surfaces.
   b. Chemically-Bonded Seams: Bond seams with chemical-bonding compound to permanently fuse sections into a seamless floor covering. Prepare seams and apply compound to produce tightly-fitted seams without gaps, overlays, or excess bonding compound on floor covering surfaces.
10. Integral-Flash-Cove Base: Cove floor coverings 6 inches (152 mm) **OR** dimension indicated, **as directed**, up vertical surfaces. Support floor coverings at horizontal and vertical junction by cove strip. Butt at top against cap strip.
    a. Install metal corners at inside and outside corners.

C. Cleaning And Protection
1. Comply with manufacturer's written instructions for cleaning and protection of floor coverings.
2. Perform the following operations immediately after completing floor covering installation:
   a. Remove adhesive and other blemishes from floor covering surfaces.
   b. Sweep and vacuum floor coverings thoroughly.
   c. Damp-mop floor coverings to remove marks and soil.
3. Protect floor coverings from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
4. Floor Polish: Remove soil, visible adhesive, and surface blemishes from floor covering before applying liquid floor polish.
   a. Apply one **OR** two **OR** three, **as directed**, coat(s).
5. Cover floor coverings until Final Completion.

END OF SECTION 09 65 23 00

Task	Specification	Specification Description
09 65 23 00	09 65 13 13	Cork Flooring
09 65 43 00	09 65 13 13	Cork Flooring
09 65 43 00	09 65 23 00	Resilient Sheet Flooring

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SECTION 09 65 66 00 - FLUID-APPLIED ATHLETIC FLOORING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for fluid-applied sports flooring. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes polyurethane flooring that is fluid applied directly on substrates or over base mats.

C. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Show installation details for flooring including layout, colors, widths, and dimensions of game lines and markers and locations of athletic equipment floor inserts.
3. Samples: For each color, gloss, and texture of flooring required, 12 inches (305 mm) square, applied to a rigid backing. Include sample sets showing the game-line paint and marker paint colors applied to the flooring.
4. Qualification Data: For Installer.
5. Maintenance Data: For fluid-applied sports flooring to include in maintenance manuals.

D. Quality Assurance
1. Installer Qualifications: An installer (applicator) who is approved, trained, or certified by fluid-applied sports flooring manufacturer.
2. Game Lines and Markers: Comply with requirements of National Collegiate Athletic Association (NCAA) **OR** National Federation of State High School Associations, **as directed,** for sports activities indicated.

E. Field Conditions
1. Environmental Limitations: Comply with flooring manufacturer's written instructions for substrate temperature, ambient temperature, humidity, ventilation, and other conditions affecting flooring application.
   a. Do not apply flooring until spaces are enclosed and weatherproof; wet work in spaces is complete and dry; and overhead work, including installing mechanical systems, lighting, and athletic equipment, is complete.
2. Conditioning Period: Begins not less than seven days before flooring application, is continuous through application, and continues not less than three days after application.
   a. During conditioning period, maintain an ambient temperature between 65 and 75 deg F (18 and 24 deg C) and not more than 50 percent relative humidity in spaces to receive flooring.
   b. After conditioning period, maintain relative humidity and ambient temperature planned for building occupants.

1.2 PRODUCTS

A. Direct-Applied Flooring:
1. Description: Fluid-applied athletic flooring system consisting of primer and polyurethane body and top coats applied directly to substrate.
2. Performance:
   a. Low-Emitting Materials: Provide products with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1) Primer: VOC content of not less than 250 g/L.
2) Body and Top Coats: VOC content of not more than 100 g/L.

b. Low-Emitting Materials: Provide adhesives, paints and coatings, and flooring systems that comply with the maximum allowable concentrations of VOC's when tested according to California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

3. Materials:
   a. Primer: Manufacturer's primer recommended for substrate indicated.
   b. Body Coat(s): Two-component, self-leveling, pigmented, polyurethane containing no rubber fillers and no mercury.
   c. Topcoat (Finish Coat): Manufacturer's standard pigmented polyurethane.
   d. Finishes:
      1) Color: As selected from manufacturer's full range.
      2) Surface Texture: Manufacturer's standard.

B. Flooring Applied over Base Mats:
1. Description: Fluid-applied athletic flooring system consisting of resilient base mat adhered to substrate, base mat sealer, and fluid-applied polyurethane body and top coats.
2. Performance:
   a. Low-Emitting Materials: Provide products with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
      1) Base Mat Adhesive: VOC content of not more than 60 g/L.
      2) Base Mat Sealer: VOC content of not more than 200 g/L.
      3) Body and Topcoats: VOC content of not more than 100 g/L.
   b. Low-Emitting Materials: Provide adhesives, paints and coatings, and flooring systems that comply with the maximum allowable concentrations of VOC's when tested according to California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
3. Materials:
   a. Base Mat: Manufacturer's standard base mats of granulated recycled rubber in polyurethane binder.
      1) Thickness: **5/32 inch (4 mm) OR 1/4 inch (6 mm) OR 9/32 inch (7 mm) OR 11/32 inch (9 mm) OR 15/32 inch (12 mm).**
   b. Base-Mat Adhesive: Manufacturer's standard two-component polyurethane.
   c. Base-Mat Sealer: Manufacturer's standard two-component polyurethane compound formulated for sealing base mat.
   d. Body Coat(s): Two-component, self-leveling, pigmented, polyurethane containing no rubber fillers and no mercury.
   e. Topcoat (Finish Coat): Manufacturer's standard pigmented polyurethane.
4. Finishes:
   a. Color: As selected by Architect from manufacturer's full range.
   b. Surface Texture: Manufacturer's standard.

C. Accessories
1. Trowelable Leveling and Patching Compound: Latex-modified, hydraulic-cement-based formulation approved by flooring manufacturer.
2. Game-Line and Marker Paint: Complete system including primer, if any, compatible with flooring and recommended in writing by flooring and paint manufacturers for use indicated.
   a. VOC content: Provide products with VOC content of not more than 150 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. Colors: As selected **OR** As required to comply with game-line and marker requirements of sports association indicated, **as directed**.

1.3 EXECUTION

A. Examination
1. Examine substrates, with Installer present, for compliance with requirements for installation tolerances, moisture content, and other conditions affecting performance.
a. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
b. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Concrete Substrates: Prepare and clean substrates according to manufacturer's written instructions.
a. Remove laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants that might impair flooring bond. Remove contaminants using mechanical means.
b. Treat nonmoving substrate cracks and control joints to prevent cracks from telegraphing (reflecting) through flooring according to manufacturer's written recommendations.
c. Protect substrate voids and joints to prevent flooring resins from flowing into or leaking through them.
2. Protect walls, floor openings, athletic equipment inserts, electrical openings, door frames, and other obstructions during installation. Cover floor and wall areas at mixing stations.

C. Flooring Installation, General
1. General: Mix and apply flooring components according to manufacturer's written instructions.
a. At substrate expansion, isolation, and other moving joints, install continuous joint of same width through flooring.

D. Installation of Direct-Applied Flooring:
1. Apply primer over prepared substrate at manufacturer's recommended spreading rate.
2. Apply body coat(s) and topcoat to produce a uniform, level surface and finish.

E. Installation of Flooring Applied over Base Mats:
a. Adhesively apply resilient base mats to substrate according to manufacturer's written instructions.
1) Base mats must not be in compression. Leave gap of width recommended in writing by manufacturer at butted base-mat sheets, walls, floor openings, athletic equipment inserts, electrical openings, door frames, and other obstructions.
2) Roll base mats to set them into adhesive and eliminate air pockets.
3) Repair ridges at seams, loose areas, and air pockets according to manufacturer's written instructions.
b. Apply seal coat to base mats before applying body coat(s).
c. Smooth ridges and high spots in seal coat before applying elastomeric resin.
d. Apply elastomeric resin and topcoat to produce a uniform surface and finish.

F. Game Lines And Markers
1. Mask flooring surfaces at game lines and markers, and apply paint to produce sharp edges.
a. Where game lines cross, break minor game line at intersection; do not overlap lines.
b. Apply game lines and markers in widths and colors according to requirements indicated on Drawings **OR** sports association indicated, **as directed**.

G. Protection
1. Protect fluid-applied sports flooring during remainder of construction period to allow it to cure and to ensure that flooring and finish are without damage or deterioration at the time of Final Completion.

END OF SECTION 09 65 66 00

SECTION 09 65 66 00a - RESILIENT SPORTS-FLOOR COVERINGS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for resilient sports-floor coverings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Interlocking, rubber floor tile.
      b. Interlocking, suspended, polymer floor tile.
      c. Interlocking, open-grid, vinyl floor tile.
      d. Rubber mats.
      e. Rubber floor tile.
      f. Rubber-strip floor tile.
      g. Rubber sheet floor covering.
      h. Sheet vinyl floor covering.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. Shop Drawings: Show installation details and locations of the following:
      a. Border tiles.
      b. Floor patterns.
      c. Layout, colors, widths, and dimensions of game lines.
      d. Locations of floor inserts for athletic equipment.
      e. Seam locations.
   3. Samples: For each exposed finish.
   4. LEED Submittals:
      a. Credit EQ 4.1: Manufacturers' product data for adhesives, including printed statement of VOC content.
      b. Credit EQ 4.2: Manufacturers' product data for game-line and marker paints, including printed statement of VOC content.
      c. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
         1) Include statement that indicates costs for each product having recycled content.
   5. Maintenance data.

D. Delivery, Storage, And Handling
   1. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storing.
   2. Store materials to prevent deterioration. Store tiles on flat surfaces and rolls upright.

E. Field Conditions
   1. Adhesively Applied Products:
      a. Maintain temperatures within range recommended in writing by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive floor coverings during the following time periods:
         1) 48 hours before installation, unless longer period is recommended in writing by manufacturer.
         2) During installation.

3) 48 hours after installation, unless longer period is recommended in writing by manufacturer.

b. After postinstallation period, maintain temperatures within range recommended in writing by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).

c. Close spaces to traffic during floor covering installation.

d. Close spaces to traffic for 48 hours after floor covering installation, unless manufacturer recommends longer period in writing.

2. Install floor coverings after other finishing operations, including painting, have been completed.

1.2 PRODUCTS

A. Interlocking, Rubber Floor Tile

1. Material: Rubber **OR** Recycled-rubber compound, **as directed**.
2. Installation Method: Free lay.
3. Tile Interlock: Visible **OR** Hidden, **as directed**.
4. Traffic-Surface Texture: Smooth **OR** Nondirectional, stipple texture **OR** Textured, **as directed**.
   a. Provide reversible tiles (with traffic-surface texture on both sides).
5. Size: Manufacturer's standard-size square tile, not less than 24 inches (610 mm) square.
6. Thickness: 3/8 inch (9.5 mm) **OR** 7/16 inch (11.1 mm) **OR** 1/2 inch (13 mm) **OR** 9/16 inch (14.3 mm) **OR** 3/4 inch (19 mm), **as directed**.
7. Color and Pattern: As selected from manufacturer's full range **OR** As indicated by manufacturer's designations, **as directed**.
8. Accessories:
   a. Border Tiles: Interlocking, beveled-edge tiles, of same material as floor tile, with bevels that transition from thickness of floor tile to surface below it, with straight outside edges, and for use where floor covering corners and edges do not abut vertical surfaces.
      1) Color and Pattern: Matching floor tile **OR** As selected from manufacturer's full range to contrast with floor tile **OR** As indicated by manufacturer's designations, **as directed**.

B. Interlocking, Suspended, Polymer Floor Tile

1. Material and Construction: High-impact-polymer modular floor tile with top suspended over supporting backing that intermittently contacts the substrate.
   a. Traffic Surface: Solid.
2. Installation Method: Free lay.
3. Tile Interlock: Manufacturer's standard.
4. Size: Manufacturer's standard-size square tile **OR** 12 inches (305 mm) square **OR** 9.8 inches (250 mm) square, **as directed**.
5. Thickness: 1/2 inch (13 mm).
6. Color: As selected from manufacturer's full range **OR** As indicated by manufacturer's designations, **as directed**.
7. Accessories:
   a. Border Tiles: Interlocking, beveled-edge tiles, of same material as floor tile, with bevels that transition from thickness of floor tile to surface below it, with straight outside edges, and for use where floor covering corners and edges do not abut vertical surfaces.
      1) Color: Matching floor tile **OR** As selected from manufacturer's full range to contrast with floor tile **OR** As indicated by manufacturer's designations, **as directed**.
   b. Game-Line and Marker Paint: Complete system including primer, if any, compatible with floor covering and recommended in writing by floor covering and paint manufacturers for use indicated.
   c. Underlayment:
      1) Material: Manufacturer's standard rubber compound **OR** Recycled-rubber compound, **as directed**.
      2) Thickness: 0.08 inch (2 mm) **OR** 0.12 inch (3 mm), **as directed**.

C. Interlocking, Open-Grid, Vinyl Floor Tile
1. Material: Vinyl **OR** Recycled-plastic compound, **as directed**.
2. Installation Method: Free lay.
3. Tile Interlock: Manufacturer's standard.
4. Size: 12 inches (305 mm) square.
5. Thickness: 1/4 inch (6.4 mm) **OR** 3/8 inch (9.5 mm) **OR** 7/16 inch (11.1 mm) **OR** 3/4 inch (19 mm), **as directed**.
6. Color: As selected from manufacturer's full range **OR** As indicated by manufacturer's designations, **as directed**.
7. Accessories:
   a. Border Tiles: Interlocking, beveled-edge tiles, of same material as floor tile, with bevels that transition from thickness of floor tile to surface below it, with straight outside edges, and for use where floor covering corners and edges do not abut vertical surfaces.
      1) Color: Matching floor tile **OR** As selected from manufacturer's full range to contrast with floor tile **OR** As indicated by manufacturer's designations, **as directed**.

D. Rubber Mats
1. Material: Recycled-rubber compound.
2. Installation Method: Free lay.
3. Traffic-Surface Texture: Smooth.
4. Size: 48 by 72 inches (1219 by 1829 mm).
5. Thickness: 3/8 inch (9.5 mm) **OR** 1/2 inch (13 mm), **as directed**.
6. Color and Pattern: As selected from manufacturer's full range **OR** As indicated by manufacturer's designations, **as directed**.

E. Rubber Floor Tile
1. Material: Rubber **OR** Recycled-rubber compound **OR** Rubber wear layer and rubber shock-absorbent layer, vulcanized together, **as directed**.
2. Installation Method: Adhered.
3. Traffic-Surface Texture: Smooth **OR** Nondirectional, stipple texture **OR** Textured, **as directed**.
4. Size: Manufacturer's standard-size square tile **OR** 18 inches (457 mm) square **OR** 24 inches (610 mm) square **OR** 36 inches (914 mm) square, **as directed**.
5. Thickness: 1/4 inch (6.4 mm) **OR** 3/8 inch (9.5 mm), **as directed**.
6. Color and Pattern: As selected from manufacturer's full range **OR** As indicated by manufacturer's designations, **as directed**.
7. Accessories:
   a. Trowelable Leveling and Patching Compound: Latex-modified, hydraulic-cement-based formulation approved by floor covering manufacturer.
   b. Installation Adhesive: Water-resistant type recommended in writing by manufacturer for substrate and conditions indicated.
      1) Use adhesive that has a VOC content of 60 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. Rubber-Strip Floor Tile
1. Materials and Construction: Close-nap, carpetlike tiles of rubber-fabric strips, made from recycled tires, bonded to a dry-adhesive backing that acts as a catalyst with installation adhesive to form tile-to-substrate bond.
2. Fire-Test-Response Characteristics: Passing 16 CFR 1630 (DOC FF-1-70).
3. Installation Method: Adhered.
4. Size: 12 inches (305 mm) square.
5. Thickness: 3/8 inch (9.5 mm).
6. Color and Pattern: As selected from manufacturer's full range **OR** As indicated by manufacturer's designations, **as directed**.
7. Accessories:
   a. Trowelable Leveling and Patching Compound: Latex-modified, hydraulic-cement-based formulation approved by floor covering manufacturer.

b. Installation Adhesive: Water-resistant type recommended in writing by manufacturer for substrate and conditions indicated.
   1) Use adhesive that has a VOC content of 60 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

G. Rubber Sheet Flooring
1. Description: Rubber athletic flooring provided as rolled goods for adhered installation.
2. Material: Recycled-rubber compound **OR** Rubber wear layer and rubber shock-absorbent layer, vulcanized together, **as directed**.
3. Traffic-Surface Texture: Smooth.
4. Roll Size: Not less than 48 inches (1219 mm) wide by longest length that is practical to minimize splicing during installation.
5. Thickness: 1/4 inch (6.4 mm) **OR** 3/8 inch (9.5 mm), **as directed**.
6. Color and Pattern: As selected from manufacturer's full range **OR** As indicated by manufacturer's designations, **as directed**.
7. Border: Interlocking, beveled-edge tiles, of same material as floor tile; with bevels that transition from thickness of floor tile to surface below it; with straight outside edges; and for use where flooring corners and edges do not abut vertical surfaces.
   a. Border Color and Pattern: Matching floor tile **OR** As selected from manufacturer's full range to contrast with floor tile, **as directed**.

H. Sheet Vinyl Flooring
1. Description: Sheet vinyl flooring specifically designed for adhered athletic flooring applications.
2. Unbacked Sheet Vinyl Flooring: ASTM F 1913, 0.080 inch (2.0 mm) thick.
   a. Separate underlayment pad of bonded recycled rubber and polyurethane particles.
3. Sheet Vinyl Flooring with Backing: ASTM F 1303.
   a. Type (Binder Content): I, minimum binder content of 90 percent **OR** II, minimum binder content of 34 percent, **as directed**.
   b. Wear-Layer Thickness: Grade 1.
   c. Interlayer Material: Foamed plastic **OR** None, **as directed**.
   d. Backing Class: Class B (nonfoamed plastic) **OR** C (foamed plastic), **as directed**.
4. Seaming Method: Heat welded **OR** Chemically bonded, **as directed**.
5. Traffic-Surface Texture: Smooth **OR** Embossed, **as directed**.
6. Applied Finish: Factory-applied UV urethane **OR** Field-applied polyurethane, **as directed**.
7. Roll Size: Not less than 48 inches (1219 mm) wide by longest length that is practical to minimize splicing during installation.
8. Color and Pattern: As selected from manufacturer's full range **OR** As indicated by manufacturer's designations, **as directed**.

I. Accessories:
1. Trowelable Leveling and Patching Compound: Latex-modified, hydraulic-cement-based formulation approved by floor covering manufacturer.
2. Adhesives: Water-resistant type recommended in writing by manufacturer for substrate and conditions indicated.
   a. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Game-Line and Marker Paint: Complete system including primer, if any, compatible with floor covering and recommended in writing by floor covering and paint manufacturers for use indicated.
   a. VOC content: Provide products with VOC content not more than 150 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1.3 EXECUTION

A. Preparation

1. Prepare substrates according to manufacturer's written recommendations to ensure adhesion of floor coverings.
2. Concrete Substrates: Prepare according to ASTM F 710.
   a. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
   b. Alkalinity and Adhesion Testing: Perform tests recommended in writing by manufacturer. Proceed with installation only after substrates pass testing.
   c. Moisture Testing:
      1) Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
         a) Perform tests so that each test area does not exceed 200 sq. ft. (18.6 sq. m) and perform not less than 2 tests in each installation area and with test areas evenly spaced in installation areas.
      2) Perform tests recommended in writing by manufacturer. Proceed with installation only after substrates pass testing.
3. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended in writing by manufacturer. Do not use solvents.
4. Use trowelable leveling and patching compound to fill cracks, holes, and depressions in substrates.
5. Move floor coverings and installation materials into spaces where they will be installed at least 48 hours in advance of installation, unless manufacturer recommends a longer period in writing.
   a. Do not install floor coverings until they are same temperature as space where they are to be installed.
6. Sweep and vacuum clean substrates to be covered by floor coverings immediately before installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, and dust. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Flooring Installation, General
   1. Comply with manufacturer's written installation instructions.
   2. Scribe, cut, and fit floor coverings to butt neatly and tightly to vertical surfaces, equipment anchors, floor outlets, and other interruptions of floor surface.
   3. Extend floor coverings into toe spaces, door reveals, closets, and similar openings, unless otherwise indicated.
   4. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating subfloor markings on floor coverings. Use nonpermanent, nonstaining marking device.

C. Floor Tile Installation
   1. Lay out tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
      a. Lay tiles square with room axis **OR** at a 45-degree angle with room axis **OR** in pattern indicated, **as directed**.
   2. Discard broken, cracked, chipped, or deformed tiles.
   3. Match tiles for color and pattern by selecting tiles from cartons in same sequence as manufactured and packaged, if so numbered.
      a. Lay tiles with grain running in one direction **OR** with grain direction alternating in adjacent tiles (basket-weave pattern) **OR** in pattern of colors and sizes indicated, **as directed**.

D. Sheet Flooring Installation
   1. Unroll sheet floor coverings and allow them to stabilize before cutting and fitting.
   2. Lay out sheet floor coverings as follows:
      a. Maintain uniformity of floor covering direction.
      b. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches (152 mm) away from parallel joints in floor covering substrates.
      c. Match edges of floor coverings for color shading at seams.

d. Locate seams per approved Shop Drawings.

3. Adhered Flooring: Adhere products to substrates using a full spread of adhesive applied to substrate to comply with adhesive and flooring manufacturers' written instructions, including those for trowel notching, adhesive mixing, and adhesive open and working times.
   a. Provide completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
4. Vinyl Sheet Flooring Seams: Prepare and finish seams to produce surfaces flush with adjoining flooring surfaces.
   a. Heat-Welded Seams: Comply with ASTM F 1516. Rout joints and use welding bead to permanently fuse sections into a seamless flooring.
   b. Chemically Bonded Seams: Comply with ASTM F 693. Seal seams to prevent openings from forming between cut edges and to prevent penetration of dirt, liquids, and other substances into seams.

E. Game Lines And Markers
1. Mask floor coverings at game lines and markers, and apply paint to produce sharp edges.Where cross, break minor game line at intersection; do not overlap lines.
2. Lay out game lines and markers to comply with rules and diagrams published by National Collegiate Athletic Association (NCAA) **OR** National Federation of State High School Associations for athletic activities indicated.

F. Field-Applied Finishes
1. Apply finish after game-line and marker paint is fully cured.
2. Apply finish according to manufacturer's written instructions to produce a sealed surface that is ready for use.
3. Do not cover floor coverings after finishing until finish reaches full cure.

G. Cleaning And Protecting
1. Perform the following operations immediately after completing floor covering installation:
   a. Remove adhesive and other blemishes from floor covering surfaces.
   b. Sweep and vacuum floor coverings thoroughly.
   c. Damp-mop floor coverings to remove marks and soil.
      1) Do not wash floor coverings until after time period recommended in writing by manufacturer.
2. Protect floor coverings from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods recommended in writing by manufacturer.
   a. Do not move heavy and sharp objects directly over floor coverings. Protect floor coverings with plywood or hardboard panels to prevent damage from storing or moving objects over floor coverings.

END OF SECTION 09 65 66 00a

Task	Specification	Specification Description
09 65 66 00	09 65 13 33	Resilient Floor Tile
09 66 13 00	09 01 60 91	Portland Cement Terrazzo Flooring
09 66 13 13	09 01 60 91	Portland Cement Terrazzo Flooring
09 66 13 16	09 01 60 91	Portland Cement Terrazzo Flooring
09 66 13 19	09 01 60 91	Portland Cement Terrazzo Flooring
09 66 16 13	09 01 60 91	Portland Cement Terrazzo Flooring

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SECTION 09 66 23 00 - RESINOUS MATRIX TERRAZZO FLOORING

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for resinous matrix terrazzo flooring. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Thin-set epoxy-resin terrazzo flooring and base.
      b. Precast terrazzo units.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittals:
      a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For marble chips, aggregates, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
         1) Include statement that indicates cost for each product having recycled content.
      b. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
   3. Shop Drawings: Include terrazzo installation requirements. Include plans, elevations, sections, component details, and attachments to other work.
   4. Samples: For each type, material, color, and pattern of terrazzo and accessory required showing the full range of color, texture, and pattern variations expected.
   5. Installer certificates.
   6. Qualification data.
   7. Material certificates.
   8. Maintenance data.

D. Quality Assurance
   1. Installer Qualifications: A qualified installer who is acceptable to terrazzo manufacturer to install manufacturer's products.
      a. Engage an installer who is certified in writing by terrazzo manufacturer as qualified to install manufacturer's products.
      b. Engage an installer who is a contractor member of NTMA.
   2. NTMA Standards: Comply with NTMA's "Terrazzo Specifications and Design Guide" and with written recommendations for terrazzo type indicated unless more stringent requirements are specified.
   3. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
   1. Deliver materials to Project site in supplier's original wrappings and containers, labeled with source's or manufacturer's name, material or product brand name, and lot number if any.
   2. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

F. Project Conditions
   1. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting terrazzo installation.

2. Field Measurements: Verify actual dimensions of construction contiguous with precast terrazzo by field measurements before fabrication.
3. Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during terrazzo installation.
4. Close spaces to traffic during terrazzo application and for not less than 24 hours after application unless manufacturer recommends a longer period.
5. Control and collect dust produced by grinding operations. Protect adjacent construction from detrimental effects of grinding operations.
   a. Provide dustproof partitions and temporary enclosures to limit dust migration and to isolate areas from noise.

1.2 PRODUCTS

A. Epoxy-Resin Terrazzo
1. Materials:
   a. Flexible Reinforcing Membrane: Manufacturer's resinous membrane for substrate crack preparation and reflective crack reduction.
      1) Reinforcement: Fiberglass scrim.
   b. Primer: Manufacturer's product recommended for substrate and use indicated.
   c. Epoxy-Resin Matrix: Manufacturer's standard recommended for use indicated and in color required for mix indicated.
      1) Physical Properties without Marble Chips **OR** Aggregates, **as directed**:
         a) Hardness: 60 to 85 per ASTM D 2240, Shore D.
         b) Minimum Tensile Strength: 3000 psi (20.7 MPa) per ASTM D 638 for a 2-inch (51-mm) specimen made using a "C" die per ASTM D 412.
         c) Minimum Compressive Strength: 10,000 psi (6.9 MPa) per ASTM D 695, Specimen B cylinder.
         d) Chemical Resistance: No deleterious effects by contaminants listed below after seven-day immersion at room temperature per ASTM D 1308.
            i. Distilled water.
            ii. Mineral water.
            iii. Isopropanol.
            iv. Ethanol.
            v. 0.025 percent detergent solution.
            vi. 1.0 percent soap solution.
            vii. 10 percent sodium hydroxide.
            viii. 10 percent hydrochloric acid.
            ix. 30 percent sulfuric acid.
            x. 5 percent acetic acid.
      2) Physical Properties with Marble Chips **OR** Aggregates, **as directed**: For resin blended with Georgia white marble, ground, grouted, and cured per requirements in NTMA's "Terrazzo Specifications and Design Guide," comply with the following:
         a) Flammability: Self-extinguishing, maximum extent of burning 0.25 inch (6.35 mm) per ASTM D 635.
         b) Thermal Coefficient of Linear Expansion: 0.0025 inch/inch per deg F (0.0025 mm/mm per 0.5556 deg C) for temperature range of minus 12 to plus 140 deg F (minus 24 to plus 60 deg C) per ASTM D 696.
   d. Marble Chips **OR** Aggregates, **as directed**: Complying with NTMA gradation standards for mix indicated and containing no deleterious or foreign matter.
      1) Abrasion and Impact Resistance: Less than 40 percent loss per ASTM C 131.
      2) 24-Hour Absorption Rate: Less than 0.75 percent.
      3) Dust Content: Less than 1.0 percent by weight.
   e. Finishing Grout: Resin based.

2. Terrazzo (for NTMA-formulated design mixes): Comply with NTMA's "Terrazzo Specifications and Design Guide" and manufacturer's written instructions for matrix and marble-chip proportions and mixing.
   a. Formulated Mix Color and Pattern: As selected by the Owner from manufacturer's full range **OR** As selected from NTMA standard-terrazzo plates **OR** As selected from NTMA thin-set terrazzo plates, **as directed**.
3. Terrazzo (for custom design mixes): Comply with NTMA's "Terrazzo Specifications and Design Guide" and manufacturer's written instructions for matrix and marble-chip **OR** aggregate, **as directed**, proportions and mixing.
   a. Custom Mix Color and Pattern: Match sample **OR** Match existing, **as directed**.

B. Strip Materials
1. Thin-Set Divider Strips: L-type angle or T-type, 1/4 inch (6.4 mm) deep.
   a. Material: White-zinc alloy **OR** Brass **OR** Aluminum **OR** Plastic, in color selected from manufacturer's full range, **as directed**.
   b. Top Width: 1/8 inch (3.2 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
2. Heavy-Top Divider Strips: L-type angle in depth required for topping thickness indicated.
   a. Bottom-Section Material: Galvanized steel **OR** Matching top-section material, **as directed**.
   b. Top-Section Material: White-zinc alloy **OR** Brass **OR** Aluminum **OR** Plastic, in color selected from manufacturer's full range, **as directed**.
   c. Top-Section Width: 1/8 inch (3.2 mm) **OR** 1/4 inch (6.4 mm) **OR** 3/8 inch (9.5 mm) **OR** 1/2 inch (12.7 mm), **as directed**.
3. Control-Joint Strips: Separate, double L-type angles, positioned back to back, that match material, thickness, and color of divider strips and in depth required for topping thickness indicated.
4. Accessory Strips: Match divider strip width, material, and color unless otherwise indicated. Use the following types of accessory strips as required to provide a complete installation:
   a. Base-bead strips for exposed top edge of terrazzo base.
   b. Edge-bead strips for exposed edges of terrazzo.
   c. Nosings for terrazzo stair treads and landings.
5. Abrasive Strips (for terrazzo stair treads and landings): Silicon carbide or aluminum oxide, or combination of both, in epoxy-resin binder and set in channel.
   a. Width: 1/2 inch (12.7 mm).
   b. Depth: As required by terrazzo thickness.
   c. Length: 4 inches (100 mm) less than stair width **OR** As indicated, **as directed.**
   d. Color: As selected from manufacturer's full range.

C. Miscellaneous Accessories
1. Strip Adhesive: Epoxy-resin adhesive recommended by adhesive manufacturer for this use and acceptable to terrazzo manufacturer.
   a. Use adhesives that have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Anchoring Devices:
   a. Strips: Provide mechanical anchoring devices for strip materials as required for secure attachment to substrate.
   b. Precast Terrazzo: Provide mechanical anchoring devices as recommended by fabricator for proper anchorage and support of units for conditions of installation and support.
3. Patching and Fill Material: Terrazzo manufacturer's resinous product approved and recommended by manufacturer for application indicated.
4. Joint Compound: Terrazzo manufacturer's resinous product approved and recommended by manufacturer for application indicated.
5. Cleaner: Chemically neutral cleaner with pH factor between 7 and 10 that is biodegradable, phosphate free, and recommended by sealer manufacturer for use on terrazzo type indicated.
6. Sealer: Slip- and stain-resistant penetrating-type sealer that is chemically neutral with pH factor between 7 and 10; does not affect color or physical properties of terrazzo; is recommended by

sealer manufacturer; and complies with NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated **OR** Acrylic **OR** Urethane **OR** Chemical-resistant epoxy, **as directed**.

D. Precast Terrazzo
1. Precast Terrazzo Units: Precast epoxy-resin terrazzo base**,** stair tread, threshold, bench, and planter units.
2. Precast Terrazzo Base Units: 1/4 inch (6.4 mm) thick; cast in maximum lengths possible, but not less than 36 inches (900 mm); with rounded, finished top edge.
   a. Type: Coved with minimum 3/4-inch (19-mm) radius **OR** Straight **OR** Splayed **OR** As indicated, **as directed**.
   b. Height: 6 inches (152 mm) **OR** 4 inches (101 mm) **OR** As indicated, **as directed**.
   c. Outside Corner Units: With finished returned edges at outside corner.
   d. Color, Pattern, and Finish: As selected from manufacturer's full range **OR** Match sample **OR** Match adjacent poured-in-place terrazzo flooring, **as directed**.
3. Precast Terrazzo Stair Treads: 1/2 inch (12.7 mm) thick with rounded nosing edge.
   a. Abrasive Strips: Three-line **OR** Two-line **OR** One-line **OR** Abrasive nosing strip and two-line, **as directed**, abrasive inserts at nosings.
   b. Color, Pattern, and Finish: As selected from manufacturer's full range **OR** Match sample **OR** Match adjacent poured-in-place terrazzo flooring, **as directed**.
4. Precast Terrazzo Finishing (for custom precast terrazzo components):
   a. Finish exposed-to-view edges or reveals to match face finish.
   b. Ease exposed edges to 1/8-inch (3-mm) radius.

1.3 EXECUTION

A. Preparation
1. Clean substrates of substances, including oil, grease, and curing compounds, that might impair terrazzo bond. Provide clean, dry, and neutral substrate for terrazzo application.
2. Concrete Slabs:
   a. Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with terrazzo.
      1) Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
      2) Repair damaged and deteriorated concrete according to terrazzo manufacturer's written recommendations.
      3) Use patching and fill material to fill holes and depressions in substrates according to terrazzo manufacturer's written instructions.
   b. Verify that concrete substrates are visibly dry and free of moisture.
   c. Moisture Testing:
      1) Test for moisture by anhydrous calcium chloride method according to ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
      2) Test for moisture by relative humidity probe and digital meter method according to ASTM F 2170. Proceed with installation only after substrates have a maximum relative-humidity-measurement reading of 70 to 75 percent in 24 hours.
      3) Test for moisture content by method recommended in writing by terrazzo manufacturer. Proceed with installation only after substrates pass testing.
3. Protect other work from dust generated by grinding operations. Control dust to prevent air pollution and comply with environmental protection regulations.
   a. Erect and maintain temporary enclosures and other suitable methods to limit dust migration and to ensure adequate ambient temperatures and ventilation conditions during installation.

4. Installation of terrazzo indicates acceptance of surfaces and conditions.

B. Epoxy-Resin Terrazzo Installation
1. General:
a. Comply with NTMA's written recommendations for terrazzo and accessory installation.
b. Place, rough grind, grout, cure grout, fine grind, and finish terrazzo according to manufacturer's written instructions and NTMA's "Terrazzo Specifications and Design Guide."
c. Installation Tolerance: Limit variation in terrazzo surface from level to 1/4 inch in 10 feet (6 mm in 3 m); noncumulative.
d. Ensure that matrix components and fluids from grinding operations do not stain terrazzo by reacting with divider and control-joint strips.
e. Delay fine grinding until heavy trade work is complete and construction traffic through area is restricted.
2. Thickness: 1/4 inch (6.4 mm) **OR** 3/8 inch (9.5 mm) **OR** As indicated, **as directed**, nominal.
3. Flexible Reinforcing Membrane:
a. Prepare and prefill substrate cracks with membrane material.
b. Install membrane to produce full substrate coverage in areas to receive terrazzo.
c. Reinforce membrane with fiberglass scrim.
d. Prepare membrane according to manufacturer's written instructions before applying substrate primer.
4. Primer: Apply to terrazzo substrates according to manufacturer's written instructions.
5. Strip Materials:
a. Divider and Control-Joint Strips:
1) Locate divider strips in locations indicated.
2) Install control-joint strips back to back directly above concrete-slab control joints **OR** in locations indicated, **as directed**.
3) Install control-joint strips with 1/4-inch (6.4-mm) gap between strips, and install sealant in gap.
4) Install strips in adhesive setting bed without voids below strips, or mechanically anchor strips as required to attach strips to substrate, as recommended by strip manufacturer.
b. Accessory Strips: Install accessory strips as required to provide a complete installation **OR** in locations indicated, **as directed**.
c. Abrasive Strips: Install with surface of abrasive strip positioned 1/16 inch (1.6 mm) **OR** 1/32 inch (0.8 mm), **as directed**, higher than terrazzo surface.
6. Fine Grinding: Grind with stones 120 grit or finer until all grout is removed from surface. Repeat rough grinding, grout coat, and fine grinding if large voids exist after initial fine grinding. Produce surface with a minimum of 70 percent aggregate exposure.
7. Repair: Remove and replace terrazzo areas that evidence lack of bond with substrate. Cut out terrazzo areas in panels defined by strips and replace to match adjacent terrazzo, or repair panels according to NTMA's written recommendations, as approved by the Owner.

C. Precast Terrazzo Installation
1. Install precast terrazzo units using method recommended NTMA and manufacturer unless otherwise indicated.
2. Installation Tolerance: Set units with alignment level and true to dimensions, varying 1/8-inch (3.2-mm) maximum in length, height, or width; noncumulative.
3. Do not install units that are chipped, cracked, discolored, or not properly finished.
4. Seal joints between units with joint compound matching precast terrazzo matrix **OR** joint sealant, **as directed**.

D. Cleaning And Protection
1. Cleaning:
a. Remove grinding dust from installation and adjacent areas.

   b. Wash surfaces with cleaner according to NTMA's written recommendations and manufacturer's written instructions; rinse surfaces with water and allow to dry thoroughly.
2. Sealing:
   a. Seal surfaces according to NTMA's written recommendations.
   b. Apply sealer according to sealer manufacturer's written instructions.
3. Protection: Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure that terrazzo is without damage or deterioration at time of Final Completion.

END OF SECTION 09 66 23 00

Task	Specification	Specification Description
09 66 23 16	09 66 23 00	Resinous Matrix Terrazzo Flooring
09 66 33 13	09 66 23 00	Resinous Matrix Terrazzo Flooring
09 66 33 16	09 66 23 00	Resinous Matrix Terrazzo Flooring
09 66 33 19	09 66 23 00	Resinous Matrix Terrazzo Flooring

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SECTION 09 67 16 00 - RESINOUS FLOORING

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for resinous flooring. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Decorative resinous flooring systems.
      b. Industrial resinous flooring systems.
      c. High-performance resinous flooring systems.

C. Submittals
   1. Product Data: For each type of product indicated. Include manufacturer's technical data, application instructions, and recommendations for each resinous flooring component required.
   2. LEED Submittal:
      a. Product Data for Credit EQ 4.2: For resinous flooring systems, documentation including printed statement of VOC content and chemical components.
   3. Samples: For each resinous flooring system required, 6 inches (150 mm) square, applied to a rigid backing by Installer for this Project.
   4. Product Schedule: For resinous flooring. Use same designations indicated on Drawings.
   5. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.
   6. Material Certificates: For each resinous flooring component, from manufacturer.
   7. Material Test Reports: For each resinous flooring system.
   8. Maintenance Data: For resinous flooring to include in maintenance manuals.

D. Quality Assurance
   1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of flooring systems required for this Project.
      a. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.
   2. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Provide secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from source recommended by manufacturer of primary materials.
   3. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
   1. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

F. Project Conditions
   1. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.
   2. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.

3. Close spaces to traffic during resinous flooring application and for not less than 24 hours after application unless manufacturer recommends a longer period.

1.2 PRODUCTS

A. Materials
1. VOC Content of Resinous Flooring: Provide resinous flooring systems, for use inside the weatherproofing system, that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
    a. Resinous Flooring: 100 g/L.

B. Decorative Resinous Flooring
1. Resinous Flooring: Abrasion-, impact- and chemical-resistant, decorative-aggregate-filled, epoxy-resin-based, monolithic floor surfacing designed to produce a seamless floor and integral cove base, **as directed**.
2. System Characteristics:
    a. Color and Pattern: As selected from manufacturer's full range **OR** As indicated by product designation, **as directed**.
    b. Wearing Surface: Textured for slip resistance **OR** Orange-peel texture **OR** Smooth **OR** Manufacturer's standard wearing surface, **as directed**.
    c. Overall System Thickness: 1/16 inch (1.6 mm) **OR** 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
    d. Federal Agency Approvals: USDA **OR** FDA, **as directed**, approved for food-processing environments.
3. Body Coats:
    a. Resin: Epoxy.
    b. Formulation Description: 100 percent solids **OR** High solids **OR** Water based, **as directed**.
    c. Application Method: Self-leveling slurry with broadcast aggregates **OR** Self-leveling slurry **OR** Troweled or screeded, **as directed**.
        1) Thickness of Coats: 1/16 inch (1.6 mm) **OR** 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
        2) Number of Coats: One **OR** Two, **as directed**.
    d. Aggregates: Manufacturer's standard **OR** Colored quartz (ceramic-coated silica) **OR** Vinyl flakes **OR** Granite **OR** Natural silica, **as directed**.
4. Topcoat: Sealing or finish coats.
    a. Resin: Epoxy **OR** Urethane **OR** Vinyl ester, **as directed**.
    b. Formulation Description: 100 percent solids **OR** High solids **OR** Water based, **as directed**.
    c. Type: Clear **OR** Pigmented, **as directed**.
    d. Finish: Matte **OR** Gloss, **as directed**.
    e. Number of Coats: One **OR** Two, **as directed**.
5. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:
    a. Compressive Strength: per ASTM C 579.
    b. Tensile Strength: per ASTM C 307.
    c. Flexural Modulus of Elasticity: per ASTM C 580.
    d. Water Absorption: per ASTM C 413.
    e. Coefficient of Thermal Expansion: per ASTM C 531.
    f. Indentation: per MIL-D-3134.
    g. Impact Resistance: No chipping, cracking, or delamination and not more than 1/16-inch (1.6-mm) permanent indentation per MIL-D-3134.
    h. Resistance to Elevated Temperature: No slip or flow of more than 1/16 inch (1.6 mm) per MIL-D-3134.
    i. Abrasion Resistance: maximum weight loss per ASTM D 4060.
    j. Flammability: Self-extinguishing per ASTM D 635.

k. Critical Radiant Flux: 0.45 W/sq. cm **OR** 0.22 W/sq. cm, **as directed**, or greater per NFPA 253.
l. Hardness: Shore D per ASTM D 2240.
m. Bond Strength: 100 percent concrete failure per ACI 503R.

6. System Chemical Resistance: Test specimens of cured resinous flooring system are unaffected when tested according to ASTM D 1308 for 50 percent immersion **OR** ASTM D 543, Procedure A, for immersion **OR** ASTM C 267 for immersion, **as directed**, in reagents **as directed** for no fewer than seven days.

C. Industrial Resinous Flooring

1. Resinous Flooring: Abrasion-, impact- and chemical-resistant, industrial-aggregate-filled, resin-based, monolithic floor surfacing designed to produce a seamless floor and integral cove base, **as directed**.
2. System Characteristics:
   a. Color and Pattern: As selected from manufacturer's full range **OR** As indicated by product designation, **as directed**.
   b. Wearing Surface: Textured for slip resistance **OR** Orange-peel texture **OR** Smooth **OR** Manufacturer's standard wearing surface, **as directed**.
   c. Overall System Thickness: 1/16 inch (1.6 mm) **OR** 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
   d. Federal Agency Approvals: USDA **OR** FDA, **as directed**, approved for food-processing environments.
3. Body Coats:
   a. Resin: Epoxy **OR** Urethane **OR** Vinyl ester, **as directed**.
   b. Formulation Description: 100 percent solids **OR** High solids **OR** Water based, **as directed**.
   c. Application Method: Self-leveling slurry with broadcast aggregates **OR** Self-leveling slurry **OR** Troweled or screeded, **as directed**.
      1) Thickness of Coats: 1/16 inch (1.6 mm) **OR** 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
      2) Number of Coats: One **OR** Two, **as directed**.
   d. Aggregates: Manufacturer's standard **OR** Colored quartz (ceramic-coated silica) **OR** Vinyl flakes **OR** Granite **OR** Natural silica, **as directed**.
4. Topcoat: Sealing or finish coats.
   a. Resin: Epoxy **OR** Urethane **OR** Vinyl ester, **as directed**.
   b. Formulation Description: 100 percent solids **OR** High solids **OR** Water based, **as directed**.
   c. Type: Clear **OR** Pigmented, **as directed**.
   d. Finish: Matte **OR** Gloss, **as directed**.
   e. Number of Coats: One **OR** Two, **as directed**.
5. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:
   a. Compressive Strength: per ASTM C 579.
   b. Tensile Strength: per ASTM C 307.
   c. Flexural Modulus of Elasticity: per ASTM C 580.
   d. Water Absorption: per ASTM C 413.
   e. Coefficient of Thermal Expansion: per ASTM C 531.
   f. Indentation: percent maximum per MIL-D-3134.
   g. Impact Resistance: No chipping, cracking, or delamination and not more than 1/16-inch (1.6-mm) permanent indentation per MIL-D-3134.
   h. Resistance to Elevated Temperature: No slip or flow of more than 1/16 inch (1.6 mm) per MIL-D-3134.
   i. Abrasion Resistance: maximum weight loss per ASTM D 4060.
   j. Flammability: Self-extinguishing per ASTM D 635.
   k. Critical Radiant Flux: 0.45 W/sq. cm **OR** 0.22 W/sq. cm, **as directed**, or greater per NFPA 253.
   l. Hardness: Shore D per ASTM D 2240.
   m. Bond Strength: 100 percent concrete failure per ACI 503R.

6. System Chemical Resistance: Test specimens of cured resinous flooring system are unaffected when tested according to ASTM D 1308 for 50 percent immersion **OR** ASTM D 543, Procedure A, for immersion **OR** ASTM C 267 for immersion, **as directed**, in reagents **as directed** for no fewer than seven days.

D. High-Performance Resinous Flooring
1. Resinous Flooring: Abrasion-, impact- and chemical-resistant, high-performance-aggregate-filled, resin-based, monolithic floor surfacing designed to produce a seamless floor and integral cove base, **as directed**.
2. System Characteristics:
   a. Color and Pattern: As selected from manufacturer's full range **OR** As indicated by product designation, **as directed**.
   b. Wearing Surface: Textured for slip resistance **OR** Orange-peel texture **OR** Smooth **OR** Manufacturer's standard wearing surface, **as directed**.
   c. Overall System Thickness: 1/16 inch (1.6 mm) **OR** 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
   d. Federal Agency Approvals: USDA **OR** FDA, **as directed**, approved for food-processing environments.
3. Body Coats:
   a. Resin: Epoxy **OR** Epoxy novolac **OR** Urethane **OR** Vinyl ester **OR** Methyl methacrylate, **as directed**.
   b. Formulation Description: 100 percent solids **OR** High solids **OR** Water based, **as directed**.
   c. Application Method: Self-leveling slurry with broadcast aggregates **OR** Self-leveling slurry **OR** Troweled or screeded, **as directed**.
      1) Thickness of Coats: 1/16 inch (1.6 mm) **OR** 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
      2) Number of Coats: One **OR** Two, **as directed**.
   d. Aggregates: Manufacturer's standard **OR** Colored quartz (ceramic-coated silica) **OR** Vinyl flakes **OR** Granite **OR** Natural silica, **as directed**.
4. Topcoat: Sealing or finish coats.
   a. Resin: Epoxy **OR** Epoxy novolac **OR** Urethane **OR** Vinyl ester **OR** Methyl methacrylate, **as directed**.
   b. Formulation Description: 100 percent solids **OR** High solids **OR** Water based, **as directed**.
   c. Type: Clear **OR** Pigmented, **as directed**.
   d. Finish: Matte **OR** Gloss, **as directed**.
   e. Number of Coats: One **OR** Two, **as directed**.
5. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:
   a. Compressive Strength: per ASTM C 579.
   b. Tensile Strength: per ASTM C 307.
   c. Flexural Modulus of Elasticity: per ASTM C 580.
   d. Water Absorption: per ASTM C 413.
   e. Coefficient of Thermal Expansion: per ASTM C 531.
   f. Indentation: percent maximum per MIL-D-3134.
   g. Impact Resistance: No chipping, cracking, or delamination and not more than 1/16-inch (1.6-mm) permanent indentation per MIL-D-3134.
   h. Resistance to Elevated Temperature: No slip or flow of more than 1/16 inch (1.6 mm) per MIL-D-3134.
   i. Abrasion Resistancemaximum weight loss per ASTM D 4060.
   j. Flammability: Self-extinguishing per ASTM D 635.
   k. Critical Radiant Flux: 0.45 W/sq. cm **OR** 0.22 W/sq. cm, **as directed**, or greater per NFPA 253.
   l. Hardness: Shore D per ASTM D 2240.
   m. Bond Strength: 100 percent concrete failure per ACI 503R.

6. System Chemical Resistance: Test specimens of cured resinous flooring system are unaffected when tested according to ASTM D 1308 for 50 percent immersion **OR** ASTM D 543, Procedure A, for immersion **OR** ASTM C 267 for immersion, **as directed**, in reagents **as directed** for no fewer than seven days.

E. Accessories
1. Primer: Type recommended by manufacturer for substrate and body coats indicated.
   a. Formulation Description: 100 percent solids **OR** High solids **OR** Water based, **as directed**.
2. Waterproofing Membrane: Type recommended by manufacturer for substrate and primer and body coats indicated.
   a. Formulation Description: 100 percent solids **OR** High solids, **as directed**.
3. Reinforcing Membrane: Flexible resin formulation that is recommended by manufacturer for substrate and primer and body coats indicated and that prevents substrate cracks from reflecting through resinous flooring.
   a. Formulation Description: 100 percent solids **OR** High solids, **as directed**.
      1) Provide fiberglass scrim embedded in reinforcing membrane.
4. Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended by manufacturer for application indicated.

1.3 EXECUTION

A. Preparation
1. General: Prepare and clean substrates according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry substrate for resinous flooring application.
2. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.
   a. Roughen concrete substrates as follows:
      1) Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
      OR
      Comply with ASTM C 811 requirements unless manufacturer's written instructions are more stringent.
   b. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written instructions.
   c. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.
      1) Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with application of resinous flooring only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) of slab area in 24 hours.
      2) Perform plastic sheet test, ASTM D 4263. Proceed with application only after testing indicates absence of moisture in substrates.
      3) Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
   d. Alkalinity and Adhesion Testing: Verify that concrete substrates have pH within acceptable range. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.
3. Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.
4. Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.
5. Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written instructions.

B. Application
1. General: Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.
   a. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
   b. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
   c. At substrate expansion and isolation joints, comply with resinous flooring manufacturer's written instructions.
2. Apply primer over prepared substrate at manufacturer's recommended spreading rate.
3. Apply waterproofing membrane, where indicated, in manufacturer's recommended thickness.
   a. Apply waterproofing membrane to integral cove base substrates.
4. Apply reinforcing membrane to substrate cracks **OR** entire substrate surface, **as directed**.
5. Integral Cove Base: Apply cove base mix to wall surfaces before applying flooring. Apply according to manufacturer's written instructions and details including those for taping, mixing, priming, troweling, sanding, and topcoating of cove base. Round internal and external corners.
   a. Integral Cove Base: 4 inches (100 mm) high.
6. Apply self-leveling slurry body coats in thickness indicated for flooring system.
   a. Broadcast aggregates at rate recommended by manufacturer and, after resin is cured, remove excess aggregates to provide surface texture indicated.
7. Apply troweled or screeded body coats in thickness indicated for flooring system. Hand or power trowel and grout to fill voids. When cured, remove trowel marks and roughness using method recommended by manufacturer.
8. Apply grout coat, of type recommended by resinous flooring manufacturer, to fill voids in surface of final body coat and to produce wearing surface indicated.
9. Apply topcoats in number indicated for flooring system and at spreading rates recommended in writing by manufacturer.

C. Field Quality Control
1. Core Sampling: At the direction of the Owner and at locations designated by the Owner, take one core sample per 1000 sq. ft. (92.9 sq. m) of resinous flooring, or portion of, to verify thickness. For each sample that fails to comply with requirements, take two additional samples. Repair damage caused by coring and correct deficiencies.
2. Material Sampling: the Owner may at any time and any number of times during resinous flooring application require material samples for testing for compliance with requirements.
   a. Contractor will engage an independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence of Contractor.
   b. Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer's product data.
   c. If test results show applied materials do not comply with specified requirements, pay for testing, remove noncomplying materials, prepare surfaces coated with unacceptable materials, and reapply flooring materials to comply with requirements.

D. Protection
1. Protect resinous flooring from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

END OF SECTION 09 67 16 00

Task	Specification	Specification Description
09 67 23 00	09 67 16 00	Resinous Flooring

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SECTION 09 68 13 00 - CARPET TILE

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for carpet tile. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes modular, fusion-bonded **OR** tufted, **as directed**, carpet tile.

C. Submittals
1. Product Data: For each product indicated.
2. Shop Drawings: Show the following:
   a. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
   b. Existing flooring materials to be removed.
   c. Existing flooring materials to remain.
   d. Carpet tile type, color, and dye lot.
   e. Type of subfloor.
   f. Type of installation.
   g. Pattern of installation.
   h. Pattern type, location, and direction.
   i. Pile direction.
   j. Type, color, and location of insets and borders.
   k. Type, color, and location of edge, transition, and other accessory strips.
   l. Transition details to other flooring materials.
3. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
   a. Carpet Tile: Full-size Sample.
   b. Exposed Edge, Transition, and other Accessory Stripping: 12-inch- (300-mm-) long Samples.
4. LEED Submittal:
   a. Product Data for Credit EQ 4.3:
      1) For carpet tile, documentation indicating compliance with testing and product requirements of Carpet and Rug Institute's "Green Label Plus" program.
      2) For installation adhesive, including printed statement of VOC content.
5. Product Schedule: For carpet tile. Use same designations indicated on Drawings.
6. Maintenance data.

D. Quality Assurance
1. Installer Qualifications: An experienced installer who is certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements.
2. Fire-Test-Response Characteristics: Provide products with the critical radiant flux classification indicated in Part 2, as determined by testing identical products per ASTM E 648 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
3. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
1. Comply with CRI 104, Section 5, "Storage and Handling."

F. Project Conditions

1. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."
2. Environmental Limitations: Do not install carpet tiles until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
3. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
4. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

G. Warranty

1. Special Warranty for Carpet Tiles: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
   a. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
   b. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, loss of tuft bind strength, dimensional stability, excess static discharge, and delamination.
   c. Warranty Period: 10 years from date of Final Completion.

1.2 PRODUCTS

A. Carpet Tile

1. Fiber Content: 100 percent nylon 6, 6 **OR** 100 percent nylon 6 **OR** 100 percent polypropylene **OR** 100 percent wool **OR** 80 percent wool; 20 percent nylon 6, 6 **OR** 80 percent wool; 20 percent nylon 6, **as directed**.
2. Fiber Type: <**Insert proprietary fiber type**.>
3. Pile Characteristic: Level-loop **OR** Cut **OR** Cut-and-loop, **as directed**, pile.
4. Yarn Twist: <**Insert twist in TPI (TPCM)**.>
5. Yarn Count: <**Insert yarn count**.>
6. Density: <**Insert oz./cu. yd. (g/cu. cm)**.>
7. Pile Thickness: <**Insert inches (mm)**> for finished carpet tile per ASTM D 6859.
8. Stitches: <**Insert stitches per inch (mm)**.>
9. Gage: <**Insert gage in ends per inch (mm)**.>
10. Surface Pile Weight: <**Insert oz./sq. yd. (g/sq. m)**.>
11. Total Weight: <**Insert oz./sq. yd. (g/sq. m)**> for finished carpet tile.
12. Primary Backing/Backcoating: Manufacturer's standard composite materials **OR** PVC **OR** Fiberglass-reinforced PVC **OR** Fiberglass-reinforced amorphous resin **OR** Reinforced polyurethane composite cushion **OR** Reinforced polyurethane composite **OR** Reinforced thermoplastic copolymer, **as directed**.
13. Secondary Backing: Manufacturer's standard material.
14. Backing System: <**Insert proprietary name**.>
15. Size: 18 by 18 inches (457 by 457 mm) **OR** 24 by 24 inches (610 by 610 mm) **OR** 18 by 36 inches (457 by 914 mm) **OR** 36 by 36 inches (914 by 914 mm), **as directed**.
16. Applied Soil-Resistance Treatment: Manufacturer's standard material.
17. Antimicrobial Treatment: Manufacturer's standard material.
18. Performance Characteristics: As follows:
    a. Critical Radiant Flux Classification: Not less than0.45 W/sq. cm **OR** 0.22 W/sq. cm, **as directed**.
    b. Dry Breaking Strength: Not less than 100 lbf (445 N) per ASTM D 2646.
    c. Tuft Bind: Not less than 3 lbf (13 N) **OR** 5 lbf (22 N) **OR** 6.2 lbf (28 N) **OR** 8 lbf (36 N) **OR** 10 lbf (45 N), **as directed**, per ASTM D 1335.

d. Delamination: Not less than 3.5 lbf/in. (15 N/mm) **OR** 4 lbf/in. (18 N/mm), **as directed**, per ASTM D 3936.
e. Dimensional Tolerance: Within 1/32 inch (0.8 mm) of specified size dimensions, as determined by physical measurement.
f. Dimensional Stability: 0.2 percent or less per ISO 2551 (Aachen Test).
g. Resistance to Insects: Comply with AATCC 24.
h. Noise Reduction Coefficient (NRC): <**Insert NRC**> per ASTM C 423.
i. Colorfastness to Crocking: Not less than 4, wet and dry, per AATCC 165.
j. Colorfastness to Light: Not less than 4 after 40 **OR** 60, **as directed**, AFU (AATCC fading units) per AATCC 16, Option E.
k. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria; not less than 1-mm halo of inhibition for gram-negative bacteria; no fungal growth; per AATCC 174.
l. Electrostatic Propensity: Less than 3.5 **OR** 2, **as directed**, kV per AATCC 134.
m. Environmental Requirements: Provide carpet tile that complies with testing and product requirements of Carpet and Rug Institute's "Green Label Plus" program.

B. Installation Accessories
1. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
2. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.
   a. VOC Limits: Provide adhesives with VOC content not more than 50 g/L when calculated according to 40 CFR 59, Subpart D (EPA method 24).

1.3 EXECUTION

A. Preparation
1. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.
2. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch (3 mm) wide or wider and protrusions more than 1/32 inch (0.8 mm), unless more stringent requirements are required by manufacturer's written instructions.
3. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet tile manufacturer.
4. Clean metal substrates of grease, oil, soil and rust, and prime if directed by adhesive manufacturer. Rough sand painted metal surfaces and remove loose paint. Sand aluminum surfaces, to remove metal oxides, immediately before applying adhesive.
5. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

B. Installation
1. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.
2. Installation Method: As recommended in writing by carpet tile manufacturer **OR** Glue down; install every tile with full-spread, releasable, pressure-sensitive adhesive **OR** Partial glue down; install periodic tiles with releasable, pressure-sensitive adhesive **OR** Free lay; install carpet tiles without adhesive, **as directed**.
3. Maintain dye lot integrity. Do not mix dye lots in same area.
4. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.

5. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
6. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.
7. Install pattern parallel to walls and borders.
8. Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free of adhesive.

C. Cleaning And Protection
1. Perform the following operations immediately after installing carpet tile:
    a. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet tile manufacturer.
    b. Remove yarns that protrude from carpet tile surface.
    c. Vacuum carpet tile using commercial machine with face-beater element.
2. Protect installed carpet tile to comply with CRI 104, Section 16, "Protection of Indoor Installations."
3. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 09 68 13 00

SECTION 09 68 16 00 - CARPET

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for carpet. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Tufted carpet.
b. Woven carpet.
c. Carpet cushion.

C. Submittals
1. Product Data: For each product indicated.
2. Shop Drawings: Show the following:
a. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet.
b. Existing flooring materials to be removed.
c. Existing flooring materials to remain.
d. Carpet type, color, and dye lot.
e. Locations where dye lot changes occur.
f. Seam locations, types, and methods.
g. Type of subfloor.
h. Type of installation.
i. Pattern type, repeat size, location, direction, and starting point.
j. Pile direction.
k. Type, color, and location of insets and borders.
l. Type, color, and location of edge, transition, and other accessory strips.
m. Transition details to other flooring materials.
n. Type of carpet cushion.
3. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
a. Carpet: 12-inch- (300-mm-) square Sample.
b. Exposed Edge, Transition, and other Accessory Stripping: 12-inch- (300-mm-) long Samples.
c. Carpet Cushion: 6-inch- (150-mm-) square Sample.
d. Carpet Seam: 6-inch (150-mm) Sample.
e. Mitered Carpet Border Seam: 12-inch- (300-mm-) square Sample. Show carpet pattern alignment.
4. LEED Submittals:
a. Product Data for Credit EQ 4.3:
1) For carpet, documentation indicating compliance with testing and product requirements of Carpet and Rug Institute's "Green Label Plus" program.
2) For carpet cushion, documentation indicating compliance with testing and product requirements of Carpet and Rug Institute's "Green Label" program.
3) For installation adhesive, including printed statement of VOC content.
5. Product Schedule: For carpet and carpet cushion. Use same designations indicated on Drawings.
6. Maintenance data.

D. Quality Assurance
   1. Installer Qualifications: An experienced installer who is certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements.
   2. Fire-Test-Response Characteristics: Provide products with the critical radiant flux classification indicated in Part 1.2, as determined by testing identical products per ASTM E 648 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
   3. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
   1. Comply with CRI 104, Section 5, "Storage and Handling."

F. Project Conditions
   1. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."
   2. Environmental Limitations: Do not install carpet and carpet cushion until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
   3. Do not install carpet and carpet cushion over concrete slabs until slabs have cured, are sufficiently dry to bond with adhesive, and have pH range recommended by carpet manufacturer.
   4. Where demountable partitions or other items are indicated for installation on top of carpet, install carpet before installing these items.

G. Warranty
   1. Special Warranty for Carpet: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet installation that fail in materials or workmanship within specified warranty period.
      a. Warranty does not include deterioration or failure of carpet due to unusual traffic, failure of substrate, vandalism, or abuse.
      b. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, loss of tuft bind strength, excess static discharge, and delamination.
      c. Warranty Period: 10 years from date of Final Completion.
   2. Special Warranty for Carpet Cushion: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet cushion installation that fail in materials or workmanship within specified warranty period.
      a. Warranty includes consequent removal and replacement of carpet and accessories.
      b. Warranty does not include deterioration or failure of carpet cushion due to unusual traffic, failure of substrate, vandalism, or abuse.
      c. Failure includes, but is not limited to, permanent indentation or compression.
      d. Warranty Period: 10 years from date of Final Completion.

1.2 PRODUCTS

A. Tufted Carpet
   1. Fiber Content: 100 percent nylon 6, 6 **OR** 100 percent nylon 6 **OR** 100 percent polypropylene, **as directed**.
   2. Pile Characteristic: Level-loop **OR** Cut **OR** Cut-and-loop **OR** Multilevel-loop **OR** Level tip shear **OR** Random shear **OR** Frieze **OR** Sculptured, **as directed**, pile.
   3. Yarn Twist: as directed by the Owner.
   4. Yarn Count: as directed by the Owner.
   5. Density: as directed by the Owner.
   6. Pile Thickness: finished carpet per ASTM D 6859.
   7. Stitches: as directed by the Owner.
   8. Gage: as directed by the Owner.
   9. Face Weight: as directed by the Owner.

10. Total Weight: for finished carpet.
11. Primary Backing: Manufacturer's standard material **OR** Woven polypropylene **OR** Nonwoven, polypropylene or polyester, **as directed**.
12. Secondary Backing: Manufacturer's standard material **OR** Woven polypropylene **OR** Nonwoven, polypropylene or polyester **OR** Woven jute **OR** Fiberglass, **as directed**.
13. Backcoating: Manufacturer's standard material **OR** SBR latex **OR** PVC **OR** Thermoplastic copolymer, **as directed**.
14. Width: 12 feet (3.7 m) **OR** 6 feet (1.8 m) **OR** 13.5 feet (4.1 m) **OR** 15 feet (4.6 m), **as directed**.
15. Applied Soil-Resistance Treatment: Manufacturer's standard material.
16. Antimicrobial Treatment: Manufacturer's standard material.
17. Performance Characteristics: As follows:
    a. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm **OR** 0.22 W/sq. cm, **as directed**.
    b. Dry Breaking Strength: Not less than 100 lbf (445 N) per ASTM D 2646.
    c. Tuft Bind: Not less than 3 lbf (13 N) **OR** 5 lbf (22 N) **OR** 6.2 lbf (28 N) **OR** 8 lbf (36 N) **OR** 10 lbf (45 N), **as directed**, per ASTM D 1335.
    d. Delamination: Not less than 2.5 lbf/in. (12 N/mm) **OR** 3.5 lbf/in. (15 N/mm) **OR** 4 lbf/in. (18 N/mm), **as directed**, per ASTM D 3936.
    e. Resistance to Insects: Comply with AATCC 24.
    f. Noise Reduction Coefficient (NRC): per ASTM C 423.
    g. Colorfastness to Crocking: Not less than 4, wet and dry, per AATCC 165.
    h. Colorfastness to Light: Not less than 4 after 40 **OR** 60, **as directed**, AFU (AATCC fading units) per AATCC 16, Option E.
    i. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria; not less than 1-mm halo of inhibition for gram-negative bacteria; no fungal growth; per AATCC 174.
    j. Electrostatic Propensity: Less than 3.5 **OR** 2, **as directed**, kV per AATCC 134.
    k. Environmental Requirements: Provide carpet that complies with testing and product requirements of Carpet and Rug Institute's "Green Label Plus" program.

B. Woven Carpet
1. Fiber Content: 100 percent wool **OR** 80 percent wool; 20 percent nylon 6, 6 **OR** 80 percent wool; 20 percent nylon 6, **as directed**.
2. Face Construction: Axminster **OR** Wilton **OR** Velvet, **as directed**.
3. Pile Characteristic: Level-loop **OR** Cut **OR** Cut-and-loop, **as directed**, pile.
4. Yarn Twist: as directed by the Owner.
5. Yarn Count: as directed by the Owner.
6. Density: as directed by the Owner.
7. Pile Thickness: for finished carpet per ASTM D 6859.
8. Rows: as directed by the Owner.
9. Pitch: as directed by the Owner.
10. Face Weight: as directed by the Owner.
11. Total Weight: as directed by the Owner., for finished carpet.
12. Backing: Manufacturers standard **OR** As follows, **as directed**:
    a. Chain Warp: as directed by the Owner.
    b. Stuffer Warp: as directed by the Owner.
    c. Shot or Fill Weft: as directed by the Owner.
    d. Backcoating: as directed by the Owner.
13. Applied Soil-Resistance Treatment: Manufacturer's standard material.
14. Performance Characteristics: As follows:
    a. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm **OR** 0.22 W/sq. cm, **as directed**.
    b. Dry Breaking Strength: Not less than 100 lbf (445 N) per ASTM D 2646.
    c. Resistance to Insects: Comply with AATCC 24.
    d. Noise Reduction Coefficient (NRC): per ASTM C 423.
    e. Colorfastness to Crocking: Not less than 4, wet and dry, per AATCC 165.

f. Colorfastness to Light: Not less than 4 after 40 **OR** 60, **as directed**, AFU (AATCC fading units) per AATCC 16, Option E.
g. Electrostatic Propensity: Less than 3.5 **OR** 2, **as directed**, kV per AATCC 134.
h. Environmental Requirements: Provide carpet that complies with testing and product requirements of Carpet and Rug Institute's "Green Label Plus" program.

C. Carpet Cushion
1. Traffic Classification: CCC Class I, moderate **OR** II, heavy **OR** III, extra-heavy, **as directed**, traffic.
2. Fiber Cushion: Rubberized hair, mothproofed and sterilized **OR** Rubberized jute, mothproofed and sterilized **OR** Synthetic **OR** Resinated, recycled textile, **as directed**.
   a. Weight: as directed by the Owner.
   b. Thickness: as directed by the Owner.plus 5 percent maximum.
   c. Density: as directed by the Owner.
3. Rubber Cushion: Flat **OR** Rippled waffle **OR** Textured flat **OR** Reinforced, **as directed**.
   a. Weight: as directed by the Owner.
   b. Thickness: as directed by the Owner.plus 5 percent maximum.
   c. Compression Resistance: at 25 **OR** 65, **as directed**, percent per ASTM D 3676.
   d. Density: as directed by the Owner.
4. Polyurethane-Foam Cushion: Grafted prime **OR** Densified **OR** Bonded **OR** Mechanically frothed, **as directed**.
   a. Compression Force Deflection at 65 Percent: per ASTM D 3574.
   b. Thickness: as directed by the Owner.
   c. Density: as directed by the Owner.
5. Performance Characteristics: As follows:
   a. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm **OR** 0.22 W/sq. cm, **as directed**.
   b. Noise Reduction Coefficient (NRC): per ASTM C 423.
   c. Environmental Requirements: Provide carpet cushion that complies with testing and product requirements of Carpet and Rug Institute's "Green Label" program.

D. Installation Accessories
1. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet **OR** carpet cushion, **as directed**, manufacturer.
2. Adhesives: Water-resistant, mildew-resistant, nonstaining type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet and is recommended or provided by carpet manufacturer **OR** carpet and carpet cushion manufacturers, **as directed**.
   a. VOC Limits: Provide adhesives with VOC content not more than 50g/L when calculated according to 40 CFR 59, Subpart D (EPA method 24).
3. Tackless Carpet Stripping: Water-resistant plywood, in strips as required to match cushion thickness and that comply with CRI 104, Section 12.2.
4. Seam Adhesive: Hot-melt adhesive tape or similar product recommended by carpet manufacturer for sealing and taping seams and butting cut edges at backing to form secure seams and to prevent pile loss at seams.
5. Metal Edge Strips: Extruded aluminum with mill finish of width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

1.3 EXECUTION

A. Preparation
1. General: Comply with CRI 104, Section 7.3, "Site Conditions; Floor Preparation," and with carpet manufacturer's written installation instructions for preparing substrates.

2. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch (3 mm) wide or wider, and protrusions more than 1/32 inch (0.8 mm), unless more stringent requirements are required by manufacturer's written instructions.
3. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet **OR** carpet cushion, **as directed**, manufacturer.
4. Broom and vacuum clean substrates to be covered immediately before installing carpet.

B. Installation
1. Comply with CRI 104 and carpet manufacturer's **OR** carpet and carpet cushion manufacturers', **as directed**, written installation instructions for the following:
   a. Direct-Glue-Down Installation: Comply with CRI 104, Section 9, "Direct Glue-Down Installation."
   b. Double-Glue-Down Installation: Comply with CRI 104, Section 10, "Double Glue-Down Installation."
   c. Carpet with Attached-Cushion Installation: Comply with CRI 104, Section 11, "Attached-Cushion Installations."
   d. Preapplied Adhesive Installation: Comply with CRI 104, Section 11.4, "Pre-Applied Adhesive Systems (Peel and Stick)."
   e. Hook-and-Loop Installation: Comply with CRI 104, Section 11.5, "Hook and Loop Technology."
   f. Stretch-in Installation: Comply with CRI 104, Section 12, "Stretch-in Installation."
   g. Stair Installation: Comply with CRI 104, Section 13, "Carpet on Stairs" for stretch-in **OR** glue-down, **as directed**, installation.
2. Comply with carpet manufacturer's written recommendations and Shop Drawings for seam locations and direction of carpet; maintain uniformity of carpet direction and lay of pile. At doorways, center seams under the door in closed position.
   a. Bevel adjoining border edges at seams with hand shears **OR** Level adjoining border edges, **as directed**.
3. Do not bridge building expansion joints with carpet.
4. Cut and fit carpet to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet manufacturer.
5. Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
6. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.
7. Install pattern parallel to walls and borders to comply with CRI 104, Section 15, "Patterned Carpet Installations" and with carpet manufacturer's written recommendations.
8. Comply with carpet cushion manufacturer's written recommendations. Install carpet cushion seams at 90-degree angle with carpet seams.

C. Cleaning And Protecting
1. Perform the following operations immediately after installing carpet:
   a. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet manufacturer.
   b. Remove yarns that protrude from carpet surface.
   c. Vacuum carpet using commercial machine with face-beater element.
2. Protect installed carpet to comply with CRI 104, Section 16, "Protection of Indoor Installations."
3. Protect carpet against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet manufacturer and carpet cushion manufacturer **OR** and carpet adhesive manufacturer **OR** and carpet cushion and adhesive manufacturers, **as directed**.

END OF SECTION 09 68 16 00

Task	Specification	Specification Description
09 68 16 00	09 68 13 00	Carpet Tile

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SECTION 09 69 13 00 - ACCESS FLOORING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for access flooring. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Access flooring panels and understructure.
b. Floor panel coverings.

C. Definition
1. ESD: Electrostatic discharge. The transfer of electric charge between bodies at different potentials.

D. System Description
1. Access Flooring System: Assemblies composed of modular floor panels on pedestals with or without stringers.

E. Performance Requirements
1. Structural Performance: Provide access flooring systems capable of withstanding the following loads and stresses within limits and under conditions indicated, as determined by testing manufacturer's current standard products according to referenced procedures in CISCA A/F, "Recommended Test Procedures for Access Floors":
a. Concentrated Loads: Provide floor panels, including those with cutouts, capable of withstanding a concentrated design load of 1000 lbf (4448 N) **OR** 1250 lbf (5560 N) **OR** 1500 lbf (6672 N) **OR** 2000 lbf (8896 N), **as directed**, with a top-surface deflection under load and a permanent set not to exceed, respectively, 0.10 and 0.010 inch (2.54 and 0.25 mm) **OR** 0.080 inch and 0.010 inch (2.03 and 0.25 mm), **as directed**, according to CISCA A/F, Section I, "Concentrated Loads."
OR
Concentrated Loads: Provide floor panels, including those with cutouts, capable of withstanding a concentrated design load of 1000 lbf (4448 N) **OR** 1250 lbf (5560 N) **OR** 1500 lbf (6672 N) **OR** 2000 lbf (8896 N), **as directed**, with a bottom-surface deflection under load and a permanent set not to exceed, respectively, 0.10 and 0.010 inch (2.54 and 0.25 mm) **OR** 0.13 inch and 0.010 inch (3.30 and 0.25 mm), **as directed**, measured below each applied-load location at horizontal surface of nearest composite beam according to CISCA A/F, Section I, "Concentrated Loads."
b. Ultimate Loads: Provide access flooring systems capable of withstanding a minimum ultimate concentrated load of 2000 lbf (8896 N) **OR** 2500 lbf (11 121 N) **OR** 2600 lbf (11 565 N) **OR** 3000 lbf (13 345 N) **OR** 4000 lbf (17 793 N), **as directed**, without failing, according to CISCA A/F, Section II, "Ultimate Loading."
c. Rolling Loads: Provide access flooring systems capable of withstanding rolling loads of the following magnitude, with a combination of local and overall deformation not to exceed 0.040 inch (1.02 mm) after exposure to rolling load over CISCA A/F Path A or B, whichever path produces the greatest top-surface deformation, according to CISCA A/F, Section III, "Rolling Loads."
1) CISCA A/F Wheel 1 Rolling Load: 600 lbf (2669 N) **OR** 800 lbf (3559 N) **OR** 1000 lbf (4448 N) **OR** 1200 lbf (5338 N), **as directed**.

2) CISCA A/F Wheel 2 Rolling Load: 500 lbf (2224 N) **OR** 600 lbf (2669 N) **OR** 800 lbf (3559 N) **OR** 1000 lbf (4448 N), **as directed**.

d. Stringer Load Testing: Provide stringers, without panels in place, capable of withstanding a concentrated load of 75 lbf (334 N) **OR** 225 lbf (1001 N) **OR** 450 lbf (2002 N) **OR** 850 lbf (3781 N), **as directed**, at center of span with a permanent set not to exceed 0.010 inch (0.25 mm), as determined per CISCA A/F, Section IV, "Stringer Load Testing."

e. Pedestal Axial Load Test: Provide pedestal assemblies, without panels or other supports in place, capable of withstanding a 5000 lbf (22 240 N) **OR** 6000 lbf (26 690 N), **as directed**, axial load per pedestal, according to CISCA A/F, Section V, "Pedestal Axial Load Test."

f. Pedestal Overturning Moment Test: Provide pedestal assemblies, without panels or other supports in place, capable of withstanding an overturning moment per pedestal of 1000 lbf x inches (113 N x meters), according to CISCA A/F, Section VI, "Pedestal Overturning Moment Test."

2. Floor Panel Impact-Load Performance: Provide access flooring system capable of withstanding an impact load of 75 lb (34.0 kg) **OR** 100 lb (45.5 kg) **OR** 125 lb (56.7 kg) **OR** 150 lb (68.0 kg) **OR** 175 lbs (79.4 kg), **as directed**, when dropped from 36 inches (914 mm) onto a 1-sq. in. (6.5-sq. cm) area located anywhere on panel, without failing. Failure is defined as collapse of access flooring system.

3. Seismic Performance: Provide access flooring system capable of withstanding the effects of seismic motions determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

4. ESD-Control Properties: Provide floor coverings with ESD-control properties indicated as determined by testing identical products per test method indicated by an independent testing and inspecting agency.

a. Static-Dissipative Floor Covering Properties:

1) Electrical Resistance: Test per ASTM F 150 with 100-V applied voltage **OR** ESD STM 7.1, **as directed**.

a) Average greater than 1 megohm and less than or equal to 1000 megohms when test specimens are tested surface to ground.

b) Average no less than 1 megohm and less than or equal to 1000 megohms when installed floor coverings are tested surface to ground.

2) Static Generation: Less than 300 V when tested per AATCC-134 at 20 percent relative humidity with conductive footwear.

3) Static Decay: 5000 to 0 V in less than 0.25 seconds when tested per FED-STD-101C/4046.1.

b. Static-Conductive Floor Covering Properties:

1) Electrical Resistance: Test per ASTM F 150 with 500-V applied voltage **OR** ESD STM 7.1 **OR** NFPA 99, Annex 2 **OR** UL 779, **as directed**.

a) Average greater than 25,000 ohms and less than 1 megohm when test specimens and installed floor coverings are tested surface to surface (point to point).

b) Average no less than 25,000 ohms with no single measurement less than 10,000 ohms when installed floor coverings are tested surface to ground.

2) Static Generation: Less than 100 V when tested per AATCC-134 at 20 percent relative humidity with conductive footwear.

3) Static Decay: 5000 to 0 V in less than 0.03 **OR** 0.01, **as directed**, seconds when tested per FED-STD-101C/4046.1.

c. Antistatic Floor Covering Properties:

1) Electrical Resistance: Test per ESD STM 7.1.

a) Average greater than 25,000 ohms and less than 1,000 megohm when test specimens and installed floor coverings are tested surface to surface (point to point).

2) Static Generation: Less than 100 V when tested per AATCC-134 at 20 percent relative humidity with conductive footwear.

d. Panel-to-Understructure Resistance: Not more than 10 ohms as measured without floor coverings.

F. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Include layout of access flooring system and relationship to adjoining Work based on field-verified dimensions.
3. Shop Drawings: Include layout, details, sections, and relationship to adjoining Work.
4. LEED Submittals:
a. Product Data for Credit EQ 4.1: For pedestal installation adhesive, including printed statement of VOC content.
b. Product Data for Credit EQ 4.3: For carpet and installation adhesive, documentation indicating compliance with specified requirements.
c. Product Data for Credit EQ 4.4: For particleboard used in steel-encapsulated, wood core panels, documentation indicating that particleboard contains no urea formaldehyde.
5. Product test reports.

G. Quality Assurance
1. Regulatory Requirements: Fabricate and install access flooring to comply with NFPA 75 requirements for raised flooring.
2. Preinstallation Conference: Conduct conference at Project site.

1.2 PRODUCTS

A. Floor Panels And Understructure
1. Floor Panels, General: Provide modular panels complying with the following requirements that one person, using a portable lifting device, can interchange with other field panels without disturbing adjacent panels or understructure:
a. Nominal Panel Size: 24 by 24 inches (610 by 610 mm) **OR** 600 by 600 mm, **as directed**.
b. Fabrication Tolerances: Fabricate panels to the following tolerances with squareness tolerances expressed as the difference between diagonal measurements from corner to corner:
1) Size and Squareness: Plus or minus 0.015 inch (0.38 mm) of required size, with a squareness tolerance of plus or minus 0.015 inch (0.38 mm), unless tolerances are otherwise indicated for a specific panel type.
2) Flatness: Plus or minus 0.020 inch (0.50 mm), measured on a diagonal on top of panel.
c. Panel Attachment to Understructure: By gravity.
d. Panel Attachment to Understructure: By bolting to pedestal head. Provide panels with holes drilled in corners to align precisely with threaded holes in pedestal heads and to accept countersunk screws with heads flush with top of panel.
1) Provide fasteners held captive to panels.
2. Steel-Encapsulated, Wood-Core Panels: Fabricated with 1-inch- (25-mm-) thick, particleboard core, made without urea formaldehyde laminated to top and bottom steel face sheets, with metal surfaces protected against corrosion by manufacturer's standard factory-applied finish, and with a flame-spread index of 25 or less per ASTM E 84. Provide core edges enclosed with upturned, die-formed edge of bottom sheet or with perimeter steel channel welded to top sheet and welded or bonded to bottom sheet.
3. Formed-Steel Panels: Fabricated with die-cut flat top sheet and die-formed and stiffened steel bottom pan formed from cold-rolled steel sheet and joined together by resistance welding, with metal surfaces protected against corrosion by manufacturer's standard factory-applied finish to produce units of the following type:
a. Solid Panels: Flat, solid top surface.

b. Perforated Panels: Perforated top surface with holes **OR** slots, **as directed**, of number, spacing, and size standard with manufacturer to produce a nominal open area of 25 percent. Provide mechanical dampers with each panel unit, **as directed**.
1) Quantity: As directed.
2) Finish: Manufacturer's standard **OR** To match solid panels, **as directed**.

c. Grates: Grating ribs arranged in manufacturer's standard pattern to produce a nominal open area of 56 percent. Provide mechanical dampers with each panel unit, **as directed**.
1) Quantity: As directed.
2) Finish: Manufacturer's standard **OR** To match solid panels, **as directed**.

4. Cementitious-Filled, Formed-Steel Panels: Fabricated with die-cut flat top sheet and die-formed and stiffened bottom pan formed from cold-rolled steel sheet joined together by resistance welding to form an enclosed assembly, with metal surfaces protected against corrosion by manufacturer's standard factory-applied finish. Fully grout internal spaces of completed units with manufacturer's standard cementitious fill.

5. Die-Cast Aluminum Panels: Fabricated from manufacturer's standard aluminum alloy but not less than the strength and corrosion resistance of Alloy UNS No. A03830 or UNS No. A03840 per ASTM B 85, to produce units of the following type and with the following finish:

a. Solid Panels: Flat, solid surface on top and symmetrical crossing ribs on bottom; edge machined after casting to specified tolerances.

b. Perforated Panels: Perforated top surface with holes **OR** slots, **as directed**, of number, spacing, and size standard with manufacturer to produce a nominal open area of 25 percent. Provide mechanical dampers with each panel unit, **as directed**.
1) Quantity: As directed.
2) Finish: Manufacturer's standard **OR** To match solid panels, **as directed**.

c. Grates: Grating ribs arranged in manufacturer's standard pattern to produce a nominal open area of 56 percent. Provide mechanical dampers with each panel unit, **as directed**.
1) Quantity: As directed.
2) Finish: Manufacturer's standard **OR** To match solid panels, **as directed**.

d. Epoxy Finish: Epoxy **OR** Conductive epoxy, **as directed**, powder coating with a minimum average thickness of 2.5 mils (0.064 mm) and in color selected from manufacturer's full range.

e. Plated Finish: Nickel-chrome electrodeposited plating, 0.000005-inch (0.000127-mm) chrome over 0.0008-inch (0.02-mm) nickel, without copper or brass strike, to produce complete coverage over significant surfaces with a matte metallic appearance.

6. Concrete-Filled, Steel Pan Panels: Fabricated with bottom pan die-formed from electrolytic-zinc-coated steel sheet and filled with lightweight concrete that is reinforced and bonded to pan by shear ties.

7. Pedestals: Assembly consisting of base, column with provisions for height adjustment, and head (cap); made of steel **OR** aluminum, **as directed**.

a. Provide pedestals designed for use in seismic applications.

b. Base: Square or circular base with not less than 16 sq. in. (103 sq. cm) of bearing area.

c. Column: Of height required to bring finished floor to elevations indicated. Weld to base plate.

d. Provide vibration-proof leveling mechanism for making and holding fine adjustments in height over a range of not less than 2 inches (51 mm) and for locking at a selected height, so deliberate action is required to change height setting and vibratory displacement is prevented.

e. Head: Designed to support understructure system indicated.
1) Provide sound-deadening pads or gaskets at contact points between heads and panels.
2) Provide head with four holes aligned with holes in floor panels for bolting of panels to pedestals.

8. Stringer Systems: Modular steel **OR** aluminum, **as directed**, stringer systems made to interlock with pedestal heads and form a grid pattern placing stringers under each edge of each floor panel

and a pedestal under each corner of each floor panel. Protect steel components with manufacturer's standard galvanized or corrosion-resistant paint finish.

a. Bolted Stringers: System of main and cross stringers connected to pedestals with threaded fasteners accessible from above.
b. Snap-on Stringers: System of stringers attached to pedestals with nonbolted interlocking connections to provide a stable understructure and to prevent accidental disengagement.
c. Provide continuous gasket at contact surfaces between panel and stringers to deaden sound, to seal off underfloor cavity from above, and to maintain panel alignment and position.
d. Provide stringers that support each edge of each panel where required to meet design-load criteria.

B. Floor Panel Coverings

1. Provide bare panels without factory-applied floor coverings on traffic surfaces.
2. General: Provide factory-applied floor coverings of type indicated that are laminated by access flooring manufacturer to tops of floor panels including perforated panels, **as directed**.
3. Colors, Textures, and Patterns: As selected from manufacturer's full range.
4. Standard Plastic Laminate: NEMA LD 3, High-Wear type, Grade HWH **OR** HDS, **as directed**; fabricated in one piece to cover each panel face within perimeter plastic **OR** with integral trim serving as, **as directed**, edging.
5. Static-Conductive Plastic Laminate: NEMA LD 3, High-Wear type, Grade CHWH **OR** CHDS, **as directed**, fabricated in one piece to cover each panel face within perimeter plastic edging or with integral trim serving as edging.
6. Solid Vinyl Tile: Static-Conductive **OR** Static-Dissipative, **as directed**, ASTM F 1700, Class I (Monolithic Vinyl Tile), Type A (Smooth Surface), fabricated in one piece to cover panel face within plastic edging.
7. Low-Emissivity, Solid Vinyl Tile: Static-Conductive **OR** Static-Dissipative, **as directed**, ASTM F 1700, Class I (Monolithic Vinyl Tile), Type A (Smooth Surface), with minimum 50 percent reduction in outgasing **OR** total mass loss of 1 percent and minimum 98 percent reduction in collected volatile condensable materials, **as directed**, compared to products with dioctyl phthalate as determined by testing per ASTM E 595.
8. Standard Commercial Carpet: Die cut and adhesively bonded to top surface of panel.
   a. Provide factory-applied carpet with the following characteristics:
      1) Style: Passport.
      2) Fiber Type: 100% BCF nylon.
      3) Pile Characteristics: Level loop.
      4) Pile Thickness: 0.130 inch (3.30 mm).
      5) Stitches: 10.0/inch (10.0/2.54 cm).
      6) Surface Pile Weight: 26 oz./sq. yd. (881 g/sq. m).
      7) Total Weight: 56 oz./sq. yd. (1899 g/sq. m).
      8) Backing: Woven polypropylene.
      9) Critical Radiant Flux Rating: Minimum of 0.45 W/sq. cm per ASTM E 648.
   b. Environmental Requirements: Provide carpet that complies with testing and product requirements of Carpet and Rug Institute's "Green Label Plus" program. Bond carpet to panels with adhesives with VOC content not more than 50g/L when calculated according to 40 CFR 59, Subpart D (EPA method 24).
9. Antistatic Carpet: Antistatic modular carpet tile bonded with conductive adhesive to **OR** with buttons that engage into positioning holes in, **as directed**, top surface of panel.
   a. Provide carpet with the following characteristics:
      1) Style: Classic **OR** Contempo, **as directed**.
      2) Fiber Type: Solutia LXI nylon **OR** Performa SD Type 6 nylon, **as directed**
      3) Pile Characteristics: Textured loop **OR** Textured graphic loop, **as directed**.
      4) Pile Thickness: 0.125 and 0.188 inch (3.18 and 4.78 mm).
      5) Stitches: 11.0/inch (11.0/2.54 cm) **OR** 10.0/inch (10.0/ 2.54 cm), **as directed**.
      6) Surface Pile Weight: 24 oz./sq. yd. (814 g/sq. m).
      7) Total Weight: 148 oz./sq. yd. (5018 g/sq. m).

8) Backing: Static-dissipative, unitary PVC backing with conductive additive.
9) Critical Radiant Flux Rating: Minimum of 0.45 W/sq. cm per ASTM E 648.

b. Environmental Requirements: Provide carpet that complies with testing and product requirements of Carpet and Rug Institute's "Green Label Plus" program. Bond carpet to panels with adhesives with VOC content not more than 50g/L when calculated according to 40 CFR 59, Subpart D (EPA method 24), **as directed**.

10. Edging: Manufacturer's standard applied **OR** integral, **as directed**, edge trim. Provide size and profile of applied edge trim that fits floor coverings selected.
11. Resilient Wall Base: ASTM F 1861, Type TS (rubber, vulcanized thermoset) **OR** TV (vinyl, thermoplastic), **as directed**, Group 1 (solid), Style B (cove), 0.080 inch (2.03 mm) **OR** 0.125 inch (3.18 mm), **as directed**, thick and 2-1/2 inches (63.5 mm) **OR** 4 inches (102 mm) **OR** 6 inches (152 mm), **as directed**, high, with matching end stops and factory-made corner units, **as directed**.

C. Accessories

1. Adhesives: Manufacturer's standard adhesive for bonding pedestal bases to subfloor.
   a. Provide adhesive with a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Post-Installed Anchors: For anchoring pedestal bases to subfloor, provide 2 **OR** 4, **as directed**, post-installed expansion anchors **OR** threaded concrete screws, **as directed**, made from carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (5 microns) for Class SC 1 service condition (mild), with the capability to sustain, without failure, a load equal to 1.5 times the loads imposed by pedestal overturning moment on fasteners, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
3. Cutouts: Provide cutouts in floor panels for cable penetrations and service outlets. Provide reinforcement or additional support, if needed, to make panels with cutouts comply with standard performance requirements.
   a. Number, Size, Shape, and Location: As directed.
   b. Trim edge of cutouts with manufacturer's standard plastic molding.
   c. Fit cutouts with manufacturer's standard grommets in sizes indicated or, if size of cutouts exceeds maximum grommet size available, trim edge of cutouts with manufacturer's standard plastic molding having tapered top flange. Furnish removable covers for grommets, **as directed**.
   d. Provide foam-rubber pads for sealing annular space formed in cutouts by cables.
4. Service Outlets: Standard UL-listed and -labeled assemblies, for recessed mounting flush with top of floor panels, for power, communication, and signal services, and complying with the following requirements:
   a. Structural Performance: Cover capable of supporting a 1000-lbf (4448-N) concentrated load.
   b. Cover and Box Type: Hinged polycarbonate cover with opening for passage of cables when cover is closed and including frame and steel box or formed-steel plate for mounting electrical receptacles.

      OR

      Cover and Box Type: Grommet with twist-close cover and including steel junction box for electrical receptacle with provision for telephone Amphenol connectors and signal cables.
   c. Location: In center of panel quadrant, unless otherwise indicated.
   d. Receptacles and Wiring: Electrical receptacles and wiring for service outlets are specified in Division 22.

      OR

      Receptacles and Wiring: Equip each service outlet with power receptacles to comply with the following requirements:
      1) Type of Receptacle: Heavy-duty duplex, 2-pole, 3-wire grounding, 20 A, 125 V, NEMA WD 6, Configuration 5-20R, unless otherwise indicated.
      2) Number of Receptacles for Outlet: One **OR** Two **OR** Four, **as directed**.

3) Wiring Method: Factory wired for hard wiring in field with armored cable, containing 3 insulated No. 12 AWG solid-copper conductors, terminated with a 6-inch- (152-mm-) long pigtail.
OR
Wiring Method: Power-in connectors, built into outlet housing, of type to fit power-in and power-out connectors of branch-circuit cables supplied with building electrical system.

5. Diffusers: Manufacturer's standard round diffusers, 4 inches (102 mm) **OR** 8 inches (203 mm), **as directed**, in diameter, formed from aluminum **OR** polycarbonate plastic, **as directed**, to produce a removable 1-piece unit complete with diffuser, manually adjustable flow regulator, dirt and dust receptacle, trim ring, and underfloor compression mounting ring; precisely fitted in factory-prepared openings of standard field panels, and complying with the following requirements:
   a. Air-Distribution Characteristics: 100 cfm (47 L/s) at 0.096-inch (24-Pa) static pressure and a maximum noise criterion rating of 15, **as directed**.
   b. Structural Performance: Capable of supporting a 600-lbf (2669-N) concentrated load, **as directed**.
   c. Fire-Test-Response Characteristics: Classified 94V-0 per UL 94.
6. Floor Grilles: Standard load-bearing grilles formed from aluminum **OR** polycarbonate plastic, **as directed**, to produce removable one-piece unit precisely fitted in factory-prepared openings of standard field panels, with adjustable/removable **OR** without, **as directed**, dampers and complying with the following requirements:
   a. Air-Distribution Characteristics: 468 cfm at 0.10-inch wg (221 L/s at 25-Pa) static pressure.
   b. Structural Performance: Capable of supporting a 1000-lbf (4448-N) concentrated load.
   c. Fire-Test-Response Characteristics: Classified 94V-0 per UL 94.
7. Cavity Dividers: Provide manufacturer's standard metal dividers located where indicated to divide underfloor cavities.
8. Vertical Closures (Fasciae): Where underfloor cavity is not enclosed by abutting walls or other construction, provide metal-closure plates with manufacturer's standard finish.
9. Ramps: Manufacturer's standard ramp construction of width and slope indicated but not steeper than 1:12, with raised-disc or textured rubber or vinyl floor coverings, and of same materials, performance, and construction requirements as access flooring.
10. Steps: Provide steps of size and arrangement indicated with floor coverings to match access flooring. Apply nonslip aluminum nosings to treads, unless otherwise indicated.
11. Railings: Standard extruded-aluminum railings, at ramps and open-sided perimeter of access flooring where indicated. Include handrail, intermediate rails, posts, brackets, end caps, wall returns, wall and floor flanges, plates, and anchorages where required.
    a. Provide railings that comply with structural performance requirements specified in Division 05 Section(s) "Pipe And Tube Railings" OR "Decorative Metal", **as directed.**
12. Panel Lifting Device: Manufacturer's standard portable lifting device of type required for specified panels. Provide one lifting devices per room of each type required.
13. Perimeter Support: Where indicated, provide manufacturer's standard method for supporting panel edge and forming transition between access flooring and adjoining floor coverings at same level as access flooring.

1.3 EXECUTION

A. Preparation
   1. Lay out floor panel installation to keep the number of cut panels at floor perimeter to a minimum. Avoid using panels cut to less than 6 inches (152 mm).
   2. Locate each pedestal, complete any necessary subfloor preparation, and vacuum clean subfloor to remove dust, dirt, and construction debris before beginning installation.

B. Installation

1. Install access flooring system and accessories under supervision of access flooring manufacturer's authorized representative to produce a rigid, firm installation that complies with performance requirements and is free of instability, rocking, rattles, and squeaks.
2. Set pedestals in adhesive as recommended in writing by access flooring manufacturer to provide full bearing of pedestal base on subfloor.
3. Attach pedestals to subfloor by post-installed mechanical anchors.
4. Adjust pedestals to permit top of installed panels to be set flat, level, and to proper height.
5. Secure stringers to pedestal heads according to access flooring manufacturer's written instructions.
6. Install flooring panels securely in place, properly seated with panel edges flush. Do not force panels into place.
   a. Carpeted Panels: Install panels with carpet pile in same direction.
7. Scribe perimeter panels to provide a close fit with adjoining construction with no voids greater than 1/8 inch (3 mm) where panels abut vertical surfaces.
   a. To prevent dusting, seal cut edges of steel-encapsulated, wood-core panels with sealer recommended in writing by panel manufacturer.
8. Cut and trim access flooring and perform other dirt-or-debris-producing activities at a remote location or as required to prevent contamination of subfloor under access flooring already installed.
9. Ground flooring system as recommended by manufacturer and as needed to comply with performance requirements for electrical resistance of floor coverings.
10. Scribe and install underfloor-cavity dividers to closely fit against subfloor surfaces, and seal with mastic.
11. Scribe vertical closures to closely fit against subfloor and adjacent finished-floor surfaces. Set in mastic and seal to maintain plenum effect within underfloor cavity.
12. Clean dust, dirt, and construction debris caused by floor installation, and vacuum subfloor area, as installation of floor panels proceeds.
13. Seal underfloor air cavities at construction seams, penetrations, and perimeter to control air leakage as recommended in writing by manufacturer.
14. Install access flooring without change in elevation between adjacent panels and within the following tolerances:
   a. Plus or minus 1/16 inch (1.5 mm) **OR** 1/8 inch (3 mm), **as directed**, in any 10-foot (3-m) distance.
   b. Plus or minus 1/8 inch (3 mm) **OR** 1/4 inch (6.5 mm), **as directed**, from a level plane over entire access flooring area.

C. Adjusting, Cleaning, And Protection
1. Prohibit traffic on access flooring for 24 hours and removal of floor panels for 72 hours after installation to allow pedestal adhesive to set.
2. After completing installation, vacuum clean access flooring and cover with continuous sheets of reinforced paper or plastic. Maintain protective covering until time of Final Completion.
3. Replace access flooring panels that are stained, scratched, or otherwise damaged or that do not comply with specified requirements.

END OF SECTION 09 69 13 00

Task	Specification	Specification Description
09 69 53 00	09 69 13 00	Access Flooring

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SECTION 09 72 13 00 - WALL COVERINGS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for wall coverings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Vinyl wall covering.
   b. Woven glass-fiber wall covering.
   c. Textile wall covering.
   d. Heavy-duty synthetic textile wall covering.
   e. Wood-veneer wall covering.
   f. Wallpaper.

C. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood-veneer wall coverings comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
   b. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
   c. Product Data for Credit EQ 4.2: For paints and coatings, including printed statement of VOC content and chemical components.
3. Shop Drawings: Show location and extent of each wall-covering type. Indicate pattern placement, veneer matching, seams and termination points.
4. Samples: Full width by 36-inch- (914-mm-) long section of wall covering from same print run or dye lot to be used for the Work, with specified treatments, paint, applied. Show complete pattern repeat. Mark top and face of fabric.
5. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for wall covering.
6. Maintenance Data: For wall coverings to include in maintenance manuals.

D. Quality Assurance

1. Forest Certification: Fabricate products with wood veneer produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
2. Fire-Test-Response Characteristics: As determined by testing identical wall coverings applied with identical adhesives to substrates according to test method indicated below by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   a. Surface-Burning Characteristics: As follows, per ASTM E 84:
      1) Flame-Spread Index: 25 or less.
      2) Smoke-Developed Index: 50 **OR** 450, **as directed**, or less.
   b. Fire-Growth Contribution: Textile wall coverings complying with acceptance criteria of IBC Standard 803.
   c. Fire-Growth Contribution: Textile wall coverings tested according to NFPA 265 **OR** NFPA 286, **as directed**, and complying with test protocol and criteria in the IBC Standard 803.

E. Project Conditions
1. Environmental Limitations: Do not deliver or install wall coverings until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
a. Wood-Veneer Wall Coverings: Condition spaces for not less than 48 hours before installation.
2. Lighting: Do not install wall covering until a permanent level of lighting is provided on the surfaces to receive wall covering.
3. Ventilation: Provide continuous ventilation during installation and for not less than the time recommended by wall-covering manufacturer for full drying or curing.

1.2 PRODUCTS

A. Wall Coverings
1. General: Provide rolls of each type of wall covering from same print run or dye lot.

B. Vinyl Wall Covering
1. Vinyl Wall-Covering Standards: Provide products **OR** mildew-resistant products, **as directed**, complying with the following:
a. FS CCC-W-408D and CFFA-W-101-D for Type I, Light-Duty **OR** Type II, Medium-Duty **OR** Type III, Heavy-Duty, **as directed**, products.
b. ASTM F 793 for peelable **OR** strippable, **as directed**, wall coverings that qualify as Category I, Decorative Only **OR** Category II, Decorative with Medium Serviceability **OR** Category III, Decorative with High Serviceability **OR** Category IV, Type I, Commercial Serviceability **OR** Category V, Type II, Commercial Serviceability **OR** Category VI, Type III, Commercial Serviceability, **as directed**, products.
2. Width: 27 inches (686 mm) **OR** 54 inches (1372 mm), **as directed**.
3. Backing: Scrim **OR** Osnaburg **OR** Drill **OR** Nonwoven, **as directed**, fabric.
a. Fiber Content: Cotton **OR** Polyester **OR** Polycotton **OR** Polyester cellulose, **as directed**.
4. Repeat: Random.
5. Colors, Textures, and Patterns: As selected from manufacturer's full range.

C. Woven Glass-Fiber Wall Covering
1. Width: 39 inches (991 m).
2. Colors, Textures, and Patterns: As selected from manufacturer's full range.

D. Textile Wall Covering
1. Wall-Covering Standard: Provide mildew-resistant **OR** peelable **OR** strippable, **as directed**, wall coverings that comply with ASTM F 793 for Category I, Decorative Only **OR** Category II, Decorative with Medium Serviceability **OR** Category III, Decorative with High Serviceability **OR** Category IV, Type I, Commercial Serviceability **OR** Category V, Type II, Commercial Serviceability **OR** Category VI, Type III, Commercial Serviceability, **as directed**, products.
2. Test Responses:
a. Colorfastness to Wet and Dry Crocking: Passes AATCC 8, Grade 3, minimum.
b. Colorfastness to Light: Passes AATCC 16, Option 1 or 3, Grade 4, minimum, at 40 hours.
3. Repeat: Random.
4. Applied Backing Material: Acrylic **OR** Paper, **as directed**.
5. Colors, Textures, and Patterns: As selected from manufacturer's full range.

E. Heavy-Duty Synthetic Textile Wall Covering
1. Wall-Covering Standard: Provide wall coverings **OR** mildew-resistant wall coverings, **as directed**, that comply with ASTM F 793 for Category IV, Type I, Commercial Serviceability **OR**

Category V, Type II, Commercial Serviceability **OR** Category VI, Type III, Commercial Serviceability, **as directed**, products.

2. Test Responses:
   a. Colorfastness to Wet and Dry Crocking: Passes AATCC 8, Class 3, minimum.
   b. Colorfastness to Light: Passes AATCC 16A or AATCC 16E, Class 4, minimum, at 40 hours.
3. Width: 54 inches (1372 mm) **OR** 60 inches (1524 mm), **as directed**.
4. Colors, Textures, and Patterns: As selected from manufacturer's full range.

F. Wood-Veneer Wall Covering
1. Sheet Size: 24 by 96 inches (610 by 2440 mm) **OR** 48 by 96 inches (1220 by 2440 mm) **OR** 48 by 120 inches (1220 by 3050 mm), **as directed**.
2. Veneer Construction: Single ply veneer **OR** Two veneer plies assembled perpendicular to one another, **as directed**.
3. Wood Species: Red oak **OR** Maple **OR** Cherry, **as directed**.
4. Veneer Match: Book **OR** Slip, **as directed**.
5. Sheet Match: Running **OR** Balance **OR** Center **OR** Sequence, as indicated **OR** Blueprint, as indicated, **as directed**.
6. Applied Backing Material: Fabric.
7. Finish: Factory **OR** Field, **as directed**, applied using wall-covering manufacturer's standard stain and polyurethane system.
   a. Colors: As selected from manufacturer's full range.

G. Wallpaper
1. Wall-Covering Standard: Provide mildew-resistant **OR** peelable **OR** strippable, **as directed**, wallpaper that complies with ASTM F 793 for Category I, Decorative Only **OR** Category II, Decorative with Medium Serviceability **OR** Category III, Decorative with High Serviceability, **as directed**, products.
2. Width: 20-1/2 inches (520.7 mm) **OR** 28 inches (711.2 mm), **as directed**.
3. Repeat: Random.
4. Colors, Textures, and Patterns: As selected from manufacturer's full range.

H. Accessories
1. Adhesive: Mildew-resistant, nonstaining, strippable, **as directed**, adhesive, for use with specific wall covering and substrate application; as recommended in writing by wall-covering manufacturer and with a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Primer/Sealer: Mildew resistant, complying with requirements in Division 09 Section "Interior Painting" and recommended in writing by wall-covering manufacturer for intended substrate.
3. Wall Liner: Nonwoven, synthetic underlayment and adhesive as recommended by wall-covering manufacturer.
4. Seam Tape: As recommended in writing by wall-covering manufacturer.
5. Metal Primer: Interior ferrous metal primer complying with Division 09 Section "Interior Painting".

1.3 EXECUTION

A. Preparation
1. Comply with manufacturer's written instructions for surface preparation.
2. Clean substrates of substances that could impair bond of wall covering, including dirt, oil, grease, mold, mildew, and incompatible primers.
3. Prepare substrates to achieve a smooth, dry, clean, structurally sound surface free of flaking, unsound coatings, cracks, and defects.
   a. Moisture Content: Maximum of 5 percent on new plaster, concrete, and concrete masonry units when tested with an electronic moisture meter.

b. Plaster: Allow new plaster to cure. Neutralize areas of high alkalinity. Prime with primer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
c. Metals: If not factory primed, clean and apply metal as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
d. Gypsum Board: Prime with primer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
e. Painted Surfaces: Treat areas susceptible to pigment bleeding.

4. Check painted surfaces for pigment bleeding. Sand gloss, semigloss, and eggshell finish with fine sandpaper.
5. Remove hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.
6. Acclimatize wall-covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.
7. Install wall liner, with no gaps or overlaps, where required by wall-covering manufacturer. Form smooth wrinkle-free surface for finished installation. Do not begin wall-covering installation until wall liner has dried.

B. Installation
1. General: Comply with wall-covering manufacturers' written installation instructions applicable to products and applications indicated except where more stringent requirements apply.
2. Cut wall-covering strips in roll number sequence. Change roll numbers at partition breaks and corners.
3. Install strips in same order as cut from roll.
4. Install reversing every other strip.
5. Install wall covering with no gaps or overlaps, no lifted or curling edges, and no visible shrinkage.
6. Match pattern 72 inches (1830 mm) above the finish floor.
7. Install seams vertical and plumb at least 6 inches (150 mm) from outside corners and 3 inches (75 mm) **OR** 6 inches (150 mm), **as directed**, from inside corners unless a change of pattern or color exists at corner. No horizontal seams are permitted.
8. Fully bond wall covering to substrate. Remove air bubbles, wrinkles, blisters, and other defects.
9. Trim edges and seams for color uniformity, pattern match, and tight closure. Butt seams without any overlay or spacing between strips.

C. Field Finishing Of Wood-Veneer Wall Coverings
1. Apply wall-covering manufacturer's standard stain and polyurethane system according to coating manufacturer's written instructions to produce finish that is consistent in color and gloss and matches approved Samples.
2. Apply no fewer than two **OR** three, **as directed**, finish coats.

D. Cleaning
1. Remove excess adhesive at finished seams, perimeter edges, and adjacent surfaces.
2. Use cleaning methods recommended in writing by wall-covering manufacturer.
3. Replace strips that cannot be cleaned.
4. Reinstall hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

END OF SECTION 09 72 13 00

Task	Specification	Specification Description
09 72 16 13	09 72 13 00	Wall Coverings
09 72 23 00	09 72 13 00	Wall Coverings
09 73 00 00	09 68 16 00	Carpet
09 81 16 00	09 84 13 00	Acoustical Wall Panels

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SECTION 09 84 13 00 - ACOUSTICAL WALL PANELS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for acoustical wall panels. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes spline-mounted **OR** back-mounted, **as directed**, acoustical wall panels.

C. Definitions
   1. NRC: Noise reduction coefficient.

D. Submittals
   1. Product Data: For each type of panel edge, core material, and mounting indicated.
   2. Shop Drawings: For acoustical wall panels. Include mounting devices and details.
   3. Coordination Drawings: Show intersections with adjacent work.
   4. Samples: For each fabric and sample panels.
   5. LEED Submittal:
      a. Product Data for Credit EQ 4.1: For installation adhesive, including printed statement of VOC content.
   6. Product certificates **OR** test reports, **as directed**.
   7. Maintenance data.
   8. Warranty: Special warranty specified in this Section.

E. Quality Assurance
   1. Fire-Test-Response Characteristics: Provide acoustical wall panels with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 **OR** IBC Chapter 8, **as directed**, by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
      a. Flame-Spread Index: 25 or less.
      b. Smoke-Developed Index: 450 or less.
   2. Fire Growth Contribution: Meeting acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 265 **OR** NFPA 286, **as directed**.
   3. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
   1. Comply with fabric and acoustical wall panel manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.
   2. Deliver materials and panels in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.
   3. Protect panel edges from crushing and impact.

G. Project Conditions
   1. Environmental Limitations: Do not install acoustical wall panels until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
   2. Lighting: Do not install acoustical wall panels until a permanent level of lighting **OR** a lighting level of not less than 50 fc (538 lux), **as directed**, is provided on surfaces to receive acoustical wall panels.

3. Air-Quality Limitations: Protect acoustical wall panels from exposure to airborne odors, such as tobacco smoke, and install panels under conditions free from odor contamination of ambient air.
4. Field Measurements: Verify locations of acoustical wall panels by field measurements before fabrication and indicate measurements on Shop Drawings.

H. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of acoustical wall panels that fail in performance, materials, or workmanship within two years from date of Final Completion.
   a. Failure in performance includes, but is not limited to, acoustical performance.
   b. Failures in materials include, but are not limited to, fabric sagging, distorting, or releasing from panel edge; or warping of core.

1.2 PRODUCTS

A. Core Materials
1. Glass-Fiber Board: ASTM C 612, Type IA or Types IA and IB; density as specified, unfaced, dimensionally stable, molded rigid board, with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
2. Mineral-Fiber Board: Maximum flame-spread and smoke-developed indexes of 15 and 5, respectively.
3. Cementitious-Fiber Board Core: Density of not less than 20 lb/cu. ft. (320 kg/cu. m).
4. Tackable, Impact-Resistant, High-Density Face Layer: 1/8-inch- (3.2-mm-) thick layer of compressed molded glass-fiber board with a minimum nominal density of 16 to 18 lb/cu. ft. (256 to 288 kg/cu. m) laminated to face of core.
5. Impact-Resistant, Acoustically Transparent, Copolymer Face-Sheet Layer for High-Abuse Applications: 1/16- to 1/8-inch- (1.6- to 3.2-mm-) thick layer of perforated, noncombustible, copolymer sheet laminated to face of core.
6. Wood: Clear, vertical grain, straight, kiln-dried hardwood of manufacturer's standard species, AWPA C20, Interior Type A, fire-retardant treated, low-hygroscopic-type formulation. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Kiln-dry material after treatment to 5 to 10 percent moisture content.

B. Spline-Mounted Acoustical Wall Panels With Perforated Mineral-Fiber Board Core Or Cementitious-Fiber Board Core
1. Panel Construction: Manufacturer's standard panel construction consisting of facing material laminated to front face of a perforated, water-felted, mineral-fiber board **OR** cementitious-fiber board, **as directed**, core, with long edges kerfed and rabbeted to receive splines.
   a. Mineral-Fiber Board: Not less than 13-lb/cu. ft. (208-kg/cu. m) **OR** 20-lb/cu. ft. (320-kg/cu. m), **as directed**, nominal density; with perforated surface.
2. Facing Material: Fabric from same dye lot; color and pattern as indicated by manufacturer's designations **OR** matching samples **OR** as selected from manufacturer's full range **OR** as indicated on Drawings, **as directed**.
   a. Fiber Content: 100 percent woven polyester **OR** nonwoven polyester **OR** polyolefin **OR** acoustically transparent vinyl, **as directed**.
   b. Width: 54 inches (1371 mm) **OR** 66 inches (1676 mm), **as directed**.
   c. Applied Treatments: Stain resistance.
3. Nominal Overall Panel Thickness: 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**.
4. NRC: For Type A mounting per ASTM E 795, NRC 0.50 to NRC 0.90 **OR** NRC 0.60 to NRC 0.70 **OR** NRC 0.65 to NRC 0.75, **as directed**.
5. Panel Width: 24 inches (610 mm) **OR** 30 inches (762 mm) **OR** 48 inches (1220 mm) **OR** 600 mm **OR** As indicated on Drawings, **as directed**.
6. Panel Height: Fabricated from units 96 inches (2438 mm) **OR** 108 inches (2743 mm) **OR** 120 inches (3048 mm), **as directed**, in height; mounting height **as directed**.

7. Panel Edge: Core self-edge.
8. Panel Short Edge Detail: Square.

C. Spline-Mounted Acoustical Wall Panels With Glass-Fiber Board Core
1. Panel Construction: Manufacturer's standard panel construction consisting of facing material laminated to front face of a dimensionally stable, rigid glass-fiber board core with a nominal density of 6 to 7 lb/cu. ft. (96 to 112 kg/cu. m); with long edges kerfed and rabbeted to receive splines.
2. Core-Face Layer: Tackable, impact-resistant, high-density board **OR** Impact-resistant, acoustically transparent, copolymer face-sheet, **as directed**.
3. Facing Material: Fabric from same dye lot; color and pattern as indicated by manufacturer's designations **OR** matching samples **OR** as selected from manufacturer's full range **OR** as indicated on Drawings, **as directed**.
   a. Fiber Content: 100 percent woven polyester **OR** nonwoven polyester **OR** polyolefin **OR** acoustically transparent vinyl, **as directed**.
   b. Width: 54 inches (1371 mm) **OR** 66 inches (1676 mm), **as directed**.
   c. Applied Treatments: Stain resistance.
4. Nominal Overall Panel Thickness: 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (51 mm), **as directed**.
5. NRC: For Type A mounting per ASTM E 795, not less than NRC 0.20 **OR** NRC 0.80 **OR** NRC 0.95, **as directed**.
6. Panel Width: Manufacturer's standard **OR** 24 inches (610 mm) **OR** 30 inches (762 mm) **OR** 48 inches (1220 mm) **OR** 600 mm **OR** 1200 mm **OR** As indicated on Drawings, **as directed**.
7. Panel Height: Fabricated from units 96 inches (2438 mm) **OR** 108 inches (2743 mm) **OR** 120 inches (3048 mm), **as directed**, in height; mounting height **as directed**.
8. Panel Edge: Manufacturer's standard short edge.
9. Panel Short Edge Detail: Square.

D. Back-Mounted Acoustical Wall Panels With Perforated Mineral-Fiber Board Core
1. Panel Construction: Manufacturer's standard panel construction consisting of facing material laminated to front face of a perforated, water-felted, mineral-fiber board core of not less than 13-lb/cu. ft. (208-kg/cu. m) **OR** 20-lb/cu. ft. (320-kg/cu. m), **as directed**, nominal density; with perforated surface.
2. Facing Material: Fabric from same dye lot; color and pattern as indicated by manufacturer's designations **OR** matching samples **OR** as selected from manufacturer's full range **OR** as indicated on Drawings, **as directed**.
   a. Fiber Content: 100 percent woven polyester **OR** nonwoven polyester **OR** polyolefin **OR** acoustically transparent vinyl, **as directed**.
   b. Width: 54 inches (1371 mm) **OR** 66 inches (1676 mm), **as directed**.
   c. Applied Treatments: Stain resistance.
3. Nominal Core Thickness and Overall System NRC: 1/2 inch (13 mm) and not less than NRC 0.35 **OR** 3/4 inch (19 mm) and not less than NRC 0.45, **as directed**, for Type A mounting.
4. Panel Width: 24 inches (610 mm) **OR** 30 inches (762 mm) **OR** 48 inches (1220 mm) **OR** 600 mm **OR** As indicated on Drawings, **as directed**.
5. Panel Height: Fabricated from units 96 inches (2438 mm) **OR** 108 inches (2743 mm) **OR** 120 inches (3048 mm), **as directed**, in height; mounting height **as directed**.
6. Panel Edge: Core self-edge.
7. Panel Short Edge Detail: Square.

E. Back-Mounted, Edge-Reinforced Acoustical Wall Panels With Glass-Fiber Board Core
1. Panel Construction: Manufacturer's standard panel construction consisting of facing material laminated to front face, edges, and back border of dimensionally stable, rigid glass-fiber **OR** rock-fiber/slag-fiber, **as directed**, board core; with edges chemically hardened or impact resistant and resilient to reinforce panel perimeter against warpage and damage.
2. Nominal Core Density: 4 to 7 lb/cu. ft. (64 to 112 kg/cu. m) **OR** 6 to 7 lb/cu. ft. (96 to 112 kg/cu. m), **as directed**.

3. Core-Face Layer: Tackable, impact-resistant, high-density board **OR** Impact-resistant, acoustically transparent, copolymer face-sheet, **as directed**.
4. Facing Material: Fabric from same dye lot; color and pattern as indicated by manufacturer's designations **OR** matching samples **OR** as selected from manufacturer's full range **OR** as indicated on Drawings, **as directed**.
   a. Fiber Content: 100 percent woven polyester **OR** nonwoven polyester **OR** polyolefin **OR** acoustically transparent vinyl, **as directed**.
   b. Width: 54 inches (1371 mm) **OR** 66 inches (1676 mm), **as directed**.
   c. Applied Treatments: Stain resistance.
5. Nominal Core Thickness and Overall System NRC: 3/4 inch (19 mm) and not less than NRC 0.65 **OR** 1 inch (25 mm) and not less than NRC 0.80 **OR** 1-1/2 inches (38 mm) and not less than NRC 0.85 **OR** 2 inches (51 mm) and not less than NRC 0.90 **OR** 2 inches (51 mm) and not less than NRC 1.00, **as directed**, for Type A mounting per ASTM E 795.
6. Panel Width: Manufacturer's standard **OR** 24 inches (610 mm) **OR** 30 inches (762 mm) **OR** 48 inches (1220 mm) **OR** 600 mm **OR** 1200 mm **OR** As indicated on Drawings, **as directed**.
7. Panel Height: Fabricated height as indicated on Drawings **OR as directed**; mounting height as indicated on Drawings **OR as directed**.
8. Panel Edge Detail: Square **OR** Bullnosed (radiused) **OR** Chamfered (beveled) **OR** Mitered **OR** Custom as indicated on Drawings, **as directed**.
9. Corner Detail: Square **OR** Round, radius as indicated **OR** Off-square, dimensions as indicated, **as directed**, to form continuous profile to match edge detail.

F. Back-Mounted, Edge-Framed Acoustical Wall Panels With Glass-Fiber Board Core
1. Panel Construction: Manufacturer's standard panel construction consisting of facing material stretched over front face of edge-framed, dimensionally stable, rigid glass-fiber board core and bonded or attached to edges and back of frame.
2. Nominal Core Density: 4 to 7 lb/cu. ft. (64 to 112 kg/cu. m) **OR** 6 to 7 lb/cu. ft. (96 to 112 kg/cu. m), **as directed**.
3. Core-Face Layer: Tackable, impact-resistant, high-density board **OR** Impact-resistant, acoustically transparent, copolymer face-sheet, **as directed**.
4. Facing Material: Fabric from same dye lot; color and pattern as indicated by manufacturer's designations **OR** matching samples **OR** as selected from manufacturer's full range **OR** as indicated on Drawings, **as directed**.
   a. Fiber Content: 100 percent woven polyester **OR** nonwoven polyester **OR** polyolefin **OR** acoustically transparent vinyl, **as directed**.
   b. Width: 54 inches (1371 mm) **OR** 66 inches (1676 mm), **as directed**.
   c. Applied Treatments: Stain resistance.
5. Nominal Core Thickness and Overall System NRC: 1 inch (25 mm) and not less than NRC 0.80 **OR** 1-1/2 inches (38 mm) and not less than NRC 0.85 **OR** 2 inches (51 mm) and not less than NRC 0.90, **as directed**, for Type A mounting per ASTM E 795.
6. Panel Width: Manufacturer's standard **OR** 24 inches (610 mm) **OR** 30 inches (762 mm) **OR** 48 inches (1220 mm) **OR** 600 mm **OR** 1200 mm **OR** As indicated on Drawings, **as directed**.
7. Panel Height: Fabricated height as indicated on Drawings **OR as directed**; mounting height as indicated on Drawings **OR as directed**.
8. Panel Edge and Frame: Extruded-aluminum or zinc-coated, rolled-steel shape **OR** Extruded PVC **OR** Hardwood, rabbeted, and splined with glued joints and machined corners, **as directed**.
   a. Panel Edge Detail: Square.

G. Fabrication
1. Sound-Absorption Performance: Provide acoustical wall panels with minimum NRCs indicated, as determined by testing per ASTM C 423 for mounting type specified.
2. Acoustical Wall Panels: Panel construction consisting of facing material adhered to face, **as directed**, edges and back border of dimensionally stable core; with rigid edges to reinforce panel perimeter against warpage and damage.
   a. Glass-Fiber Board: Resin harden areas of core for attachment of mounting devices.

3. Fabric Facing: Stretched straight, on the grain, tight, square, and free from puckers, ripples, wrinkles, sags, blisters, seams, adhesive, or other foreign matter. Applied with visible surfaces fully covered.
   a. Where square corners are indicated, tailor corners. Heat seal vinyl fabric seams at corners.
   b. Where radius or other nonsquare corners are indicated, attach facing material so there are no seams or gathering of material.
   c. Where fabrics with directional or repeating patterns or directional weave are indicated, mark fabric top and attach fabric in same direction so pattern or weave matches in adjacent panels.
4. Core-Face Layer: Evenly stretched over core face and edges and securely attached to core; free from puckers, ripples, wrinkles, sags.
5. Dimensional Tolerances of Finished Units: Plus or minus 1/16 inch (1.6 mm) for the following:
   a. Thickness.
   b. Edge straightness.
   c. Overall length and width.
   d. Squareness from corner to corner.
   e. Chords, radii, and diameters.
6. Spline-Mounting Accessories: Manufacturer's standard concealed, extruded-aluminum or plastic connecting splines designed and fabricated for screw attachment to walls, with other moldings and trim for interior and exterior corners, leveling and base support with factory-applied finish on exposed items.
   a. Finish Color: White **OR** Black **OR** Match color of facing material **OR** Match sample, **as directed**.
7. Back-Mounting Devices: Concealed on backside of panel, recommended to support weight of panel, with base-support bracket system where recommended by manufacturer for additional support of panels, and as follows:
   a. Adhesive. Use only adhesives that have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. Hook-and-loop tape.
   c. Impaling clips.
   d. Magnetic strip or devices.
   e. Metal "Z" Clips: Two-part panel clips, with one part of each clip mechanically attached to back of panel and the other part to wall substrate, designed to allow for panel removal.
   f. As recommended by manufacturer.
8. Owner-Furnished Fabric: Provide fabric acceptable to acoustical wall panel manufacturer for application indicated. Notify the Owner of fabric unacceptability.

1.3 EXECUTION

A. Installation
1. Install acoustical wall panels in locations indicated with vertical surfaces and edges plumb, top edges level and in alignment with other panels, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.
   a. Cut units to be at least 50 percent of unit width, with facing material extended over cut edge to match uncut edge. Scribe acoustical wall panels to fit adjacent work. Butt joints tightly.
2. Comply with acoustical wall panel manufacturer's written instructions for installation of panels using type of concealed mounting accessories indicated or, if not indicated, as recommended by manufacturer. Anchor panels securely to supporting substrate.
3. Match and level fabric pattern and grain among adjacent panels.
4. Installation Tolerances: As follows:
   a. Variation from Level and Plumb: Plus or minus 1/16 inch (1.6 mm).
   b. Variation of Panel Joints from Hairline: Not more than 1/16 inch (1.6 mm) **OR** 1/32 inch (0.79 mm), **as directed**, wide.

B. Cleaning
1. Clip loose threads; remove pills and extraneous materials.
2. Clean panels with fabric facing, on completion of installation, to remove dust and other foreign materials according to manufacturer's written instructions.

C. Protection
1. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, to ensure that acoustical wall panels are without damage or deterioration at time of Final Completion.
2. Replace acoustical wall panels that cannot be cleaned and repaired, in a manner approved by the Owner, before time of Final Completion.

END OF SECTION 09 84 13 00

Task	Specification	Specification Description
09 84 13 00	09 28 13 00	Gypsum Board
09 84 13 00	09 23 13 00	Gypsum Board Renovation
09 84 13 00	09 28 13 00a	Gypsum Board Shaft-Wall Assemblies

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SECTION 09 91 13 00 - EXTERIOR PAINTING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for exterior painting. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes surface preparation and the application of paint systems on the following exterior substrates:
   a. Concrete.
   b. Clay masonry.
   c. Concrete masonry units (CMU).
   d. Steel.
   e. Galvanized metal.
   f. Aluminum (not anodized or otherwise coated).
   g. Wood.
   h. Plastic trim fabrications.
   i. Exterior portland cement (stucco).
   j. Exterior gypsum board.

C. Submittals
1. Product Data: For each type of product indicated.
2. Samples: For each finish and for each color and texture required.
3. Product List: Printout of current "MPI Approved Products List" for each product category specified in Part 1.2, with the proposed product highlighted.

D. Quality Assurance
1. MPI Standards:
   a. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
   b. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated. For renovation projects, comply with requirements of "MPI Maintenance Repainting Manual" for products and paint systems indicated.
2. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   a. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
      1) Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
      2) Other Items: Architect will designate items or areas required.
   b. Final approval of color selections will be based on mockups.
      1) If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
   c. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   d. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Delivery, Storage, And Handling
1. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
    a. Maintain containers in clean condition, free of foreign materials and residue.
    b. Remove rags and waste from storage areas daily.

F. Project Conditions
1. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
2. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

1.2 PRODUCTS

A. Paint, General
1. Material Compatibility:
    a. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
    b. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
2. Colors: As selected from manufacturer's full range.

B. Block Fillers
1. Interior/Exterior Latex Block Filler: MPI #4.
    a. VOC Content: E Range of E2 **OR** E3, **as directed**.

C. Primers/Sealers
1. Alkali-Resistant Primer: MPI #3.
    a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Bonding Primer (Water Based): MPI #17.
    a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. Bonding Primer (Solvent Based): MPI #69.
    a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
4. Wood-Knot Sealer: Sealer recommended in writing by topcoat manufacturer for use in paint system indicated.

D. Metal Primers
1. Alkyd Anticorrosive Metal Primer: MPI #79.
    a. VOC Content: E Range of E1 **OR** E2, **as directed**.
2. Quick-Drying Alkyd Metal Primer: MPI #76.
    a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. Cementitious Galvanized-Metal Primer: MPI #26.
    a. VOC Content: E Range of E1.
4. Waterborne Galvanized-Metal Primer: MPI #134.
    a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
    b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
5. Quick-Drying Primer for Aluminum: MPI #95.
    a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

E. Wood Primers
1. Exterior Latex Wood Primer: MPI #6.
    a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Exterior Alkyd Wood Primer: MPI #5.

a. VOC Content: E Range of E2 **OR** E3, **as directed**.
3. Exterior Oil Wood Primer: MPI #7.
a. VOC Content: E Range of E2.

F. Exterior Latex Paints
1. Exterior Latex (Flat): MPI #10 (Gloss Level 1).
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Exterior Latex (Semigloss): MPI #11 (Gloss Level 5).
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. Exterior Latex (Gloss): MPI #119 (Gloss Level 6, except minimum gloss of 65 units at 60 deg).
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

G. Exterior Alkyd Paints
1. Exterior Alkyd Enamel (Flat): MPI #8 (Gloss Level 1).
a. VOC Content: E Range of E1.
2. Exterior Alkyd Enamel (Semigloss): MPI #94 (Gloss Level 5).
a. VOC Content: E Range of E1 **OR** E2, **as directed**.
3. Exterior Alkyd Enamel (Gloss): MPI #9 (Gloss Level 6).
a. VOC Content: E Range of E1 **OR** E2, **as directed**.

H. Quick-Drying Enamels
1. Quick-Drying Enamel (Semigloss): MPI #81 (Gloss Level 5).
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Quick-Drying Enamel (High Gloss): MPI #96 (Gloss Level 7).
a. VOC Content: E Range of E1 **OR** E **OR** E3, **as directed**.

I. Textured And High-Build Coatings
1. Latex Stucco and Masonry Textured Coating: MPI #42.
a. VOC Content: E Range of E2 **OR** E3, **as directed**.
2. High-Build Latex (Exterior): MPI #40.
a. VOC Content: E Range of E1 **OR** E3, **as directed**.

J. Aluminum Paint
1. Aluminum Paint: MPI #1.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

K. Floor Coatings
1. Interior/Exterior Clear Concrete Floor Sealer (Water Based): MPI #99.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Interior/Exterior Clear Concrete Floor Sealer (Solvent Based): MPI #104.
a. VOC Content: E Range of E1 **OR** E2, **as directed**.
3. Interior/Exterior Latex Floor and Porch Paint (Low Gloss): MPI #60 (maximum Gloss Level 3).
a. VOC Content: E Range of E2 **OR** E3, **as directed**.
b. Environmental Performance Rating: EPR 3.
4. Exterior/Interior Alkyd Floor Enamel (Gloss): MPI #27 (Gloss Level 6).
a. VOC Content: E Range of E1 **OR** E2, **as directed**.
b. Additives: Manufacturer's standard additive to increase skid resistance of painted surface.

1.3 EXECUTION

A. Examination
1. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
2. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

a. Concrete: 12 percent.
b. Masonry (Clay and CMU): 12 percent.
c. Wood: 15 percent.
d. Plaster: 12 percent.
e. Gypsum Board: 12 percent.

3. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
4. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
   a. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

B. Preparation And Application

1. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
2. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
   a. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.
3. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
4. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
5. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

C. Exterior Painting Schedule

1. Paint systems herein are based on "MPI Architectural Painting Specification Manual" (hereafter, "MPI Manual"). For renovation projects, consult "MPI Maintenance Repainting Manual" and revise paint systems accordingly.
2. For a Premium Grade system, "MPI Manual" requires intermediate coat; if Custom Grade system is required or if so directed, delete intermediate coat, **unless directed otherwise** or as otherwise required by manufacturer's recommendations.
3. Concrete Substrates, Nontraffic Surfaces:
   a. Latex System: MPI EXT 3.1A.
      1) Prime Coat: Exterior latex matching topcoat.
      2) Intermediate Coat: Exterior latex matching topcoat.
      3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   b. Latex Aggregate/Latex System: MPI EXT 3.1 B.
      1) Prime Coat: Latex stucco and masonry textured coating.
      2) Intermediate Coat: Exterior latex matching topcoat.
      3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   c. Latex Over Alkali-Resistant Primer System: MPI EXT 3.1K.
      1) Prime Coat: Alkali-resistant primer.
      2) Intermediate Coat: Exterior latex matching topcoat.
      3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   d. High-Build Latex System: MPI EXT 3.1L, applied to form dry film thickness of not less than 10 mils (0.25 mm).
      1) Prime Coat: As recommended in writing by topcoat manufacturer.
      2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
      3) Topcoat: High-build latex (exterior).
   e. Latex Aggregate System: MPI EXT 3.1N.
      1) Prime Coat: As recommended in writing by topcoat manufacturer.

2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
3) Topcoat: Latex stucco and masonry textured coating.

4. Concrete Substrates, Traffic Surfaces:
   a. Latex Floor Paint System: MPI EXT 3.2A.
      1) Prime Coat: Interior/exterior latex floor and porch paint (low gloss).
      2) Intermediate Coat: Interior/exterior latex floor and porch paint (low gloss).
      3) Topcoat: Interior/exterior latex floor and porch paint (low gloss).
   b. Alkyd Floor Enamel System: MPI EXT 3.2D.
      1) Prime Coat: Exterior/interior alkyd floor enamel (gloss).
      2) Intermediate Coat: Exterior/interior alkyd floor enamel (gloss).
      3) Topcoat: Exterior/interior alkyd floor enamel (gloss).
   c. Clear Sealer System: MPI EXT 3.2G.
      1) Prime Coat: Interior/exterior clear concrete floor sealer (solvent based).
      2) Intermediate Coat: Interior/exterior clear concrete floor sealer (solvent based).
      3) Topcoat: Interior/exterior clear concrete floor sealer (solvent based).
   d. Water-Based Clear Sealer System: MPI EXT 3.2H.
      1) Prime Coat: Interior/exterior clear concrete floor sealer (water based).
      2) Intermediate Coat: Interior/exterior clear concrete floor sealer (water based).
      3) Topcoat: Interior/exterior clear concrete floor sealer (water based).
5. Clay-Masonry Substrates:
   a. Latex System: MPI EXT 4.1A.
      1) Prime Coat: Exterior latex matching topcoat.
      2) Intermediate Coat: Exterior latex matching topcoat.
      3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   b. High-Build Latex System: MPI EXT 4.1H, applied to form dry film thickness of not less than 10 mils (0.25 mm).
      1) Prime Coat: As recommended in writing by topcoat manufacturer.
      2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
      3) Topcoat: High-build latex (exterior).
   c. Latex Aggregate System: MPI EXT 4.1B.
      1) Prime Coat: As recommended in writing by topcoat manufacturer.
      2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
      3) Topcoat: Latex stucco and masonry textured coating.
6. CMU Substrates:
   a. Latex System: MPI EXT 4.2A.
      1) Prime Coat: Interior/exterior latex block filler.
      2) Intermediate Coat: Exterior latex matching topcoat.
      3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   b. Latex Over Alkali-Resistant Primer System: MPI EXT 4.2L.
      1) Prime Coat: Alkali-resistant primer.
      2) Intermediate Coat: Exterior latex matching topcoat.
      3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   c. High-Build Latex System: MPI EXT 4.2K, applied to form dry film thickness of not less than 10 mils (0.25 mm).
      1) Prime Coat: As recommended in writing by topcoat manufacturer.
      2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
      3) Topcoat: High-build latex (exterior).
   d. Latex Aggregate System: MPI EXT 4.2B.
      1) Prime Coat: As recommended in writing by topcoat manufacturer.
      2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
      3) Topcoat: Latex stucco and masonry textured coating.
7. Steel Substrates:
   a. Quick-Drying Enamel System: MPI EXT 5.1A.
      1) Prime Coat: Quick-drying alkyd metal primer.
      2) Intermediate Coat: Quick-drying enamel matching topcoat.
      3) Topcoat: Quick-drying enamel (semigloss) **OR** (high gloss), **as directed**.

b. Alkyd System: MPI EXT 5.1D.
  1) Prime Coat: Alkyd anticorrosive metal primer.
  2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
  3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Aluminum Paint System: MPI EXT 5.1K.
  1) Prime Coat: Alkyd anticorrosive metal primer.
  2) Intermediate Coat: Aluminum paint.
  3) Topcoat: Aluminum paint.

8. Galvanized-Metal Substrates: Galvanized-metal substrates should not be chromate passivated (commercially known as "bonderized") if primer is field applied. If galvanized metal is chromate passivated, consult manufacturers for appropriate surface preparation and primers.
  a. Latex System: MPI EXT 5.3A.
    1) Prime Coat: Cementitious galvanized-metal primer.
    2) Intermediate Coat: Exterior latex matching topcoat.
    3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
  b. Latex Over Water-Based Primer System: MPI EXT 5.3H. "MPI Manual" recommends latex over water-based primer system for low-contact/traffic areas.
    1) Prime Coat: Waterborne galvanized-metal primer.
    2) Intermediate Coat: Exterior latex matching topcoat.
    3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
  c. Alkyd System: MPI EXT 5.3B.
    1) Prime Coat: Cementitious galvanized-metal primer.
    2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
    3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

9. Aluminum Substrates:
  a. Latex System: MPI EXT 5.4H.
    1) Prime Coat: Quick-drying primer for aluminum.
    2) Intermediate Coat: Exterior latex matching topcoat.
    3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
  b. Alkyd System: MPI EXT 5.4F.
    1) Prime Coat: Quick-drying primer for aluminum.
    2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
    3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

10. Glue-Laminated Beam and Column Substrates:
  a. Latex System: MPI EXT 6.1L.
    1) Prime Coat: Exterior latex wood primer.
    2) Intermediate Coat: Exterior latex matching topcoat.
    3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
  b. Latex Over Alkyd Primer System: MPI EXT 6.1A.
    1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
    2) Intermediate Coat: Exterior latex matching topcoat.
    3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
  c. Alkyd System: MPI EXT 6.1B.
    1) Prime Coat: Exterior alkyd **OR** oil, **as directed,** wood primer.
    2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
    3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

11. Dressed Lumber Substrates: Including architectural woodwork **OR** doors, **as directed**.
  a. Latex System: MPI EXT 6.3L.
    1) Prime Coat: Exterior latex wood primer.
    2) Intermediate Coat: Exterior latex matching topcoat.
    3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**. Flat paint is not recommended for use on doors.
  b. Latex Over Alkyd Primer System: MPI EXT 6.3A.
    1) Prime Coat: Exterior alkyd **OR** oil, **as directed,** wood primer.
    2) Intermediate Coat: Exterior latex matching topcoat.

3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**. Flat paint is not recommended for use on doors.

c. Alkyd System: MPI EXT 6.3B.
   1) Prime Coat: Exterior alkyd **OR** oil, **as directed,** wood primer.
   2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
   3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**. Flat paint is not recommended for use on doors.

12. Wood Panel Substrates: Including plywood siding **OR** fascias **OR** soffits, **as directed**.
    a. Latex System: MPI EXT 6.4K.
       1) Prime Coat: Exterior latex wood primer.
       2) Intermediate Coat: Exterior latex matching topcoat.
       3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
    b. Latex Over Alkyd Primer System: MPI EXT 6.4G.
       1) Prime Coat: Exterior alkyd wood primer.
       2) Intermediate Coat: Exterior latex matching topcoat.
       3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
    c. Alkyd System: MPI EXT 6.4B.
       1) Prime Coat: Exterior alkyd **OR** oil, **as directed,** wood primer.
       2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
       3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
13. Wood Shingle and Shake Substrates (Excluding Roofs):
    a. Latex System: MPI EXT 6.6E.
       1) Prime Coat: Exterior latex wood primer.
       2) Intermediate Coat: Exterior latex matching topcoat.
       3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
    b. Latex Over Alkyd Primer System: MPI EXT 6.6A.
       1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
       2) Intermediate Coat: Exterior latex matching topcoat.
       3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
    c. Alkyd System: MPI EXT 6.6B.
       1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
       2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
       3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
14. Dimension Lumber Substrates, Nontraffic Surfaces: Including board siding **OR** fencing **OR** undersides of decking, **as directed**.
    a. Latex System: MPI EXT 6.2M.
       1) Prime Coat: Exterior latex wood primer.
       2) Intermediate Coat: Exterior latex matching topcoat.
       3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
    b. Latex Over Alkyd Primer System: MPI EXT 6.2A.
       1) Prime Coat: Exterior alkyd **OR** oil, **as directed,** wood primer.
       2) Intermediate Coat: Exterior latex matching topcoat.
       3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
    c. Alkyd System: MPI EXT 6.2C.
       1) Prime Coat: Exterior alkyd **OR** oil, **as directed,** wood primer.
       2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
       3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
15. Dimension Lumber Substrates, Traffic Surfaces: Including lumber decking **OR** stairs, **as directed**.
    a. Latex System: MPI EXT 6.5E.
       1) Prime Coat: Exterior latex wood primer.
       2) Intermediate Coat: Interior/exterior latex floor and porch (low gloss).
       3) Topcoat: Interior/exterior latex floor and porch (low gloss).
          a) With additive to increase skid resistance of painted surface.
    b. Latex Over Alkyd Primer System: MPI EXT 6.5A.
       1) Prime Coat: Exterior alkyd wood primer.

2) Intermediate Coat: Interior/exterior latex floor and porch (low gloss).
3) Topcoat: Interior/exterior latex floor and porch (low gloss).
a) With additive to increase skid resistance of painted surface.
c. Alkyd Floor Enamel System: MPI EXT 6.5B.
1) Prime Coat: Exterior/interior alkyd floor enamel (gloss).
2) Intermediate Coat: Exterior/interior alkyd floor enamel (gloss).
3) Topcoat: Exterior/interior alkyd floor enamel (gloss).
a) With additive to increase skid resistance of painted surface.
16. Plastic Trim Fabrication Substrates:
a. Latex System: MPI EXT 6.8A.
1) Prime Coat: Bonding primer (water based) **OR** (solvent based), **as directed**.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
b. Alkyd System: MPI EXT 6.8B.
1) Prime Coat: Bonding primer (water based) **OR** (solvent based , **as directed**.
2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
17. Stucco Substrates:
a. Latex System: MPI EXT 9.1A.
1) Prime Coat: Exterior latex matching topcoat.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
b. Latex Over Alkali-Resistant Primer System: MPI EXT 9.1J.
1) Prime Coat: Alkali-resistant primer.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
c. High-Build Latex System: MPI EXT 9.1H, applied to form dry film thickness of not less than 10 mils (0.25 mm).
1) Prime Coat: As recommended in writing by topcoat manufacturer.
2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
3) Topcoat: High-build latex (exterior).
18. Exterior Gypsum Board Substrates:
a. Latex System: MPI EXT 9.2A.
1) Prime Coat: Exterior latex matching topcoat.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

END OF SECTION 09 91 13 00

SECTION 09 91 13 00a - WOOD STAINS AND TRANSPARENT FINISHES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for wood stains and transparent finishes. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes surface preparation and the application of wood finishes on the following substrates:
      a. Exterior Substrates:
         1) Exposed glue-laminated beams and columns.
         2) Exposed dimension lumber (rough carpentry).
         3) Dressed lumber (finish carpentry).
         4) Exposed wood panel products.
         5) Wood decks and stairs.
         6) Wood shingles and shakes (excluding roofs).
      b. Interior Substrates:
         1) Exposed glue-laminated beams and columns.
         2) Exposed dimension lumber (rough carpentry).
         3) Dressed lumber (finish carpentry).
         4) Exposed wood panel products.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittal:
      a. Product Data for Credit EQ 4.2: For interior primers, stains, and transparent finishes, including printed statement of VOC content.
   3. Samples: For each finish and for each color and texture required.
   4. Product List: Printout of MPI's current "MPI Approved Products List" for each product category specified in Part 1.2, with the product proposed for use highlighted.

D. Quality Assurance
   1. MPI Standards:
      a. Products: Complying with MPI standards indicated and listed in its "MPI Approved Products List."
      b. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and finish systems indicated.

E. Delivery, Storage, And Handling
   1. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
      a. Maintain containers in clean condition, free of foreign materials and residue.
      b. Remove rags and waste from storage areas daily.

F. Project Conditions
   1. Apply finishes only when temperature of surfaces to be finished and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
   2. Do not apply exterior finishes in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

1.2 PRODUCTS

A. Materials, General
1. Material Compatibility:
a. Provide materials for use within each finish system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
b. For each coat in a finish system, provide products recommended in writing by manufacturers of topcoat for use in finish system and on substrate indicated.
2. VOC Content of Field-Applied Interior Primers, Stains, and Transparent Finishes: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24); these requirements do not apply to primers, stains, and transparent finishes that are applied in a fabrication or finishing shop:
a. Flat Primers: VOC content of not more than 50 g/L.
b. Nonflat Primers: VOC content of not more than 150 g/L.
c. Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
d. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
e. Clear Wood Finishes, Lacquers: VOC not more than 550 g/L.
f. Floor Coatings: VOC not more than 100 g/L.
g. Shellacs, Clear: VOC not more than 730 g/L.
h. Stains: VOC not more than 250 g/L.
3. Stain Colors: As selected from manufacturer's full range **OR** Match samples **OR** As indicated in a color schedule, **as directed**.

B. Wood Fillers
1. Wood Filler Paste: MPI #91.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

C. Primers And Sealers
1. Exterior Alkyd Wood Primer: MPI #5.
a. VOC Content: E Range of E2 **OR** E3, **as directed**.
2. Exterior Latex Wood Primer: MPI #6.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. Exterior Oil Wood Primer: MPI #7.
a. VOC Content: E Range of E2.
4. Wood Preservative: MPI #37.
a. VOC Content: E Range of E1 **OR** E3, **as directed**.
5. Alkyd Sanding Sealer: MPI #102.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
6. Lacquer Sanding Sealer: MPI #84.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
7. Shellac: MPI #88.
a. VOC Content: E Range of E2 **OR** E3, **as directed**.

D. Stains
1. Exterior Semitransparent Stain (Solvent Based): MPI #13.
a. VOC Content: E Range of E1 **OR** E2, **as directed**.
2. Exterior Solid-Color Stain (Solvent Based): MPI #14.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. Exterior, Solid-Color Latex Stain: MPI #16.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
4. Stain for Wood Decks: MPI #33.
a. VOC Content: E Range of E1 **OR** E3, **as directed**.
5. Interior Wood Stain (Semitransparent): MPI #90.

a. VOC Content: E Range of E1 **OR** E2, **as directed**.

E. Varnishes
1. Exterior Marine Spar Varnish (Gloss): MPI #28, Gloss Level 7.
a. VOC Content: E Range of E1 **OR** E2, **as directed**.
2. Exterior Varnish (Gloss): MPI #29, Gloss Level 6.
a. VOC Content: E Range of E1.
3. Exterior Varnish (Semigloss): MPI #30, Gloss Level 5.
a. VOC Content: E Range of E1.
4. Interior Varnish (Flat): MPI #73, Gloss Level 1, alkyd type.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
5. Interior Varnish (Semigloss): MPI #74, Gloss Level 5, alkyd type.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
6. Interior Varnish (Gloss): MPI #75, Gloss Level 6, alkyd type.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

F. Polyurethane Finishes
1. Two-Component Aliphatic Polyurethane (Clear): MPI #78.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Interior, Oil-Modified, Clear Urethane (Satin): MPI #57, Gloss Level 4.
a. VOC Content: E Range of E1 **OR** E2, **as directed**.
3. Interior, Oil-Modified, Clear Urethane (Gloss): MPI #56, Gloss Level 6.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
4. Moisture-Cured Clear Polyurethane (Flat): MPI #71, Gloss Level 1.
a. VOC Content: E Range of E2.
5. Moisture-Cured Clear Polyurethane (Gloss): MPI #31.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

G. Waterborne Acrylic Finishes
1. Waterborne Clear Acrylic (Satin): MPI #128, Gloss Level 4.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
2. Waterborne Clear Acrylic (Semigloss): MPI #129, Gloss Level 5.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
3. Waterborne Clear Acrylic (Gloss): MPI #130, Gloss Level 6.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3**, as directed**.
b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.

H. Lacquers
1. Lacquer (Clear Flat): MPI #87, Gloss Level 1.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Lacquer (Clear Satin): MPI #85, Gloss Level 4.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. Lacquer (Clear Gloss): MPI #86, Gloss Level 6.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

I. Oil Finish
1. Danish Oil: MPI #92.
a. VOC Content: E Range of E3.

1.3 EXECUTION

A. Preparation

1. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
2. Remove plates, machined surfaces, and similar items already in place that are not to be finished. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and finishing.
   a. After completing finishing operations, reinstall items that were removed; use workers skilled in the trades involved. Remove surface-applied protection if any.
3. Clean and prepare surfaces to be finished according to manufacturer's written instructions for each particular substrate condition and as specified.
   a. Remove surface dirt, oil, or grease by washing with a detergent solution; rinse thoroughly with clean water and allow to dry. Remove grade stamps and pencil marks by sanding lightly. Remove loose wood fibers by brushing.
   b. Remove mildew by scrubbing with a commercial wash formulated for mildew removal and as recommended by stain manufacturer.
   c. Countersink steel nails, if used, and fill with putty tinted to final color to eliminate rust leach stains.
4. Apply wood filler paste to open-grain woods, as defined in "MPI Architectural Painting Specification Manual," to produce smooth, glasslike finish.

B. Application
1. Apply finishes according to manufacturer's written instructions.
   a. Use applicators and techniques suited for finish and substrate indicated.
   b. Finish surfaces behind movable equipment and furniture same as similar exposed surfaces.
2. Apply finishes to produce surface films without cloudiness, holidays, lap marks, brush marks, runs, ropiness, or other surface imperfections.

C. Field Quality Control
1. The following procedure may be requested at any time and as often as the Owner deems necessary during the period when finishes are being applied:
   a. Engage the services of a qualified testing agency to sample finish materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
   b. Testing agency will perform tests for compliance with product requirements.
   c. the Owner may direct Contractor to stop applying finishes if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying materials from Project site, pay for testing, and refinish surfaces finished with rejected materials. Contractor will be required to remove rejected materials from previously finished surfaces if, on refinishing with complying materials, the two finishes are incompatible.

D. Cleaning And Protection
1. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
2. After completing finish application, clean spattered surfaces. Remove spattered materials by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
3. Protect work of other trades against damage from finish application. Correct damage by cleaning, repairing, replacing, and refinishing, as approved by the Owner, and leave in an undamaged condition.
4. At completion of construction activities of other trades, touch up and restore damaged or defaced finished wood surfaces.

E. Exterior Wood-Finish-System Schedule
1. Exposed Glue-Laminated Beam and Column Substrates:
   a. Solid-Color, Solvent-Based Stain System: MPI EXT 6.1C.

1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
2) Two Stain Coats: Exterior solid-color stain (solvent based).

b. Varnish Over Semitransparent Stain System: MPI EXT 6.1D.
1) Stain Coat: Exterior semitransparent stain (solvent based).
2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Exterior marine spar varnish (gloss) **OR** varnish (gloss) **OR** varnish (semigloss), **as directed**.

c. Varnish System: MPI EXT 6.1K.
1) Four (for a Premium Grade system) **OR** Three, **as directed**, Finish Coats: Exterior marine spar varnish (gloss) **OR** varnish (gloss) **OR** varnish (semigloss), **as directed**.

d. Clear, Two-Component Polyurethane Over Stain System: MPI EXT 6.1E.
1) Stain Coat: Exterior semitransparent stain (solvent based).
2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Two-component aliphatic polyurethane (clear).

e. Clear, Two-Component Polyurethane System: MPI EXT 6.1H.
1) Three Finish Coats: Two-component aliphatic polyurethane (clear).

2. Exposed Rough Carpentry Substrates:

a. Solid-Color Latex Stain System: MPI EXT 6.2B.
1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
2) Two Stain Coats (for a Premium Grade system) **OR** One Stain Coat, **as directed**: Exterior, solid-color latex stain.

b. Solid-Color, Solvent-Based Stain System: MPI EXT 6.2D.
1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.

c. Two Stain Coats (for a Premium Grade system) One Stain Coat, **as directed**: Exterior solid-color stain (solvent based).

d. Semitransparent Stain System: MPI EXT 6.2L.
1) Two Stain Coats: Exterior semitransparent stain (solvent based).

e. Varnish Over Semitransparent Stain System: MPI EXT 6.2E.
1) Stain Coat: Exterior semitransparent stain (solvent based).
2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Exterior marine spar varnish (gloss) **OR** varnish (gloss) **OR** varnish (semigloss), **as directed**.

f. Varnish System: MPI EXT 6.2K.
1) Four (for a Premium Grade system) **OR** Three, **as directed,** Finish Coats: Exterior varnish (marine spar, high gloss) **OR** (gloss) **OR** (semigloss), **as directed**.

g. Clear, Two-Component Polyurethane System: MPI EXT 6.2H.
1) Three Finish Coats: Two-component aliphatic polyurethane (clear).

3. Finish Carpentry Substrates:

a. Solid-Color Latex Stain System: MPI EXT 6.3K.
1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
2) Two Stain Coats (for a Premium Grade system) **OR** One Stain Coat, **as directed**: Exterior, solid-color latex stain.

b. Solid-Color, Solvent-Based Stain System: MPI EXT 6.3C.
1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
2) Two Stain Coats (for a Premium Grade system) **OR** One Stain Coat, **as directed**: Exterior solid-color stain (solvent based).

c. Semitransparent Stain System: MPI EXT 6.3D.
1) Two Stain Coats: Exterior semitransparent stain (solvent based).

d. Varnish Over Semitransparent Stain System: MPI EXT 6.3E.
1) Stain Coat: Exterior semitransparent stain (solvent based).
2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Exterior varnish (marine spar, high gloss) **OR** (gloss) **OR** (semigloss), **as directed**.

e. Varnish System: MPI EXT 6.3F.
1) Four (for a Premium Grade system) **OR** Three, **as directed**, Finish Coats: Exterior varnish (marine spar, high gloss) **OR** (gloss) **OR** (semigloss), **as directed**.

f. Clear, Two-Component Polyurethane System: MPI EXT 6.3G.
1) Three Finish Coats: Two-component aliphatic polyurethane (clear).

F. Exposed Wood Panel-Product Substrates:
   a. Solid-Color Latex Stain System: MPI EXT 6.4A.
      1) Prime Coat: Exterior alkyd **OR** latex **OR** oil, **as directed**, wood primer.
      2) Two Stain Coats (for a Premium Grade system) **OR** One Stain Coat, **as directed**: Exterior, solid-color latex stain.
   b. Solid-Color, Solvent-Based Stain System: MPI EXT 6.4C.
      1) Prime Coat (for a Premium Grade system): Exterior alkyd **OR** oil, **as directed**, wood primer.
      2) Two Stain Coats: Exterior solid-color stain (solvent based).
   c. Semitransparent Stain System: MPI EXT 6.4D.
      1) Two Stain Coats: Exterior semitransparent stain (solvent based).
   d. Varnish Over Semitransparent Stain System: MPI EXT 6.4J.
      1) Stain Coat: Exterior semitransparent stain (solvent based).
      2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Exterior varnish (marine spar, high gloss) **OR** (gloss) **OR** (semigloss), **as directed**.
   e. Varnish System: MPI EXT 6.4H.
      1) Four (for a Premium Grade system) **OR** Three, **as directed**, Finish Coats: Exterior varnish (marine spar, high gloss) **OR** (gloss) **OR** (semigloss), **as directed**.

2. Wood Deck and Stair Substrates:
   a. MPI EXT 6.5D.
      1) Preservative Coat: Wood preservative.
      2) Two Stain Coats (for a Premium Grade system) **OR** One Stain Coat, **as directed**: Stain for wood decks.
   b. MPI EXT 6.5F.
      1) Two Stain Coats: Stain for wood decks.

3. Wood Shingle and Shake Substrates (Excluding Roofs):
   a. Solid-Color Latex Stain System: MPI EXT 6.6D.
      1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
      2) Two Stain Coats (for a Premium Grade system) **OR** One Stain Coat, **as directed**: Exterior, solid-color latex stain.
   b. Solid-Color, Solvent-Based Stain System: MPI EXT 6.6C.
      1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
      2) Two Stain Coats (for a Premium Grade system) **OR** One Stain Coat, **as directed**: Exterior solid-color stain (solvent based).
   c. Semitransparent Stain System: MPI EXT 6.6F.
      1) Two Stain Coats: Exterior semitransparent stain (solvent based).

G. Interior Wood-Finish-System Schedule

1. Exposed Glue-Laminated Beam and Column Substrates:
   a. Alkyd Varnish Over Stain System: MPI INT 6.1K.
      1) Stain Coat: Interior wood stain (semitransparent).
      2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Interior varnish (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   b. Alkyd Varnish Over Stain and Sealer System: MPI INT 6.1P.
      1) Stain Coat: Interior wood stain (semitransparent).
      2) Seal Coat: Alkyd sanding sealer.
      3) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Interior varnish (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   c. Alkyd Varnish Over Sealer System: MPI INT 6.1C.
      1) Seal Coat: Alkyd sanding sealer.
      2) Two Finish Coats: Interior varnish (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   d. Polyurethane Varnish Over Stain System: MPI INT 6.1J.
      1) Stain Coat: Interior wood stain (semitransparent).
      2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Interior, oil-modified, clear urethane (satin) **OR** (gloss), **as directed**.

e. Polyurethane Varnish System: MPI INT 6.1D.
   1) One Factory-Applied Finish Coat: Matching field-applied finish coats.
   2) Two Field-Applied Finish Coats: Interior, oil-modified, clear urethane (satin) **OR** (gloss), **as directed**.
f. Moisture-Cured Clear Polyurethane Over Stain System: MPI INT 6.1S.
   1) Stain Coat: Interior wood stain (semitransparent).
   2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Moisture-cured clear polyurethane (flat) **OR** (gloss), **as directed**.
g. Waterborne Clear Acrylic Over Stain System: MPI INT 6.1R.
   1) Stain Coat: Interior wood stain (semitransparent).
   2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Waterborne clear acrylic (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
h. Waterborne Clear Acrylic System: MPI INT 6.F.
   1) Three Finish Coats: Waterborne clear acrylic (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
i. Solid-Color Latex Stain System: MPI INT 6.1T.
   1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
   2) Two Stain Coats (for a Premium Grade system) **OR** One Stain Coat, **as directed**: Exterior, solid-color latex stain.
j. Solid-Color, Solvent-Based Stain System: MPI INT 6.1H.
   1) Two Stain Coats: Exterior solid-color stain (solvent based).
k. Semitransparent Stain System: MPI INT 6.1G.
   1) Two Stain Coats: Exterior semitransparent stain (solvent based).

2. Exposed Rough Carpentry Substrates:
a. Alkyd Varnish Over Stain and Sealer System: MPI INT 6.2K.
   1) Stain Coat: Interior wood stain (semitransparent).
   2) Seal Coat: Alkyd sanding sealer.
   3) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Interior varnish (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
b. Alkyd Varnish Over Sealer System: MPI INT 6.2P.
   1) Seal Coat: Alkyd sanding sealer.
   2) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Interior varnish (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
c. Polyurethane Varnish Over Stain System: MPI INT 6.2J.
   1) Stain Coat: Interior wood stain (semitransparent).
   2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Interior, oil-modified, clear urethane (satin) **OR** (gloss), **as directed**.
d. Polyurethane Varnish System: MPI INT 6.2H.
   1) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Interior, oil-modified, clear urethane (satin) **OR** (gloss), **as directed**.
e. Moisture-Cured Clear Polyurethane Over Stain System: MPI INT 6.2N.
   1) Stain Coat: Interior wood stain (semitransparent).
   2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Moisture-cured clear polyurethane (flat) **OR** (gloss), **as directed**.
f. Waterborne Clear Acrylic Over Stain System: MPI INT 6.2M.
   1) Stain Coat: Interior wood stain (semitransparent).
   2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Waterborne clear acrylic (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

3. Finish Carpentry Substrates:
a. Alkyd Varnish Over Stain and Sealer System: MPI INT 6.3D.
   1) Stain Coat: Interior wood stain (semitransparent).
   2) Seal Coat: Alkyd sanding sealer **OR** Shellac, **as directed**.
   3) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Interior varnish (semigloss) **OR** (gloss), **as directed**.
b. Alkyd Varnish Over Sealer System: MPI INT 6.3J.
   1) Seal Coat: Alkyd sanding sealer **OR** Shellac, **as directed**.

2) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Interior varnish (semigloss) **OR** (gloss), **as directed**.

c. Polyurethane Varnish Over Stain System: MPI INT 6.3E.
   1) Stain Coat: Interior wood stain (semitransparent).
   2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Interior, oil-modified, clear urethane (satin) **OR** (gloss), **as directed**.

d. Polyurethane Varnish System: MPI INT 6.3K.
   1) One Factory-Applied Finish Coat: Matching field-applied finish coats.
   2) Two Field-Applied Finish Coats: Interior, oil-modified, clear urethane (satin) **OR** (gloss), **as directed**.

e. Moisture-Cured Clear Polyurethane Over Stain System: MPI INT 6.3Y.
   1) Stain Coat: Interior wood stain (semitransparent).
   2) Three (for a Premium Grade system **OR** Two, **as directed**, Finish Coats: Moisture-cured clear polyurethane (flat) **OR** (gloss), **as directed**.

f. Moisture-Cured Clear Polyurethane System: MPI INT 6.3X.
   1) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Moisture-cured clear polyurethane (flat) **OR** (gloss), **as directed**.

g. Clear, Two-Component Polyurethane System: MPI INT 6.3Z.
   1) Three (for a Premium Grade system) Two, **as directed**, Finish Coats: Two-component aliphatic polyurethane (clear).

h. Waterborne Clear Acrylic Over Stain System: MPI INT 6.3W.
   1) Stain Coat: Interior wood stain (semitransparent).
   2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Waterborne clear acrylic (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

i. Waterborne Clear Acrylic System: MPI INT 6.3Q.
   1) Three Finish Coats: Waterborne clear acrylic (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

j. Lacquer Over Stain and Sealer System: MPI INT 6.3F.
   1) Stain Coat: Interior wood stain (semitransparent).
   2) Seal Coat: Lacquer sanding sealer.
   3) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Lacquer (clear flat **OR** satin **OR** gloss, **as directed**).

k. Lacquer Over Sealer System: MPI INT 6.3H.
   1) Seal Coat: Lacquer sanding sealer.
   2) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Lacquer (clear flat **OR** satin **OR** gloss, **as directed**).

l. Semitransparent Stain System: MPI INT 6.3C.
   1) Two Stain Coats: Exterior semitransparent stain (solvent based).

m. Danish Oil System: MPI INT 6.3M.
   1) Two Finish Coats: Danish oil.

4. Exposed Wood Panel-Product Substrates:

a. Alkyd Varnish Over Sealer and Stain System: MPI INT 6.4D.
   1) Stain Coat: Interior wood stain (semitransparent).
   2) Seal Coat: Alkyd sanding sealer **OR** Shellac, **as directed**.
   3) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Interior varnish (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Alkyd Varnish Over Sealer System: MPI INT 6.4G.
   1) Seal Coat: Alkyd sanding sealer **OR** Shellac, **as directed**.
   2) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Interior varnish (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Polyurethane Varnish Over Stain System: MPI INT 6.4E.
   1) Stain Coat: Interior wood stain (semitransparent).
   2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Interior, oil-modified, clear urethane (satin) **OR** (gloss), **as directed**.

d. Polyurethane Varnish System: MPI INT 6.4.J.

1) One Factory-Applied Finish Coat: Matching field-applied finish coats.
2) Two Field-Applied Finish Coats: Interior, oil-modified, clear urethane (satin) **OR** (gloss), **as directed**.

e. Moisture-Cured Clear Polyurethane Over Stain System: MPI INT 6.4V.
1) Stain Coat: Interior wood stain (semitransparent).
2) Three (for a Premium Grade system) Two, **as directed**, Finish Coats: Moisture-cured clear polyurethane (flat) **OR** (gloss), **as directed**.

f. Waterborne Clear Acrylic Over Stain System: MPI INT 6.4U.
1) Stain Coat: Interior wood stain (semitransparent).
2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Waterborne clear acrylic (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

g. Lacquer Over Stain and Sealer System: MPI INT 6.4F.
1) Stain Coat: Interior wood stain (semitransparent).
2) Seal Coat: Lacquer sanding sealer.
3) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Lacquer (clear flat **OR** satin **OR** gloss, **as directed**).

h. Lacquer Over Sealer System: MPI INT 6.4Y.
1) Seal Coat: Lacquer sanding sealer.
2) Three (for a Premium Grade system) Two, **as directed**, Finish Coats: Lacquer (clear flat **OR** satin **OR** gloss, **as directed**).

i. Semitransparent Stain System: MPI INT 6.4C.
1) Two Stain Coats: Exterior semitransparent stain (solvent based).

j. Danish Oil System: MPI INT 6.4K.
1) Two Finish Coats: Danish oil.

END OF SECTION 09 91 13 00a

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SECTION 09 91 13 00b - HIGH-TEMPERATURE-RESISTANT COATINGS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for high-temperature-resistant coatings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes surface preparation and application of high-temperature-resistant coating systems on steel substrates subject to high temperatures.

C. Submittals
1. Product Data: For each type of product indicated.
2. Samples: For each coating and for each color and texture required.
3. LEED Submittal:
   a. Product Data for Credit EQ 4.2: For coatings, including printed statement of VOC content and chemical components.

D. Quality Assurance
1. Master Painters Institute (MPI) Standards:
   a. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List" **OR** "MPI Maintenance Repainting Manual," **as directed**.
   b. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" **OR** "MPI Maintenance Repainting Manual," **as directed**, for products and coating systems indicated.

E. Delivery, Storage, And Handling
1. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
   a. Maintain containers in clean condition, free of foreign materials and residue.
   b. Remove rags and waste from storage areas daily.

F. Project Conditions
1. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 50 and 104 deg F (10 and 40 deg C).
2. Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

1.2 PRODUCTS

A. High-Temperature-Resistant Coatings
1. VOC Content of Interior Paints and Coatings: Provide products that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24) :
   a. Flat Paints, Coatings, and Primers: VOC content of not more than 50 g/L.
   b. Nonflat Paints, Coatings, and Primers: VOC content of not more than 150 g/L.
   c. Anticorrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC content of not more than 250 g/L.
   d. Flat Interior Topcoat Paints: VOC content of not more than 50 g/L.
   e. Nonflat Interior Topcoat Paints: VOC content of not more than 150 g/L.

f. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
g. Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
h. Zinc-Rich Industrial Maintenance Primers: VOC content of not more than 340 g/L.

2. Chemical Components of Interior Paints and Coatings: Provide topcoat paints and anti-corrosive and anti-rust paints applied to ferrous metals that comply with the following chemical restrictions; these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:
   a. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing 1 or more benzene rings).
   b. Restricted Components: Paints and coatings shall not contain any of the following:
      1) Acrolein.
      2) Acrylonitrile.
      3) Antimony.
      4) Benzene.
      5) Butyl benzyl phthalate.
      6) Cadmium.
      7) Di (2-ethylhexyl) phthalate.
      8) Di-n-butyl phthalate.
      9) Di-n-octyl phthalate.
      10) 1,2-dichlorobenzene.
      11) Diethyl phthalate.
      12) Dimethyl phthalate.
      13) Ethylbenzene.
      14) Formaldehyde.
      15) Hexavalent chromium.
      16) Isophorone.
      17) Lead.
      18) Mercury.
      19) Methyl ethyl ketone.
      20) Methyl isobutyl ketone.
      21) Methylene chloride.
      22) Naphthalene.
      23) Toluene (methylbenzene).
      24) 1,1,1-trichloroethane.
      25) Vinyl chloride.
3. Colors: As selected from manufacturer's full range **OR** Match samples, **as directed**.
4. Primer: Undercoating recommended in writing for use in coating system by manufacturer of high-temperature-resistant coating under conditions indicated.
5. Heat-Resistant Enamel (Gloss): MPI #21.
   a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
6. Inorganic Zinc Primer: MPI #19.
   a. VOC Content: Minimum E Range of 0 **OR** E1 **OR** E2 **OR** E3, **as directed**.
7. Aluminum Heat-Resistant Enamel: MPI #2.
   a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
8. High-Heat-Resistant Coating: MPI #22.
   a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.

1.3 EXECUTION

A. Preparation

1. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" **OR** "MPI Maintenance Repainting Manual," **as directed,** applicable to substrates indicated.
2. Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
   a. After completing coating operations, reinstall items that were removed; use workers skilled in the trades involved.
3. Clean steel substrates of substances that could impair bond of coatings, including dirt, oil, grease, and incompatible paints and encapsulants.
   a. Remove incompatible primers as required to produce coating systems indicated.

B. Application
1. Apply high-temperature-resistant coating systems according to manufacturer's written instructions.
   a. Use applicators and techniques suited for coating and substrate indicated.
   b. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
   c. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.

C. Field Quality Control
1. Contractor shall invoke the following procedure at any time and as often as necessary during the period when coatings are being applied:
   a. Engage the services of a qualified testing agency to sample coating material being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
   b. Testing agency will perform tests for compliance with specified requirements.
   c. the Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with specified requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

D. Cleaning And Protection
1. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
2. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
3. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by the Owner, and leave in an undamaged condition.
4. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

E. High-Temperature-Resistant Coating Schedule
1. Heat-Resistant Enamel (Gloss) Coating System (System below corresponds with MPI EXT 5.2A and MPI INT 5.2A coating systems) {suitable for use on surfaces that reach a maximum temperature of 400 deg F (205 deg C)}:
   a. Surface Preparation: Clean using methods recommended in writing by finish-coat manufacturer, but not less than blast cleaning according to SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning **OR** SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning **OR** SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning," **as directed**.
   b. Prime Coat: Primer.

c. Finish Coat(s): Heat-resistant enamel (gloss), MPI #21, in number of coats recommended in writing by manufacturer for conditions indicated.

2. Inorganic Zinc Primer Coating System (System below corresponds with MPI EXT 5.2C and MPI INT 5.2C coating systems) {suitable for use on surfaces that reach a maximum temperature of 750 deg F (400 deg C)}:
   a. Surface Preparation: Clean using methods recommended in writing by finish-coat manufacturer, but not less than blast cleaning according to SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning **OR** SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning **OR** SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning," **as directed**.
   b. Prime Coat: Primer.
   c. Finish Coat(s): Inorganic zinc primer, MPI #19, in number of coats recommended in writing by manufacturer for conditions indicated.
3. Aluminum Heat-Resistant Enamel Coating System (System below corresponds with MPI EXT 5.2B and MPI INT 5.2B coating systems) {suitable for use on surfaces that reach a maximum temperature of 800 deg F (427 deg C)}:
   a. Surface Preparation: Clean using methods recommended in writing by finish-coat manufacturer, but not less than blast cleaning according to SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning **OR** SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning **OR** SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning," **as directed**.
   b. Prime Coat: Primer.
   c. Finish Coat(s): Aluminum heat-resistant enamel, MPI #2, in number of coats recommended in writing by manufacturer for conditions indicated.
4. High-Heat-Resistant Coating System (System below corresponds with MPI EXT 5.2D and MPI INT 5.2D coating systems) {suitable for use on surfaces that reach a maximum temperature of 1100 deg F (593 deg C)}:
   a. Surface Preparation: Clean using methods recommended in writing by finish-coat manufacturer, but not less than blast cleaning according to SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning **OR** SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning **OR** SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning," **as directed**.
   b. Prime Coat: Primer.
   c. Finish Coat(s): High-heat-resistant coating, MPI #22, in number of coats recommended in writing by manufacturer for conditions indicated.

END OF SECTION 09 91 13 00b

Task	Specification	Specification Description
09 91 13 00	01 22 16 00	No Specification Required

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SECTION 09 91 23 00 - INTERIOR PAINTING

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for interior painting. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes surface preparation and the application of paint systems on the following interior substrates:
      a. Concrete.
      b. Clay masonry.
      c. Concrete masonry units (CMU).
      d. Steel.
      e. Galvanized metal.
      f. Aluminum (not anodized or otherwise coated).
      g. Wood.
      h. Gypsum board.
      i. Plaster.
      j. Spray-textured ceilings.
      k. Cotton or canvas insulation covering.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. Samples: For each finish and for each color and texture required.
   3. Product List: Printout of current "MPI Approved Products List" for each product category specified in Part 1.2, with the proposed product highlighted.
   4. LEED Submittal:
      a. Product Data for Credit EQ 4.2: For paints, including printed statement of VOC content and chemical components.

D. Quality Assurance
   1. MPI Standards:
      a. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
      b. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.
   2. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
      a. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
         1) Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
         2) Other Items: Architect will designate items or areas required.
      b. Final approval of color selections will be based on mockups.
         1) If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
      c. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

d. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Delivery, Storage, And Handling

1. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
   a. Maintain containers in clean condition, free of foreign materials and residue.
   b. Remove rags and waste from storage areas daily.

F. Project Conditions

1. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
2. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

1.2 PRODUCTS

A. Paint, General

1. Material Compatibility:
   a. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
   b. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
2. VOC Content of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24); these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:
   a. Flat Paints, Coatings, and Primers: VOC content of not more than 50 g/L.
   b. Nonflat Paints, Coatings, and Primers: VOC content of not more than 150 g/L.
   c. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
   d. Floor Coatings: VOC not more than 100 g/L.
   e. Shellacs, Clear: VOC not more than 730 g/L.
   f. Shellacs, Pigmented: VOC not more than 550 g/L.
   g. Flat Topcoat Paints: VOC content of not more than 50 g/L.
   h. Nonflat Topcoat Paints: VOC content of not more than 150 g/L.
   i. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
   j. Floor Coatings: VOC not more than 100 g/L.
   k. Shellacs, Clear: VOC not more than 730 g/L.
   l. Shellacs, Pigmented: VOC not more than 550 g/L.
   m. Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
   n. Dry-Fog Coatings: VOC content of not more than 400 g/L.
   o. Zinc-Rich Industrial Maintenance Primers: VOC content of not more than 340 g/L.
   p. Pre-Treatment Wash Primers: VOC content of not more than 420 g/L.
3. Chemical Components of Field-Applied Interior Paints and Coatings: Provide topcoat paints and anti-corrosive and anti-rust paints applied to ferrous metals that comply with the following chemical restrictions; these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:
   a. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
   b. Restricted Components: Paints and coatings shall not contain any of the following:

1) Acrolein.
2) Acrylonitrile.
3) Antimony.
4) Benzene.
5) Butyl benzyl phthalate.
6) Cadmium.
7) Di (2-ethylhexyl) phthalate.
8) Di-n-butyl phthalate.
9) Di-n-octyl phthalate.
10) 1,2-dichlorobenzene.
11) Diethyl phthalate.
12) Dimethyl phthalate.
13) Ethylbenzene.
14) Formaldehyde.
15) Hexavalent chromium.
16) Isophorone.
17) Lead.
18) Mercury.
19) Methyl ethyl ketone.
20) Methyl isobutyl ketone.
21) Methylene chloride.
22) Naphthalene.
23) Toluene (methylbenzene).
24) 1,1,1-trichloroethane.
25) Vinyl chloride.

4. Colors: As selected from manufacturer's full range **OR** Match samples **OR** As indicated in a color schedule, **as directed**.

B. Block Fillers
1. Interior/Exterior Latex Block Filler: MPI #4.
   a. VOC Content: E Range of E2 **OR** E3, **as directed**.

C. Primers/Sealers
1. Interior Latex Primer/Sealer: MPI #50.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
2. Interior Alkyd Primer/Sealer: MPI #45.
   a. VOC Content: E Range of E1 **OR** E2, **as directed**.
3. Wood-Knot Sealer: Sealer recommended in writing by topcoat manufacturer for use in paint systems indicated.

D. Metal Primers
1. Alkyd Anticorrosive Metal Primer: MPI #79.
   a. VOC Content: E Range of E1 **OR** E2, **as directed**.
2. Quick-Drying Alkyd Metal Primer: MPI #76.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. Rust-Inhibitive Primer (Water Based): MPI #107.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
4. Cementitious Galvanized-Metal Primer: MPI #26.
   a. VOC Content: E Range of E1.
5. Waterborne Galvanized-Metal Primer: MPI #134.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
6. Vinyl Wash Primer: MPI #80.
   a. VOC Content: E Range of E2 **OR** E3, **as directed**.

7. Quick-Drying Primer for Aluminum: MPI #95.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

E. Wood Primers
1. Interior Latex-Based Wood Primer: MPI #39.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.

F. Latex Paints
1. Interior Latex (Flat): MPI #53 (Gloss Level 1).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 0.5 **OR** EPR 1.5 **OR** EPR 2.5, **as directed**.
2. Interior Latex (Low Sheen): MPI #44 (Gloss Level 2).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
3. Interior Latex (Eggshell): MPI #52 (Gloss Level 3).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
4. Interior Latex (Satin): MPI #43 (Gloss Level 4).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 1.5 **OR** EPR 2 **OR** EPR 2.5 **OR** EPR 3.5, **as directed**.
5. Interior Latex (Semigloss): MPI #54 (Gloss Level 5).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 2 **OR** EPR 3 **OR** EPR 4, **as directed**.
6. Interior Latex (Gloss): MPI #114 (Gloss Level 6, except minimum gloss of 65 units at 60 deg).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 2 **OR** EPR 3 **OR** EPR 4, **as directed**.
7. Institutional Low-Odor/VOC Latex (Flat): MPI #143 (Gloss Level 1).
   a. VOC Content: E Range of E3.
   b. Environmental Performance Rating: EPR 4 **OR** EPR 5.5, **as directed**.
8. Institutional Low-Odor/VOC Latex (Low Sheen): MPI #144 (Gloss Level 2).
   a. VOC Content: E Range of E3.
   b. Environmental Performance Rating: EPR 4.5.
9. Institutional Low-Odor/VOC Latex (Eggshell): MPI #145 (Gloss Level 3).
   a. VOC Content: E Range of E3.
   b. Environmental Performance Rating: EPR 4.5.
10. Institutional Low-Odor/VOC Latex (Semigloss): MPI #147 (Gloss Level 5).
   a. VOC Content: E Range of E3.
   b. Environmental Performance Rating: EPR 3 **OR** EPR 5.5, **as directed**.
11. High-Performance Architectural Latex (Low Sheen): MPI #138 (Gloss Level 2).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 4 **OR** EPR 5 **OR** EPR 6, **as directed**.
12. High-Performance Architectural Latex (Eggshell): MPI #139 (Gloss Level 3).
   a. VOC Content: E Range of E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 5 **OR** EPR 6, **as directed**.
13. High-Performance Architectural Latex (Satin): MPI #140 (Gloss Level 4).
   a. VOC Content: E Range of E1 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 4.5 **OR** EPR 6.5, **as directed**.
14. High-Performance Architectural Latex (Semigloss): MPI #141 (Gloss Level 5).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 5 **OR** EPR 6 **OR** EPR 7, **as directed**.
15. Exterior Latex (Flat): MPI #10 (Gloss Level 1).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
16. Exterior Latex (Semigloss): MPI #11 (Gloss Level 5).

a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

17. Exterior Latex (Gloss): MPI #119 (Gloss Level 6, except minimum gloss of 65 units at 60 deg).
    a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

G. Alkyd Paints
1. Interior Alkyd (Flat): MPI #49 (Gloss Level 1).
    a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Interior Alkyd (Eggshell): MPI #51 (Gloss Level 3).
    a. VOC Content: E Range of E1 **OR** E2, **as directed**.
3. Interior Alkyd (Semigloss): MPI #47 (Gloss Level 5).
    a. VOC Content: E Range of E1 **OR** E2, **as directed**.
    b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
4. Interior Alkyd (Gloss): MPI #48 (Gloss Level 6).
    a. VOC Content: E Range of E1 **OR** E2, **as directed**.

H. Quick-Drying Enamels
1. Quick-Drying Enamel (Semigloss): MPI #81 (Gloss Level 5).
    a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Quick-Drying Enamel (High Gloss): MPI #96 (Gloss Level 7).
    a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

I. Textured Coating
1. Latex Stucco and Masonry Textured Coating: MPI #42.
    a. VOC Content: E Range of E2 **OR** E3, **as directed**.

J. Dry Fog/Fall Coatings
1. Latex Dry Fog/Fall: MPI #118.
    a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
    b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
2. Waterborne Dry Fall: MPI #133.
    a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
    b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
3. Interior Alkyd Dry Fog/Fall: MPI #55.
    a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

K. Aluminum Paint
1. Aluminum Paint: MPI #1.
    a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

L. Floor Coatings
1. Interior Concrete Floor Stain: MPI #58.
    a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
    b. Environmental Performance Rating: EPR 2.
2. Interior/Exterior Clear Concrete Floor Sealer (Water Based): MPI #99.
    a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. Interior/Exterior Clear Concrete Floor Sealer (Solvent Based): MPI #104.
    a. VOC Content: E Range of E1 **OR** E2, **as directed**.
4. Interior/Exterior Latex Floor and Porch Paint (Low Gloss): MPI #60 (maximum Gloss Level 3).
    a. VOC Content: E Range of E2 **OR** E3, **as directed**.
    b. Environmental Performance Rating: EPR 3.
5. Exterior/Interior Alkyd Floor Enamel (Gloss): MPI #27 (Gloss Level 6).
    a. VOC Content: E Range of E1 **OR** E2, **as directed**.
    b. Additives: Manufacturer's standard additive to increase skid resistance of painted surface.

1.3 EXECUTION

A. Preparation
1. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
2. Remove plates, machined surfaces, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
   a. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
   b. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
3. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
   a. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.
4. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
5. Clay Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content of surfaces or alkalinity of mortar joints to be painted exceed that permitted in manufacturer's written instructions.
6. Concrete Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
7. Steel Substrates: Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer.
8. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
9. Aluminum Substrates: Remove surface oxidation.
10. Wood Substrates:
   a. Scrape and clean knots, and apply coat of knot sealer before applying primer.
   b. Sand surfaces that will be exposed to view, and dust off.
   c. Prime edges, ends, faces, undersides, and backsides of wood.
   d. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
11. Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth.
12. Plaster Substrates: Do not begin paint application until plaster is fully cured and dry.
13. Spray-Textured Ceiling Substrates: Do not begin paint application until surfaces are dry.
14. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

B. Application
1. Apply paints according to manufacturer's written instructions.
   a. Use applicators and techniques suited for paint and substrate indicated.
   b. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
   c. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
2. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

3. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
4. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
5. Painting Mechanical and Electrical Work: Paint items exposed in equipment rooms and occupied spaces including, but not limited to, the following:
   a. Mechanical Work:
      1) Uninsulated metal piping.
      2) Uninsulated plastic piping.
      3) Pipe hangers and supports.
      4) Tanks that do not have factory-applied final finishes.
      5) Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.
      6) Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
      7) Mechanical equipment that is indicated to have a factory-primed finish for field painting.
   b. Electrical Work:
      1) Switchgear.
      2) Panelboards.
      3) Electrical equipment that is indicated to have a factory-primed finish for field painting.

C. Field Quality Control
1. Testing of Paint Materials: The following procedure may be requested at any time and as often as the Owner deems necessary during the period when paints are being applied:
   a. Engage the services of a qualified testing agency to sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
   b. Testing agency will perform tests for compliance with product requirements.
   c. the Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying-paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

D. Cleaning And Protection
1. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
2. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
3. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by the Owner, and leave in an undamaged condition.
4. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

E. Interior Painting Schedule
1. Concrete Substrates, Nontraffic Surfaces:
   a. Latex System: MPI INT 3.1E.
      1) Prime Coat: Interior latex matching topcoat.
      2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
      3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
   b. Latex Over Sealer System: MPI INT 3.1A.

1) Prime Coat: Interior latex primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Latex Over Latex Aggregate System: MPI INT 3.1B.
1) Prime Coat: Latex stucco and masonry textured coating.
2) Intermediate Coat (for MPI Premium Grade system): Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

d. Alkyd System: MPI INT 3.1D.
1) Prime Coat: Interior latex primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

e. Institutional Low-Odor/VOC Latex System: MPI INT 3.1M.
1) Prime Coat: Institutional low-odor/VOC interior latex matching topcoat.
2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

f. High-Performance Architectural Latex System: MPI INT 3.1C.
1) Prime Coat: Interior latex primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

2. Concrete Substrates, Traffic Surfaces:

a. Latex Floor Enamel System: MPI INT 3.2A.
1) Prime Coat: Interior/exterior latex floor and porch paint (low gloss).
2) Intermediate Coat (for MPI Premium Grade system): Interior/exterior latex floor and porch paint (low gloss).
3) Topcoat: Interior/exterior latex floor and porch paint (low gloss).

b. Alkyd Floor Enamel System: MPI INT 3.2B.
1) Prime Coat: Exterior/interior alkyd floor enamel (gloss).
2) Intermediate Coat (for MPI Premium Grade system): Exterior/interior alkyd floor enamel (gloss).
3) Topcoat: Exterior/interior alkyd floor enamel (gloss).

c. Concrete Stain System: MPI INT 3.2E.
1) First Coat (for MPI Premium Grade system): Interior concrete floor stain.
2) Topcoat: Interior concrete floor stain.

d. Clear Sealer System: MPI INT 3.2F.
1) First Coat: Interior/exterior clear concrete floor sealer (solvent based).
2) Topcoat: Interior/exterior clear concrete floor sealer (solvent based).

e. Water-Based Clear Sealer System: MPI INT 3.2G.
1) First Coat: Interior/exterior clear concrete floor sealer (water based).
2) Topcoat: Interior/exterior clear concrete floor sealer (water based).

3. Clay-Masonry Substrates:

a. Latex System: MPI INT 4.1A.
1) Prime Coat: Interior latex matching topcoat.
2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Alkyd System: MPI INT 4.1D.
1) Prime Coat: Interior latex primer/sealer.

2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Latex Aggregate System: MPI INT 4.1B.
1) Prime Coat: As recommended in writing by topcoat manufacturer.
2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
3) Topcoat: Latex stucco and masonry textured coating.

d. Institutional Low-Odor/VOC Latex System: MPI INT 4.1M.
1) Prime Coat: Institutional low-odor/VOC interior latex matching topcoat.
2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

e. High-Performance Architectural Latex System: MPI INT 4.1L.
1) Prime Coat: High-performance architectural latex matching topcoat.
2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

4. CMU Substrates:

a. Latex System: MPI INT 4.2A.
1) Prime Coat: Interior/exterior latex block filler.
2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Alkyd System: MPI INT 4.2C.
1) Prime Coat: Interior/exterior latex block filler.
2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Alkyd Over Latex Sealer System: MPI INT 4.2N.
1) Prime Coat: Interior/exterior latex block filler.
2) Sealer Coat: Interior latex primer/sealer.
3) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
4) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

d. Institutional Low-Odor/VOC Latex System: MPI INT 4.2E.
1) Prime Coat: Interior/exterior latex block filler.
2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

e. High-Performance Architectural Latex System: MPI INT 4.2D.
1) Prime Coat: Interior/exterior latex block filler.
2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

5. Steel Substrates:

a. Quick-Drying Enamel System: MPI INT 5.1A.
1) Prime Coat: Quick-drying alkyd metal primer.
2) Intermediate Coat: Quick-drying enamel matching topcoat.
3) Topcoat: Quick-drying enamel (semigloss) **OR** (high gloss), **as directed**.

b. Water-Based Dry-Fall System: MPI INT 5.1C.
1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
2) Topcoat: Latex dry fog/fall **OR** Waterborne dry fall, **as directed**.

c. Alkyd Dry-Fall System: MPI INT 5.1D.
   1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
   2) Topcoat: Interior alkyd dry fog/fall.
d. Latex Over Alkyd Primer System: MPI INT 5.1Q.
   1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
   2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
   3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
e. Alkyd System: MPI INT 5.1E.
   1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
   2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
   3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
f. Aluminum Paint System: MPI INT 5.1M.
   1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
   2) Intermediate Coat (for MPI Premium Grade system): Aluminum paint.
   3) Topcoat: Aluminum paint.
g. Institutional Low-Odor/VOC Latex System: MPI INT 5.1S.
   1) Prime Coat: Rust-inhibitive primer (water based).
   2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
   3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
h. High-Performance Architectural Latex System: MPI INT 5.1R.
   1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
   2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
   3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

6. Galvanized-Metal Substrates:
   a. Water-Based Dry-Fall System: MPI INT 5.3H.
      1) Prime Coat: Waterborne dry fall.
      2) Topcoat: Waterborne dry fall.
   b. Alkyd Dry-Fall System: MPI INT 5.3F.
      1) Prime Coat: Cementitious galvanized-metal primer.
      2) Topcoat: Interior alkyd dry fog/fall.
   c. Latex System: MPI INT 5.3A.
      1) Prime Coat: Cementitious galvanized-metal primer.
      2) Intermediate Coat: Interior latex matching topcoat.
      3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
   d. Latex Over Waterborne Primer System: MPI INT 5.3J.
      1) Prime Coat: Waterborne galvanized-metal primer.
      2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
      3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
   e. Alkyd System: MPI INT 5.3C.
      1) Prime Coat: Cementitious galvanized-metal primer.
      2) Intermediate Coat: Interior alkyd matching topcoat.
      3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
   f. Aluminum Paint System: MPI INT 5.3G.
      1) Prime Coat: Cementitious galvanized-metal primer.
      2) Intermediate Coat (for MPI Premium Grade system): Aluminum paint.
      3) Topcoat: Aluminum paint.
   g. Institutional Low-Odor/VOC Latex System: MPI INT 5.3N.

1) Prime Coat: Waterborne galvanized-metal primer.
2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

h. High-Performance Architectural Latex System: MPI INT 5.3M.
1) Prime Coat: Waterborne galvanized-metal primer.
2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

7. Aluminum (Not Anodized or Otherwise Coated) Substrates:

a. Latex System: MPI INT 5.4H.
1) Prime Coat: Quick-drying primer for aluminum.
2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Alkyd Over Vinyl Wash Primer System: MPI INT 5.4A.
1) Prime Coat: Vinyl wash primer.
2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Alkyd Over Quick-Drying Primer System: MPI INT 5.4J.
1) Prime Coat: Quick-drying primer for aluminum.
2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
3) Topcoat: Interior alkyd (flat **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

d. Aluminum Paint System: MPI INT 5.4D.
1) Prime Coat: Vinyl wash primer.
2) Intermediate Coat (for MPI Premium Grade system): Aluminum paint.
3) Topcoat: Aluminum paint.

e. Institutional Low-Odor/VOC Latex System: MPI INT 5.4G.
1) Prime Coat: Quick-drying primer for aluminum.
2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

f. High-Performance Architectural Latex System: MPI INT 5.4F.
1) Prime Coat: Quick-drying primer for aluminum.
2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

8. Glue-Laminated Beam and Column Substrates:

a. Latex System: MPI INT 6.1M.
1) Prime Coat: Interior latex-based wood primer.
2) Intermediate Coat: Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Latex Over Alkyd Primer System: MPI INT 6.1A.
1) Prime Coat: Interior alkyd primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Alkyd System: MPI INT 6.1B.
1) Prime Coat: Interior alkyd primer/sealer.

2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

d. Institutional Low-Odor/VOC Latex System: MPI INT 6.1Q.
1) Prime Coat: Interior latex-based wood primer.
2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

e. High-Performance Architectural Latex System: MPI INT 6.1N.
1) Prime Coat: Interior latex-based wood primer.
2) Intermediate Coat: High-performance architectural latex matching topcoat.
3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

9. Dressed Lumber Substrates: Including architectural woodwork and doors.

a. Latex System: MPI INT 6.3T.
1) Prime Coat: Interior latex-based wood primer.
2) Intermediate Coat: Interior latex matching topcoat.
3) Topcoat: Interior latex (semigloss) **OR** (gloss), **as directed**.

b. Latex Over Alkyd Primer System: MPI INT 6.3U.
1) Prime Coat: Interior alkyd primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
3) Topcoat: Interior latex (semigloss) **OR** (gloss), **as directed**.

c. Alkyd System: MPI INT 6.3B.
1) Prime Coat: Interior alkyd primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
3) Topcoat: Interior alkyd (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

d. Institutional Low-Odor/VOC Latex System: MPI INT 6.3V.
1) Prime Coat: Interior latex-based wood primer.
2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

e. High-Performance Architectural Latex System: MPI INT 6.3A.
1) Prime Coat: Interior latex-based wood primer.
2) Intermediate Coat: High-performance architectural latex matching topcoat.
3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

10. Wood Panel Substrates: Including painted plywood, medium-density fiberboard, and hardboard.

a. Latex System: MPI INT 6.4R.
1) Prime Coat: Interior latex-based wood primer.
2) Intermediate Coat: Interior latex matching topcoat.
3) Topcoat: Interior latex (semigloss) **OR** (gloss), **as directed**.

b. Latex Over Alkyd Primer System: MPI INT 6.4A.
1) Prime Coat: Interior alkyd primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Alkyd System: MPI INT 6.4B.
1) Prime Coat: Interior alkyd primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

d. Institutional Low-Odor/VOC Latex System: MPI INT 6.4T.

1) Prime Coat: Interior latex-based wood primer.
2) Intermediate Coat : Institutional low-odor/VOC interior latex matching topcoat.
3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

e. High-Performance Architectural Latex System: MPI INT 6.4S.
1) Prime Coat: Interior latex-based wood primer.
2) Intermediate Coat: High-performance architectural latex matching topcoat.
3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

11. Dimension Lumber Substrates, Nontraffic Surfaces: Including exposed joists and exposed beams.

a. Latex System: MPI INT 6.2D.
1) Prime Coat: Interior latex-based wood primer.
2) Intermediate Coat: Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Latex Over Alkyd Primer System: MPI INT 6.2A.
1) Prime Coat: Interior alkyd primer/sealer.
2) Intermediate Coat : Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Alkyd System: MPI INT 6.2C.
1) Prime Coat: Interior alkyd primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

d. Institutional Low-Odor/VOC Latex System: MPI INT 6.2L.
1) Prime Coat: Interior latex-based wood primer.
2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

e. High-Performance Architectural Latex System: MPI INT 6.2B.
1) Prime Coat: Interior alkyd primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

12. Wood Substrates, Traffic Surfaces:

a. Latex Floor Paint System: MPI INT 6.5G.
1) Prime Coat: Interior alkyd primer/sealer.
2) Intermediate Coat: Interior/exterior latex floor and porch paint (low gloss).
3) Topcoat: Interior/exterior latex floor and porch paint (low gloss).

b. Alkyd Floor Enamel System: MPI INT 6.5A.
1) Prime Coat: Exterior/interior alkyd floor enamel (gloss).
2) Intermediate Coat: Exterior/interior alkyd floor enamel (gloss).
3) Topcoat: Exterior/interior alkyd floor enamel (gloss).

13. Gypsum Board Substrates:

a. Latex System: MPI INT 9.2A.
1) Prime Coat: Interior latex primer/sealer (for MPI Premium Grade system) **OR** matching topcoat, **as directed**.
2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Alkyd Over Latex Primer System: MPI INT 9.2C.
1) Prime Coat: Interior latex primer/sealer.

2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Institutional Low-Odor/VOC Latex System: MPI INT 9.2M.
1) Prime Coat: Interior latex primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

d. High-Performance Architectural Latex System: MPI INT 9.2B.
1) Prime Coat: Interior latex primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

14. Plaster Substrates:

a. Latex System: MPI INT 9.2A.
1) Prime Coat: Interior latex primer/sealer (for MPI Premium Grade system) **OR** matching topcoat, **as directed**.
2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Latex Over Alkyd Primer System: MPI INT 9.2K.
1) Prime Coat: Interior alkyd primer/sealer.
2) Intermediate Coat: Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Alkyd Over Latex Primer System: MPI INT 9.2C.
1) Prime Coat: Interior latex primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

d. Institutional Low-Odor/VOC Latex System: MPI INT 9.2M.
1) Prime Coat: Interior latex primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

e. High-Performance Architectural Latex System: MPI INT 9.2B.
1) Prime Coat: Interior latex primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

15. Spray-Textured Ceiling Substrates:

a. Latex (Flat) System: MPI INT 9.1A, spray applied.
1) Prime Coat: Interior latex primer/sealer **OR** (flat), **as directed**.
2) Topcoat: Interior latex (flat).

b. Latex System: MPI INT 9.1E, spray applied.
1) Prime Coat: Interior latex matching topcoat.
2) Intermediate Coat: Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

c. Latex Over Alkyd Primer System: MPI INT 9.1B.
1) Prime Coat: Interior alkyd primer/sealer.

2) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

d. Alkyd (Flat) System: MPI INT 9.1C.

1) Prime Coat: Interior alkyd (flat).

2) Topcoat: Interior alkyd (flat).

e. Alkyd System: MPI INT 9.1D.

1) Prime Coat: Interior alkyd primer/sealer.

2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.

3) Topcoat: Interior alkyd (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

16. Cotton or Canvas Insulation-Covering Substrates: Including pipe and duct coverings.

a. Latex System: MPI INT 10.1A.

1) Prime Coat: Interior latex primer/sealer (for MPI Premium Grade system) **OR** matching topcoat, **as directed**.

2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.

3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Alkyd Over Latex Primer System: MPI INT 10.1B.

1) Prime Coat: Interior latex primer/sealer.

2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.

3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Aluminum Paint System: MPI INT 10.1C.

1) Prime Coat: Interior latex primer/sealer.

2) Intermediate Coat (for MPI Premium Grade system): Aluminum paint.

3) Topcoat: Aluminum paint.

d. Institutional Low-Odor/VOC Latex System: MPI INT 10.1D.

1) Prime Coat: Interior latex primer/sealer.

2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.

3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

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SECTION 09 91 23 00a - MULTICOLORED INTERIOR COATINGS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for multicolored interior coatings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes surface preparation and field application of multicolor interior coating systems applied on the following substrates:
a. Vertical concrete.
b. Cementitious composition board.
c. Clay masonry units.
d. Concrete masonry units (CMU).
e. Wood.
f. Fiberglass moldings and trim.
g. Plastic moldings and trim.
h. Plaster, Gypsum veneer plaster, and Gypsum board.

C. Submittals
1. Product Data: For each type of product indicated.
2. Samples: For each finish-coat product and for each color and texture required.
3. LEED Submittal:
a. Product Data for Credit EQ 4.2: For coatings, including printed statement of VOC content and chemical components.

D. Quality Assurance
1. Fire-Test-Response Characteristics: Provide coatings with flame-spread and smoked-developed indexes of 25 or less and 450 or less, respectively, as determined by testing identical products per ASTM E 84 by testing and inspecting agency acceptable to authorities having jurisdiction.
2. Master Painters Institute (MPI) Standards: Comply with recommendations in "MPI Architectural Painting Specification Manual" **OR** "MPI Maintenance Repainting Manual," **as directed**, applicable to products and coating systems indicated.
3. Mockups: Apply mockup of each coating system indicated to verify preliminary selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
a. Architect will select one surface to represent surfaces and conditions for application of each coating system and type of substrate.
1) Wall Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
2) Other Items: Architect will designate items or areas required.
b. Apply mockup after permanent lighting and other environmental services have been activated.
c. Final approval of color and pattern selections will be based on mockup.
1) If preliminary color and pattern selections are not approved, apply additional mockups of colors and patterns selected by Architect at no added cost to Owner.
d. Repair Mockup: After approval of color and pattern selections, apply representative repairs to 100 sq. in. (65 sq. cm) of mockup to establish quality standards for coating system repairs.
e. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

f. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Delivery, Storage, And Handling

1. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
    a. Maintain containers in clean condition, free of foreign materials and residue.
    b. Remove rags and waste from storage areas daily.

1.2 PRODUCTS

A. Multicolor Coating Systems, General

1. Material Compatibility: Provide materials for use within each coating system that are compatible with one another and substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
2. VOC Content of Interior Paints and Coatings: Provide products that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
    a. Flat Paints, Coatings, and Primers: VOC content of not more than 50 g/L.
    b. Nonflat Paints, Coatings, and Primers: VOC content of not more than 150 g/L.
    c. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
    d. Shellacs, Clear: VOC not more than 730 g/L.
    e. Shellacs, Pigmented: VOC not more than 550 g/L.
    f. Flat Topcoat Paints: VOC content of not more than 50 g/L.
    g. Nonflat Topcoat Paints: VOC content of not more than 150 g/L.
    h. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
    i. Shellacs, Clear: VOC not more than 730 g/L.
    j. Shellacs, Pigmented: VOC not more than 550 g/L.
    k. Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
3. Chemical Components of Interior Paints and Coatings: Provide topcoat paints that comply with the following chemical restrictions; these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:
    a. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing 1 or more benzene rings).
    b. Restricted Components: Paints and coatings shall not contain any of the following:
        1) Acrolein.
        2) Acrylonitrile.
        3) Antimony.
        4) Benzene.
        5) Butyl benzyl phthalate.
        6) Cadmium.
        7) Di (2-ethylhexyl) phthalate.
        8) Di-n-butyl phthalate.
        9) Di-n-octyl phthalate.
        10) 1,2-dichlorobenzene.
        11) Diethyl phthalate.
        12) Dimethyl phthalate.
        13) Ethylbenzene.
        14) Formaldehyde.
        15) Hexavalent chromium.
        16) Isophorone.
        17) Lead.
        18) Mercury.
        19) Methyl ethyl ketone.

20) Methyl isobutyl ketone.
21) Methylene chloride.
22) Naphthalene.
23) Toluene (methylbenzene).
24) 1,1,1-trichloroethane.
25) Vinyl chloride.

4. Colors and Patterns: Match samples **OR** As selected from manufacturer's full range **OR** As indicated in color schedule, **as directed**.

B. Fillers And Primers

1. General: Undercoatings recommended in writing for use in coating systems by manufacturer of multicolor interior coating on substrates and under conditions indicated.
2. Latex Block Filler: Waterborne, high-solids, emulsion-type, pigmented coating product recommended in writing for use in coating system indicated by manufacturer of multicolor interior coating, with bridging and filling properties, and formulated for filling surfaces of CMU for subsequent applications of finish coatings.
   a. VOC Content: Minimum E Range of E2 **OR** E3, **as directed**, according to requirements for MPI #4.
3. Wood Filler Paste: Solvent-based, high-solids, clear paste product recommended in writing for use in coating system indicated by manufacturer of multicolor interior coating, for use on open-grained or damaged woods and that fills hardwood pores with minimal surface residues and without showing cracking or shrinkage. When dry, sanding filler produces a smooth surface without clogging or gumming sandpaper.
   a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**, according to requirements for MPI #91.
4. Wood-Knot Sealer: White shellac or other sealer recommended in writing for this purpose by manufacturer of multicolor interior coating.
5. Primer/Sealer for Multicolor Systems: Acrylic or acrylic/polyvinyl acetate (PVA) co-polymer emulsion-type, pigmented primer/sealer product recommended in writing for use in coating system indicated by manufacturer of multicolor interior coating.
   a. VOC Content: Minimum E Range of E2 **OR** E3, **as directed**, according to requirements for MPI #125.
6. Interior Alkyd Primer/Sealer: Solvent-based, pigmented primer/sealer.
   a. VOC Content: Minimum E Range of E1 **OR** E2, **as directed**, according to requirements for MPI #45.
7. Water-Based Bonding Primer: Water-based, emulsion-type, pigmented primer product recommended in writing for use in coating system indicated by manufacturer of multicolor interior coating, and formulated to promote adhesion of subsequent coatings.
   a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**, according to requirements for MPI #17.
8. Solvent-Based Bonding Primer: Solvent-based, pigmented product recommended in writing for use in coating system indicated by manufacturer of multicolor interior coating, and formulated to promote adhesion of subsequent coatings to substrate.
   a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**, according to requirements for MPI #69.

C. Multicolor Coatings

1. Multicolor Coatings: Complying with MPI #112 and listed in "MPI Approved Products List."
   a. VOC Content: Minimum E Range of E1 **OR** E3, **as directed**.
2. Clear Topcoat: Product of multicolor coating manufacturer complying with MPI #121 and listed in "MPI Approved Products List."
   a. VOC Content: Minimum E Range of E1 **OR** E2, **as directed**.

1.3 EXECUTION

A. Preparation
1. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
2. Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
   a. After completing coating operations, reinstall items that were removed; use workers skilled in the trades involved.
3. Clean substrates of substances that could impair bond of coatings, including dirt, oil, grease, and incompatible primers, paints, and encapsulants.
4. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
5. Clay Masonry Substrates: Remove efflorescence and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
6. Concrete Masonry Substrates: Remove efflorescence and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
7. Wood Substrates:
   a. Scrape and clean small, dry, seasoned knots, and apply a thin coat of knot sealer before applying primer.
   b. Sand surfaces that will be exposed to view and dust off.
   c. Prime edges, ends, faces, undersides, and back sides of wood.
   d. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

B. Application
1. Apply coatings according to manufacturer's written instructions using applicators and techniques suited for coating and substrate indicated.
2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Apply coating systems to produce uniformly textured, colored, and patterned finished-surface films without substrates, undercoats, marks, or stains showing through. Produce sharp, even glass lines and color breaks.

C. Cleaning And Protection
1. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
2. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
3. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by the Owner, and leave in an undamaged condition.
4. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

D. Multicolor Interior Coating Schedule
1. Vertical Concrete Substrates: System below corresponds to MPI INT 3.1H
   a. Prime Coat: Primer/sealer for multicolor systems.

b. Multicolor Base Coat: Multicolor coating, MPI #112.
c. Multicolor Pattern Coat: Multicolor coating, MPI #112.
d. Topcoat (for a Premium Grade system): Clear topcoat, MPI #121.

2. Cementitious Composition Board Substrates: System below corresponds to MPI INT 3.3F
   a. Prime Coat: Primer/sealer for multicolor systems.
   b. Multicolor Base Coat: Multicolor coating, MPI #112.
   c. Multicolor Pattern Coat: Multicolor coating, MPI #112.
   d. Topcoat (for a Premium Grade system): Clear topcoat, MPI #121.
3. Clay Masonry Units Substrates: System below corresponds to MPI INT 4.1H
   a. Prime Coat: Primer/sealer for multicolor systems tinted to match multicolor basecoat.
   b. Multicolor Base Coat: Multicolor coating, MPI #112.
   c. Multicolor Pattern Coat: Multicolor coating, MPI #112.
   d. Topcoat (for a Premium Grade system): Clear topcoat, MPI #121.
4. CMU Substrates: System below corresponds to MPI INT 4.2H
   a. Block Filler: Latex block filler.
   b. Prime Coat: Primer/sealer for multicolor systems.
   c. Multicolor Base Coat: Multicolor coating, MPI #112.
   d. Multicolor Pattern Coat: Multicolor coating, MPI #112.
   e. Topcoat (for a Premium Grade system): Clear topcoat, MPI #121.
5. Wood Substrates: System below corresponds to MPI INT 6.2E, MPI INT 6.3N, and MPI INT 6.4L
   a. Fill Coat: Wood filler paste (Fill coat is optional component and is for use on open-grained woods where a smooth, glasslike finish is desired).
   b. Prime Coat: Interior alkyd primer/sealer tinted to match multicolor base coat {for dressed lumber (finished carpentry)}.
   c. Multicolor Base Coat: Multicolor coating, MPI #112.
   d. Multicolor Pattern Coat: Multicolor coating, MPI #112.
   e. Topcoat (for a Premium Grade system): Clear topcoat, MPI #121.
6. Fiberglass Molding and Trim Substrates: System below corresponds to MPI INT 6.7G
   a. Prime Coat: Water-based **OR** Solvent-based, **as directed**, bonding primer.
   b. Multicolor Base Coat: Multicolor coating, MPI #112.
   c. Multicolor Pattern Coat: Multicolor coating, MPI #112.
   d. Topcoat (for a Premium Grade system): Clear topcoat, MPI #121.
7. Plastic Molding and Trim Substrates: System below corresponds to MPI INT 6.8D
   a. Prime Coat: Solvent-based bonding primer.
   b. Multicolor Base Coat: Multicolor coating, MPI #112.
   c. Multicolor Pattern Coat: Multicolor coating, MPI #112.
   d. Topcoat (for a Premium Grade system): Clear topcoat, MPI #121.
8. Plaster **OR** Gypsum Veneer Plaster **OR** Gypsum Board, **as directed**, Substrates: System below corresponds to MPI INT 9.2G
   a. Prime Coat: Primer/sealer for multicolor systems.
   b. Multicolor Base Coat: Multicolor coating, MPI #112.
   c. Multicolor Pattern Coat: Multicolor coating, MPI #112.
   d. Topcoat (for a Premium Grade system): Clear topcoat, MPI #121.

END OF SECTION 09 91 23 00a

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Task	Specification	Specification Description
09 91 23 00	09 91 13 00	Exterior Painting
09 91 33 00	09 91 13 00a	Wood Stains and Transparent Finishes
09 91 33 00	09 91 13 00b	High-Temperature-Resistant Coatings
09 93 13 13	09 91 13 00	Exterior Painting

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SECTION 09 93 23 13 - FLOOR TREATMENT REFINISHING WOOD FLOORS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for refinishing wood floors. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. Product Data: For each type of product indicated.

C. Quality Assurance
   1. Build mockup of typical flooring area as shown on Drawings including base and shoe moldings.
      a. To set quality standards for sanding and application of field finishes, prepare finish mockup of floor area as shown on Drawings.
      b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
      c. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.2 PRODUCTS

A. Cleaning Compound: A liquid chemical cleaner containing non-ionic and anionic type detergents, non-reactive to wood flooring. Compound shall have no free metal alkalies, no artificial coloring and no fatty acids. Compound shall be UL listed as "slip-resistant."

B. Varnish Remover: Non-flammable paint and varnish remover.

C. Stain: Penetrating type non-fading wood stain.

D. Wood Filler: Paste type wood filler, pigmented if necessary to match sample, complying with Fed. Spec. TT-F-336.

E. Floor Sealer: Penetrating type, pliable, wood-hardening finish/sealer.

F. Floor Varnish: Alkyd resin varnish, specially compounded for floor finish, Fed. Spec. TT-V-109.

G. Urethane Finish: Specially compounded for wood floor finish, moisture curing type, for multiple-coat application.

H. Floor Wax: Liquid, solvent-type, slip-resistant, CID A-A-1550, Type II.

1.3 EXECUTION

A. Preparation:
   1. Cleaning: Scrub thoroughly with cleaning compound and warm water. Rinse with clean water, mop dry, and buff with polishing machine.
   2. Varnish Removal: Apply paint and varnish remover as required.

3. Sanding: Traverse floors two times with an electric-powered sanding machine. A rotary disc sander may be used for the final cut, but first cut shall be made with a drum-type machine. The first cut may be made crosswise of the grain or at a 45-degree angle. Make second cut in direction of grain. Use No. 1/2 sandpaper for first traverse and No. 0 for second traverse. Use an electric edger or hand sander for sanding areas near walls, in corners, and small closets.

B. Installation:
1. Apply Wood Paste Filler, followed by wiping cross-grain to work into pores and cracks.
2. Apply Stain if needed to match selected finish.
3. Apply Sealer (2 coats) complying with Fed. Spec. TT-S-176. Use Class I for white oak and red oak floors and Class II for beech, birch, and hard maple floors.
4. Apply Floor Varnish, (3 coats) buffing after each coat. First coat may be thinned as a sealer.
5. Apply Urethane Finish. Apply as many coats as needed to build a dry film thickness of 1.0 mil.
6. When Floors are Dry, apply two coats of wax complying with Fed. Spec. P-W-155; concentration 12 percent. Spread the wax at the rate of 1,500 square feet per gallon and polish the floors with a weighted floor brush or an electric polisher.
7. Protection: Upon completion of work, cover all traffic areas immediately with nonstaining kraft paper or polyethylene, taped along edges, and maintain floor protection until acceptance.

END OF SECTION 09 93 23 13

Task	Specification	Specification Description
09 93 23 13	09 91 13 00a	Wood Stains and Transparent Finishes
09 93 23 53	09 93 23 13	Floor Treatment Refinishing Wood Floors
09 93 23 53	09 91 13 00a	Wood Stains and Transparent Finishes

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SECTION 09 96 00 00 - HIGH-PERFORMANCE COATINGS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for high performance coatings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes surface preparation and application of high-performance coating systems on the following substrates:
      a. Exterior Substrates:
         1) Concrete, vertical and horizontal surfaces.
         2) Clay masonry.
         3) Concrete masonry units (CMU).
         4) Steel.
         5) Galvanized metal.
         6) Aluminum (not anodized or otherwise coated).
         7) Wood.
      b. Interior Substrates:
         1) Concrete, vertical and horizontal surfaces.
         2) Clay masonry.
         3) Concrete masonry units (CMU).
         4) Steel.
         5) Galvanized metal.
         6) Aluminum (not anodized or otherwise coated).
         7) Wood.
         8) Gypsum board.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. Samples: For each type of finish-coat product indicated.
   3. Product List: For each product indicated. Cross-reference products to coating system and locations of application areas. Use same designations indicated on Drawings and in schedules.
   4. LEED Submittals:
      a. Product Data for Credit EQ 4.2: For coatings, including printed statement of VOC content and chemical components.

D. Quality Assurance
   1. Master Painters Institute (MPI) Standards:
      a. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
      b. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" **OR** "MPI Maintenance Repainting Manual," **as directed**, for products and coating systems indicated.
   2. Mockups: Apply mockups of each coating system indicated to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
      a. Architect will select one surface to represent surfaces and conditions for application of each coating system specified in Part 3.
         1) Wall and Ceiling Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
         2) Other Items: Architect will designate items or areas required.

b. Final approval of color selections will be based on mockups.
   1) If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
c. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
d. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Delivery, Storage, And Handling
1. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
   a. Maintain containers in clean condition, free of foreign materials and residue.
   b. Remove rags and waste from storage areas daily.

F. Project Conditions
1. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 50 and 95 deg F (10 and 35 deg C).
2. Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

1.2 PRODUCTS

A. High-Performance Coatings, General
1. Material Compatibility:
   a. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
   b. Provide products of same manufacturer for each coat in a coating system.
2. VOC Content of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   a. Flat Paints, Coatings, and Primers: VOC content of not more than 50 g/L.
   b. Nonflat Paints, Coatings, and Primers: VOC content of not more than 150 g/L.
   c. Anticorrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC content of not more than 250 g/L.
   d. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
   e. Clear Wood Finishes, Lacquers: VOC not more than 550 g/L.
   f. Floor Coatings: VOC not more than 100 g/L.
   g. Shellacs, Clear: VOC not more than 730 g/L.
   h. Shellacs, Pigmented: VOC not more than 550 g/L.
   i. Stains: VOC content of not more than 250 g/L.
   j. Flat Interior Topcoat Paints: VOC content of not more than 50 g/L.
   k. Nonflat Interior Topcoat Paints: VOC content of not more than 150 g/L.
   l. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
   m. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
   n. Clear Wood Finishes, Lacquers: VOC not more than 550 g/L.
   o. Floor Coatings: VOC not more than 100 g/L.
   p. Shellacs, Clear: VOC not more than 730 g/L.
   q. Shellacs, Pigmented: VOC not more than 550 g/L.
   r. Stains: VOC not more than 250 g/L.
   s. Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
   t. Zinc-Rich Industrial Maintenance Primers: VOC content of not more than 340 g/L.

u. Pre-Treatment Wash Primers: VOC content of not more than 420 g/L.

3. Chemical Components of Field-Applied Interior Paints and Coatings: Provide topcoat paints and anti-corrosive and anti-rust paints applied to ferrous metals that comply with the following chemical restrictions; these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:
   a. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing 1 or more benzene rings).
   b. Restricted Components: Paints and coatings shall not contain any of the following:
      1) Acrolein.
      2) Acrylonitrile.
      3) Antimony.
      4) Benzene.
      5) Butyl benzyl phthalate.
      6) Cadmium.
      7) Di (2-ethylhexyl) phthalate.
      8) Di-n-butyl phthalate.
      9) Di-n-octyl phthalate.
      10) 1,2-dichlorobenzene.
      11) Diethyl phthalate.
      12) Dimethyl phthalate.
      13) Ethylbenzene.
      14) Formaldehyde.
      15) Hexavalent chromium.
      16) Isophorone.
      17) Lead.
      18) Mercury.
      19) Methyl ethyl ketone.
      20) Methyl isobutyl ketone.
      21) Methylene chloride.
      22) Naphthalene.
      23) Toluene (methylbenzene).
      24) 1,1,1-trichloroethane.
      25) Vinyl chloride.
4. Colors: As selected from manufacturer's full range **OR** Match samples **OR** As indicated in color schedule, **as directed**.

B. Block Fillers
   1. Interior/Exterior Latex Block Filler: MPI#4.
      a. VOC Content: Minimum E Range of E2 **OR** E3, **as directed**.
   2. Epoxy Block Filler: MPI #116.
      a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.

C. Interior Primers/Sealers
   1. Interior Latex Primer/Sealer: MPI #50.
      a. Environmental Characteristics:
         1) VOC Content:
            a) Minimum E Range of E2 **OR** E3, **as directed**.
            b) Meets or exceeds LEED requirements for VOC content.
         2) Environmental Performance Rating (EPR): Minimum EPR 2 **OR** 3, **as directed**.
   2. Interior Alkyd Primer/Sealer: MPI #45.
      a. VOC Content: Minimum E Range of E1 **OR** E2, **as directed**.
   3. Interior Latex-Based Wood Primer: MPI #39.
      a. Environmental Characteristics:
         1) VOC Content:
            a) Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.

b) Meets or exceeds LEED requirements for VOC content.
2) Environmental Performance Rating (EPR): Minimum EPR 1 **OR** 2 **OR** 3, **as directed**.
4. Wood-Knot Sealer: White shellac or other sealer recommended in writing by manufacturer for this purpose.

D. Metal Primers
1. Inorganic Zinc Primer: MPI #19.
a. VOC Content: Minimum E Range of 0 **OR** E1 **OR** E2 **OR** E3, **as directed**.
2. Epoxy Zinc Primer: MPI #20.
a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. Rust-Inhibitive Primer (Water Based): MPI #107.
a. Environmental Characteristics:
1) VOC Content:
a) Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
b) Meets or exceeds LEED requirements for VOC content.
2) Environmental Performance Rating (EPR): Minimum EPR 1 **OR** 2 **OR** 3, **as directed**.
4. Cold-Curing Epoxy Primer: MPI #101.
a. VOC Content: Minimum E Range of E1 **OR** E3, **as directed**.
5. Alkyd Anticorrosive Metal Primer: MPI #79.
a. VOC Content: Minimum E Range of E1 **OR** E2, **as directed**.
6. Quick-Dry Alkyd Metal Primer: MPI #76.
a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
7. Cementitious Galvanized-Metal Primer: MPI #26.
a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
8. Waterborne Galvanized-Metal Primer: MPI #134.
a. Environmental Characteristics:
1) VOC Content:
a) Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
b) Meets or exceeds LEED requirements for VOC content.
2) Environmental Performance Rating (EPR): Minimum EPR 1 **OR** 2 **OR** 3, **as directed**.
9. Quick-Drying Primer for Aluminum: MPI #95.
a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
10. Vinyl Wash Primer: MPI #80.
a. VOC Content: Minimum E Range of E2 **OR** E3, **as directed**.

E. Water-Based, Light-Industrial Coatings
1. Gloss, Water-Based, Light-Industrial Coating: MPI #110-G6.
a. Environmental Characteristics:
1) VOC Content: Minimum E Range of E2.
2) Environmental Performance Rating (EPR): Minimum EPR 2.
2. Semigloss, Water-Based, Light-Industrial Coating: MPI #110-G5.
a. Environmental Characteristics:
1) VOC Content:
a) Minimum E Range of E2 **OR** E3, **as directed**.
b) Meets or exceeds LEED requirements for VOC content.
2) Environmental Performance Rating (EPR): Minimum EPR 2 **OR** 3, **as directed**.
3. Eggshell, Water-Based, Light-Industrial Coating: MPI #110-G3.
a. Environmental Characteristics:
1) VOC Content:
a) Minimum E Range of E2 **OR** E3, **as directed**.
b) Meets or exceeds LEED requirements for VOC content.
2) Environmental Performance Rating (EPR): Minimum EPR 2 **OR** 3, **as directed**.

F. Epoxy Coatings
1. Epoxy, Cold-Cured, Gloss: MPI #77.
a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Water-Based Epoxy (Interior and Exterior): MPI #115.
a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. High-Build Epoxy Marine Coating, Low Gloss: MPI #108.
a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
4. Epoxy Deck Coating: MPI #82.
a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
5. Water-Based Epoxy Floor Paint: MPI #93.
a. Environmental Characteristics:
1) VOC Content:
a) Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
b) Meets or exceeds LEED requirements for VOC content.
2) Environmental Performance Rating (EPR): Minimum EPR 1 **OR** 2 **OR** 3, **as directed**.

G. Polyurethane Coatings
1. Polyurethane, Two-Component, Pigmented, Gloss: MPI #72.
a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Two-Component, Aliphatic Polyurethane, Clear: MPI #78.
a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. Polyurethane, Moisture Cured, Clear, Gloss: MPI #31.
a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
4. Polyurethane, Moisture Cured, Clear, Flat: MPI #71.
a. VOC Content: Minimum E Range of E2.

H. Interior High-Performance Architectural Latex Coatings
1. High-Performance Architectural Latex, Velvet Finish: MPI #138, Gloss Level 2.
a. Environmental Characteristics:
1) VOC Content:
a) Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
b) Meets or exceeds LEED requirements for VOC content.
2) Environmental Performance Rating (EPR): Minimum EPR 4 **OR** 5 **OR** 6, **as directed**.
2. High-Performance Architectural Latex, Eggshell Finish: MPI #139, Gloss Level 3.
a. Environmental Characteristics:
1) VOC Content:
a) Minimum E Range of E2 **OR** E3, **as directed**.
b) Meets or exceeds LEED requirements for VOC content.
2) Environmental Performance Rating (EPR): Minimum EPR 5 **OR** 6, **as directed**.
3. High-Performance Architectural Latex, Satin Finish: MPI #140, Gloss Level 4.
a. Environmental Characteristics:
1) VOC Content:
a) Minimum E Range of E1 **OR** E3, **as directed**.
b) Meets or exceeds LEED requirements for VOC content.
2) Environmental Performance Rating (EPR): Minimum EPR 4.5 **OR** 6.5, **as directed**.
4. High-Performance Architectural Latex, Semigloss Finish: MPI #141, Gloss Level 5.
a. Environmental Characteristics:
1) VOC Content:
a) Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
b) Meets or exceeds LEED requirements for VOC content.
2) Environmental Performance Rating (EPR): Minimum EPR 5 **OR** 6 **OR** 7, **as directed**.

I. Wood Stains

1. Exterior Semitransparent Stain (Solvent Based): MPI #13.
   a. VOC Content: Minimum E Range of E1 **OR** E2, **as directed**.
2. Interior Wood Stain, Semitransparent (Solvent Based): MPI #90.
   a. VOC Content: Minimum E Range of E1 **OR** E2, **as directed**.

1.3 EXECUTION

A. Preparation
1. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
2. Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
   a. After completing coating operations, reinstall items that were removed; use workers skilled in the trades involved.
3. Clean substrates of substances that could impair bond of coatings, including dirt, oil, grease, and incompatible paints and encapsulants.
   a. Remove incompatible primers and reprime substrate with compatible primers as required to produce coating systems indicated.
4. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
   a. Clean surfaces with pressurized water. Use pressure range of 1500 to 4000 psi (10 350 to 27 580 kPa) at 6 to 12 inches (150 to 300 mm) **OR** 4000 to 10,000 psi (27 580 to 68 950 kPa), **as directed**.
      OR
      Abrasive blast clean surfaces to comply with SSPC-SP 7/NACE No. 4, "Brush-Off Blast Cleaning."
5. Clay Masonry Substrates: Remove efflorescence and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
   a. Clean surfaces with pressurized water. Use pressure range of 100 to 600 psi (690 to 4140 kPa) **OR** 1500 to 4000 psi (10 350 to 27 580 kPa), **as directed**, at 6 to 12 inches (150 to 300 mm).
6. CMU Substrates: Remove efflorescence and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
7. Steel Substrates (for field applied primers): Remove rust and loose mill scale.
   a. Clean using methods recommended in writing by coating manufacturer.

      Blast clean according to SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning **OR** SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning **OR** SSPC-SP 7/NACE No. 4, "Brush-Off Blast Cleaning **OR** SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning," **as directed**.
8. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied coatings.
9. Aluminum Substrates: Remove surface oxidation.
10. Wood Substrates:
    a. Scrape and clean small, dry, seasoned knots, and apply a thin coat of knot sealer before applying primer.
    b. Sand surfaces that will be exposed to view and dust off.
    c. Prime edges, ends, faces, undersides, and back sides of wood.
    d. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

B. Application
1. Apply high-performance coatings according to manufacturer's written instructions.
   a. Use applicators and techniques suited for coating and substrate indicated.
   b. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
   c. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
2. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
3. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.
4. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

C. Field Quality Control
1. The following procedure may be requested at any time and as often as the Owner deems necessary during the period when coatings are being applied:
   a. Engage the services of a qualified testing agency to sample coating material being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
   b. Testing agency will perform tests for compliance with specified requirements.
   c. the Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with specified requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

D. Cleaning And Protection
1. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
2. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
3. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by the Owner, and leave in an undamaged condition.
4. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

E. Exterior High-Performance Coating Schedule
1. Coating systems in this Article are based on "MPI Architectural Painting Specification Manual." For renovation projects, consult "MPI Maintenance Repainting Manual" and revise coating systems accordingly.
2. Concrete Substrates, Vertical Surfaces:
   a. Water-Based, Light-Industrial Coating System (System below corresponds to MPI EXT 3.1C):
      1) Prime Coat: Water-based, light-industrial coating, MPI #110, gloss matching topcoat.
      2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
      3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.
   b. Epoxy Coating System (System below corresponds to MPI EXT 3.1D):
      1) Prime Coat: Epoxy, cold-cured, gloss, MPI #77.

2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.

c. Water-Based Epoxy Coating System (System below corresponds to MPI EXT 3.1E):
1) Prime Coat: Water-based epoxy (interior and exterior), MPI #115.
2) Intermediate Coat: Not required **OR** Water-based epoxy (interior and exterior), MPI #115, **as directed**.
3) Topcoat: Water-based epoxy (interior and exterior), MPI #115.

3. Concrete Substrates, Horizontal Surfaces (System below corresponds to MPI EXT 3.2C):
a. Epoxy Slip-Resistant Deck Coating System:
1) Topcoat: Epoxy deck coating, MPI #82.

4. Clay-Masonry Substrates (System below corresponds to MPI EXT 4.1C):
a. Water-Based, Light-Industrial Coating System:
1) Prime Coat: Water-based, light-industrial coating, MPI #110, gloss matching topcoat.
2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.

b. Epoxy Coating System (System below corresponds to MPI EXT 4.1D) (MPI recommends this system for smooth brick.):
1) Prime Coat: Epoxy, cold-cured, gloss, MPI #77.
2) Intermediate Coat : Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.

c. Water-Based Epoxy Coating System (System below corresponds to MPI EXT 4.1E) (MPI recommends this system for smooth brick.):
1) Prime Coat: Water-based epoxy (interior and exterior), MPI #115.
2) Intermediate Coat: Not required **OR** Water-based epoxy (interior and exterior), MPI #115, **as directed**.
3) Topcoat: Water-based epoxy (interior and exterior), MPI #115.

d. Polyurethane, Pigmented, Over Epoxy Coating System (System below corresponds to MPI EXT 4.1J):
1) Prime Coat: Epoxy, cold-cured, gloss, MPI #77.
2) Intermediate Coat: Epoxy, cold-cured, gloss, MPI #77.
3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.

5. CMU Substrates:
a. Water-Based, Light-Industrial Coating System (System below corresponds to MPI EXT 4.2C):
1) Prime Coat: Interior/exterior latex block filler, MPI #4.
2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.

b. Epoxy Coating System (System below corresponds to MPI EXT 4.2E):
1) Block Filler: Epoxy block filler, MPI #116.
2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.

c. Water-Based Epoxy Coating System (System below corresponds to MPI EXT 4.2F):
1) Block Filler: Epoxy block filler, MPI #116.
2) Intermediate Coat: Not required **OR** Water-based epoxy (interior and exterior), MPI #115, **as directed**.
3) Topcoat: Water-based epoxy (interior and exterior), MPI #115.

d. Polyurethane, Pigmented, Over High-Build Epoxy Coating System (System below corresponds to MPI EXT 4.2G):
   1) Block Filler: Epoxy block filler, MPI #116.
   2) Intermediate Coat: High-build epoxy marine coating, low gloss, MPI #108.
   3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.

6. Steel Substrates:
   a. Water-Based, Light-Industrial Coating System (System below corresponds to MPI EXT 5.1B, MPI EXT 5.1C, MPI EXT 5.1M and MPI EXT 5.1N, depending on primer selected):
      1) Prime Coat: Inorganic zinc primer, MPI #19 **OR** Alkyd anticorrosive metal primer, MPI #79 **OR** Rust-inhibitive primer, (water based), MPI #107 **OR** Cold-curing epoxy primer, MPI #101, **as directed**, primer.
      2) Intermediate Coat: Water-based, light-industrial coating, MPI #110, gloss matching topcoat (intermediate coat is required for coating systems except MPI Custom Grade system using inorganic zinc primer).
      3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.
   b. High-Build Epoxy Coating System (System below corresponds to MPI EXT 5.1F):
      1) Prime Coat: Cold-curing epoxy primer, MPI #101.
      2) Intermediate Coat: High-build epoxy marine coating, low gloss, MPI #108.
      3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.
   c. Water-Based Epoxy Coating System (System below corresponds to MPI EXT 5.1E):
      1) Prime Coat: Rust-inhibitive primer, (water based), MPI #107.
      2) Intermediate Coat: Water-based epoxy (interior and exterior), MPI #115.
      3) Topcoat: Water-based epoxy (interior and exterior), MPI #115.
   d. Polyurethane, Pigmented, Over Epoxy Coating System (System below corresponds to MPI EXT 5.1H):
      1) Prime Coat: Cold-curing epoxy primer, MPI #101.
      2) Intermediate Coat: Epoxy, cold-cured, gloss, MPI #77.
      3) First Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
      4) Second Topcoat (for Premium Grade system): Polyurethane, two-component, pigmented, gloss, MPI #72.
   e. Polyurethane, Pigmented, Over Epoxy Coating System (System below corresponds to MPI EXT 5.1P)
      1) Prime Coat: Epoxy zinc primer, MPI#20.
      2) Intermediate Coat: Epoxy, cold-cured, gloss, MPI #77.
      3) First Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
      4) Second Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
   f. Polyurethane, Pigmented, Over High-Build Epoxy Coating System (System below corresponds to MPI EXT 5.1G):
      1) Prime Coat: Epoxy zinc primer, MPI#20.
      2) Intermediate Coat: High-build epoxy marine coating, low gloss, MPI #108.
      3) First Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
      4) Second Topcoat (for Premium Grade system): Polyurethane, two-component, pigmented, gloss, MPI #72.
   g. Polyurethane, Pigmented, Over High-Build Epoxy Coating System (System below corresponds to MPI EXT 5.1J):
      1) Prime Coat: Cold-curing epoxy primer, MPI #101.
      2) Intermediate Coat: High-build epoxy marine coating, low gloss, MPI #108.
      3) First Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
      4) Second Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
   h. Polyurethane, Pigmented, Over High-Build Epoxy Coating System (System below corresponds to MPI EXT 5.1L):
      1) Prime Coat: Inorganic zinc primer, MPI #19.
      2) Intermediate Coat: High-build epoxy marine coating, low gloss, MPI #108.
      3) First Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.

4) Second Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.

7. Galvanized-Metal Substrates:
   a. Water-Based, Light-Industrial Coating System (System below corresponds to MPI EXT 5.3G and MPI EXT 5.3J, depending on primer selected):
      1) Prime Coat: Cementitious galvanized-metal primer, MPI #26 **OR** Waterborne galvanized-metal primer, MPI #134, **as directed**.
      2) Intermediate Coat (for Premium Grade system): Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
      3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.
   b. Epoxy Coating System (System below corresponds to MPI EXT 5.3C) (MPI recommends this system for high-contact and -traffic areas.):
      1) Prime Coat: Cold-curing epoxy primer, MPI #101.
      2) Intermediate Coat (for Premium Grade system): Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
      3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.
   c. Polyurethane, Pigmented Coating System (System below corresponds to MPI EXT 5.3D) (MPI recommends these systems for high-contact and -traffic areas.):
      1) Prime Coat: Vinyl wash primer, MPI #80.
      2) Intermediate Coat: Not required **OR** Cold-curing epoxy primer, MPI #101, **as directed**.
      3) First Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
      4) Second Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
   d. Polyurethane, Pigmented Coating System (System below corresponds to MPI EXT 5.3L):
      1) Prime Coat: Cold-curing epoxy primer, MPI #101.
      2) Intermediate Coat: Not required **OR** Polyurethane, two-component, pigmented, gloss, MPI #72, **as directed**.
      3) First Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
      4) Second Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.

8. Aluminum (Not Anodized or Otherwise Coated) Substrates:
   a. Water-Based, Light-Industrial Coating System (System below corresponds to MPI EXT 5.4G):
      1) Prime Coat: Quick-drying primer for aluminum, MPI #95.
      2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
      3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.
   b. Epoxy Coating System (System below corresponds to MPI EXT 5.4E):
      1) Prime Coat: Vinyl wash primer, MPI #80.
      2) Intermediate Coat (for Premium Grade system): Epoxy, cold-cured, gloss, MPI #77.
      3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.
   c. Polyurethane, Pigmented Coating System (System below corresponds to MPI EXT 5.4B) (MPI recommends these systems for high-contact and -traffic areas.):
      1) Prime Coat: Vinyl wash primer, MPI #80.
      2) Intermediate Coat: Cold-curing epoxy primer, MPI #101.
      3) First Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
      4) Second Topcoat (for Premium Grade system): Polyurethane, two-component, pigmented, gloss, MPI #72.

9. Wood Substrates:
   a. Pigmented Polyurethane Coating System (System below corresponds to MPI EXT 6.1J, MPI EXT 6.2J, and MPI EXT 6.3H):
      1) Prime Coat: Polyurethane, two-component, pigmented, gloss, MPI #72.
      2) Intermediate Coat: Polyurethane, two-component, pigmented, gloss, MPI #72.
      3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.

b. Polyurethane, Clear, Two-Component Coating System (System below corresponds to MPI EXT 6.1E for use on glue-laminated beams and columns):
1) Stain Coat: Exterior semitransparent stain (solvent based), MPI #13.
2) Intermediate Coat: Two-component, aliphatic polyurethane, clear, MPI #78.
3) First Topcoat: Two-component, aliphatic polyurethane, clear, MPI #78.
4) Second Topcoat (for Premium Grade systems): Two-component, aliphatic polyurethane, clear, MPI #78.

F. Interior High-Performance Coating Schedule
1. Coating systems in this Article are based on "MPI Architectural Painting Specification Manual." For renovation projects, consult "MPI Maintenance Repainting Manual" and revise coating systems accordingly.
2. Concrete Substrates, Vertical Surfaces (System below corresponds to MPI INT 3.1C):
a. High-Performance Architectural Latex Coating System:
1) Prime Coat: Interior latex primer/sealer, MPI #50.
2) Intermediate Coat: Not required **OR** High-performance architectural latex matching topcoat, **as directed**.
3) Topcoat: High-performance architectural latex, velvet finish, MPI #138, Gloss Level 2 **OR** eggshell finish, MPI #139, Gloss Level 3 **OR** satin finish, MPI #140, Gloss Level 4 **OR** semigloss finish, MPI #141, Gloss Level 5, **as directed**.
b. Water-Based, Light-Industrial Coating System (System below corresponds to MPI INT 3.1L):
1) Prime Coat: Water-based, light-industrial coating, MPI #110, gloss matching topcoat.
2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.
c. Epoxy Coating System (System below corresponds to MPI INT 3.1F.) (MPI recommends this system for smooth concrete.):
1) Prime Coat: Epoxy, cold-cured, gloss, MPI #77.
2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.
d. Water-Based Epoxy Coating System (System below corresponds to MPI INT 3.1G) (MPI recommends this system for smooth concrete.):
1) Prime Coat: Water-based epoxy (interior and exterior), MPI #115.
2) Intermediate Coat: Not required **OR** Water-based epoxy (interior and exterior), MPI #115, **as directed**.
3) Topcoat: Water-based epoxy (interior and exterior), MPI #115.
3. Concrete Substrates, Horizontal Surfaces.
a. Epoxy Coating System (System below corresponds to MPI INT 3.2C):
1) Prime Coat: Epoxy, cold-cured, gloss, MPI #77.
2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.
b. Water-Based Epoxy Floor Paint Coating System (System below corresponds to MPI INT 3.2L).
1) Prime Coat: Water-based epoxy floor paint, MPI #93.
2) Intermediate Coat: Not required **OR** Water-based epoxy floor paint, MPI #93, **as directed**.
3) Topcoat: Water-based epoxy floor paint, MPI #93.
c. Polyurethane, Pigmented Coating System (System below corresponds to MPI INT 3.2D):
1) Prime Coat: Epoxy, cold-cured, gloss, MPI #77.
2) Intermediate Coat: Not required **OR** Polyurethane, two-component, pigmented, gloss, MPI #72, **as directed**.

3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.

d. Polyurethane, Clear, Two-Component Coating System (System below corresponds to MPI INT 3.2K):
   1) Prime Coat: Two-component, aliphatic polyurethane, clear, MPI #78.
   2) Intermediate Coat: Not required **OR** Two-component, aliphatic polyurethane, clear, MPI #78, **as directed**.
   3) Topcoat: Two-component, aliphatic polyurethane, clear, MPI #78.

4. Clay-Masonry Substrates:
   a. High-Performance Architectural Latex Coating System (System below corresponds to MPI INT 4.1L):
      1) Prime Coat: High-performance architectural latex matching topcoat.
      2) Intermediate Coat: Not required **OR** High-performance architectural latex matching topcoat, **as directed**.
      3) Topcoat: High-performance architectural latex, velvet finish, MPI #138, Gloss Level 2 **OR** eggshell finish, MPI #139, Gloss Level 3 **OR** satin finish, MPI #140, Gloss Level 4 **OR** semigloss finish, MPI #141, Gloss Level 5, **as directed**.
   b. Water-Based, Light-Industrial Coating System (System below corresponds to MPI INT 4.1C):
      1) Prime Coat: Water-based, light-industrial coating, MPI #110, gloss matching topcoat.
      2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
      3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.
   c. Epoxy Coating System (System below corresponds to MPI INT 4.1F) (MPI recommends this system for smooth brick.):
      1) Prime Coat: Epoxy, cold-cured, gloss, MPI #77.
      2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
      3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.
   d. Water-Based Epoxy Coating System (System below corresponds to MPI INT 4.1G) (MPI recommends this system for smooth brick.):
      1) Prime Coat: Water-based epoxy (interior and exterior), MPI #115.
      2) Intermediate Coat: Not required **OR** Water-based epoxy (interior and exterior), MPI #115, **as directed**.
      3) Topcoat: Water-based epoxy (interior and exterior), MPI #115.
   e. Polyurethane, Clear, Two-Component Coating System (System below corresponds to MPI INT 4.1K):
      1) Prime Coat: Two-component, aliphatic polyurethane, clear, MPI #78.
      2) Intermediate Coat: Not required **OR** Two-component, aliphatic polyurethane, clear, MPI #78, **as directed**.
      3) Topcoat: Two-component, aliphatic polyurethane, clear, MPI #78.

5. CMU Substrates:
   a. High-Performance Architectural Latex Coating System (System below corresponds to MPI INT 4.2D):
      1) Prime Coat: Interior/exterior latex block filler, MPI #4.
      2) Intermediate Coat: Not required **OR** High-performance architectural latex matching topcoat, **as directed**.
      3) Topcoat: High-performance architectural latex, velvet finish, MPI #138, Gloss Level 2 **OR** eggshell finish, MPI #139, Gloss Level 3 **OR** satin finish, MPI #140, Gloss Level 4 **OR** semigloss finish, MPI #141, Gloss Level 5, **as directed**.
   b. Water-Based, Light-Industrial Coating System (System below corresponds to MPI INT 4.2K):
      1) Prime Coat: Interior/exterior latex block filler, MPI #4.

2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.

c. Epoxy Coating System (System below corresponds to MPI INT 4.2F and MPI INT 4.2G, depending on primer selected) (MPI recommends these systems for dry environments.):
1) Prime Coat: Interior/exterior latex block filler, MPI #4 **OR** Epoxy block filler, MPI #116, **as directed**.
2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.

d. Water-Based Epoxy Coating System (System below corresponds to MPI INT 4.2J) (MPI recommends this system for wet environments.):
1) Prime Coat: Interior/exterior latex block filler, MPI #4.
2) Intermediate Coat: Not required **OR** Water-based epoxy (interior and exterior), MPI #115, **as directed**.
3) Topcoat: Water-based epoxy (interior and exterior), MPI #115.

6. Steel Substrates:

a. High-Performance Architectural Latex Coating System (System below corresponds to MPI INT 5.1R):
1) Prime Coat: Alkyd anticorrosive metal primer, MPI #79 **OR** Quick-dry alkyd metal primer, MPI #76, **as directed**.
2) Intermediate Coat: Not required **OR** High-performance architectural latex matching topcoat, **as directed**.
3) Topcoat: High-performance architectural latex, velvet finish, MPI #138, Gloss Level 2 **OR** eggshell finish, MPI #139, Gloss Level 3 **OR** satin finish, MPI #140, Gloss Level 4 **OR** semigloss finish, MPI #141, Gloss Level 5, **as directed**.

b. Water-Based, Light-Industrial Coating System (System below corresponds to MPI INT 5.1B and MPI INT 5.1N, depending on primer selected.):
1) Prime Coat: Rust-inhibitive primer (water based), MPI #107 **OR** Cold-curing epoxy primer, MPI #101, **as directed**.
2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.

c. High-Build Epoxy Coating System - Premium Grade (System below corresponds to MPI INT 5.1P):
1) Prime Coat: Epoxy zinc primer, MPI#20.
2) Intermediate Coat: High-build epoxy marine coating, low gloss, MPI #108.
3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.

d. High-Build Epoxy Coating System – Custom Grade (System below corresponds to MPI INT 5.1P):
1) Prime Coat: Epoxy zinc primer, MPI#20.
2) Topcoat: High-build epoxy marine coating, low gloss, MPI #108.

e. Epoxy Coating System (System below corresponds to MPI INT 5.1L):
1) Prime Coat: Cold-curing epoxy primer, MPI #101.
2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.

f. Water-Based Epoxy Coating System (System below corresponds to MPI INT 5.1K):
1) Prime Coat: Rust-inhibitive primer (water based), MPI #107.
2) Intermediate Coat: Water-based epoxy (interior and exterior), MPI #115.
3) Topcoat: Water-based epoxy (interior and exterior), MPI #115.

g. Polyurethane, Pigmented Coating System (System below corresponds to MPI INT 5.1F):
1) Prime Coat: Cold-curing epoxy primer, MPI #101.

2) Intermediate Coat: Not required **OR** Polyurethane, two-component, pigmented, gloss, MPI #72, **as directed**.
3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.

h. Polyurethane, Pigmented Coating System (System below corresponds to MPI INT 5.1H):
1) Prime Coat: Inorganic zinc primer, MPI #19.
2) Intermediate Coat: Epoxy, cold-cured, gloss, MPI #77.
3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.

i. Polyurethane, Pigmented Coating System (System below corresponds to MPI INT 5.1J):
1) Prime Coat: Epoxy zinc primer, MPI#20.
2) Intermediate Coat: Epoxy, cold-cured, gloss, MPI #77.
3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.

j. Polyurethane, Pigmented, Over High-Build Epoxy Coating System (System below corresponds to MPI INT 5.1G):
1) Prime Coat: Cold-curing epoxy primer, MPI #101.
2) Intermediate Coat: High-build epoxy marine coating, low gloss, MPI #108.
3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.

7. Galvanized-Metal Substrates:

a. High-Performance Architectural Latex Coating System (System below corresponds to MPI INT 5.3M):
1) Prime Coat: Waterborne galvanized-metal primer, MPI #134.
2) Intermediate Coat: Not required **OR** High-performance architectural latex matching topcoat, **as directed**.
3) Topcoat: High-performance architectural latex, velvet finish, MPI #138, Gloss Level 2 **OR** eggshell finish, MPI #139, Gloss Level 3 **OR** satin finish, MPI #140, Gloss Level 4 **OR** semigloss finish, MPI #141, Gloss Level 5, **as directed**.

b. Water-Based, Light-Industrial Coating System (System below corresponds to MPI INT 5.3B and MPI INT 5.3K, depending on primer selected.):
1) Prime Coat: Cementitious galvanized-metal primer, MPI #26 **OR** Waterborne galvanized-metal primer, MPI #134, **as directed**.
2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.

c. Epoxy Coating System (System below corresponds to MPI INT 5.3D):
1) Prime Coat: Cold-curing epoxy primer, MPI #101.
2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.

8. Aluminum (Not Anodized or Otherwise Coated) Substrates (System below corresponds to MPI INT 5.4F):

a. High-Performance Architectural Latex Coating System:
1) Prime Coat: Quick-drying primer for aluminum, MPI #95.
2) Intermediate Coat: Not required **OR** High-performance architectural latex, matching topcoat, **as directed**.
3) Topcoat: High-performance architectural latex, velvet finish, MPI #138, Gloss Level 2 **OR** eggshell finish, MPI #139, Gloss Level 3 **OR** satin finish, MPI #140, Gloss Level 4 **OR** semigloss finish, MPI #141, Gloss Level 5, **as directed**.

b. Water-Based, Light-Industrial Coating System (System below corresponds to MPI INT 5.4E):
1) Prime Coat: Quick-drying primer for aluminum, MPI #95.
2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.

c. Epoxy Coating System (System below corresponds to MPI INT 5.4B):

1) Prime Coat: Vinyl wash primer, MPI #80.
2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.

d. Polyurethane, Pigmented Coating System (System below corresponds to MPI INT 5.4C):
1) Prime Coat: Vinyl wash primer, MPI #80.
2) Intermediate Coat: Epoxy, cold-cured, gloss, MPI #77.
3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.

9. Wood Substrates:

a. High-Performance Architectural Latex Coating System (System below corresponds to MPI INT 6.1N, MPI INT 6.3A, and MPI INT 6.4S):
1) Prime Coat: Interior latex-based wood primer, MPI #39.
2) Intermediate Coat: High-performance architectural latex matching topcoat.
3) Topcoat: High-performance architectural latex, velvet finish, MPI #138, Gloss Level 2 **OR** eggshell finish, MPI #139, Gloss Level 3 **OR** satin finish, MPI #140, Gloss Level 4 **OR** semigloss finish, MPI #141, Gloss Level 5, **as directed**.

b. Water-Based, Light-Industrial Coating System (System below corresponds to MPI INT 6.3P and MPI INT 6.4N):
1) Prime Coat: Interior alkyd primer/sealer, MPI #45.
2) Intermediate Coat: Water-based, light-industrial coating, MPI #110, gloss matching topcoat.
3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.

c. Epoxy Coating System (System below corresponds to MPI INT 6.1L and MPI INT 6.3L):
1) Prime Coat: Epoxy, cold-cured, gloss, MPI #77.
2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.

d. Pigmented Polyurethane Coating System (System below corresponds to MPI INT 6.1E):
1) Prime Coat: Polyurethane, two-component, pigmented, gloss, MPI #72.
2) Intermediate Coat: Polyurethane, two-component, pigmented, gloss, MPI #72.
3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.

e. Polyurethane, Clear, Moisture-Cured Coating System (System below corresponds to MPI INT 6.1S, MPI INT 6.2N, MPI INT 6.3Y, and MPI INT 6.4V):
1) Stain Coat: Interior wood stain, semitransparent (solvent based), MPI #90.
2) Intermediate Coat: Polyurethane, moisture cured, clear, flat, MPI #71 **OR** Polyurethane, moisture cured, clear, gloss, MPI #31, **as directed**.
3) First Topcoat: Polyurethane, moisture cured, clear, flat, MPI #71 **OR** Polyurethane, moisture cured, clear, gloss, MPI #31, **as directed.**
4) Second Topcoat: Not required **OR** Polyurethane, moisture cured, clear, flat, MPI #71 **OR** Polyurethane, moisture cured, clear, gloss, MPI #31, **as directed**.

f. Polyurethane, Clear, Moisture-Cured Coating System (System below corresponds to MPI INT 6.3X):
1) Intermediate Coat: Polyurethane, moisture cured, clear, flat, MPI #71 **OR** Polyurethane, moisture cured, clear, gloss, MPI #31, **as directed**.
2) First Topcoat: Polyurethane, moisture cured, clear, flat, MPI #71 **OR** Polyurethane, moisture cured, clear, gloss, MPI #31, **as directed.**
3) Second Topcoat: Not required **OR** Polyurethane, moisture cured, clear, flat, MPI #71 **OR** Polyurethane, moisture cured, clear, gloss, MPI #31, **as directed**.

g. Polyurethane, Clear, Two-Component Coating System (System below corresponds to MPI INT 6.3Z):
1) Stain Coat: Exterior semitransparent stain (solvent based), MPI #13.
2) Intermediate Coat: Not required **OR** Two-component, aliphatic polyurethane, clear, MPI #78, **as directed**.
3) Topcoat: Two-component, aliphatic polyurethane, clear, MPI #78.

10. Gypsum Board Substrates:

a. High-Performance Architectural Latex Coating System (System below corresponds to MPI INT 9.2B):
   1) Prime Coat: Interior latex primer/sealer, MPI #50.
   2) Intermediate Coat: High-performance architectural latex matching topcoat.
   3) Topcoat: High-performance architectural latex, velvet finish, MPI #138, Gloss Level 2 **OR** eggshell finish, MPI #139, Gloss Level 3 **OR** satin finish, MPI #140, Gloss Level 4 **OR** semigloss finish, MPI #141, Gloss Level 5, **as directed**.

b. Water-Based, Light-Industrial Coating System (System below corresponds to MPI INT 9.2L):
   1) Prime Coat: Interior latex primer/sealer, MPI #50.
   2) Intermediate Coat: Water-based, light-industrial coating, MPI #110, gloss matching topcoat.
   3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.

c. Epoxy Coating System (System below corresponds to MPI INT 9.2E):
   1) Prime Coat: Interior latex primer/sealer, MPI #50.
   2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
   3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.

d. Water-Based Epoxy Coating System (System below corresponds to MPI INT 9.2F):
   1) Prime Coat: Interior latex primer/sealer, MPI #50.
   2) Intermediate Coat: Not required **OR** Water-based epoxy (interior and exterior), MPI #115, **as directed**.
   3) Topcoat: Water-based epoxy (interior and exterior), MPI #115.

END OF SECTION 09 96 00 00

Task	Specification	Specification Description
09 96 53 00	09 91 13 00	Exterior Painting

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SECTION 09 96 56 00 - FIBERGLASS REINFORCED EPOXY COATING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for fiberglass reinforced epoxy coating. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each coating system specified.

C. Material Storage
1. Store materials in a temperature controlled environment (50ºF - 90ºF) and out of direct sunlight.
2. Keep resins, hardeners, and solvents separated from each other and away from sources of ignition. One year shelf life is expected for products stored between 50ºF - 90ºF.

1.2 PRODUCTS

A. Materials
1. Multi-Layer, High Build Wall and Ceiling Surfacing System
   a. Primer
      1) Water-based epoxy base coating.
   b. Base Coat
      1) High performance epoxy coating.
   c. Fiberglass Mesh Reinforcement
      1) Bound fiberglass cloth, 5.6 oz.
   d. Saturant
      1) High performance epoxy coating.
   e. Level Coat
      1) High performance epoxy coating.
   f. Chemical Resistant Finish Coat
      1) 100% solids polyurethane.

1.3 EXECUTION

A. Primer
1. Mixing and Application: Water Based Epoxy Wall Coating should only be used on unpainted, porous surfaces. If the surface is painted with latex or an epoxy coating, clean and abrade the surface then apply the primer.
2. Premix resin and hardener separately, using a low speed drill and Jiffy mixer. Mix for three minutes and until uniform, exercising caution not to whip air into the materials.
3. Add 2 parts resin to 1 part hardener, mix with low speed drill and Jiffy mixer for three minutes and until uniform. Apply material using a 1/4" short nap roller at a spread rate of 300-350 sq. ft. per gallon to yield 5 mils WFT.
4. Allow to cure for a minimum of 3 hours depending upon air movement. Lightly "pole sand" smooth rough edges of the flake before applying base coat.

B. Base Coat
1. Mixing and Application

a. Premix resin and hardener separately, using a low speed drill and Jiffy mixer. Mix for three minutes and until uniform, exercising caution not to introduce air into the material.
b. Add 3 parts resin to 1 part hardener by volume. Mix with low speed drill and Jiffy mixer for three minutes and until uniform. To insure proper system cure and performance, strictly follow mix ratio recommendations.
c. Base coat may be applied via spray, roller or brush. Apply using a 1/4" nap roller at a spread rate of 200-250 sq. ft. per gallon to yield 6-8 mils WFT evenly with no runs. Coverage will vary depending upon porosity of the substrate and surface texture.

C. Fiberglass Reinforcement
1. Apply 5.6 oz. bound fiberglass cloth for walls and 4 oz. for ceilings directly into wet resin. Do not allow material to cure or recoating will be necessary.
2. Hang fiberglass cloth directly to the wall similar to hanging wallpaper so seams are uniform and even. Overlap each strip using a double cut method. Remove the trimmed material behind the front strip.
3. After hand affixing to wall, use a broad knife to remove air pockets, wrinkles or any irregularities.

D. Saturant Coat
1. Mixing and Application
a. Premix resin and hardener separately, using a low speed drill and Jiffy mixer. Mix for three minutes and until uniform, exercising caution not to introduce air into the material.
b. Add 3 parts 3548PA (resin) to 1 part 3548B (hardener) by volume. Mix with low speed drill and Jiffy mixer for three minutes and until uniform. To insure proper system cure and performance, strictly follow mix ratio recommendations.
c. Saturant coat may be applied via spray, roller or brush. Apply at a spread rate of 250-400 sq. ft. per gallon to yield 4-6 mils WFT evenly with no runs. Allow to cure overnight (minimum 10 hours) before lightly sanding seams, bumps and other imperfections with 60-80 grit sandpaper caused by the saturant coat.

E. Level Coat
1. Mixing and Application
a. Apply leveling coat as described in previous step.
b. Allow to cure overnight.
c. An additional level coat may be applied.
d. Sand any imperfections prior to applying finish coat.

F. Finish Coat
1. Mixing and Application
a. Premix resin using a low speed drill and Jiffy mixer. Mix for three minutes and until uniform, exercising caution not to introduce air into the material.
b. Add 1 part resin to 1 part hardener by volume. Mix with low speed drill and Jiffy mixer for three minutes and until uniform. To insure proper system cure and performance, strictly follow mix ratio recommendations.
c. Finish coat may be applied via spray, roller or brush. Apply using a 1/4" nap non-shedding, urethane enamel roller at a spread rate of 250-400 sq. ft. per gallon to yield 4-6 WFT mils evenly with no runs. If second coat is required, the surface must be abraded with 80-120 grit paper or screen and tack wiped prior to second application.
d. Allow to cure 48 hours for water exposure and 7 days for chemical exposure. In cool and/or high humidity conditions, a surface film may form which can be washed with soap and water.

END OF SECTION 09 96 56 00

Task	Specification	Specification Description
09 96 56 00	09 96 00 00	High-Performance Coatings

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SECTION 09 96 66 00 - CEMENTITIOUS COATINGS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for cementitious coatings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section includes surface preparation and application of cementitious coating systems on the following substrates:
      a. Exterior and Interior concrete.
      b. Exterior and Interior concrete masonry units.
      c. Exterior and Interior brick.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittal:
      a. Product Data for Credit EQ 4.2: For paints and coatings, including printed statement of VOC content and chemical components.
   3. Samples: In each color and gloss of finish coat indicated.
      a. Submit Samples on rigid backing **OR** actual substrate, **as directed**, not less than 4 by 8 inches (100 by 200 mm), with mortar joint in center, **as directed**.
      b. Step coats on Samples to show each coat required for system.
      c. Label each coat of each Sample.
   4. Material Certificates: For each cementitious coating, from manufacturer.
   5. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency or by a qualified testing agency, for each product formulation.

D. Quality Assurance
   1. Source Limitations: Obtain cementitious coating materials from single source from single manufacturer.
   2. Mockups: Apply benchmark samples of coating system indicated and each color and finish selected to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
      a. Architect will select one actual substrate of each type to represent surfaces and conditions for application of coating.
         1) Wall Surfaces: Prepare samples of at least 100 sq. ft. (9.3 sq. m).
      b. Apply benchmark samples after permanent lighting and other environmental services have been activated.
      c. Final approval of color selections will be based on benchmark samples.
         1) If preliminary color selections are not approved, apply additional benchmark samples of additional colors selected by Architect at no added cost to Owner.

E. Delivery, Storage, And Handling
   1. Deliver materials to Project site in manufacturer's original, new, unopened packages and containers bearing manufacturer's name and label, and the following information:
      a. Product name or title of material.
      b. Manufacturer's stock number and date of manufacture.
      c. Contents by volume, for pigment and vehicle constituents.
      d. Application instructions.

e. Color name and number.
f. Handling instructions and precautions.

2. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F (7 deg C). Maintain containers used in storage of coatings in a clean condition, free of foreign materials and residue.
   a. Protect cementitious coating materials from freezing. Keep materials dry and storage area neat and orderly. Remove waste daily. Take necessary measures to ensure that workers and work areas are protected from health hazards resulting from handling, mixing, and applying the coating.

F. Project Conditions
1. Apply coatings only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
2. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

1.2 PRODUCTS

A. Cementitious Coatings
1. Polymer-Modified Cementitious Coating: Containing portland cement, polymer, and hydrated lime or aggregates.
2. Performance Requirements: Comply with the following:
   a. Compressive Strength: Not less than 3500 psi (24.1 MPa) at 28 days according to ASTM C 109/C 109M.
   b. Tensile Strength: Not less than 350 psi (2.41 MPa) at 28 days according to ASTM C 109/C 109M.
   c. Flexural Strength: as directed by the Owner.
   d. Adhesion: as directed by the Owner.
   e. Permeance: as directed by the Owner.
   f. Accelerated Weathering: as directed by the Owner.
   g. UV Resistance: as directed by the Owner.
   h. Salt-Spray Resistance: as directed by the Owner.
3. Other Materials: Provide crack fillers, block fillers, and related materials that are compatible with cementitious finish-coat materials and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
4. Chemical Components of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and the following chemical restrictions:
   a. Flat Paints and Coatings: VOC content of not more than 50 g/L.
   b. Nonflat Paints and Coatings: VOC content of not more than 150 g/L.
5. Chemical Components of Interior Paints and Coatings: Provide topcoat paints that comply with the following chemical restrictions:
   a. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
   b. Restricted Components: Paints and coatings shall not contain any of the following:
      1) Acrolein.
      2) Acrylonitrile.
      3) Antimony.
      4) Benzene.
      5) Butyl benzyl phthalate.
      6) Cadmium.
      7) Di (2-ethylhexyl) phthalate.

8) Di-n-butyl phthalate.
9) Di-n-octyl phthalate.
10) 1,2-dichlorobenzene.
11) Diethyl phthalate.
12) Dimethyl phthalate.
13) Ethylbenzene.
14) Formaldehyde.
15) Hexavalent chromium.
16) Isophorone.
17) Lead.
18) Mercury.
19) Methyl ethyl ketone.
20) Methyl isobutyl ketone.
21) Methylene chloride.
22) Naphthalene.
23) Toluene (methylbenzene).
24) 1,1,1-trichloroethane.
25) Vinyl chloride.

6. Colors: As selected from manufacturer's full range **OR** As indicated in a color schedule, **as directed**.

1.3 EXECUTION

A. Examination
1. Examine substrates and conditions, with Applicator present, for compliance with requirements and other conditions affecting performance of the Work.
2. Verify suitability of substrates, including surface conditions and compatibility.
3. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
    a. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

B. Preparation
1. Comply with manufacturer's written instructions for mixing and preparing materials and as applicable to substrates indicated.
2. Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
    a. After completing coating operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
3. Clean substrates of substances that could impair bond of coatings, including dirt, oil, grease, incompatible coatings, and loose substrate materials.
4. Cementitious and Masonry Surfaces: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
5. Crack Repair: Fill cracks according to manufacturer's written instructions before coating surfaces.
    a. Cracks Larger Than 1/32 Inch (0.8 mm): Cut out static cracks, voids, or honeycombing larger than 1/32 inch (0.8 mm) and patch with materials recommended in writing by coating manufacturer. Identify dynamic cracks and treat according to manufacturer's written instructions before beginning application.

C. Application
1. Apply coatings according to manufacturer's written instructions. Use applicators and techniques suited for coating and substrate indicated.

a. Dampen substrate of surfaces to receive cementitious coatings one hour before beginning application to prevent surface drag. Immediately before applying coatings, redampen substrate. Substrates shall be saturated surface dry at time of application.
b. Brushes: Use tampico or masonry brushes best suited for material being applied.
c. Spray Equipment: Use spray equipment recommended in writing by manufacturer for material and texture required.

2. Apply each material at not less than manufacturer's recommended spreading rate. Provide total cured material thickness indicated or as recommended in writing by manufacturer.
3. Brush Application: Brush-out and work brush coats into surfaces in an even film, filling all pores and voids at rate recommended in writing by manufacturer to achieve cured material thickness indicated. Finish coat with smooth, horizontal strokes.
4. Spray Application: Apply each coat according to manufacturer's written instructions to provide the equivalent hiding of brush-applied coats. Follow spray application with a general light brooming of coated surface to impart a slight texture.

D. Field Quality Control

1. Testing of Coating Materials: Contractor shall invoke the following procedure at any time and as often as necessary during the period when coating operations are being conducted:
   a. Engage the services of a qualified testing agency to sample coating materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
   b. Testing agency will perform tests for compliance with the following product requirements.
      1) Quantitative material analysis.
      2) Compressive strength.
      3) Tensile strength.
      4) Flexural strength.
      5) Permeance.
      6) Accelerated weathering.
   c. the Owner may direct Contractor to stop coating application if test results show materials being used do not comply with requirements. Contractor shall remove noncomplying materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

E. Cleaning And Protection

1. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
2. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
3. Protect work of other trades against damage from coating application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by the Owner, and leave in an undamaged condition.
4. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

F. Coating Schedule

1. General: Apply additional coats when undercoats or other conditions show through final coat until cured film is of uniform coating finish, color, and appearance.
2. Above-Grade Concrete and Masonry: Two finish coats with total cured thickness not less than 40 mils (1.0 mm).
   a. First Coat: Apply polymer-modified cementitious coating material at the rate of 2 lb/sq. yd. (1 kg/sq. m) to achieve a total cured thickness of 25 mils (0.6 mm).
   b. Second Coat: Apply polymer-modified cementitious coating material at the rate of 1 lb/sq. yd. (0.5 kg/sq. m) to achieve a total cured thickness of 15 mils (0.4 mm).

3. Surfaces Previously Coated with Polymer-Modified Cementitious Coating: One finish coat with a total cured thickness of not less than 15 mils (0.4 mm).
   a. Apply polymer-modified cementitious coating material at the rate of 1 lb/sq. yd. (0.5 kg/sq. m) to achieve a total cured thickness of 15 mils (0.4 mm).

END OF SECTION 09 96 66 00

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Task	Specification	Specification Description
09 97 13 23	09 96 00 00	High-Performance Coatings
09 97 13 24	09 96 00 00	High-Performance Coatings
09 97 26 13	09 96 00 00	High-Performance Coatings
09 97 35 00	09 91 23 00	Interior Painting
09 97 63 00	09 96 00 00	High-Performance Coatings

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SECTION 10 01 50 11 - METAL LOCKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Knocked-down corridor lockers.
2. Welded corridor lockers.
3. Knocked-down athletic lockers.
4. Welded athletic lockers.
5. Knocked-down, open-front athletic lockers.
6. Welded, open-front athletic lockers.
7. Locks.
8. Locker benches.

B. Related Requirements:

1. Section 105113.13 "Coin-Operated Metal Lockers" for coin-operated lockers used in public facilities for temporary storage of personal belongings.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**>.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal locker[**and bench**].

B. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for recycled content.>
2. <Double click to insert sustainable design text for EPDs and HPDs.>
3. <Double click to insert sustainable design text for composite wood.>

C. Shop Drawings: For metal lockers.

1. Include plans, elevations, sections, and attachment details.
2. Show locker trim and accessories.
3. Include locker identification system and numbering sequence.

D. Samples: For each color specified, in manufacturer's standard size.

E. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available.

F. Samples for Verification: For the following products, in manufacturer's standard size:

1. Lockers and equipment.
2. Locker benches.

G. Product Schedule: For lockers.[**Use same designations indicated on Drawings.**]

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. The following metal locker hardware items equal to [**10**] <**Insert number**> percent of amount installed for each type and finish installed, but no fewer than [**five**] <**Insert number**> units:

a. Locks.
b. Blank identification plates.
c. Hooks.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver metal lockers until spaces to receive them are clean, dry, and ready for their installation.

B. Deliver [**master and control keys**] [**combination control charts**] to Owner by registered mail or overnight package service[**.**][**, addressed as follows:**]

1. <**Insert name and address of Owner's representative**>.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of recessed openings by field measurements before fabrication.

1.9 COORDINATION

A. Coordinate sizes and locations of [**concrete**] [**concrete masonry**] [**wood**] bases for metal lockers.

B. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that metal lockers can be supported and installed as indicated.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of metal lockers that fail in materials or workmanship, excluding finish, within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures.
b. Faulty operation of latches and other door hardware.

2. Damage from deliberate destruction and vandalism is excluded.
3. Warranty Period for Knocked-Down Metal Lockers: [**Two**] <**Insert number**> years from date of Substantial Completion.
4. Warranty Period for Welded Metal Lockers: [**Lifetime**] [**10 years**] <**Insert years**> from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain metal lockers[**, locker benches,**] and accessories from single source from single locker manufacturer.

1. Obtain locks from single lock manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: For lockers[**and locker benches**] indicated to be accessible, comply with applicable provisions in [**the USDOJ's "2010 ADA Standards for Accessible Design"**] [**the ABA standards of the Federal agency having jurisdiction**] [**and**] [**ICC A117.1**] <**Insert requirement**>.

2.3 KNOCKED-DOWN CORRIDOR LOCKERS <**Insert designation**>

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Doors: One piece; fabricated from [**0.060-inch (1.52-mm)**] [**0.075-inch (1.90-mm)**] nominal-thickness steel sheet; formed into channel shape with double bend at vertical edges and with right-angle single bend at horizontal edges.

1. Doors less than 12 inches (305 mm) wide may be fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.
2. Doors for box lockers less than 15 inches (381 mm) wide may be fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.
3. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than 15 inches (381 mm) wide; welded to inner face of doors.

4. Stiffeners: Manufacturer's standard full-height stiffener fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet; welded to inner face of doors.
5. Sound-Dampening Panels: Manufacturer's standard, designed to stiffen doors and reduce sound levels when doors are closed, of die-formed metal with full perimeter flange and sound-dampening material; welded to inner face of doors.
6. Door Style: [**Unperforated panel.**] [**Vented panel as follows:**]

   a. Louvered Vents: No fewer than [**six louver openings at top and bottom for single-tier**] [**three louver openings at top and bottom for double-tier**] [**two louver openings at top and bottom, or three louver openings at top or bottom, for triple-tier**] <**Insert configuration**> lockers.
   b. Security Vents: Manufacturer's standard, stamped horizontal or vertical.
   c. Perforated Vents: [**Manufacturer's standard shape and configuration**] <**Insert shape and configuration**>.
   d. Concealed Vents: Slotted perforations in top and bottom horizontal door return flanges.

C. Body: Assembled by riveting or bolting body components together. Fabricate from unperforated steel sheet with thicknesses as follows:

1. Tops, Bottoms, and Intermediate Dividers: 0.024-inch (0.61-mm) nominal thickness, with single bend at sides.
2. Backs and Sides: 0.024-inch (0.61-mm) nominal thickness, with full-height, double-flanged connections.
3. Shelves: 0.024-inch (0.61-mm) nominal thickness, with double bend at front and single bend at sides and back.

D. Frames: Channel formed; fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral, full-height door strikes on vertical main frames.

1. Cross Frames between Tiers: Channel formed and fabricated from same material as main frames; welded to vertical main frames.
2. Frame Vents: Fabricate face frames with vents.

E. Hinges: Welded to door and attached to door frame with no fewer than two factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees[**; self-closing**].

1. Knuckle Hinges: Steel, full loop, five or seven knuckles, tight pin; minimum 2 inches (51 mm) high. Provide no fewer than three hinges for each door more than 42 inches (1067 mm) high.
2. Continuous Hinges: Manufacturer's standard, steel, full height.
3. Hinges: Manufacturer's standard, steel, continuous or knuckle type.

F. Projecting Door Handle and Latch: Finger-lift latch control designed for use with either built-in combination locks or padlocks; positive automatic latching, chromium plated; pry and vandal resistant.

1. Latch Hooks: Equip doors 48 inches (1219 mm) and higher with three latch hooks and doors less than 48 inches (1219 mm) high with two latch hooks; fabricated from 0.105-inch (2.66-mm) nominal-thickness steel sheet; welded or riveted to full-height door strikes; with resilient silencer on each latch hook.
2. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact, and incorporating a prelocking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.

G. Recessed Door Handle and Latch: Stainless steel cup with integral door pull, recessed so locking device does not protrude beyond door face; pry and vandal resistant.

1. Multipoint Latching: Finger-lift latch control designed for use with built-in combination locks, built-in key locks, or padlocks; positive automatic latching and prelocking.

    a. Latch Hooks: Equip doors 48 inches (1219 mm) and higher with three latch hooks and doors less than 48 inches (1219 mm) high with two latch hooks; fabricated from 0.105-inch (2.66-mm) nominal-thickness steel sheet; welded or riveted to full-height door strikes; with resilient silencer on each latch hook.
    b. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact, and incorporating a prelocking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.

2. Single-Point Latching: Nonmoving latch hook [**designed to engage bolt of built-in combination or cylinder lock**] [**with steel padlock loop that projects through recessed cup and is finished to match metal locker body**].

    a. Latch Hook: Equip each door with one latch hook, fabricated from 0.105-inch (2.66-mm) nominal-thickness steel sheet; welded midway up full-height door strike; with resilient silencer.

H. Door Handle and Latch for [**Box**] [**16-Person**] Lockers: Stainless steel strike plate with integral pull; with steel padlock loop that projects through metal locker door.

I. Locks: [**Combination padlocks**] [**Built-in combination locks**] [**Cylinder locks**] [**Built-in, card-operated locks**] [**Digital keypad locks**] [**Built-in, coin-operated locks**].

J. Identification Plates: Manufacturer's standard, etched, embossed, or stamped [**aluminum**] [**plastic**] plates, with numbers and letters at least 3/8 inch (9 mm) high.

K. Hooks: Manufacturer's standard ball-pointed hooks, aluminum or steel; zinc plated.

L. Coat Rods: [**1-inch- (25-mm-) diameter steel tube or rod, chrome finished**] [**1-inch- (25-mm-) diameter steel tube or rod, nickel plated**] [**3/4-inch- (19-mm-) diameter steel tube or rod, chrome finished**] [**3/4-inch- (19-mm-) diameter steel tube or rod, nickel plated**] [**Manufacturer's standard**].

M. Legs: [**6 inches (152 mm)**] <**Insert dimension**> high; formed by extending vertical frame members, or fabricated from 0.075-inch (1.90-mm) nominal-thickness steel sheet; welded to bottom of locker.

1. Closed Front and End Bases: Fabricated from 0.036-inch (0.91-mm) nominal-thickness steel sheet.

N. Continuous Zee Base: Fabricated from [**0.060-inch (1.52-mm)**] [**0.075-inch (1.90-mm)**] [**manufacturer's standard thickness, but not less than 0.060-inch (1.52-mm)**] nominal-thickness steel sheet.

1. Height: [**4 inches (102 mm)**] <**Insert dimension**>.

O. Continuous Sloping Tops: Fabricated from [**0.036-inch (0.91-mm)**] [**0.048-inch (1.21-mm)**] [**manufacturer's standard thickness, but not less than 0.036-inch (0.91-mm)**] nominal-thickness steel sheet.

1. Closures: [**Vertical**] [**Hipped**]-end type.
2. Sloping-top corner fillers, mitered.

P. Individual Sloping Tops: Fabricated from 0.024-inch (0.61-mm) nominal-thickness steel sheet.

Q. Recess Trim: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.

R. Filler Panels: Fabricated from [**0.036-inch (0.91-mm)**] [**0.048-inch (1.21-mm)**] [**manufacturer's standard thickness, but not less than 0.036-inch (0.91-mm)**] nominal-thickness steel sheet.

S. Boxed End Panels: Fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet.

T. Finished End Panels: Fabricated from 0.024-inch (0.61-mm) nominal-thickness steel sheet to cover unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.

U. Center Dividers: Fabricated from 0.024-inch (0.61-mm) nominal-thickness steel sheet.

V. Materials:

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
2. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with A60 (ZF180) zinc-iron, alloy (galvannealed) coating designation.
3. <Double click to insert sustainable design text for recycled content.>

W. Finish: Baked enamel or powder coat.

1. Color: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] [**Two colors, with door one color and frame and body another color; as selected by Architect from manufacturer's full range**] <**Insert color**>.

2.4 WELDED CORRIDOR LOCKERS <**Insert designation**>

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Doors: One piece; fabricated from 0.075-inch (1.90-mm) nominal-thickness steel sheet; formed into channel shape with double bend at vertical edges and with right-angle single bend at horizontal edges.

1. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than 15 inches (381 mm) wide; welded to inner face of doors.
2. Door Style: [**Unperforated panel.**] [**Vented panel as follows:**]

a. Louvered Vents: No fewer than [**six louver openings at top and bottom for single-tier**] [**three louver openings at top and bottom for double-tier**] [**two louver openings at top and bottom, or three louver openings at top or bottom, for triple-tier**] <**Insert configuration**> lockers.
b. Security Vents: Manufacturer's standard, stamped horizontal or vertical.
c. Perforated Vents: [**Manufacturer's standard shape and configuration**] <**Insert shape and configuration**>.

C. Body: Assembled by welding body components together. Fabricate from unperforated steel sheet with thicknesses as follows:

1. Tops, Bottoms, and Sides: 0.060-inch (1.52-mm) nominal thickness.

2. Backs: 0.048-inch (1.21-mm) nominal thickness.
3. Shelves: 0.060-inch (1.52-mm) nominal thickness, with double bend at front and single bend at sides and back.

D. Frames: Channel formed; fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral, full-height door strikes on vertical main frames.

1. Cross Frames between Tiers: Channel formed and fabricated from same material as main frames; welded to vertical main frames.

E. Hinges: Welded to door and attached to door frame with no fewer than two factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees[**; self-closing**].

1. Knuckle Hinges: Steel, full loop, five or seven knuckles, tight pin; minimum 2 inches (51 mm) high. Provide no fewer than three hinges for each door more than 42 inches (1067 mm) high.
2. Continuous Hinges: Manufacturer's standard, steel, full height.
3. Hinges: Manufacturer's standard, steel, continuous or knuckle type.

F. Projecting Door Handle and Latch: Finger-lift latch control designed for use with either built-in combination locks or padlocks; positive automatic latching, chromium plated; pry and vandal resistant.

1. Latch Hooks: Equip doors 48 inches (1219 mm) and higher with three latch hooks and doors less than 48 inches (1219 mm) high with two latch hooks; fabricated from 0.105-inch (2.66-mm) nominal-thickness steel sheet; welded or riveted to full-height door strikes; with resilient silencer on each latch hook.
2. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact, and incorporating a prelocking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.

G. Recessed Door Handle and Latch: Stainless steel cup with integral door pull, recessed so locking device does not protrude beyond door face; pry and vandal resistant.

1. Multipoint Latching: Finger-lift latch control designed for use with built-in combination locks or padlocks; positive automatic latching and prelocking.

a. Latch Hooks: Equip doors 48 inches (1219 mm) and higher with three latch hooks and doors less than 48 inches (1219 mm) high with two latch hooks; fabricated from 0.120-inch (3.04-mm) nominal-thickness steel sheet; welded to full-height door strikes; with resilient silencer on each latch hook.
b. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact, and incorporating a prelocking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.

2. Single-Point Latching: Nonmoving latch hook [**designed to engage bolt of built-in combination or cylinder lock**] [**with steel padlock loop that projects through recessed cup and is finished to match metal locker body**].

a. Latch Hook: Equip each door with one latch hook, fabricated from 0.120-inch (3.04-mm) nominal-thickness steel sheet; welded midway up full-height door strike; with resilient silencer.

H. Door Handle and Latch for [**Box**] [**16-Person**] Lockers: Stainless steel strike plate with integral pull; with steel padlock loop that projects through metal locker door.

I. Locks: [**Combination padlocks**] [**Built-in combination locks**] [**Cylinder locks**] [**Built-in, card-operated locks**] [**Digital keypad locks**] [**Built-in, coin-operated locks**].

J. Identification Plates: Manufacturer's standard, etched, embossed, or stamped [**aluminum**] [**plastic**] plates, with numbers and letters at least 3/8 inch (9 mm) high.

K. Hooks: Manufacturer's standard ball-pointed, aluminum or steel; zinc plated.

L. Coat Rods: [**1-inch- (25-mm-) diameter steel, chrome finished**] [**1-inch- (25-mm-) diameter steel, nickel plated**] [**3/4-inch- (19-mm-) diameter steel, chrome finished**] [**3/4-inch- (19-mm-) diameter steel, nickel plated**] [**Manufacturer's standard**].

M. Legs: [**6 inches (152 mm)**] <**Insert dimension**> high; formed by extending vertical frame members, or fabricated from 0.075-inch (1.90-mm) nominal-thickness steel sheet; welded to bottom of locker.

1. Closed Front and End Bases: Fabricated from 0.036-inch (0.91-mm) nominal-thickness steel sheet.

N. Continuous Zee Base: Fabricated from, [**0.060-inch (1.52-mm)**] [**0.075-inch (1.90-mm)**] [**manufacturer's standard thickness, but not less than 0.060-inch (1.52-mm)**] nominal-thickness steel sheet.

1. Height: [**4 inches (102 mm)**] <**Insert dimension**>.

O. Continuous Sloping Tops: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet, with a pitch of approximately 20 degrees.

1. Closures: [**Vertical**] [**Hipped**]-end type.

P. Recess Trim: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.

Q. Filler Panels: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.

R. Boxed End Panels: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.

S. Finished End Panels: Fabricated from 0.024-inch (0.61-mm) nominal-thickness steel sheet to cover unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.

T. Materials:

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
2. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with A60 (ZF180) zinc-iron, alloy (galvannealed) coating designation.
3. <Double click to insert sustainable design text for recycled content.>

U. Finish: Baked enamel or powder coat.

1. Color: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] [**Two colors, with door one color and**

frame and body another color; as selected by Architect from manufacturer's full range] <**Insert color**>.

2.5 KNOCKED-DOWN ATHLETIC LOCKERS <**Insert designation**>

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Perforated Doors: One piece; fabricated from 0.075-inch (1.90-mm) nominal-thickness steel sheet with manufacturer's standard diamond perforations; formed into channel shape with double bend at [**vertical edges and with right-angle single bend at horizontal edges**] [**and**] [**latch point (bottom) and right-angle single bend at remaining edges for box lockers**].

1. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than 15 inches (381 mm) wide; welded to inner face of doors.

C. Expanded-Metal Doors: Fabricated from 0.090-inch (2.28-mm) nominal-thickness expanded metal; welded to 0.105-inch (2.66-mm) nominal-thickness steel angle frame; with 0.090-inch (2.28-mm) nominal-thickness, steel sheet lock panel backed by 0.060-inch (1.52-mm) nominal-thickness, steel sheet retainer welded to door frame.

D. Body: Assembled by riveting or bolting body components together. Fabricate from unperforated steel sheet with thicknesses as follows:

1. Tops and Bottoms: 0.060-inch (1.52-mm) nominal thickness, with single bend at edges.
2. Backs: 0.048-inch (1.21-mm) nominal thickness.
3. Shelves: 0.060-inch (1.52-mm) nominal thickness, with double bend at front and single bend at sides and back.

E. Unperforated Sides: Fabricated from [**0.048-inch (1.21-mm)**] [**0.060-inch (1.52-mm)**] nominal-thickness steel sheet.

F. Perforated Sides: Fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet with manufacturer's standard diamond perforations.

G. Expanded-Metal Sides: Fabricated from 0.090-inch (2.28-mm) nominal-thickness expanded metal; welded to 0.105-inch (2.66-mm) nominal-thickness steel angles or 0.060-inch (1.52-mm) nominal-thickness steel channel frames.

H. Frames: Channel formed; fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet or 0.097-inch (2.45-mm) nominal-thickness steel angles; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral, full-height door strikes on vertical main frames.

1. Cross Frames for [**Double-Tier**] [**Triple-Tier**] Lockers: Channel formed and fabricated from same material as main frames; welded to vertical main frames.

I. Reinforced Bottoms: Structural channels, formed from [**0.060-inch (1.52-mm)**] [**0.075-inch (1.90-mm)**] nominal-thickness steel sheet; welded to front and rear of side-panel frames.

J. Hinges: Welded to door and attached to door frame with no fewer than two factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees[**; self-closing**].

1. Knuckle Hinges: Steel, full loop, five or seven knuckles, tight pin; minimum 2 inches (51 mm) high. Provide no fewer than three hinges for each door more than 42 inches (1067 mm) high.

2. Continuous Hinges: Manufacturer's standard, steel; side or top mounted as required by locker configuration.
3. Hinges: Manufacturer's standard, steel, continuous or knuckle type.

K. Recessed Door Handle and Latch: Stainless steel cup with integral door pull, recessed so locking device does not protrude beyond door face; pry and vandal resistant.

1. Multipoint Latching: Finger-lift latch control designed for use with built-in combination locks, built-in cylinder locks, or padlocks; positive automatic latching and prelocking.

a. Latch Hooks: Equip doors 48 inches (1219 mm) and higher with three latch hooks and doors less than 48 inches (1219 mm) high with two latch hooks; fabricated from 0.120-inch (3.04-mm) nominal-thickness steel sheet; welded to full-height door strikes; with resilient silencer on each latch hook.
b. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact, and incorporating a prelocking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.

2. Single-Point Latching: Nonmoving latch hook [**designed to engage bolt of built-in combination or cylinder lock**] [**with steel padlock loop that projects through recessed cup and is finished to match metal locker body**].

a. Latch Hook: Equip each door with one latch hook, fabricated from 0.120-inch (3.04-mm) nominal-thickness steel sheet; welded midway up full-height door strike; with resilient silencer.

L. Projecting Turn-Handle and Latch: Steel handle welded to manufacturer's standard, three-point, cremone-type latching mechanism consisting of steel rods or bars that engage locker frame at top and bottom of door, and center latch that engages strike jamb; with steel padlock loop.

M. Door Handle and Latch for Box Lockers: Stainless steel strike plate with integral pull; with steel padlock loop that projects through metal locker door.

N. Locks: [**Combination padlocks**] [**Built-in combination locks**] [**Cylinder locks**] [**Built-in, card-operated locks**] [**Digital keypad locks**] [**Built-in, coin-operated locks**].

O. Identification Plates: Manufacturer's standard, etched, embossed, or stamped [**aluminum**] [**plastic**] plates, with numbers and letters at least 3/8 inch (9 mm) high.

P. Hooks: Manufacturer's standard ball-pointed, aluminum or steel; zinc plated.

Q. Coat Rods: [**1-inch- (25-mm-) diameter steel, chrome finished**] [**1-inch- (25-mm-) diameter steel, nickel plated**] [**3/4-inch- (19-mm-) diameter steel, chrome finished**] [**3/4-inch- (19-mm-) diameter steel, nickel plated**] [**Manufacturer's standard**].

R. Legs: [**6 inches (152 mm)**] <**Insert dimension**> high; formed by extending vertical frame members, or fabricated from 0.075-inch (1.90-mm) nominal-thickness steel sheet; welded to bottom of locker.

1. Closed Front and End Bases: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.

S. Continuous Zee Base: 4 inches (102 mm) high; fabricated from 0.075-inch (1.90-mm) nominal-thickness steel sheet.

T. Continuous Sloping Tops: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet, with a pitch of approximately 20 degrees.

1. Closures: [**Vertical**] [**Hipped**]-end type.

U. Recess Trim: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.

V. Filler Panels: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.

W. Boxed End Panels: Fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet.

X. Finished End Panels: Fabricated from 0.024-inch (0.61-mm) nominal-thickness steel sheet to cover unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.

Y. Materials:

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
2. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with A60 (ZF180) zinc-iron, alloy (galvannealed) coating designation.
3. Expanded Metal: ASTM F1267, Type II (flattened), Class I (uncoated), 3/4-inch (19-mm) steel mesh, with at least 70 percent open area.
4. <Double click to insert sustainable design text for recycled content.>

Z. Finish: Baked enamel or powder coat.

1. Color: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] [**Two colors, with door one color and frame and body another color; as selected by Architect from manufacturer's full range**] <**Insert color**>.

2.6 WELDED ATHLETIC LOCKERS <**Insert designation**>

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Perforated Doors: One piece; fabricated from 0.075-inch (1.90-mm) nominal-thickness steel sheet with manufacturer's standard diamond perforations; formed into channel shape with double bend at [**vertical edges and with right-angle single bend at horizontal edges**] [**and**] [**latch point (bottom) and right-angle single bend at remaining edges for box lockers**].

1. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than 15 inches (381 mm) wide; welded to inner face of doors.

C. Expanded-Metal Doors: Fabricated from 0.090-inch (2.28-mm) nominal-thickness expanded metal; welded to 0.105-inch (2.66-mm) nominal-thickness steel angle frame; with 0.090-inch (2.28-mm) nominal-thickness, steel sheet lock panel backed by 0.060-inch (1.52-mm) nominal-thickness, steel sheet retainer welded to door frame.

D. Body: Assembled by welding body components together. Fabricate from unperforated steel sheet with thicknesses as follows:

1. Tops and Bottoms: 0.060-inch (1.52-mm) nominal thickness, with single bend at edges.
2. Backs: 0.048-inch (1.21-mm) nominal thickness.

3. Shelves: 0.060-inch (1.52-mm) nominal thickness, with double bend at front and single bend at sides and back.

E. Unperforated Sides: Fabricated from [**0.048-inch (1.21-mm)**] [**0.060-inch (1.52-mm)**] nominal-thickness steel sheet.

F. Perforated Sides: Fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet with manufacturer's standard diamond perforations.

G. Expanded-Metal Sides: Fabricated from 0.090-inch (2.28-mm) nominal-thickness expanded metal; welded to 0.105-inch (2.66-mm) nominal-thickness steel angles or 0.060-inch (1.52-mm) nominal-thickness steel channel frames.

H. Frames: Channel formed; fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet or 0.097-inch (2.45-mm) nominal-thickness steel angles; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral, full-height door strikes on vertical main frames.

1. Cross Frames for [**Double-Tier**] [**Triple-Tier**] Lockers: Channel formed and fabricated from same material as main frames; welded to vertical main frames.

I. Reinforced Bottoms: Structural channels, formed from [**0.060-inch (1.52-mm)**] [**0.075-inch (1.90-mm)**] nominal-thickness steel sheet; welded to front and rear of side-panel frames.

J. Hinges: Welded to door and attached to door frame with no fewer than two factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees[**; self-closing**].

1. Knuckle Hinges: Steel, full loop, five or seven knuckles, tight pin; minimum 2 inches (51 mm) high. Provide no fewer than three hinges for each door more than 42 inches (1067 mm) high.
2. Continuous Hinges: Manufacturer's standard, steel; side or top mounted as required by locker configuration.
3. Hinges: Manufacturer's standard, steel, continuous or knuckle type.

K. Recessed Door Handle and Latch: Stainless steel cup with integral door pull, recessed so locking device does not protrude beyond door face; pry and vandal resistant.

1. Multipoint Latching: Finger-lift latch control designed for use with built-in combination locks, built-in cylinder locks, or padlocks; positive automatic latching and prelocking.

a. Latch Hooks: Equip doors 48 inches (1219 mm) and higher with three latch hooks and doors less than 48 inches (1219 mm) high with two latch hooks; fabricated from 0.120-inch (3.04-mm) nominal-thickness steel sheet; welded to full-height door strikes; with resilient silencer on each latch hook.
b. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact, and incorporating a prelocking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.

2. Single-Point Latching: Nonmoving latch hook [**designed to engage bolt of built-in combination or cylinder lock**] [**with steel padlock loop that projects through recessed cup and is finished to match metal locker body**].

a. Latch Hook: Equip each door with one latch hook, fabricated from 0.120-inch (3.04-mm) nominal-thickness steel sheet; welded midway up full-height door strike; with resilient silencer.

L. Projecting Turn-Handle and Latch: Steel handle welded to manufacturer's standard, three-point, cremone-type latching mechanism consisting of steel rods or bars that engage locker frame at top and bottom of door, and center latch that engages strike jamb; with steel padlock loop.

M. Door Handle and Latch for Box Lockers: Stainless steel strike plate with integral pull; with steel padlock loop that projects through metal locker door.

N. Locks: [**Combination padlocks**] [**Built-in combination locks**] [**Cylinder locks**] [**Built-in, card-operated locks**] [**Digital keypad locks**] [**Built-in, coin-operated locks**].

O. Identification Plates: Manufacturer's standard, etched, embossed, or stamped [**aluminum**] [**plastic**] plates, with numbers and letters at least 3/8 inch (9 mm) high.

P. Hooks: Manufacturer's standard ball-pointed, aluminum or steel; zinc plated.

Q. Coat Rods: [**1-inch- (25-mm-) diameter steel, chrome finished**] [**1-inch- (25-mm-) diameter steel, nickel plated**] [**3/4-inch- (19-mm-) diameter steel, chrome finished**] [**3/4-inch- (19-mm-) diameter steel, nickel plated**] [**Manufacturer's standard**].

R. Legs: [**6 inches (152 mm)**] <**Insert dimension**> high; formed by extending vertical frame members, or fabricated from 0.075-inch (1.90-mm) nominal-thickness steel sheet; welded to bottom of locker.

1. Closed Front and End Bases: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.

S. Continuous Zee Base: 4 inches (102 mm) high; fabricated from 0.075-inch (1.90-mm) nominal-thickness steel sheet.

T. Continuous Sloping Tops: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet, with a pitch of approximately 20 degrees.

1. Closures: [**Vertical**] [**Hipped**]-end type.

U. Recess Trim: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.

V. Filler Panels: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.

W. Boxed End Panels: Fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet.

X. Finished End Panels: Fabricated from 0.024-inch (0.61-mm) nominal-thickness steel sheet to cover unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.

Y. Materials:

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
2. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with A60 (ZF180) zinc-iron, alloy (galvannealed) coating designation.
3. Expanded Metal: ASTM F1267, Type II (flattened), Class I (uncoated), 3/4-inch (19-mm) steel mesh, with at least 70 percent open area.

4. <Double click to insert sustainable design text for recycled content.>

Z. Finish: Baked enamel or powder coat.

1. Color: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] [**Two colors, with door one color and frame and body another color; as selected by Architect from manufacturer's full range**] <**Insert color**>.

2.7 KNOCKED-DOWN, OPEN-FRONT ATHLETIC LOCKERS <**Insert designation**>

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Locker Arrangement: Open front, with [**seat/shelf**] [**seat/footlocker**] [**upper shelf**] [**upper shelf with security box**] [**and**] [**full-width security compartment**] [**configuration as indicated on Drawings**].

C. Body: Assembled by riveting or bolting body components together. Fabricate from unperforated steel sheet with thicknesses as follows:

1. Tops and Bottoms: 0.060-inch (1.52-mm) nominal thickness, with single bend at edges.
2. Backs: 0.048-inch (1.21-mm) nominal thickness.
3. Shelves: 0.060-inch (1.52-mm) nominal thickness, with double bend at front and single bend at sides and back.

D. Unperforated Sides: Fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet.

E. Perforated Sides: Fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet with manufacturer's standard diamond perforations. Perforations shall not occur [**above upper shelf**] [**at security compartment**] [**or**] [**at seat/footlocker**].

F. Expanded-Metal Sides: Fabricated from 0.090-inch (2.28-mm) nominal-thickness expanded metal; welded to 0.105-inch (2.66-mm) nominal-thickness steel angles or 0.060-inch (1.52-mm) nominal-thickness steel channel frames.

G. Frames: Channel formed; fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet or 0.105-inch (2.66-mm) nominal-thickness steel angles; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames.

H. Reinforced Bottoms: Structural channels, formed from 0.075-inch (1.90-mm) nominal-thickness steel sheet; welded to front and rear of side-panel frames.

I. Seats/Shelves: Full width of metal locker; channel formed; fabricated from 0.075-inch (1.90-mm) nominal-thickness steel sheet; with stiffeners for reinforcement.

J. Seats/Footlockers: Enclosure full width of bottom of metal locker; fabricated from cold-rolled steel sheet.

1. Seat/Lid: 0.075-inch (1.90-mm) nominal-thickness steel sheet; channel formed and reinforced with stiffeners; with manufacturer's standard, steel continuous hinge that is completely concealed and tamper resistant when seat/lid is closed; with padlock hasp.
2. Front Panel: 0.075-inch (1.90-mm) nominal-thickness steel sheet; channel formed at top edge; with minilouvers for ventilation; recessed for padlock loop.
3. Sides: [**Integral part of unperforated**] [**Unperforated bottom portions of perforated**] [**0.060-inch (1.52-mm) nominal-thickness steel sheet inside expanded-metal**] sides.

K. Security Boxes: Nonperforated, consisting of partition extending from upper shelf to top of metal locker, fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet; with channel-formed, 0.060-inch (1.52-mm) nominal-thickness, steel sheet door frame, and door fabricated from 0.075-inch (1.90-mm) nominal-thickness steel sheet with right-angle single bend at edges; with manufacturer's standard, steel continuous hinge that is completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees.

1. Single-Point Latching: Stainless steel strike plate with integral pull; with steel, nonmoving latch hook [**designed to engage bolt of lock**] [**with steel padlock loop that projects through door and is finished to match metal locker body**].
2. Locks: [**Combination padlocks**] [**Built-in combination locks**] <**Insert item**>.

L. Security Compartments: Nonperforated, running full width of metal locker, with door fabricated from 0.075-inch (1.90-mm) nominal-thickness steel sheet.

1. Locks: [**Combination padlocks**] [**Built-in combination locks**] <**Insert item**>.

M. Identification Plates: Manufacturer's standard, etched, embossed, or stamped [**aluminum**] [**plastic**] plates, with numbers and letters at least 3/8 inch (9 mm) high.

N. Hooks: Manufacturer's standard ball-pointed, aluminum or steel; zinc plated.

O. Coat Rods: [**1-inch- (25-mm-) diameter steel, chrome finished**] [**1-inch- (25-mm-) diameter steel, nickel plated**] [**3/4-inch- (19-mm-) diameter steel, chrome finished**] [**3/4-inch- (19-mm-) diameter steel, nickel plated**] [**Manufacturer's standard**].

P. Continuous Sloping Tops: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet, with a pitch of approximately 20 degrees.

1. Closures: [**Vertical**] [**Hipped**]-end type.

Q. Recess Trim: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.

R. Filler Panels: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.

S. Boxed End Panels: Fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet.

T. Finished End Panels: Fabricated from 0.024-inch (0.61-mm) nominal-thickness steel sheet to cover unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.

U. Materials:

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
2. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with A60 (ZF180) zinc-iron, alloy (galvannealed) coating designation.
3. Expanded Metal: ASTM F1267, Type II (flattened), Class I (uncoated), 3/4-inch (19-mm) steel mesh, with at least 70 percent open area.
4. <Double click to insert sustainable design text for recycled content.>

V. Finish: Baked enamel or powder coat.

1. Color: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] <**Insert color**>.

2.8 WELDED, OPEN-FRONT ATHLETIC LOCKERS <**Insert designation**>

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Locker Arrangement: Open front, with [**seat/shelf**] [**seat/footlocker**] [**upper shelf**] [**upper shelf with security box**] [**and**] [**full-width security compartment**] [**configuration as indicated on Drawings**].

C. Material: [**Cold-rolled**] [**Metallic-coated**] steel sheet.

D. Body: Assembled by [**welding**] [**or**] [**riveting or bolting**] body components together. Fabricate from unperforated steel sheet with thicknesses as follows:

1. Tops and Bottoms: 0.060-inch (1.52-mm) nominal thickness, with single bend at edges.
2. Backs: 0.048-inch (1.21-mm) nominal thickness.
3. Shelves: 0.060-inch (1.52-mm) nominal thickness, with double bend at front and single bend at sides and back.

E. Unperforated Sides: Fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet.

F. Perforated Sides: Fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet with manufacturer's standard diamond perforations. Perforations shall not occur [**above upper shelf**] [**at security compartment**] [**or**] [**at seat/footlocker**].

G. Expanded-Metal Sides: Fabricated from 0.090-inch (2.28-mm) nominal-thickness expanded metal; welded to 0.105-inch (2.66-mm) nominal-thickness steel angles or 0.060-inch (1.52-mm) nominal-thickness steel channel frames.

H. Frames: Channel formed; fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet or 0.105-inch (2.66-mm) nominal-thickness steel angles; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames.

I. Reinforced Bottoms: Structural channels, formed from 0.075-inch (1.90-mm) nominal-thickness steel sheet; welded to front and rear of side-panel frames.

J. Seats/Shelves: Full width of metal locker; channel formed; fabricated from 0.075-inch (1.90-mm) nominal-thickness steel sheet; with stiffeners for reinforcement.

K. Seats/Footlockers: Enclosure full width of bottom of metal locker; fabricated from cold-rolled steel sheet.

1. Seat/Lid: 0.075-inch (1.90-mm) nominal-thickness steel sheet; channel formed and reinforced with stiffeners; with manufacturer's standard, steel continuous hinge that is completely concealed and tamper resistant when seat/lid is closed; with padlock hasp.
2. Front Panel: 0.075-inch (1.90-mm) nominal-thickness steel sheet; channel formed at top edge; with minilouvers for ventilation; recessed for padlock loop.
3. Sides: [**Integral part of unperforated**] [**Unperforated bottom portions of perforated**] [**0.060-inch (1.52-mm) nominal-thickness steel sheet inside expanded-metal**] sides.

L. Security Boxes: Nonperforated, consisting of partition extending from upper shelf to top of metal locker, fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet; with channel-formed, 0.060-inch (1.52-mm) nominal-thickness, steel sheet door frame, and door fabricated from 0.075-inch (1.90-mm) nominal-thickness steel sheet with right-angle single bend at edges; with manufacturer's standard, steel continuous hinge that is completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees.

1. Single-Point Latching: Stainless steel strike plate with integral pull; with steel, nonmoving latch hook [**designed to engage bolt of lock**] [**with steel padlock loop that projects through door and is finished to match metal locker body**].
2. Locks: [**Combination padlocks**] [**Built-in combination locks**] <**Insert item**>.

M. Security Compartments: Nonperforated, running full width of metal locker, with door fabricated from 0.075-inch (1.90-mm) nominal-thickness steel sheet.

1. Locks: [**Combination padlocks**] [**Built-in combination locks**] <**Insert item**>.

N. Identification Plates: Manufacturer's standard, etched, embossed, or stamped [**aluminum**] [**plastic**] plates, with numbers and letters at least 3/8 inch (9 mm) high.

O. Hooks: Manufacturer's standard ball-pointed, aluminum or steel; zinc plated.

P. Coat Rods: [**1-inch- (25-mm-) diameter steel, chrome finished**] [**1-inch- (25-mm-) diameter steel, nickel plated**] [**3/4-inch- (19-mm-) diameter steel, chrome finished**] [**3/4-inch- (19-mm-) diameter steel, nickel plated**] [**Manufacturer's standard**].

Q. Continuous Sloping Tops: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet, with a pitch of approximately 20 degrees.

1. Closures: [**Vertical**] [**Hipped**]-end type.

R. Recess Trim: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.

S. Filler Panels: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.

T. Boxed End Panels: Fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet.

U. Finished End Panels: Fabricated from 0.024-inch (0.61-mm) nominal-thickness steel sheet to cover unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.

V. Materials:

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
2. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with A60 (ZF180) zinc-iron, alloy (galvannealed) coating designation.
3. Expanded Metal: ASTM F1267, Type II (flattened), Class I (uncoated), 3/4-inch (19-mm) steel mesh, with at least 70 percent open area.
4. <Double click to insert sustainable design text for recycled content.>

W. Finish: Baked enamel or powder coat.

1. Color: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] <**Insert color**>.

2.9 LOCKS

A. Combination Padlock: [**Key-controlled, three-number dialing combination locks; capable of five combination changes**] [**Provided by Owner**].

B. Built-in Combination Lock: Key-controlled, three-number dialing combination locks; capable of at least five combination changes made automatically with a control key.

1. Bolt Operation: [**Manually locking deadbolt**] [**or**] [**automatically locking spring bolt**].

C. Cylinder Lock: Built-in, flush, cam lock with five-pin tumbler keyway, keyed separately and master keyed. Furnish two change keys for each lock and [**two**] <**Insert number**> master keys.

1. Key Type: [**Flat**] [**Grooved**][**, with minimum 2- by 2.68-inch (51- by 68.3-mm) key head for accessible lockers**].
2. Bolt Operation: [**Manually locking deadbolt**] [**or**] [**automatically locking spring bolt**].

D. Built-in, Card-Operated Lock: Self-contained units mounted on interior of door with replaceable lock cylinders keyed separately and master keyed. Mount instruction decals on both door faces. Furnish one change card key for each lock and one master card key.

1. Bolt Operation: [**Manually locking deadbolt**] [**or**] [**automatically locking spring bolt**].

E. Digital Keypad Lock: Battery-powered electronic keypad with reprogrammable manager and owner codes that override access. Three consecutive incorrect code entries shall disable lock for three minutes.

1. Designed for permanently assigned access via entry of user's four-digit code.
2. Designed for shared or temporary access by multiple users, with user-defined code to lock and unlock. Provide LED indicator to show when lock is in use.

F. Built-in, Coin-Operated Lock: Self-contained units mounted on interior of door with replaceable lock cylinders keyed separately and master keyed. Mount instruction decals on both door faces. Furnish one change key for each lock and one master key.

1. Bolt Operation: [**Manually locking deadbolt**] [**or**] [**automatically locking spring bolt**].
2. Lock Type: Fee [**return/deposit**] [**collect/pay**].
3. Fee Type: [**Token**] [**Coin, one quarter**] [**Coin, two quarters**].
4. Coin Box: Manufacturer's standard housing or stainless steel cash box with stainless steel flanged cover set into base of lock channel frame. Furnish with removable cylinder and key, and master code changer key.

2.10 LOCKER BENCHES <**Insert designation**>

A. <u><Double click here to find, evaluate, and insert list of manufacturers and products.></u>

B. Provide bench units with overall assembly height of [**17-1/2 inches (445 mm)**] <**Insert dimension**>.

C. Bench Tops: Manufacturer's standard one-piece units, with rounded corners and edges.

1. Size: Minimum 9-1/2 inches wide by 1-1/4 inches thick (241 mm wide by 32 mm thick)[**except provide 20- to 24-inch- (508- to 610-mm-) wide tops where accessible benches are indicated**].
2. Laminated clear hardwood with one coat of clear sealer on all surfaces and one coat of clear lacquer on top and sides.
3. Plastic laminate over particleboard core, with two steel tubes running full length of top and positioned to receive pedestal fasteners.

a. Color: [**Match metal lockers**] [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**].

4. Extruded aluminum with clear anodic finish.

D. Fixed-Bench Pedestals: Manufacturer's standard supports, with predrilled fastener holes for attaching bench top and anchoring to floor, complete with fasteners and anchors, and as follows:

1. Tubular Steel:

a. 1-1/2-inch- (38-mm-) diameter steel tubing: threaded on both ends, with standard pipe flange at top and bell-shaped cast-iron base; with baked-enamel or powder-coat finish; anchored with exposed fasteners.

1) Color: [**Match metal lockers**] [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**].

b. 1-1/4-inch- (32-mm-) diameter steel tubing: with 0.1265-inch- (3.2-mm-) thick steel flanges welded at top and base; with [**baked-enamel**] [**zinc-plated**] finish; anchored with exposed fasteners.

1) Color: [**Match metal lockers**] [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**].

E. Movable-Bench Pedestals: Manufacturer's standard supports, with predrilled fastener holes for attaching bench top, complete with fasteners, and as follows:

1. Aluminum: 1/8-inch-thick by 3-inch-wide (3-mm-thick by 76-mm-wide) channel or 1/4-inch-thick by 3-inch-wide (6-mm-thick by 76-mm-wide) bar stock, shaped into [**trapezoidal**] [**inverted-T**] form; with nonskid pads at bottom.

a. Finish: [**Clear**] [**Black**] [**Gold**] anodic finish.

2. Stainless Steel: 1/8-inch-thick by 3-inch-wide (3-mm-thick by 76-mm-wide) channel or 1/4-inch-thick by 3-inch-wide (6-mm-thick by 76-mm-wide) bar stock, shaped into trapezoidal form; with nonskid pads at bottom.

a. Finish: [**Manufacturer's standard**] [**No. 4B**].

F. Materials:

1. Stainless Steel Plate, Sheet, and Strip: ASTM A240/A240M or ASTM A666, Type 304.
2. Plastic Laminate: NEMA LD 3, Grade HGP.
3. Extruded Aluminum: ASTM B221 (ASTM B221M), alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated.
4. Steel Tube: ASTM A500/A500M, cold rolled.
5. <Double click to insert sustainable design text for composite wood products.>
6. Particleboard: ANSI A208.1, Grade M-2.

2.11 FABRICATION

A. Fabricate metal lockers square, rigid, without warp, and with metal faces flat and free of dents or distortion. Make exposed metal edges safe to touch and free of sharp edges and burrs.

1. Form body panels, doors, shelves, and accessories from one-piece steel sheet unless otherwise indicated.
2. Provide fasteners, filler plates, supports, clips, and closures as required for complete installation.

B. Fabricate each metal locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments.

C. Equipment: Provide each locker with an identification plate and the following equipment:

1. Single-Tier Units: Shelf, one double-prong ceiling hook, and two single-prong wall hooks.
2. Double-Tier Units: One double-prong ceiling hook and two single-prong wall hooks.
3. Triple-Tier Units: One double-prong ceiling hook.
4. Coat Rods: [**As indicated on Drawings**] [**For each compartment of each locker**] [**In lieu of ceiling hook for metal lockers 24 inches (610 mm) high or more**] [**In lieu of ceiling hook for metal lockers 18 inches (457 mm) deep or more**].
5. Open-Front Athletic Lockers: Two single-prong wall hooks bolted to locker back and coat rod.

D. Knocked-Down Construction: Fabricate metal lockers by [**assembling at Project site**] [**preassembling at plant prior to shipping**], using manufacturer's nuts, bolts, screws, or rivets.

E. Welded Construction: Factory preassemble metal lockers by welding all joints, seams, and connections; with no bolts, nuts, screws, or rivets used in assembly of main locker groups. Factory weld main locker groups into one-piece structures. Grind exposed welds smooth and flush.

F. Accessible Lockers: Fabricate as follows:

1. Locate bottom shelf no lower than 15 inches (381 mm) above the floor.
2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches (1219 mm) above the floor.

G. Continuous Zee Base: Fabricated in lengths as long as practical to enclose base and base ends; finished to match lockers.

H. Continuous Sloping Tops: Fabricated in lengths as long as practical, without visible fasteners at splice locations; finished to match lockers.

1. Sloping-top corner fillers, mitered.

I. Individual Sloping Tops: Fabricated in width to fit one locker frame in lieu of flat locker tops; with integral back; finished to match lockers. Provide wedge-shaped divider panels between lockers.

J. Recess Trim: Fabricated with minimum 2-1/2-inch (64-mm) face width and in lengths as long as practical; finished to match lockers.

K. Filler Panels: Fabricated in an unequal leg angle shape; finished to match lockers. Provide slip-joint filler angle formed to receive filler panel.

L. Boxed End Panels: Fabricated with 1-inch- (25-mm-) wide edge dimension, and designed for concealing fasteners and holes at exposed ends of nonrecessed metal lockers; finished to match lockers.

1. Provide one-piece panels for double-row (back-to-back) locker ends.

M. Finished End Panels: Fabricated to conceal unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.

1. Provide one-piece panels for double-row (back-to-back) locker ends.

N. Center Dividers: Full-depth, vertical partitions between bottom and shelf; finished to match lockers.

2.12 ACCESSORIES

A. Fasteners: Zinc- or nickel-plated steel, slotless-type, exposed bolt heads; with self-locking nuts or lock washers for nuts on moving parts.

B. Anchors: Material, type, and size required for secure anchorage to each substrate.

1. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls[**, and elsewhere as indicated,**] for corrosion resistance.
2. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls and floors or support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install lockers level, plumb, and true; shim as required, using concealed shims.

1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches (910 mm) o.c. Using concealed fasteners, install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion.
2. Anchor single rows of metal lockers to walls near top [**and bottom of lockers**] [**of lockers and to floor**].
3. Anchor back-to-back metal lockers to floor.

B. Knocked-Down Lockers: Assemble with manufacturer's standard fasteners, with no exposed fasteners on door faces or face frames.

C. Welded Lockers: Connect groups together with manufacturer's standard fasteners, with no exposed fasteners on face frames.

D. Equipment:

1. Attach hooks with at least two fasteners.

2. Attach door locks on doors using security-type fasteners.
3. Identification Plates: Identify metal lockers with identification indicated on Drawings.

   a. Attach plates to each locker door, near top, centered, with at least two aluminum rivets.
   b. Attach plates to upper shelf of each open-front metal locker, centered, with a least two aluminum rivets.

E. Trim: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.

1. Attach recess trim to recessed metal lockers with concealed clips.
2. Attach filler panels with concealed fasteners. Locate filler panels where indicated on Drawings.
3. Attach sloping-top units to metal lockers, with closures at exposed ends.
4. Attach boxed end panels using concealed fasteners to conceal exposed ends of nonrecessed metal lockers.
5. Attach finished end panels using fasteners only at perimeter to conceal exposed ends of nonrecessed metal lockers.

F. Fixed Benches: Provide no fewer than two pedestals for each bench, uniformly spaced not more than 72 inches (1830 mm) apart. Securely fasten tops of pedestals to undersides of bench tops, and anchor bases to floor.

G. Movable Benches: Place benches in locations indicated on Drawings.

3.3 ADJUSTING

A. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding.[**Verify that integral locking devices operate properly.**]

3.4 PROTECTION

A. Protect metal lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.

B. Touch up marred finishes, or replace metal lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION 10 01 50 11

SECTION 10 11 13 13 - VISUAL DISPLAY SURFACES

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for visual display surfaces. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Chalkboards.
      b. Markerboards.
      c. Tackboards.
      d. Visual display rails.
      e. Visual display wall panels.
      f. Support systems for visual display boards.
      g. Sliding visual display units.
      h. Visual display conference units.
      i. Visual display wall coverings.
      j. Electronic markerboards.

C. Definitions
   1. Tackboard: Framed or unframed, tackable, visual display board assembly.
   2. Visual Display Board Assembly: Visual display surface that is factory fabricated into composite panel form, either with or without a perimeter frame; includes chalkboards, markerboards, and tackboards.
   3. Visual Display Surface: Surfaces that are used to convey information visually, including surfaces of chalkboards, markerboards, tackboards, and surfacing materials that are not fabricated into composite panel form but are applied directly to walls.

D. Submittals
   1. Product Data: For each type of product indicated.
      a. Include rated capacities, operating characteristics, electrical characteristics and individual panel weights for sliding visual display units.
      b. Include computer system requirements for electronic markerboards.
   2. LEED Submittals:
      a. Product Data for Credit EQ 4.4: For composite wood products, documentation indicating that the product contains no urea formaldehyde.
      b. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content and chemical components.
   3. Shop Drawings: For visual display surfaces. Include plans, elevations, sections, details, and attachments to other work.
      a. Show locations of panel joints.
      b. Show locations of special-purpose graphics for visual display surfaces.
      c. Include sections of typical trim members.
      d. Wiring Diagrams: For power, signal, and control wiring.
   4. Samples: For each exposed product and for each color and texture specified.
   5. Qualification Data: For qualified Installer.
   6. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for surface-burning characteristics of fabrics.
   7. Operation and Maintenance Data: For visual display surfaces and power-operated units to include in maintenance manuals.

8. Warranties: Sample of special warranties.

E. Quality Assurance
1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of motor-operated, sliding visual display units required for this Project.
2. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   a. Flame-Spread Index: 25 or less.
   b. Smoke-Developed Index: 50 **OR** 450, **as directed**, or less.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Deliver factory-built visual display surfaces, including factory-applied trim where indicated, completely assembled in one piece without joints, where possible. If dimensions exceed maximum manufactured panel size, provide two or more pieces of equal length as acceptable to the Owner. When overall dimensions require delivery in separate units, prefit components at the factory, disassemble for delivery, and make final joints at the site.
2. Store visual display surfaces vertically with packing materials between each unit.

G. Project Conditions
1. Environmental Limitations: Do not deliver or install visual display surfaces until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Field Measurements: Verify actual dimensions of construction contiguous with visual display surfaces by field measurements before fabrication.
   a. Allow for trimming and fitting where taking field measurements before fabrication might delay the Work.

H. Warranty
1. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer's standard form in which manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Surfaces lose original writing and erasing qualities.
      2) Surfaces exhibit crazing, cracking, or flaking.
   b. Warranty Period: 50 years from date of Final Completion **OR** Life of the building, **as directed**.
2. Special Warranty for Electronic Markerboards: Manufacturer's standard form in which manufacturer agrees to repair or replace electronic markerboards that fail in materials or workmanship within two years from date of Final Completion.

1.2 PRODUCTS

A. Materials, General
1. Porcelain-Enamel Face Sheet: ASTM A 424, enameling-grade steel, uncoated thickness indicated; with exposed face and edges coated with primer, 1.7-to-2.5-mil- (0.043-to-0.064-mm-) thick ground coat, and color cover coat; and with concealed face coated with primer and 1.7-to-2.5-mil- (0.043-to-0.064-mm-) thick ground coat.
   a. Matte-Finish Cover Coat: Low reflective; chalk wipes clean with dry cloth or standard eraser. Minimum 2.0-to-2.5-mil- (0.051-to-0.064-mm-) thick cover coat. Cover and ground

coats shall be fused to steel at manufacturer's standard firing temperatures but not less than 1250 deg F (677 deg C).

b. Gloss-Finish Cover Coat: Gloss as indicated; dry-erase markers wipe clean with dry cloth or standard eraser. Minimum 3.0-to-4.0-mil- (0.076-to-0.102-mm-) thick cover coat. Cover and ground coats shall be fused to steel at manufacturer's standard firing temperatures but not less than 1475 deg F (802 deg C).

2. Porcelain-Enamel Face Sheet: Porcelain-enamel-clad, ASTM A 463/A 463M, Type 1, stretcher-leveled aluminized steel, with 0.024-inch (0.60-mm) uncoated thickness; with porcelain-enamel coating fused to steel at approximately 1000 deg F (538 deg C).
   a. Matte Finish: Low reflective; chalk wipes clean with dry cloth or standard eraser.
   b. Gloss Finish: Low gloss; dry-erase markers wipe clean with dry cloth or standard eraser. Suitable for use as projection screen.
3. Porcelain-Enamel Face Sheet: Manufacturer's standard steel sheet with porcelain-enamel coating fused to steel; uncoated thickness indicated.
   a. Matte Finish: Low reflective; chalk wipes clean with dry cloth or standard eraser.
   b. Gloss Finish: Gloss as indicated; dry-erase markers wipe clean with dry cloth or standard eraser.
4. Melamine: Thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.
5. High-Pressure Plastic Laminate: NEMA LD 3.
6. Natural Cork Sheet: Seamless, single-layer, compressed fine-grain cork sheet; bulletin board quality; face sanded for natural finish with surface-burning characteristics indicated.
7. Plastic-Impregnated Cork Sheet: Seamless, homogeneous, self-sealing sheet consisting of granulated cork, linseed oil, resin binders, and dry pigments that are mixed and calendared onto fabric backing; with washable vinyl finish and integral color throughout with surface-burning characteristics indicated.
8. Vinyl Fabric: Mildew resistant, washable, complying with FS CCC-W-408D, Type II, burlap weave; weighing not less than 13 oz./sq. yd. (440 g/sq. m); with surface-burning characteristics indicated.
9. Polyester Fabric: Nondirectional weave, 100 percent polyester; weighing not less than 15 oz./sq. yd. (508 g/sq. m); with surface-burning characteristics indicated.
10. Hardboard: ANSI A135.4, tempered.
11. Particleboard: ANSI A208.1, Grade M-1, made with binder containing no urea formaldehyde.
12. Fiberboard: ASTM C 208.
13. Extruded Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6063.

B. Chalkboard Assemblies
1. Porcelain-Enamel Chalkboards: Balanced, high-pressure, factory-laminated chalkboard assembly of three-ply construction consisting of backing sheet, core material, and 0.021-inch- (0.53-mm-) thick, **OR** 0.013-inch- (0.33-mm-) thick, **as directed**, porcelain-enamel face sheet with matte finish.
   a. Hardboard Core: 1/4 inch (6 mm) thick; with 0.005-inch- (0.127-mm-) thick, aluminum foil **OR** 0.015-inch- (0.38-mm-) thick, aluminum sheet **OR** 0.0129-inch- (0.35-mm-) thick, galvanized-steel sheet, **as directed**, backing.
   b. Particleboard Core: 3/8 inch (9.5 mm) thick; with 0.005-inch- (0.127-mm-) thick, aluminum foil **OR** 0.015-inch- (0.38-mm-) thick, aluminum sheet **OR** 0.0129-inch- (0.35-mm-) thick, galvanized-steel sheet, **as directed**, backing.
   c. Fiberboard Core: 3/8 inch (9.5 mm) **OR** 1/2 inch (13 mm), **as directed**, thick; with 0.001-inch- (0.025-mm-) thick, aluminum foil **OR** 0.015-inch- (0.38-mm-) thick, aluminum sheet **OR** 0.0129-inch- (0.35-mm-) thick, galvanized-steel sheet, **as directed**, backing.
   d. Manufacturer's Standard Core: Minimum 1/4 inch (6 mm) thick, with manufacturer's standard moisture-barrier backing.
   e. Laminating Adhesive: Manufacturer's standard, moisture-resistant thermoplastic type.
2. High-Pressure-Laminate Chalkboards: Balanced, high-pressure, factory-laminated chalkboard assembly of two-ply construction consisting of fiberboard core material and high-pressure-laminate writing surface.

3. Melamine Chalkboards: Fabricated from 1/4-inch- (6-mm-) thick, sealed and primed hardboard panels permanently bonded with melamine writing surface.
4. Painted-Finish Chalkboards: Fabricated from two plies of 1/4-inch- (6-mm-) thick, treated, tempered hardboard panels permanently surfaced with manufacturer's standard, heat-cured organic coating formulated for chalk-receptive matte finish.
5. Natural-Slate Chalkboards: Select grade, resurfaced, natural slate; free from ribbons and other natural marks that impair their functional use and durability as a writing surface.
   a. Writing surface shall be free of tooling marks, pits, chipping, scratches, and surface spalls in excess of those that can be easily corrected; and shall be free of surface-applied stain, dye, or other artificial coloring.
   b. Thickness: Not less than 1/4 inch (6 mm) or more than 3/8 inch (9.5 mm) thick with maximum deviation of 1/16 inch (1.6 mm) when an average thickness of at least 1/4 inch (6 mm) is maintained.

C. Markerboard Assemblies
1. Porcelain-Enamel Markerboards: Balanced, high-pressure, factory-laminated markerboard assembly of three-ply construction consisting of backing sheet, core material, and 0.021-inch- (0.53-mm-) thick, **OR** 0.013-inch- (0.33-mm-) thick, **as directed**, porcelain-enamel face sheet with high-gloss **OR** low-gloss, **as directed**, finish.
   a. Hardboard Core: 1/4 inch (6 mm) thick; with 0.005-inch- (0.127-mm-) thick, aluminum foil **OR** 0.015-inch- (0.38-mm-) thick, aluminum sheet **OR** 0.013-inch- (0.35-mm-) thick, galvanized-steel sheet, **as directed**, backing.
   b. Particleboard Core: 3/8 inch (9.5 mm) **OR** 1/2 inch (13 mm), **as directed**, thick; with 0.005-inch- (0.127-mm-) thick, aluminum foil **OR** 0.015-inch- (0.38-mm-) thick, aluminum sheet **OR** 0.013-inch- (0.35-mm-) thick, galvanized-steel sheet, **as directed**, backing.
   c. Fiberboard Core: 3/8 inch (9.5 mm) **OR** 1/2 inch (13 mm), **as directed**, thick; with 0.001-inch- (0.025-mm-) thick, aluminum foil **OR** 0.015-inch- (0.38-mm-) thick, aluminum sheet **OR** 0.013-inch- (0.35-mm-) thick, galvanized-steel sheet, **as directed**, backing.
   d. Manufacturer's Standard Core: Minimum 1/4 inch (6 mm) thick, with manufacturer's standard moisture-barrier backing.
   e. Laminating Adhesive: Manufacturer's standard, moisture-resistant thermoplastic type.
2. Melamine Markerboards: Fabricated from 1/4-inch- (6-mm-) thick, sealed and primed hardboard panels permanently bonded with melamine or another high-pressure-laminate writing surface.
3. High-Pressure-Laminate Markerboard Assembly: Balanced, high-pressure, factory-laminated chalkboard assembly of three-ply construction consisting of backing sheet, fiberboard core material, and high-pressure-laminate writing surface.

D. Tackboard Assemblies
1. Natural-Cork Tackboard:
   a. 1/16-inch- (1.6-mm-) thick, natural cork sheet factory laminated to 3/8-inch- (9.5-mm-) **OR** 7/16-inch- (11-mm-), **as directed**, thick fiberboard backing.
   b. 1/8-inch- (3-mm-) thick, natural cork sheet factory laminated to 3/8-inch- (9.5-mm-) thick fiberboard backing.
   c. 1/4-inch- (6-mm-) thick, natural cork sheet factory laminated to 1/4-inch- (6-mm-) thick hardboard **OR** particleboard, **as directed**, backing.
2. Plastic-Impregnated-Cork Tackboard:
   a. 1/8-inch- (3-mm-) thick, plastic-impregnated cork sheet factory laminated to 3/8-inch- (9.5-mm-) thick fiberboard backing.
   b. 1/4-inch- (6-mm-) thick, plastic-impregnated cork sheet factory laminated to 1/4-inch- (6-mm-) thick hardboard **OR** particleboard, **as directed**, backing.
3. Vinyl-Fabric-Faced Tackboard:
   a. Vinyl fabric factory laminated to 3/8-inch- (9.5-mm-) **OR** 7/16-inch- (11-mm-) **OR** 1/2-inch- (13-mm-), **as directed**, thick fiberboard backing.
   b. 1/16-inch- (1.6-mm-) thick, vinyl-fabric-faced cork sheet factory laminated to 3/8-inch- (9.5-mm-) thick fiberboard backing.

c. 1/8-inch- (3-mm-) thick, vinyl-fabric-faced cork sheet factory laminated to 3/8-inch- (9.5-mm-) thick fiberboard backing.
d. 1/4-inch- (6-mm-) thick, vinyl-fabric-faced cork sheet factory laminated to 1/4-inch- (6-mm-) thick hardboard **OR** particleboard, **as directed**, backing.
4. Polyester-Fabric-Faced Tackboard:
a. Polyester fabric factory laminated to 3/8-inch- (9.5-mm-) **OR** 1/2-inch- (13-mm-), **as directed**, thick fiberboard backing.
b. 1/16-inch- (1.6-mm-) thick, polyester-fabric-faced cork sheet factory laminated to 3/8-inch- (9.5-mm-) thick fiberboard backing.
c. 1/8-inch- (3-mm-) thick, polyester-fabric-faced cork sheet factory laminated to 3/8-inch- (9.5-mm-) thick fiberboard backing.
d. 1/4-inch- (6-mm-) thick, polyester-fabric-faced cork sheet factory laminated to 1/4-inch- (6-mm-) thick hardboard **OR** particleboard, **as directed**, backing.

E. Visual Display Rails
1. General: Manufacturer's standard, aluminum-framed, tackable cork **OR** fabric, **as directed**, visual display surface fabricated into narrow rail shape and designed for displaying material.

F. Visual Display Wall Panels
1. Marker Wall Sheets: Fabricated from 0.021-inch (0.53-mm) uncoated thickness, porcelain-enamel face sheets; for direct application to wall surface.
2. Marker Wall Panels: Fabricated from markerboard assembly indicated.
3. Tack Wall Panels: With tackable surface.
a. Fabricated from tackboard assembly indicated.
b. Natural Cork: 1/8-inch- (3-mm-) **OR** 1/4-inch- (6-mm-), **as directed**, thick, natural cork sheet for direct application to wall surface.
c. Plastic-Impregnated Cork: 1/8-inch- (3-mm-) **OR** 1/4-inch- (6-mm-), **as directed**, thick, plastic-impregnated cork sheet for direct application to wall surface.
d. Vinyl Fabric-Faced Cork: 1/4-inch- (6-mm-) thick, vinyl-fabric-faced cork sheet for direct application to wall surface.
e. Polyester-Fabric-Faced Cork: 1/4-inch- (6-mm-) thick, polyester-fabric-faced cork sheet for direct application to wall surface.
4. Joint Accessories: Manufacturer's standard, exposed trim **OR** concealed aluminum or steel spline, **as directed**, at butt joints.
5. Adhesive: Mildew-resistant, nonstaining adhesive, for use with specific tack wall panels and substrate application, as recommended in writing by visual display surface manufacturer, and with a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Primer/Sealer: Mildew-resistant primer/sealer complying with requirements in Division 09 Section "Interior Painting" and recommended in writing by visual display surface manufacturer for intended substrate.

G. Rail Support System For Visual Display Boards
1. Support Rails: Horizontal, wall-mounted, extruded-aluminum rails designed to receive hanger clip and to support visual display boards; capable of gripping and suspending paper directly from rail.
a. Finish: Clear anodic **OR** Color anodic **OR** Baked enamel **OR** Powder coat, **as directed**.
b. Color and Gloss: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
2. Hanger Clips: Extruded aluminum with finish to match rails; designed to support independent visual display boards by engaging support rail and top trim of board.
3. Visual Display Panels: Fabricated from not less than 3/8-inch- (9.5-mm-) thick, kraft-paper honeycomb core; designed to be rigid and to resist warpage, and with aluminum trim designed to engage hanger clips.

H. Modular Support System For Visual Display Boards

1. Standards: 72-inch- (1829-mm-) long, extruded-aluminum slotted standards designed for supporting visual display boards on panel clips. Standards shall be punched at not less than 4 inches (100 mm) o.c.
   a. Finish: Clear anodic **OR** Color anodic **OR** Baked enamel **OR** Powder coat, **as directed**.
   b. Color and Gloss: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
2. Panel Clips: Extruded aluminum or steel with finish to match standards.

I. Sliding Visual Display Units
1. Horizontal-Sliding Visual Display Units: Factory-fabricated units consisting of extruded-aluminum tubular frame, fixed-rear visual display panel, aluminum-framed horizontal-sliding panels, and extruded-aluminum fascia that conceals overhead sliding track; designed for recessed mounting. Provide panels that operate smoothly without vibration or chatter.
   a. Two-Track Units: Fabricate unit with fixed rear panel covering entire rear surface. Provide two sliding panels, each equal to not less than one-half of overall length of unit.
   b. Three-Track Units: Fabricate unit with fixed rear panel covering entire rear surface. Provide three sliding panels, each equal to not less than one-third **OR** one-half, **as directed**, of overall length of unit.
   c. Four-Track Units: Fabricate unit with fixed rear panel centered in and covering not less than one-half of rear surface, and fixed front panel on each side of unit equal to not less than one-quarter of overall length of unit. Provide four sliding panels, each equal to not less than one-quarter of overall length of unit.
      1) Swinging Doors: Fabricated from same construction as sliding panels and supported on full-height continuous hinges. Provide visual display surface on both sides of each door.
   d. Sliding Panels: Fabricated from not less than 3/8-inch- (9.5-mm-) thick, kraft-paper honeycomb core; designed to be rigid and to resist warpage.
      1) Fabricate sliding panels with 0.021-inch (0.53-mm) uncoated thickness, porcelain-enamel face sheets.
   e. Hardware: Manufacturer's standard, extruded-aluminum overhead track and channel-shaped bottom guides; with two nylon ball-bearing carriers and two nylon rollers for each sliding panel.
2. Vertical-Sliding Visual Display Units: Factory-fabricated units consisting of extruded-aluminum tubular frame, fixed-rear visual display panel, and aluminum-framed vertical-sliding panels; designed for recessed mounting. Provide panels that operate smoothly without vibration or chatter.
   a. Type: Tubular frame on four sides **OR** top and two sides, with sides extending to floor; with kick panel to conceal sliding panels, **as directed**. Unit shall be designed to support panels independent of wall.
   b. Two-Track Units: Fabricate unit with fixed rear panel covering entire rear surface. Provide two sliding panels, each equal to not less than one-half of overall height of unit.
   c. Three-Track Units: Fabricate unit with fixed rear panel covering entire rear surface. Provide three sliding panels, each equal to not less than one-half of overall height of unit.
   d. Four-Track Units: Fabricate unit with fixed rear panel centered in and covering not less than one-half of rear surface. Provide four sliding panels, each equal to not less than one-half of overall height of unit.
   e. Sliding Panels: Fabricated from not less than 3/8-inch- (9.5-mm-) thick, kraft-paper honeycomb core; designed to be rigid and to resist warpage.
      1) Fabricate sliding panels with 0.021-inch (0.53-mm) uncoated thickness, porcelain-enamel face sheets.
   f. Hardware: Manufacturer's standard, neoprene ball-bearing end rollers, four on each side of each sliding panel. Counterbalance each sliding panel with lead counterweights supported by steel aircraft cable over ball-bearing sheaves; with removable cover plate for

access to counterweights. Provide rubber bumpers at top and bottom for each sliding panel.

g. Motorized Operation: Provide not less than one motor with gearhead reducers for each sliding panel, mounted above visual display unit and connected to sliding panels with steel aircraft cable. Provide removable cover plate for access to motor. Equip motors with limit switches to automatically stop motor at each end of travel.
   1) Electric Motors: UL approved or recognized, totally enclosed, complying with NEMA MG 1, with thermal-overload protection; 1/15 hp, single phase, 110 **OR** 220, **as directed**, V, 60 Hz.
   2) Control Station: Three-position, maintained-contact **OR** momentary-contact, **as directed**, switch-operated control station with open, close, and off functions; with NEMA ICS 6, Type 1 enclosure. Provide one control station for each sliding panel unit, unless directed otherwise.
   3) Key Switch: Provide supplementary key switch for each control station. Furnish two keys for each control station, keyed alike.

J. Visual Display Conference Units

1. Visual Display Conference Units: Factory-fabricated units consisting of hinged-door wood cabinet with perimeter face frame, sides, and back; not less than 3-inch (75-mm) interior depth and designed for surface wall mounting. Fabricate inside of cabinet and cabinet doors with fixed visual display surfaces.
   a. Wood Cabinets: Fabricated from solid wood with integral, solid-wood markertray. Fabricate hinged door panels with solid wood frame and wood-veneer exterior surface.
   b. Plastic-Laminate Cabinets: Cabinet and hinged door panels fabricated from manufacturer's standard, high-pressure, plastic-laminate-finished panels; with integral markertray.
   c. Hardware: Manufacturer's standard, full-height continuous hinges, wire door pulls, and door bumpers.
   d. Projection Screens: Manufacturer's standard, pull-down, matte, white projection screen, not less than 8 inches (200 mm) smaller in each direction than overall cabinet size, and mounted above rear visual display surface.
   e. Fluorescent Light: Manufacturer's standard, not less than 24 inches (610 mm) long, and mounted above rear visual display surface.

K. Visual Display Wall Coverings

1. Visual Display Wall Covering: Intended for use with dry-erase markers and as a projection surface, **as directed**, and consisting of low-gloss **OR** moderate-gloss **OR** high-gloss, **as directed**, plastic film bonded to fabric backing; not less than 0.012-mil (0.0003-mm) **OR** 0.020-mil (0.0005-mm), **as directed**, total thickness.
2. Surface Graphics: 2-inch- (50-mm-) square grid.
   a. Color: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
3. Magnetic Visual Display Wall Covering: Intended for use with dry-erase markers and magnetic aids and consisting of moderate-gloss plastic film bonded to ferrous-powdered fabric backing; not less than 0.025-mil (0.0006-mm) total thickness.
   a. Color: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
4. Adhesive: Mildew-resistant, nonstaining, strippable, **as directed**, adhesive, for use with specific wall covering and substrate application, as recommended in writing by wall covering manufacturer, and with a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
5. Primer/Sealer: Mildew-resistant primer/sealer complying with requirements in Division 09 Section "Interior Painting" and recommended in writing by wall covering manufacturer for intended substrate.

L. Electronic Markerboards

1. General: Provide manufacturer's standard electronic markerboard that consists of touch-sensitive writing surface connected to microcomputer via RS-232 serial cable and that electronically records writing with standard dry-erase markers. Equip unit with cables, software, pens, erasers, mounting hardware, and accessories required for a complete installation.
2. Software: Capable of real-time recording, saving, and printing of everything that is written and drawn on electronic markerboard; with Windows **OR** Macintosh, **as directed**, operating system.
   a. File Export Formats: BMP, WMF, HTML, and vector-based formats.
   b. Compatibility: Compatible with Microsoft NetMeeting or other T.120-compliant software.
   c. Features: Capable of the following:
      1) Saving directly from screen.
      2) Erasing portions of screen.
      3) Printing directly from screen.
      4) Saving individual screens as separate pages.
      5) Showing onscreen toolbar **OR** keyboard, **as directed**.
      6) Recognizing not less than four pen colors.
      7) Recognizing finger touch control for presentations.
      8) Connecting multiple electronic markerboards to a single computer.
      9) Showing online help and tutorial.
3. Overall Size: Approximately 48 inches high by 60 inches wide (1219 mm high by 1524 mm wide).
4. Mounting: Wall mounted **OR** Supported by rail support system, **as directed**.

M. Chalkboard, Markerboard, And Tackboard Accessories
1. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch- (1.57-mm-) thick, extruded aluminum; standard size and shape **OR** slim size and standard shape **OR** of size and shape indicated on Drawings, **as directed**.
   a. Field-Applied Trim: Manufacturer's standard, snap-on trim with no visible screws or exposed joints **OR** slip-on trim **OR** screw-on trim with Phillips flat-head screws, **as directed**.
   b. Factory-Applied Trim: Manufacturer's standard.
2. Factory-Applied Wood Trim: Red oak **OR** Walnut **OR** Manufacturer's standard species, **as directed**, not less than 1/2 inch (13 mm) thick; standard size and shape **OR** of size and shape indicated on Drawings, **as directed**.
3. Field-Applied Wood Trim: Comply with requirements specified in Division 06 Section(s) "Finish Carpentry" OR "Interior Architectural Woodwork" **as directed**.
4. Chalktray: Manufacturer's standard, continuous.
   a. Box Type: Extruded aluminum with slanted front, grooved tray, and cast-aluminum end closures.
   b. Solid Type: Extruded aluminum with ribbed section and smoothly curved exposed ends.
5. Map Rail: Provide the following accessories:
   a. Display Rail: Continuous and integral with map rail; fabricated from cork approximately 1 to 2 inches (25 to 50 mm) wide.
   b. End Stops: Located at each end of map rail.
   c. Map Hooks: Two map hooks for every 48 inches (1219 mm) **OR** 1200 mm, **as directed**, of map rail or fraction thereof.
   d. Map Hooks and Clips: Two map hooks with flexible metal clips for every 48 inches (1219 mm) **OR** 1200 mm, **as directed**, of map rail or fraction thereof.
   e. Flag Holder: One for each room.
   f. Paper Holder: Extruded aluminum; designed to hold paper by clamping action.
6. Special-Purpose Graphics: Fuse or paint the following graphics into surface of porcelain-enamel visual display unit:
   a. Semivisible writing guidelines.
   b. Penmanship lines.
   c. Music staff lines.
   d. Grid, 1 inch (25 mm) square.
   e. Graph coordinates, rectangular.

f. Horizontal lines, 2 inches (50 mm) o.c.
g. Polar coordinates.
h. USA map.
i. World map.
j. Soccer field.
k. Football field.
l. Basketball court.

N. Fabrication
1. Porcelain-Enamel Visual Display Assemblies: Laminate porcelain-enamel face sheet and backing sheet to core material under heat and pressure with manufacturer's standard flexible, waterproof adhesive.
2. Natural-Slate Chalkboards: Surface slate panels to a natural plane. Grind and hone to smooth, uniform finish equivalent to that obtained by minimum 180 grit and maximum 220 grit.
a. Cut joints straight and true. Space joints symmetrically. Fit and match panels before shipment to provide continuous, uniform writing surface.
b. Length: Furnish panels approximately equal in length with permissible variation not more than 3 inches (75 mm) in either direction of equal spacing. Allow 1/4-inch (6-mm) clearance at trim in length and width for fitting. Provide lengths of panels in each space as follows:
1) Up to 5 feet (1.5 m); one panel.
2) More than 5 feet (1.5 m) but less than 9 feet (2.7 m); two panels.
3) More than 9 feet (2.7 m) but less than 13.5 feet (4.1 m); three panels.
4) More than 13.5 feet (4.1 m) but less than 18 feet (5.5 m); four panels.
5) More than 18 feet (5.5 m) but less than 22.5 feet (6.9 m); five panels.
6) More than 22.5 feet (6.9 m) but less than 27 feet (8.2 m); six panels.
3. Visual Display Boards: Factory **OR** Field, **as directed**, assemble visual display boards unless otherwise indicated.
a. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display boards at manufacturer's factory before shipment.
4. Factory-Assembled Visual Display Units: Coordinate factory-assembled units with trim and accessories indicated. Join parts with a neat, precision fit.
a. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board, as acceptable to the Owner **OR** as indicated on approved Shop Drawings, **as directed**.
b. Provide manufacturer's standard vertical-joint spline **OR** H-trim, **as directed**, system between abutting sections of chalkboards **OR** markerboards, **as directed**.
c. Provide manufacturer's standard mullion trim at joints between chalkboards **OR** markerboards **OR** tackboards, **as directed**, of combination units.
d. Where size of visual display boards or other conditions require support in addition to normal trim, provide structural supports or modify trim as indicated or as selected by the Owner from manufacturer's standard structural support accessories to suit conditions indicated.
5. Modular Visual Display Boards: Fabricated with integral panel clips attached to core material.
6. Aluminum Frames and Trim: Fabricate units straight and of single lengths, keeping joints to a minimum. Miter corners to a neat, hairline closure.
a. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display units at manufacturer's factory before shipment.

O. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

3. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

P. Aluminum Finishes
1. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
2. Color Anodic Finish: AAMA 611, AA-M12C22A32/A34, Class II, 0.010 mm or thicker.
3. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1.3 EXECUTION

A. Examination
1. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.
2. Examine roughing-in for electrical power systems to verify actual locations of connections before installation of motor-operated, sliding visual display units.
3. Examine walls and partitions for proper preparation and backing for visual display surfaces.
4. Examine walls and partitions for suitable framing depth where sliding visual display units will be installed.
5. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Comply with manufacturer's written instructions for surface preparation.
2. Clean substrates of substances that could impair the performance of and affect the smooth, finished surfaces of visual display boards, including dirt, mold, and mildew.
3. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, depressions, and substances that will impair bond between visual display surfaces and wall surfaces.
   a. Prime wall surfaces indicated to receive direct-applied, visual display tack wall panels **OR** visual display wall coverings, **as directed**, and as recommended in writing by primer/sealer manufacturer and wall covering manufacturer.
   b. Prepare surfaces to receive visual display wall coverings and test for moisture according to requirements specified in Division 09 Section "Wall Coverings".
      OR
      Prepare substrates indicated to receive visual display wall covering as required by manufacturer's written instructions to achieve a smooth, dry, clean, structurally sound surface that is uniform in color.
      1) Moisture Content: Maximum of 4 percent when tested with an electronic moisture meter.
      2) Plaster: Allow new plaster to cure. Neutralize areas of high alkalinity. Prime with primer as recommended in writing by primer/sealer manufacturer and wall covering manufacturer.
      3) Metals: If not factory primed, clean and apply metal as recommended in writing by primer/sealer manufacturer and wall covering manufacturer.
      4) Gypsum Board: Prime with primer as recommended in writing by primer/sealer manufacturer and wall covering manufacturer.
      5) Painted Surfaces: Treat areas susceptible to pigment bleeding.
4. Prepare recesses for sliding visual display units as required by type and size of unit.

C. Installation, General

1. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings, or if not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.
    a. Mounting Height for Grades K through 3: 24 inches (610 mm) above finished floor to top of chalktray.
    b. Mounting Height for Grades 4 through 6: 28 inches (711 mm) above finished floor to top of chalktray.
    c. Mounting Height for Grades 7 and Higher: 36 inches (914 mm) above finished floor to top of chalktray.
    OR
    a. Mounting heights of 24 inches (610 mm) above finished floor to top of chalktray for kindergarten.
    b. Mounting heights of 26 inches (660 mm) above finished floor to top of chalktray for Grades 1 through 3.
    c. Mounting heights of 30 inches (762 mm) above finished floor to top of chalktray for Grades 4 through 6.
    d. Mounting heights of 34 inches (864 mm) above finished floor to top of chalktray for Grades 7 through 9.
    e. Mounting heights of 37 inches (940 mm) above finished floor to top of chalktray for Grades 10 and higher,
    as directed

D. Installation Of Field-Fabricated Visual Display Boards And Assemblies
1. Field-Assembled Visual Display Units: Coordinate field-assembled units with grounds, trim, and accessories indicated. Join parts with a neat, precision fit.
    a. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board, as acceptable to the Owner **OR** as indicated on approved Shop Drawings, **as directed**.
    b. Provide manufacturer's standard vertical-joint spline **OR** H-trim, **as directed**, system between abutting sections of chalkboards **OR** markerboards, **as directed**.
    c. Provide manufacturer's standard mullion trim at joints between chalkboards **OR** markerboards **OR** tackboards, **as directed**, of combination units.
    d. Where size of visual display boards or other conditions require support in addition to normal trim, provide structural supports or modify trim as indicated or as selected by the Owner from manufacturer's standard structural support accessories to suit conditions indicated.
2. Natural-Slate Chalkboards: Align and level joints between adjoining panels and apply manufacturer's recommended joint-filler compound. Hone and finish joints to continuous even plane.

E. Installation Of Factory-Fabricated Visual Display Boards And Assemblies
1. Visual Display Boards:
    a. Attach visual display boards to wall surfaces with egg-size adhesive gobs at 16 inches (400 mm) o.c., horizontally and vertically.
    OR
    Attach concealed clips, hangers, and grounds to wall surfaces and to visual display boards with fasteners at not more than 16 inches (400 mm) o.c. Secure both top and bottom of boards to walls.
    b. Field-Applied Aluminum Trim: Attach trim over edges of visual display boards and conceal grounds and clips. Attach trim to boards with fasteners at not more than 24 inches (610 mm) o.c.
        1) Attach chalktrays to boards with fasteners at not more than 12 inches (300 mm) o.c.
    c. Field-Applied Wood Trim: Install trim according to requirements in Division 06 Section(s) "Finish Carpentry" OR "Interior Architectural Woodwork", **as directed**.

F. Installation Of Visual Display Rails
1. Display Rails: Install rails in locations and at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to wall surface with fasteners at not more than 16 inches (400 mm) o.c.
a. Mounting Height: 48 inches (1219 mm) **OR** 60 inches (1524 mm), **as directed**, above finished floor to top of rail.

G. Installation Of Visual Display Wall Panels
1. Marker Wall Sheets: Attach wall sheets to wall surface with thin layer of adhesive over entire wall surface. Butt join adjacent panels and cover joint with matching joint strip installed with double-stick tape, **as directed**.
2. Marker Wall Panels: Attach panels to wall surface with egg-size adhesive gobs at 16 inches (400 mm) o.c., horizontally and vertically.
a. Join adjacent wall panels with concealed steel splines for smooth alignment.
OR
Join adjacent wall panels with exposed, H-shaped aluminum trim painted to match wall panel.
3. Tack Wall Panels: Attach panels to wall surface with egg-size adhesive gobs at 16 inches (400 mm) o.c. horizontally and vertically.
a. Install wrapped-edge wall panels with butt joints between adjacent wall panels.
b. Join adjacent wall panels with exposed, H-shaped aluminum trim covered with same fabric as wall panels.

H. Installation Of Rail **OR** Modular, **as directed**, Support System
1. Rail Support System: Install horizontal support rail in locations and at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to wall surface with fasteners at 12 inches (300 mm) o.c.
a. Mounting Height: 72 inches (1829 mm) above finished floor to top of rail.
b. Hang visual display units on rail support system.
2. Modular Support System: Install adjustable standards in locations and at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Install standards at 48 inches (1219 mm) o.c., vertically aligned and plumb, and attached to wall surface with fasteners at 12 inches (300 mm) o.c.
a. Mounting Height: 12 inches (300 mm) above finished floor to bottom of standard.
b. Install single-slotted standard at each end of each run of standards and double-slotted standards at intermediate locations.
c. Provide locking screw at top corner of visual display board at each standard.
d. Hang visual display units on modular support system.

I. Installation Of Factory-Fabricated Visual Display Units
1. Sliding Visual Display Units: Install units in recessed locations and at mounting heights indicated. Attach to wall framing with fasteners at not more than 16 inches (400 mm) o.c.
a. Adjust panels to operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.
2. Visual Display Conference Units: Install units in locations and at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to wall surface with fasteners through back of cabinet **OR** concealed brackets screwed to wall **OR** concealed wood cleats screwed to wall, **as directed**.
a. Mounting Height: 72 inches (1829 mm) above finished floor to top of cabinet.

J. Installation Of Visual Display Wall Covering
1. General: Comply with visual display wall covering manufacturers' written installation instructions.
2. Install seams horizontal and level, with lowest seam 24 inches (610 mm) above finished floor. Railroad fabric (reverse roll direction) to ensure color matching.

3. Double cut seams, with no gaps or overlaps. Remove air bubbles, wrinkles, blisters, and other defects.
4. After installation, clean visual display wall covering according to manufacturer's written instructions. Remove excess adhesive at finished seams, perimeter edges, and adjacent surfaces.

K. Installation Of Visual Electronic Markerboards
   1. Electronic Markerboards: Install units in locations and at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to wall **OR** cubicle, **as directed**, surface with manufacturer's standard mounting hardware.
      a. Mounting Height: 72 inches (1829 mm) above finished floor to top of markerboard.

L. Cleaning And Protection
   1. Clean visual display surfaces according to manufacturer's written instructions. Attach one cleaning label to visual display surface in each room.
   2. Touch up factory-applied finishes to restore damaged or soiled areas.
   3. Cover and protect visual display surfaces after installation and cleaning.

M. Demonstration
   1. Train Owner's maintenance personnel to adjust, operate, and maintain motor-operated, sliding visual display units.

END OF SECTION 10 11 13 13

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Task	Specification	Specification Description
10 11 13 33	10 11 13 13	Visual Display Surfaces
10 11 16 13	10 11 13 13	Visual Display Surfaces
10 11 16 33	10 11 13 13	Visual Display Surfaces
10 11 23 13	10 11 13 13	Visual Display Surfaces
10 13 11 00	10 11 13 13	Visual Display Surfaces

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SECTION 10 14 00 00 - VITRIFIED BRICK PAVEMENT REPLACEMENT

1.1 GENERAL

A. General

1. Limits of Brick Pavement Replacement shall be as per the detail entitled "Payment Limits for Surface Restoration" shown in the plans, plus one foot on each side. Alternate individual bricks may have to be removed in order to maintain staggered joint pattern along the edge of the undisturbed brick pavement.

1.2 PRODUCT

A. Preparation

1. Base shall be provided and shaped to match level, kind and thickness (4" min.) of adjoining base. The base material shall be compacted to meet the density standards. 4" 2500 PSI concrete base may be used for irregular patches and where compaction is otherwise impractical. Concrete shall be properly placed, consolidated and cured. One inch of sand, or good grade dirt, free from clay, loam or other foreign matter shall be used for cushion to hold the bricks in place. The sand shall be shaped to a true surface parallel to required finished pavement surface.

B. Materials

1. Existing bricks shall be cleaned, stored, and secured by the Contractor.

1.3 EXECUTION

A. Reinstallation of Bricks

1. The bricks shall be installed in rows, better face upward, sorted by size with joints staggered, then rolled daily with a static tandem wheel roller. Additional bricks, if required, will be supplied by the Owner. City Personnel shall inspect work daily. After inspection, the bricks shall be sprayed with a solution of lime and water, using 26 lbs. of lime to 55 gallons of water. Asphalt steep 7330 or equal shall be used for joint filler. The steep shall be heated until fluid and poured over bricks and removed when cool with square pointed shovels dipped in lime water. Removed asphalt may be reused. If adjoining bricks are grouted, new filler shall be grout (8:1, builders sand: cement).

B. Acceptance

1. Upon completion of the work, and before acceptance and final payment, the Contractor shall remove all false work, equipment, rubbish, surplus, and discarded materials. The Contractor shall restore in an acceptable manner all property, both public and private, damaged during the prosecution of the work. The Contractor shall leave the roadway in a neat and presentable condition each day.

END OF SECTION 10 14 00 00

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Task	Specification	Specification Description
10 14 00 00	01 58 13 00	Signage
10 14 16 00	10 14 00 00	Vitrified Brick Pavement Replacement
10 14 16 00	01 58 13 00	Signage
10 14 19 00	01 22 16 00	No Specification Required
10 14 19 00	10 14 00 00	Vitrified Brick Pavement Replacement
10 14 19 00	01 58 13 00	Signage
10 14 23 00	10 14 00 00	Vitrified Brick Pavement Replacement
10 14 23 11	10 14 00 00	Vitrified Brick Pavement Replacement
10 14 23 11	01 58 13 00	Signage
10 14 29 00	10 14 00 00	Vitrified Brick Pavement Replacement
10 14 29 00	01 58 13 00	Signage
10 14 31 00	10 14 00 00	Vitrified Brick Pavement Replacement
10 14 31 00	01 58 13 00	Signage
10 14 53 00	10 14 00 00	Vitrified Brick Pavement Replacement
10 14 53 11	01 55 26 00	Traffic Signs
10 14 56 00	10 14 00 00	Vitrified Brick Pavement Replacement
10 14 56 00	01 58 13 00	Signage
10 14 63 00	10 14 00 00	Vitrified Brick Pavement Replacement
10 14 63 00	01 58 13 00	Signage

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SECTION 10 21 13 13 - TOILET COMPARTMENTS

1.1 GENERAL

A. Description Of Work:

1. This specification covers the furnishing and installation of materials for toilet compartments. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
    a. Steel toilet compartments configured as toilet enclosures, entrance screens, and urinal screens.
    b. Stainless-steel toilet compartments configured as toilet enclosures, entrance screens, and urinal screens.
    c. Plastic-laminate-faced toilet compartments configured as toilet enclosures, entrance screens, and urinal screens.
    d. Phenolic-core toilet compartments configured as toilet enclosures, entrance screens, and urinal screens.
    e. Solid-polymer toilet compartments configured as toilet enclosures, entrance screens, and urinal screens.

C. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittals:
    a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
    b. Product Data for Credit EQ 4.4: For particleboard, documentation indicating that product contains no urea formaldehyde.
3. Shop Drawings: For toilet compartments. Include plans, elevations, sections, details, and attachments to other work.
4. Samples for each exposed product and for each color and texture specified.
5. Product certificates.
6. Maintenance data.

D. Quality Assurance

1. Comply with requirements in GSA's CID-A-A-60003, "Partitions, Toilets, Complete", **as directed**.
2. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84, or another standard acceptable to authorities having jurisdiction, by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
    a. Flame-Spread Index: 25 **OR** 75 **OR** 200, **as directed**, or less.
    b. Smoke-Developed Index: 450 or less.
3. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities" and ICC/ANSI A117.1 for toilet compartments designated as accessible.

1.2 PRODUCTS

A. Materials

1. Aluminum Castings: ASTM B 26/B 26M.
2. Aluminum Extrusions: ASTM B 221 (ASTM B 221M).
3. Brass Castings: ASTM B 584.
4. Brass Extrusions: ASTM B 455.
5. Steel Sheet: Commercial steel sheet for exposed applications; mill phosphatized and selected for smoothness.
    a. Electrolytically Zinc Coated: ASTM A 879/A 879M, 01Z (03G).
    b. Hot-Dip Galvanized: ASTM A 653/A 653M, either hot-dip galvanized or galvannealed.
6. Stainless-Steel Sheet: ASTM A 666, Type 304, stretcher-leveled standard of flatness.
7. Stainless-Steel Castings: ASTM A 743/A 743M.
8. Zamac: ASTM B 86, commercial zinc-alloy die castings.
9. Particleboard: ANSI A208.1, Grade M-2 with 45-lb (20.4-kg) density, made with binder containing no urea formaldehyde.
10. Plastic Laminate: NEMA LD 3, general-purpose HGS grade, 0.048-inch (1.2-mm) nominal thickness.

B. Steel Units
1. Toilet-Enclosure Style: Overhead braced **OR** Floor anchored **OR** Ceiling hung **OR** Floor and ceiling anchored, **as directed**.
2. Entrance-Screen Style: Overhead braced **OR** Floor anchored **OR** Ceiling hung **OR** Floor and ceiling anchored, **as directed**.
3. Urinal-Screen Style: Wall hung, flat panel **OR** Wall hung with integral flanges **OR** Wall hung, wedge shaped **OR** Floor anchored **OR** Overhead braced **OR** Post to ceiling, **as directed**.
4. Door, Panel, and Pilaster Construction: Seamless, metal facing sheets pressure laminated to core material; with continuous, interlocking molding strip or lapped-and-formed edge closures; corners secured by welding or clips and exposed welds ground smooth. Provide with no-sightline system, **as directed**. Exposed surfaces shall be free of pitting, seam marks, roller marks, stains, discolorations, telegraphing of core material, or other imperfections.
    a. Core Material: Manufacturer's standard sound-deadening honeycomb of resin-impregnated kraft paper in thickness required to provide finished thickness of 1 inch (25 mm) for doors and panels and 1-1/4 inches (32 mm) for pilasters.
    b. Grab-Bar Reinforcement: Provide concealed internal reinforcement for grab bars mounted on units.
    c. Tapping Reinforcement: Provide concealed reinforcement for tapping (threading) at locations where machine screws are used for attaching items to units.
5. Urinal-Screen Construction:
    a. Flat-Panel Urinal Screen: Matching panel construction.
    b. Integral-Flange, Wall-Hung Urinal Screen: Similar to panel construction, with integral full-height flanges for wall attachment, and maximum 1-1/4 inches (32 mm) thick.
    c. Wedge-Shaped, Wall-Hung Urinal Screen: Similar to panels, V-shaped, fabricated for concealed wall attachment, and maximum 6 inches (152 mm) wide at wall and minimum 1 inch (25 mm) wide at protruding end.
6. Facing Sheets and Closures: Electrolytically coated steel **OR** Hot-dip galvanized-steel **OR** Electrolytically coated or hot-dip galvanized-steel, **as directed**, sheet with nominal base-metal (uncoated) thicknesses as follows:
    a. Pilasters, Braced at Both Ends (for overhead-braced and floor-and-ceiling-anchored mounting styles): Manufacturer's standard thickness, but not less than 0.036 inch (0.91 mm).
    b. Pilasters, Unbraced at One End (for floor-anchored and ceiling-hung mounting styles): Manufacturer's standard thickness, but not less than 0.048 inch (1.21 mm).
    c. Panels: Manufacturer's standard thickness, but not less than 0.030 inch (0.76 mm) **OR** 0.036 inch (0.91 mm), **as directed**.
    d. Doors: Manufacturer's standard thickness, but not less than 0.030 inch (0.76 mm).
    e. Flat-Panel Urinal Screens: Thickness matching the panels.

f. Integral-Flange, Wall-Hung Urinal Screens (for government-style metal screens): Manufacturer's standard thickness, but not less than 0.030 inch (0.76 mm).
g. Wedge-Shaped, Wall-Hung Urinal Screens: Manufacturer's standard thickness, but not less than 0.036 inch (0.91 mm).

7. Pilaster Shoes and Sleeves (Caps): Stainless-steel sheet, not less than 0.031-inch (0.79-mm) nominal thickness and 3 inches (76 mm) high, finished to match hardware.
8. Urinal-Screen Post (for floor-anchored, overhead-braced, and post-to-ceiling urinal screens): Manufacturer's standard post design of material matching the thickness and construction of pilasters **OR** 1-3/4-inch- (44-mm-) square, aluminum tube with satin finish, **as directed**; with shoe and sleeve (cap), **as directed**, matching that on the pilaster.
9. Brackets (Fittings):
   a. Stirrup Type: Ear or U-brackets; chrome-plated zamac **OR** clear-anodized aluminum **OR** stainless steel **OR** chrome-plated brass, **as directed**.
   b. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel **OR** aluminum, **as directed**.
10. Steel-Sheet Finish: Immediately after cleaning and pretreating, apply manufacturer's standard baked-on finish, including thermosetting, electrostatically applied, and powder coatings. Comply with coating manufacturer's written instructions for applying and baking. Apply one color **OR** two colors, **as directed**, in each room.
    a. Color: As selected from manufacturer's full range.

C. Stainless-Steel Units
1. Toilet-Enclosure Style: Overhead braced **OR** Floor anchored **OR** Ceiling hung **OR** Floor and ceiling anchored, **as directed**.
2. Entrance-Screen Style: Overhead braced **OR** Floor anchored **OR** Ceiling hung **OR** Floor and ceiling anchored, **as directed**.
3. Urinal-Screen Style: Wall hung flat panel **OR** Wall hung with integral flanges **OR** Wall hung, wedge shaped **OR** Floor anchored **OR** Overhead braced **OR** Post to ceiling, **as directed**.
4. Door, Panel, and Pilaster Construction: Seamless, metal facing sheets pressure laminated to core material; with continuous, interlocking molding strip or lapped-and-formed edge closures; corners secured by welding or clips and exposed welds ground smooth. Provide with no-sightline system, **as directed**. Exposed surfaces shall be free of pitting, seam marks, roller marks, stains, discolorations, telegraphing of core material, or other imperfections.
   a. Core Material: Manufacturer's standard sound-deadening honeycomb of resin-impregnated kraft paper in thickness required to provide finished thickness of 1 inch (25 mm) for doors and panels and 1-1/4 inches (32 mm) for pilasters.
   b. Grab-Bar Reinforcement: Provide concealed internal reinforcement for grab bars mounted on units.
   c. Tapping Reinforcement: Provide concealed reinforcement for tapping (threading) at locations where machine screws are used for attaching items to units.
5. Urinal-Screen Construction:
   a. Flat-Panel Urinal Screen: Matching panel construction.
   b. Integral-Flange, Wall-Hung Urinal Screen (for government-style metal screens): Similar to panel construction, with integral full-height flanges for wall attachment, and maximum 1-1/4 inches (32 mm) thick.
   c. Wedge-Shaped, Wall-Hung Urinal Screen: Similar to panels, V-shaped, fabricated for concealed wall attachment, and maximum 6 inches (152 mm) wide at wall and minimum 1 inch (25 mm) wide at protruding end.
6. Facing Sheets and Closures: Stainless-steel sheet of nominal thicknesses as follows:
   a. Pilasters, Braced at Both Ends (for overhead-braced and floor-and-ceiling-anchored mounting styles): Manufacturer's standard thickness, but not less than 0.038 inch (0.95 mm).
   b. Pilasters, Unbraced at One End (for floor-anchored and ceiling-hung mounting styles: Manufacturer's standard thickness, but not less than 0.050 inch (1.27 mm).
   c. Panels: Manufacturer's standard thickness, but not less than 0.031 inch (0.79 mm) **OR** 0.038 inch (0.95 mm), **as directed**.

d. Doors: Manufacturer's standard thickness, but not less than 0.031 inch (0.79 mm).
e. Flat-Panel Urinal Screens: Thickness matching the panels.
f. Integral-Flange, Wall-Hung Urinal Screens (for government-style metal screens: Manufacturer's standard thickness, but not less than 0.031 inch (0.79 mm).
g. Wedge-Shaped, Wall-Hung Urinal Screens: Manufacturer's standard thickness, but not less than 0.038 inch (0.95 mm).

7. Pilaster Shoes and Sleeves (Caps): Stainless-steel sheet, not less than 0.031-inch (0.79-mm) nominal thickness and 3 inches (76 mm) high, finished to match hardware.
8. Urinal-Screen Post (for floor-anchored, overhead-braced, and post-to-ceiling urinal screens): Manufacturer's standard post design of material matching the thickness and construction of pilasters **OR** 1-3/4-inch- (44-mm-) square, aluminum tube with satin finish, **as directed**; with shoe and sleeve (cap) matching that on the pilaster.
9. Brackets (Fittings):
   a. Stirrup Type: Ear or U-brackets; chrome-plated zamac **OR** clear-anodized aluminum **OR** stainless steel **OR** chrome-plated brass, **as directed**.
   b. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel **OR** aluminum, **as directed**.
10. Stainless-Steel Finish: No. 4 bright, directional polish **OR** Manufacturer's standard textured finish, **as directed**, on exposed faces. Protect exposed surfaces from damage by application of strippable, temporary protective covering before shipment.

D. Plastic-Laminate-Faced Units
1. Toilet-Enclosure Style: Overhead braced **OR** Floor anchored **OR** Ceiling hung **OR** Floor and ceiling anchored, **as directed**.
2. Entrance-Screen Style: Overhead braced **OR** Floor anchored **OR** Ceiling hung **OR** Floor and ceiling anchored, **as directed**.
3. Urinal-Screen Style: Wall hung **OR** Floor anchored **OR** Overhead braced **OR** Post to ceiling, **as directed**.
4. Door, Panel, Screen, and Pilaster Construction: One-piece, plastic-laminate facing sheets pressure laminated to core material without splices or joints in facings or cores; with laminate **OR** stainless-steel edge trim 0.050 inch (1.27 mm) thick, **as directed**, applied to edges before faces to seal edges and prevent laminate from being pried loose. Seal exposed core material at cutouts to protect core from moisture. Provide with no-sightline system, **as directed**.
   a. Core Material: Particleboard.
   b. Doors and Panels: Finished to not less than 7/8 inch (22 mm) **OR** 1 inch (25 mm), **as directed**, thick.
   c. Pilasters: Provide construction to comply with one of the following, **as directed**:
      1) Finished to not less than 1-1/4 inches (32 mm) thick and with internal, nominal 0.134-inch- (3.42-mm-) thick, steel-sheet reinforcement, **as directed**.
      2) Finished to 1-1/4 inches (32 mm) thick and with manufacturer's standard steel-sheet core laminated to both sides of honeycomb of resin-impregnated kraft paper in lieu of particleboard core.
      3) Finished to not less than 1 inch (25 mm) thick and with internal, nominal 0.120-inch- (3.04-mm-) thick, steel-sheet reinforcement.
5. Pilaster Shoes and Sleeves (Caps): Formed from stainless-steel sheet, not less than 0.031-inch (0.79-mm) nominal thickness and 3 inches (76 mm) high, finished to match hardware.
6. Urinal-Screen Post (for floor-anchored, overhead-braced, and post-to-ceiling urinal screens): Manufacturer's standard post design of material matching the thickness and construction of pilasters **OR** 1-3/4-inch- (44-mm-) square, aluminum tube with satin finish **OR** 1-1/4-inch- (32-mm-) square, stainless-steel tube 0.050 inch (1.27 mm) thick with satin finish, **as directed**; with shoe and sleeve (cap) matching that on the pilaster.
7. Brackets (Fittings):
   a. Stirrup Type: Ear or U-brackets, chrome-plated zamac **OR** clear-anodized aluminum **OR** stainless steel **OR** chrome-plated brass, **as directed**.

b. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel **OR** aluminum, **as directed**.

8. Plastic-Laminate Finish: One color and pattern **OR** Two colors and patterns, **as directed**, in each room.
   a. Color and Pattern: As selected from manufacturer's full range.

E. Phenolic-Core Units
1. Toilet-Enclosure Style: Overhead braced **OR** Floor anchored **OR** Ceiling hung **OR** Floor and ceiling anchored, **as directed**.
2. Entrance-Screen Style: Overhead braced **OR** Floor anchored **OR** Ceiling hung **OR** Floor and ceiling anchored, **as directed**.
3. Urinal-Screen Style: Wall hung **OR** Floor anchored **OR** Overhead braced **OR** Post to ceiling, **as directed**.
4. Door, Panel, Screen, and Pilaster Construction: Solid phenolic-core panel material with melamine facing on both sides fused to substrate during panel manufacture (not separately laminated), and with eased and polished edges and no-sightline system, **as directed**. Provide minimum 3/4-inch- (19-mm-) thick doors and pilasters and minimum 1/2-inch- (13-mm-) thick panels.
5. Pilaster Shoes and Sleeves (Caps): Fabricated from stainless-steel sheet, not less than 0.031-inch (0.79-mm) nominal thickness and 3 inches (76 mm) high, finished to match hardware.
6. Urinal-Screen Post (for floor-anchored, overhead-braced, and post-to-ceiling urinal screens): Manufacturer's standard post design of monolithic phenolic urinal screen cut out at bottom to form a post **OR** material matching the thickness and construction of pilasters **OR** 1-3/4-inch- (44-mm-) square, aluminum tube with satin finish, **as directed**; with shoe and sleeve (cap) matching that on the pilaster.
7. Brackets (Fittings):
   a. Stirrup Type: Ear or U-brackets, chrome-plated zamac **OR** clear-anodized aluminum **OR** stainless steel **OR** chrome-plated brass, **as directed**.
   b. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel **OR** aluminum, **as directed**.
8. Phenolic-Panel Finish:
   a. Facing Sheet Finish: One color and pattern **OR** Two colors and patterns, **as directed**, in each room.
   b. Color and Pattern: As selected from manufacturer's full range, with manufacturer's standard dark color core **OR** through-color core matching face sheet, **as directed**.

F. Solid-Polymer Units
1. Toilet-Enclosure Style: Overhead braced **OR** Floor anchored **OR** Ceiling hung **OR** Floor and ceiling anchored, **as directed**.
2. Entrance-Screen Style: Overhead braced **OR** Floor anchored **OR** Ceiling hung **OR** Floor and ceiling anchored, **as directed**.
3. Urinal-Screen Style: Wall hung **OR** Floor anchored **OR** Overhead braced **OR** Post to ceiling, **as directed**.
4. Door, Panel, Screen, and Pilaster Construction: Solid, high-density polyethylene (HDPE) **OR** polypropylene (PP), **as directed**, panel material, not less than 1 inch (25 mm) thick, seamless, with eased edges, no-sightline system, **as directed**, and with homogenous color and pattern throughout thickness of material.
   a. Integral Hinges: Configure doors and pilasters to receive integral hinges.
   b. Heat-Sink Strip: Manufacturer's standard continuous, extruded-aluminum **OR** stainless-steel, **as directed**, strip fastened to exposed bottom edges of solid-polymer components to prevent burning.
   c. Color and Pattern: One color and pattern **OR** Two colors and patterns, **as directed**, in each room as indicated by manufacturer's designations **OR** as selected from manufacturer's full range, **as directed**.
5. Pilaster Shoes and Sleeves (Caps): Manufacturer's standard design; polymer **OR** stainless steel, **as directed**.

a. Polymer Color and Pattern: Matching pilaster **OR** Contrasting with pilaster, as indicated by manufacturer's designations **OR** Contrasting with pilaster, as selected from manufacturer's full range, **as directed**.

6. Urinal-Screen Post (for floor-anchored, overhead-braced, and post-to-ceiling urinal screens): Manufacturer's standard post design of material matching the thickness and construction of pilasters **OR** 1-3/4-inch- (44-mm-) square, aluminum tube with satin finish, **as directed**; with shoe and sleeve (cap) matching that on the pilaster.
7. Brackets (Fittings):
   a. Stirrup Type: Ear or U-brackets, chrome-plated zamac **OR** clear-anodized aluminum **OR** stainless steel **OR** chrome-plated brass, **as directed**.
   b. Full-Height (Continuous) Type: Manufacturer's standard design; polymer or extruded aluminum **OR** polymer **OR** extruded aluminum **OR** stainless steel, **as directed**.
      1) Polymer Color and Pattern: Matching panel **OR** Contrasting with panel, as indicated by manufacturer's designations **OR** Contrasting with panel, as selected from manufacturer's full range, **as directed**.
8. Overhead Cross Bracing for Ceiling-Hung Units: As recommended by manufacturer and fabricated from solid polymer.

G. Accessories

1. Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories.
   a. Material: Chrome-plated zamac **OR** Clear-anodized aluminum **OR** Stainless steel **OR** Chrome-plated brass, **as directed**.
   b. Hinges: Manufacturer's standard paired, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees **OR** continuous, cam type that swings to a closed or partially open position **OR** continuous, spring-loaded type **OR** integral hinge for solid-polymer doors, **as directed**.
   c. Latch and Keeper: Manufacturer's standard recessed **OR** surface-mounted, **as directed**, latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
   d. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories.
   e. Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging doors and entrance-screen doors, **as directed**.
   f. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.
2. Overhead Bracing (for overhead-braced units): Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.
3. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel or chrome-plated steel or brass, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel.

H. Fabrication

1. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.
2. Floor-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.
3. Ceiling-Hung Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at pilasters for connection to structural support above finished

ceiling. Provide assemblies that support pilasters from structure without transmitting load to finished ceiling. Provide sleeves (caps) at tops of pilasters to conceal anchorage.

4. Floor-and-Ceiling-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment at tops and bottoms of pilasters. Provide shoes and sleeves (caps) at pilasters to conceal anchorage.
5. Urinal-Screen Posts: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment at tops and bottoms, **as directed**, of posts. Provide shoes and sleeves (caps) at posts to conceal anchorage.
6. Door Size and Swings: Unless otherwise indicated, provide 24-inch- (610-mm-) wide, in-swinging doors for standard toilet compartments and 36-inch- (914-mm-) wide, out-swinging doors with a minimum 32-inch- (813-mm-) wide, clear opening for compartments designated as accessible.

1.3 EXECUTION

A. Installation

1. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.
    a. Maximum Clearances:
        1) Pilasters and Panels: 1/2 inch (13 mm).
        2) Panels and Walls: 1 inch (25 mm).
    b. Stirrup Brackets: Secure panels to walls and to pilasters with no fewer than two brackets attached **OR** three brackets attached at midpoint and, **as directed**, near top and bottom of panel.
        1) Locate wall brackets so holes for wall anchors occur in masonry or tile joints.
        2) Align brackets at pilasters with brackets at walls.
2. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches (44 mm) into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels, and adjust so tops of doors are parallel with overhead brace when doors are in closed position.
3. Floor-Anchored Units: Set pilasters with anchors penetrating not less than 2 inches (51 mm) into structural floor unless otherwise indicated in manufacturer's written instructions. Level, plumb, and tighten pilasters. Hang doors and adjust so tops of doors are level with tops of pilasters when doors are in closed position.
4. Ceiling-Hung Units: Secure pilasters to supporting structure and level, plumb, and tighten. Hang doors and adjust so bottoms of doors are level with bottoms of pilasters when doors are in closed position.
5. Floor-and-Ceiling-Anchored Units: Secure pilasters to supporting construction and level, plumb, and tighten. Hang doors and adjust so doors are level and aligned with panels when doors are in closed position.
6. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

B. Adjusting

1. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors and doors in entrance screens to return doors to fully closed position.

END OF SECTION 10 21 13 13

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Task	Specification	Specification Description
10 21 13 13	01 22 16 00	No Specification Required
10 21 13 14	01 22 16 00	No Specification Required
10 21 13 14	10 21 13 13	Toilet Compartments
10 21 13 16	01 22 16 00	No Specification Required
10 21 13 16	10 21 13 13	Toilet Compartments

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SECTION 10 21 13 19 - SOLID SURFACE MATERIAL TOILET COMPARTMENTS

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for solid surface material toilet compartments. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   2. Samples:
      a. Panel: 1'-0" by 1'-0" panel showing construction with two sides and two edges, including one finished corner condition.
      b. Hardware: Actual hardware item
   3. Manufacturer's installation and maintenance instructions.

C. Warranty
   1. Special Warranty: Solid surface material compartment manufacturer's three year warranty against defects in fabricated products. Provide for product replacement only; labor not included. Damage caused by physical or chemical abuse is not warrantied.

1.2 PRODUCTS

A. Manufactured Units
   1. Product standard of quality: E.I. DuPont de Nemours and Company, Inc.; Privacy Partitions.

B. Types:
   1. Floor supported, overhead braced compartments.
   2. Wall hung urinal screens.

C. Materials:
   1. Partitions, panels, headrails, and doors:
      a. Material: E.I. DuPont de Nemours and Company, Inc.; Corian, or approved equivalent.
      b. Characteristics:
         1) Material type: Homogeneous filled methyl methacrylate sheet, not coated.
         2) Meet ANSI Zl24.3 and 6, Type Six.
         3) Thickness: 1/2".
            a) Partition panels and doors: 1/2".
            b) Urinal screen panels: 1/2".
      c. Colors: Selected from manufacturer's color selection.
      d. Finish: Matte.
   2. Pilasters, hardware, and fittings: Note requirements in FABRICATION Article for hardware concealment.
      a. Pilaster material: Same material as panels; 1" thickness.
      b. Acceptable hardware manufacturer: Jack Knob Hardware, or approved equivalent.
      c. Hinges:
         1) ANSI Type 304 stainless steel; surface mounted; self closing pivot hinge type, two per door; matt finish.
         2) Type: Adjustable to return door by gravity to preset position when not latched.
      d. Wall brackets:

1) Material: ASTM B209-90, extruded aluminum alloy 6463-T5, mill finish, full length continuous wall brackets; extrusion weighing not less than 1.685 lbs. per LF.
2) Predrill by manufacturer; holes spaced 6" along full bracket length; tamper resistant bolt attachment.

e. Pilaster hanger:
1) Manufacturer's standard galvanized anchorage device for attachment of pilaster to structural support and for leveling compartment.
2) Hanger consists of threaded rods, saddle, lock washers, and leveling nuts.
3) Design pilaster hangers to transmit loads to above-ceiling support system, not finished ceiling.

f. Pilaster base:
1) Type: Manufacturer's standard galvanized anchorage devices for attachment of pilaster to supporting floor and for leveling of compartment. Base consists of threaded rods, saddle, lock washers, leveling nuts, and minimum of two brass or lead expansion shields per base.
2) Anchor penetration: Penetrate floor at least 1" for overhead braced compartments.

g. Latch and keeper: AISI Type 304 Type stainless steel; 360 deg. pivot on latch; ADA compatible; surface mounted.
h. Door stop/bumper: AISI Type 304 Type stainless steel; surface mounted.
i. Door pull: Same material as panels; meet ADA requirements on handicap stalls.
j. Coat hook; one per unit: Same material as panels; surface mounted.
k. Grab bar mounting plate: Same material as panels; recessed back; complete with "T" nuts and screws; one per each mounting location to divider panel.
l. Headrail for overhead braced units: ASTM B209-90, 6063-T6 extruded aluminum, satin anodized finish.

D. Accessories:
1. Exposed fasteners: Stainless steel or chrome plated brass with theft resistant one-way heads,
2. Unexposed fasteners: Galvanized steel, hot-dip coated following fabrication.
3. Inserts for door hardware, hinges, latches, and coat hooks: Threaded steel.
4. Adhesives: Type recommended by panel material manufacturer for joints.
5. Silicone sealant: Specified in Joints Sealants Section.

E. Fabrication
1. Shop assembly:
a. Fabricate components in accord with manufacturers standards, without face or edge seams in solid plastic material; bevel exposed edges.
b. Factory install metal inserts into components for screw fastened hardware; fasteners secured directly into core are prohibited.
c. Pre-notch and predrill panels for hardware at factory. Exposed hardware in completed installation includes only the following items or portion of items:
1) Door hinge barrel.
2) Door latch and keeper.
3) Door striker.
d. Cover hardware with 1/2" solid surfacing material strips, except as indicated above.
e. Secure templates and factory cut panels for installation of accessories furnished under other Sections.
f. Doors: Inswing and outswing type indicated.
g. Exposed surfaces free from marks and blemishes; completely hide through material joints.
2. Tolerances; variation in size: ±1/8"

1.3 EXECUTION

A. Installation

1. General:
   a. Erect solid surface material compartment system plumb; attach to supporting structure indicated on reviewed shop drawings.
   b. Attach solid surface material compartment system to back-up construction; use fasteners indicated on reviewed shop drawings.
   c. Secure solid surface material panels to walls with continuous mounting flanges.
   d. Locate wall brackets aligning holes for fasteners with masonry or tile joints.
   e. Floor supported, overhead braced compartments:
      1) Attach pilasters to supporting floor with pilaster base indicated on reviewed shop drawings.
      2) Level and plumb compartments. Tighten pilaster base fasteners.
      3) Secure pilaster shoes in position against finished floor.
      4) Secure headrail to panels with minimum of two fasteners per face. Provide cover plates for exposed ends.
      5) Set door tops parallel with headrail when doors are in closed position.
   f. Wall hung screens:
      1) Attach screens to wall construction with brackets and fasteners, indicated on reviewed shop drawings.
      2) Position and level units. Tighten fasteners in place.

B. Application
1. Tolerances:
   a. Between panel and pilaster: 1/2", except where concealed fasteners are used.
   b. Between door edge and pilaster: 1/4"
   c. Between panel and wall: 1".
2. Conceal evidence of drilling, cutting, and fitting to room finishes.

C. Adjustment And Cleaning
1. Adjustment:
   a. Lubricate and adjust hardware. Tighten fasteners.
   b. Set hinges on in-swing doors to hold doors open approximately 15 deg. from closed position when unlatched.
   c. Set hinges on out-swing doors to return to closed position.
2. Cleaning:
   a. Remove protective coverings from compartments and hardware.
   b. Clean exposed surfaces of compartments and hardware using materials and methods recommended by solid surface material compartment system manufacturer.

END OF SECTION 10 21 13 19

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Task	Specification	Specification Description
10 21 13 19	10 21 13 13	Toilet Compartments
10 21 13 40	10 21 13 13	Toilet Compartments
10 21 13 43	01 22 16 00	No Specification Required
10 21 13 43	10 21 13 13	Toilet Compartments

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SECTION 10 21 16 17 - SHOWER AND DRESSING COMPARTMENTS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for shower and dressing compartments. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Shower compartments fabricated from steel, stainless steel, solid phenolic, or solid polymer.
      b. Dressing compartments fabricated from steel, stainless steel, solid phenolic, solid polymer, or plastic laminate.
      c. Shower receptors.

C. Submittals
   1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. LEED Submittals:
      a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
      b. Product Data for Credit EQ 4.4: For particleboard, documentation indicating that product contains no urea formaldehyde.
   3. Shop Drawings: For shower and dressing compartments. Include plans, elevations, sections, details, and attachments to other work.
      a. Show locations of cutouts for compartment-mounted accessories.
      b. Show locations of reinforcements for compartment-mounted grab bars.
      c. Show locations of centerlines of drains.
      d. Show ceiling grid and overhead support or bracing locations.
   4. Samples: For the following products, in manufacturer's standard sizes unless otherwise indicated:
      a. Each type of material, color, and finish required for compartments, prepared on 6-inch- (152-mm-) square Samples of same thickness and material indicated for the Work.
      b. Each type of hardware and accessory.
      c. Curtain Fabric: 12-inch- (305-mm-) square swatch or larger as required to show complete pattern repeat, from dye lot used for the Work, with specified treatments applied. Mark top and face of material.
   5. Product Certificates: For each type of shower and dressing compartment, from manufacturer.
   6. Maintenance Data: For shower and dressing compartments to include in maintenance manuals.

D. Quality Assurance
   1. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84, or another standard acceptable to authorities having jurisdiction, by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
      a. Flame-Spread Index: 25 **OR** 75 **OR** 200, **as directed**, or less.
      b. Smoke-Developed Index: 450 or less.
   2. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1 for shower and dressing compartments designated as accessible.

E. Project Conditions
1. Field Measurements: Verify actual locations of walls, columns, ceilings, and other construction contiguous with shower and dressing compartments by field measurements before fabrication.

1.2 PRODUCTS

A. Materials
1. Aluminum Castings: ASTM B 26/B 26M.
2. Aluminum Extrusions: ASTM B 221 (ASTM B 221M).
3. Brass Castings: ASTM B 584.
4. Brass Extrusions: ASTM B 455.
5. Steel Sheet: ASTM A 653/A 653M, either hot-dip galvanized or galvannealed; mill phosphatized and selected for smoothness.
6. Stainless-Steel Sheet: ASTM A 666, Type 304, stretcher-leveled standard of flatness.
7. Stainless-Steel Castings: ASTM A 743/A 743M.
8. Particleboard: ANSI A208.1, Grade M-2 with 45-lb (20.4-kg) density, made with binder containing no urea formaldehyde.
9. Plastic Laminate: NEMA LD 3, general-purpose HGS grade, 0.048-inch (1.2-mm) nominal thickness.

B. Steel Compartments
1. Configuration: Shower compartment **OR** Shower and dressing compartments **OR** Shower compartment with two dressing compartments **OR** As shown on Drawings, **as directed**.
2. Enclosure Style: Overhead braced **OR** Floor and ceiling anchored, **as directed**.
3. Panel and Pilaster Construction: Seamless metal facing sheets, pressure laminated to core material; with continuous, interlocking molding strip or lapped-and-formed edge closures and with corners secured by welding or clips and exposed welds ground smooth. Exposed surfaces shall be free of pitting, seam marks, roller marks, stains, discolorations, telegraphing of core material, or other imperfections.
   a. Core Material: Manufacturer's standard, sound-deadening honeycomb of resin-impregnated kraft paper in thickness required to provide finished thickness of 1 inch (25 mm) for panels and 1-1/4 inches (32 mm) for pilasters.
   b. Grab-Bar Reinforcement: Provide concealed internal reinforcement for grab bars mounted on compartments.
   c. Tapping Reinforcement: Provide concealed reinforcement for tapping (threading) at locations where machine screws are used for attaching items to compartments.
4. Door Construction: Match panels; 1-inch (25-mm) finished thickness.
5. Facing Sheets and Closures: Hot-dip galvanized-steel sheet with nominal base-metal (uncoated) thicknesses as follows:
   a. Pilasters, Braced at Both Ends: Manufacturer's standard thickness, but not less than 0.036 inch (0.91 mm).
   b. Panels: Manufacturer's standard thickness, but not less than 0.030 inch (0.76 mm) **OR** 0.036 inch (0.91 mm), **as directed**.
   c. Doors: Manufacturer's standard thickness, but not less than 0.030 inch (0.76 mm).
6. Pilaster Shoes and Sleeves (Caps): Formed from stainless-steel sheet, not less than 0.031-inch (0.79-mm) nominal thickness and 3 inches (76 mm) high, finished to match hardware.
7. Brackets (Fittings):
   a. Full-Height (Continuous) Type: Manufacturer's standard design; clear-anodized aluminum.
   b. Stirrup Type: Ear or U-brackets; clear-anodized aluminum **OR** stainless steel **OR** chrome-plated brass, **as directed**.
   c. Dressing-Compartment Brackets: Match toilet-compartment brackets specified in Division 10 Section "Toilet Compartments".
8. Steel-Sheet Finish: Immediately after cleaning and pretreating, apply manufacturer's standard baked-on finish, including thermosetting, electrostatically applied, and powder coatings. Comply

with coating manufacturer's written instructions for applying and baking. Apply one color **OR** two colors, **as directed**, in each room.

a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range **OR** Match steel toilet compartments specified in Division 10 Section "Toilet Compartments", **as directed**.

C. Stainless-Steel Compartments

1. Configuration: Shower compartment **OR** Shower and dressing compartments **OR** Shower compartment with two dressing compartments **OR** As shown on Drawings, **as directed**.
2. Enclosure Style: Overhead braced **OR** Floor and ceiling anchored, **as directed**.
3. Panel and Pilaster Construction: Seamless metal facing sheets, pressure laminated to core material; with continuous, interlocking molding strip or lapped-and-formed edge closures and with corners secured by welding or clips and exposed welds ground smooth. Exposed surfaces shall be free of pitting, seam marks, roller marks, stains, discolorations, telegraphing of core material, or other imperfections.
    a. Core Material: Manufacturer's standard, sound-deadening honeycomb of resin-impregnated kraft paper in thickness required to provide finished thickness of 1 inch (25 mm) for panels and 1-1/4 inches (32 mm) for pilasters.
    b. Grab-Bar Reinforcement: Provide concealed internal reinforcement for grab bars mounted on compartments.
    c. Tapping Reinforcement: Provide concealed reinforcement for tapping (threading) at locations where machine screws are used for attaching items to compartments.
4. Door Construction: Match panels; 1-inch (25-mm) finished thickness.
5. Facing Sheets and Closures: Stainless-steel sheet of nominal thicknesses as follows:
    a. Pilasters, Braced at Both Ends: Manufacturer's standard thickness, but not less than 0.038 inch (0.95 mm).
    b. Panels: Manufacturer's standard thickness, but not less than 0.031 inch (0.79 mm) **OR** 0.038 inch (0.95 mm), **as directed**.
6. Doors: Manufacturer's standard thickness, but not less than 0.031 inch (0.79 mm).
7. Pilaster Shoes and Sleeves (Caps): Formed from stainless-steel sheet, not less than 0.031-inch (0.79-mm) nominal thickness and 3 inches (76 mm) high, finished to match hardware.
8. Brackets (Fittings):
    a. Full-Height (Continuous) Type: Manufacturer's standard design; clear-anodized aluminum.
    b. Stirrup Type: Ear or U-brackets; clear-anodized aluminum **OR** stainless steel **OR** chrome-plated brass, **as directed**.
    c. Dressing-Compartment Brackets: Match toilet-compartment brackets specified in Division 10 Section "Toilet Compartments".
9. Stainless-Steel Finish: No. 4, bright, directional polish **OR** Manufacturer's standard textured finish **OR** Match stainless-steel toilet-compartment finish, specified in Division 10 Section "Toilet Compartments", **as directed**, on exposed faces. Protect exposed surfaces from damage by applying strippable, temporary protective covering before shipment.

D. Phenolic-Core Compartments

1. Configuration: Shower compartment **OR** Shower and dressing compartments **OR** Shower compartment with two dressing compartments **OR** As shown on Drawings, **as directed**.
2. Enclosure Style: Overhead braced **OR** Floor and ceiling anchored, **as directed**.
3. Panel and Pilaster Construction: Solid phenolic material consisting of solid phenolic-core panel with melamine facing on both sides fused to substrate during panel manufacture (not separately laminated) and with eased and polished edges. Provide minimum 3/4-inch- (19-mm-) thick pilasters and minimum 1/2-inch- (13-mm-) thick panels.
4. Door Construction: Match panels; 3/4-inch (19-mm) minimum thickness.
5. Pilaster Shoes and Sleeves (Caps): Formed from stainless-steel sheet, not less than 0.031-inch (0.79-mm) nominal thickness and 3 inches (76 mm) high, finished to match hardware.
6. Brackets (Fittings):
    a. Full-Height (Continuous) Type: Manufacturer's standard design; clear-anodized aluminum.

b. Stirrup Type: Ear or U-brackets; clear-anodized aluminum **OR** stainless steel **OR** chrome-plated brass, **as directed**.
c. Dressing-Compartment Brackets: Match toilet-compartment brackets specified in Division 10 Section "Toilet Compartments".

7. Phenolic-Core-Panel Finish:
   a. Facing Sheet Finish: One color and pattern **OR** Two colors and patterns, **as directed**, in each room.
   b. Color and Pattern: As indicated by manufacturer's designations, **OR** As selected from manufacturer's full range, **OR** Match phenolic-core toilet compartments specified in Division 10 Section "Toilet Compartments", **as directed**, with manufacturer's standard dark-color core **OR** through-color core matching face sheet, **as directed**.

E. Solid-Polymer Compartments
1. Configuration: Shower compartment **OR** Shower and dressing compartments **OR** Shower compartment with two dressing compartments **OR** As shown on Drawings, **as directed**.
2. Enclosure Style: Overhead braced **OR** Floor and ceiling anchored, **as directed**.
3. Panel and Pilaster Construction: Solid HDPE panel material, not less than 1 inch (25 mm) thick, seamless, with eased edges and with homogenous color and pattern throughout thickness of material.
   a. Integral Hinges: Configure doors and pilasters to receive integral hinges.
   b. Heat-Sink Strip: Manufacturer's standard, continuous, clear-anodized extruded-aluminum or stainless-steel strip fastened to exposed bottom edges of solid-polymer components to prevent burning.
   c. Color and Pattern: One color and pattern **OR** Two colors and patterns, **as directed**, in each room; as indicated by manufacturer's designations **OR** as selected from manufacturer's full range **OR** match solid-polymer toilet compartments specified in Division 10 Section "Toilet Compartments", **as directed**.
4. Door Construction: Match panels.
5. Pilaster Shoes and Sleeves (Caps): Manufacturer's standard design; polymer or stainless steel.
   a. Polymer Color and Pattern: Match pilaster **OR** Contrast with pilaster, as indicated by manufacturer's designations **OR** Contrast with pilaster, as selected from manufacturer's full range **OR** Match solid-polymer toilet compartments specified in Division 10 Section "Toilet Compartments", **as directed**.
6. Brackets (Fittings):
   a. Full-Height (Continuous) Type: Manufacturer's standard design; polymer or clear-anodized extruded aluminum **OR** polymer **OR** clear-anodized extruded aluminum, **as directed**.
      1) Polymer Color and Pattern: Match panel **OR** Contrast with panel, as indicated by manufacturer's designations **OR** Contrast with panel, as selected from manufacturer's full range **OR** Match solid-polymer toilet compartments specified in Division 10 Section "Toilet Compartments", **as directed**.
   b. Stirrup Type: Ear or U-brackets; clear-anodized aluminum **OR** stainless steel **OR** chrome-plated brass, **as directed**.
   c. Dressing-Compartment Brackets: Match toilet-compartment brackets specified in Division 10 Section "Toilet Compartments".

F. Plastic-Laminate-Faced Dressing Compartments
1. Configuration: Dressing compartment attached to steel **OR** stainless-steel **OR** phenolic-core **OR** solid-polymer, **as directed**, shower compartment as shown on Drawings.
2. Enclosure Style: Overhead braced **OR** Floor and ceiling anchored, **as directed**.
3. Panel and Pilaster Construction: One-piece, plastic-laminate facing sheets pressure laminated to core material without splices or joints in facings or cores; with laminate **OR** stainless-steel edge trim 0.050 inch (1.27 mm) thick, **as directed**, applied to edges before faces to seal edges and prevent laminate from being pried loose. Seal exposed core material at cutouts to protect core from moisture.
   a. Core Material: Particleboard.

b. Panels: Finished to not less than 1 inch (25 mm) thick.

c. Pilasters: Comply with one of the following:

1) Finished to not less than 1-1/4 inches (32 mm) thick and with internal, nominal 0.134-inch- (3.42-mm-) thick, steel-sheet reinforcement.

OR

Finished to not less than 1 inch (25 mm) thick and with internal, nominal 0.120-inch- (3.04-mm-) thick, steel-sheet reinforcement.

4. Door Construction: Match panels.

5. Pilaster Shoes and Sleeves (Caps): Formed from stainless-steel sheet, not less than 0.031-inch (0.79-mm) nominal thickness and 3 inches (76 mm) high, finished to match hardware.

6. Brackets (Fittings):

a. Full-Height (Continuous) Type: Manufacturer's standard design; clear-anodized aluminum.

b. Stirrup Type: Ear or U-brackets; clear-anodized aluminum **OR** stainless steel **OR** chrome-plated brass, **as directed**.

7. Plastic-Laminate Finish: One color and pattern **OR** Two colors and patterns, **as directed**, in each room.

a. Color and Pattern: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range **OR** Match toilet compartments specified in Division 10 Section "Toilet Compartments", **as directed**.

G. Shower Receptors

1. General: Manufacturer's standard, prefabricated, terrazzo receptor complete with integral drain.

a. Curb: Not less than 2 inches (51 mm) and not more than 9 inches (229 mm) deep when measured from the top of the curb to the top of the drain; with curb threshold not less than 1 inch (25 mm) below the sides and back of the receptor; and with a ramped entrance surface for accessible compartments, **as directed**.

b. Floor: Finished, sloping uniformly toward the drain and not less than 1/4 unit vertical in 12 units horizontal and not more than 1/2 inch (13 mm).

c. Drain Strainer: Manufacturer's standard, removable brass strainer **OR** chrome strainer **OR** stainless-steel strainer **OR** plastic strainer, matching the receptor, **as directed**.

d. Drain Gasket: Manufacturer's standard gasket sized to fit waste pipe.

e. Waterstop: Manufacturer's standard, continuous galvanized-steel flange or rabbeted groove to receive panels and create a waterstop when panels are in place.

2. Finish: Manufacturer's standard finish on exposed surfaces, matching the enclosure panels **OR** contrasting with the enclosure panels, as indicated by manufacturer's designations **OR** contrasting with the enclosure panels, as selected from manufacturer's full range, **as directed**, and with slip-resistant floor surface texture.

H. Accessories

1. Door Hardware and Accessories: Manufacturer's standard design, heavy-duty, operating hardware and accessories.

a. Material: Clear-anodized aluminum **OR** Stainless steel **OR** Chrome-plated brass, **as directed**.

b. Hinges: Manufacturer's standard, paired, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees **OR** continuous, cam type that swings to a closed or partially open position **OR** continuous, spring-loaded type **OR** integral hinge for solid-polymer doors, **as directed**.

c. Latch and Keeper: Manufacturer's standard, recessed **OR** surface-mounted, **as directed**, latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at each compartment, accessible or not **OR** at compartments designated as accessible, **as directed**.

d. Clothing Hooks: Manufacturer's standard clothing hooks in each dressing compartment; include one combination hook and rubber-tipped bumper at in-swinging doors, sized to prevent door from hitting wall panel or compartment-mounted accessories, **as directed**.

e. Door Bumper: Manufacturer's standard, rubber-tipped bumper at out-swinging doors.

f. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.

2. Overhead Bracing: Manufacturer's standard, continuous, extruded-aluminum head rail or cap with antigrip profile; in manufacturer's standard finish.

3. Head Rail with Hooks: Manufacturer's standard, continuous, extruded-aluminum head rail or cap with curtain hooks running in concealed track; with antigrip profile; in manufacturer's standard finish.

OR

Curtain Rod with Hooks: Manufacturer's standard, 1-inch- (25-mm-) diameter, stainless-steel curtain rod with matching hooks.

4. Curtain: Flame-resistant, polyester-reinforced vinyl fabric **OR** manufacturer's standard fabric, **as directed**, that is stain resistant, self-sanitizing, antistatic, and antimicrobial; launderable to a temperature of not less than 90 deg F (32 deg C).

a. Flame Resistance: Passes NFPA 701 tests when tested by a testing and inspecting agency acceptable to authorities having jurisdiction.

b. Labeling: Identify fabrics with appropriate markings of applicable testing and inspecting agency.

c. Curtain Grommets: Two-piece, rolled-edge, rustproof, nickel-plated brass; spaced not more than 6 inches (152 mm) o.c.; machined into top hem.

d. Length: Where curtain extends to a floor surface, size so that bottom hem clears finished floor by not more than 1 inch (25 mm) and not less than 1/2 inch (13 mm) above floor surface. Where curtains extend to a shower-receptor curb, size so that bottom hem hangs above curb line and clears curb line by not more than 1/2 inch (13 mm).

e. Color and Pattern: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

5. Soap Holder: Surface-mounted **OR** Recessed, **as directed**, seamless stainless-steel soap dish.

6. Seats: Manufacturer's standard, panel-mounted, wall-mounted or floor-mounted benches.

a. Material: Wood **OR** Solid phenolic **OR** Molded plastic **OR** Stainless steel, **as directed**.

b. Operation: Fixed **OR** Folding, **as directed**.

c. Finish: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range **OR** Match enclosure panels, **as directed**.

7. Anchorages and Fasteners: Manufacturer's standard, exposed fasteners of stainless steel, chrome-plated steel, or solid brass, finished to match the items they are securing; with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel.

I. Fabrication

1. Overhead-Braced Compartments: Provide manufacturer's standard, corrosion-resistant supports, leveling method, and anchors at pilasters and walls to suit floor and wall conditions. Provide shoes at pilasters to conceal supports and leveling method.

2. Floor-and-Ceiling-Anchored Compartments: Provide manufacturer's standard, corrosion-resistant anchoring assemblies at pilasters and walls with leveling adjustment at tops and bottoms of pilasters. Provide shoes and sleeves (caps) at pilasters to conceal anchorage.

3. Door Sizes and Swings: Unless otherwise indicated, provide 24-inch- (610-mm-) wide, in-swinging doors for standard shower and dressing compartments, and 36-inch- (914-mm-) wide, out-swinging doors with a minimum 32-inch- (813-mm-) wide, clear opening for compartments designated as accessible.

1.3 EXECUTION

A. Installation

1. General: Comply with manufacturer's written installation instructions. Install compartments rigid, straight, level, and plumb. Secure compartments in position with manufacturer's recommended anchoring devices.
   a. Maximum Clearances for Dressing Compartment:
      1) Pilasters and Panels: 1/2 inch (13 mm).
      2) Panels and Walls: 1 inch (25 mm).
   b. Stirrup Brackets: Secure panels to walls and to pilasters with no fewer than two brackets attached **OR** three brackets attached at midpoint and, **as directed**, near top and bottom of panel.
      1) Locate wall brackets so holes for wall anchors occur in masonry or tile joints.
      2) Align brackets at pilasters with brackets at walls.
2. Overhead-Braced Compartments: Secure pilasters to floor, and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches (44 mm) into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels, and adjust so tops of doors are parallel with overhead brace when doors are in closed position, **as directed**.
3. Floor-and-Ceiling-Anchored Compartments: Secure pilasters to supporting construction, and level, plumb, and tighten. Hang doors and adjust so doors are level and aligned with panels when doors are in closed position, **as directed**.
4. Curtains: Install curtains to specified length and verify that they hang vertically without stress points or diagonal folds.
5. Shower Receptors: Install prefabricated shower receptors with drain gasket compression fit to outside diameter of waste pipe.

B. Adjusting
1. Curtain Adjustment: After hanging curtains, test and adjust each track or rod to produce unencumbered, smooth operation. Steam and dress down curtains as required to produce crease- and wrinkle-free installation. Remove and replace curtains that are stained or soiled or that have stress points or diagonal folds.
2. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION 10 21 16 17

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SECTION 10 21 16 17a - CUBICLE CURTAINS AND TRACKS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for cubicle curtains and tracks. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Curtain tracks and curtain carriers.
   b. IV tracks and hangers.
   c. Cubicle, dressing area, tub, and shower curtains.

C. Definition
1. IV: Intravenous.

D. Performance Requirements
1. Curtains: Provide curtain fabrics with the following characteristics:
   a. Fabrics are launderable to a temperature of not less than 160 deg F (71 deg C) **OR** 90 deg F (32 deg C), **as directed**.
   b. Fabrics are flame resistant and are identical to those that have passed NFPA 701 when tested by a testing and inspecting agency acceptable to authorities having jurisdiction.
      1) Identify fabrics with appropriate markings of applicable testing and inspecting agency.

E. Submittals
1. Product Data: Include durability, laundry temperature limits, fade resistance, and fire-test-response characteristics for each type of curtain fabric indicated.
   a. Include data on each type of applied curtain treatment.
2. Shop Drawings: Show layout and types of cubicles, sizes of curtains, number of carriers, anchorage details, and conditions requiring accessories. Indicate dimensions taken from field measurements.
   a. Include details on blocking above ceiling and in walls.
3. Samples: For each type of product required.
4. Curtain and Track Schedule: Use same designations indicated on Drawings.
5. Operation and Maintenance Data.

1.2 PRODUCTS

A. Curtain Tracks
1. Extruded-Aluminum Track: Not less than 1-1/4 inches wide by 3/4 inch high (32 mm wide by 19 mm high) **OR** 5/8 inch wide by 1/2 inch high (16 mm wide by 13 mm high), **as directed**; with minimum wall thickness of 0.050 inch (1.27 mm) **OR** 0.058 inch (1.47 mm) **OR** 0.062 inch (1.57 mm), **as directed**.
   a. Curved Track: Factory-fabricated, 12-inch- (305-mm-) **OR** 14-inch- (356-mm-) **OR** 18-inch- (457-mm-), **as directed**, radius bends.
   b. Finish: Clear anodized **OR** Satin anodized **OR** Baked enamel, acrylic, or epoxy, **as directed**.
2. PVC Track: Not less than 1-1/4 inches wide by 15/16 inch high (32 mm wide by 24 mm high).
   a. Curved Track: Factory-fabricated, 12-inch- (305-mm-) radius bends.

3. Track Accessories: Fabricate splices, end caps, connectors, end stops, coupling and joining sleeves, wall flanges, brackets, ceiling clips, and other accessories from same material and with same finish as track.
    a. Suspended Track Support: Not less than 5/8-inch- (16-mm-) square **OR** 7/8-inch- (22.2-mm-) OD, **as directed**, tube.
    b. End Stop: Nonremovable **OR** Removable with carrier hook, **as directed**.
    c. Switch Unit: Shuttle and coupling device for rerouting and securing cubicle curtain, with pull chain for switching track.
    d. Hinged Loading Unit: Detachable hinge and lock unit factory assembled on 60-inch (1524-mm) section of manufacturer's extruded-aluminum track. Provide 1 operating wand for every 10 cubicles.
4. Curtain Carriers: Two nylon rollers and nylon axle with chrome-plated steel **OR** nylon **OR** aluminum, **as directed**, hook.
5. Curtain Carriers: One-piece nylon glide with chrome-plated steel **OR** nylon, **as directed**, hook.
6. Breakaway Curtain Carriers: One-piece nylon **OR** Velcro, **as directed**, breakaway curtain carriers designed to allow curtains to detach from tracks with a pulling force of no more than 5 lbf (22.2 N).
7. Exposed Fasteners: Stainless steel.
8. Concealed Fasteners: Hot-dip galvanized **OR** Stainless steel, **as directed**.

B. IV Support Systems
1. Extruded-Aluminum IV Track: Not less than 1-1/4 inches wide by 3/4 inch high (32 mm wide by 19 mm high); with minimum wall thickness of 0.058 inch (1.47 mm) **OR** 0.062 inch (1.57 mm), **as directed**.
    a. Curved Track: Factory fabricated 12-inch- (305-mm-) **OR** 14-inch- (356-mm-) **OR** 18-inch- (457-mm-), **as directed**, radius bends.
    b. Finish: Clear anodized **OR** Satin anodized **OR** Baked enamel, acrylic, or epoxy, **as directed**.
2. IV Carriers: Four nylon rollers and nylon **OR** steel or stainless-steel, **as directed**, axles, with ball bearings, **as directed**, with hanger loop fabricated from 1/4-inch- (6-mm-) diameter stainless steel.
3. Stationary IV Hangers: 24-inch (610-mm) **OR** 30-inch (762-mm) **OR** 36-inch (914-mm) **OR** 42-inch (1067-mm) **OR** 48-inch (1219-mm), **as directed**, overall height with stainless-steel shaft; with 4 **OR** 8, **as directed**, folding **OR** nonfolding, **as directed**, 1/4-inch (6-mm) stainless-steel arms with loops, a stainless-steel bottom loop, and a stainless-steel top loop to attach to carrier.
    a. Top Loop: Coated for nonconductivity **OR** Uncoated, **as directed**.
4. Telescoping IV Hangers: 28-inch (711-mm) **OR** 39-inch (991-mm) **OR** 45-inch (1143-mm) **OR** 51-inch (1295-mm) **OR** 57-inch (1448-mm), **as directed**, overall height with a 3/4-inch (19-mm) stainless-steel main shaft and a 3/8-inch (9.5-mm) stainless-steel inner shaft, minimum vertical adjustment of 16 inches (406 mm); with 4 **OR** 8, **as directed**, folding **OR** nonfolding, **as directed**, 1/4-inch (6-mm) stainless-steel arms with loops and a stainless-steel top loop to attach to carrier.
    a. Top Loop: Coated for nonconductivity **OR** Uncoated, **as directed**.
    b. Adjustment Control: Push button **OR** Release ring, **as directed**.

C. Curtains
1. Cubicle Curtain and Dressing Area Fabric: Curtain manufacturer's standard, 100 percent polyester, inherently and permanently flame resistant, stain resistant, and antimicrobial.
    a. Pattern: <**Insert manufacturer's style name**.>
    b. Color: As selected from manufacturer's full range.
2. Shower and Tub Curtain Fabric: Curtain manufacturer's standard. Polyester-reinforced vinyl fabric; flame resistant, stain resistant, and antimicrobial.
    a. Pattern: <**Insert manufacturer's style name**.>
    b. Color: As selected from manufacturer's full range.
3. Curtain Grommets: Two-piece, rolled-edge, rustproof, nickel-plated brass; spaced not more than 6 inches (152 mm) o.c.; machined into top hem.

4. Mesh Top: No. 50 **OR** 40 **OR** 42, **as directed**, nylon mesh.
5. Beaded-Chain Curtain Drop: 6 inches (152 mm) **OR** 9 inches (229 mm) **OR** 12 inches (305 mm) **OR** 15 inches (381 mm) **OR** 18 inches (457 mm), **as directed**, long; nickel-plated steel, with aluminum hook.
6. PVC-Strip Curtain Drop: 16 inches (406 mm) **OR** 18 inches (457 mm), **as directed**, long, with chrome-plated steel hook.
   a. Curtain Movers: In-line hinged nylon spacers that connect to the top of PVC-strip curtain drops to provide tangle-free operation.
7. Curtain Tieback: Nickel-plated brass chain; one at each curtain termination.

D. Curtain Fabrication
1. Fabricate curtains to comply with the following requirements:
   a. Width: Equal to track length from which curtain is hung plus 10 percent added fullness, but not less than 12 inches (305 mm) added fullness.
   b. Length: Equal to floor-to-ceiling height minus depth of track and carrier at top, and minus distance above the finished floor at bottom as follows:
      OR
      Length: Equal to floor-to-ceiling height, with 20-inch (508-mm) mesh top, and minus distance above the finished floor at bottom as follows:
      OR
      Length: Equal to floor-to-ceiling height minus 18 inches (457 mm) from finished ceiling at top, and minus distance above the finished floor at bottom as follows:
      1) Cubicle Curtains: 12 inches (305 mm) **OR** 15 inches (381 mm), **as directed**.
      2) Dressing Area Curtains: 4 inches (102 mm) **OR** 6 inches (152 mm), **as directed**.
      3) Tub Curtains: 6 inches (152 mm).
      4) Shower Curtains: 1/2 inch (13 mm).
   c. Top Hem: Not less than 1 inch (25.4 mm) and not more than 1-1/2 inches (38 mm) wide, triple thickness, reinforced with integral web, and double lock stitched.
   d. Mesh Top: Top hem not less than 1 inch (25.4 mm) and not more than 1-1/2 inches (38 mm) wide, triple thickness, reinforced with integral web, and double lock stitched. Double lock stitch bottom of mesh directly to 1/2-inch (13-mm) triple thickness, top hem of curtain fabric.
   e. Bottom Hem: Not less than 1 inch (25.4 mm) and not more than 1-1/2 inches (38 mm) wide, double thickness and single **OR** double thickness and double **OR** triple thickness, reinforced, and double, **as directed**, lock stitched.
   f. Side Hems: Not less than 1/2 inch (13 mm) and not more than 1-1/4 inches (32 mm) wide, with double **OR** triple, **as directed**, turned edges, and single lock stitched.
2. Vertical Seams: Not less than 1/2 inch (13 mm) wide, double turned and double stitched.

1.3 EXECUTION

A. Installation
1. General: Install tracks level and plumb, according to manufacturer's written instructions.
2. Up to 16 feet (4.9 m) **OR** 20 feet (6.0 m), **as directed**, in length, provide track fabricated from 1 continuous length.
   a. Curtain Track Mounting: Surface **OR** Suspended **OR** Recessed **OR** As indicated on Drawings, **as directed**.
   b. IV Track Mounting: Surface.
3. Surface Track Mounting: Fasten surface-mounted tracks at intervals of not less than 24 inches (610 mm). Fasten support at each splice and tangent point of each corner. Center fasteners in track to ensure unencumbered carrier operation. Attach track to ceiling as follows:
   a. Mechanically fasten directly to bottom of concrete deck with post-installed anchors.
   b. Mechanically fasten directly to finished ceiling with toggle bolts.
   c. Mechanically fasten to furring through suspended ceiling with screw and tube spacer.
   d. Mechanically fasten to suspended ceiling grid with screws.

e. Attach track to suspended ceiling grid with manufacturer's proprietary clip.

4. Suspended Track Mounting: Install track with suspended supports at intervals of not more than 48 inches (1219 mm). Fasten support at each splice and tangent point of each corner. Secure ends of track to wall with flanged fittings or brackets.
5. Track Accessories: Install splices, end caps, connectors, end stops, coupling and joining sleeves, and other accessories as required for a secure and operational installation.
   a. Provide one locking switch unit for each pair of beds.
   b. Provide one hinged loading unit for each bed **OR** pair of beds with locking switch unit, **as directed**.
6. IV Hangers: Unless otherwise indicated, install one IV hook on each IV track and hang one IV hanger.
7. Curtain Carriers: Provide curtain carriers adequate for 6-inch (152-mm) spacing along full length of curtain plus an additional carrier.
8. Curtains: Hang curtains on each curtain track. Secure with curtain tieback, **as directed**.

B. Protection
   1. Protect installed recessed track openings with nonresidue adhesive tape to prevent construction debris from impeding carrier operation. Remove tape prior to Final Completion.

END OF SECTION 10 21 16 17a

Task	Specification	Specification Description
10 21 16 17	10 21 13 13	Toilet Compartments
10 21 23 13	10 21 16 17a	Cubicle Curtains and Tracks
10 21 23 16	10 21 16 17a	Cubicle Curtains and Tracks

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SECTION 10 22 13 00 - WIRE MESH PARTITIONS

1.1 GENERAL

A. Description Of Work:

1. This specification covers the furnishing and installation of materials for wire mesh partitions. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Standard-duty wire mesh partitions.
   b. Heavy-duty wire mesh partitions.
   c. Wire mesh ceilings.
   d. Wire mesh storage lockers.
   e. Wire mesh stairway partitions.
   f. Wire mesh equipment barriers.

C. Definitions

1. As defined in ASTM E 2016:
   a. Intermediate Crimp: Wires pass over one and under the next adjacent wire in both directions, with wires crimped before weaving and with extra crimps between the intersections.
   b. Lock Crimp: Deep crimps at points of the intersection that lock wires securely in place.

D. Performance Requirements

1. Delegated Design: Design wire mesh units, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Structural Performance: Wire mesh units shall withstand the effects of gravity loads and loads and stresses within limits and under conditions indicated according to SEI/ASCE 7.
3. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

E. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
3. Samples: For each exposed product and for each color and texture specified.
4. Delegated-Design Submittal: For wire mesh units indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
5. Maintenance data.

F. Quality Assurance

1. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. AWS D1.3, "Structural Welding Code - Sheet Steel."
2. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling

1. Deliver wire mesh items with cardboard protectors on perimeters of panels and doors and with posts wrapped **OR** palleted **OR** crated, **as directed**, to provide protection during transit and Project-site storage. Use vented plastic.
2. Inventory wire mesh partition door hardware on receipt and provide secure lockup for wire mesh partition door hardware delivered to Project site.
   a. Tag each item or package separately with identification and include basic installation instructions with each item or package.
3. Deliver keys to the Owner by registered mail or overnight package service.

1.2 PRODUCTS

A. Materials

1. Steel Wire: ASTM A 510 (ASTM A 510M).
2. Steel Plates, Channels, Angles, and Bars: ASTM A 36/A 36M.
3. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.
4. Steel Pipe: ASTM A 53/A 53M, Schedule 40 unless another weight is indicated or required by structural loads.
5. Square Steel Tubing: ASTM A 500, cold-formed structural-steel tubing.
6. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with G60 (Z180) zinc (galvanized) or A60 (ZF180) zinc-iron-alloy (galvannealed) coating designation.
7. Panel-to-Panel Fasteners: Manufacturer's standard steel bolts, nuts, and washers.
8. Postinstalled Expansion Anchors: With capability to sustain, without failure, load imposed within factors of safety indicated, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
   a. Carbon Steel: Zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition (mild).
   b. Stainless Steel: ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Alloy Group 1 or 4), for bolts and nuts; ASTM A 276 or ASTM A 666, Type 304 or 316, for anchors.
   c. For Postinstalled Anchors in Concrete: Capability to sustain, without failure, a load equal to four times the loads imposed.
   d. For Postinstalled Anchors in Grouted Masonry Units: Capability to sustain, without failure, a load equal to six times the loads imposed.
9. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated and fabricated from corrosion-resistant materials; with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by wire mesh construction, as determined by testing per ASTM E 1190, conducted by a qualified testing and inspecting agency.
10. Seismic Bracing: Angles with legs not less than 1-1/4 inch (32 mm) wide, formed from 0.04-inch- (1-mm-) thick, metallic-coated steel sheet; with bolted connections and 1/4-inch- (6-mm-) diameter bolts.
11. Shop Primers: Provide primers that comply with Division 07..
12. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer, complying with MPI#79.
    a. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
13. Zinc-Rich Primer: Compatible with topcoat, complying with SSPC-Paint 20 or SSPC-Paint 29.
14. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

B. Standard-Duty Wire Mesh Partitions

1. Mesh: 0.135-inch- (3.5-mm-) diameter, intermediate-crimp steel wire woven into 1-1/2-inch (38-mm) diamond mesh.

2. Vertical Panel Framing: 1-1/4-by-5/8-by-0.097-inch (32-by-16-by-2.5-mm) cold-rolled, C-shaped steel channels with 1/4-inch- (6-mm-) diameter bolt holes spaced not more than 18 inches (450 mm) o.c. along center of framing.
3. Horizontal and Vertical Panel Framing: 1-by-1/2-by-1/8-inch (25-by-13-by-3-mm) cold-rolled steel channels.
4. Horizontal Panel Stiffeners: 2 cold-rolled steel channels, not less than 1 by 3/8 by 1/8 inch (25 by 9.5 by 3 mm), bolted or riveted toe to toe through mesh or 1-by-1/2-by-1/8-inch (25-by-13-by-3-mm) cold-rolled steel channels with wire woven through.
5. Top Capping Bars: 2-1/4-by-1-inch (57-by-25-mm) cold-rolled steel channels.
6. Posts for 90-Degree Corners: 1-1/4-by-1-1/4-by-1/8-inch (32-by-32-by-3-mm) steel angles with 1/4-inch- (6-mm-) diameter bolt holes aligning with bolt holes in vertical framing; with floor anchor clips.
7. Posts for Other-Than-90-Degree Corners: Manufacturer's standard steel pipe or tubing with 1/4-inch- (6-mm-) diameter bolt holes aligning with bolt holes in vertical framing.
    a. Partitions up to 12 Feet (3.7 m) High: 1-1/4-inch (32-mm) OD.
    b. Partitions up to 20 Feet (6.1 m) High: 2-1/2-inch (65-mm) OD.
8. Adjustable Corner Posts: 2, manufacturer's standard steel pipe or tubing posts connected by steel hinges at 36 inches (900 mm) o.c. attached to posts; with 1/4-inch- (6-mm-) diameter bolt holes aligning with bolt holes in vertical framing.
9. Line Posts: 3-inch-by-4.1-lb (76-mm-by-1.9-kg) or 3-1/2-by-1-1/4-by-0.127-inch (89-by-32-by-3.2-mm) steel channels; with 5-by-18-by-1/4-inch (125-by-450-by-6-mm) steel base plates punched for attachment to floor.
10. Three- and Four-Way Intersection Posts: 1-1/4-by-1-1/4-inch (32-by-32-mm) tubular steel, with 1/4-inch- (6-mm-) diameter bolt holes aligned for bolting to adjacent panels.
11. Floor Shoes: Steel, cast iron, or cast aluminum, not less than 2 inches (50 mm) high; sized to suit vertical framing, drilled for attachment to floor, and with set screws for leveling adjustment.
12. Swinging Doors: Fabricated from same mesh as partitions, with framing fabricated from 1-1/4-by-1/2-by-1/8-inch (32-by-13-by-3-mm) steel channels or C-channels, banded with 1-1/4-by-1/8-inch (32-by-3-mm) flat steel bar cover plates on 3 **OR** 4, **as directed**, sides, and with 1/8-inch- (3-mm-) thick angle strike bar and cover on strike jamb.
    a. Hinges: Full-surface type, 3-by-3-inch (76-by-76-mm) steel, 1-1/2 pairs per door; bolted, riveted, or welded to door and jamb framing.
    b. Padlock Lug: Mortised into door framing and enclosed with steel cover.
    c. Cylinder Lock: Mortise type with manufacturer's standard cylinder **OR** cylinder specified in Division 08 Section "Door Hardware", **as directed**; operated by key outside and recessed turn knob **OR** knob **OR** lever, **as directed**, inside.
    d. Inactive Leaf Hardware: Cane bolt at bottom and chain bolt at top.
13. Swinging Dutch Doors: Fabricated from same mesh as partitions, with framing fabricated from 1-1/4-by-1/2-by-1/8-inch (32-by-13-by-3-mm) steel channels or C-channels, banded with 1-1/4-by-1/8-inch (32-by-3-mm) flat steel bar cover plates on 3 **OR** 4, **as directed**, sides, and with 1/8-inch- (3-mm-) thick angle strike bar and cover on strike jamb.
    a. Hinges: Full-surface type, 3-by-3-inch (76-by-76-mm) steel, 1 pair per section of door (top and bottom); bolted, riveted, or welded to door and jamb framing.
    b. Cylinder Lock: Mortise type with manufacturer's standard cylinder **OR** cylinder specified in Division 08 Section "Door Hardware", **as directed**; operated by key outside and recessed turn knob **OR** knob **OR** lever, **as directed**, inside; mounted in lower section of door.
    c. Bolt: Mounted in, securing upper section of door.
    d. Shelf: Fabricated from 0.097-inch- (2.5-mm-) thick, cold-rolled steel sheet, 12 inches (300 mm) deep by full width of door; with corners rounded and edges finished smooth; mounted on top of lower section of door and braced with manufacturer's standard brackets.
14. Sliding Doors: Fabricated from same mesh as partitions, with framing fabricated from 1-1/2-by-3/4-by-1/8-inch (38-by-19-by-3-mm) steel channels or C-channels, banded with 1-1/2-by-1/8-inch (38-by-3-mm) flat steel bar cover plates on 4 sides.
    a. Hardware: Two, four-wheel roller-bearing carriers, box track, and bottom guide channel for each door.
    b. Padlock Lug: Mortised into door framing and enclosed with steel cover.

c. Cylinder Lock: Mortise type with manufacturer's standard cylinder **OR** cylinder specified in Division 08 Section "Door Hardware", **as directed**; operated by key outside and recessed turn knob **OR** knob **OR** lever, **as directed**, inside.

15. Vertically Sliding Service Windows: Fabricated from same mesh and framing as panels and equipped with spring catch **OR** slide bolts, **as directed**, on each jamb that locks window in open and closed positions. Include opening frame in partition fabricated from 1-1/4-by-1/2-by-1/8-inch (32-by-13-by-3-mm) steel channels or C-channels.
    a. Size: 24 inches wide by 18 inches high (600 mm wide by 450 mm high) **as directed** As indicated, **as directed**.
    b. Shelf: Fabricated from 0.097-inch- (2.5-mm-) thick, cold-rolled steel sheet; with corners rounded and edges finished smooth; braced with manufacturer's standard brackets.
        1) Size: 24 inches wide by 12 inches deep (600 mm wide by 300 mm deep) **OR** As indicated, **as directed**.
16. Swinging Service Windows: Fabricated from same mesh and framing as panels and equipped with spring catch on strike jamb that locks window in closed position. Include opening frame in partition fabricated from 1-1/4-by-1/2-by-1/8-inch (32-by-13-by-3-mm) steel channels or C-channels.
    a. Size: 24 inches wide by 18 inches high (600 mm wide by 450 mm high) **OR** As indicated, **as directed**.
    b. Shelf: Fabricated from 0.097-inch- (2.5-mm-) thick, cold-rolled steel sheet; with corners rounded and edges finished smooth; braced with manufacturer's standard brackets.
        1) Size: 24 inches wide by 12 inches deep (600 mm wide by 300 mm deep) **OR** As indicated, **as directed**.
17. Accessories:
    a. Sheet Metal Base: Not less than 0.060-inch- (1.5-mm-) thick, cold-rolled steel sheet.
    b. Adjustable Filler Panels: Not less than 0.060-inch- (1.5-mm-) thick, cold-rolled steel sheet; capable of filling openings from 2 to 12 inches (50 to 300 mm).
    c. Wall Clips: Manufacturer's standard, cold-rolled steel sheet; allowing up to 1 inch (25 mm) of adjustment, **as directed**.
18. Finish for Uncoated Ferrous Steel: Hot-dip galvanized **OR** Hot-dip galvanized and shop primed for field painting **OR** Shop primed for field painting **OR** Shop coat **OR** Baked-enamel finish **OR** Powder-coated finish, **as directed**, unless otherwise indicated.
    a. Color: As selected from manufacturer's full range.

C. Heavy-Duty Wire Mesh Partitions
1. Mesh: 0.192-inch- (4.8-mm-) diameter, intermediate-crimp steel wire woven into 2-inch (50-mm) diamond mesh.
2. Vertical and Horizontal Panel Framing: 1-1/2-by-3/4-by-0.097-inch (38-by-19-by-2.5-mm) cold-rolled, C-shaped steel channels; with 3/8-inch- (9.5-mm-) diameter bolt holes spaced not more than 18 inches (450 mm) o.c. along center of framing.
3. Vertical and Horizontal Panel Framing: 1-1/2-by-3/4-by-1/4-inch (38-by-19-by-6-mm) cold-rolled steel channels; with 3/8-inch- (9.5-mm-) diameter bolt holes spaced not more than 18 inches (450 mm) o.c. along center of framing. Provide vertical panel stiffeners in shapes and sizes as recommended by manufacturers.
4. Horizontal Panel Stiffeners: 2 cold-rolled steel channels, not less than 1 by 1/2 by 1/8 inch (25 by 13 by 3 mm), bolted or riveted toe to toe through mesh or 1-1/2-by-3/4-by-1/8-inch (38-by-19-by-3-mm) cold-rolled steel channels with wire woven through.
5. Top Capping Bars: 3-inch-by-4.1-lb (76-mm-by-1.9-kg) hot-rolled steel channels.
6. Posts for 90-Degree Corners: 2-by-2-by-1/8-inch (50-by-50-by-3-mm) steel angles with 3/8-inch- (9.5-mm-) diameter bolt holes aligning with bolt holes in vertical framing; with floor anchor clips.
7. Posts for Other-Than-90-Degree Corners: Manufacturer's standard steel 2-inch- (50-mm) OD pipe or tubing with 3/8-inch- (9.5-mm-) diameter bolt holes aligning with bolt holes in vertical framing.

8. Adjustable Corner Posts: 2, manufacturer's standard steel pipe or tubing posts connected by steel hinges at 36 inches (900 mm) o.c. attached to posts; with 1/4-inch- (6-mm-) diameter bolt holes aligning with bolt holes in vertical framing.
9. Line Posts: 3-inch-by-4.1-lb (76-mm-by-1.9-kg) or 3-1/2-by-1-1/4-by-0.1265-inch (89-by-32-by-3.2-mm) steel channels; with 5-by-18-by-1/4-inch (125-by-450-by-6-mm) steel base plates punched for attachment to floor.
10. Three- and Four-Way Intersection Posts: 2-by-2-inch (50-by-50-mm) tubular steel, with 3/8-inch- (9.5-mm-) diameter bolt holes aligned for bolting to adjacent panels.
11. Floor Shoes: Steel, cast iron, or cast aluminum, not less than 2 inches (50 mm) high; sized to suit vertical framing, drilled for attachment to floor, and with set screws for leveling adjustment.
12. Swinging Doors: Fabricated from same mesh as partitions, with framing fabricated from 1-1/2-by-3/4-by-1/8-inch (38-by-19-by-3-mm) steel channels or C-channels, banded with 1-1/2-by-1/8-inch (38-by-3-mm) flat steel bar cover plates on 4 sides, and with 1/8-inch- (3-mm-) thick angle strike bar and cover on strike jamb.
    a. Hinges: Full-surface type, 3-1/2-by-3-1/2-inch (89-by-89-mm) steel, 1-1/2 pairs per door; bolted, riveted, or welded to door and jamb framing.
    b. Padlock Lug: Mortised into door framing and enclosed with steel cover.
    c. Cylinder Lock: Mortise type with manufacturer's standard cylinder **OR** cylinder specified in Division 08 Section "Door Hardware", **as directed**; operated by key outside and recessed turn knob **OR** knob **OR** lever, **as directed**, inside.
    d. Inactive Leaf Hardware: Cane bolt at bottom and chain bolt at top.
13. Swinging Dutch Doors: Fabricated from same mesh as partitions, with framing fabricated from 1-1/2-by-3/4-by-1/8-inch (38-by-19-by-3-mm) steel channels or C-channels, banded with 1-1/2-by-1/8-inch (38-by-3-mm) flat steel bar cover plates on 3 **OR** 4, **as directed**, sides, and with 1/8-inch- (3-mm-) thick angle strike bar and cover on strike jamb.
    a. Hinges: Full-surface type, 3-1/2-by-3-1/2-inch (89-by-89-mm) steel, 1 pair per section of door (top and bottom); bolted, riveted, or welded to door and jamb framing.
    b. Cylinder Lock: Mortise type with manufacturer's standard cylinder **OR** cylinder specified in Division 08 Section "Door Hardware", **as directed**; operated by key outside and recessed turn knob **OR** knob **OR** lever, **as directed**, inside.
    c. Bolt: Mounted in, securing upper section of door.
    d. Shelf: Fabricated from 0.097-inch- (2.5-mm-) thick, cold-rolled steel sheet, 12 inches (300 mm) deep by full width of door; with corners rounded and edges finished smooth; mounted on top of lower section of door and braced with manufacturer's standard brackets.
14. Sliding Doors: Fabricated from same mesh as partitions, with framing fabricated from 1-1/2-by-3/4-by-1/8-inch (38-by-19-by-3-mm) steel channels or C-channels, banded with 1-1/2-by-1/8-inch (38-by-3-mm) flat steel bar cover plates on 4 sides.
    a. Hardware: Two, four-wheel roller-bearing carriers, box track, and bottom guide channel for each door.
    b. Padlock Lug: Mortised into door framing and enclosed with steel cover.
    c. Cylinder Lock: Mortise type with manufacturer's standard cylinder **OR** cylinder specified in Division 08 Section "Door Hardware", **as directed**; operated by key outside and recessed turn knob **OR** knob **OR** lever, **as directed**, inside.
15. Vertically Sliding Service Windows: Fabricated from same mesh and framing as panels and equipped with spring catch **OR** slide bolts, **as directed**, on each jamb that locks window in open and closed positions. Include opening frame in partition fabricated from 1-1/4-by-1/2-by-1/8-inch (32-by-13-by-3-mm) steel channels or C-channels.
    a. Size: 24 inches wide by 18 inches high (600 mm wide by 450 mm high) **OR** As indicated, **as directed**.
    b. Shelf: Fabricated from 0.097-inch- (2.5-mm-) thick, cold-rolled steel sheet; with corners rounded and edges finished smooth; braced with manufacturer's standard brackets.
        1) Size: 24 inches wide by 12 inches deep (600 mm wide by 300 mm deep) **OR** As indicated, **as directed**.
16. Swinging Service Windows: Fabricated from same mesh and framing as panels and equipped with spring catch on strike jamb that locks window in closed position. Include opening frame in

partition fabricated from 1-1/4-by-1/2-by-1/8-inch (32-by-13-by-3-mm) steel channels or C-channels.
   a. Size: 24 inches wide by 18 inches high (600 mm wide by 450 mm high) **OR** As indicated, **as directed**.
   b. Shelf: Fabricated from 0.097-inch- (2.5-mm-) thick, cold-rolled steel sheet; with corners rounded and edges finished smooth; braced with manufacturer's standard brackets.
      1) Size: 24 inches wide by 12 inches deep (600 mm wide by 300 mm deep) **OR** As indicated, **as directed**.

17. Accessories:
   a. Sheet Metal Base: Not less than 0.060-inch- (1.5-mm-) thick, cold-rolled steel sheet.
   b. Adjustable Filler Panels: Not less than 0.0598-inch- (1.5-mm-) thick, cold-rolled steel sheet; capable of filling openings from 2 to 12 inches (50 to 300 mm).
   c. Wall Clips: Manufacturer's standard, cold-rolled steel sheet; allowing up to 1 inch (25 mm) of adjustment, **as directed**.
18. Finish for Uncoated Ferrous Steel: Hot-dip galvanized **OR** Hot-dip galvanized and shop primed for field painting **OR** Shop primed for field painting **OR** Shop coat **OR** Baked-enamel finish **OR** Powder-coated finish, **as directed**, unless otherwise indicated.
   a. Color: As selected from manufacturer's full range.

D. Wire Mesh Ceilings
1. Mesh, Framing, and Stiffeners: Fabricated from same mesh and framing as wire mesh partition panels.
2. Perimeter Partition Supports: 1-1/2-by-1-1/2-by-1/8-inch (38-by-38-by-3-mm) steel angle, with 1/4-inch- (6-mm-) diameter bolt holes aligned for bolting to top of wire mesh partitions and to sides of wire mesh ceiling panels.
3. Wall Supports: 1-1/2-by-1-1/2-by-1/8-inch (38-by-38-by-3-mm) steel angle punched for attachment to wall and wire mesh ceiling panels.
4. Intermediate Supports: Steel I-beam, as recommended by manufacturer.
5. Intermediate Support Posts: 2-by-2-by-1/8-inch (50-by-50-by-3-mm) steel pipe or tubing.
6. Finishes: Match adjacent wire mesh partitions.

E. Wire Mesh Storage Lockers
1. Unit Sizes:
   a. Width: 36 inches (914 mm) **OR** 48 inches (1219 mm), **as directed**.
   b. Depth: 36 inches (914 mm) **OR** 48 inches (1219 mm) **OR** 60 inches (1524 mm), **as directed**.
   c. Height: 90 inches (2286 mm).
2. Mesh: 0.135-inch- (3.5-mm-) diameter, intermediate-crimp steel wire woven into 1-1/2-inch (38-mm) diamond **OR** 1-by-2-inch (25-by-50-mm) rectangular, **as directed**, mesh.
3. Wall Panels: 1-1/4-by-1-1/4-by-1/8-inch (32-by-32-by-3-mm) steel angle framing on top, bottom, and back sides, and 3-by-1/8-inch (76-by-3-mm) cold-rolled steel flat bar framing on front side; with wire mesh welded to framing.
   a. Horizontal Panel Stiffeners: 1-1/4-by-1-1/4-by-1/8-inch (32-by-32-by-3-mm) steel angles or 3/4-by-1/4-inch (19-by-6-mm) hot-rolled steel flat bars.
4. Backs: 0.027-inch- (0.7-mm-) thick, metallic-coated steel sheet.
5. Tops: Fabricated from same mesh and framing as doors **OR** 0.027-inch- (0.7-mm-) thick, metallic-coated steel sheet, **as directed**.
6. Horizontal Dividers/Shelves: 0.043-inch- (1.1-mm-) thick, metallic-coated, **as directed**, steel sheet; with flanged edges and reinforced across width with 3/4-by-1/4-inch (19-by-6-mm) steel stiffeners, **as directed**.
7. Doors: Fabricated from same mesh as wall panels, with framing fabricated from 1-1/4-by-1-1/4-by-1/8-inch (32-by-32-by-3-mm) steel angles on 4 sides; with wire mesh welded to framing. Include door strike and padlock hasp.
   a. Horizontal Stiffeners for Single-Tier Doors: 3/4-by-1/4-inch (19-by-6-mm) steel flat bars.

b. Hinges: Full-surface type, 2-1/2-by-2-1/2-inch (64-by-64-mm) steel, 1-1/2 pairs per single-tier door and 1 pair per double-tier door; bolted, riveted, or welded to door and jamb framing.

8. Finish for Uncoated Ferrous Steel: Hot-dip galvanized **OR** Hot-dip galvanized and shop primed for field painting **OR** Shop primed for field painting **OR** Shop coat **OR** Baked-enamel finish **OR** Powder-coated finish, **as directed**, unless otherwise indicated.
    a. Color: As selected from manufacturer's full range.

F. Wire Mesh Stairway Partitions
1. Standard-Duty Stairway Partitions:
    a. Diamond Mesh: 0.135-inch- (3.5-mm-) diameter, intermediate-crimp steel wire woven into 1-1/2-inch (38-mm) diamond pattern and securely clinched to frames.
    b. Square Mesh: 0.135-inch- (3.5-mm-) diameter, intermediate **OR** lock, **as directed**,-crimp steel wire woven into 1-1/2-inch (38-mm) square pattern, inserted through frame holes and welded into frame. Vertical wires are plumb, and horizontal wires are perpendicular to vertical wires.
    c. Rectangular Mesh: 0.135-inch- (3.5-mm-) diameter, intermediate **OR** lock, **as directed**,-crimp steel wire woven into 2-by-1-inch (50-by-25-mm) rectangular pattern, inserted through frame holes and welded into frame. Vertical wires are plumb, and horizontal wires are perpendicular to vertical wires.
    d. Vertical Panel Framing: 1-1/4-by-5/8-by-0.0966-inch (32-by-16-by-2.5-mm) cold-rolled, C-shaped steel channels; with 1/4-inch- (6-mm-) diameter bolt holes spaced not more than 18 inches (450 mm) o.c. along center of framing.
    e. Horizontal Panel Framing: 1-by-1/2-by-1/8-inch (25-by-13-by-3-mm) cold-rolled steel channels.
    f. Horizontal Panel Stiffeners: 1-by-1/2-by-1/8-inch (25-by-13-by-3-mm) cold-rolled steel channels with wire woven through, or two 1-by-1/2-by-1/8-inch (25-by-13-by-3-mm) cold-rolled steel channels bolted or riveted toe to toe through mesh.
2. Heavy-Duty Stairway Partitions:
    a. Diamond Mesh: 0.192-inch- (4.9-mm-) diameter, intermediate-crimp steel wire woven into 2-inch (50-mm) diamond pattern and securely clinched to frames.
    b. Square Mesh: 0.192-inch- (4.9-mm-) diameter, intermediate **OR** lock, **as directed**,-crimp steel wire woven into 2-inch (50-mm) square pattern, inserted through frame holes and welded into frame. Vertical wires are plumb, and horizontal wires are perpendicular to vertical wires.
    c. Rectangular Mesh: 0.192-inch- (4.9-mm-) diameter, intermediate **OR** lock, **as directed**,-crimp steel wire woven into 2-by-1-inch (50-by-25-mm) rectangular pattern, inserted through frame holes and welded into frame. Vertical wires are plumb, and horizontal wires are perpendicular to vertical wires.
    d. Vertical and Horizontal Panel Framing: 1-1/2-by-3/4-by-0.0966-inch (38-by-19-by-2.5-mm) cold-rolled, C-shaped steel channels; with 3/8-inch- (9.5-mm-) diameter bolt holes spaced not more than 18 inches (450 mm) o.c. along center of framing.
    e. Horizontal Panel Stiffeners: 1-1/2-by-3/4-by-1/8-inch (38-by-19-by-3-mm) cold-rolled steel channels with wire woven through, or two 1-by-1/2-by-1/8-inch (25-by-13-by-3-mm) cold-rolled steel channels bolted or riveted toe to toe through mesh.
3. Swinging Doors: Fabricated from same mesh as partitions, with framing fabricated from 1-1/2-by-3/4-by-1/8-inch (38-by-19-by-3-mm) steel channels, banded with 1-1/2-by-1/8-inch (38-by-3-mm) flat steel bar cover plates on 3 **OR** 4, **as directed**, sides, and with 1/8-inch- (3-mm-) thick angle strike bar and cover on strike jamb.
    a. Hinges: Full-surface spring type, 3-1/2-by-3-1/2-inch (89-by-89-mm) steel, 1-1/2 pairs per door; bolted, riveted, or welded to door and jamb framing.
    b. Exit Device: As specified in Division 08 Section "Door Hardware".
    c. Tamper Shield: Fabricated from 0.097-inch- (2.5-mm-) thick, cold-rolled steel sheet; 15 inches (381 mm) high by width of door.
4. Door Jamb Framing: 2-by-2-by-1/8-inch (50-by-50-by-3-mm) steel pipe or tubing.

5. Floor Shoes: Steel, cast iron, or cast aluminum, not less than 2 inches (50 mm) high; sized to suit vertical framing, drilled for attachment to floor, and with set screws for leveling adjustment.
6. Wall Clips: Manufacturer's standard, cold-rolled steel sheet; allowing up to 1 inch (25 mm) of adjustment, **as directed**.
7. Finish for Uncoated Ferrous Steel: Hot-dip galvanized **OR** Hot-dip galvanized and shop primed for field painting **OR** Shop primed for field painting **OR** Shop coat **OR** Baked-enamel finish **OR** Powder-coated finish, **as directed**, unless otherwise indicated.
   a. Color: As selected from manufacturer's full range.

G. Wire Mesh Equipment Barriers
1. Mesh: 0.135-inch- (3.5-mm-) diameter, intermediate-crimp steel wire woven into 1-1/2-inch (38-mm) diamond **OR** 1-by-2-inch (25-by-50-mm) rectangular, **as directed**, mesh.
2. Panels: 1-1/4-by-1-1/4-by-1/8-inch (32-by-32-by-3-mm) steel angle framing on 4 sides, with wire mesh welded to framing.
   a. Horizontal Panel Stiffeners: 1-1/4-by-1-1/4-by-1/8-inch (32-by-32-by-3-mm) steel angles or 3/4-by-1/4-inch (19-by-6-mm) hot-rolled steel flat bars.
   b. Height: 48 inches (1220 mm) **OR** 60 inches (1525 mm), **as directed**.
3. Line and Corner Posts: 2-by-2-by-0.068-inch (50-by-50-by-1.7-mm) steel tubing with steel base plates welded to bottoms, drilled for attachment to floor, and with steel caps welded to tops.
   a. Height: Panel height plus 12-inch- (300-mm-), **as directed**, high, sweep space.
4. Swinging Gates: Fabricated from same mesh as panels, with gate framing fabricated from 1-1/4-by-1-1/4-by-3/16-inch (32-by-32-by-4.7-mm) steel angles on 4 sides, and with wire mesh welded to framing.
   a. Hinges: Full-surface spring, **as directed**, type, 3-1/2-by-3-1/2-inch (89-by-89-mm) steel, 1 pair per door; bolted, riveted, or welded to door and jamb framing.
   b. Padlock Lug: Mortised into door framing and enclosed with steel cover.
   c. Cylinder Lock: Mortise type with manufacturer's standard cylinder **OR** cylinder specified in Division 08 Section "Door Hardware", **as directed**; operated by key outside and recessed turn knob **OR** knob **OR** lever, **as directed**, inside.
5. Sliding Gates: Fabricated from same mesh as panels, with framing fabricated from 1-1/4-by-1-1/4-by-3/16-inch (32-by-32-by-4.7-mm) steel angles on 4 sides, and with wire mesh welded to framing.
   a. Hardware: Two, four-wheel roller-bearing carriers, box track, and bottom guide channel for each door.
   b. Padlock Lug: Mortised into door framing and enclosed with steel cover.
   c. Cylinder Lock: Mortise type with manufacturer's standard cylinder **OR** cylinder specified in Division 08 Section "Door Hardware", **as directed**; operated by key outside and recessed turn knob **OR** knob **OR** lever, **as directed**, inside.
6. Finish for Uncoated Ferrous Steel: Hot-dip galvanized **OR** Hot-dip galvanized and shop primed for field painting **OR** Shop primed for field painting **OR** Shop coat **OR** Baked-enamel finish **OR** Powder-coated finish, **as directed**, unless otherwise indicated.
   a. Color: As selected from manufacturer's full range.

H. Fabrication
1. General: Fabricate wire mesh items from components of sizes not less than those indicated. Use larger-sized components as recommended by wire mesh item manufacturer. As required for complete installation, provide bolts, hardware, and accessories with manufacturer's standard finishes.
   a. Fabricate wire mesh items to be readily disassembled.
   b. Welding: Weld corner joints of framing and grind smooth, leaving no evidence of joint **OR** finish sand **OR** remove spatter **OR** leave as applied, **as directed**.
2. Standard- and Heavy-Duty Wire Mesh Partitions: Fabricate wire mesh partitions with cutouts for pipes, ducts, beams, and other items indicated. Finish edges of cutouts to provide a neat, protective edge.
   a. Mesh: Securely clinch mesh to framing.

b. Framing: Fabricate framing with mortise and tenon corner construction.
   1) Provide horizontal stiffeners as indicated or, if not indicated, as required by panel height and as recommended by wire mesh partition manufacturer. Weld horizontal stiffeners to vertical framing.
   2) Fabricate three- and four-way intersections using intersection posts **OR** manufacturer's standard connecting clips and fasteners, **as directed**.
   3) Fabricate partition and door framing with slotted holes for connecting adjacent panels.
c. Fabricate wire mesh partitions with 3 inches (76 mm) of clear space between finished floor and bottom horizontal framing.
d. Fabricate wire mesh partitions with bottom horizontal framing flush with finished floor.
e. Doors: Align bottom of door with bottom of adjacent panels.
   1) For doors that do not extend full height of partition, provide transom over door, fabricated from same mesh and framing as partition panels.
f. Hardware Preparation: Mortise, reinforce, drill, and tap doors and framing as required to install hardware.

3. Wire Mesh Ceilings: Fabricate wire mesh partitions with cutouts for pipes, ducts, beams, and other items indicated. Finish edges of cutouts to provide a neat, protective edge.
   a. Mesh: Securely clinch mesh to framing.
   b. Framing: Fabricate framing with mortise and tenon corner construction.
      1) Provide stiffeners as indicated or, if not indicated, as required by panel span and as recommended by wire mesh ceiling manufacturer. Weld stiffeners to framing.
4. Wire Mesh Stairway Partitions: Provide door jamb framing on each side of doors. Attach tamper shields centered behind exit devices.
5. Wire Mesh Storage Lockers: Fabricate initial storage locker with front and two sides. Fabricate additional storage lockers similarly, so each unit is independent **OR** as add-on units, designed to share one side with initial storage locker, **as directed**.
   a. Fabricate wall panel and door framing with slotted holes for connecting adjacent panels.
   b. Prehang doors in factory.

I. General Finish Requirements
   1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

J. Steel And Iron Finishes
   1. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:
      a. ASTM A 123/A 123M, for galvanizing steel and iron components.
      b. ASTM A 153/A 153M, for galvanizing steel and iron hardware.
      c. Preparation for Shop Priming: After galvanizing, thoroughly clean wire mesh components of grease, dirt, oil, flux, and other foreign matter, and treat with metallic-phosphate process.
   2. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed metal fabrications:
      a. Exteriors (SSPC Zone 1B) and Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
      b. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."
   3. Shop Priming: Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
      a. Stripe paint corners, crevices, bolts, welds, and sharp edges.

4. Shop Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard one-coat, shop-coat finish suitable for use intended. Comply with paint manufacturer's written instructions for applying and curing.
    a. Color and Gloss: As selected from manufacturer's full range.
5. Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard 2-coat, baked-on finish, suitable for use indicated, consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat.
    a. Color and Gloss: As selected from manufacturer's full range.

1.3 EXECUTION

A. Wire Mesh Partitions Erection
1. Anchor wire mesh partitions to floor with 3/8-inch- (9.5-mm-) diameter, postinstalled expansion anchors at 12 inches (305 mm) o.c. through anchor clips located at each post and corner. Shim anchor clips as required to achieve level and plumb installation.
2. Anchor wire mesh partitions to floor with 3/8-inch- (9.5-mm-) diameter, postinstalled expansion anchors at 12 inches (305 mm) o.c. through floor shoes located at each post and corner. Adjust wire mesh partition posts in floor shoes to achieve level and plumb installation.
3. Anchor wire mesh partitions to walls at 12 inches (305 mm) o.c. through back corner panel framing and as follows:
    a. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
    b. For hollow masonry anchorage, use toggle bolts.
    c. For wood stud partitions, use hanger or lag bolts set into wood backing between studs. Coordinate with carpentry work to locate backing members.
    d. For steel-framed gypsum board assemblies, use hanger or lag bolts set into wood backing between studs. Coordinate with stud installation to locate backing members.
    e. For steel-framed gypsum board assemblies, fasten brackets directly to steel framing or concealed reinforcements using self-tapping screws of size and type required to support structural loads.
4. Secure top capping bars to top framing channels with 1/4-inch- (6-mm-) diameter "U" bolts spaced not more than 28 inches (700 mm) o.c.
5. Provide line posts at locations indicated or, if not indicated, as follows:
    a. On each side of sliding door openings.
    b. For partitions that are 7 to 9 feet (2.1 to 2.7 m) high, spaced at 15 to 20 feet (4.6 to 6.1 m) o.c.
    c. For partitions that are 10 to 12 feet (3.0 to 3.7 m) high, located between every other panel.
    d. For partitions that are more than 12 feet (3.7 m) high, located between each panel.
6. Provide seismic supports and bracing as indicated or, if not indicated, as recommended by manufacturer and as required for stability, extending and fastening members to supporting structure.
7. Where standard-width wire mesh partition panels do not fill entire length of run, provide adjustable filler panels to fill openings.
8. Install doors complete with door hardware.
9. Install service windows complete with window hardware.
10. Weld or bolt sheet metal bases to wire mesh partitions and doors **OR** where indicated, **as directed**.
11. Bolt accessories to wire mesh partition framing.

B. Wire Mesh Ceilings Erection
1. Anchor wall support angle to walls at 12 inches (305 mm) o.c. and as follows:
    a. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.

b. For hollow masonry anchorage, use toggle bolts.
c. For wood stud partitions, use hanger or lag bolts set into wood backing between studs. Coordinate with carpentry work to locate backing members.
d. For steel-framed gypsum board assemblies, use hanger or lag bolts set into wood backing between studs. Coordinate with stud installation to locate backing members.
e. For steel-framed gypsum board assemblies, fasten brackets directly to steel framing or concealed reinforcements using self-tapping screws of size and type required to support structural loads.

2. Attach wire mesh ceiling panels to wall support angles with bolts at 12 inches (305 mm) o.c.
3. Attach wire mesh ceiling panels to wire mesh partitions with slotted angles bolted to sides of ceiling panels and to top of partitions at 12 inches (305 mm) o.c.
4. Attach wire mesh ceiling panels to intermediate supports as recommended by manufacturer.
5. Provide seismic supports and bracing as indicated or, if not indicated, as recommended by manufacturer and as required for stability, extending and fastening members to supporting structure.

C. Wire Mesh Storage Lockers Erection
1. Anchor wire mesh storage lockers to floor with 3/8-inch- (9.5-mm-) diameter, expansion anchors at 12 inches (305 mm) o.c. through bottom panel framing. Shim panel framing as required to achieve level and plumb installation.
2. Anchor wire mesh storage lockers to walls at 12 inches (305 mm) o.c. through back corner panel framing and as follows:
   a. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
   b. For hollow masonry anchorage, use toggle bolts.
   c. For wood stud partitions, use hanger or lag bolts set into wood backing between studs. Coordinate with carpentry work to locate backing members.
   d. For steel-framed gypsum board assemblies, use hanger or lag bolts set into wood backing between studs. Coordinate with stud installation to locate backing members.
   e. For steel-framed gypsum board assemblies, fasten brackets directly to steel framing or concealed reinforcements using self-tapping screws of size and type required to support structural loads.
3. Attach adjacent wire mesh storage lockers to each other through side panel framing.
4. Install horizontal dividers/shelving in double-tier storage lockers.
5. Install doors complete with door hardware.

D. Wire Mesh Stairway Partitions Erection
1. Anchor wire mesh stairway partitions to floor with 3/8-inch- (9.5-mm-) diameter, postinstalled expansion anchors at 12 inches (305 mm) o.c. through floor shoes located at each post. Adjust wire mesh partition posts in floor shoes to achieve level and plumb installation.
2. Anchor angle clips supporting wire mesh stairway partitions at stairs and intermediate landings with 3/8-inch- (9.5-mm-) diameter, postinstalled expansion anchors at 12 inches (305 mm) o.c. Weld stairway partition framing to angle clips.
3. Provide seismic supports and bracing as indicated or, if not indicated, as recommended by manufacturer and as required for stability, extending and fastening members to supporting structure.
4. Install doors complete with door hardware.

E. Wire Mesh Equipment Barriers Erection
1. Anchor wire mesh equipment barriers to floor with 3/8-inch- (9.5-mm-) diameter, expansion anchors through post bases. Shim post bases as required to achieve level and plumb installation.
2. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if indicated on Shop Drawings.
3. Install gates complete with gate hardware.

F. Adjusting And Cleaning
1. Adjust doors **OR** gates **OR** service windows, **as directed**, to operate smoothly and easily, without binding or warping. Adjust hardware to function smoothly. Confirm that latches and locks engage accurately and securely without forcing or binding.
2. Remove and replace defective work including doors and framing that are warped, bowed, or otherwise unacceptable.
3. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
4. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 10 22 13 00

SECTION 10 22 19 13 - DEMOUNTABLE PARTITIONS

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for demountable partitions. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Demountable site-assembled partitions.
b. Demountable unitized-panel partitions.

C. Performance Requirements
1. Structural Performance: Provide demountable partitions capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
a. Load-Bearing Capacity of Panel System: Not less than 300-lb (136-kg concentrated) **OR** 2.3-lb/linear inch (0.041-kg/linear mm) distributed, **as directed**, proof load when tested according to BIFMA X 5.6, Section 6, Table 1.
b. Transverse-Load Capacity of Panel System: Lateral deflection of not more than 1/120 **OR** 1/240, **as directed**, of the overall span when tested under a uniformly distributed load of 5 lb/sq. ft. (24.4 kg/sq. m) according to ASTM E 72.
c. Seismic Performance: Provide demountable partitions capable of withstanding the effects of earthquake motions determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

D. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: For demountable partitions. Include plans, elevations, sections, details, and attachments to other work.
3. Samples: For each type of exposed finish required.
4. Product Test Reports.
5. Maintenance Data.

E. Quality Assurance
1. Sound Transmission Characteristics: Where STC ratings are indicated, provide partitions with STC rating that was determined by testing an identical system according to ASTM E 90 and classified according to ASTM E 413 by a qualified independent testing agency.
2. Fire-Test-Response Characteristics: Provide demountable partitions complying with the following requirements:
a. Where indicated, provide demountable partitions identical to those of assemblies tested for fire resistance per ASTM E 119 by UL or a testing and inspecting agency acceptable to authorities having jurisdiction.
1) Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
b. Surface-Burning Characteristics: Provide demountable partitions per ASTM E 84:
1) Flame-Spread Index: 25 or less.
2) Smoke-Developed Index: 450 or less.
3. Fire-Rated Door and Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated.
a. Test Pressure:

1) Test at atmospheric (neutral) pressure according to NFPA 252 or UL 10B.
OR
Test according to NFPA 252 or UL 10C. After 5 minutes into the test, neutral pressure level in furnace shall be established at 40 inches (1016 mm) or less above the sill.

b. As scheduled on Drawings.

4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.2 PRODUCTS

A. Demountable Site-Assembled Partitions

1. Face Panels: Manufacturer's standard **OR** Gypsum board, ASTM C 36/C 36M **OR** Wood composite **OR** Fiber composite **OR** Steel-sheet-faced gypsum board, ASTM C 36/C 36M **OR** Stainless-steel-sheet-faced gypsum board, ASTM C 36/C 36M**, as directed**.
   a. Thickness: Manufacturer's standard **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm) **OR** 3/4 inch (19 mm)**, as directed**.
   b. Width: Manufacturer's standard **OR** 24 inches (610 mm) **OR** 30 inches (762 mm) **OR** As indicated**, as directed**.
   c. Finish: Unfinished **OR** Manufacturer's standard prime-coat finish ready for field painting **OR** Vinyl wall covering complying with CFFA-W-101-A **OR** Fabric **OR** Factory-applied paint finish **OR** Powder-coat finish **OR** No. 4 satin**, as directed**.
   d. Colors, Textures, and Patterns: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range**, as directed**.
2. Accessory Panels: Manufacturer's standard fabric-covered tackable panels **OR** porcelain-enamel chalkboard and markerboard panels**, as directed**.
3. Framing: Studs, top and bottom track, 2-1/2 inches (64 mm) **OR** 4 inches (102 mm) **OR** manufacturer's standard**, as directed**, deep.
   a. Steel: Metallic-coated, 0.0359-inch (0.912-mm) base metal thickness.
   b. Aluminum.
   c. Fiberglass.
4. Panel Joint Closure: Manufacturer's standard **OR** Vinyl **OR** Aluminum **OR** Steel**, as directed**.
5. Trim: Continuous, factory-finished, snap-on type; adjustable for variations in floor level **OR** floor and ceiling levels**, as directed**.
   a. Outside Corner Trim: Square **OR** Radiused**, as directed**.
   b. Base: Snap-on vinyl **OR** metal**, as directed**.
   c. Base Trim Profile: Recessed **OR** Projected **OR** Flush**, as directed**.
   d. Ceiling Trim Profile: Recessed **OR** Projected**, as directed**.
   e. Cornice Trim: Continuous over tops of partial-height units for maximum stability.
   f. Exposed-Metal Trim Finish: Factory-applied paint finish **OR** Clear-anodized aluminum; AAMA 611, AA-M12C22A31, Class II **OR** Color-anodized aluminum; AAMA 611, AA-M12C22A32/A34, Class II **OR** Manufacturer's standard prime-coat finish ready for field painting**, as directed**.
   g. Trim Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range**, as directed**.
6. Doors: As specified in Division 12.
7. Door Frames: Manufacturer's standard steel **OR** aluminum**, as directed**, reversible**, as directed**, factory mortised to receive hardware**, as directed**, for 1-3/4-inch (45-mm) doors.
   a. Frame Finishes: Factory-applied paint finish **OR** Clear-anodized aluminum; AAMA 611, AA-M12C22A31, Class II **OR** Color-anodized aluminum; AAMA 611, AA-M12C22A32/A34, Class II **OR** Manufacturer's standard prime-coat finish ready for field painting**, as directed**.
   b. Frame Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range**, as directed**.

8. Fire-Protection Rating of Rated Door Assemblies: Labeled 20 **OR** 45**, as directed**, minutes.
9. Hardware: As specified in Division 08 Section "Door Hardware".
10. Glazing Frames: Manufacturer's standard **OR** Match door frames**, as directed**, for glazing thickness indicated.
    a. Frame Finishes: Factory-applied paint finish **OR** Clear-anodized aluminum; AAMA 611, AA-M12C22A31, Class II **OR** Color-anodized aluminum; AAMA 611, AA-M12C22A32/A34, Class II **OR** Manufacturer's standard prime-coat finish ready for field painting**, as directed**.
    b. Frame Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range**, as directed**.
11. Glazing: Fully tempered clear float glass **OR** Laminated clear float glass **OR** Glass type indicated**, as directed**, complying with Division 08 Section "Glazing".
12. Acoustical Rating: STC 35, unless directed otherwise.
13. Fire-Resistance Rating of Partition Assemblies: 1 hour.
14. Seals: Manufacturer's standard **OR** Open cell, 2 lb/cu. ft. (32 kg/cu. m)**, as directed**.

B. Demountable Unitized-Panel Partitions
1. Panels: Manufacturer's standard **OR** Gypsum board, ASTM C 36/C 36M **OR** Wood composite **OR** Fiber composite **OR** Steel-sheet-faced gypsum board, ASTM C 36/C 36M **OR** Stainless-steel-sheet-faced gypsum board, ASTM C 36/C 36M**, as directed**.
    a. Type: Unfinished **OR** Factory finished **OR** Metal faced**, as directed**.
    b. Thickness: Manufacturer's standard **OR** 1-3/4 inches (45 mm) **OR** 2-1/4 inches (57 mm)**, as directed**.
    c. Width: Manufacturer's standard **OR** 24 inches (610 mm) **OR** 30 inches (762 mm) **OR** As indicated**, as directed**.
    d. Finish: Vinyl wall covering complying with CFFA-W-101-A **OR** Fabric **OR** Factory-applied paint finish **OR** Powder-coat finish **OR** Stainless steel**, as directed**.
    e. Colors, Textures, and Patterns: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range**, as directed**.
2. Accessory Panels: Manufacturer's standard fabric-covered tackable panels **OR** porcelain-enamel chalkboard and markerboard panels**, as directed**.
3. Framing: Manufacturer's standard **OR** Steel **OR** Aluminum**, as directed**.
    a. Frame Finishes: Factory-applied paint finish **OR** Clear-anodized aluminum; AAMA 611, AA-M12C22A31, Class II **OR** Color-anodized aluminum; AAMA 611, AA-M12C22A32/A34, Class II **OR** Manufacturer's standard prime-coat finish ready for field painting**, as directed**.
    b. Frame Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range**, as directed**.
4. Panel Joint Closure: Manufacturer's standard **OR** Flush **OR** Vinyl **OR** Aluminum **OR** Steel**, as directed**.
5. Trim: Continuous, factory-finished, snap-on type; adjustable for variations in floor level **OR** floor and ceiling levels**, as directed**.
    a. Base Trim Profile: Recessed **OR** Projected **OR** Flush**, as directed**.
    b. Ceiling Trim Profile: Recessed **OR** Projected**, as directed**.
    c. Cornice Trim: Continuous over tops of partial-height units for maximum stability.
    d. Exposed-Metal Trim Finish: Factory-applied paint finish **OR** Clear-anodized aluminum; AAMA 611, AA-M12C22A31, Class II **OR** Color-anodized aluminum; AAMA 611, AA-M12C22A32/A34, Class II **OR** Manufacturer's standard prime-coat finish ready for field painting**, as directed**.
    e. Colors: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range**, as directed**.
6. Doors: Manufacturer's standard solid-core wood **OR** steel **OR** glazed**, as directed**, 1-3/4 inches (45 mm) thick.
    a. Door Finishes: Factory-applied paint finish **OR** Clear-anodized aluminum; AAMA 611, AA-M12C22A31, Class II **OR** Color-anodized aluminum; AAMA 611, AA-M12C22A32/A34, Class II **OR** Manufacturer's standard prime-coat finish ready for field painting**, as directed**.
    b. Door Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range**, as directed**.

7. Door Frames: Manufacturer's standard steel **OR** aluminum**, as directed**, reversible**, as directed**, factory mortised to receive hardware**, as directed**, for 1-3/4-inch (45-mm) doors.
   a. Frame Finishes: Factory-applied paint finish **OR** Clear-anodized aluminum; AAMA 611, AA-M12C22A31, Class II **OR** Color-anodized aluminum; AAMA 611, AA-M12C22A32/A34, Class II **OR** Manufacturer's standard prime-coat finish ready for field painting**, as directed**.
   b. Frame Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range**, as directed**.
8. Hardware: As specified in Division 08 Section "Door Hardware".
9. Glazing Frames: Manufacturer's standard **OR** Match door frames**, as directed**, for glazing thickness indicated.
   a. Frame Finishes: Factory-applied paint finish **OR** Clear-anodized aluminum; AAMA 611, AA-M12C22A31, Class II **OR** Color-anodized aluminum; AAMA 611, AA-M12C22A32/A34, Class II **OR** Manufacturer's standard prime-coat finish ready for field painting**, as directed**.
   b. Frame Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range**, as directed**.
10. Glazing: Fully tempered clear float glass **OR** Laminated clear float glass **OR** Glass type indicated**, as directed**, complying with Division 08 Section "Glazing".
11. Acoustical Rating: STC 35, unless directed otherwise.
12. Seals: Manufacturer's standard **OR** Open cell, 2 lb/cu. ft. (32 kg/cu. m)**, as directed**.

C. Fabrication
1. Demountable Site-Assembled Panels: Fabricate each panel from one sheet **OR** two sheets**, as directed**, of gypsum board.
   a. Transom Panels: Fabricate in material and finish to match wall panels, unless otherwise indicated.
2. Demountable Unitized Panels: Factory-assembled, flush, hollow unit construction; with faces smooth and free of buckles, oil canning, and seams; and insulated with solidly packed, inorganic, mineral filler. Fabricate panels for installation with concealed fastening devices and pressure-fit components that will not damage ceiling or floor coverings. Fabricate panels with continuous light-and-sound seals at floor, ceiling, and other locations where panels abut fixed construction.
   a. Factory glaze panels to the greatest extent possible.
3. Components: Fabricate components for installation with concealed fastening devices and pressure-fit members that will not damage ceiling or floor coverings. Fabricate for installation with continuous seals at floor, ceiling, and other locations where partition assemblies abut fixed construction and for installation of sound attenuation insulation in partition cavities.

D. Finishes, General
1. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
2. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

1.3 EXECUTION

A. Installation
1. Install demountable partition systems rigid, level, plumb, and aligned. Install seals to prevent light and sound transmission at connections to floors, ceilings, fixed walls, and abutting surfaces.
   a. Installation Tolerance: Install each demountable partition so surfaces vary not more than 1/8 inch (3 mm) from the plane formed by the faces of adjacent partitions.
2. Do not alter ceiling suspension system **OR** Make alterations to ceiling suspension system required by partition installation or to gain access to electrical or communication systems without

affecting the structural integrity of ceiling suspension system. Make alterations so they are not noticeable after panel installation**, as directed**.

3. Install door-and-frame and glazing-and-glazing-frame assemblies securely anchored to partitions and with doors aligned and fitted. Install and adjust door hardware for proper operation.
   a. Install fire-rated door frames according to NFPA 80.

END OF SECTION 10 22 19 13

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Task	Specification	Specification Description
10 22 19 43	10 22 19 13	Demountable Partitions
10 22 19 53	10 22 19 13	Demountable Partitions
10 22 23 23	10 22 19 13	Demountable Partitions

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SECTION 10 22 43 00 - OPERABLE PANEL PARTITIONS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for operable panel partitions. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Manually operated, acoustical panel partitions.
b. Electrically operated, acoustical panel partitions.
c. Manually operated, fire-rated panel partitions.
d. Manually operated, glass panel partitions.

C. Definitions
1. ADA-ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities."
2. Glass and Glazing Definitions: See Division 08 Section "Glazing".
3. NIC: Noise Isolation Class.
4. NRC: Noise Reduction Coefficient.
5. STC: Sound Transmission Class.

D. Performance Requirements
1. Delegated Design: Design operable panel partitions, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Seismic Performance: Operable panel partitions shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
a. The term "withstand" means "the panels will remain in place without separation of any parts from the system when subjected to the seismic forces specified."
3. Acoustical Performance: Provide operable panel partitions tested by a qualified testing agency for the following acoustical properties according to test methods indicated:
a. Sound-Transmission Requirements: Operable panel partition assembly tested for laboratory sound-transmission loss performance according to ASTM E 90, determined by ASTM E 413, and rated for not less than the STC indicated.
b. Noise-Reduction Requirements: Operable panel partition assembly, identical to partition tested for STC, tested for sound-absorption performance according to ASTM C 423, and rated for not less than the NRC indicated.
c. Acoustical Performance Requirements: Installed operable panel partition assembly, identical to partition tested for STC, tested for NIC according to ASTM E 336, determined by ASTM E 413, and rated for 10 dB less than STC value indicated.
4. Fire Resistance: Provide fire-rated operable panel partition assemblies including pass doors with fire-resistance ratings indicated.
a. Pass Doors: Provide doors in fire-rated operable panel partition assemblies with fire-resistance ratings indicated. Pass doors shall meet positive-pressure requirements.

E. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:

a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that operable panel partitions comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
b. Product Data for Credit EQ 4.4: For each composite wood product used in operable panel partitions, documentation indicating that product contains no urea formaldehyde.

3. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   a. For installed products indicated to comply with design loads, include structural analysis data for attachments, signed and sealed by the qualified professional engineer responsible for their preparation.
   b. Indicate storage and operating clearances. Indicate location and installation requirements for hardware and track, blocking, and direction of travel.
   c. Wiring Diagrams: For power, signal, and control wiring.
4. Samples: For each type of exposed material, finish, covering, or facing indicated.
5. Delegated-Design Submittal: For operable panel partitions indicated to comply with performance requirements, including analysis data and calculations signed and sealed by the qualified professional engineer responsible for their preparation.
   a. Design Calculations: Calculate requirements for seismic restraints.
6. Coordination Drawings: Reflected ceiling plans, drawn to scale, and coordinated with each other, based on input from installers of the items involved.
7. Setting Drawings: For embedded items and cutouts required in other work, including support-beam, mounting-hole template.
8. Seismic Qualification Certificates: For operable panel partitions, accessories, and components, from manufacturer.
9. Product Certificates.
10. Product Test Reports.
11. Field quality-control reports.
12. Operation and Maintenance Data.
13. Warranty: Sample of special warranty.

F. Quality Assurance
1. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
2. Installer Qualifications: An employer of workers trained and approved by manufacturer.
3. Forest Certification: Fabricate products with wood, wood veneers, and wood-based panel products produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
4. Fire-Test-Response Characteristics: Provide panels with finishes meeting one of the following as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
   a. Surface-Burning Characteristics: As determined by testing per ASTM E 84.
      1) Flame-Spread Index: 25 or less **OR** 26 to 75 **OR** 76 to 200, **as directed**.
      2) Smoke-Developed Index: 450 or less.
   b. Fire Growth Contribution: Meeting acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 265 **OR** NFPA 286, **as directed**.
5. Fire-Rated Door Assemblies: Comply with NFPA 80, based on testing according to UL 10B.
   a. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a testing agency acceptable to authorities having jurisdiction that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
7. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling

1. Protectively package and sequence panels in order for installation. Clearly mark packages and panels with numbering system used on Shop Drawings. Do not use permanent markings on panels.

H. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of operable panel partitions that fail in materials or workmanship within two years from date of Final Completion.

1.2 PRODUCTS

A. Materials
1. Steel Frame: Steel sheet, manufacturer's standard **OR** 0.0508-inch (1.3-mm) **OR** 0.0641-inch (1.6-mm) **OR** 0.0747-inch (1.9-mm), **as directed**, nominal minimum thickness for uncoated steel.
2. Steel Face/Liner Sheets: Tension-leveled steel sheet, manufacturer's standard **OR** minimum 0.0299-inch (0.75-mm) **OR** 0.0359-inch (0.9-mm) **OR** 0.0478-inch (1.2-mm) **OR** 0.0598-inch (1.5-mm) **OR** 0.0747-inch (1.9-mm), **as directed**, nominal minimum thickness for uncoated steel.
3. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use, corrosion resistance, and finish indicated; ASTM B 221 (ASTM B 221M) for extrusions; manufacturer's standard strengths and thicknesses for type of use.
   a. Frame Reinforcement: Manufacturer's standard steel or aluminum.
4. Wood Frame: Clear, vertical-grain, straight, kiln-dried, wood **OR** fire-retardant-treated wood, **as directed**; of manufacturer's standard species **OR** one of the following species, **as directed**:
   a. Cherry.
   b. Hemlock.
   c. Maple.
   d. Meranti.
   e. Poplar.
   f. Red oak.
5. Gypsum Board: ASTM C 36/C 36M.
6. Cement Board: ASTM C 1288.
7. Plywood: DOC PS 1.
8. Particleboard: ANSI A208.1, made with binder containing no urea formaldehyde.
9. Medium-Density Fiberboard: ANSI A208.2, made with binder containing no urea formaldehyde.

B. Operable Acoustical Panels
1. Operable Acoustical Panels: Operable acoustical panel partition system, including panels, seals, finish facing, suspension system, operators, and accessories.
2. Panel Operation: Manually operated, individual **OR** Manually operated, paired **OR** Manually operated, continuously hinged **OR** Electrically operated, continuously hinged, **as directed**, panels.
3. Panel Construction: Provide top reinforcement as required to support panel from suspension components and provide reinforcement for hardware attachment. Fabricate panels with tight hairline joints and concealed fasteners. Fabricate panels so finished in-place partition is rigid; level; plumb; aligned, with tight joints and uniform appearance; and free of bow, warp, twist, deformation, and surface and finish irregularities.
4. Dimensions: Fabricate operable acoustical panel partitions to form an assembled system of dimensions indicated and verified by field measurements.
   a. Panel Width: Standard widths **OR** Equal widths **OR** As indicated, **as directed**.
5. STC: Not less than 38 **OR** 41 **OR** 45 **OR** 47 **OR** 50 **OR** 52 **OR** 54, **as directed**.
6. NRC: Not less than 0.50 **OR** 0.60 **OR** 0.65 **OR** 0.90, **as directed**.
7. Panel Weight: 8 lb/sq. ft. (40 kg/sq. m) **OR** 10 lb/sq. ft. (50 kg/sq. m) **OR** 12 lb/sq. ft. (59 kg/sq. m), **as directed**, maximum.
8. Panel Thickness: Not less than 3 inches (75 mm) **OR** 3-1/2 inches (89 mm) **OR** 4 inches (102 mm), **as directed**.

9. Panel Closure: Manufacturer's standard.
   a. Initial Closure: Flexible, resilient PVC, bulb-shaped acoustical seal **OR** Fixed jamb **OR** As indicated, **as directed**.
   b. Final Closure: Constant-force, lever-operated mechanical closure expanding from panel edge to create a constant-pressure acoustical seal **OR** Hinged jamb closure **OR** Hinged communicating panel **OR** Fixed jamb **OR** Angle jamb **OR** Flexible, resilient PVC, bulb-shaped acoustical seal, **as directed**.
10. Hardware: Manufacturer's standard as required to operate operable panel partition and accessories; with decorative, protective finish.
    a. Hinges: Manufacturer's standard **OR** Concealed (invisible), **as directed**.
    b. Exit Device: Manufacturer's standard.

C. Operable Fire-Rated Panels
1. Operable Fire-Rated Panels: Operable fire-rated acoustical panel partition system, including panels, seals, finish facing, suspension system, operators, and accessories.
2. Panel Operation: Manually operated, individual **OR** Manually operated, paired, **as directed**, panels.
3. Panel Construction: Provide top reinforcement as required to support panel from suspension components and provide reinforcement for hardware attachment. Fabricate panels with tight hairline joints and concealed fasteners. Fabricate panels so finished in-place partition is rigid; level; plumb; aligned, with tight joints and uniform appearance; and free of bow, warp, twist, deformation, and surface and finish irregularities.
4. Dimensions: Fabricate operable fire-rated panel partitions to form an assembled system of dimensions indicated and verified by field measurements.
   a. Panel Width: Standard widths **OR** Equal widths **OR** As indicated, **as directed**.
5. Fire Rating: 1 hour **OR** 2 hours, **as directed**.
6. STC: Not less than 38 **OR** 41 **OR** 45 **OR** 47 **OR** 50 **OR** 52 **OR** 54, **as directed**.
7. NRC: Not less than 0.50 **OR** 0.60 **OR** 0.65 **OR** 0.90, **as directed**.
8. Panel Weight: 8 lb/sq. ft. (40 kg/sq. m) **OR** 10 lb/sq. ft. (50 kg/sq. m) **OR** 12 lb/sq. ft. (59 kg/sq. m), **as directed**, maximum.
9. Panel Thickness: Not less than 3 inches (75 mm) **OR** 3-1/2 inches (89 mm) **OR** 4 inches (102 mm), **as directed**.
10. Panel Closure: Manufacturer's standard fire-rated closure.
    a. Initial Closure: Flexible, resilient PVC, bulb-shaped acoustical seal **OR** Fixed jamb **OR** As indicated, **as directed**.
    b. Final Closure: Fire-rated, constant-force, lever-operated mechanical closure expanding from panel edge to create a constant-pressure acoustical seal **OR** hinged jamb closure **OR** hinged communicating panel **OR** fixed jamb **OR** angle jamb **OR** flexible, resilient PVC, bulb-shaped acoustical seal, **as directed**.
11. Hardware: Manufacturer's standard as required to operate fire-rated operable panel partition and accessories; with decorative, protective finish.
    a. Hinges: Manufacturer's standard **OR** Concealed (invisible), **as directed**.
    b. Exit Device: Manufacturer's standard.

D. Operable Glass Panels
1. Operable Glass Panels: Operable frameless aluminum **OR** aluminum-framed **OR** wood-framed, **as directed**, glass panel partition system with acoustical properties, **as directed**, including panels, seals, **as directed**, suspension system, operators, and accessories.
2. Panel Operation: Manually operated, individual **OR** Manually operated, paired **OR** Manually operated, continuously hinged, **as directed**, panels.
3. Panel Construction: Manufacturer's standard glazed panels, reinforced as required to support panel from suspension components and with reinforcement for hardware attachment. Fabricate panels with tight hairline joints and concealed fasteners. Fabricate panels so finished in-place partition is rigid; level; plumb; aligned, with tight joints and uniform appearance; and free of bow, warp, twist, deformation, and surface and finish irregularities.

a. Factory-Glazed Fabrication: Glaze operable glass panels in the factory where practical and possible for applications indicated. Comply with manufacturer's written requirements and with requirements in Division 08 Section "Glazing".

4. Glass and Glazing:
   a. Safety Glass: Provide glass products complying with testing requirements in 16 CFR 1201, for Category II materials, unless those of Category I are expressly indicated and permitted.
   b. Glass: Manufacturer's standard **OR** Custom, **as directed**, glass and glass assemblies as indicated and complying with the following:
      1) Tempered Glass: ASTM C 1048, Kind FT (fully tempered), Type I (transparent flat glass), Class 1 (clear) **OR** Class 2 (tinted), **as directed**, Quality-Q3.
      2) Tempered Patterned Glass: ASTM C 1048, Kind FT (fully tempered), Type II (patterned flat glass), Class 1 (clear), Form 3 (patterned); and of quality, finish, and pattern specified.
      3) Laminated Glass: ASTM C 1172, with clear **OR** colored **OR** patterned **OR** graphic, **as directed**, interlayer.
         a) Annealed Float Glass: ASTM C 1036, Type I (transparent flat glass), Class 1 (clear) **OR** Class 2 (tinted), **as directed**, Quality-Q3.
         b) Patterned Glass: ASTM C 1036, Type II (patterned and wired flat glass), Class 1 (clear), Form 3 (patterned); and of quality, finish, and pattern specified.
      4) Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass as indicated, separated by a dehydrated interspace, and complying with ASTM E 774 for Class CBA units.
         a) Spacer Specifications: Manufacturer's standard spacer material and construction.
         b) Spacer Specifications: Manufacturer's standard spacer construction and material as follows: Aluminum with mill or clear anodic finish **OR** Aluminum with black, color anodic finish **OR** Aluminum with bronze, color anodic finish **OR** Aluminum with powdered-metal paint finish in color selected **OR** Galvanized steel **OR** Stainless steel, **as directed**.
      5) Glass Thickness: Manufacturer's standard thickness for indicated requirements **OR** As indicated **OR** 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1 inch (25 mm) **OR** 2-1/4 inches (57 mm), **as directed**.
      6) Glass Vertical Edge: Polished **OR** Manufacturer's standard, permanently adhered edge trim, **as directed**.
   c. Glazing System: Manufacturer's standard factory-glazing system **OR** Manufacturer's standard factory-glazing system that produces acoustical seal **OR** Manufacturer's standard factory-glazing system as indicated, **as directed**.
5. Dimensions: Fabricate operable glass panel partitions to form an assembled system of dimensions indicated and verified by field measurements.
   a. Panel Width: Standard widths **OR** Equal widths **OR** As indicated, **as directed**.
6. STC: Not less than 36 **OR** 41 **OR** 46 **OR** 48, **as directed**.
7. Panel Weight: 8 lb/sq. ft. (40 kg/sq. m) **OR** 20 lb/sq. ft. (98 kg/sq. m), **as directed**, maximum.
8. Panel Frame Thickness: Maximum 1-7/8 inches (48 mm) **OR** 2-1/4 inches (57 mm) **OR** 3-3/4 inches (96 mm), **as directed**.
9. Panel Closure: Manufacturer's standard.
10. Hardware: Manufacturer's standard as required to operate operable panel partition and accessories; with decorative, protective finish.
11. Finishes:
    a. Exposed Metal: Match sample **OR** As selected from manufacturer's full range, **as directed**, as follows:
       1) Aluminum: Clear anodized **OR** Light bronze anodized **OR** Medium bronze anodized **OR** Dark bronze anodized **OR** Black anodized **OR** Baked powder coating, **as directed**.

2) Metal-Clad Aluminum: Satin stainless steel **OR** Polished stainless steel **OR** Satin brass **OR** Polished brass **OR** Satin bronze **OR** Polished bronze, **as directed**.

b. Wood Finish: Match sample **OR** As selected from manufacturer's full range, **as directed**, as follows:

1) Type: Transparent finish **OR** Transparent finish over stain, **as directed**, over wood variety indicated.

E. Seals

1. General: Provide types of seals indicated that produce operable panel partitions complying with acoustical and fire-resistive performance requirements, **as directed**, and the following:
   a. Manufacturer's standard seals.
   b. Seals made from materials and in profiles that minimize sound leakage.
   c. Seals fitting tight at contact surfaces and sealing continuously between adjacent panels and between operable panel partition perimeter and adjacent surfaces, when operable panel partition is extended and closed.
2. Vertical Seals: Deep-nesting, interlocking steel, **as directed**, astragals mounted on each edge of panel, with continuous PVC acoustical seal.
3. Horizontal Top Seals:
   a. Continuous-contact, extruded-PVC seal exerting uniform constant pressure on track.
      OR
      PVC-faced, mechanical, retractable, constant-force-contact seal exerting uniform constant pressure on track when extended.
      OR
      Continuous-contact, extruded-PVC seal exerting uniform constant pressure on track or PVC-faced, mechanical, retractable, constant-force-contact seal exerting uniform constant pressure on track when extended.
4. Horizontal Bottom Seals: PVC-faced, mechanical, retractable, constant-force-contact seal exerting uniform constant pressure on floor when extended, ensuring horizontal and vertical sealing and resisting panel movement.
   a. Mechanically Operated for Acoustical Panels: Extension and retraction of bottom seal by operating handle or built-in operating mechanism, with operating range not less than 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 4 inches (102 mm) **OR** 6 inches (152 mm), **as directed**, between retracted seal and floor finish.
      OR
      Mechanically Operated for Fire-Rated Panels: Extension and retraction of bottom seal by operating handle or built-in operating mechanism, with operating range not less than 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 4 inches (102 mm), **as directed**, between retracted seal and floor finish.
      OR
      Automatically Operated for Acoustical Panels: Extension and retraction of bottom seal automatically operated by movement of partition, with operating range not less than 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, between retracted seal and floor finish.

F. Finish Facing

1. General: Provide finish facings for panels that comply with indicated fire-test-response characteristics and that are factory applied to operable panel partitions with appropriate backing, using mildew-resistant nonstaining adhesive as recommended by facing manufacturer's written instructions.
   a. Apply facings **OR** one-piece, seamless facings, **as directed**, free of air bubbles, wrinkles, blisters, and other defects, with edges tightly butted, and **OR** with invisible seams complying with Shop Drawings for location, and, **as directed**, with no gaps or overlaps. Horizontal butted edges **OR** seams, **as directed**, are not permitted. Tightly secure and conceal raw and selvage edges of facing for finished appearance.

b. Where facings with directional or repeating patterns or directional weave **OR** directional, repeating, or matching grain, **as directed**, are indicated, mark facing top and attach facing in same direction.
c. Match facing pattern 72 inches (1830 mm) above finished floor.
d. Color/Pattern: Match samples **OR** As selected from manufacturer's full range, **as directed**.

2. Vinyl-Coated Fabric Wall Covering: Manufacturer's standard, mildew-resistant, washable, vinyl-coated fabric wall covering; complying with CFFA-W-101-D for type indicated; Class A.
   a. Antimicrobial Treatment: Additives capable of inhibiting growth of bacteria, fungi, and yeasts.
3. Carpet Wall Covering: Manufacturer's standard nonwoven, needle-punched carpet with fibers fused to backing, from same dye lot, treated to resist stains.
4. Fabric Wall Covering: Manufacturer's standard fabric **OR** 100 percent polyolefin woven fabric, **as directed**, from same dye lot, treated to resist stains.
5. High-Pressure Decorative Laminate: NEMA LD 3, Horizontal grade.
6. Wood Veneer: Laminated to noncombustible **OR** fire-retardant-treated wood, **as directed**, core with moisture-resistant adhesive, of wood species indicated.
   a. Wood Finish: Match sample **OR** As selected from manufacturer's full range, **as directed**, as follows:
      1) Type: Transparent finish **OR** Transparent finish over stain, **as directed**, over wood variety indicated.
7. Paint: Manufacturer's standard factory-painted finish.
   a. Color: As indicated **OR** As selected, **as directed**.
8. Cap-Trimmed Edges: Protective perimeter-edge trim with tight hairline joints concealing edges of panel and finish facing, finished as follows:
   a. Steel, Painted: Finished with manufacturer's standard neutral color **OR** Matching sample **OR** As selected from manufacturer's full range, **as directed**.
   b. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper required to comply with performance requirements; and with manufacturer's standard mill **OR** clear anodic **OR** color anodic, **as directed**, finish.
9. Trimless Edges: Fabricate exposed panel edges so finish facing wraps uninterrupted around panel, covering edge and resulting in an installed partition with facing visible on vertical panel edges, without trim, for minimal sightlines at panel-to-panel joints.

G. Suspension Systems

1. Suspension Tracks: Steel or aluminum mounted directly to overhead structural support, **OR** with adjustable steel hanger rods for overhead support, **as directed**, designed for type of operation, size, and weight of operable panel partition indicated. Size track to support partition operation and storage without damage to suspension system, operable panel partitions, or adjacent construction. Limit track deflection to no more than 0.10 inch (2.54 mm) between bracket supports. Provide a continuous system of track sections and accessories to accommodate configuration and layout indicated for partition operation and storage.
   a. Panel Guide: Aluminum; finished with factory-applied, decorative, protective finish.
   b. Head Closure Trim: As required for acoustical performance; with factory-applied, decorative, protective finish **OR** primed for field finish, **as directed**.
2. Carriers: Trolley system as required for configuration type, size, and weight of partition and for easy operation; with ball-bearing wheels.
   a. Multidirectional Carriers: Capable of negotiating 90-degree L, T, and X intersections without track switches.
3. Track Intersections, Switches, and Accessories: As required for type of operation, storage, track configuration, and layout indicated for operable panel partitions, and compatible with partition assembly specified. Fabricate track intersections and switches from steel or aluminum.
   a. Curve-and-Diverter Switches: Allowing radius turns to divert panels to an auxiliary track.
   b. L Intersections: Allowing panels to change 90 degrees in direction of travel.
   c. T Intersections: Allowing panels to pass through or change 90 degrees to another direction of travel.

d. X Intersections: Allowing panels to pass through or change travel direction full circle in 90-degree increments, and allowing 1 partition to cross track of another.
e. Multidirectional Switches: Adjustable switch configuring track into L, T, or X intersections and allowing panels to be moved in all pass-through, 90-degree change, and cross-over travel direction combinations.
f. Center carrier stop.
4. Aluminum Finish: Mill finish or manufacturer's standard, factory-applied, decorative finish unless otherwise indicated.
5. Steel Finish: Manufacturer's standard, factory-applied, corrosion-resistant, protective coating unless otherwise indicated.

H. Electric Operators
1. General: Provide factory-assembled electric operation system of size and capacity recommended and provided by operable panel partition manufacturer for partition specified; with electric motor and factory-prewired motor controls, speed reducer, chain drive, remote-control stations, control devices, and accessories required for proper operation. Include wiring from motor control to motor. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
2. Comply with NFPA 70.
3. Control Equipment: Complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6.
4. Motor Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, within installed environment, with indicated operating sequence, and without exceeding nameplate rating or considering service factor. Comply with NEMA MG 1 and the following:
a. Voltage: 120 V **OR** 208-220 V **OR** NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected, **as directed**.
b. Horsepower: 1/4 **OR** 1/3 **OR** 3/4 **OR** Manufacturer's standard, **as directed**.
c. Efficiency: Standard **OR** Premium, **as directed**.
d. Enclosure: Open dripproof **OR** Totally enclosed **OR** Manufacturer's standard, **as directed**.
e. Duty: Continuous duty at ambient temperature of 105 deg F (40 deg C) and at altitude of 3300 feet (1005 m) above sea level.
f. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.
g. Phase: Single **OR** Polyphase, **as directed**.
5. Remote-Control Stations: Two single-key-operated, constant-pressure control stations located remotely from each other on opposite sides and opposite ends of partition run. Wire in series to require simultaneous activation of both key stations to operate partition. Each three-position control station labeled "Open," "Close," and "Off **OR** Stop, **as directed**." Provide two keys per station.
6. Obstruction-Detection Devices: Provide each motorized operable panel partition with automatic safety sensor indicated, that causes operator to immediately shut off motor **OR** stop and reverse direction, **as directed**.
a. Sensor Edge: Contact-pressure-sensitive safety edge along partition's leading edge.
b. Sensor Mat: Electrically operated, contact-weight-sensitive safety mat in storage pocket area.
c. Infrared Sensor System: Designed to detect an obstruction in partition's path and sound an audible alarm, without obstruction contacting partition.
7. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop operable panel partition at fully extended and fully stacked positions.
8. Emergency Release Mechanism: Quick disconnect-release of electric-motor drive system, permitting manual operation in event of operating failure.

I. Accessories
1. Pass Doors: Fabricated to comply with recommendations in ICC/ANSI A117.1 **OR** the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines, **as directed**. Swinging door built into and matching panel materials, **OR** construction, **OR**

acoustical qualities, **OR** fire rating, **as directed**, finish, and thickness, complete with frames and operating hardware. Hinges finished to match other exposed hardware.

a. Single Pass Door: 36 by 80 inches (914 by 2032 mm) **OR** 36 by 84 inches (914 by 2134 mm), **as directed**, with the following:
b. Double Pass Door: 72 by 80 inches (1829 by 2032 mm) **OR** 72 by 84 inches (1829 by 2134 mm), **as directed**, with the following:
    1) Door Seals: Mechanically operated floor seal on panels containing pass doors **OR** Sweep floor seals, **as directed**.
    2) Panic **OR** Fire, **as directed**, exit device.
    3) Concealed door closer.
    4) Door Viewer: Installed with view in direction of swing.
    5) Exit Sign: Recessed, self-illuminated.
    6) Latchset: Passage set.
    7) Lock: Key-operated lock cylinder, keyed to master key system, **as directed**, operable from both sides of door. Include two keys per lock.
       OR
       Lock: Deadlock to receive cylinder, operable from both sides of door. Refer to Division 12 for lock cylinder and keying requirements.

2. Storage Pocket Door: Full height at end of partition runs to conceal stacked partition; of same materials, finish, construction, thickness, and acoustical qualities as panels; complete with operating hardware and acoustical seals at soffit, floor, and jambs, **as directed**. Hinges in finish to match other exposed hardware.
    a. Manufacturer's standard method to secure storage pocket door in closed position.
       OR
       Rim Lock: Key-operated lock cylinder, keyed to master key system, **as directed**, to secure storage pocket door in closed position. Include two keys per lock.
       OR
       Rim Lock: Deadlock to receive cylinder, to secure storage pocket door in closed position. Refer to Division 12 for lock cylinder and keying requirements.
3. Electric Interlock: Provide each motorized operable panel partition with electric interlocks at locations indicated, to prevent operation of operable panel partition under the following conditions:
    a. On storage pocket door, to prevent operation if door is not in fully open position.
    b. On partitions at location of convergence by another partition, to prevent operation if merging partitions are in place.
4. Windows: Manufacturer's standard **OR** As indicated, **as directed**.
5. Work Surfaces: Quantities, placement, and size indicated.
    a. Surface: Porcelain steel marker/projection surface **OR** Self-healing, tackable, vinyl-coated fabric wall covering, complying with CFFA-W-101-D, Type II, and indicated fire-test-response characteristics; laminated to natural cork tackboard, **as directed**.
    b. Surface Color: Matching sample **OR** As selected from manufacturer's full range, **as directed**.
    c. Size: Full width and height of panel **OR** Full width of panel by 48 inches (1219 mm) **OR** 48 by 48 inches (1219 by 1219 mm) **OR** As indicated on Drawings, **as directed**.
    d. Trim: Aluminum slip-on or snap-on trim with no visible screws or exposed joints and with corners mitered to a neat, hairline joint.
6. Chalk Tray and Eraser Pocket, **as directed**: Manufacturer's standard.
    a. Aluminum with mill **OR** clear anodic **OR** color anodic, **as directed**, finish.
7. Chair Rails: Recessed **OR** Surface mounted, **as directed**, in locations indicated on Drawings.
8. Vertical Edge Trim: Manufacturer's standard transparent **OR** thin aluminum astragal, **as directed**, trim to protect vertical edges of glass in frameless panels.

1.3 EXECUTION

A. Installation

1. General: Comply with ASTM E 557 except as otherwise required by operable panel partition manufacturer's written installation instructions.
2. Install operable panel partitions and accessories after other finishing operations, including painting, have been completed.
3. Install panels from marked packages in numbered sequence indicated on Shop Drawings.
4. Broken, cracked, chipped, deformed, or unmatched panels are not acceptable.
5. Broken, cracked, deformed, or unmatched gasketing or gasketing with gaps at butted ends is not acceptable.

B. Adjusting
1. Adjust operable panel partitions to operate smoothly, without warping or binding. Lubricate hardware, electric operator, **as directed**, and other moving parts.
2. Adjust pass doors and storage pocket doors, **as directed**, to operate smoothly and easily, without binding or warping. Check and readjust operating hardware. Confirm that latches and locks engage accurately and securely without forcing or binding.

C. Field Quality Control
1. This paragraph is applicable if sound control is critical. Installer shall conduct a light-leakage test at completion of installation, and prior to NIC testing, to correct alignment of vertical joints and top and bottom seals.
2. Light-Leakage Test: Illuminate one side of partition installation and observe vertical joints and top and bottom seals for voids; adjust partitions for acceptable fit.
3. NIC Testing: Engage a qualified testing agency to perform tests and inspections.
4. Testing Methodology: Perform testing of installed operable panel partition for noise isolation according to ASTM E 336, determined by ASTM E 413, and rated for not less than NIC indicated. Adjust and fit partitions to comply with NIC test method requirements.
5. Testing Extent: Testing agency shall randomly select one operable panel partition installation(s) for testing.
6. Repair or replace operable panel partitions that do not comply with requirements.
7. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of repaired, replaced, or additional work with specified requirements.
8. Prepare test and inspection reports.

D. Cleaning
1. Clean soiled surfaces of operable panel partitions to remove dust, loose fibers, fingerprints, adhesives, and other foreign materials according to manufacturer's written instructions.

END OF SECTION 10 22 43 00

SECTION 10 26 13 00 - IMPACT-RESISTANT WALL PROTECTION

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for impact-resistant wall protection. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Wall guards.
   b. Impact-resistant handrails.
   c. Bed locators.
   d. Corner guards.
   e. Impact-resistant wall coverings.
   f. Door protection systems.

C. Performance Requirements

1. Structural Performance: Provide handrails capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
   a. Uniform load of 50 lbf/ft. (0.73 kN/m) applied in any direction.
   b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
   c. Uniform and concentrated loads need not be assumed to act concurrently.

D. Submittals

1. Product Data: Include construction details, material descriptions, impact strength, fire-test-response characteristics, dimensions of individual components and profiles, and finishes for each impact-resistant wall protection unit.
2. LEED Submittals:
   a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood rails comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
      1) Include statement indicating costs for each certified wood product.
   b. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
   c. Product Data for Credit EQ 4.4: For particleboard, documentation indicating that products contain no urea formaldehyde.
3. Shop Drawings: For each impact-resistant wall protection unit showing locations and extent. Include sections, details, and attachments to other work.
   a. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
4. Samples: For each type of exposed finish required, prepared on Samples of size indicated below. Include Samples of accent strips to verify color selected.
   a. Wall and Corner Guards: 12 inches (300 mm) long. Include examples of joinery, corners, end caps, top caps, and field splices.
   b. Handrails: 12 inches (300 mm) long. Include examples of joinery, corners, and field splices.
   c. Impact-Resistant Wall Covering: 6 by 6 inches (150 by 150 mm) square.
   d. Door-Surface Protection: 6 by 6 inches (150 by 150 mm) square.
   e. Door-Edge and -Frame Protectors: 12 inches (300 mm) long.
   f. Door-Knob and -Lever Protectors: Full-size unit of each type.

5. Qualification Data: For qualified Installer and testing agency.
6. Material Certificates: For each impact-resistant plastic material, from manufacturer.
7. Material Test Reports: For each impact-resistant plastic material.
8. Maintenance Data: For each impact-resistant wall protection unit to include in maintenance manuals.
    a. Include recommended methods and frequency of maintenance for maintaining optimum condition of plastic covers under anticipated traffic and use conditions. Include precautions against using cleaning materials and methods that may be detrimental to plastic finishes and performance.
9. Warranty: Sample of special warranty.

E. Quality Assurance
1. Installer Qualifications: An employer of workers trained and approved by manufacturer.
2. Source Limitations: Obtain impact-resistant wall protection units from single source from single manufacturer.
3. Product Options: Drawings indicate size, profiles, and dimensional requirements of impact-resistant wall protection units and are based on the specific system indicated.
    a. Do not modify intended aesthetic effects, as judged solely by the Owner, except with the Owner's approval. If modifications are proposed, submit comprehensive explanatory data to the Owner for review.
4. Forest Certification: Fabricate wood rails from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
5. Surface-Burning Characteristics: Provide impact-resistant, plastic wall protection units with surface-burning characteristics as determined by testing identical products per ASTM E 84, NFPA 255, or UL 723 by UL or another qualified testing agency.
6. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.
7. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Store impact-resistant wall protection units in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
    a. Maintain room temperature within storage area at not less than 70 deg F (21 deg C) during the period plastic materials are stored.
    b. Keep plastic sheet material out of direct sunlight.
    c. Store plastic wall protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of 70 deg F (21 deg C).
        1) Store corner-guard covers in a vertical position.
        2) Store wall-guard, bed-locator and handrail covers in a horizontal position.

G. Project Conditions
1. Environmental Limitations: Do not deliver or install impact-resistant wall protection units until building is enclosed and weatherproof, wet work is complete and dry, and HVAC system is operating and maintaining temperature at 70 deg F (21 deg C) for not less than 72 hours before beginning installation and for the remainder of the construction period.

H. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of impact-resistant wall protection units that fail in materials or workmanship within specified warranty period.
    a. Failures include, but are not limited to, the following:
        1) Structural failures.

2) Deterioration of plastic and other materials beyond normal use.

b. Warranty Period: Five years from date of Final Completion.

1.2 PRODUCTS

A. Materials

1. PVC Plastic: ASTM D 1784, Class 1, textured, chemical- and stain-resistant, high-impact-resistant PVC or acrylic-modified vinyl plastic with integral color throughout; extruded and sheet material, thickness as indicated.
   a. Impact Resistance: Minimum 25.4 ft-lbf/in. (1356 J/m) of notch when tested according to ASTM D 256, Test Method A.
   b. Chemical and Stain Resistance: Tested according to ASTM D 543 **OR** ASTM D 1308.
   c. Self-extinguishing when tested according to ASTM D 635.
   d. Flame-Spread Index: 25 or less.
   e. Smoke-Developed Index: 450 or less.
2. Polycarbonate Plastic Sheet: ASTM D 6098, S-PC01, Class 1 or 2, abrasion resistant; with a minimum impact-resistance rating of 15 ft-lbf/in. (800 J/m) of notch when tested according to ASTM D 256, Test Method A.
3. Aluminum Extrusions: Alloy and temper recommended by manufacturer for type of use and finish indicated, but with not less than strength and durability properties specified in ASTM B 221 (ASTM B 221M) for Alloy 6063-T5.
4. Stainless-Steel Sheet: ASTM A 240/A 240M.
5. Brass: ASTM B 249/B 249M for extruded shapes and ASTM B 36/B 36 M for sheet.
6. Solid Wood: Clear hardwood lumber of species indicated, free of appearance defects, and selected for compatible grain and color.
7. Particleboard: ANSI A208.1, Grade M-2; made with binder containing no urea formaldehyde.
8. Fasteners: Aluminum, nonmagnetic stainless-steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with items being fastened. Use security-type fasteners where exposed to view.
9. Adhesive: As recommended by impact-resistant plastic wall protection manufacturer and with a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Wall Guards

1. Crash Rail: Heavy-duty assembly consisting of continuous snap-on plastic cover installed over concealed retainer system; designed to withstand impacts.
   a. Cover: Extruded rigid plastic, minimum 0.100-inch (2.5-mm) wall thickness; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
      1) Profile: Flat **OR** Convex, **as directed**.
         a) Dimensions: Nominal 6 inches high by 1 inch deep (150 mm high by 25 mm deep) **OR** 8 inches high by 1 inch deep (200 mm high by 25 mm deep), **as directed**.
         b) Surface: Uniform **OR** Uniform with coextruded accent inlay strip in contrasting color **OR** Grooved, **as directed**.
            i. Accent Inlay Strip: Nominal 2 inches (50 mm) high by length of rail.
      2) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   b. Continuous Retainer: Minimum 0.080-inch- (2.0-mm-) thick, one-piece, extruded aluminum.

      OR

      Retainer Clips: Manufacturer's standard impact-absorbing clips designed for heavy-duty performance.
   c. Bumper: Continuous rubber or vinyl bumper cushion(s).

d. End Caps and Corners: Prefabricated, injection-molded plastic; matching color **OR** contrasting with color, **as directed**, cover; field adjustable for close alignment with snap-on cover.
e. Accessories: Concealed splices and mounting hardware.
f. Mounting: Surface mounted directly to wall **OR** Reveal mounted on bumper cushion(s) **OR** Extended mounting on injection-molded plastic mounting brackets, **as directed**.

2. Bumper Rail: Assembly consisting of continuous snap-on plastic cover installed over concealed, continuous retainer; designed to withstand impacts.
   a. Cover: Extruded rigid plastic, minimum 0.078-inch (2.0-mm) wall thickness; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
      1) Profile: Half round profile, nominal 1 inch high by 1 inch deep (25 mm high by 25 mm deep) **OR** Rounded bullnose profile, nominal 4 inches high by 2 inches deep (100 mm high by 50 mm deep) **OR** Angled profile with rounded-bullnose front edge, nominal 4 inches high by 2 inches deep (100 mm high by 50 mm deep) **OR** Flat profile, nominal 4 inches high by 1 inch deep (100 mm high by 25 mm deep), **as directed**.
      2) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   b. Continuous Retainer: Minimum 0.080-inch- (2.0-mm-) thick, one-piece, extruded aluminum.
      OR
      Retainer Clips: Manufacturer's standard impact-absorbing clips.
   c. Bumper: Continuous rubber or vinyl bumper cushion(s).
   d. End Caps and Corners: Prefabricated, injection-molded plastic; matching color **OR** contrasting with color, **as directed**, cover; field adjustable for close alignment with snap-on cover.
   e. Accessories: Concealed splices and mounting hardware.
   f. Mounting: Surface mounted directly to wall **OR** Reveal mounted on bumper cushions **OR** Extended mounting on injection-molded plastic mounting brackets, **as directed**.
3. Rub Rail: Assembly consisting of continuous snap-on cover installed over concealed, continuous retainer.
   a. Cover: Extruded rigid plastic **OR** flexible PVC, **as directed**, minimum 0.078-inch (2.0-mm) wall thickness; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
      1) Profile: Half-round profile, nominal 1-1/8 inches high by 1-1/8 inches deep (30 mm high by 30 mm deep) **OR** Rounded bullnose profile, nominal 2 inches high by 1 inch deep (50 mm high by 25 mm deep), **as directed**.
      2) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   b. Retainer: Minimum 0.0625-inch- (1.6-mm-) thick, one-piece, extruded aluminum.
   c. End Caps and Corners: Prefabricated, injection-molded plastic; color matching cover; field adjustable for close alignment with snap-on cover.
   d. Accessories: Concealed splices and mounting hardware.
   e. Mounting: Surface mounted directly to wall **OR** Reveal mounted on bumper cushions, **as directed**.
4. Wood Chair Rail with Bumper: Assembly consisting of continuous sculpted, solid-wood rail, with continuous bumper insert installed in continuous recessed retainer.
   a. Wood Rail: 3-1/2 inches high by 7/8 inch deep (89 mm high by 22 mm deep) **OR** 5-1/2 inches high by 1-1/2 inches deep (140 mm high by 38 mm deep) **OR** Size and profile indicated on Drawings, **as directed**.
      1) Wood Species: Red oak **OR** Maple **OR** Ash **OR** Beech, **as directed**.
      2) Finish: Clear **OR** Stained, **as directed**.
      3) Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

b. Bumper: Extruded rigid plastic **OR** flexible vinyl, **as directed**, minimum 0.078-inch (2.0-mm) wall thickness; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
   1) Profile: Half-round profile, nominal 2 inches high by 1 inch deep (50 mm high by 25 mm deep) **OR** Small rounded profile, nominal 1-1/8 inches high by 1-1/8 inches deep (30 mm high by 30 mm deep), **as directed**.
   2) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   3) End Caps and Corners: Prefabricated, injection-molded plastic; color matching bumper; field adjustable for close alignment with snap-on bumper.

c. Retainer: Minimum 0.0625-inch- (1.6-mm-) thick, one-piece, extruded aluminum.
   1) Finish: Mill **OR** Brass colored, **as directed**.

d. Accessories: Concealed splices and mounting hardware.

e. Mounting: Surface mounted directly to wall.

5. Wood Chair Rail: Assembly consisting of continuous sculpted, solid-wood rail.
   a. Rail: 3-1/2 inches high by 7/8 inch deep (89 mm high by 22 mm deep) **OR** 5-1/2 inches high by 1-1/2 inches deep (140 mm high by 38 mm deep) **OR** As indicated on Drawings, **as directed**.
      1) Wood Species: Red oak **OR** Maple **OR** Ash **OR** Bamboo, **as directed**.
      2) Finish: Clear **OR** Stained, **as directed**.
      3) Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   b. Accessories: Concealed splices and mounting hardware.
   c. Mounting: Surface mounted directly to wall.

6. Opaque-Plastic Chair Rail: Assembly consisting of continuous snap-on cover installed over continuous retainer.
   a. Cover: Extruded rigid plastic, minimum 0.070-inch (1.8-mm) wall thickness; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
      1) Profile: Rounded bullnose profile, nominal 2 inches high by 1 inch deep (50 mm high by 25 mm deep) **OR** Half-round profile, nominal 1-1/8 inches high by 1-1/8 inches deep (30 mm high by 30 mm deep), **as directed**.
      2) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   b. Retainer: Minimum 0.060-inch- (1.5-mm-) thick, one-piece, extruded aluminum.
   c. Bumper: Continuous rubber or vinyl bumper cushion(s).
   d. End Caps and Corners: Prefabricated, injection-molded plastic; color matching cover; field adjustable for close alignment with snap-on cover.
   e. Accessories: Concealed splices and mounting hardware.
   f. Mounting: Surface mounted directly to wall **OR** Reveal mounted on bumper cushions, **as directed**.

7. Transparent-Plastic Chair Rail: Consisting of clear polycarbonate plastic sheet.
   a. Height: 3 inches (75 mm) nominal **OR** 4 inches (100 mm) nominal **OR** As indicated on Drawings, **as directed**.
   b. Mounting: Surface mounted using flat-head countersunk screws through factory-drilled mounting holes.

8. Rub Strip: Consisting of minimum 0.040-inch- (1.0-mm-) **OR** 0.060-inch- (1.5-mm-), **as directed**, thick, plastic sheet wall-covering material.
   a. Height: 8 inches (200 mm) nominal.
   b. Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   c. Mounting: Surface mounted with adhesive or double-faced adhesive tape.

C. Handrails
   1. Impact-Resistant Plastic Handrails: Assembly consisting of snap-on plastic cover installed over continuous retainer.

a. Cover: Minimum 0.078-inch- (2.0-mm-) **OR** 0.100-inch- (2.5-mm-), **as directed**, thick, extruded rigid plastic; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
   1) Single Handrail: Cylindrical tube profile cover with continuous retainer; with mounting brackets supporting bottom of rail.
      a) Tube Diameter: as directed by the Owner.
   2) Bumper Rail: Cover with flat **OR** sculpted with contoured thumb recess on, **as directed**, front side; with 1-1/2-inch- (38-mm-) diameter gripping surface and finger recess on back side; supported by concealed, continuous retainer and extended mounting brackets.
      a) Bumper-Rail Dimensions: Nominal 5-1/2 inches high by 1-1/2 inches deep (140 mm high by 38 mm deep) **OR** 5-1/2 inches high by 2 inches deep (140 mm high by 50 mm deep), **as directed**.
      b) Bumper Surface: Smooth **OR** Smooth with coextruded accent inlay strip in contrasting color **OR** Grooved, **as directed**.
      c) Accent Inlay Strip: Nominal 2 inches (50 mm) high by length of rail.
   3) Double Handrail with Bumper-Rail Profile: Two tubes mounted above and below nominal, flat-faced bumper rail; each tube with 1-1/2-inch- (38-mm-) diameter gripping surface and finger recess on back side; supported by concealed, continuous retainer and extended mounting brackets.
      a) Bumper-Rail Dimensions: Nominal 4 inches high by 1-1/2 inches deep (100 mm high by 38 mm deep).
      b) Bumper Surface: Smooth **OR** Smooth with coextruded accent inlay strip in contrasting color **OR** Grooved, **as directed**.
      c) Accent Inlay Strip: Nominal 2 inches (50 mm) high by length of rail.
   4) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

b. Retainer: Minimum 0.080-inch- (2.0-mm-) thick, one-piece, extruded aluminum.

c. Mounting Bracket: Extended mounting on injection-molded plastic **OR** anodized-aluminum, **as directed**, mounting brackets.

d. End Caps and Corners: Prefabricated, injection-molded plastic; matching color **OR** contrasting with color, **as directed**, cover; field adjustable for close alignment with snap-on cover.

e. Accessories: Concealed splices, cushions, and mounting hardware.

2. Combination Wood-Plastic Bumper Handrail: Assembly consisting of solid-wood handrail mounted above plastic bumper rail, both mounted on continuous retainer; with reveal between handrail and bumper serving as thumb recess on front side; with 1-1/2-inch- (38-mm-) diameter gripping surface and finger recess on back side.

a. Wood Handrail: 1-1/2 inches (38 mm) in diameter; with matching end caps and corners.
   1) Wood Species: Red oak **OR** Maple **OR** Ash **OR** Beech, **as directed**.
   2) Finish: Clear **OR** Stained, **as directed**.
   3) Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

b. Bumper: Extruded rigid plastic, minimum 0.078-inch- (2.0-mm-) **OR** 0.100-inch- (2.5-mm-), **as directed**, wall thickness; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
   1) Profile: Flat **OR** Convex, **as directed**, profile, nominal 4 inches high by 1 inch deep (100 mm high by 25 mm deep).
   2) Accent Inlay Strip: Nominal 2 inches (50 mm) high by length of rail.
   3) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   4) End Caps and Corners: Prefabricated, injection-molded plastic; color matching bumper; field adjustable for close alignment with snap-on bumper.

c. Retainer: Minimum 0.0625-inch- (1.6-mm-) thick, one-piece, extruded aluminum.

d. Reveal: Extruded rigid plastic or vinyl over aluminum retainer.

1) Color: Brass **OR** Chrome **OR** As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

e. Accessories: Concealed splices, cushion(s), and mounting hardware.

3. Wood Handrail with Bumper: Assembly consisting of continuous sculpted, solid-wood handrail, with bumper insert installed in continuous retainer recessed into the face of the wood.
   a. Wood Handrail: As indicated on Drawings with 1-1/2-inch- (38-mm-) diameter gripping surface.
      1) End Caps, Returns, Corners, and Mounting Brackets: Solid wood that matches rail.
      2) Wood Species: Red oak **OR** Maple **OR** Ash **OR** Beech **OR** Bamboo, **as directed**.
      3) Finish: Clear **OR** Stained, **as directed**.
      4) Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   b. Bumper: Extruded rigid plastic **OR** flexible vinyl, **as directed**, minimum 0.078-inch (2.0-mm) wall thickness; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
      1) Profile: Half-round profile, nominal 2 inches high by 1 inch deep (50 mm high by 25 mm deep) **OR** Small rounded profile, nominal 1-1/8 inches high by 1-1/8 inches deep (30 mm high by 30 mm deep), **as directed**.
      2) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
      3) End Caps and Corners: Prefabricated, injection-molded plastic; color matching bumper; field adjustable for close alignment with snap-on bumper.
   c. Retainer: Minimum 0.0625-inch- (1.6-mm-) thick, one-piece, extruded aluminum.
      1) Finish: Mill **OR** Brass colored, **as directed**.
   d. Accessories: Concealed splices and mounting hardware.
4. Solid-Wood Handrail: Assembly consisting of continuous sculpted, solid-wood handrail.
   a. Handrail: 5-1/2 inches high by 1-1/2 inches deep (140 mm high by 38 mm deep) **OR** As indicated on Drawings, **as directed**, with 1-1/2-inch- (38-mm-) diameter gripping surface.
      1) End Caps, Returns, Corners, and Mounting Brackets: Solid wood that matches rail.
      2) Wood Species: Red oak **OR** Maple **OR** Ash **OR** Beech, **as directed**.
      3) Finish: Clear **OR** Stained, **as directed**.
      4) Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

D. Bed Locators
1. Bed Locators: Assembly consisting of continuous snap-on plastic cover installed over continuous retainer; with two bed-locator end caps and mounting hardware; cover designed to spring back when hit.
   a. Cover: Extruded rigid plastic, minimum 0.078-inch (2.0-mm) wall thickness.
      1) Profile: Large rounded angled **OR** bullnose, **as directed**, profile, nominal 4 inches high by 2 inches deep (100 mm high by 50 mm deep).
      2) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   b. Retainer: Minimum 0.080-inch- (2.0-mm-) thick, one-piece, extruded aluminum.
   c. Bed-Locator End Caps: Prefabricated, injection-molded plastic; color matching cover; field adjustable for close alignment with snap-on cover.
   d. Mounting Type: Surface mounted on 1/2-inch- (13-mm-) thick cushion spacers **OR** Extended mounting on injection-molded plastic mounting brackets **OR** Extended mounting on aluminum mounting brackets, **as directed**.

E. Corner Guards
1. Surface-Mounted, Resilient, Plastic Corner Guards: Assembly consisting of snap-on plastic cover installed over continuous retainer; including mounting hardware; fabricated with 90- or 135-degree turn to match wall condition.

a. Cover: Extruded rigid plastic, minimum 0.078-inch (2.0-mm) **OR** 0.100-inch (2.5-mm), **as directed**, wall thickness; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
   1) Profile: Nominal 2-inch- (50-mm-) long leg and 1/4-inch (6-mm) corner radius **OR** 3-inch- (75-mm-) long leg and 1/4-inch (6-mm) corner radius **OR** 3-inch- (75-mm-) long leg and 1-1/4-inch (32-mm) corner radius, **as directed**.
   2) Height: 4 feet (1.2 m) **OR** 8 feet (2.4 m), **as directed**.
   3) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

b. Retainer: Minimum 0.060-inch- (1.5-mm-) thick, one-piece, extruded aluminum **OR** One-piece extruded plastic, **as directed**.
   OR
   Retainer Clips: Manufacturer's standard impact-absorbing clips.

c. Top and Bottom Caps: Prefabricated, injection-molded plastic; color matching cover; field adjustable for close alignment with snap-on cover.

2. Flush-Mounted, Resilient, Plastic Corner Guards: Assembly consisting of snap-on plastic cover that is flush with adjacent wall surface, installed over continuous retainer; including mounting hardware; fabricated with 90- or 135-degree turn to match wall condition; full wall height.
   a. Cover: Extruded rigid plastic, minimum 0.078-inch (2.0-mm) **OR** 0.100-inch (2.5-mm), **as directed**, wall thickness; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
      1) Profile: Nominal 2-inch- (50-mm-) long leg and 1/4-inch (6-mm) corner radius **OR** 3-inch- (75-mm-) long leg and 1/4-inch (6-mm) corner radius **OR** 3-inch- (75-mm-) long leg and 1-1/4-inch (32-mm) corner radius, **as directed**.
      2) Height: 4 feet (1.2 m) **OR** 8 feet (2.4 m), **as directed**.
      3) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   b. Retainer: Minimum 0.060-inch- (1.5-mm-) thick, one-piece, extruded aluminum.
      OR
      Retainer Clips: Manufacturer's standard impact-absorbing clips.
   c. Aluminum Cove Base: Nominal 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, high.

3. Fire-Rated, Resilient, Plastic Corner Guards: Assembly consisting of snap-on plastic cover that is flush with adjacent wall surface, installed over continuous retainer and intumescent fire barrier; including mounting hardware; fabricated with 90- or 135-degree turn to match wall condition; full wall height.
   a. Fire Rating: 1 hour **OR** 2 hours **OR** Same rating as wall in which corner guard is installed, **as directed**; UL listed and labeled according to UL 2079.
   b. Cover: Extruded rigid plastic, minimum 0.078-inch (2.0-mm) **OR** 0.100-inch (2.5-mm), **as directed**, wall thickness; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
      1) Leg: Nominal 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**.
      2) Corner Radius: 1/4 inch (6 mm) **OR** 1-1/4 inches (32 mm), **as directed**.
      3) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   c. Retainer: Minimum 0.070-inch- (1.8-mm-) thick, one-piece, extruded aluminum.
   d. Aluminum Cove Base: Nominal 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, high.

4. Surface-Mounted, Opaque-Plastic Corner Guards: Fabricated from PVC plastic, acrylic-modified vinyl sheet or opaque polycarbonate sheet; with formed edges; fabricated with 90- or 135-degree turn to match wall condition.
   a. Wing Size: Nominal 3/4 by 3/4 inch (20 by 20 mm) **OR** 1-1/8 by 1-1/8 inches (30 by 30 mm) **OR** 2-1/2 by 2-1/2 inches (65 by 65 mm), **as directed**.
   b. Mounting: Countersunk screws through factory-drilled mounting holes **OR** Adhesive **OR** Double-faced adhesive foam tape, **as directed**.

c. Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

5. Surface-Mounted, Transparent-Plastic Corner Guards: Fabricated from clear polycarbonate plastic sheet; with formed edges; fabricated with 90- or 135-degree turn to match wall condition.
   a. Wing Size: Nominal 3/4 by 3/4 inch (20 by 20 mm) **OR** 1-1/8 by 1-1/8 inches (30 by 30 mm) **OR** 2-1/2 by 2-1/2 inches (65 by 65 mm), **as directed**.
   b. Thickness: Minimum 0.050 inch (1.3 mm) **OR** 0.075 inch (1.9 mm) **OR** 0.100 inch (2.5 mm), **as directed**.
   c. Mounting: Countersunk screws through factory-drilled mounting holes **OR** Corner clips, **as directed**.
6. Surface-Mounted, Metal Corner Guards: Fabricated from one-piece, formed or extruded metal with formed edges; with 90- or 135-degree turn to match wall condition.
   a. Material: Stainless steel, Type 304 **OR** Type 430, **as directed**.
      1) Thickness: Minimum 0.0500 inch (1.3 mm) **OR** 0.0625 inch (1.6 mm) **OR** 0.0781 inch (2.0 mm), **as directed**.
      2) Finish: Directional satin, No. 4 **OR** Bright annealed, **as directed**.

      OR

      Material: Extruded aluminum, minimum 0.0625 inch (1.6 mm) thick, with clear anodic finish.

      OR

      Material: Brass sheet, minimum 0.0500 inch (1.3 mm) thick, with buffed, smooth specular **OR** fine satin, **as directed**, finish.
   b. Wing Size: Nominal 1-1/2 by 1-1/2 inches (38 by 38 mm) **OR** 2-1/2 by 2-1/2 inches (65 by 65 mm) **OR** 3-1/2 by 3-1/2 inches (90 by 90 mm), **as directed**.
   c. Corner Radius: 1/8 inch (3 mm) **OR** 3/4 inch (19 mm), **as directed**.
   d. Mounting: Flat-head, countersunk screws through factory-drilled mounting holes **OR** Oval head, countersunk screws through factory-drilled mounting holes **OR** Double-faced, adhesive foam tape **OR** Adhesive, **as directed**.

F. End-Wall Guards

1. Surface-Mounted, Resilient, Plastic End-Wall Guard: Assembly consisting of snap-on plastic cover installed over continuous retainer **OR** continuous retainer at each corner, with end of wall covered by semirigid, impact-resistant sheet wall covering, **as directed**; including mounting hardware.
   a. Cover: Extruded rigid plastic, minimum 0.078-inch (2.0-mm) **OR** 0.100-inch (2.5-mm), **as directed**, wall thickness; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
      1) Profile: Nominal 2-inch- (50-mm-) long leg and 1/4-inch (6-mm) corner radius **OR** 3-inch- (75-mm-) long leg and 1/4-inch (6-mm) corner radius **OR** 3-inch- (75-mm-) long leg and 1-1/4-inch (32-mm) corner radius, **as directed**.
      2) Height: 4 feet (1.2 m) **OR** 8 feet (2.4 m), **as directed**.
      3) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **a directed**.
   b. Retainer: Minimum 0.060-inch- (1.5-mm-) thick, one-piece, extruded aluminum.
   c. Top and Bottom Caps: Prefabricated, injection-molded plastic; color matching cover; field adjustable for close alignment with snap-on cover.
2. Flush-Mounted, Resilient, Plastic End-Wall Guard: Assembly consisting of snap-on plastic cover that is flush with adjacent wall surface and that covers entire end of wall, installed over continuous retainer **OR** continuous retainer at each corner, with end of wall covered by semirigid, impact-resistant sheet wall covering, **as directed**; including mounting hardware.
   a. Cover: Extruded rigid plastic, minimum 0.078-inch (2.0-mm) **OR** 0.100-inch (2.5-mm), **as directed**, wall thickness; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
      1) Profile: Nominal 2-inch- (50-mm-) long leg and 1/4-inch (6-mm) corner radius **OR** 3-inch- (75-mm-) long leg and 1/4-inch (6-mm) corner radius **OR** 3-inch- (75-mm-) long leg and 1-1/4-inch (32-mm) corner radius, **as directed**.

2) Height: 4 feet (1.2 m) **OR** 8 feet (2.4 m), **as directed**.
3) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

b. Retainer: Minimum 0.060-inch- (1.5-mm-) thick, one-piece, extruded aluminum.
c. Aluminum Cove Base: Nominal 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, high.

3. Fire-Rated, Resilient, Plastic End-Wall Guard: Assembly consisting of snap-on plastic cover that is flush with adjacent wall surface and that covers entire end of wall, installed over continuous retainer and intumescent fire barrier; including mounting hardware; full wall height.
   a. Fire Rating: 1 hour **OR** 2 hours **OR** Same rating as wall in which end guard is installed, **as directed**; UL listed and labeled according to UL 2079.
   b. Cover: Extruded rigid plastic, minimum 0.078-inch (2.0-mm) **OR** 0.100-inch (2.5-mm), **as directed**, wall thickness; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
      1) Leg: Nominal 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**.
      2) Corner Radius: 1/4 inch (6 mm) **OR** 1-1/4 inches (32 mm), **as directed**.
      3) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   c. Retainer: Minimum 0.070-inch- (1.8-mm-) thick, one-piece, extruded aluminum.
   d. Aluminum Cove Base: Nominal 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, high.
4. Surface-Mounted, Metal, End-Wall Guards: Fabricated from one-piece, formed or extruded metal that covers entire end of wall; with formed edges.
   a. Material: Stainless steel, Type 304 **OR** Type 430 **as directed**.
      1) Thickness: Minimum 0.0500 inch (1.3 mm) **OR** 0.0625 inch (1.6 mm) **OR** 0.0781 inch (2.0 mm), **as directed**.
      2) Finish: Directional satin, No. 4 **OR** Bright annealed, **as directed**.

      OR

      Material: Extruded aluminum, minimum 0.0625 inch (1.6 mm) thick, with clear anodic finish.

      OR

      Material: Brass sheet, minimum 0.0500 inch (1.3 mm) thick, with buffed, smooth specular **OR** fine satin, **as directed**, finish.
   b. Wing Size: Nominal 1-1/2 by 1-1/2 inches (38 by 38 mm) **OR** 2-1/2 by 2-1/2 inches (65 by 65 mm) **OR** 3-1/2 by 3-1/2 inches (90 by 90 mm), **as directed**.
   c. Corner Radius: 1/8 inch (3 mm) **OR** 3/4 inch (19 mm), **as directed**.
   d. Mounting: Flat-head, countersunk screws through factory-drilled mounting holes **OR** Oval head, countersunk screws through factory-drilled mounting holes **OR** Double-faced, adhesive foam tape **OR** Adhesive, **as directed**.

G. Impact-Resistant Wall Coverings
1. Impact-Resistant Sheet Wall Covering: Fabricated from plastic sheet wall-covering material.
   a. Size: 48 by 96 inches (1219 by 2438 mm) for sheet **OR** 48 by 120 inches (1219 by 3048 mm) for roll **OR** As indicated, **as directed**.
   b. Sheet Thickness: 0.022 inch (0.56 mm) **OR** 0.028 inch (0.7 mm) **OR** 0.040 inch (1.0 mm) **OR** 0.060 inch (1.5 mm) **OR** 0.080 inch (2.0 mm) **OR** 0.093 inch (2.4 mm) **OR** 0.125 inch (3.0 mm), **as directed**.
   c. Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   d. Height: Full wall **OR** Wainscot **OR** As indicated, **as directed**.
   e. Trim and Joint Moldings: Extruded rigid plastic that matches sheet wall covering color.
   f. Mounting: Adhesive.
2. Prelaminated, Impact-Resistant Wall Panels: Rigid wall panels consisting of impact-resistant plastic sheet wall covering material factory laminated to high-impact-resistant core, with moisture-resistant vapor barrier factory laminated to reverse side of panel for stability.

a. Composition: 0.028-inch- (0.70-mm-) thick plastic sheet laminated to 3/8-inch- (9.5-mm-) thick, particleboard core **OR** 0.04-inch- (1.02-mm-) thick plastic sheet laminated to 3/8-inch- (9.5-mm-) thick, particleboard core, **as directed**.
b. Sheet Size: 48 by 96 inches (1219 by 2438 mm) **OR** 48 by 108 inches (1219 by 2743 mm) **OR** 48 by 120 inches (1219 by 3048 mm) **OR** As indicated, **as directed**.
c. Height: Full wall **OR** Wainscot **OR** As indicated, **as directed**.
d. Sheet Edge: Square **OR** Beveled, **as directed**.
e. Trim and Joint Moldings: Extruded rigid plastic that matches sheet wall covering color.
f. Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
g. Mounting: Adhesive.

H. Door Protection Systems
1. General: Comply with BHMA A156.6.
   a. For fire-rated doors, provide door protection systems that are UL listed and labeled.
2. Protection Plates: Fabricated from extruded rigid plastic, of thickness indicated.
3. Full-Height Door-Surface Protection: Minimum 0.040-inch (1.0-mm) **OR** 0.060-inch (1.5-mm) **OR** 0.080-inch (2.0-mm), **as directed**, wall thickness; with 90-degree bend for door-edge protection.
   a. Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   b. Mounting: Adhesive **OR** Countersunk screws through factory-drilled mounting holes **OR** Double-faced adhesive foam tape, **as directed**.
4. Armor Plates: Minimum 0.040-inch (1.0-mm) **OR** 0.060-inch (1.5-mm) **OR** 0.080-inch (2.0-mm), **as directed**, wall thickness; beveled four sides.
   a. Size: 32 inches (813 mm) **OR** 36 inches (914 mm) **OR** 40 inches (1016 mm) **OR** 42 inches (1067 mm), **as directed**, high by door width, with allowance for frame stops.
   b. Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   c. Mounting: Adhesive **OR** Countersunk screws through factory-drilled mounting holes **OR** Double-faced adhesive foam tape, **as directed**.
5. Kick Plates: Minimum 0.040-inch (1.0-mm) **OR** 0.060-inch (1.5-mm) **OR** 0.080-inch (2.0-mm), **as directed** wall thickness; beveled four sides.
   a. Size: 8 inches (203 mm) **OR** 10 inches (254 mm) **OR** 12 inches (305 mm), **as directed**, high by door width, with allowance for frame stops.
   b. Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   c. Mounting: Adhesive **OR** Countersunk screws through factory-drilled mounting holes **OR** Double-faced adhesive foam tape, **as directed**.
6. Mop Plates: Minimum 0.040-inch (1.0-mm) **OR** 0.060-inch (1.5-mm) **OR** 0.080-inch (2.0-mm), **as directed**, wall thickness; beveled four sides.
   a. Size: 4 inches (102 mm) **OR** 6 inches (152 mm), **as directed**, high by 1 inch (25 mm) less than door width.
   b. Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   c. Mounting: Adhesive **OR** Countersunk screws through factory-drilled mounting holes **OR** Double-faced adhesive foam tape, **as directed**.
7. Stretcher Plates: Minimum 0.040-inch (1.0-mm) **OR** 0.060-inch (1.5-mm) **OR** 0.080-inch (2.0-mm), **as directed**, wall thickness; beveled four sides.
   a. Size: 6 inches (152 mm) **OR** 8 inches (203 mm), **as directed**, high by door width, with allowance for frame stops.
   b. Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   c. Mounting: Adhesive **OR** Countersunk screws through factory-drilled mounting holes **OR** Double-faced adhesive foam tape, **as directed**.
8. Push Plates: Minimum 0.040-inch (1.0-mm) **OR** 0.060-inch (1.5-mm) **OR** 0.080-inch (2.0-mm), **as directed**, wall thickness; beveled four sides.

a. Size: 12 inches high by 4 inches wide (305 mm high by 102 mm wide) **OR** 16 inches high by 4 inches wide (406 mm high by 102 mm wide), **as directed**.
b. Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
c. Mounting: Adhesive **OR** Countersunk screws through factory-drilled mounting holes **OR** Double-faced adhesive foam tape, **as directed**.

9. Door-Edge Protection: Fabricated from extruded rigid plastic, minimum 0.040-inch (1.0-mm) **OR** 0.060-inch (1.5-mm), **as directed**, wall thickness; formed to fit over door edge without mortising.
   a. Shape: L **OR** U, **as directed**.
   b. Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   c. Mounting: Adhesive **OR** Countersunk screws through factory-drilled mounting holes **OR** Double-faced adhesive foam tape, **as directed**.
10. Door-Frame Protector: Fabricated from extruded rigid plastic, minimum 0.040-inch (1.0-mm) **OR** 0.050-inch (1.3-mm) **OR** 0.060-inch (1.5-mm), **as directed**, wall thickness; formed to fit entire door-frame profile.
   a. Height: 36 inches (914 mm) **OR** 48 inches (1219 mm), **as directed**.
   b. Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   c. Mounting: Adhesive **OR** Countersunk screws through factory-drilled mounting holes **OR** Double-faced adhesive foam tape, **as directed**.
11. Door-Frame Protector: Assembly consisting of snap-on plastic cover installed over continuous retainer; formed to fit door frame on opposite side of door swing.
   a. Cover: Extruded rigid plastic, minimum 0.080-inch (2.0-mm) wall thickness; in dimensions and profiles indicated.
      1) Height: 36 inches (914 mm) **OR** 48 inches (1219 mm), **as directed**.
      2) Corner Radius: 1/4 inch (6 mm) **OR** 1-1/4 inches (32 mm), **as directed**.
      3) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   b. Retainer: Minimum 0.080-inch- (2.0-mm-) thick, one-piece, extruded aluminum.
12. Door-Knob **OR** Door-Lever, **as directed**, Protector: Fabricated from injection-molded plastic, minimum 0.060-inch (1.5-mm) wall thickness.
   a. Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   b. Mounting: Countersunk screws through factory-drilled mounting holes.

I. Fabrication
1. Fabricate impact-resistant wall protection units to comply with requirements indicated for design, dimensions, and member sizes, including thicknesses of components.
2. Preform curved semirigid, impact-resistant sheet wall covering in factory for radius and sheet thickness as follows:
   a. Sheet Thickness of 0.040 Inch (1.0 mm): 24-inch (610-mm) radius.
   b. Sheet Thickness of 0.060 Inch (1.5 mm): 36-inch (914-mm) radius.
3. Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.
4. Fabricate components with tight seams and joints with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.
5. Miter corners and ends of wood handrails for returns.

J. Metal Finishes
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   a. Remove tool and die marks and stretch lines, or blend into finish.
   b. Grind and polish surfaces to produce uniform finish, free of cross scratches.

c. Run grain of directional finishes with long dimension of each piece.
d. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

1.3 EXECUTION

A. Examination
1. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances, fire rating, and other conditions affecting performance of work.
2. Examine walls to which impact-resistant wall protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.
   a. For impact-resistant wall protection units attached with adhesive or foam tape, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Complete finishing operations, including painting, before installing impact-resistant wall protection system components.
2. Before installation, clean substrate to remove dust, debris, and loose particles.

C. Installation
1. General: Install impact-resistant wall protection units level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
   a. Install impact-resistant wall protection units in locations and at mounting heights indicated on Drawings or, if not indicated, at heights indicated on Drawings **OR** as directed.
   b. Provide splices, mounting hardware, anchors, and other accessories required for a complete installation.
      1) Provide anchoring devices to withstand imposed loads.
      2) Where splices occur in horizontal runs of more than 20 feet (6.1 m), splice aluminum retainers and plastic covers at different locations along the run, but no closer than 12 inches (305 mm).
      3) Adjust end and top caps as required to ensure tight seams.
2. Impact-Resistant Wall Covering: Install top and edge moldings, corners, and divider bars as required for a complete installation.

D. Cleaning
1. Immediately after completion of installation, clean plastic covers and accessories using a standard, ammonia-based, household cleaning agent.
2. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION 10 26 13 00

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Task	Specification	Specification Description
10 26 13 00	05 50 00 00	Metal Fabrications
10 26 23 13	10 26 13 00	Impact-Resistant Wall Protection

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SECTION 10 28 13 13 - TOILET AND BATH ACCESSORIES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for toilet and bath accessories. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Public-use washroom accessories.
      b. Public-use shower room accessories.
      c. Private-use bathroom accessories.
      d. Healthcare accessories.
      e. Warm-air dryers.
      f. Childcare accessories.
      g. Underlavatory guards.
      h. Custodial accessories.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. Product Schedule:
      a. Identify locations using room designations indicated on Drawings.
      b. Identify products using designations indicated on Drawings.

D. Warranty
   1. Special Mirror Warranty: Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within 15 years from date of Final Completion.

1.2 PRODUCTS

A. Materials
   1. Stainless Steel: ASTM A 666, Type 304, 0.0312-inch (0.8-mm) minimum nominal thickness, unless otherwise indicated.
   2. Brass: ASTM B 19 flat products; ASTM B 16 (ASTM B 16M), rods, shapes, forgings, and flat products with finished edges; or ASTM B 30, castings.
   3. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.0359-inch (0.9-mm) minimum nominal thickness.
   4. Galvanized Steel Sheet: ASTM A 653/A 653M, with G60 (Z180) hot-dip zinc coating.
   5. Galvanized Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
   6. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.
   7. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).
   8. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.
   9. ABS Plastic: Acrylonitrile-butadiene-styrene resin formulation.

B. Public-Use Washroom Accessories
   1. Toilet Tissue (Roll) Dispenser:

a. Description: Roll-in-reserve dispenser with hinged front secured with tumbler lockset **OR** Single-roll dispenser **OR** Double-roll dispenser **OR** Double-roll dispenser with shelf, **as directed**.
b. Mounting: Recessed **OR** Partition mounted serving two adjacent toilet compartments **OR** Surface mounted, **as directed**.
c. Operation: Noncontrol delivery with standard spindle **OR** Noncontrol delivery with theft-resistant spindle **OR** Spindleless with tension-spring controlled delivery **OR** Spindleless with tension-spring controlled delivery and self-locking device extending through core that prevents core removal until roll is empty **OR** Eccentric-shaped, molded-plastic spindle revolves one-half revolution per dispensing operation for controlled delivery; core cannot be removed until roll is empty, **as directed**.
d. Capacity: Designed for 4-1/2- or 5-inch- (114- or 127-mm-) **OR** 5-inch- (127-mm-), **as directed,** diameter tissue rolls.
e. Material and Finish: Stainless steel, No. 4 finish (satin) **OR** Chrome-plated zinc alloy (zamac) or steel **OR** Satin-finish aluminum bracket with plastic spindle **OR** ABS plastic, gray, **as directed**.

2. Combination Toilet Tissue Dispenser:
   a. Description: Combination unit with double-roll toilet tissue dispenser and the following:
      1) Removable sanitary-napkin waste receptacle with self-closing disposal-opening cover.
      2) Seat-cover dispenser with minimum capacity of 500 **OR** 1000, **as directed,** single or half-fold seat covers.
   b. Mounting: Recessed **OR** Surface mounted **OR** Partition mounted, dual access with two tissue rolls per compartment **OR** Partition mounted, dual access with two tissue rolls per compartment and with one side that mounts flush with partition of accessible compartment, **as directed**.
   c. Toilet Tissue Dispenser Capacity: 4-1/2- or 5-inch- (114- or 127-mm-) diameter tissue rolls.
   d. Toilet Tissue Dispenser Operation: Noncontrol delivery with theft-resistant spindles.
   e. Material and Finish: Stainless steel, No. 4 finish (satin).
   f. Lockset: Tumbler type.
3. Toilet Tissue (Folded) Dispenser:
   a. Description: Folded-tissue dispenser with cover hinged at bottom.
   b. Mounting: Surface mounted.
   c. Minimum Capacity: 1250 single-fold tissues.
   d. Material and Finish: Stainless steel, No. 4 finish (satin).
   e. Lockset: Tumbler type.
   f. Refill Indicators: Pierced slots at front.
4. Toilet Tissue (Jumbo-Roll) Dispenser:
   a. Description: One-roll unit **OR** Two-roll unit with sliding panel to expose other roll, **as directed**.
   b. Mounting: Surface mounted.
   c. Capacity: 9- or 10-inch- (228- or 254-mm-) diameter rolls.
   d. Material and Finish: Stainless steel, No. 4 finish (satin) **OR** ABS plastic, gray, **as directed**.
   e. Lockset: Tumbler type.
   f. Refill Indicator: Pierced slots at front.
5. Paper Towel (Folded) Dispenser:
   a. Mounting: Recessed **OR** Semirecessed **OR** Deck mounted, recessed **OR** Surface mounted, **as directed**.
   b. Minimum Capacity: 400 C-fold or 525 multifold towels **OR** 600 C-fold or 800 multifold towels **OR** 400 single-fold towels, **as directed**.
   c. Material and Finish: Stainless steel, No. 4 finish (satin) **OR** ABS plastic, gray, **as directed**.
   d. Lockset: Tumbler type.
   e. Refill Indicators: Pierced slots at sides or front.
6. Paper Towel (Roll) Dispenser:

a. Description: Lever-actuated mechanism permits controlled delivery of paper rolls in preset lengths per stroke.
b. Mounting: Recessed **OR** Semirecessed **OR** Surface mounted, **as directed**.
c. Minimum Capacity: 8-inch (203-mm) wide, 800-foot (244-m) long roll.
d. Material and Finish: Stainless steel, No. 4 finish (satin) **OR** ABS plastic, gray, **as directed**.
e. Lockset: Tumbler type.

7. Waste Receptacle:
   a. Mounting: Open top, recessed **OR** Self-closing disposal-opening cover, recessed **OR** Semirecessed **OR** Surface mounted **OR** Wall mounted for corner installation **OR** Freestanding **OR** Undercounter, **as directed**.
   b. Minimum Capacity: Capacity in gal. (L) **as directed**.
   c. Material and Finish: Stainless steel, No. 4 finish (satin).
   d. Liner: Reusable vinyl liner.
   e. Lockset: Tumbler type for waste-receptacle.
8. Combination Towel (Folded) Dispenser/Waste Receptacle:
   a. Description: Combination unit for dispensing C-fold or multifold towels, with removable waste receptacle.
   b. Mounting: Surface mounted **OR** Surface mounted with stainless-steel collar **OR** Recessed **OR** Recessed with projecting receptacle **OR** Semirecessed, **as directed**.
      1) Designed for nominal 4-inch (100-mm) **OR** 6-inch (150-mm), **as directed,** wall depth.
   c. Minimum Towel-Dispenser Capacity: 600 C-fold or 800 multifold paper towels.
   d. Minimum Waste-Receptacle Capacity: 4 gal. (15 L) **OR** 12 gal. (45.4 L), **as directed.**
   e. Material and Finish: Stainless steel, No. 4 finish (satin).
   f. Liner: Reusable, vinyl waste-receptacle liner.
   g. Lockset: Tumbler type for towel-dispenser compartment and waste receptacle.
9. Combination Towel (Roll) Dispenser/Waste Receptacle:
   a. Description: Combination unit for dispensing preset length of roll paper towels, with removable waste receptacle.
   b. Mounting: Recessed **OR** Semirecessed **OR** Surface mounted, **as directed**.
   c. Minimum Towel-Dispenser Capacity: 8-inch (203-mm) wide, 800-foot (244-m) long roll.
   d. Minimum Waste Receptacle Capacity: 8 gal. (30 L) **OR** 12 gal. (45.4 L) **OR** 15 gal. (56.8 L), **as directed**.
   e. Material and Finish: Stainless steel, No. 4 finish (satin).
   f. Liner: Reusable, vinyl waste-receptacle liner.
   g. Lockset: Tumbler type for towel dispenser compartment and waste receptacle.
10. Multipurpose Soap/Towel Dispenser Unit:
    a. Description: Combination unit for dispensing soap in liquid or lotion **OR** lather, **as directed,** form and folded towels.
    b. Mounting: Recessed, designed for nominal 4-inch (100-mm) wall depth **OR** Surface mounted with stainless-steel collar, **as directed**.
    c. Minimum Soap-Dispenser Capacity: 80 oz. (2.36 L).
    d. Minimum Towel-Dispenser Capacity: 600 C-fold or 800 multifold **OR** 1000 single-fold, **as directed,** towels.
    e. Material and Finish: Stainless steel, No. 4 finish (satin) for unit body and soap valve.
    f. Lockset: Tumbler type.
11. Liquid-Soap Dispenser:
    a. Description: Designed for dispensing soap in liquid or lotion **OR** lather, **as directed,** form.
    b. Mounting: Deck mounted on vanity **OR** Deck mounted on lavatory **OR** Horizontally oriented, recessed **OR** Horizontally oriented, surface mounted **OR** Vertically oriented, surface mounted, **as directed**.
    c. Capacity: Capacity in **oz. (mL), as directed.**
    d. Materials: Valve and reservoir materials and finishes, **as directed**.
    e. Lockset: Tumbler type.
    f. Refill Indicator: Window type.
12. Grab Bar:

a. Mounting: Flanges with concealed **OR** exposed, **as directed,** fasteners.
b. Material: Stainless steel, 0.05 inch (1.3 mm) thick.
   1) Finish: Smooth, No. 4, satin finish **OR** Smooth, No. 4, satin finish on ends and slip-resistant texture in grip area, **as directed**.
c. Outside Diameter: 1-1/4 inches (32 mm) **OR** [1-1/2 inches (38 mm), **as directed**.
d. Configuration and Length: As indicated on Drawings **OR** Straight, 36 inches (914 mm) long, **as directed**.

13. Vendor:
   a. Type: Sanitary napkin **OR** Sanitary napkin and tampon **OR** Condom, **as directed**.
   b. Mounting: Fully recessed, designed for 4-inch (100-mm) wall depth, **OR** Semirecessed, **OR** Surface mounted, **as directed**.
   c. Capacity: **As directed**.
   d. Operation: No coin (free) **OR** Single coin (25 cents) **OR** Two coin (50 cents), **as directed**.
   e. Exposed Material and Finish: Stainless steel, No. 4 finish (satin).
   f. Lockset: Tumbler type with separate lock and key for coin box.
14. Sanitary-Napkin Disposal Unit:
   a. Mounting: Recessed **OR** Partition mounted, dual access **OR** Surface mounted, **as directed**.
   b. Door or Cover: Self-closing disposal-opening cover and hinged face panel with tumbler lockset.
   c. Receptacle: Removable.
   d. Material and Finish: Stainless steel, No. 4 finish (satin) **OR** ABS plastic, gray, **as directed**.
15. Seat-Cover Dispenser:
   a. Mounting: Surface mounted **OR** Recessed **OR** Partition mounted, dual access, **as directed**.
   b. Minimum Capacity: 250 **OR** 500, **as directed,** seat covers.
   c. Exposed Material and Finish: Stainless steel, No. 4 finish (satin) **OR** ABS plastic, gray, **as directed**.
   d. Lockset: Tumbler type.
16. Fold-Down Purse Shelf:
   a. Description: Hinged unit with spring-loaded shelf that automatically returns to vertical position.
   b. Nominal Size: 15 inches (381 mm) long by 5-1/2 inches (140 mm) wide.
   c. Material and Finish: Chrome-plated cast-zinc alloy (zamac) with stippled finish on tray or stainless steel, No. 4 finish (satin) **OR** Chrome-plated cast-zinc alloy (zamac) with stippled finish on tray and bright chrome finish on edges **OR** Stainless steel, No. 4 finish (satin), **as directed**.
17. Mirror Unit:
   a. Frame: Stainless-steel angle, 0.05 inch (1.3 mm) thick **OR** Stainless-steel channel **OR** Stainless steel, fixed tilt **OR** Stainless steel, adjustable tilt, **as directed**.
      1) Corners: Manufacturer's standard **OR** Mitered and mechanically interlocked **OR** Welded and ground smooth, **as directed**.
   b. Integral Shelf: 5 inches (127 mm) deep.
   c. Hangers: Produce rigid, tamper- and theft-resistant installation, using method indicated below.
      1) One-piece, galvanized steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.
      2) Wall bracket of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.
   d. Size: As indicated on Drawings **OR as directed**.
18. Facial Tissue Dispenser:
   a. Mounting: Wall mounted, recessed **OR** Surface mounted, **as directed**.
   b. Nominal Depth: 2-1/4 inches (57 mm) **OR** 4 inches (102 mm), **as directed**.
   c. Capacity: 150 double-ply tissues.
   d. Material and Finish:

1) Dispenser Face: Stainless steel, No. 4 finish (satin) **OR** Stainless steel, No. 7 finish (polished), **as directed**.
2) Cabinet: Steel with corrosion-resistant finish.

C. Public-Use Shower Room Accessories
1. Shower Curtain Rod:
   a. Description: 1-inch (25.4-mm) OD; fabricated from nominal 0.0375-inch- (0.95-mm-) thick stainless steel **OR** 1-1/4-inch (32-mm) OD; fabricated from nominal **0.05-inch- (1.3-mm-) thick stainless steel, as directed.**
   b. Mounting Flanges: Stainless-steel flanges designed for exposed fasteners.
   c. Finish: No. 4 (satin).
2. Shower Curtain:
   a. Size: Minimum 6 inches (152 mm) **OR** 12 inches (305 mm), **as directed,** wider than opening by 72 inches (1828 mm) high.
   b. Material: Vinyl, minimum 0.006-inch- (0.15-mm-) thick, opaque, matte, **OR** Duck, minimum 8 oz. (227 g), white, 100 percent cotton, **OR** Nylon-reinforced vinyl, minimum 10-oz. (284-g) or 0.008-inch- (0.2-mm-) thick vinyl, with integral antibacterial agent, **as directed**.
   c. Color: White **OR** Green **OR** As selected from manufacturer's full range, **as directed**.
   d. Grommets: Corrosion resistant at minimum 6 inches (152 mm) o.c. through top hem.
   e. Shower Curtain Hooks: Chrome-plated or stainless-steel, spring wire curtain hooks with snap fasteners, sized to accommodate specified curtain rod. Provide one hook per curtain grommet.
3. Folding Shower Seat:
   a. Configuration: L-shaped seat, designed for wheelchair access **OR** Rectangular seat **OR** Triangular, corner-type seat **OR** Stainless-steel seat designed to fold into recessed-mounted, stainless-steel wall box, **as directed**.
   b. Seat: Phenolic or polymeric composite of slat-type or one-piece construction in color as selected **OR** White vinyl padded seat **OR** Stainless steel, No. 4 finish (satin); 0.05-inch (1.3-mm) minimum nominal thickness; with single-piece, pan-type construction and edge seams welded and ground smooth, **as directed**.
   c. Mounting Mechanism: Stainless steel, No. 4 finish (satin).
   d. Dimensions: **As directed.**
4. Soap Dish:
   a. Description: With **OR** Without, **as directed,** washcloth bar.
   b. Mounting: Recessed **OR** Surface mounted, **as directed.**
   c. Material and Finish: Stainless steel, No. 4 finish (satin) **OR** Ceramic at Cermaic Tile Bathtub surround (See Ceramic Tile Section) **OR** Metal at Porcelain Steel Bathtub Surround (Fastenings: Plated expansion toggle or molly bolts, lead anchors or as required by existing wall conditions), **as directed**.

D. Private-Use Bathroom Accessories
1. Toilet Tissue Dispenser:
   a. Description: Single-roll dispenser **OR** Double-roll dispenser **OR** Single-roll dispenser with hood **OR** Double-roll dispenser with hood, **as directed**.
   b. Mounting: Recessed **OR** Surface mounted, **as directed**.
   c. Capacity: Designed for 4-1/2- or 5-inch- (114- or 127-mm-) diameter tissue rolls.
   d. Material and Finish: Solid brass, polished **OR** Polished brass-plated zinc alloy (zamac) **OR** Polished chrome-plated brass **OR** Polished chrome-plated zinc alloy (zamac) **OR** Stainless steel, No. 4 finish (satin) **OR** Stainless steel, No. 7 finish (polished), **as directed**.
2. Shower Curtain Rod:
   a. Outside Diameter: 1 inch (25.4 mm) **OR** 1-1/4 inch (32 mm), **as directed**.
   b. Mounting: Flanges with exposed **OR** concealed, **as directed,** fasteners.
   c. Rod Material and Finish: Solid brass, polished **OR** Polished chrome-plated brass **OR** Stainless steel, No. 4 finish (satin) **OR** Stainless steel, No. 7 finish (polished), **as directed**.

   d. Flange Material and Finish: Polished brass-plated zinc alloy (zamac) **OR** Polished chrome-plated brass **OR** Polished chrome-plated zinc alloy (zamac) **OR** Stainless steel, No. 4 finish (satin) **OR** Stainless steel, No. 7 finish (polished), **as directed**.
   e. Accessories: Integral chrome-plated brass glide hooks.

3. Soap Dish:
   a. Description: **As directed**.
   b. Mounting: Recessed **OR** Surface mounted, **as directed**.
   c. Material and Finish: Solid brass, polished **OR** Polished brass-plated zinc alloy (zamac) **OR** Polished chrome-plated brass **OR** Polished chrome-plated zinc alloy (zamac) **OR** Stainless steel, No. 4 finish (satin) **OR** Stainless steel, No. 7 finish (polished) **OR** Ceramic at Cermaic Tile Bathtub surround (See Ceramic Tile Section) **OR** Metal at Porcelain Steel Bathtub Surround (Fastenings: Plated expansion toggle or molly bolts, lead anchors or as required by existing wall conditions), **as directed**.
4. Medicine Cabinet:
   a. Mounting: Recessed, for nominal 4-inch (100-mm) wall depth **OR** Surface mounted, **as directed**.
   b. Size: 18 by 24 inches (460 by 610 mm).
   c. Door: Framed mirror door concealing storage cabinet equipped with continuous hinge and spring-buffered, rod-type stop and magnetic door catch.
   d. Shelves: Three, adjustable.
   e. Material and Finish:
      1) Cabinet: Stainless steel, No. 4 finish (satin) **OR** Steel with corrosion resistant finish, **as directed**.
      2) Mirror Frame: **As directed.**
      3) Door: **As directed.**
      4) Hinge: **As directed.**
      5) Shelves: **As directed.**
5. Facial Tissue Dispenser:
   a. Mounting: Wall mounted, recessed **OR** Surface mounted, **as directed**.
   b. Depth: 2-5/8 inches (67 mm) **OR** 4 inches (102 mm), **as directed**.
   c. Material and Finish:
      1) Dispenser Face: Polished chrome-plated brass **OR** Polished brass-plated zinc alloy (zamac) **OR** Polished chrome-plated steel **OR** Stainless steel, No. 4 finish (satin) **OR** Stainless steel, No. 7 finish (polished), **as directed**.
      2) Cabinet: Steel with corrosion-resistant finish.
6. Robe Hook:
   a. Description: Double-prong **OR** Single-prong, **as directed,** unit.
   b. Material and Finish: Solid brass, polished **OR** Polished brass-plated zinc alloy (zamac) **OR** Polished chrome-plated brass **OR** Polished chrome-plated zinc alloy (zamac) **OR** Stainless steel, No. 4 finish (satin) **OR** Stainless steel, No. 7 finish (polished), **as directed**.
7. Toothbrush and Tumbler Holder:
   a. Description: **As directed**.
   b. Material and Finish: Solid brass, polished **OR** Polished brass-plated zinc alloy (zamac) **OR** Polished chrome-plated brass **OR** Polished chrome-plated zinc alloy (zamac) **OR** Stainless steel, No. 4 finish (satin) **OR** Stainless steel, No. 7 finish (polished), **as directed**.
8. Towel Bar:
   a. Description: 3/4-inch- (19-mm-) square tube with rectangular end brackets **OR** 3/4-inch- (19-mm-) round tube with circular end brackets, **as directed**.
   b. Mounting: Flanges with concealed **OR** exposed, **as directed,** fasteners.
   c. Length: 18 inches (457 mm), **OR** 24 inches (610 mm), **OR** 30 inches (762 mm), **as directed**.
   d. Material and Finish: Stainless steel, No. 4 finish (satin) **OR** Stainless steel, No. 7 finish (polished) **OR** Polished aluminum, **as directed**.
9. Towel Pin:

a. Description: Projecting minimum of 3 inches (75 mm) **OR** 5 inches (127 mm), **as directed,** from wall surface.
b. Material and Finish: Polished brass-plated zinc alloy (zamac) **OR** Polished chrome-plated brass **OR** Stainless steel, No. 4 finish (satin) **OR** Stainless steel, No. 7 finish (polished), **as directed**.

10. Towel Ring:
    a. Description: Pin projecting approximately 2-1/2 inches (63 mm) from wall with square **OR** circular **OR** oval **OR** trapezoidal, **as directed,** ring.
    b. Pin Material and Finish: Solid brass, polished **OR** Polished brass-plated zinc alloy (zamac) **OR** Polished chrome-plated brass **OR** Polished chrome-plated zinc alloy (zamac) **OR** Stainless steel, No. 4 finish (satin) **OR** Stainless steel, No. 7 finish (polished), **as directed**.
    c. Ring Material and Finish: Matching pin **OR** Clear plastic, **as directed**.
11. Towel Shelf:
    a. Description: Surface-mounted, guest-towel shelf with four 3/8-inch- (9-mm-) diameter **OR** 5/16-inch- (8-mm-) square, **as directed,** stainless steel tubes mounted in support arms.
       1) Towel Bar: 1/4-inch (6-mm-) diameter **OR** 5/16-inch- (8-mm-) square, **as directed,** stainless-steel towel bar below shelf.
    b. Length: 18 inches (457 mm) **OR** 24 inches (610 mm), **as directed.**
    c. Material and Finish: Polished brass-plated stainless steel tubes mounted in zinc alloy (zamac) support arms **OR** Polished chrome-plated stainless steel tubes mounted in zinc alloy (zamac) support arms **OR** Stainless steel, No. 7 finish (polished), **as directed**.
12. Towel Rack:
    a. Description: Surface-mounted, guest-towel unit with approximately 1/4-inch- (6-mm-) diameter wire rings welded to upright wire bracket.
    b. Capacity: 2 **OR** 3 **OR** 4, **as directed,** sets of bath towels, hand towels, and washcloths.
    c. Nominal Height: 11 inches (279 mm) **OR** 17 inches (432 mm) **OR** 21 inches (533 mm), **as directed**.
    d. Material and Finish: Polished brass-plated zinc alloy (zamac) **OR** Polished chrome-plated zinc alloy (zamac), **as directed**.
13. Retractable Clothesline:
    a. Description: Surface-mounted rectangular **OR** circular, **as directed,** housing with minimum 72-inch- (1829-mm-) long, retractable, spring-actuated, synthetic clothesline and remote retention bracket.
    b. Material and Finish Chrome-plated brass **OR** Stainless steel, No. 7 finish (polished), **as directed**.
14. Bottle Opener:
    a. Description: Surface-mounted unit with standard **OR** vandal-resistant, **as directed,** fasteners.
    b. Material and Finish: Stainless steel, No. 4 finish (satin) **OR** Stainless steel, No. 7 finish (polished) **OR** Chrome-plated steel, **as directed**.

E. Healthcare Accessories
1. Specimen Pass-Through Cabinet:
    a. Description: With self-closing doors on both sides, lock that prevents doors from both being opened at the same time, and removable stainless-steel tray.
    b. Nominal Wall Opening: 12 by 11-1/4 inches (305 by 285 mm), width times height.
    c. Material and Finish: Stainless steel, No. 4 finish (satin).
2. Specimen Pass-Through Box:
    a. Description: With minimum 12-inch (305-mm) diameter turntable removable cylinder that revolves on stainless-steel self-lubricating ball bearing plates, and with mechanism to prevent over rotation of cylinder.
    b. Nominal Wall Opening: 13-1/4 by 14 inches (335 by 355 mm), width times height.
    c. Material and Finish: Stainless steel, No. 4 finish (satin).
    d. Lockset: Tumbler type.
3. Bedpan and Urinal Cabinet:

a. Description: For storing one conventional size bedpan and one urinal bottle; with door that produces 1/2-inch (13-mm) opening at top and bottom of cabinet to allow air circulation.
b. Mounting: Recessed.
c. Nominal Wall Opening: 13-1/2 by 26-1/2 by 5 inches (340 by 670 by 130 mm), width times height times depth.
d. Material and Finish: Stainless steel, No. 4 finish (satin).

4. Bedpan and Urinal Rack:
   a. Description: For storing one conventional size bedpan and one urinal bottle.
   b. Mounting: Surface mounted.
   c. Size: 12 by 27 inches (300 by 685 mm), width times height.
   d. Material and Finish: Stainless steel, No. 4 finish (satin).

F. Warm-Air Dryers
1. Warm-Air Dryer:
   a. Mounting: Recessed **OR** Semirecessed **OR** Surface mounted, **as directed**.
   b. Operation: Touch-button **OR** Electronic-sensor, **as directed,** activated with timed power cut-off switch.
      1) Operation Time: 30 to 40, **OR** 80, **as directed,** seconds.
   c. Cover Material and Finish: Steel, with white enamel finish **OR** Cast iron, with enamel finish in color selected **OR** Chrome-plated steel **OR** Stainless steel, No. 4 finish (satin) **OR** Molded plastic, gray **OR** Molded plastic, white, **as directed**.
   d. Electrical Requirements: 115 V, 13 A, 1500 W **OR** 115 V, 15 A, 1725 W **OR** 115 V, 20 A, 2300 W **OR** 208-240 V, 9-10 A, 1900-2300 W, **as directed**.

G. Childcare Accessories
1. Diaper-Changing Station:
   a. Description: Horizontal **OR** Vertical, **as directed,** unit that opens by folding down from stored position and with child-protection strap.
      1) Engineered to support a minimum of 250-lb (113-kg) static load when opened.
   b. Mounting: Surface mounted, with unit projecting not more than 4 inches (100 mm) from wall when closed **OR** Semirecessed, with unit projecting not more than 1 inch (25 mm) from wall when closed, **as directed**.
   c. Operation: By pneumatic shock-absorbing mechanism.
   d. Material and Finish: High-density polyethylene in manufacturer's standard color **OR** High-density polyethylene with plastic laminate insert in color selected **OR** Stainless steel, No. 4 finish (satin), with replaceable insulated polystyrene tray liner and rounded plastic corners **OR** Stainless steel, No. 4 finish (satin), exterior shell with rounded plastic corners; high-density polyethylene interior in manufacturer's standard color, **as directed**.
   e. Liner Dispenser: Built in.
2. Diaper-Pack Vendor:
   a. Mounting: Surface mounted **OR** Recessed, **as directed**.
   b. Minimum Capacity: 100 diaper packs.
   c. Coin Operation: Coin slot preset for 1 U.S. dollar, adjustable up in 25-cent increments.
   d. Material and Finish: Stainless steel, No. 4 finish (satin).
3. Child-Protection Seat:
   a. Description: Unit that opens by folding down from stored position and with child-protection strap.
      1) Engineered to support a minimum of 80-lb (36-kg), **OR** 150-lb (68-kg), **as directed,** static load when opened.
   b. Mounting: Surface mounted, with unit projecting not more than 4-1/2 inches (114 mm), **OR** 6 inches (152 mm), **as directed,** from wall when closed.
   c. Material and Finish: High-density polyethylene in manufacturer's standard color.

H. Underlavatory Guards
1. Material and Finish: Antimicrobial, molded-plastic, white.

I. Custodial Accessories
1. Utility Shelf:
a. Description: With exposed edges turned down not less than 1/2 inch (12.7 mm) and supported by two triangular brackets welded to shelf underside.
b. Size: 16 inches (406 mm) long by 6 inches (152 mm) deep.
c. Material and Finish: Not less than nominal 0.05-inch- (1.3-mm-) thick stainless steel, No. 4 finish (satin).
2. Mop and Broom Holder:
a. Description: Unit with shelf, hooks, holders, and rod suspended beneath shelf.
b. Length: 36 inches (914 mm).
c. Hooks: Three.
d. Mop/Broom Holders: Four, spring-loaded, rubber hat, cam type.
e. Material and Finish: Stainless steel, No. 4 finish (satin).
1) Shelf: Not less than nominal 0.05-inch- (1.3-mm-) thick stainless steel.
2) Rod: Approximately 1/4-inch- (6-mm-) diameter stainless steel.
3. Paper Towel (Folded) Dispenser:
a. Mounting: Recessed **OR** Semirecessed **OR** Surface mounted, **as directed**.
b. Minimum Capacity: 400 C-fold or 525 multifold towels **OR** 600 C-fold or 800 multifold towels **OR** 400 single-fold towels, **as directed**.
c. Material and Finish: Stainless steel, No. 4 finish (satin) **OR** ABS plastic, gray, **as directed**.
d. Lockset: Tumbler type.
e. Refill Indicators: Pierced slots at sides or front.
4. Paper Towel (Roll) Dispenser:
a. Description: Lever-actuated mechanism permits controlled delivery of paper rolls in preset lengths per stroke.
b. Mounting: Recessed **OR** Semirecessed **OR** Surface mounted, **as directed**.
c. Minimum Capacity: 8-inch (203-mm) wide, 800-foot (244-m) long roll.
d. Material and Finish: Stainless steel, No. 4 finish (satin), **OR** ABS plastic, gray, **as directed**.
e. Lockset: Tumbler type.
5. Liquid-Soap Dispenser:
a. Description: Designed for dispensing soap in liquid or lotion **OR** lather, **as directed,** form.
b. Mounting: Deck mounted on vanity **OR** Deck mounted on lavatory **OR** Horizontally oriented, recessed **OR** Horizontally oriented, surface mounted **OR** Vertically oriented, surface mounted, **as directed**.
c. Capacity: Capacity in oz. (mL), **as directed.**
d. Materials: Valve and reservoir materials and finishes, **as directed**.
e. Lockset: Tumbler type.
f. Refill Indicator: Window type.

J. Fabrication
1. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

1.3 EXECUTION

A. Installation
a. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
b. Grab Bars: Install to withstand a downward load of at least 250 lbf (1112 N), when tested according to method in ASTM F 446.

END OF SECTION 10 28 13 13

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SECTION 10 28 13 13a - DETENTION TOILET ACCESSORIES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for detention toilet accessories. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
    a. Safety hooks.
    b. Shelves.
    c. Combination shelves with safety hooks.
    d. Miscellaneous toilet accessories.
    e. Stainless-steel mirrors.
    f. Grab bars.
    g. Shower seats.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
    a. Product Data for Credit EQ 4.1: For security sealants, including printed statement of VOC content.
3. Samples: For each type of detention toilet accessory indicated.
4. Product Schedule: Indicate types, quantities, sizes, and installation locations by room.
5. Coordination Drawings: Drawings showing location of each built-in anchor supporting detention toilet accessories, including anchors to be installed as work of other Sections, drawn to scale and coordinating anchorage with detention toilet accessories.
6. Welding certificates.
7. Maintenance data.
8. Warranties: Sample of special warranties.
9. Other Informational Submittals:
    a. Examination reports documenting inspection of substrates, areas, and conditions.
    b. Anchor inspection reports documenting inspections of built-in and cast-in anchors.
    c. Field quality-control certification signed by Contractor and Detention Specialist.

D. Quality Assurance
1. Welding Qualifications: Qualify procedures and personnel according to the following:
    a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
    b. AWS D1.3, "Structural Welding Code - Sheet Steel."
    c. AWS D1.6, "Structural Welding Code - Stainless Steel."
2. Preinstallation Conference: Conduct conference at Project site.
3. Coordination Meetings: Conduct coordination meetings at Project site to comply with requirements in Division 01 Section "Special Project Procedures For Detention Facilities".

E. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace detention toilet accessories that fail in materials or workmanship within two years from date of Final Completion.

1.2 PRODUCTS

A. Materials
1. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, CS (Commercial Steel), Type B.
2. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, CS (Commercial Steel), Type B; with G60 (Z180) zinc (galvanized) coating designation.
3. Stainless-Steel Sheet: ASTM A 666 or ASTM A 240/A 240M, austenitic stainless steel, Type 304; Type 430 for mirrors.
4. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
5. Concealed Bolts: ASTM A 307, Grade A unless otherwise indicated.
6. Cast-in-Place Anchors in Concrete: Anchors of type indicated below, fabricated from corrosion-resistant materials capable of sustaining, without failure, a load equal to 4 times the load imposed, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
   a. Threaded or wedge type; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized per ASTM A 153/A 153M.
7. Embedded Plate Anchors: Fabricated from steel shapes and plates, minimum 3/16 inch (4.8 mm) thick; with minimum 1/2-inch- (12.7-mm-) diameter headed studs welded to back of plate.
8. Proprietary Built-in Masonry Anchors: Fabricated from 0.134-inch (3.41-mm) nominal-thickness steel sheet **OR** 1/4-inch (6.3-mm) nominal-thickness steel plate **OR** 1/2-inch (12.7-mm) nominal-thickness steel plate, **as directed**, into 6-inch- (152-mm-) **OR** 8-inch- (203-mm-), **as directed**, deep blocks matching size of concrete masonry units; with weld nuts attached on inside to receive field-bolted attachments, **as directed**.
   a. Finish: Factory primed for field painting for anchors with field-welded attachments **OR** Polyester powder coat for anchors with bolted attachments **OR** Epoxy paint for anchors with bolted attachments, **as directed**.
9. Welding Rods and Bare Electrodes: Select according to AWS specifications.

B. Security Sealants
1. Manufacturer's standard, high-modulus, nonsag, two-part, pick-proof, epoxy sealant, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), recommended for sealing nonmoving interior joints in security applications.

C. Security Fasteners
1. Fasteners that are operable only by tools produced by fastener manufacturer or other licensed fabricator for use on specific type of fastener.
2. Provide drive-system type, head style, material, and protective coating as required for assembly, installation, and strength, and as follows:
   a. Drive-System Types: Pinned Torx-Plus **OR** Pinned Torx, **as directed**.
   b. Fastener Strength: 120,000 psi (827 MPa).
   c. Socket Button Head Fasteners:
      1) Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
      2) Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.
   d. Socket Flat Countersunk Head Fasteners:
      1) Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
      2) Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.
   e. Socket Head Cap Fasteners:
      1) Heat-treated alloy steel, ASTM A 574 (ASTM A 574M).
      2) Stainless steel, ASTM F 837 (ASTM F 837M), Group 1 CW.
   f. Protective Coatings for Heat-Treated Alloy Steel:
      1) Zinc and clear trivalent chromium, where indicated.
      2) Zinc phosphate with oil, ASTM F 1137, Grade I, or black oxide unless otherwise indicated.

D. Detention Safety Hooks
1. Individual, Curved, Detention Safety Hook: 0.188-inch (4.77-m) nominal-thickness, stainless-steel curved hook held by 0.141-inch- (3.58-mm-) **OR** 0.109-inch- (2.77-mm-), **as directed**, thick, stainless-steel bracket punched with not less than 2 holes for fastening with security fastener. Provide friction washer assembly, adjustable with a nonremovable security screw that maintains pressure on hook and allows hook to pivot when load exceeds preset limit. Provide No. 4 finish.
2. Individual, Straight, Detention Safety Hook: 3/8-inch- (9.5-mm-) **OR** 1/4-inch- (6.3-mm-), **as directed**, diameter, stainless-steel straight hook held by 0.109-inch- (2.77-mm-) **OR** 0.078-inch- (1.98-mm-), **as directed**, thick, stainless-steel mounting plate approximately 4 inches (102 mm) square. Provide pivoting assembly that maintains pressure on hook and snaps down when load exceeds 8 lbf (35.6 N). Provide No. 4 finish.
   a. Mounting: Front mounting with security fasteners **OR** Chase mounting with welded anchor nuts on backplate, **as directed**.
3. Multiple, Curved, Safety Hook Strip: Minimum 5-1/2-inch- (140-mm-) high backplate by length indicated, formed from 0.125-inch- (3.18-mm-) **OR** 0.109-inch- (2.77-mm-) **OR** 0.078-inch- (1.98-mm-), **as directed**, thick, stainless-steel sheet. Provide 0.188-inch- (4.77-mm-) thick, stainless-steel hooks attached to backplate; with each hook having a friction washer assembly, adjustable with a nonremovable security screw that maintains pressure on hook and allows hook to pivot when load exceeds preset limit. Provide No. 4 finish.
   a. Configuration: 16 inches (406 mm) long with 2 hooks **OR** 18 inches (457 mm) long with 4 hooks **OR** 21 inches (533 mm) long with 4 hooks **OR** 24 inches (610 mm) long with 3 hooks **OR** 32 inches (813 mm) long with 4 hooks, **as directed**.
   b. Mounting: Front mounting with security fasteners **OR** Chase mounting with welded anchor nuts on backplate, **as directed**.
4. Multiple, Straight, Safety Hook Strip: Minimum 5-1/2-inch- (140-mm-) high backplate by length indicated, formed from 0.141-inch- (3.58-mm-) **OR** 0.109-inch- (2.77-mm-) **OR** 0.078-inch- (1.98-mm-), **as directed**, thick, stainless-steel sheet. Provide 3/8-inch- (9.5-mm-) **OR** 1/4-inch- (6.3-mm-), **as directed**, diameter, stainless-steel straight hooks attached to backplate. Provide pivoting assembly that maintains pressure on hook and snaps down when load exceeds 8 lbf (35.6 N). Provide No. 4 finish.
   a. Configuration: 16 inches (406 mm) long with 2 hooks **OR** 18 inches (457 mm) long with 4 hooks **OR** 24 inches (610 mm) long with 3 hooks **OR** 32 inches (813 mm) long with 4 hooks, **as directed**.
   b. Mounting: Front mounting with security fasteners **OR** Chase mounting with welded anchor nuts on backplate, **as directed**.

E. Detention Shelves
1. Surface-Mounted, Steel Detention Shelf: Minimum 6 inches high by 8 inches (152 mm high by 203 mm) deep by 16 inches (406 mm) **OR** 24 inches (610 mm) **OR** 32 inches (813 mm), **as directed**, long; formed from 0.138-inch (3.50-mm) **OR** 0.108-inch (2.74-mm), **as directed**, nominal-thickness, metallic-coated steel sheet; with welded side gussets and minimum 1-inch (25.4-mm) flanged front edge; with back punched for fastening to wall with security fasteners. Provide factory priming for field-painted **OR** baked-enamel, **as directed**, finish.
2. Surface-Mounted, Stainless-Steel Detention Shelf: Minimum 5-1/2 inches high by 8 inches (140 mm high by 203 mm) deep by 18 inches (457 mm) **OR** 24 inches (610 mm), **as directed**, long; formed from 0.078-inch- (1.98-mm-) thick, stainless-steel sheet; with welded side gussets and hemmed front edge. Provide No. 4 finish.
   a. Mounting: Front mounting with security fasteners **OR** Chase mounting with welded anchor nuts on backplate, **as directed**.
3. Recessed Detention Shelf: Minimum inside dimensions of 16 inches (406 mm) wide by 5 inches high by 4 inches (127 mm high by 102 mm) deep; formed from 0.062-inch- (1.57-mm-) thick, stainless-steel sheet; with 1-inch- (25.4-mm-) wide flanged front edge. Secure to wall with rear-mounting steel strap and adjustment bolts. Provide No. 4 finish.

F. Combination Detention Shelves With Safety Hooks

1. Steel Detention Shelf with Multiple, Curved Safety Hooks: Minimum 6 inches high by 8 inches (152 mm high by 203 mm) deep by length indicated, formed from 0.138-inch (3.50-mm) **OR** 0.108-inch (2.74-mm), **as directed**, nominal-thickness, metallic-coated steel sheet, with welded side gussets and hemmed or flanged front edge. Provide 0.138-inch (3.50-mm) nominal-thickness, zinc-plated-steel curved hooks held by 0.1265-inch- (3.21-mm-) thick steel brackets welded to backplate, with each hook having a friction washer assembly, adjustable with a nonremovable security screw that maintains pressure on hook and allows hook to pivot when load exceeds preset limit. Provide factory priming for field-painted **OR** baked-enamel, **as directed**, finish.
    a. Configuration: 16 inches (406 mm) long with 2 hooks **OR** 24 inches (610 mm) long with 3 hooks **OR** 32 inches (813 mm) long with 4 hooks, **as directed**.
    b. Mounting: Front mounting with security fasteners **OR** Chase mounting with welded anchor nuts on backplate, **as directed**.
2. Stainless-Steel Detention Shelf with Multiple, Curved Safety Hooks: Minimum 5-1/2 inches high by 8 inches (140 mm high by 203 mm) deep by length indicated; formed from 0.078-inch- (1.98-mm-) thick, stainless-steel sheet; with welded side gussets and hemmed or flanged front edge. Provide 0.141-inch (3.58-mm) stainless-steel curved hooks held by 0.141-inch- (3.58-mm-) thick stainless-steel brackets welded to backplate, with each hook having a friction washer assembly, adjustable with a nonremovable security screw that maintains pressure on hook and allows hook to pivot when load exceeds preset limit. Provide No. 4 finish.
    a. Configuration: 16 inches (406 mm) long with 2 hooks **OR** 18 inches (457 mm) long with 4 hooks **OR** 24 inches (610 mm) long with 3 hooks **OR** 32 inches (813 mm) long with 4 hooks, **as directed**.
    b. Mounting: Front mounting with security fasteners **OR** Chase mounting with welded anchor nuts on backplate, **as directed**.
3. Stainless-Steel Detention Shelf with Multiple, Straight Safety Hooks: Minimum 5-1/2 inches high by 8 inches (140 mm high by 203 mm) deep by length indicated; formed from 0.078-inch- (1.98-mm-) thick, stainless-steel sheet; with welded side gussets and hemmed or flanged front edge. Provide 3/8-inch- (9.5-mm-) **OR** 1/4-inch- (6.3-mm-), **as directed**, diameter, stainless-steel straight hooks held by 0.109-inch- (2.77-mm-) **OR** 0.078-inch- (1.98-mm-), **as directed**, thick, stainless-steel mounting plate. Provide pivoting assembly that maintains pressure on hook and snaps down when load exceeds 8 lbf (35.6 N). Provide No. 4 finish.
    a. Configuration: 16 inches (406 mm) long with 2 hooks **OR** 18 inches (457 mm) long with 4 hooks **OR** 24 inches (610 mm) long with 3 hooks **OR** 32 inches (813 mm) long with 4 hooks, **as directed**.
    b. Mounting: Front mounting with security fasteners **OR** Chase mounting with welded anchor nuts on backplate, **as directed**.

G. Miscellaneous Detention Toilet Accessories
1. Recessed, Detention Toilet Tissue Dispenser: Minimum 5-inch diameter by 4-1/2 inches (127-mm diameter by 114 mm) deep; formed from 0.062-inch- (1.57-mm-) thick, stainless-steel sheet. Secure to wall with rear-mounting steel strap and adjustment bolts. Provide No. 4 finish.
    a. Face: 1-inch (25.4-mm) lip around entire face **OR** 7-inch- (178-mm-) square face flange, **as directed**.
2. Recessed, Detention Soap Dish: Minimum inside dimensions of 5-3/4 inches wide by 4-1/2 inches high by 2-1/2 inches (146 mm wide by 114 mm high by 64 mm) deep with 3/4-inch (19-mm) lip around entire face; formed from 0.062-inch- (1.57-mm-) **OR** 0.050-inch- (1.27-mm-), **as directed**, thick, stainless-steel sheet. Secure to wall with rear-mounting steel strap and adjustment bolts. Provide No. 4 finish.

H. Detention Mirrors
1. Small, Framed Detention Mirror: Approximately 9-1/2 inches wide by 11 inches (241 mm wide by 279 mm) high; formed from 0.038-inch- (0.95-mm-) thick, stainless-steel sheet with fiberboard backing; enclosed in a frame formed from 0.064-inch (1.63-mm) nominal-thickness, zinc-plated

steel sheet; with round corners. Fabricate frame with welded and ground corners or from one piece of metal. Provide No. 8 **OR** 4, **as directed**, finish for mirror, chrome plating for frame.

a. Mounting: Front mounting with security fasteners to 0.168-inch (4.27-mm) nominal-thickness, metallic-coated steel mounting plate **OR** Chase mounting with welded anchor nuts on backplate, **as directed**.

2. Small, Integrally Framed Detention Mirror: Approximately 9-1/2 inches wide by 11 inches (241 mm wide by 279 mm) high; with mirror and integral frame formed from a single sheet of 0.038-inch- (0.95-mm-) **OR** 0.062-inch- (1.57-mm-), **as directed**, thick stainless steel; with round corners. Provide No. 8 **OR** 4, **as directed**, finish for mirror, chrome plating for frame.
   a. Mounting: Front mounting with security fasteners to 0.168-inch (4.27-mm) nominal-thickness, metallic-coated steel mounting plate **OR** Chase mounting with welded anchor nuts on backplate, **as directed**.
3. Large, Framed Detention Mirror with Square Corners: Minimum 11 inches wide by 16 inches (279 mm wide by 406 mm) high; formed from 0.038-inch- (0.95-mm-) **OR** 0.078-inch- (1.98-mm-), **as directed**, thick, stainless-steel sheet with fiberboard backing and No. 8 **OR** No. 4, **as directed**, finish; enclosed in a metal frame.
   a. Frame: Formed from 0.064-inch (1.63-mm) nominal-thickness, chrome-plated steel **OR** 0.062-inch- (1.57-mm-) thick, stainless-steel **OR** 0.078-inch- (1.98-mm-) thick, stainless-steel, **as directed**, sheet. Fabricate frame with welded and ground corners or from one piece of metal.
   b. Mounting: Front mounting with security fasteners to 0.168-inch (4.27-mm) nominal-thickness, metallic-coated steel mounting plate **OR** Chase mounting with welded anchor nuts on backplate, **as directed**.
4. Large, Framed Detention Mirror with Round Corners: Minimum 11 inches wide by 16 inches (279 mm wide by 406 mm) high, formed from a single sheet of 0.038-inch- (0.95-mm-) **OR** 0.078-inch- (1.98-mm-), **as directed**, thick stainless steel with No. 8 **OR** No. 4, **as directed**, finish; enclosed in a metal frame.
   a. Frame: Formed from 0.064-inch (1.63-mm) nominal-thickness, chrome-plated steel **OR** 0.078-inch- (1.98-mm-) thick, stainless-steel, **as directed**, sheet. Fabricate frame with welded and ground corners or from one piece of metal.
   b. Mounting: Front mounting with security fasteners to 0.168-inch (4.27-mm) nominal-thickness, metallic-coated steel mounting plate **OR** Chase mounting with welded anchor nuts on backplate, **as directed**.
5. Large, Integrally Framed Detention Mirror with Round Corners: Minimum 11 inches wide by 16 inches (279 mm wide by 406 mm) high; with mirror and integral frame formed from 0.038-inch- (0.95-mm-) **OR** 0.062-inch- (1.57-mm-) **OR** 0.078-inch- (1.98-mm-), **as directed**, thick, stainless-steel sheet; with round corners. Provide No. 8 **OR** 4, **as directed**, finish for mirror, chrome plating for frame.
   a. Mounting: Front mounting with security fasteners to 0.168-inch (4.27-mm) nominal-thickness, metallic-coated steel mounting plate **OR** Chase mounting with welded anchor nuts on backplate, **as directed**.

I. Detention Grab Bars

1. Grab Bars: 1-1/2 inches (38.1 mm) in diameter; formed from 0.038-inch- (0.95-mm-) thick, stainless-steel tubing, with 3-inch- (76.2-mm-) diameter flanges formed from 0.125-inch- (3.18-mm-) thick, stainless steel. Closure plates formed from 0.125-inch- (3.18-mm-) thick, stainless steel. All-welded construction. Provide No. 4 finish.
   a. Length: As indicated on Drawings **OR** 36 inches (914 mm) long, **as directed**.
   b. Mounting: Front mounting with security fasteners **OR** Chase mounting with welded anchor nuts on backplate, **as directed**.

J. Detention Shower Seats

1. Shower Seats: Double-pan retractable, recessed shower seat with recessed handle. Approximately 16-inch by 16-inch (406-mm by 406-mm) overall size formed from 0.062-inch- (1.57-mm-) **OR** 0.078-inch- (1.98-mm-), **as directed**, thick, stainless-steel sheet. Seat pivots on

solid 0.375-inch- (9.5-mm-) diameter stainless-steel rod and self-latches when closed. Minimum 750 lb. (340 kg) loading capacity. Provide No. 4 finish.

K. Fabrication
1. Coordinate dimensions and attachment methods of detention toilet accessories with those of adjoining construction to produce integrated assemblies with closely fitting joints and with edges and surfaces aligned unless otherwise indicated.
2. Shear and punch metals cleanly and accurately. Remove burrs.
3. Form edges and corners to be free of sharp edges and rough areas. Fold back exposed edges of unsupported sheet metal to form a 1/2-inch- (12.7-mm-) wide hem on the concealed side, or ease edges to a radius of approximately 1/32 inch (0.8 mm) and support with concealed stiffeners.
4. Form metal in maximum lengths to minimize joints. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
5. Weld corners and seams continuously to comply with referenced AWS standard and the following:
   a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   b. Obtain fusion without undercut or overlap.
   c. Remove welding flux immediately.
   d. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
   e. Weld before finishing components to greatest extent possible. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
6. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure detention toilet accessories rigidly in place and to support expected loads. Build in straps, plates, and brackets as needed to support and anchor fabricated items to adjoining construction. Reinforce formed-metal units as needed to attach and support other construction.
7. Cut, reinforce, drill, and tap detention toilet accessories to receive hardware, security fasteners, and similar items.
8. Form exposed work true to line and level with accurate angles and surfaces. Grind off and ease edges unless otherwise indicated.
9. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Use exposed security fasteners of type indicated or, if not indicated, flat-head (countersunk) security fasteners. Locate joints where least conspicuous.

L. Finishes
1. Finish detention toilet accessories after assembly.
2. Steel Finishes:
   a. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
   b. Factory Priming for Field-Painted Finish: Apply manufacturer's standard prime coat immediately after surface preparation and pretreatment.
   c. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 1.2 mils (0.03 mm).
      1) Color and Gloss: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
   d. Chromium Plating: ASTM B 456, Service Condition Number SC 2 (moderate service), nickel plus chromium electrodeposited on base metal.
3. Stainless-Steel Finishes: Remove tool and die marks and stretch lines or blend into finish.

a. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

1.3 EXECUTION

A. Installation
1. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing detention toilet accessories to in-place construction. Include threaded fasteners for concrete and masonry inserts, security fasteners, and other connectors.
2. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry or similar construction.
3. Apply security sealant around perimeter in a continuous ribbon on back of detention toilet accessories before installation.
4. Security Fasteners: Install detention toilet accessories using security fasteners with head style appropriate for installation requirements, strength, and finish of adjacent materials. Provide stainless-steel security fasteners in stainless-steel materials, **as directed**.

B. Field Quality Control
1. Inspect installed products to verify compliance with requirements. Prepare inspection reports and indicate compliance with and deviations from the Contract Documents.
2. Remove and replace detention work where inspections indicate that work does not comply with specified requirements.
3. Perform additional inspections to determine compliance of replaced or additional work. Prepare inspection reports.
4. Prepare field quality-control certification that states installed products and their installation comply with requirements in the Contract Documents.

C. Adjusting And Cleaning
1. Remove temporary labels and protective coatings.
2. Adjust safety hooks to release with application of 8-lbf (35.6-N) load.
3. Painting: Immediately after erection, clean bolted connections and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
4. Touchup Painting: Cleaning and touchup painting of bolted connections and abraded areas of shop paint are specified in Division 07..

END OF SECTION 10 28 13 13a

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Task	Specification	Specification Description
10 28 13 13	01 22 16 00	No Specification Required
10 28 13 63	10 28 13 13	Toilet And Bath Accessories
10 28 13 63	10 28 13 13a	Detention Toilet Accessories

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SECTION 10 28 16 13 - BATH ACCESSORIES

DESCRIPTION OF WORK

This specification covers the furnishing and installation of materials for bath accessories. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

GENERAL

Definitions

1. Supply and Delivery Only: Include supply and delivery to site(s) FOB destination freight prepaid. Unless otherwise specified or scheduled, unloading and handling at site is by the Owner.

Submittals

2. Product Data.
3. Shop Drawings.
4. Quality Assurance/Control Submittals:
   a. Certificates: Submit manufacturer's written self certification that bath accessories meet or exceed specified requirements.

Quality Assurance

5. Regulatory Requirements: Comply with following:
   a. Accessibility:
      1) Architectural Barriers Act of 1968 as amended (42 USC 4152-4157) and HUD implementing regulations (24 CFR Part 40).
         a) Uniform Federal Accessibility Standards (UFAS).
      2) Section 504 of the Rehabilitation Act of 1973 as amended (29 USC 794) and HUD implementing regulations 24 CFR Part 8.
      3) Fair Housing Accessibility Guidelines (24 CFR Chapter 1).
      4) Americans with Disabilities Act of 1990 (ADA) (28 CFR Part 35).
6. Mock-ups: Install one complete mock-up of bath accessories in each typical bathroom installation. Comply with Detailed Scope of Work for bathroom renovation mock-up requirements.
   a. Locations: As directed.
   b. Approved Mock-ups: Standard for rest of work.
   c. Approved Mock-ups: May remain part of completed project.

Scheduling

7. Scheduling and Completion: Comply with requirements of Detailed Scope of Work.

PRODUCTS

Bath Accessories

8. Ceramic Soap Dishes at Ceramic Tile Bathtub Surround: See Division 9 Section "Ceramic Tile."
9. Metal Soap Dishes at Porcelain Steel Bathtub Surround:
   a. Recessed: FS WW-P-541/8B, Type VI, Class 2, heavy duty satin stainless steel.
   b. Fastenings: Plated expansion toggle or molly bolts, lead anchors or as required by existing wall conditions.

10. Safety Grab Bars: Type 304 stainless steel, minimum 32 mm (1-1/4 inch) OD, maximum 38 mm (1-1/2 inch) OD, 1.2 mm (18 gage) wall thickness in accordance with Uniform Federal Accessibility Standards (UFAS).
    a. Grab Bar Posts: Stainless steel.
    b. Post Flanges: Diameter of not less than 68 mm (2-11/16 inches) with center line of screw holes located minimum 13 mm (1/2 inch) from edges of flange.
11. Shower Curtains and Rods: By Bobrick Washroom Equipment, McKinney/Parker, or Leigh Products, or approved equal:
    a. Rods: Type 304 stainless steel, satin finish, adjustable length type to fit bathtub length, minimum 25 mm (1 inch) OD, minimum 1.0 mm (20 gage) wall thickness, similar to Bobrick No. B-6107 or McKinney/Parker No. 267.
    b. Flanges: Chrome plated cast brass or stainless steel.
    c. Shower Curtains: FS L-C-780a, Style I, opaque, matte white vinyl 0.2 mm (0.008 inch) thick, 1 829 mm (72 inches) by 1 829 mm (72 inches) high.
        1) Curtains: Germ proof, bacteria proof, and mildew resistant.
        2) Curtains: Similar to Bobrick No. 204-2 or McKinney/Parker No. 268SC.
    d. Curtain Hooks: Stainless steel, Type 304 or nickel plated brass wire, similar to Bobrick No. 204-1 or McKinney/Parker No. 269SH. Provide 12 hooks per curtain.
12. Other Bathroom Accessories: FS WW-P-541/8B, Type 304 stainless steel, satin finish, by Bobrick Washroom Equipment, McKinney/Parker, or Leigh Products, or approved equal:
    a. Surface Mounted:
        1) Medicine Cabinets: Type III, Class 2, Style S, swinging door, minimum 381 mm (15 inches) wide by 610 mm (24 inches) high. Provide complete with magnetic catch, three adjustable shelves, and full length mirror.
        2) Towel Bars: Type IV, Class 1, square bar, 610 mm (24 inches) long.
        3) Toilet Paper Holders: Type I, Class 1, Mounting S, Style A.
        4) Tumbler and Toothbrush Holders: Type VI, Class 4.
        5) Lavatory Soap Dishes: Type VI, Class 1.
        6) Robe hooks.
    b. Recessed:
        1) Medicine Cabinets: Type III, Class 2, Style R, enamel painted steel, swinging door, minimum 381 mm (15 inches) wide by 610 mm (24 inches) high. Provide complete with magnetic catch, three adjustable shelves, and full length mirror.
        2) Toilet Paper Holders: Type I, Class 1, Style K.
        3) Lavatory Soap Dishes: Type VI, Class 2.
13. Window Curtains and Rods: Provide over bathroom window openings.
    a. Rods: Solid steel with brass finish, minimum 10 mm (3/8 inch) diameter.
    b. Rod Brackets: Two brass-finished brackets with open tops and brass finish.
    c. Window Curtains: FS L-C-780a, Style II, opaque, matte white vinyl 0.2 mm (0.008 inch) thick.
        1) Curtains : Germ proof, bacteria proof, and mildew resistant.
        2) Size: To fit bathroom windows.
14. Joint Sealant: Mildew resistant one-component silicone; FS TT-S-001543A, Class A; ASTM C 920, Type S, Grade NS, Class 25, Uses NT, G, and A.
    a. Color: As selected from manufacturer's standard line.

EXECUTION

Examination

15. Site Verification of Conditions:
        1) Field Measurements: Verify field measurements.
        2) Existing Conditions: Ensure proper openings and blocking have been installed.

Installation

16. General: Install accessories rigidly and securely to blocking in walls using methods and materials recommended by manufacturer.
    a. Locations and Mounting Heights: As indicated or directed.
    b. Comply with Regulatory Requirements.
17. Bath Accessories: Securely install flanges for bath accessories and window curtain rods in accordance with manufacturer s recommendations and approved Shop Drawing.
    a. Safety Grab Bars: Install 100 mm (4 inch) by 100 mm (4 inch) perforated 1.2 mm (18 gage) galvanized steel plates at each post, flush to wall, by using toggle bolts, molly bolts, or anchors as required by conditions.
        1) After installation of wall finish, secure each grab bar flange to perforated plates through wall finish with three - 6 mm (1/4 inch) chrome plated machine screws, screwed into threaded sleeves or tee nuts welded to plates.
    b. Shower Curtains and Rods: Mount flanges to existing wall with approved expansion type inserts and chrome plated or stainless steel wood screws.
18. Bath Accessories at Bathroom with Porcelain Steel Surround:
    a. Metal Soap Dishes: Mount to new porcelain enamel panels and anchored securely to existing walls using approved mechanical fastenings.
        1) Waterproof with joint sealant between surround panel and dishes.
    b. China Soap Dishes: Anchor securely, using approved mechanical fastening.
    c. Safety Grab Bars: After installation of wall panels, secure each grab bar flange to perforated plates through panels with three - 6 mm (1/4 inch) chrome plated machine screws, screwed into threaded sleeves or tee nuts welded to plates.

Cleaning

19. Cleaning: Comply with requirements of Detailed Scope of Work.

END OF SECTION 10 28 16 13

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Task	Specification	Specification Description
10 28 16 13	10 28 13 13	Toilet And Bath Accessories
10 28 16 13	10 28 13 13a	Detention Toilet Accessories

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SECTION 10 28 19 16 - PLUMBING FIXTURES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for plumbing fixtures. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following conventional plumbing fixtures and related components:
a. Faucets for lavatories, bathtubs, bathtub/showers, showers, and sinks.
b. Laminar-flow faucet-spout outlets.
c. Flushometers.
d. Toilet seats.
e. Protective shielding guards.
f. Fixture supports.
g. Interceptors.
h. Shower receptors.
i. Dishwasher air-gap fittings.
j. Disposers.
k. Hot-water dispensers.
l. Water closets.
m. Urinals.
n. Bidets.
o. Lavatories.
p. Commercial sinks.
q. Shampoo bowls.
r. Wash fountains.
s. Bathtubs.
t. Individual showers.
u. Group showers.
v. Whirlpool bathtubs.
w. Kitchen sinks.
x. Service sinks.
y. Service basins.
z. Laundry trays.
aa. Sacristy sinks.

C. Definitions
1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
3. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.
4. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.
5. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.
6. FRP: Fiberglass-reinforced plastic.
7. PMMA: Polymethyl methacrylate (acrylic) plastic.
8. PVC: Polyvinyl chloride plastic.

9. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

D. Submittals
1. Product Data: For each type of plumbing fixture indicated.
2. LEED Submittal:
   a. Product Data for Credit WE 2, 3.1, and 3.2: Documentation indicating flow and water consumption requirements.
3. Shop Drawings: Diagram power, signal, and control wiring.
4. Operation and maintenance data
5. Warranty: Special warranty specified in this Section.

E. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities" **OR** Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act", **as directed**; for plumbing fixtures for people with disabilities.
3. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
4. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
5. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
6. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
   a. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
   b. Plastic Bathtubs: ANSI Z124.1.
   c. Plastic Lavatories: ANSI Z124.3.
   d. Plastic Laundry Trays: ANSI Z124.6.
   e. Plastic Mop-Service Basins: ANSI Z124.6.
   f. Plastic Shower Enclosures: ANSI Z124.2.
   g. Plastic Sinks: ANSI Z124.6.
   h. Plastic Urinal Fixtures: ANSI Z124.9.
   i. Plastic Whirlpool Bathtubs: ANSI Z124.1 and ASME A112.19.7M.
   j. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
   k. Slip-Resistant Bathing Surfaces: ASTM F 462.
   l. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
   m. Stainless-Steel Commercial, Handwash Sinks: NSF 2 construction.
   n. Stainless-Steel Residential Sinks: ASME A112.19.3.
   o. Vitreous-China Fixtures: ASME A112.19.2M.
   p. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
   q. Water-Closet, Flushometer Tank Trim: ASSE 1037.
   r. Whirlpool Bathtub Fittings: ASME A112.19.8M.
7. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
   a. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
   b. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
   c. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
   d. Faucets: ASME A112.18.1.
   e. Hose-Connection Vacuum Breakers: ASSE 1011.
   f. Hose-Coupling Threads: ASME B1.20.7.
   g. Integral, Atmospheric Vacuum Breakers: ASSE 1001.

h. NSF Potable-Water Materials: NSF 61.
i. Pipe Threads: ASME B1.20.1.
j. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
k. Supply Fittings: ASME A112.18.1.
l. Brass Waste Fittings: ASME A112.18.2.

8. Comply with the following applicable standards and other requirements specified for bathtub, bathtub/shower, and shower faucets:
   a. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
   b. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
   c. Deck-Mounted Bath/Shower Transfer Valves: ASME 18.7.
   d. Faucets: ASME A112.18.1.
   e. Hand-Held Showers: ASSE 1014.
   f. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
   g. Hose-Coupling Threads: ASME B1.20.7.
   h. Manual-Control Antiscald Faucets: ASTM F 444.
   i. Pipe Threads: ASME B1.20.1.
   j. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
   k. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
   l. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
9. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
   a. Atmospheric Vacuum Breakers: ASSE 1001.
   b. Brass and Copper Supplies: ASME A112.18.1.
   c. Dishwasher Air-Gap Fittings: ASSE 1021.
   d. Manual-Operation Flushometers: ASSE 1037.
   e. Plastic Tubular Fittings: ASTM F 409.
   f. Brass Waste Fittings: ASME A112.18.2.
   g. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
10. Comply with the following applicable standards and other requirements specified for miscellaneous components:
   a. Disposers: ASSE 1008 and UL 430.
   b. Dishwasher Air-Gap Fittings: ASSE 1021.
   c. Flexible Water Connectors: ASME A112.18.6.
   d. Floor Drains: ASME A112.6.3.
   e. Grab Bars: ASTM F 446.
   f. Hose-Coupling Threads: ASME B1.20.7.
   g. Hot-Water Dispensers: ASSE 1023 and UL 499.
   h. Off-Floor Fixture Supports: ASME A112.6.1M.
   i. Pipe Threads: ASME B1.20.1.
   j. Plastic Shower Receptors: ANSI Z124.2.
   k. Plastic Toilet Seats: ANSI Z124.5.
   l. Supply and Drain Protective Shielding Guards: ICC A117.1.
   m. Whirlpool Bathtub Equipment: UL 1795.

F. Warranty
1. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.
   a. Warranty Period for Commercial Applications: One **OR** Three, **as directed**, year(s) from date of Final Completion.
   b. Warranty Period for Residential Applications of Shells: Five **OR** 20 **OR** 30, **as directed**, years from date of Final Completion.
   c. Warranty Period for Residential Applications of Pumps and Blowers: Five **OR** 20, **as directed**, years from date of Final Completion.

d. Warranty Period for Residential Applications of Electronic Controls: Five years from date of Final Completion.

1.2 PRODUCTS

A. Lavatory Faucets
1. Description: Single-control mixing **OR** Single-control nonmixing **OR** Two-handle mixing, **as directed**, valve. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
a. Body Material: Commercial, solid brass **OR** General-duty, solid brass **OR** General-duty, solid brass or copper or brass underbody with brass cover plate **OR** General-duty, copper or brass underbody with brass cover plate **OR** Residential, nonmetallic underbody with brass cover plate **OR** Residential, nonmetallic underbody with nonmetallic cover plate, **as directed**.
b. Finish: Polished chrome plate **OR** Polished brass **OR** Nonmetallic, **as directed**.
c. Maximum Flow Rate: 0.5 gpm (1.5 L/min.) **OR** 2.2 gpm (8.3 L/min.) **OR** 2.5 gpm (9.5 L/min.), **as directed**.
OR
Maximum Flow: 0.25 gal. (0.95 L).
d. Centers: 3-3/8 inches (86 mm) **OR** 4 inches (102 mm) **OR** 6 inches (152 mm) **OR** 8 inches (203 mm) **OR** Single hole **OR** Adjustable, **as directed**.
e. Mounting: Deck, exposed **OR** Deck, concealed **OR** Back/wall, exposed **OR** Back/wall, concealed, **as directed**.
f. Valve Handle(s): Lever **OR** Knob **OR** Knob, nonmetallic **OR** Cross, four arm **OR** Wrist blade, 4 inches (102 mm) **OR** Elbow, 6 inches (152 mm) **OR** Push button **OR** Not applicable, **as directed**.
g. Inlet(s): NPS 3/8 (DN 10) tubing, plain end **OR** NPS 3/8 (DN 10) tubing, with NPS 1/2 (DN 15) male adaptor **OR** NPS 1/2 (DN 15) male shank **OR** NPS 1/2 (DN 15) female shank, **as directed**.
h. Spout: Rigid **OR** Swing **OR** Rigid, gooseneck **OR** Swivel, gooseneck, **as directed**, type.
i. Spout Outlet: Aerator **OR** Spray **OR** Laminar flow **OR** Plain end **OR** Spray, 0.5 gpm (1.5 L/min.), **as directed**.
j. Operation: Compression, manual **OR** Noncompression, manual **OR** Sensor **OR** Self-closing, metering, **as directed**.
k. Drain: Not required **OR** Pop up **OR** Stopper with chain **OR** Grid **OR** Lift and turn, **as directed**.
l. Tempering Device: Mechanical **OR** Thermostatic **OR** Pressure balance **OR** Not required, **as directed**.

B. Bathtub Faucets
1. Description: Single-control mixing **OR** Two-handle mixing **OR** Three-handle mixing **OR** Push-button, metering, nonmixing, **as directed**, valve. Include hot- and cold-water indicators and tub spout. Coordinate faucet inlets with supplies.
a. Body Material: Solid brass.
b. Finish: Polished chrome plate **OR** Polished brass, **as directed**.
c. Mounting: Deck **OR** Exposed, over rim **OR** Wall, **as directed**.
d. Valve Handle(s): Lever **OR** Knob **OR** Knob, nonmetallic **OR** Cross, four arm **OR** Not applicable, **as directed**.
e. Bathtub Spout: Chrome-plated brass with diverter, **as directed**.
f. Operation: Compression, manual **OR** Noncompression, manual **OR** Sensor, **as directed**.
g. Supply Connections: NPS 1/2 (DN 15) **OR** NPS 1/2 (DN 15), union **OR** Sweat, **as directed**.

C. Bathtub/Shower Faucets

1. Description: Single-handle pressure-balance **OR** thermostatic **OR** thermostatic/pressure-balance, **as directed**, valve for bathtub and for shower. Include hot- and cold-water indicators; check stops; tub spout; and shower head, arm, and flange. Coordinate faucet inlets with supplies; coordinate outlet with diverter valve.
   a. Body Material: Solid brass with nonmetallic trim, **as directed**.
   b. Finish: Polished chrome plate **OR** Polished brass, **as directed**.
   c. Maximum Flow Rate: 2.5 gpm (9.5 L/min.), unless otherwise indicated.
   d. Diverter Valve: Integral **OR** Not integral, **as directed**, with mixing valve.
   e. Mounting: Wall.
   f. Bathtub Spout: Chrome-plated brass with diverter, **as directed**.
   g. Operation: Compression, manual **OR** Noncompression, manual **OR** Sensor, **as directed**.
   h. Antiscald Device: Integral with mixing valve **OR** Separate unit, **as directed**.
   i. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
   j. Supply Connections: NPS 1/2 (DN 15) **OR** NPS 1/2 (DN 15), union **OR** Sweat, **as directed**.
   k. Backflow Protection Device for Hand-Held Shower: Required **OR** Not required, **as directed**.
   l. Shower Head Type: Ball joint **OR** Without ball joint **OR** Ball joint and head integral with mounting flange **OR** Integral with mounting flange **OR** Hand held, slide-bar mounted **OR** Hand held, hook mounted, **as directed**.
   m. Shower Head Material: Metallic **OR** Nonmetallic **OR** Combined, metallic and nonmetallic, **as directed**, with chrome-plated finish.
   n. Spray Pattern: Fixed **OR** Adjustable, **as directed**.
   o. Integral Volume Control: Required **OR** Not required, **as directed**.
   p. Shower-Arm Flow-Control Fitting: Not required **OR** 1.5 gpm (5.7 L/min.) **OR** 2.0 gpm (7.6 L/min.), **as directed**.

D. Shower Faucets
1. Description: Single-handle pressure-balance **OR** thermostatic **OR** thermostatic and pressure-balance, **as directed**, valve. Include hot- and cold-water indicators; check stops; and shower head, arm, and flange. Coordinate faucet inlets with supplies and outlet with diverter valve.
   a. Body Material: Solid brass with nonmetallic trim, **as directed**.
   b. Finish: Polished chrome plate **OR** Polished brass, **as directed**.
   c. Maximum Flow Rate: 2.5 gpm (9.5 L/min.), unless otherwise indicated.
   d. Diverter Valve: Not required **OR** Integral with mixing valve **OR** Not integral with mixing valve, **as directed**.
   e. Mounting: Exposed **OR** Concealed, **as directed**.
   f. Backflow Protection Device for Hand-Held Shower: Required **OR** Not required, **as directed**.
   g. Operation: Compression, manual **OR** Noncompression, manual **OR** Sensor, **as directed**.
   h. Antiscald Device: Integral with mixing valve **OR** Separate unit **OR** Not required, **as directed**.
   i. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
   j. Supply Connections: NPS 1/2 (DN 15) **OR** NPS 1/2 (DN 15), union **OR** Sweat, **as directed**.
   k. Shower Head Type: Ball joint **OR** Without ball joint **OR** Ball joint and head integral with mounting flange **OR** Integral with mounting flange **OR** Hand held, slide-bar mounted **OR** Hand held, hook mounted, **as directed.**
   l. Shower Head Material: Metallic **OR** Nonmetallic **OR** Combined, metallic and nonmetallic, **as directed**, with chrome-plated finish.
   m. Spray Pattern: Fixed **OR** Adjustable, **as directed**.
   n. Integral Volume Control: Required **OR** Not required, **as directed**.
   o. Shower-Arm Flow-Control Fitting: Not required **OR** 1.5 gpm (5.7 L/min.) **OR** 2.0 gpm (7.6 L/min.), **as directed**.

p. Temperature Indicator: Not required **OR** Integral with faucet, **as directed**.

E. Sink Faucets

1. Description: Kitchen faucet with spray, three-hole fixture **OR** Kitchen faucet with spray, four-hole fixture **OR** Kitchen faucet without spray **OR** Laundry tray faucet **OR** Service sink faucet with stops in shanks, vacuum breaker, hose-thread outlet, and pail hook **OR** Bar sink faucet, **as directed**. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
   a. Body Material: Commercial, solid brass **OR** General-duty, solid brass **OR** General-duty, solid brass or copper or brass underbody with brass cover plate **OR** General-duty, copper or brass underbody with brass cover plate **OR** Residential, nonmetallic underbody with brass cover plate **OR** Residential, nonmetallic underbody with nonmetallic cover plate, **as directed**.
   b. Finish: Polished chrome plate **OR** Polished brass **OR** Nonmetallic **OR** Polished or rough brass **OR** Rough brass, **as directed**.
   c. Maximum Flow Rate: 2.5 gpm (9.5 L/min.), unless otherwise indicated.
   d. Mixing Valve: Single control **OR** Two-lever handle, **as directed**.
   e. Backflow Protection Device for Hose Outlet: Required **OR** Not required, **as directed**.
   f. Backflow Protection Device for Side Spray: Required **OR** Not required, **as directed**.
   g. Centers: 3-3/8 inches (86 mm) **OR** 4 inches (102 mm) **OR** 6 inches (152 mm) **OR** 8 inches (203 mm) **OR** Single hole **OR** Adjustable, **as directed**.
   h. Mounting: Deck **OR** Back/wall, **as directed**, exposed **OR** concealed, **as directed**.
   i. Handle(s): Lever **OR** Knob **OR** Knob, nonmetallic **OR** Cross, four arm **OR** Wrist blade, 4 inches (102 mm) **OR** Elbow, 6 inches (152 mm) **OR** Not applicable, **as directed**.
   j. Inlet(s): NPS 3/8 (DN 10) plain-end tubing **OR** NPS 3/8 (DN 10) tubing with NPS 1/2 (DN 15) male adapter **OR** NPS 1/2 (DN 15) male shank **OR** NPS 1/2 (DN 15) female shank, **as directed**.
   k. Spout Type: Rigid, solid brass **OR** Rigid, solid brass with wall brace **OR** Swing, round tubular **OR** Swing, shaped tube **OR** Swing, solid brass **OR** Rigid gooseneck **OR** Swivel gooseneck, **as directed**.
   l. Spout Outlet: Aerator **OR** Swivel aerator/spray **OR** Spray **OR** Laminar flow **OR** Hose thread **OR** Plain end, **as directed**.
   m. Vacuum Breaker: Required **OR** Not required, **as directed**.
   n. Operation: Compression, manual **OR** Noncompression, manual **OR** Sensor, **as directed**.
   o. Drain: Not required **OR** Pop up **OR** Stopper with chain **OR** Grid **OR** Lift and turn, **as directed**.

F. Laminar-Flow Faucet-Spout Outlets

1. Description: Chrome-plated-brass faucet-spout outlet that produces non-aerating, laminar stream. Include male or female thread that mates with faucet outlet for attachment to faucets where indicated and flow-rate range that includes flow of faucet.

G. Flushometers

1. Description: Flushometer for urinal-type **OR** water-closet-type, **as directed**, fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, **as directed**, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.
   a. Internal Design: Diaphragm **OR** Piston, **as directed**, operation.
   b. Style: Exposed **OR** Concealed, **as directed**.
   c. Inlet Size: NPS 3/4 (DN 20) **OR** NPS 1 (DN 25), **as directed**.
   d. Trip Mechanism: Oscillating, lever-handle actuator **OR** Mechanical, push-button actuator with stainless-steel access plate **OR** Hydraulic, push-button actuator **OR** Foot-pedal actuator **OR** Hard-wired, electric-sensor actuator **OR** Battery-operated sensor actuator, **as directed**.

e. Consumption: 0.5 gal./flush (1.9 L/flush) **OR** 1.0 gal./flush (3.8 L/flush) **OR** 1.5 gal./flush (5.7 L/flush) **OR** 1.6 gal./flush (6.0 L/flush) **OR** 3.5 gal./flush (13.3 L/flush), **as directed**.
f. Tailpiece Size: NPS 3/4 (DN 20) **OR** NPS 1-1/4 (DN 32) **OR** NPS 1-1/2 (DN 40), **as directed**, and standard, **as directed**, length to top of bowl.

H. Toilet Seats
1. Description: Toilet seat for water-closet-type fixture.
a. Material: Molded, solid plastic with antimicrobial agent, **as directed**.
b. Configuration: Closed **OR** Open, **as directed**, front with **OR** without, **as directed**, cover.
c. Size: Elongated **OR** Regular, **as directed**.
d. Hinge Type: CK, check **OR** SS, self-sustaining **OR** SC, self-sustaining, check **OR** SR, self-raising, **as directed**.
e. Class: Residential **OR** Standard commercial **OR** Heavy-duty commercial, **as directed**.
f. Color: White **OR** Black, **as directed**.

I. Protective Shielding Guards
1. Protective Shielding Pipe Covers:
a. Description: Manufactured plastic wraps for covering plumbing fixture hot-water supply **OR** hot- and cold-water supplies, **as directed**, and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
2. Protective Shielding Piping Enclosures:
a. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

J. Fixture Supports
1. Water-Closet Supports:
a. Description: Combination carrier designed for accessible **OR** standard, **as directed**, mounting height of wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.
2. Urinal Supports:
a. Description: Type **I**, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture **OR** Type **II**, urinal carrier with hanger and bearing plates, **as directed**, for wall-mounting, urinal-type fixture. Include steel uprights with feet.
b. Accessible-Fixture Support: Include rectangular steel uprights.
3. Lavatory Supports:
a. Description: Type **I**, lavatory carrier with exposed arms and tie rods **OR** Type **II**, lavatory carrier with concealed arms and tie rod **OR** Type **III**, lavatory carrier with hanger plate and tie rod, **as directed**, for wall-mounting, lavatory-type fixture. Include steel uprights with feet.
b. Accessible-Fixture Support: Include rectangular steel uprights.
4. Sink Supports:
a. Description: Type **I**, sink carrier with exposed arms and tie rods **OR** Type **II**, sink carrier with hanger plate, bearing studs, and tie rod **OR** Type **III**, sink carrier with hanger plate and exposed arms, **as directed**, for sink-type fixture. Include steel uprights with feet.

K. Interceptors
1. Hair Interceptors:
a. Description: Manufactured unit with removable screen or strainer and removable cover; designed to trap and retain hair.
1) Material: Brass **OR** Stainless-steel, **as directed**, body.
2) Pipe Connections: NPS 1-1/4 (DN 32) **OR** NPS 1-1/2 (DN 40), **as directed**.
2. Sediment Interceptors:

a. Description: Manufactured unit with removable screens or strainer and removable cover; designed to trap and retain waste material.
   1) Material: Cast-iron or steel body with acid-resistant lining and coating **OR** Carbon-steel body with acid-resistant lining and coating **OR** Stainless-steel, **as directed**.
   2) Pipe Connections: NPS 1-1/2 (DN 40) **OR** NPS 2 (DN 50), **as directed**.

L. Shower Receptors
1. Description: Cast-polymer **OR** FRP **OR** PMMA **OR** Precast-terrazzo **OR** Solid-surface, **as directed**, base for built-up-type shower fixture.
   1) Type: Standard, residential **OR** Handicapped/wheelchair, **as directed**.
   2) Size: 32 by 32 inches (813 by 813 mm) **OR** 36 by 36 inches (914 by 914 mm) **OR** 32 by 42 inches (813 by 1067 mm) **OR** 48 by 60 inches (1219 by 1524 mm), **as directed**.
   3) Color: White.
   4) Outlet: Cast-in-floor drain **OR** Drain, **as directed**, with NPS 1-1/2 (DN 40) **OR** NPS 2 (DN 50) **OR** NPS 3 (DN 80), **as directed**, outlet.

M. Dishwasher Air-Gap Fittings
1. Description: Fitting suitable for use with domestic dishwashers and for deck mounting; with plastic body, chrome-plated brass cover, **as directed**; and capacity of at least 5 gpm (0.32 L/s); and inlet pressure of at least 5 psig (35 kPa) at a temperature of at least 140 deg F (60 deg C). Include 5/8-inch- (16-mm-) ID inlet and 7/8-inch- (22-mm-) ID outlet hose connections.
2. Hoses: Rubber and suitable for temperature of at least 140 deg F (60 deg C).
   a. Inlet Hose: 5/8-inch (16-mm) ID and 48 inches (1219 mm) long.
   b. Outlet Hose: 7/8-inch (22-mm) ID and 48 inches (1219 mm) long.

N. Disposers
1. Description: Batch-feed **OR** Continuous-feed, **as directed**, household, food-waste disposer. Include reset button; wall switch; corrosion-resistant chamber with jam-resistant, cutlery- or stainless-steel grinder or shredder; NPS 1-1/2 (DN 40) outlet; quick-mounting, stainless-steel sink flange; antisplash guard; and combination cover/stopper.
   a. Type: Batch-feed **OR** Continuous-feed, **as directed**, household.
   b. Model: Not applicable **OR** Sound-insulated chamber **OR** Sound-insulated chamber and stainless-steel outer shell, **as directed**.
   c. Motor: 115-V ac, 1725 rpm, 1/3 **OR** 1/2 **OR** 3/4 **OR** 1, **as directed**, hp with overload protection.

O. Hot-Water Dispensers
1. Description: Gooseneck spout with lever-handle **OR** Spout with twist-knob or push-button, **as directed**, flow control, household-type dispenser with instant on-off control; insulated, corrosion-resistant-metal storage tank that is open to atmosphere; electric heating element; chrome-plated faucet or spout; removable strainer; thermostat control for water temperature up to 190 deg F (88 deg C); and thermal-overload protection.
   a. Storage Tank Capacity: 0.5 gal. (1.5 L).
   b. Heating Element: 750 W minimum, 115-V ac.

P. Water Closets
1. Water Closets, Wall-Mounting, Back-Outlet Type:
   a. Description Accessible, wall-mounting **OR** Wall-mounting, **as directed**, back-outlet, vitreous-china fixture designed for flushometer-tank **OR** gravity-type tank **OR** flushometer valve, **as directed**, operation.
      1) Style: Close coupled **OR** One piece, **as directed**.
         a) Bowl Type: Elongated **OR** Round front, **as directed**, with siphon-jet design.
         b) Design Consumption: 1.6 gal./flush (6 L/flush) **OR** 3.5 gal./flush (13.3 L/flush), **as directed**.

c) Tank: Gravity type with trim **OR** Flushometer-tank type with trim and pressurized tank, **as directed**. Include cover.
d) Trip Mechanism: Lever-handle **OR** Push-button, **as directed**, actuator.
e) Color: White.
2) Supply: NPS 1/2 (DN 15) chrome-plated brass or copper with wheel-handle **OR** screwdriver **OR** loose-key, **as directed**, stop.
3) Style: Flushometer valve.
a) Bowl Type: Elongated **OR** Round front, **as directed**, with siphon-jet **OR** blowout, **as directed**, design.
b) Design Consumption: 1.6 gal./flush (6 L/flush) **OR** 3.5 gal./flush (13.3 L/flush), **as directed**.
c) Color: White.
4) Fixture Support: Water-closet support <Insert designation> combination carrier.

2. Water Closets, Floor-Mounting, Floor-Outlet Type:
a. Description: Accessible, floor-mounting **OR** Floor-mounting, **as directed**, floor-outlet, vitreous-china fixture designed for gravity-type tank **OR** flushometer tank **OR** flushometer valve, **as directed**, operation.
1) Style: Close coupled **OR** One piece, **as directed**.
a) Bowl Type: Elongated **OR** Round front, **as directed**, with siphon-jet design. Include bolt caps matching fixture.
b) Height: Standard **OR** Accessible **OR** Juvenile **OR** Child, **as directed**.
c) Design Consumption: 1 gal./flush (3.8 L/flush) **OR** 1.6 gal./flush (6 L/flush) **OR** 3.5 gal./flush (13.3 L/flush), **as directed**.
d) Tank: Gravity type with trim **OR** Flushometer-tank type with trim and pressurized tank, **as directed**. Include cover.
e) Trip Mechanism: Lever-handle **OR** Push-button, **as directed**, actuator.
f) Color: White.
2) Supply: NPS 3/8 (DN 10) **OR** NPS 1/2 (DN 15), **as directed**, chrome-plated brass or copper with wheel-handle **OR** screwdriver **OR** loose-key, **as directed**, stop.
3) Style: Flushometer valve.
a) Bowl Type: Elongated **OR** Round front, **as directed**, with siphon-jet **OR** reverse-trap **OR** blowout **OR** siphon-vortex **OR** siphon-wash **OR** washdown, **as directed**, design. Include bolt caps matching fixture.
b) Height: Standard **OR** Accessible **OR** Juvenile **OR** Child, **as directed**.
c) Design Consumption: 1.6 gal./flush (6 L/flush) **OR** 3.5 gal./flush (13.3 L/flush), **as directed**.
d) Color: White.

3. Water Closets, Floor-Mounting, Back-Outlet Type:
a. Description Accessible, floor-mounting **OR** Floor-mounting, **as directed**, back-outlet, vitreous-china fixture designed for gravity-tank **OR** flushometer-tank **OR** flushometer-valve, **as directed**, operation.
1) Style: Close coupled.
a) Bowl Type: Elongated with siphon-jet design. Include bolt caps matching fixture.
b) Height: Standard **OR** Accessible, **as directed**.
c) Design Consumption: 1.6 gal./flush (6 L/flush).
d) Tank: Gravity type with trim. Include cover.
e) Trip Mechanism: Lever-handle actuator.
f) Color: White.
2) Supply: NPS 1/2 (DN 15) chrome-plated brass or copper with wheel-handle **OR** screwdriver **OR** loose-key, **as directed**, stop.
3) Style: Flushometer valve.
a) Bowl Type: Elongated with siphon-jet design. Include bolt caps matching fixture.
b) Height: Standard **OR** Accessible, **as directed**.

c) Design Consumption: 1.6 gal./flush (6 L/flush) **OR** 3.5 gal./flush (13.3 L/flush), **as directed**.
d) Color: White.
4) Wall Support: Manufactured waste fitting with seal and fixture bolts.

Q. Urinals
1. Urinals, Wall-Mounting, Back-Outlet Type:
a. Description: Accessible, wall-mounting **OR** Wall-mounting, **as directed**, back-outlet, vitreous-china fixture designed for flushometer valve operation.
1) Type: Blowout **OR** Siphon jet **OR** Blowout with extended shields **OR** Siphon jet with extended shields **OR** Washout with extended shields, **as directed**.
2) Strainer or Trapway: Integral cast strainer **OR** Separate removable strainer **OR** Open trapway, **as directed**, with integral trap.
3) Design Consumption: 0.5 gal./flush (1.9 L/flush) **OR** 1 gal./flush (3.8 L/flush) **OR** 1.5 gal./flush (5.7 L/flush), **as directed**.
4) Color: White.
5) Supply Spud Size: NPS 3/4 (DN 20) **OR** NPS 1-1/4 (DN 32) **OR** NPS 1-1/2 (DN 40), **as directed**.
6) Outlet Size: NPS 1-1/2 (DN 40) **OR** NPS 2 (DN 50) **OR** NPS 3 (DN 80), **as directed**.
7) Fixture Support: Urinal chair carrier.
2. Urinals, Wall-Mounting, Bottom-Outlet Type:
a. Description: Accessible, wall-mounting **OR** Wall-mounting, **as directed**, bottom-outlet, vitreous-china fixture designed for flushometer valve operation.
1) Type: Washout **OR** Washdown, **as directed**.
2) Strainer or Trapway: Integral cast strainer **OR** Separate removable strainer **OR** Open trapway, **as directed**.
3) Design Consumption: 0.5 gal./flush (1.9 L/flush) **OR** 1 gal./flush (3.8 L/flush), **as directed**.
4) Color: White.
5) Supply Spud Size: NPS 3/4 (DN 20).
6) Outlet Size: NPS 1-1/2 (DN 40).
7) Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; 0.045-inch- (1.1-mm-) thick tubular brass waste to wall; and wall escutcheon.
8) Flushing Device: Fixture manufacturer's standard matching fixture.
9) Flushometer: **As directed.**
10) Fixture Support: Urinal chair carrier.
3. Urinals, Stall-Type, Bottom-Outlet:
a. Description Stall-type, bottom-outlet, vitreous-china fixture designed for flushometer valve operation.
4. Urinals, Wall-Mounting, Bottom-Outlet, Trough-Type:
a. Description: Wall-mounting, bottom-outlet, trough-type, enameled, cast-iron fixture modified for flushometer valve operation.
1) Style: Similar to wash sink with back and without pedestal.
2) Size: 36 inches (915 mm) **OR** 48 inches (1219 mm) **OR** 60 inches (1525 mm) **OR** 72 inches (1830 mm), **as directed**.
3) Color: White.
4) Drain: Separate removable dome strainer.
5) Design Consumption: Not applicable.
6) Supply: NPS 1/2 (DN 15).
7) Outlet Size: NPS 1-1/2 (DN 40).
8) Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; 0.045-inch- (1.1-mm-) thick tubular brass waste to wall; and wall escutcheon.
9) Flushing Device: Fixture manufacturer's standard, with washdown pipe, matching fixture.

10) Fixture Support: Sink chair carrier.

5. Urinals, Wall-Mounting, Back-Outlet Dry Type:
   a. Description Accessible, wall-mounting **OR** Wall-mounting, **as directed**, back-outlet dry, plastic **OR** vitreous-china, **as directed**, fixture designed for liquid-trap-seal operation.
      1) Type: Without water supply.
      2) Trap-Seal Method: Proprietary cartridge or trap system.
      3) Color: White.
      4) Outlet Size: NPS 1-1/2 (DN 40) **OR** NPS 2 (DN 50), **as directed**. Include transition coupling, if required.
      5) Trap-Sealing Liquid: Proprietary.
      6) Fixture Support: Urinal chair carrier.

R. Bidets
1. Description: Floor-mounting, vitreous-china fixture with fittings.
   a. Type: With spray **OR** flushing rim **OR** spray and flushing rim, **as directed**, and overflow. Include bolt caps matching fixture.
   b. Faucet Hole Punching: One **OR** Two **OR** Three **OR** Four **OR** No, **as directed**, hole(s).
   c. Color: White.
   d. Faucet: Fixture manufacturer's standard, or two-valve supply, provided by fixture supplier, with vacuum breaker, diverter, submerged spray, **OR** over-rim filling, **as directed**, pop-up waste, and chrome-plated finish.
   e. Supplies: NPS 3/8 (DN 10) **OR** NPS 1/2 (DN 15), **as directed**, chrome-plated copper with stops.
   f. Drain Piping: NPS 1-1/4 (DN 32) chrome-plated, cast-brass P-trap; 0.032-inch- (0.8-mm-) **OR** 0.045-inch- (1.1-mm-), **as directed**, thick tubular brass waste to wall; and wall escutcheon.

S. Lavatories
1. Lavatories, Wall-Mounting Type:
   a. Description: Accessible, wall-mounting **OR** Wall-mounting **OR** Wall-and-pedestal-mounting, **as directed**, enameled, cast-iron **OR** vitreous-china, **as directed**, fixture.
      1) Type: With back **OR** Ledge back **OR** Shelf back **OR** Slab **OR** Pedestal, **as directed**.
      2) Size: 18 by 15 inches (457 by 381 mm) **OR** 19 by 16 inches (483 by 406 mm) **OR** 20 by 18 inches (508 by 457 mm) **OR** 24 by 20 inches (610 by 508 mm), **as directed**, rectangular.
      3) Faucet Hole Punching: One hole **OR** Three holes, 2-inch (51-mm) centers **OR** Three holes, 4-inch (102-mm) centers, **as directed**.
      4) Faucet Hole Location: Top **OR** Front wall **OR** Inclined panel, **as directed**.
      5) Pedestal: Not required **OR** Required, **as directed**.
      6) Color: White.
      7) Faucet: Lavatory with pop-up waste **OR** for separate drain, **as directed**.
      8) Supplies: NPS 3/8 (DN 10) chrome-plated copper with stops.
      9) Drain: See faucet **OR** Grid **OR** Grid with offset waste, **as directed**.
         a) Location: Not applicable **OR** Near back of bowl, **as directed**.
      10) Drain Piping: NPS 1-1/4 (DN 32) **OR** NPS 1-1/4 by NPS 1-1/2 (DN 32 by DN 40), **as directed**, chrome-plated, cast-brass P-trap; NPS 1-1/4 (DN 32) **OR** NPS 1-1/2 (DN 40), **as directed**, 0.032-inch- (0.8-mm-) **OR** 0.045-inch- (1.1-mm-), **as directed**, thick tubular brass waste to wall; and wall escutcheon.
          OR
          Drain Piping: Schedule 40 ABS **OR** PVC, **as directed**, NPS 1-1/4 (DN 32) **OR** NPS 1-1/4 by NPS 1-1/2 (DN 32 by DN 40), **as directed**, P-trap; NPS 1-1/4 (DN 32) **OR** NPS 1-1/2 (DN 40), **as directed**, tubular waste to wall; and wall escutcheon.
         a) Exception: Omit P-trap if hair interceptor is required.
      11) Hair Interceptor: Not required.
      12) Protective Shielding Guard(s): **As directed**.

13) Fixture Support: Lavatory.

2. Lavatories, Counter-Mounting Type:
   a. Description: Accessible **OR** Counter-mounting **OR** Undercounter-mounting, **as directed**, enameled, cast-iron **OR** FRP **OR** PMMA **OR** porcelain-enameled, formed-steel **OR** solid-surface **OR** stainless-steel **OR** vitreous-china, **as directed** fixture.
      1) Type: Flat rim with ledge **OR** Self-rimming, **as directed**.
      2) Rectangular Lavatory Size: 18 by 15 inches (457 by 381 mm) **OR** 19 by 16 inches (483 by 406 mm) **OR** 20 by 18 inches (508 by 457 mm) **OR** 24 by 20 inches (610 by 508 mm), **as directed**.
      3) Oval Lavatory Size: 19 by 16 inches (483 by 406 mm) **OR** 20 by 17 inches (508 by 432 mm), **as directed**.
      4) Round Lavatory Size: 18 inches (457 mm) **OR** 19 inches (483 mm), **as directed**, in diameter.
      5) Faucet Hole Punching: One hole **OR** Three holes, 2-inch (51-mm) centers **OR** Three holes, 4-inch (102-mm) centers, **as directed**.
      6) Faucet Hole Location: Top **OR** Front wall **OR** Inclined panel, **as directed**.
      7) Color: White.
      8) Faucet: Lavatory with pop-up waste **OR** for separate drain, **as directed**.
      9) Supplies: NPS 3/8 (DN 10) chrome-plated copper with stops.
      10) Drain: See faucet **OR** Grid **OR** Grid with offset waste, **as directed**.
         a) Location: Not applicable **OR** Near back of bowl, **as directed**.
      11) Drain Piping: NPS 1-1/4 (DN 32) **OR** NPS 1-1/4 by NPS 1-1/2 (DN 32 by DN 40), **as directed**, chrome-plated, cast-brass P-trap; NPS 1-1/4 (DN 32) **OR** NPS 1-1/2 (DN 40), **as directed**, 0.032-inch- (0.8-mm-) **OR** 0.045-inch- (1.1-mm-), **as directed**, thick tubular brass waste to wall; and wall escutcheon.

         OR

         Drain Piping: Schedule 40 ABS **OR** PVC, **as directed**, NPS 1-1/4 (DN 32) **OR** NPS 1-1/4 by NPS 1-1/2 (DN 32 by DN 40), **as directed**, P-trap; NPS 1-1/4 (DN 32) **OR** NPS 1-1/2 (DN 40), **as directed**, tubular waste to wall; and wall escutcheon.
         a) Exception: Omit P-trap if hair interceptor is required.
      12) Hair Interceptor: Not required.
      13) Protective Shielding Guard(s): **As directed**.

3. Lavatories, Countertop With Integral Bowl Type:
   a. Description: Countertop **OR** Accessible countertop, **as directed**, with integral bowl fixtures for mounting on base unit.
      1) Backsplash: Integral with countertop **OR** Separate, same material as countertop **OR** Not required, **as directed**.
      2) Overall Rectangular Top Size: 25 by 17 inches (635 by 432 mm) **OR** 31 by 19 inches (787 by 483 mm) **OR** 49 by 22 inches (1245 by 559 mm) **OR** 73 by 22 inches (1854 by 559 mm), **as directed**, with 1 **OR** 2 **OR** 3 **OR** 4, **as directed**, bowl(s).
         a) Bowl Size: Oval 19 by 16 inches (483 by 406 mm) **OR** 20 by 17 inches (508 by 432 mm), **as directed**.
      3) Faucet Hole Punching: One hole **OR** Three holes, 2-inch (51-mm) centers **OR** Three holes, 4-inch (102-mm) centers, **as directed**.
      4) Faucet Hole Location: Countertop.
      5) Color: White.
      6) Faucet(s): Lavatory with pop-up waste **OR** with separate drain, **as directed**, for each bowl.
      7) Supplies: NPS 3/8 (DN 10) chrome-plated copper with stops.
      8) Drain(s): See faucets **OR** Grid **OR** Grid with offset waste, **as directed**.
         a) Location: Not applicable **OR** Near back of bowl, **as directed**.
      9) Drain Piping: NPS 1-1/4 (DN 32) **OR** NPS 1-1/4 by NPS 1-1/2 (DN 32 by DN 40), **as directed**, chrome-plated, cast-brass P-trap; NPS 1-1/4 (DN 32) **OR** NPS 1-1/2 (DN 40), **as directed**, 0.032-inch- (0.8-mm-) **OR** 0.045-inch- (1.1-mm-), **as directed**, thick tubular brass waste to wall; and wall escutcheon.

OR
Drain Piping: Schedule 40 ABS **OR** PVC, **as directed**, NPS 1-1/4 (DN 32) **OR** NPS 1-1/4 by NPS 1-1/2 (DN 32 by DN 40), **as directed**, P-trap; NPS 1-1/4 (DN 32) **OR** NPS 1-1/2 (DN 40), **as directed**, tubular waste to wall; and wall escutcheon.

10) Hair Interceptor(s): **As directed** for bowls as indicated.
11) Protective Shielding Guard(s): **As directed** for bowls as indicated.

4. Lavatories, For Wheelchair-Bound Persons:
   a. Description: Accessible, wall-mounting, vitreous-china fixture designed for people in wheelchairs.
      1) Type: Ledge back **OR** Shelf back **OR** Slab, **as directed**.
      2) Size: 20 by 26 inches (508 by 660 mm) minimum; rectangular.
      3) Faucet Hole Punching: One hole **OR** Three holes, 2-inch (51-mm) centers **OR** Three holes, 4-inch (102-mm) centers **OR** Three holes, 8-inch (203-mm) centers **OR** Three holes, 12-inch (305-mm) centers, **as directed**.
      4) Color: White.
      5) Faucet: Lavatory for separate drain.
      6) Supplies: NPS 3/8 (DN 10) chrome-plated copper with stops.
      7) Drain: Grid **OR** Grid with offset waste, **as directed**.
      8) Drain Piping: NPS 1-1/4 (DN 32) **OR** NPS 1-1/4 by NPS 1-1/2 (DN 32 by DN 40), **as directed**, chrome-plated, cast-brass P-trap; NPS 1-1/4 (DN 32) **OR** NPS 1-1/2 (DN 40), **as directed**, 0.045-inch- (1.1-mm-) thick tubular brass waste to wall; and wall escutcheon.
         OR
         Drain Piping: Schedule 40 ABS **OR** PVC, **as directed**, NPS 1-1/4 (DN 32) **OR** NPS 1-1/4 by NPS 1-1/2 (DN 32 by DN 40), **as directed**, P-trap; NPS 1-1/4 (DN 32) **OR** NPS 1-1/2 (DN 40), **as directed**, tubular waste to wall; and wall escutcheon.
      9) Fixture Support: Lavatory.

T. Commercial Sinks
1. Commercial Sinks, Counter-Mounting Type:
   a. Description: One-compartment **OR** Two-compartment **OR** Three-compartment, **as directed**, counter-mounting, stainless-steel commercial sink with backsplash.
      1) Metal Thickness: 0.050 inch (1.3 mm).
      2) Compartment (for single-compartment sink):
         a) Drain: Grid with NPS 1-1/2 (DN 40) tailpiece and twist drain **OR** Grid with NPS 2 (DN 50) tailpiece and twist drain **OR** NPS 1-1/2 (DN 40) tailpiece with stopper **OR** NPS 1-1/2 (DN 40) tailpiece with pop-up waste, **as directed**.
            i. Location: Centered in compartment **OR** Near back of compartment **OR** Near left side of compartment **OR** Near right side of compartment, **as directed**.
      3) Each Compartment (for multiple-compartment sink):
         a) Drains: Grid with NPS 1-1/2 (DN 40) tailpiece and twist drain **OR** Grid with NPS 2 (DN 50) tailpiece and twist drain **OR** NPS 1-1/2 (DN 40) tailpiece with stopper **OR** NPS 1-1/2 (DN 40) tailpiece with pop-up waste, **as directed.**
            i. Location: Centered in compartment **OR** Near back of compartment, **as directed**.
      4) Faucet(s): Sink.
         a) Number Required: One **OR** Two, **as directed**.
         b) Mounting: Deck.
      5) Supplies: NPS 1/2 (DN 15) **OR** NPS 3/4 (DN 20), **as directed**, chrome-plated copper with stops or shutoff valves.
      6) Drain Piping: NPS 1-1/2 (DN 40) **OR** NPS 2 (DN 50), **as directed**, chrome-plated, cast-brass P-trap; 0.045-inch- (1.1-mm-) thick tubular brass **OR** copper pipe, **as directed**, waste to wall; continuous waste, **as directed**; and wall escutcheon(s).
2. Commercial Sinks, Freestanding Type:

a. Description: One-compartment **OR** Two-compartment **OR** Three-compartment, **as directed**, freestanding, stainless-steel commercial sink with backsplash.
  1) Metal Thickness: 0.050 inch (1.3 mm) **OR** 0.063 inch (1.6 mm), **as directed**.
  2) Compartment (for single-compartment sink):
    a) Drain: Grid with NPS 1-1/2 (DN 40) tailpiece and twist drain **OR** Grid with NPS 2 (DN 50) tailpiece and twist drain **OR** NPS 1-1/2 (DN 40) tailpiece with stopper **OR** NPS 1-1/2 (DN 40) tailpiece with pop-up waste, **as directed**.
      i. Location: Centered in compartment **OR** Near back of compartment **OR** Near left side of compartment **OR** Near right side of compartment, **as directed**.
  3) Each Compartment (for multiple-compartment sink):
    a) Drains: Grid with NPS 1-1/2 (DN 40) tailpiece and twist drain **OR** Grid with NPS 2 (DN 50) tailpiece and twist drain **OR** NPS 1-1/2 (DN 40) tailpiece with stopper **OR** NPS 1-1/2 (DN 40) tailpiece with pop-up waste, **as directed**.
      i. Location: Centered in compartment **OR** Near back of compartment, **as directed**.
  4) Drainboard(s): Not required **OR** Both **OR** Left **OR** Right, **as directed**, side(s).
    a) Dimensions Each: Not applicable.
  5) Supports: Adjustable-length, steel legs.
  6) Faucet(s): Sink.
    a) Number Required: One **OR** Two, **as directed**.
    b) Mounting: In backsplash.
  7) Supplies: NPS 1/2 (DN 15) **OR** NPS 3/4 (DN 20), **as directed**, chrome-plated copper with stops or shutoff valves.
  8) Drain Piping: NPS 1-1/2 (DN 40) **OR** NPS 2 (DN 50), **as directed**, chrome-plated, cast-brass P-trap; 0.045-inch- (1.1-mm-) thick tubular brass **OR** copper pipe, **as directed**, waste to wall; continuous waste, **as directed**; and wall escutcheon(s).

3. Commercial Sinks, Handwash Type:
  a. Description: Wall-mounting, stainless-steel, commercial, handwash-sink fixture.
    1) Type: Basin with radius corners, back for faucet, and support brackets.
    2) Size; Approximately 17 by 16 by 5 inches (432 by 406 by 127 mm).
    3) Faucet: Back-mounting, chrome-plated, solid-brass, gooseneck type with individual valves.
    4) Supplies: NPS 1/2 (DN 15) chrome-plated copper with stops.
    5) Drain: Grid.
    6) Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; 0.045-inch- (1.1-mm-) thick tubular brass waste to wall; and wall escutcheon.
    7) Fixture Support: Sink for wall-mounting installation.

U. Shampoo Bowls
  1. Description: Enameled, cast-iron **OR** PMMA, **as directed**, fixture shaped for head rest. Include vacuum breaker, faucet, hose and spray, drain, and mounting brackets.
    a. Color: White.
    b. Supplies: NPS 3/8 (DN 10) **OR** NPS 1/2 (DN 15), **as directed**, chrome-plated copper with stops.
    c. Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; 0.045-inch- (1.1-mm-) thick tubular brass waste to wall; and wall escutcheon.
      OR
      Drain Piping: Schedule 40 ABS **OR** PVC, **as directed**, NPS 1-1/2 (DN 40) P-trap; tubular waste to wall; and wall escutcheon.
    d. Hair Interceptor: **As directed**
    e. Fixture Support for Counter Mounting: Brackets or forms.
      OR
      Fixture Support for Wall Mounting: Sink.

V. Wash Fountains
1. Wash Fountains, Freestanding Type:
a. Description: Accessible, Circular, freestanding-design, wash-up fixture.
1) Arrangement: Wash-up stations facing central spray head.
2) Receptor Material: Precast terrazzo **OR** Stainless steel **OR** Solid surface, **as directed**, on base.
3) Receptor Color or Finish: Not applicable.
4) Size: 36- to 39-inch (914- to 990-mm) **OR** 54-inch (1370-mm), **as directed**, diameter.
5) Number of Stations: Two **OR** Three **OR** Four **OR** Five **OR** Six **OR** Eight, **as directed**.
6) Control: Collective **OR** Individual, **as directed**, push-button **OR** foot-pedal **OR** sensor, **as directed**, actuation with thermostatic valve and check stops or field-installed check valves.
7) Liquid Soap Dispensers: Manual **OR** Sensor, **as directed**, for each station.
8) Mounting: Floor.
9) Supplies: NPS 3/4 (DN 20) **OR** NPS 1 (DN 25), **as directed**, copper tubing with ball, gate, or globe valves from bottom **OR** top, **as directed**.
10) Shroud: Not required **OR** Stainless steel of size to cover supplies and vent piping, **as directed**.
11) Drain: Grid with NPS 2 (DN 50) tailpiece.
12) Trap Fitting: Not required **OR** NPS 2 (DN 50) trap with waste and vent connections, **as directed**.
13) Drain Piping: NPS 1-1/2 (DN 40), **OR** NPS 2 (DN 50), **as directed**, waste to floor.
14) Vent Piping: Not required **OR** NPS 1-1/2 (DN 40) to ceiling, **as directed**.
2. Wash Fountains, Semicircular Or Corner Type:
a. Description: Accessible, Semicircular **OR** Corner, **as directed**, design, wash-up fixture.
1) Arrangement: Wash-up stations facing central spray head.
2) Receptor Material: Precast terrazzo **OR** Stainless steel **OR** Solid surface, **as directed**, on base.
3) Receptor Color or Finish: Not applicable.
4) Size: 36- to 39-inch (914- to 990-mm) **OR** 54-inch (1370-mm), **as directed**, diameter.
5) Number of Stations: Two **OR** Three **OR** Four, **as directed**.
6) Control: Collective **OR** Individual, **as directed**, push-button **OR** foot-pedal **OR** sensor, **as directed**, actuation with thermostatic valve and check stops or field-installed check valves.
7) Liquid Soap Dispensers: Manual **OR** Sensor, **as directed**, for each station.
8) Mounting: Floor and flush-to-wall with wall bracket.
9) Supplies: NPS 1/2 (DN 15) **OR** NPS 3/4 (DN 20), **as directed**, copper tubing with ball, gate, or globe valves.
10) Drain: Grid with NPS 1-1/2 (DN 40) **OR** NPS 2 (DN 50), **as directed**, tailpiece.
11) Drain Piping: NPS 1-1/2 (DN 40) **OR** NPS 2 (DN 50), **as directed**, P-trap, waste to wall, and wall flange.
3. Wash Fountains, Wall-Mounting Type:
a. Description: Accessible, **as directed**, Flush-to-wall, **as directed**, linear design, wash-up fixture.
1) Arrangement: Wash-up stations facing spray heads.
2) Receptor Material: Precast terrazzo **OR** Stainless steel **OR** Solid surface, **as directed**, on base.
3) Receptor Color or Finish: Not applicable.
4) Number of Stations: One **OR** Two **OR** Three **OR** Four, **as directed**.
5) Control: Collective **OR** Individual, **as directed**, push-button **OR** sensor, **as directed**, actuation with thermostatic valve and check stops or field-installed check valves.
6) Liquid Soap Dispensers: Manual **OR** Sensor, **as directed**, for each station.

7) Mounting: Floor mounting with bracket for attaching to wall.
8) Faucet(s): Push-button **OR** Sensor-actuated, **as directed**, mixing valve with check stops.
9) Supplies: NPS 1/2 (DN 15) copper tubing with ball, gate, or globe valves.
10) Drain: Grid with NPS 1-1/2 (DN 40) tailpiece.
11) Drain Piping: NPS 1-1/2 (DN 40) P-trap, waste to wall, and wall flange.

W. Bathtubs
1. Description: Enameled, cast-iron **OR** FRP **OR** PMMA **OR** Porcelain-enameled, formed-steel, **as directed**, fixture.
a. Bathing Surface: Slip resistant.
b. Size: 48 by 30 inches (1220 by 765 mm) **OR** 60 by 30 inches (1525 by 765 mm) **OR** 66 by 30 inches (1680 by 765 mm), **as directed**, with front apron **OR** drop-in type, **as directed**.
c. Color: White.
d. Drain Location: Left **OR** Right, **as directed**, end.
e. Accessibility Options: Include grab bar and bench.
f. Faucet: Bathtub **OR** Bathtub/shower, **as directed**.
g. Supplies: NPS 1/2 (DN 15) copper tubing with ball, gate, or globe valves.
h. Drain: NPS 1-1/2 (DN 40); chrome-plated exposed parts; brass pop-up waste and overflow.
i. Drain Piping: NPS 1-1/2 (DN 40) cast-brass P-trap and waste.
OR
Drain Piping: Schedule 40 ABS **OR** PVC, **as directed**, NPS 1-1/2 (DN 40) P-trap and waste.

X. Individual Showers
1. Individual Showers, Enclosure Type:
a. Description: Accessible, **as directed**, FRP **OR** PMMA, **as directed**, shower enclosure with slip-resistant bathing surface and shower rod with curtain.
1) Size: 36 by 34 inches (915 by 865 mm) **OR** 42 by 36 inches (1065 by 915 mm) **OR** 43 by 39 inches (1090 by 990 mm) **OR** 48 by 34 inches (1220 by 865 mm) **OR** 52 by 36 inches (1320 by 915 mm) **OR** 60 by 36 inches (1525 by 915 mm) **OR** 72 by 36 inches (1830 by 915 mm), **as directed**.
2) Surround: One piece or sealed, multiple piece, **as directed**.
OR
Surround: One piece.
3) Color: White.
4) Drain Location: Left side **OR** Center **OR** Right side, **as directed**.
5) Accessibility Options: Include grab bar and bench.
6) Faucet: Shower.
7) Drain: Grid, NPS 2 (DN 50).
2. Individual Showers, Built-Up Type:
a. Description: Components for built-up shower.
1) Receptor: Not required.
3. Individual Showers, Cabinet Type:
a. Description: Factory-fabricated, accessible, **as directed**, cabinet type with faucet and receptor.
1) Size: 30 by 30 inches (760 by 760 mm) **OR** 32 by 32 inches (815 by 815 mm) **OR** 36 by 36 inches (915 by 915 mm) **OR** 36 by 39 inches (915 by 990 mm) **OR** 45 by 39 inches (1145 by 990 mm), **as directed**.
2) Material: Steel **OR** Composite **OR** Plastic, **as directed**, front **OR** corner **OR** front and rear, **as directed**, access.
3) Color: Not applicable.
4) Accessibility Options: Grab bar and bench.
5) Faucet: Shower.

6) Supplies: NPS 1/2 (DN 15) copper tubing with ball, gate, or globe valves, **as directed**.
7) Drain: Grid, NPS 2 (DN 50).

Y. Group Showers
1. Group Showers, Column Type:
a. Description: Stainless-steel column fixture with two **OR** three **OR** four **OR** five **OR** six, **as directed**, individual showers.
1) Height to Shower Heads: 66 inches (1675 mm) **OR** 72 inches (1830 mm), **as directed**.
2) Control: Thermostatic **OR** Pressure-balance, **as directed**, valve with individual hot- and cold-water mixing valve operation.
OR
Control: Thermostatic valve with individual tempered-water supply and push-button **OR** sensor, **as directed**, operation.
3) Flow Control: 2 gpm (7.6 L/min.) **OR** 2.5 gpm (9.5 L/min.), **as directed**, for each shower head.
4) Liquid Soap Dispenser: For each shower.
5) Mounting: Floor flange.
6) Supplies: NPS 3/4 (DN 20) **OR** NPS 1 (DN 25), **as directed**, copper tubing with ball, gate, or globe valves from bottom **OR** top, **as directed**.
7) Shroud: Not required **OR** Stainless steel of size to cover supplies and vent piping, **as directed**.
8) Drain Fitting: NPS 3 (DN 80) **OR** NPS 4 (DN 100), **as directed**, outlet with NPS 2 (DN 50) vent, integral with base of column.
9) Vent Piping: Not required **OR** NPS 2 (DN 50) to ceiling, **as directed**.
2. Group Showers, Wall-Mounting Type:
a. Description: Wall-mounting fixture with stainless-steel surface enclosure with two **OR** three, **as directed**, individual showers.
1) Control: Thermostatic **OR** Pressure-balance, **as directed**, valve with individual hot- and cold-water mixing valve operation.
OR
Control: Thermostatic valve with individual tempered-water supply and push-button **OR** sensor, **as directed**, operation.
2) Flow Control: 2 gpm (7.6 L/min.) **OR** 2.5 gpm (9.5 L/min.), **as directed**, for each shower head.
3) Liquid Soap Dispenser: For each shower.
4) Mounting: Wall bracket.
5) Supplies: NPS 3/4 (DN 20) copper tubing with ball, gate, or globe valves.
3. Group Showers, Freestanding, Plastic Type:
a. Description: Freestanding, plastic group-shower fixture.
1) Number of Shower Stations: One **OR** Two **OR** Three **OR** Four, **as directed**, with individual self-closing control valve(s).
2) Number of Foot Wash Stations: One **OR** Two, **as directed**, with individual self-closing control valve(s).
3) Hose Bibb: Not **OR** One, **as directed**, required.
4) Control-Valve Mounting Height: 50 inches (1270 mm) **OR** 48 inches (1219 mm), **as directed**.
5) Material: Cast-filled-polymer plastic.
6) Color: Gray.
7) Internal Piping: Factory installed.
8) Mounting: Base flange with bolt holes.
4. Group Showers, Freestanding, Steel Type:
a. Description: Freestanding, steel group-shower fixture.
1) Number of Shower Stations: One **OR** Two, **as directed**, with individual self-closing control valve(s).

2) Number of Foot Wash Stations: One **OR** Two, **as directed**, with individual self-closing control valve(s).
3) Material: Painted steel pipe.
4) Color: Blue.
5) Internal Piping: Factory installed.
6) Mounting: Base flange with bolt holes.

Z. Whirlpool Bathtubs

1. Whirlpool Bathtubs, Water-Circulation Hydromassage Type:

a. Description: Packaged, enameled, cast-iron **OR** FRP **OR** PMMA **OR** porcelain-enameled, formed-steel, **as directed**, hydromassage bathtub with air-entrained-water jet nozzles and water circulation.

1) Seating Capacity: One **OR** Two, **as directed**, person(s).
2) Bathing Surface: Slip resistant.
3) Size: 60 by 30 inches (1525 by 765 mm) **OR** 66 by 30 inches (1680 by 765 mm) **OR** 60 by 42 inches (1525 by 1065 mm), **as directed**.
4) Base for Drop-in Unit: <**Insert description**> with access panel.
OR
Apron: Matching unit, covering exposed front and sides, and with access panel.
5) Color: White.
6) Drain Location: Left **OR** Right, **as directed**, end.
7) Controls: For pump, timer, **as directed**, and water heater, **as directed**.
8) Faucet: Fixture manufacturer's individual valves **OR** mixing valve, **as directed**, with over-rim tub filler.
9) Supplies: NPS 1/2 (DN 15) copper tubing with ball, gate, or globe valves.
10) Drain: NPS 1-1/2 (DN 40); chrome-plated exposed parts; brass pop-up waste and overflow.
11) Drain Piping: NPS 1-1/2 (DN 40) cast-brass P-trap and waste.
OR
Drain Piping: Schedule 40 ABS **OR** PVC, **as directed**, NPS 1-1/2 (DN 40) P-trap and waste.
12) Water-Circulating System: Electric circulating pump and plastic piping.
13) Water Heater: Electric, inline, **as directed**.

2. Whirlpool Bathtubs, Airmassage Type:

a. Description: Packaged, PMMA airmassage bathtub with air-injection nozzles.

1) Seating Capacity: One **OR** Two, **as directed**, person(s).
2) Bathing Surface: Slip resistant.
3) Size: 60 by 30 inches (1525 by 765 mm) **OR** 66 by 30 inches (1680 by 765 mm) **OR** **OR** 60 by 42 inches (1525 by 1065 mm), **as directed**.
4) Base for Drop-in Unit: <**Insert description**> with access panel.
OR
Apron: Matching unit, covering exposed front and sides, and with access panel.
5) Color: White.
6) Drain Location: Left **OR** Right, **as directed**, end.
7) Controls: For blower, timer, **as directed**, and water heater, **as directed**.
8) Faucet: Fixture manufacturer's individual valves **OR** mixing valve, **as directed**, with over-rim tub filler.
9) Supplies: NPS 1/2 (DN 15) copper tubing with ball, gate, or globe valves.
10) Drain: NPS 1-1/2 (DN 40); chrome-plated exposed parts; brass pop-up waste and overflow.
11) Drain Piping: NPS 1-1/2 (DN 40) cast-brass P-trap and waste.
OR
Drain Piping: Schedule 40 ABS **OR** PVC, **as directed**, NPS 1-1/2 (DN 40) P-trap and waste.

12) Air-Injection System: Electric, blower **OR** combination blower/heater, **as directed**, and plastic piping.

AA. Kitchen Sinks
1. Kitchen Sinks:
a. Description: One-bowl **OR** Two-bowl **OR** Three-bowl, **as directed**, residential, counter-mounting, enameled, cast-iron **OR** PMMA **OR** porcelain-enameled, formed-steel **OR** solid-surface **OR** stainless-steel, **as directed**, kitchen sink.
1) Metal Thickness: 0.038 inch (1.0 mm) **OR** 0.050 inch (1.3 mm), **as directed**.
2) Bowl (single bowl):
a) Drain: 3-1/2-inch (89-mm) crumb cup **OR** grid **OR** grid with offset waste **OR** outlet for disposer, **as directed**.
i. Location: Centered in bowl **OR** Near back of bowl, **as directed**.
3) Left Bowl:
a) Drain: 3-1/2-inch (89-mm) crumb cup **OR** grid **OR** grid with offset waste **OR** outlet for disposer, **as directed**.
i. Location: Centered in bowl **OR** Near back of bowl, **as directed**.
4) Right Bowl:
a) Drain: 3-1/2-inch (89-mm) crumb cup **OR** grid **OR** grid with offset waste **OR** outlet for disposer, **as directed**.
i. Location: Centered in bowl **OR** Near back of bowl, **as directed**.
5) Center Bowl:
a) Drain: 1-1/2-inch (38-mm) **OR** 3-1/2-inch (89-mm), **as directed**, crumb cup **OR** grid **OR** grid with offset waste, **as directed**.
i. Location: Centered in bowl.
6) Supplies: NPS 1/2 (DN 15) chrome-plated copper with stops.
7) Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; 0.045-inch- (1.1-mm-) thick tubular brass waste to wall; continuous waste, **as directed**; and wall escutcheon(s).
OR
Drain Piping: Schedule 40 ABS **OR** PVC, **as directed**, NPS 1-1/2 (DN 40) P-trap; tubular waste to wall; continuous waste, **as directed**; and wall escutcheon(s).
8) Disposer: Not required.
9) Dishwasher Air-Gap Fitting: Required **OR** Not required, **as directed**.
10) Hot-Water Dispenser: Not required.
2. Bar Sinks:
a. Description: Single-bowl, residential, counter-mounting, enameled, cast-iron **OR** PMMA **OR** stainless-steel **OR** porcelain-enameled, cast-iron **OR** solid-surface, **as directed**, bar sink.
1) Supplies: NPS 3/8 (DN 10) **OR** NPS 1/2 (DN 15), **as directed**, chrome-plated copper with stops.
2) Drain: 1-1/2-inch (38-mm) **OR** 3-1/2-inch (89-mm), **as directed**, crumb cup **OR** grid **OR** grid with offset waste, **as directed**.
3) Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; 0.045-inch- (1.1-mm-) thick tubular brass waste to wall; and wall escutcheon.
OR
Drain Piping: Schedule 40 ABS **OR** PVC, **as directed**, NPS 1-1/2 (DN 40) P-trap; tubular waste to wall; and wall escutcheon.
4) Protective Shielding Guard(s): **As directed.**

BB. Service Sinks
1. Service Sinks, Standard Type:
a. Description: Trap-standard- and wall-mounting, enameled, cast-iron fixture with roll-rim **OR** vitreous-china fixture, **as directed**, with plain **OR** two faucet holes in, **as directed**, back and rim guard on front and sides.

1) Size (cast-iron fixture): 22 by 18 inches (560 by 460 mm) **OR** 24 by 20 inches (610 by 510 mm), **as directed**.
2) Size (vitreous-china fixture): 19 by 16 inches (480 by 405 mm) **OR** 22 by 20 inches (560 by 510 mm), **as directed**.
3) Color: White.
4) Faucet: Sink type. Polished OR rough, as directed, chrome-plated, solid-brass faucet. Include integral stops in shanks, vacuum breaker, hose-thread outlet, and pail hook. Provide type with wall brace if faucet will be mounted above back.
5) Drain: Grid with NPS 2 (DN 50) **OR** NPS 3 (DN 80), **as directed**, outlet.
6) Trap Standard: NPS 2 (DN 50) **OR** NPS 3 (DN 80), **as directed**, enameled, cast iron with cleanout and floor flange.
7) Fixture Support: Sink.

2. Service Sinks, Floor-Mounting Type:
   a. Description: Floor-mounting, enameled, cast-iron fixture with front apron, raised back, and coated, wire rim guard. (This type of service sink requires a drainage piping trap under the fixture. This trap is not part of fixture fittings)
      1) Size: 28 by 28 inches (710 by 710 mm).
      2) Color: White.
      3) Faucet: Sink type. Polished OR rough, as directed, chrome-plated, solid-brass faucet with wall brace. Include integral stops in shanks, vacuum breaker, hose-thread outlet, and pail hook..
      4) Drain: Grid with NPS 2 (DN 50) **OR** NPS 3 (DN 80), **as directed**, outlet.

CC. Service Basins
1. Description: Flush-to-wall, floor-mounting, precast terrazzo **OR** cast-polymer, **as directed**, fixture with rim guard. (This type of fixture requires a drainage piping trap under the fixture. This trap is not part of fixture fittings.)
   a. Shape: Square **OR** Rectangular **OR** Five sided **OR** Radial front, **as directed**.
   b. Size: 24 by 24 inches (610 by 610 mm) **OR** 28 by 28 inches (710 by 710 mm) **OR** 24 by 36 inches (610 by 915 mm) **OR** 32 by 32 inches (815 by 815 mm) **OR** 36 by 36 inches (915 by 915 mm), **as directed**.
   c. Height: 6 inches (150 mm) **OR** 10 inches (255 mm) **OR** 12 inches (305 mm) **OR** 12 inches (305 mm) with dropped front, **as directed**.
   d. Tiling Flange: Not required **OR** On one side **OR** On two sides **OR** On three sides, **as directed**.
   e. Rim Guard: On front **OR** all, **as directed**, top surfaces.
   f. Color: Not applicable.
   g. Faucet: Sink type. Polished OR rough, as directed, chrome-plated, solid-brass faucet with wall brace. Include integral stops in shanks, vacuum breaker, hose-thread outlet, and pail hook.
   h. Drain: Grid with NPS 2 (DN 50) **OR** NPS 3 (DN 80), **as directed**, outlet.

DD. Laundry Trays
1. Description: Stand-mounting **OR** Counter-mounting, **as directed**, enameled, cast-iron **OR** plastic, **as directed**, laundry trays.
   a. Size: 24 by 21 inches (610 by 535 mm) **OR** 25 by 22 inches (635 by 560 mm), **as directed**.
   b. Color: Not applicable.
   c. Faucet: Sink type, polished, chrome-plated, solid brass, for fixture-ledge **OR** wall **OR** counter, **as directed**, mounting.
   d. Supplies: NPS 1/2 (DN 15) chrome-plated copper with stops **OR** copper tubing with ball, gate, or globe valves, **as directed**.
   e. Drain: Grid with NPS 1-1/2 (DN 40) outlet.
   f. Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; 0.045-inch- (1.1-mm-) thick tubular brass waste to wall; and wall escutcheon.

OR
Drain Piping: Schedule 40 ABS **OR** PVC, **as directed**, NPS 1-1/2 (DN 40) P-trap; tubular waste to wall; and wall escutcheon.
g. Stand: Not required **OR** Painted steel, **as directed**.

EE. Sacristy Sinks
1. Description: Two-bowl, counter-mounting, stainless-steel fixture.
a. Size: Approximately 22 by 42 inches (560 by 1070 mm).
b. Cover: Hinged with lock on left **OR** right, **as directed**, bowl.
c. Supplies: NPS 1/2 (DN 15) chrome-plated copper with stops.
d. Drains: One with stopper and one with grid.
e. Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, tubular-brass waste. Include one trap, one direct waste without trap, separate waste piping, and wall flanges.

1.3 EXECUTION

A. Installation
1. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
2. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
a. Use carrier supports with waste fitting and seal for back-outlet fixtures.
b. Use carrier supports without waste fitting for fixtures with tubular waste piping.
c. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
3. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
4. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
5. Install wall-mounting fixtures with tubular waste piping attached to supports.
6. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.
7. Install counter-mounting fixtures in and attached to casework.
8. Install fixtures level and plumb according to roughing-in drawings.
9. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
a. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-duty Valves For Plumbing Piping".
10. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
11. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
12. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
13. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.
14. Install toilet seats on water closets.
15. Install trap-seal liquid in dry urinals.
16. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
17. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
18. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
19. Install shower flow-control fittings with specified maximum flow rates in shower arms.
20. Install traps on fixture outlets.
a. Exception: Omit trap on fixtures with integral traps.

b. Exception: Omit trap on indirect wastes, unless otherwise indicated.

21. Install disposer in outlet of each sink indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.
22. Install dishwasher air-gap fitting at each sink indicated to have air-gap fitting. Install in sink deck **OR** on countertop at sink, **as directed**. Connect inlet hose to dishwasher and outlet hose to disposer.
23. Install hot-water dispensers in back top surface of sink or in countertop with spout over sink.
24. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results For Plumbing".
25. Set bathtubs, shower receptors, and service basins in leveling bed of cement grout. Grout is specified in Division 22 Section "Common Work Results For Plumbing".
26. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants".

B. Connections

1. Piping installation requirements are specified in other Division 14. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
3. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
4. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Field Quality Control

1. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
2. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
3. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
4. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
5. Install fresh batteries in sensor-operated mechanisms.

D. Adjusting

1. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
2. Operate and adjust disposers, hot-water dispensers, and controls. Replace damaged and malfunctioning units and controls.
3. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.
4. Replace washers and seals of leaking and dripping faucets and stops.
5. Install fresh batteries in sensor-operated mechanisms.

E. Cleaning

1. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
   a. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
   b. Remove sediment and debris from drains.
2. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

F. Protection
   1. Provide protective covering for installed fixtures and fittings.
   2. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by the Owner.

END OF SECTION 10 28 19 16

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Task	Specification	Specification Description
10 28 19 19	10 28 19 16	Plumbing Fixtures

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SECTION 10 44 13 00 - FIRE PROTECTION CABINETS

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for fire extinguisher cabinets. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Fire protection cabinets for the following:
         1) Portable fire extinguishers.
         2) Fire hose valves.
         3) Fire hoses and racks.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. Show location of knockouts for hose valves.
   3. Shop Drawings: For fire protection cabinets. Include plans, elevations, sections, details, and attachments to other work.
   4. Samples: For each type of fire protection cabinet indicated.
   5. Maintenance Data.

D. Quality Assurance
   1. Fire-Rated, Fire Protection Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.
   2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Coordination
   1. Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
   2. Coordinate size of fire protection cabinets to ensure that type and capacity of fire hoses, hose valves, and hose racks indicated are accommodated.
   3. Coordinate sizes and locations of fire protection cabinets with wall depths.

F. Sequencing
   1. Apply decals **OR** vinyl lettering, **as directed**, on field-painted, fire protection cabinets after painting is complete.

1.2 PRODUCTS

A. Materials
   1. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.
   2. Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:
      a. Sheet: ASTM B 209 (ASTM B 209M).
      b. Extruded Shapes: ASTM B 221 (ASTM B 221M).
   3. Stainless-Steel Sheet: ASTM A 666, Type 304.
   4. Copper-Alloy Brass Sheet: ASTM B 36/B 36M, alloy UNS No. C26000 (cartridge brass, 70 percent copper).

5. Copper-Alloy Bronze Sheet: ASTM B 36/B 36M, alloy UNS No. C28000 (muntz metal, 60 percent copper).
6. Clear Float Glass: ASTM C 1036, Type I, Class 1, Quality q3, 3 **OR** 6, **as directed**, mm thick.
7. Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear) **OR** Class 2 (tinted, heat absorbing, and light reducing), bronze tint, **as directed**.
8. Break Glass: Clear annealed float glass, ASTM C 1036, Type I, Class 1, Quality q3, 1.5 mm thick, single strength.
9. Tempered Break Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 1.5 mm thick.
10. Wire Glass: ASTM C 1036, Type II, Class 1, Form 1, Quality q8, Mesh m1 (diamond), 6 mm thick.
11. Transparent Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet), 1.5 **OR** 3 **OR** 6, **as directed**, mm thick, with Finish 1 (smooth or polished) **OR** Finish 2 (patterned, textured), **as directed**.
12. Acrylic Bubble: One piece.

B. Fire Protection Cabinet
1. Cabinet Type: Suitable for fire extinguisher **OR** extinguisher and hose valve **OR** hose, rack, valve, and extinguisher **OR** hose, rack, and valve **OR** hose valve, **as directed**.
2. Cabinet Construction: Nonrated **OR** 1-hour fire rated **OR** 2-hour fire rated, **as directed**.
    a. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.0428-inch- (1.1-mm-) thick, cold-rolled steel sheet lined with minimum 5/8-inch- (16-mm-) thick, fire-barrier material. Provide factory-drilled mounting holes.
3. Cabinet Material: Steel **OR** Aluminum **OR** Stainless-steel, **as directed**, sheet.
    a. Shelf: Same metal and finish as cabinet.
4. Recessed Cabinet: Cabinet box recessed in walls of sufficient depth to suit style of trim indicated.
    a. Trimless with Concealed Flange: Surface of surrounding wall finishes flush with exterior finished surface of cabinet frame and door, without overlapping trim attached to cabinet. Provide recessed flange, of same material as box, attached to box to act as plaster stop **OR** drywall bead, **as directed**.
    b. Trimless with Hidden Flange: Flange of same metal and finish as box overlaps surrounding wall finish and is concealed from view by an overlapping door.
    c. Exposed Flat Trim: One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).
5. Semirecessed Cabinet: Cabinet box partially recessed in walls of sufficient depth to suit style of trim indicated; with one-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend). Provide where walls are of insufficient depth for recessed cabinets but are of sufficient depth to accommodate semirecessed cabinet installation.
    a. Square-Edge Trim: 1-1/4- to 1-1/2-inch (32- to 38-mm) backbend depth.
    b. Rolled-Edge Trim: 2-1/2-inch (64-mm) **OR** 4-inch (102-mm) **OR** 4-1/2-inch (114-mm), **as directed**, backbend depth.
6. Surface-Mounted Cabinet: Cabinet box fully exposed and mounted directly on wall with no trim. Provide where walls are of insufficient depth for semirecessed cabinet installation.
7. Cabinet Trim Material: Steel sheet **OR** Aluminum sheet **OR** Extruded-aluminum shapes **OR** Stainless-steel sheet **OR** Copper-alloy brass sheet **OR** Copper-alloy bronze sheet **OR** Same material and finish as door, **as directed**.
8. Door Material: Steel sheet **OR** Aluminum sheet **OR** Extruded-aluminum shapes **OR** Stainless-steel sheet **OR** Copper-alloy brass sheet **OR** Copper-alloy bronze sheet, **as directed**.
9. Door Style: Fully glazed, frameless, backless, acrylic panel **OR** Fully glazed panel with frame **OR** Full bubble, frameless **OR** Full bubble with frame **OR** Full bubble with frameless, rotating turntable **OR** Horizontal duo panel with frame **OR** Vertical duo panel with frame **OR** Center glass panel with frame **OR** Solid opaque panel with frame **OR** Flush opaque panel, frameless, with no exposed hinges, **as directed**.

10. Door Glazing: Clear float glass **OR** Tempered float glass (clear) **OR** Tempered float glass (bronze tint) **OR** Break glass **OR** Tempered break glass **OR** Wire glass **OR** Mirror glass **OR** Acrylic sheet **OR** Break acrylic bubble **OR** Molded acrylic bubble, **as directed**.
    a. Acrylic Sheet Color: Clear **OR** Bronze, **as directed**, transparent acrylic sheet.
    b. Acrylic Sheet Color: Clear transparent acrylic sheet painted white **OR** red **OR** black, **as directed**, on unexposed side.
    c. Acrylic Bubble Color: Clear **OR** Bronze **OR** Red, **as directed**, transparent.
11. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
    a. Provide projecting lever handle with cam-action latch **OR** projecting door pull and friction latch **OR** recessed door pull and friction latch **OR** manufacturer's standard, **as directed**.
    b. Provide continuous hinge, of same material and finish as trim, **OR** concealed hinge **OR** pivot hinge **OR** manufacturer's standard hinge, **as directed,** permitting door to open 180 degrees.
12. Accessories:
    a. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
    b. Break-Glass Strike: Manufacturer's standard metal strike, complete with chain and mounting clip, secured to cabinet.
    c. Lettered Door Handle: One-piece, cast-iron door handle with the word "FIRE" embossed into face.
    d. Door Lock: Cam lock that allows door to be opened during emergency by pulling sharply on door handle **OR** Cylinder lock, keyed alike to other cabinets, **as directed.**
    e. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed.
        1) Identify fire extinguisher in fire protection cabinet with the words "FIRE EXTINGUISHER."
            a) Location: Applied to cabinet door **OR** cabinet glazing **OR** location indicated on Drawings, **as directed**.
            b) Application Process: Silk-screened **OR** Engraved **OR** Etched **OR** Decals **OR** Pressure-sensitive vinyl letters, **as directed**.
            c) Lettering Color: Red **OR** Black **OR** White, **as directed**.
            d) Orientation: Vertical **OR** Horizontal **OR** As indicated on Drawings, **as directed**.
    f. Alarm: Manufacturer's standard alarm that actuates when fire protection cabinet door is opened and that is powered by batteries **OR** low voltage, complete with transformer, **as directed**.
13. Finishes:
    a. Manufacturer's standard baked-enamel paint for the following:
        1) Exterior of cabinet door **OR** trim, **OR** door, and trim, **as directed,** except for those surfaces indicated to receive another finish.
        2) Interior of cabinet and door, **as directed**.
    b. Aluminum: Clear anodic **OR** Color anodic **OR** Baked enamel or powder coat, **as directed**.
    c. Steel: Factory primed for field painting **OR** Baked enamel or powder coat, **as directed**.
    d. Stainless Steel: No. 2B **OR** No. 4 **OR** No. 6 **OR** No. 7 **OR** No. 8, **as directed**.
    e. Copper Alloy, Brass: Buffed **OR** Hand rubbed **OR** Hand rubbed, lacquered **OR** Medium satin **OR** Fine matte **OR** Statuary conversion **OR** Patina conversion, **as directed**.
    f. Copper Alloy, Bronze: Buffed **OR** Hand rubbed **OR** Hand rubbed, lacquered **OR** Medium satin **OR** Fine matte **OR** Statuary conversion **OR** Patina conversion, **as directed**.

C. Security Fire Protection Cabinet
1. Cabinet Type: Suitable for fire extinguisher **OR** extinguisher and hose valve **OR** hose, rack, valve, and extinguisher **OR** hose, rack, and valve **OR** hose valve, **as directed**.
2. Cabinet Construction: Nonrated **OR** 1-hour fire rated **OR** 2-hour fire rated, **as directed**.

a. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls lined with minimum 5/8-inch- (16-mm-) thick, fire-barrier material.

3. Cabinet Material: 0.0677-inch- (1.7-mm-) thick steel **OR** 0.0966-inch- (2.5-mm-) thick steel **OR** 0.0781-inch- (2.0-mm-) thick, stainless-steel, **as directed,** sheet.
   a. Shelf: Same metal and finish as cabinet.
4. Recessed Cabinet: Cabinet box recessed in walls of sufficient depth to suit style of trim indicated.
   a. Exposed Flat Trim: One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).
5. Semirecessed Cabinet: Cabinet box partially recessed in walls of sufficient depth to suit style of trim indicated; with one-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend). Provide where walls are of insufficient depth for recessed cabinets but are of sufficient depth to accommodate semirecessed cabinet installation.
   a. Square-Edge Trim: 1-1/4- to 1-1/2-inch (32- to 38-mm) backbend depth.
   b. Rolled-Edge Trim: 2-1/2-inch (64-mm) backbend depth.
6. Surface-Mounted Cabinet: Cabinet box fully exposed and mounted directly on wall; with no trim. Provide where walls are of insufficient depth for semirecessed cabinet installation.
7. Cabinet Trim Material: Steel sheet **OR** Stainless-steel sheet **OR** Same material and finish as door, **as directed**.
8. Door Material: 0.0966-inch- (2.5-mm-) thick steel **OR** 0.0781-inch- (2.0-mm-) thick, stainless-steel **OR** 0.1094-inch- (2.8-mm-) thick, stainless-steel, **as directed,** sheet.
9. Door Style: Solid opaque panel with frame.
10. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated, and as follows:
    a. Recessed door pull.
    b. Continuous Hinge: Same material and finish as trim, permitting door to open 180 degrees.
    c. Mechanical Deadlock: Lockbolt retracted and extended by five-tumbler paracentric **OR** mogul, **as directed,** cylinder; keyed one side.
       1) Lockbolt: 1-1/2 inches high by 3/4 inch (38 mm high by 19 mm) thick; 5/8-inch (16-mm) throw.
    d. Mechanical Deadlock: As specified in Division 08 Section "Detention Door Hardware".
    e. Mechanical Snaplatch: Automatic snaplatch when closed; latchbolt retracted by five-tumbler paracentric **OR** mogul, **as directed,** cylinder; keyed one side.
       1) Lockbolt: 1 inch high by 7/16 inch (25 mm high by 11 mm) thick; 5/16-inch (8-mm) throw.
    f. Mechanical Snaplatch: As specified in Division 08 Section "Detention Door Hardware".
11. Accessories:
    a. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to security fire protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
    b. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed.
       1) Identify fire extinguisher in security fire protection cabinet with the words "FIRE EXTINGUISHER."
          a) Location: Applied to cabinet door **OR** location indicated on Drawings, **as directed**.
          b) Application Process: Silk-screened **OR** Engraved **OR** Etched **OR** Decals **OR** Pressure-sensitive vinyl letters, **as directed**.
          c) Lettering Color: Red **OR** Black **OR** White, **as directed**.
          d) Orientation: Vertical **OR** Horizontal **OR** As indicated on Drawings, **as directed**.
    c. Keys to Door Locks: Three per lock.
12. Finishes:
    a. Manufacturer's standard baked-enamel paint for the following:

1) Exterior of cabinet door **OR** trim, **OR** door, and trim, **as directed,** except for those surfaces indicated to receive another finish.
2) Interior of cabinet and door, **as directed**.

b. Steel: Factory primed for field painting **OR** Baked enamel or powder coat, **as directed**.
c. Stainless Steel: No. 4 finish.

D. Fabrication
1. Fire Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
   a. Weld joints and grind smooth.
   b. Provide factory-drilled mounting holes.
   c. Prepare doors and frames to receive locks.
   d. Install door locks at factory.
2. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.
   a. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch (13 mm) thick.
   b. Fabricate door frames of one-piece construction with edges flanged.
   c. Miter and weld perimeter door frames.
3. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

E. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical finishes on exposed surfaces of fire protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
3. Finish fire protection cabinets after assembly.
4. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

F. Aluminum Finishes
1. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed,** or thicker.
2. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed,** or thicker.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black, **as directed**.
   b. Color: As selected from full range of industry colors and color densities, **as directed**.
3. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

G. Steel Finishes
1. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning" **OR** SSPC-SP 8, "Pickling", **as directed**. After cleaning, apply a conversion coating suited to the organic coating to be applied over it, **as directed**.
2. Factory Prime Finish: Apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
3. Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).

a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

H. Stainless-Steel Finishes
1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
   a. Run grain of directional finishes with long dimension of each piece.
   b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
   c. Directional Satin Finish: No. 4.
   d. Dull Satin Finish: No. 6.
   e. Reflective, Directional Polish: No. 7.
   f. Mirrorlike Reflective, Nondirectional Polish: No. 8.
3. Bright, Cold-Rolled, Unpolished Finish: No. 2B.

I. Copper-Alloy Finishes
1. Buffed Finish, Lacquered: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear organic, air drying, as specified below).
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in 2 coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
2. Hand-Rubbed Finish, Lacquered: M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear organic, air drying, as specified below).
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in 2 coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
3. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide).
   a. Color: Match sample.
4. Patina Conversion Coating: CDA-M36-C12-C52 (Mechanical Finish: directionally textured, uniform; Chemical Finish: nonetched cleaned, degreased; Chemical Finish: conversion coating, ammonium sulfate).
   a. Color: Match sample.

1.3 EXECUTION

A. Preparation
1. Prepare recesses for recessed and semirecessed fire protection cabinets as required by type and size of cabinet and trim style.

B. Installation
1. General: Install fire protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights indicated below: or, if not indicated, at heights acceptable to authorities having jurisdiction.
   a. Fire Protection Cabinets: 54 inches (1372 mm) above finished floor to top of cabinet.
2. Fire Protection Cabinets: Fasten cabinets to structure, square and plumb.
   a. Unless otherwise indicated, provide recessed fire protection cabinets. If wall thickness is not adequate for recessed cabinets, provide semirecessed fire protection cabinets.
   b. Provide inside latch and lock for break-glass panels.
   c. Fasten mounting brackets to inside surface of fire protection cabinets, square and plumb.
   d. Fire-Rated, Hose and Valve **OR** Hose-Valve, **as directed**, Cabinets:
      1) Install cabinet with not more than 1/16-inch (1.6-mm) tolerance between pipe OD and knockout OD. Center pipe within knockout.

2) Seal through penetrations with firestopping sealant as specified in Division 07 Section "Penetration Firestopping".

3. Identification: Apply decals **OR** vinyl lettering, **as directed**, at locations indicated.

C. Adjusting And Cleaning

1. Remove temporary protective coverings and strippable films, if any, as fire protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.
2. Adjust fire protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
3. On completion of fire protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
4. Touch up marred finishes, or replace fire protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire protection cabinet and mounting bracket manufacturers.
5. Replace fire protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 10 44 13 00

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SECTION 10 44 16 13 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes portable, [**hand-carried**] [**wheeled**] fire extinguishers[**and mounting brackets for fire extinguishers**].

B. Owner-Furnished Material: [**Hand-carried**] [**Wheeled**] fire extinguishers.

C. Related Requirements:

1. Section 104413 "Fire Protection Cabinets."
2. Section 233813 "Commercial-Kitchen Hoods" for fire-extinguishing systems provided as part of commercial-kitchen exhaust hoods.

1.2 ALLOWANCES

A. Fire Extinguishers are part of <**Insert name of allowance**>.

1.3 UNIT PRICES

A. Work of this Section is affected by <**Insert name of unit price**>.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**>.

1. Review methods and procedures related to fire extinguishers including, but not limited to, the following:

a. Schedules and coordination requirements.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher[**and mounting brackets**].

B. Product Schedule: For fire extinguishers. Coordinate final fire-extinguisher schedule with fire-protection cabinet schedule to ensure proper fit and function.[**Use same designations indicated on Drawings.**]

1.6 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.8 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure of hydrostatic test according to NFPA 10 when testing interval required by NFPA 10 is within the warranty period.
b. Faulty operation of valves or release levers.

2. Warranty Period: [**Six**] <**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

1. Provide fire extinguishers approved, listed, and labeled by FM Global.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each [**fire-protection cabinet**] [**and**] [**mounting bracket**] indicated.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain fire extinguishers, fire-protection cabinets, and accessories, from single source from single manufacturer.
3. Valves: [**Manufacturer's standard**] [**Nickel-plated, polished-brass body**].
4. Handles and Levers: [**Manufacturer's standard**] [**Stainless steel**].
5. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B[**, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging**].

B. Stored-Pressure Water Type <**Insert drawing designation**>: UL-rated 2-A, 2.5-gal. (9.5-L) nominal capacity, with water in stainless steel container; with pressure-indicating gage.

C. Stored-Pressure Antifreeze Water Type <**Insert drawing designation**>: UL-rated 2-A, 2.5-gal. (9.5-L) nominal capacity, with water and approved antifreeze solution mixed for temperatures as low as minus 40 deg F (minus 40 deg C) in stainless steel container; with pressure-indicating gage.

D. Stored-Pressure Water-Mist Type <**Insert drawing designation**>: UL-rated 2-A:C, 2.5-gal. (9.5-L) nominal capacity, with water in enameled-steel container; with pressure-indicating gage.

E. Pressurized, AFFF-Foam Type <**Insert drawing designation**>: UL-rated [**2-A:10-B, 1.6-gal. (6-L)**] [**3-A:20-B, 2.5-gal. (9.5-L)**] nominal capacity, with AFFF foam in stainless steel container; with pressure-indicating gage.

F. Pressurized, FFFP-Foam Type <**Insert drawing designation**>: UL-rated 3-A:20-B, 2.5-gal. (9.5-L) nominal capacity, with FFFP foam in stainless steel container; with pressure-indicating gage.

G. Wet-Chemical Type <**Insert drawing designation**>: UL-rated 2-A:1-B:C:K, [**1.6-gal. (6-L)**] [**2.5-gal. (9.5-L)**] nominal capacity, with potassium [**acetate**] [**citrate**] [**carbonate**]-based chemical in stainless steel container; with pressure-indicating gage.

H. Regular Dry-Chemical Type <**Insert drawing designation**>: UL-rated <**Insert capacity**> nominal capacity, with sodium bicarbonate-based dry chemical in manufacturer's standard enameled container.

I. Regular Dry-Chemical Type in Steel Container <**Insert drawing designation**>: UL-rated [**2-B:C, 1-lb (0.4-kg)**] [**10-B:C, 2.5-lb (1.1-kg)**] [**10-B:C, 5-lb (2.3-kg)**] [**40-B:C, 5.5-lb (2.5-kg)**] [**40-B:C, 6-lb (2.7-kg)**] [**60-B:C, 10-lb (4.5-kg)**] [**120-B:C, 20-lb (9.1-kg)**] nominal capacity, with sodium bicarbonate-based dry chemical in enameled-steel container.

J. Regular Dry-Chemical Type in Aluminum Container <**Insert drawing designation**>: UL-rated [**2-B:C, 1-lb (0.4-kg)**] [**10-B:C, 2.5-lb (1.1-kg)**] [**10-B:C, 5-lb (2.3-kg)**] [**40-B:C, 5.5-lb (2.5-kg)**] [**60-B:C, 10-lb (4.5-kg)**] [**120-B:C, 20-lb (9.1-kg)**] nominal capacity, with sodium bicarbonate-based dry chemical in enameled-aluminum container.

K. Regular Dry-Chemical Type in Brass Container <**Insert drawing designation**>: UL-rated [**40-B:C, 6-lb (2.7-kg)**] [**60-B:C, 10-lb (4.5-kg)**] [**120-B:C, 20-lb (9.1-kg)**] nominal capacity, with sodium bicarbonate-based dry chemical in chrome-plated-brass container.

L. Multipurpose Dry-Chemical Type <**Insert drawing designation**>: UL-rated <**Insert capacity**> nominal capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.

M. Multipurpose Dry-Chemical Type in Steel Container <**Insert drawing designation**>: UL-rated [**1-A:10-B:C, 2.5-lb (1.1-kg)**] [**2-A:10-B:C, 5-lb (2.3-kg)**] [**3-A:40-B:C, 5-lb (2.3-kg)**] [**3-A:40-B:C, 6-lb (2.7-kg)**] [**4-A:60-B:C, 10-lb (4.5-kg)**] [**10-A:120-B:C, 20-lb (9.1-kg)**] nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

N. Multipurpose Dry-Chemical Type in Aluminum Container <**Insert drawing designation**>: UL-rated [**1-A:10-B:C, 2.5-lb (1.1-kg)**] [**2-A:10-B:C, 5-lb (2.3-kg)**] [**3-A:40-B:C, 5-lb (2.3-kg)**] [**3-A:40-B:C, 6-lb (2.7-kg)**] [**4-A:60-B:C, 10-lb (4.5-kg)**] [**10-A:120-B:C, 20-lb (9.1-kg)**] nominal capacity, with monoammonium phosphate-based dry chemical in enameled-aluminum container.

O. Multipurpose Dry-Chemical Type in Brass Container <**Insert drawing designation**>: UL-rated [**2-A:10-B:C, 5-lb (2.3-kg)**] [**3-A:40-B:C, 6-lb (2.7-kg)**] [**4-A:60-B:C, 10-lb (4.5-kg)**] [**4-A:80-B:C, 10-lb (4.5-kg)**] [**10-A:120-B:C, 20-lb (9.1-kg)**] nominal capacity, with monoammonium phosphate-based dry chemical in chrome-plated-brass container.

P. Purple-K Dry-Chemical Type in Aluminum Container <**Insert drawing designation**>: UL-rated [**10-B:C, 2.5-lb (1.1-kg)**] [**30-B:C, 5-lb (2.3-kg)**] [**120-B:C, 20-lb (9.1-kg)**] nominal capacity, with potassium bicarbonate-based dry chemical in enameled-aluminum container.

Q. Purple-K Dry-Chemical Type in Brass Container <**Insert drawing designation**>: UL-rated [**80-B:C, 10-lb (4.5-kg)**] [**120-B:C, 20-lb (9.1-kg)**] nominal capacity, with potassium bicarbonate-based dry chemical in chrome-plated-brass container.

R. Carbon Dioxide Type <**Insert drawing designation**>: UL-rated [**5-B:C, 5-lb (2.3-kg)**] [**10-B:C, 10-lb (4.5-kg)**] [**10-B:C, 15-lb (6.8-kg)**] [**10-B:C, 20-lb (9.1-kg)**] nominal capacity, with carbon dioxide in [**manufacturer's standard enameled-metal**] [**enameled-steel**] [**enameled-aluminum**] container.

S. Dry-Powder Type <**Insert drawing designation**>: [**FM approved,**]UL-rated Class D, 30-lb (13.6-kg) nominal capacity, with [**sodium chloride**] [**copper**]-based powder in enameled-steel container; with pressure-indicating gage.

T. Halon Type <**Insert drawing designation**>: [**5-B:C, 2.5-lb (1.1-kg)**] [**10-B:C, 5-lb (2.3-kg)**] nominal capacity, in enameled-steel container; with pressure-indicating gage.

1. UL-rated.

U. Clean-Agent Type in Aluminum Container <**Insert drawing designation**>: UL-rated [**1-B:C, 1.4-lb (0.6-kg)**] [**2-B:C, 2.5-lb (1.1-kg)**] [**5-B:C, 5-lb (2.3-kg)**] nominal capacity, with HCFC Blend B agent and inert material in enameled-aluminum container; with pressure-indicating gage.

V. Clean-Agent Type in Brass Container <**Insert drawing designation**>: UL-rated [**1-A:10-B:C, 11-lb (5-kg)**] [**2-A:10-B:C, 15.5-lb (7-kg)**] nominal capacity, with HCFC Blend B agent and inert material in chrome-plated-brass container; with pressure-indicating gage.

W. Clean-Agent Type in Steel Container <**Insert drawing designation**>: UL-rated [**5-B:C, 4.75-lb (2.2-kg)**] [**1-A:10-B:C, 10-lb (4.5-kg)**] [**2-A:10-B:C, 14-lb (6.4-kg)**] nominal capacity, with HFC blend agent and inert material in enameled-steel container; with pressure-indicating gage.

2.3 MOUNTING BRACKETS <**Insert drawing designation**>

A. Mounting Brackets: Manufacturer's standard[**galvanized**] steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or [**red**] [**black**] baked-enamel finish.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain mounting brackets and fire extinguishers from single source from single manufacturer.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.

1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

   a. Orientation: [**Vertical**] [**Horizontal**].

2.4 WHEELED FIRE EXTINGUISHERS <**Insert drawing designation**>

A. Wheeled Fire Extinguishers: Type, size, and capacity for locations indicated, complete with carriage.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain wheeled fire extinguishers and fire extinguishers from single source from single manufacturer.

1. Carriage: Fabricated from enameled-steel pipe, complete with hanger assembly, long-range nozzle, hose, and [**semipneumatic solid-rubber tires**] [**wide-rim wheels**].

a. Hose: [**15 feet (4.6 m)**] [**50 feet (15.2 m)**] [**100 feet (30.5 m)**].

C. Pressurized, FFFP-Foam Type: UL-rated 20-A:160-B, 33-gal. (125-L) nominal capacity, with FFFP foam in stainless steel container.

D. Regular Dry-Chemical Type: UL-rated [**160-B:C, 50-lb (23-kg)**] [**240-B:C, 150-lb (68-kg)**] [**160-B:C, 250-lb (113-kg)**] nominal capacity, with sodium bicarbonate-based dry chemical in [**regulated**] [**stored**] [**direct**]-pressure, enameled-steel container.

E. Multipurpose Dry-Chemical Type: UL-rated [**20-A:160-B:C, 30-lb (13.6-kg)**] [**30-A:160-B:C, 50-lb (23-kg)**] [**40-A:240-B:C, 125-lb (57-kg)**] [**40-A:160-B:C, 250-lb (113-kg)**] nominal capacity, with monoammonium phosphate-based dry chemical in [**regulated**] [**stored**] [**direct**]-pressure, enameled-[**steel**] [**aluminum**] [**steel or -aluminum**] container.

F. Purple-K Dry-Chemical Type: UL-rated [**160-B:C, 50-lb (23-kg)**] [**320-B:C, 125-lb (57-kg)**] [**160-B:C, 250-lb (113-kg)**] nominal capacity, with potassium bicarbonate-based dry chemical in [**regulated**] [**stored**] [**direct**]-pressure, enameled-steel container.

G. Carbon Dioxide Type: UL-rated [**20-B:C, 50-lb (23-kg)**] [**20-B:C, 100-lb (45-kg)**] nominal capacity, with carbon dioxide in [**manufacturer's standard enameled-metal**] [**enameled-steel**] [**enameled-aluminum**] container.

H. Dry-Powder Type: [**FM approved,**]UL-rated Class D, [**sodium chloride-based powder, 150-lb (68-kg)**] [**copper-based powder, 250-lb (113-kg)**] nominal capacity, in regulated-pressure, enameled-steel container; with pressure-indicating gage.

I. Clean-Agent Type: UL-rated [**4-A:40-B:C, 65-lb (29-kg)**] [**10-A:80-B:C, 150-lb (68-kg)**] nominal capacity, with HCFC Blend B agent and inert material in stored-pressure, enameled-steel container; with pressure-indicating gage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install fire extinguishers[**and mounting brackets**] in locations indicated and in compliance with requirements of authorities having jurisdiction.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

1. Mounting Height: Top of fire extinguisher to be at [**42 inches (1067 mm)**] <**Insert dimension**> above finished floor.

END OF SECTION 10 44 16 13

Task	Specification	Specification Description
10 44 16 13	01 22 16 00	No Specification Required
10 44 16 13	10 44 13 00	Fire Protection Cabinets

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SECTION 10 51 13 00 - WIRE BASKET LOCKERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for wire basket lockers. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Shop Drawings: Submitted shop drawings showing individual locker construction and overall dimensions, including complete installation instructions.

C. Product Handling
1. Store locker components flat until assembly. Protect all finishes from soiling and damage during handling.

D. Warranty
1. Manufacturer shall warranty lockers for a period of 10 years against rust and other types of corrosion, or breakage of any of the baskets and shelves under normal use.

1.2 PRODUCTS

A. Materials
1. Wire Basket Racks:
   a. Shelving: Shelving units shall consist of minimum 13 ga. steel angle posts punched for bolting shelves.
   b. Sway Braces: Minimum 12 ga. steel for back and sides of unit.
   c. Shelves: Minimum 20 ga. formed steel, with down turned flanges at the back to act as backstop and to prevent removal from rear.
   d. Dividers: Minimum 20 ga., 3-inches in height, with an attaching flange formed at right angles. Dividers shall be bolted to shelves.
   e. Padlock Attachment: Provide minimum 14 ga. padlock staple attachment at the front edge of each shelf located to match the locking loop formed in the basket rim.
   f. Casters (Option): 3-inch dia., swivel-type mobility casters bolted to each corner post.
   g. Number Plates: Aluminum number plates with 3/8" high black letters. Rivet plates to shelf face at each basket opening.
2. Baskets:
   a. Baskets shall be 12" x 13" x 8" **OR** 9" x 13" x 8", **as directed**, all wire or wire mesh or perforated steel front type. Provide number plates specified above on the front of each basket.
   b. Pilfer Guards (Option): Provide sheet steel pilfer guard designed for field attachment to the top of the basket to cover the first 3" of depth.
3. Finish:
   a. Baskets and pilfer guards: electroplating with bright zinc chromate.
   b. Basket rack posts, shelves, and braces: In color selected from manufacturer's standard colors.

B. Fabrication
1. Locker components shall be fabricated square and rigid with a finish free of scratches and chips. All sides, tops, bottoms, and shelves shall be coated on both sides with a protective masking.

1.3 EXECUTION

A. Installation
1. Install lockers at the location shown in accordance with the manufacturer's instructions for plumb, level, rigid, and flush installations.
2. Anchor the units to wall studs through the locker back and to the floor using #8 pan head wood screws. Furring must be installed between lockers and wall of installations.

END OF SECTION 10 51 13 00

Task	Specification	Specification Description
10 51 13 00	01 22 16 00	No Specification Required
10 51 13 00	10 01 50 11	Metal Lockers

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SECTION 10 51 26 00 - SOLID PLASTIC LOCKERS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for solid plastic lockers. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. Shop Drawings: Submitted shop drawings showing individual locker construction and overall dimensions, including complete installation instructions.

C. Product Handling
   1. Store locker components flat until assembly. Protect all finishes from soiling and damage during handling.

D. Warranty
   1. Manufacturer shall warranty lockers for a period of 10 years against rust and other types of corrosion, delamination, or breakage of any of the plastic panels, doors, and shelves under normal use.

1.2 PRODUCTS

A. Materials: Sides, tips, bottoms, rears, doors, and shelves shall be made from high impact, high density polyethylene (HDPE) formed under high pressure into solid plastic components 3/8" thick with homogeneous color throughout. All panels, doors, and shelves will match in color.
   1. Material testing: All solid plastic components shall resist deterioration and discoloration when subjected to any of the following:
      Acetic Acid 80%
      Acetone
      Ammonia Liquid
      Ammonium Phosphate
      Bleach 12%
      Borax
      Brine
      Caustic Soda
      Chlorine Water
      Citric Acid
      Copper Chloride
      Core Oils
      Hydrochloric Acid 40%
      Hydrogen Peroxide 30%
      Isopropyl Alcohol
      Lactic Acid 25%
      Lime Sulfur
      Nicotine
      Potassium Bromide
      Soaps
      Sodium Bicarbonate
      Trisodium Phosphate
      Urea and Urine

Vinegar
(Testing in accordance with corrosion testing procedure established by the United States Plastic Corporation)

2. Continuous latch, capable of accepting various locking mechanisms, shall be securely fastened to the entire length of the door, providing a continuous security latch.
3. Door hinge shall be made from plastic with no steel or metal parts. Door hinge shall be continuous and integrated into the full length of the door and main locker body.
4. Coat hooks shall be made from chrome plated steel and attached with tempered screws.
5. All components shall have a smooth "orange peel" finish. All components shall be of the same color and selected from the manufacturer’s full color line.

B. Fabrication
1. Locker components shall be fabricated square and rigid with a finish free of scratches and chips. All sides, tops, bottoms, backs, doors, and shelves shall be coated on both sides with a protective masking.
2. Solid plastic locker components shall snap together for easy assembly and shall provide a solid and secure construction. Adjacent lockers shall share a common side panel. Locker units shall be manufactured for assembly in a group of no more than five adjacent lockers.

1.3 EXECUTION

A. Installation
1. Install lockers at the location shown in accordance with the manufacturer’s instructions for plumb, level, rigid, and flush installations.
2. Anchor the units to wall studs through the locker back and to the floor using #8 pan head wood screws. Furring must be installed between lockers and wall of installations.
3. Lockers can be either floor-mounted or installed on a 4" high base. Hardware and instructions for either method shall be provided by the manufacturer.
4. Number plates shall be available for field or factory mounting.

END OF SECTION 10 51 26 00

Task	Specification	Specification Description
10 51 53 00	01 22 16 00	No Specification Required

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SECTION 10 55 23 23 - POSTAL SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel, coin-operated lockers.
2. Stainless steel, coin-operated lockers.

B. Related Requirements:

1. Section 105113 "Metal Lockers" for corridor and athletic lockers.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**>.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal locker.

B. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for recycled content.>
2. <Double click to insert sustainable design text for EPDs and HPDs.>

C. Shop Drawings: For coin-operated lockers.

1. Include plans, elevations, sections, and attachment details.
2. Show locker trim and accessories.
3. Include locker identification system and numbering sequence.

D. Samples: For each color specified, in manufacturer's standard size.

E. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available.

F. Samples for Verification: For coin-operated lockers and equipment, in manufacturer's standard size.

G. Product Schedule: For coin-operated lockers.[**Use same designations indicated on Drawings.**]

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For adjusting, repairing, and replacing locker doors and locking mechanisms to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. The following coin-operated locker items equal to [**10**] <**Insert number**> percent of amount installed for each type and finish installed, but no fewer than [**five**] <**Insert number**> units:

a. Locks.
b. Blank identification plates.
c. Hooks.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver coin-operated lockers until spaces to receive them are clean, dry, and ready for their installation.

B. Deliver master and control keys to Owner by registered mail or overnight package service[**.**][**, addressed as follows:**]

1. <**Insert name and address of Owner's representative**>.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of recessed openings by field measurements before fabrication.

1.8 COORDINATION

A. Coordinate sizes and locations of [**concrete**] [**concrete masonry**] [**wood**] bases for coin-operated lockers.

B. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that coin-operated lockers can be supported and installed as indicated.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: For coin-operated lockers indicated to be accessible, comply with applicable provisions in [**the USDOJ's "2010 ADA Standards for Accessible Design"**] [**the ABA standards of the Federal agency having jurisdiction**] [**and**] [**ICC A117.1**] <**Insert requirement**>.

2.2 STEEL, COIN-OPERATED LOCKERS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Coin-Operated Lockers: Fabricated from steel sheet with thicknesses as follows:

   1. Tops, Bottoms, Sides, and Shelves: 0.024-inch (0.61-mm) nominal thickness.
   2. Backs: 0.036-inch (0.91-mm) nominal thickness.
   3. Frames: 0.060-inch (1.52-mm) nominal thickness.
   4. Doors: 0.060-inch (1.52-mm) nominal thickness.
   5. Exposed Ends of Nonrecessed Lockers: 0.060-inch (1.52-mm) nominal thickness.

C. Body: Assembled by welding or riveting body components to frames; flanged for double thickness at back vertical corners; back ventilated.

D. Frames: Channel formed; lapped and welded at corners; with top, bottom, and cross frames welded into vertical main frames. Form continuous, integral, full-height door strikes on vertical main frames, and equip frames with resilient bumpers to cushion door closing.

   1. Cross Frames between Tiers: Channel formed and fabricated from same material as main frames; welded to vertical main frame.

E. Doors: One piece; formed into channel shape at vertical edges and flanged at right angles at horizontal edges; fabricated to swing 180 degrees. Brace or reinforce inner face of doors with manufacturer's standard reinforcing angles, channels, or stiffener panels.

F. Hinges: Manufacturer's standard, [**full-loop, five- or seven-knuckle type; tight pin; minimum 2-1/2 inches (64 mm) high**] [**or**] [**continuous type**], of same material as door[**; self-closing**]. Weld hinge to inside of door frame and attach hinge to door with factory-installed fasteners that are completely concealed and tamper resistant when door is closed.

   1. Provide at least three hinges for each door more than 42 inches (1067 mm) high.

G. Projecting Door Handle: Manufacturer's standard; stainless steel; pry and vandal resistant.

H. Built-in, Coin-Operated Locks: Self-contained units mounted on door interior with replaceable lock cylinders keyed separately and master keyed. Mount instruction decals on both door faces. Furnish one change key for each lock and one master key.

   1. Bolt Operation: [**Manually locking deadbolt**] [**or**] [**automatically locking spring bolt**].
   2. Lock Type: Fee [**return/deposit**] [**collect/pay**].
   3. Fee Type: [**Token**] [**Coin, one quarter**] [**Coin, two quarters**] <**Insert requirement**>.
   4. Coin Box: Manufacturer's standard housing or stainless steel cash box with stainless steel flanged cover set into base of lock channel frame. Furnish with removable cylinder and key, and master code changer key.

I. Identification Plates: Manufacturer's standard, etched, embossed, or stamped [**aluminum**] [**plastic**] plates, with numbers and letters at least 3/8 inch (9 mm) high.

J. Hooks: Manufacturer's standard ball-pointed hooks, aluminum or steel; zinc plated.

K. Continuous Zee Base: Fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet.

   1. Height: [**4 inches (102 mm)**] <**Insert dimension**>.

L. Sloping Tops: [**Continuous**] [**Individual**] sloping top, fabricated from 0.036-inch (0.91-mm) nominal-thickness steel sheet.

M. Recess Trim: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.

N. Filler Panels: Fabricated from 0.036-inch (0.91-mm) nominal-thickness steel sheet.

O. Finished End Panels: Fabricated from 0.024-inch (0.61-mm) nominal-thickness steel sheet.

P. Materials:

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
2. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with A60 (ZF180) zinc-iron, alloy (galvannealed) coating designation.
3. <Double click to insert sustainable design text for recycled content.>

Q. Finish: Baked enamel or powder coat.

1. Color: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] [**Two colors, with door one color and frame and body another color; as selected by Architect from manufacturer's full range**] <**Insert color**>.

2.3 STAINLESS STEEL, COIN-OPERATED LOCKERS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Stainless Steel Lockers: Fabricated from stainless steel sheet with thicknesses as follows:

1. Tops, Bottoms, Sides, Backs, and Shelves: 0.025 inch (0.64 mm) thick.
2. Frames: 0.062 inch (1.59 mm) thick.
3. Doors: 0.062 inch (1.59 mm) thick.
4. Exposed Ends of Nonrecessed Lockers: 0.062 inch (1.59 mm) thick.

C. Body: Assembled by welding or riveting body components to frames; flanged for double thickness at back vertical corners; back ventilated.

D. Frames: Channel formed; lapped and welded at corners; with top, bottom, and cross frames welded into vertical main frames. Form continuous, integral, full-height door strikes on vertical main frames, and equip frames with resilient bumpers to cushion door closing.

1. Cross Frames between Tiers: Channel formed and fabricated from same material as main frames; welded to vertical main frame.

E. Doors: One piece; formed into channel shape at vertical edges and flanged at right angles at horizontal edges; fabricated to swing 180 degrees. Brace or reinforce inner face of doors with manufacturer's standard reinforcing angles, channels, or stiffener panels.

F. Hinges: Manufacturer's standard, [**full-loop, five- or seven-knuckle type; tight pin; minimum 2-1/2 inches (64 mm) high**] [**or**] [**continuous type**], of same material as door[**; self-closing**]. Weld hinge to inside of door frame and attach hinge to door with factory-installed fasteners that are completely concealed and tamper resistant when door is closed.

1. Provide at least three hinges for each door more than 42 inches (1067 mm) high.

G. Projecting Door Handle: Manufacturer's standard; stainless steel; pry and vandal resistant.

H. Built-in, Coin-Operated Locks: Self-contained units mounted on door interior with replaceable lock cylinders keyed separately and master keyed. Mount instruction decals on both door faces. Furnish one change key for each lock and one master key.

1. Bolt Operation: [**Manually locking deadbolt**] [**or**] [**automatically locking spring bolt**].
2. Lock Type: Fee [**return/deposit**] [**collect/pay**].
3. Fee Type: [**Token**] [**Coin, one quarter**] [**Coin, two quarters**] <**Insert requirement**>.
4. Coin Box: Manufacturer's standard housing or stainless steel cash box with stainless steel flanged cover set into base of lock channel frame. Furnish with removable cylinder and key, and master code changer key.

I. Identification Plates: Manufacturer's standard, etched, embossed, or stamped [**aluminum**] [**plastic**] plates, with numbers and letters at least 3/8 inch (9 mm) high.

J. Hooks: Manufacturer's standard ball-pointed hooks, aluminum or steel; zinc plated.

K. Continuous Zee Base: Fabricated from 0.062-inch (1.59-mm) thickness, stainless steel sheet.

1. Height: [**4 inches (102 mm)**] <**Insert dimension**>.

L. Sloping Tops: [**Continuous**] [**Individual**] sloping top, fabricated from 0.038-inch (0.95-mm) thickness, stainless steel sheet.

M. Recess Trim: Fabricated from 0.050-inch (1.27-mm) thickness, stainless steel sheet.

N. Filler Panels: Fabricated from 0.038-inch (0.95-mm) thickness, stainless steel sheet.

O. Finished End Panels: Fabricated from 0.024-inch (0.61-mm) thickness, steel sheet.

P. Materials: ASTM A240/A240M or ASTM A666, Type 304, stainless steel sheet.

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Q. Finish:

1. Tops, Bottoms, Sides, Backs, and Shelves: ASTM A480/A480M No. 2B or ASTM A480/A480M No. 4.
2. Frames: ASTM A480/A480M No. 3 or ASTM A480/A480M No. 4.
3. Doors: Manufacturer's standard patterned finish.
4. Exposed Ends of Nonrecessed Lockers: ASTM A480/A480M No. 4.

2.4 FABRICATION

A. Fabricate coin-operated lockers square, rigid, without warp, and with metal faces flat and free of dents or distortion. Make exposed metal edges safe to touch and free of sharp edges and burrs.

1. Form body panels, doors, shelves, and accessories from one-piece sheet unless otherwise indicated.
2. Provide fasteners, filler plates, supports, clips, and closures as required for complete installation.

B. Fabricate each coin-operated locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments.

C. For welded assemblies, factory weld main locker groups into one-piece structures. Grind exposed welds smooth and flush.

D. Equipment: Provide each locker with an identification plate and the following equipment:

1. Single-Tier Units: Shelf, one double-prong ceiling hook, and two single-prong wall hooks.
2. Double-Tier Units: One double-prong ceiling hook and two single-prong wall hooks.
3. Triple-Tier Units: One double-prong ceiling hook.
4. Coat Rods: [**As indicated on Drawings**] [**For each compartment of each locker**] [**In lieu of ceiling hook for coin-operated lockers 24 inches (610 mm) high or more**] [**In lieu of ceiling hook for coin-operated lockers 18 inches (457 mm) deep or more**].

E. Accessible Lockers: Fabricate as follows:

1. Locate bottom shelf no lower than 15 inches (381 mm) above the floor.
2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches (1219 mm) above floor.

F. Continuous Base: Formed into channel or zee profile for stiffness, and fabricated in lengths as long as practical to enclose base and base ends of coin-operated lockers; finished to match lockers.

G. Continuous Sloping Tops: Fabricated in lengths as long as practical, without visible fasteners at splice locations; finished to match lockers.

1. Sloping-top corner fillers, mitered.

H. Individual Sloping Tops: Fabricated in width to fit one locker frame in lieu of flat locker tops; with integral back; finished to match lockers. Provide wedge-shaped divider panels between lockers.

I. Recess Trim: Fabricated with minimum 2-1/2-inch (64-mm) face width and in lengths as long as practical; finished to match lockers.

J. Filler Panels: Fabricated in an unequal leg angle shape; finished to match lockers. Provide slip-joint filler angle formed to receive filler panel.

K. Finished End Panels: Fabricated to conceal unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed coin-operated lockers; finished to match lockers.

1. Provide one-piece panels for double-row (back-to-back) locker ends.

2.5 ACCESSORIES

A. Fasteners: Zinc- or nickel-plated steel, slotless-type, exposed bolt heads; with self-locking nuts or lock washers for nuts on moving parts.

B. Anchors: Material, type, and size required for secure anchorage to each substrate.

1. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls[**, and elsewhere as indicated,**] for corrosion resistance.
2. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls and floors or support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install lockers level, plumb, and true; shim as required, using concealed shims.

1. Anchor coin-operated locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches (910 mm) o.c. Using concealed fasteners, install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion.
2. Anchor single rows of coin-operated lockers to walls near top [**and bottom of lockers**] [**of lockers and to floor**].
3. Anchor back-to-back, coin-operated lockers to floor.

B. Welded Lockers: Connect groups together with standard fasteners, with no exposed fasteners on face frames.

C. Equipment:

1. Attach hooks with at least two fasteners.
2. Attach door locks on doors using security-type fasteners.
3. Identification Plates: Identify coin-operated lockers with identification indicated on Drawings.

a. Attach plates to each locker door, near top, centered, with at least two aluminum rivets.
b. Attach plates to upper shelf of each open-front metal locker, centered, with a least two aluminum rivets.

D. Trim: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.

1. Attach recess trim to recessed coin-operated lockers with concealed clips.
2. Attach filler panels with concealed fasteners. Locate filler panels where indicated on Drawings.
3. Attach sloping-top units to coin-operated lockers, with closures at exposed ends.
4. Attach finished end panels using fasteners only at perimeter to conceal exposed ends of nonrecessed coin-operated lockers.

3.3 ADJUSTING

A. Clean, lubricate, and adjust hardware. Adjust doors and locks to operate properly and easily without binding.

3.4 PROTECTION

A. Protect coin-operated lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.

B. Touch up marred finishes, or replace coin-operated lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION10 55 23 23.13

Task	Specification	Specification Description
10 55 23 26	10 55 23 23	Postal Specialties
10 55 26 00	10 55 23 23	Postal Specialties

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SECTION 10 56 13 16 - METAL STORAGE SHELVING

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for metal storage shelving. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
    a. Case-type metal storage shelving.
    b. Four-post metal storage shelving.
    c. Post-and-beam metal storage shelving.

C. Performance Requirements

1. Delegated Design: Design metal storage shelving, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Structural Performance for Case-Type and Four-Post Metal Storage Shelving: Capable of withstanding the loads indicated according to MH 28.1.
3. Structural Performance for Post-and-Beam Metal Storage Shelving: Capable of withstanding the loads indicated according to MH 28.2.
4. Seismic Performance: Metal storage shelving shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
    a. Seismic Component Importance Factor: 1.5 **OR** 1.0, **as directed**.

D. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittal:
    a. Product Data for Credit EQ 4.4: For particleboard, documentation indicating that product contains no urea formaldehyde.
3. Shop Drawings: For customized metal storage shelving. Include plans, elevations, sections, details, and attachments to other work. Include installation details of connectors, lateral bracing, and special bracing.
4. Samples: For each exposed product and for each color and texture specified.
5. Delegated-Design Submittal: For metal storage shelving indicated to comply with performance requirements, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
    a. Design Calculations: Calculate requirements for seismic restraints.
6. Seismic Qualification Certificates: For metal storage shelving, accessories, and components, from manufacturer.
7. Product certificates.
8. Maintenance data.

E. Quality Assurance

1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Preinstallation Conference: Conduct conference at Project site.

1.2 PRODUCTS

A. Materials
1. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
2. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.
3. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with G60 (Z180) zinc (galvanized) or A60 (ZF180) zinc-iron-alloy (galvannealed) coating.
4. Steel Tubing: ASTM A 513, Type 2.
5. Stainless-Steel Tubing: ASTM A 554, Grade MT-304.
6. Steel Wire: ASTM A 899.
7. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304.
8. Particleboard: ANSI A208.1, made with binder containing no urea formaldehyde.
9. Hardboard: ANSI A135.4.
10. Floor Anchors: Galvanized-steel, post-installed expansion anchors **OR** power-actuated fasteners **OR** threaded concrete screws, **as directed**. Provide number per unit recommended by manufacturer unless additional anchors are indicated in calculations.
11. Wall Anchors: Manufacturer's standard, galvanized-steel anchors designed to secure metal storage shelving to adjacent wall. Provide one per shelving unit for each shelving unit adjacent to a wall unless additional anchors are indicated in calculations.

B. Case-Type Metal Storage Shelving
1. General: Factory-formed, field-assembled, freestanding, case-type metal storage shelving system, designed for shelves to span between and be supported by sheet metal end panels (without posts), with shelves adjustable over the height of shelving unit. Fabricate shelf units with end panel at each end so each unit is independent. Provide fixed top and bottom shelves, adjustable intermediate shelves, and accessories indicated.
2. Load-Carrying Capacity per Shelf: 200 lb (91 kg) **OR** As indicated on Drawings, **as directed**.
3. End Panels: Fabricated from cold-rolled steel sheet, with concealed perforations at front and back edges at manufacturer's standard spacing **OR** 1 inch (25 mm) o.c., **as directed**, for receiving adjustable shelf clips.
   a. Steel-Sheet Thickness, Nominal: 0.036 inch (0.91 mm) **OR** As required for load-carrying capacity per shelf and number of shelves, **as directed**.
   b. Adjustable Shelf Clips: Fabricated from 0.036-inch- (0.91-mm-) nominal thickness, cold-rolled steel; with projections designed to engage at least two perforations in end panels.

   OR

   End Panels: Fabricated from cold-rolled steel sheet; with horizontal slots spaced at manufacturer's standard spacing **OR** 1 inch (25 mm) o.c. **OR** 1-1/2 inches (38 mm) o.c., **as directed**, for supporting shelves.
   a. Steel-Sheet Thickness, Nominal: 0.036 inch (0.91 mm) **OR** As required for load-carrying capacity per shelf and number of shelves, **as directed**.
4. Back Panel: One piece, fabricated from cold-rolled steel sheet.
   a. Steel-Sheet Thickness, Nominal: 0.036 inch (0.91 mm) **OR** As required for load-carrying capacity per shelf, **as directed**.
5. Shelves: Fabricated from cold-rolled steel sheet, with slots or holes at 2 inches (51 mm) o.c. for shelf dividers, **as directed**. Fabricate shelves with vertical front that is flanged and returned.
   a. Steel-Sheet Thickness, Nominal: 0.048 inch (1.21 mm) **OR** As required for load-carrying capacity per shelf and number of shelves, **as directed**.
6. Shelf Quantity: Three **OR** Four **OR** Five **OR** Six, **as directed**, shelves per shelving unit in addition to top and bottom shelf.
7. Base: Closed front, with base strips fabricated from same material and with same finish as end panels.
8. Overall Unit Width: 30 inches (762 mm) **OR** 36 inches (914 mm) **OR** 42 inches (1067 mm) **OR** 48 inches (1219 mm), **as directed**.

9. Overall Unit Depth: 12 inches (305 mm) **OR** 18 inches (457 mm) **OR** 24 inches (610 mm), **as directed**.
10. Overall Unit Height: 72 inches (1829 mm) **OR** 84 inches (2134 mm) **OR** 96 inches (2438 mm), **as directed**.
11. Accessories:
    a. Finished End Panels: Fabricated as solid **OR** perforated, **as directed**, full-height panels from same material and with same finish as end panels, with trim for a finished appearance along edges abutting end panels and top shelf.
    b. Shelf Dividers: Fabricated from same material and with same finish as shelves; full-height **OR** angle **OR** tapered **OR** sliding, **as directed**, type.
    c. Bins: Fabricated from same material and with same finish as shelves; size as indicated on Drawings **OR as directed**.
    d. Shelf-Label Holders: Clear **OR** Colored, **as directed**, plastic, designed to clip onto front edge of shelf.
12. Finish: Baked enamel **OR** Powder coat, **as directed**.
    a. Color and Gloss: As selected from manufacturer's full range.

C. Four-Post Metal Storage Shelving
1. Open **OR** Closed, **as directed**, Four-Post Metal Storage Shelving: Factory-formed, field-assembled, freestanding system, designed for shelves to span between and be supported by corner posts, with shelves adjustable over the height of shelving unit. Fabricate initial shelving unit with a post at each corner. Fabricate additional shelving units similarly, so each unit is independent **OR** as add-on units, designed to share two corner posts with initial shelving unit, **as directed**. Provide fixed top and bottom shelves, adjustable intermediate shelves, and accessories indicated.
    a. Load-Carrying Capacity per Shelf: 350 lb (159 kg) **OR** 700 lb (318 kg) **OR** 1500 lb (680 kg) **OR** As indicated on Drawings, **as directed**.
    b. Posts: Fabricated from hot-rolled steel; in angle **OR** offset angle **OR** beaded **OR** T- **OR** tubular T- **OR** V- **OR** box **OR** manufacturer's standard, **as directed**, shape; with perforations at 1-1/2 inches (38 mm) o.c. to receive shelf-to-post connectors.
        1) Steel Thickness, Nominal: 0.075 inch (1.90 mm) **OR** As required for load-carrying capacity per shelf and number of shelves, **as directed**.
        2) Add-On Shelf Posts: Fabricated from hot-rolled steel, T- **OR** manufacturer's standard, **as directed**, shape; perforated to match main posts and of same thickness.
        3) Post Base: Bolt leveler **OR** Adjustable steel floor plate, drilled for floor anchors, **as directed**.
    c. Bracing: Manufacturer's standard, single **OR** double, **as directed**, diagonal cross bracing at back **OR** ends **OR** back and ends, **as directed**; as required for stability, load-carrying capacity of shelves, and number of shelves.
    d. Back Panel: One piece **OR** Two half panels, **as directed**, fabricated from cold-rolled steel sheet.
        1) Steel-Sheet Thickness, Nominal: 0.024 inch (0.61 mm) **OR** As required for load-carrying capacity per shelf, **as directed**.
    e. End Panels: Fabricated from cold-rolled steel sheet.
        1) Steel-Sheet Thickness, Nominal: 0.024 inch (0.61 mm) **OR** As required for load-carrying capacity per shelf, **as directed**.
    f. Solid-Type Shelves: Fabricated from steel sheet as follows:
        1) Steel-Sheet Thickness, Nominal: 0.030 inch (0.76 mm) **OR** 0.036 inch (0.91 mm) **OR** 0.048 inch (1.21 mm) **OR** As required for load-carrying capacity per shelf, **as directed**.
        2) Metallic-Coated Steel-Sheet Thickness, Nominal: 0.034 inch (0.86 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.052 inch (1.32 mm) **OR** As required for load-carrying capacity per shelf, **as directed**.
        3) Slots or Holes for Shelf Dividers: 2 inches (51 mm) **OR** 3 inches (76 mm), **as directed**, o.c.

4) Fabricate fronts and backs of shelves with box-formed edges, with corners lapped and welded.
OR
Fabricate fronts and backs of shelves with vertical edges that are flanged and returned, with edges reinforced with steel bars, angles, or channels.

g. Framed-Type Wire Shelves: Steel **OR** Metallic-coated-steel, **as directed**, wire; with shelf frame fabricated from same material and with same finish as posts.
h. Truss-Type Wire Shelves: Steel **OR** Metallic-coated-steel **OR** Stainless-steel **OR** Manufacturer's standard, chrome-plated, **as directed**, wire-over-wire construction, with downturned wire truss edges.
i. Shelf Quantity: Three **OR** Four **OR** Five **OR** Six, **as directed**, shelves per shelving unit in addition to top and bottom shelf.
j. Shelf-to-Post Connectors: Mechanical fasteners (nuts and bolts) **OR** Compression clips **OR** Support clips **OR** Containment clips **OR** Horizontal supports with rivet connectors to post **OR** Manufacturer's standard connectors, **as directed**.
k. Base: Open, with exposed post legs **OR** Closed, with base strips fabricated from same material and with same finish as shelving, **as directed**.
l. Overall Unit Width: 30 inches (762 mm) **OR** 36 inches (914 mm) **OR** 42 inches (1067 mm) **OR** 48 inches (1219 mm), **as directed**.
m. Overall Unit Depth: 12 inches (305 mm) **OR** 18 inches (457 mm) **OR** 24 inches (610 mm), **as directed**.
n. Overall Unit Height: 72 inches (1829 mm) **OR** 84 inches (2134 mm) **OR** 96 inches (2438 mm), **as directed**.
o. Accessories:
   1) Finished End Panels: Fabricated as solid **OR** perforated, **as directed**, full-height panels from manufacturer's standard thickness cold-rolled steel sheet and with same finish as posts, with trim for a finished appearance along edges abutting posts and top shelf.
   2) Shelf Dividers: Fabricated from same material and with same finish as shelves; full-height **OR** angle **OR** tapered **OR** sliding, **as directed**, type.
   3) Bins: Fabricated from same material and with same finish as shelves; size as indicated on Drawings **OR as directed**.
   4) Shelf-Label Holders: Clear **OR** Colored, **as directed**, plastic, designed to clip onto front edge of shelf.
p. Finish: Baked enamel **OR** Powder coat, **as directed**.
   1) Color and Gloss: As selected from manufacturer's full range.

2. Wire-Type, Four-Post Metal Storage Shelving: Factory-formed, field-assembled, freestanding system without back or end panels, designed for shelves to span between and be supported by corner posts, with shelves adjustable over the entire height of shelving unit. Fabricate initial shelving unit with a post at each corner. Fabricate additional shelving units similarly, so each unit is independent **OR** as add-on units, designed to share two corner posts with initial shelving unit, **as directed**. Provide fixed top and bottom shelves, adjustable intermediate shelves, and accessories indicated.
   a. Load-Carrying Capacity per Shelf: 200 lb (91 kg) **OR** 600 lb (272 kg) **OR** 1200 lb (544 kg) **OR** As indicated on Drawings, **as directed**.
   b. Posts: Fabricated from 1-inch- (25-mm-) OD, square **OR** round, **as directed**, tubing of indicated material; with grooves or notches at 1 inch (25 mm) o.c. to receive shelf-to-post connectors. Label posts with numbers at not less than 2 inches (51 mm) o.c. for determining shelf height.
      1) Post Material: Steel **OR** Stainless steel, **as directed**.
      2) Post Base: Bolt leveler **OR** Adjustable steel floor plate, drilled for floor anchors, **as directed**.
      3) Post Cap: Nylon or plastic.
   c. Framed-Type Wire Shelves: Steel **OR** Metallic-coated-steel **OR** Stainless-steel, **as directed**, wire-over-wire construction, with shelf frame fabricated from same material and

with same finish as posts; with manufacturer's standard post collar, designed to engage collet (wedge), welded at each corner.

d. Truss-Type Wire Shelves: Steel **OR** Metallic-coated-steel **OR** Stainless-steel **OR** Manufacturer's standard, chrome-plated, **as directed**, wire-over-wire construction, with downturned wire truss edges; with manufacturer's standard post collar, designed to engage collet (wedge), welded at each corner.

e. Waterfall-Type Wire Shelves: Steel **OR** Metallic-coated-steel **OR** Stainless-steel, **as directed**, wire-over-wire waterfall construction; with manufacturer's standard post collar, designed to engage collet (wedge), welded at each corner.

f. Solid-Type Shelves: Fabricated from 0.050-inch- (1.27-mm-) thick, stainless-steel sheet metal of indicated material and thickness.

g. Shelf Quantity: Three **OR** Four **OR** Five **OR** Six, **as directed**, shelves per shelving unit in addition to top and bottom shelf.

h. Shelf-to-Post Connectors: Manufacturer's standard one-piece collet (wedge), designed to engage post collar attached to shelves.

i. Bracing: Manufacturer's standard diagonal cross bracing, as required for stability, load-carrying capacity of shelves, and number of shelves.

j. Overall Unit Width: 24 inches (610 mm) **OR** 36 inches (914 mm) **OR** 48 inches (1219 mm) **OR** 60 inches (1524 mm), **as directed**.

k. Overall Unit Depth: 12 inches (305 mm) **OR** 18 inches (457 mm) **OR** 24 inches (610 mm), **as directed**.

l. Overall Unit Height: 60 inches (1524 mm) **OR** 72 inches (1829 mm) **OR** 84 inches (2134 mm), **as directed**.

m. Accessories:

1) Shelf Dividers: Fabricated from same material and with same finish as shelves; full-height **OR** angle **OR** tapered **OR** sliding, **as directed**, type.

2) Shelf Inlay: Manufacturer's standard clear plastic **OR** static-dissipative plastic **OR** hardboard, **as directed**, mat.

3) Storage Basket: Edge-of-shelf-mounted wire basket; fabricated from same material and with same finish as shelves.

4) Back Ledges: 1 inch (25 mm) **OR** 4 inches (102 mm), **as directed**, high, fabricated from same material and with same finish as shelves.

5) Side Ledges: 1 inch (25 mm) **OR** 4 inches (102 mm), **as directed**, high, fabricated from same material and with same finish as shelves.

6) Garment Hanger Tube: Width of 21 inches (533 mm) **OR** shelves, **as directed**; with mounting brackets.

7) Shelf-Label Holders: Clear plastic **OR** Colored plastic **OR** Cold-rolled steel sheet, **as directed**, designed to clip onto front edge of shelf.

n. Steel Finish: Baked enamel **OR** Powder coat **OR** Manufacturer's standard chrome plated, **as directed**.

1) Color and Gloss: As selected from manufacturer's full range.

o. Stainless-Steel Finish: No. 4 directional-satin finish **OR** Manufacturer's standard nondirectional-polish finish, **as directed**.

D. Post-And-Beam Metal Storage Shelving

1. General: Factory-formed, field-assembled, freestanding, post-and-beam metal storage shelving system, designed for shelves to be supported by beams that span between and are supported by corner posts, with beams adjustable over the entire height of shelving unit. Fabricate initial shelving unit with a post at each corner. Fabricate additional shelving units similarly, so each unit is independent **OR** as add-on units, designed to share two corner posts with initial shelving unit, **as directed**. Provide fixed top and bottom beams, adjustable intermediate beams, and accessories indicated.

2. Load-Carrying Capacity per Shelf: 400 lb (181 kg) **OR** 1000 lb (454 kg) **OR** 2000 lb (907 kg) **OR** As indicated on Drawings, **as directed**.

3. Posts: Fabricated from cold-rolled steel; in manufacturer's standard **OR** manufacturer's standard angle or open-box **OR** 1-1/2-by-1-1/2-inch (38-by-38-mm) angle **OR** open-box, **as directed**, shape; with perforations at 1-1/2 inches (38 mm) o.c. to receive beam-to-post connectors.
   a. Steel Thickness, Nominal: 0.075 inch (1.90 mm) **OR** As required for load-carrying capacity per shelf and number of shelves, **as directed**.
   b. Add-On Shelf Posts: Fabricated from hot-rolled steel, T-shape; perforated to match main posts and of same thickness.
   c. Post Base: Cold-rolled steel floor plate, drilled for floor anchors.
4. Beams: Fabricated from cold-rolled steel; in channel **OR** flanged **OR** manufacturer's standard, **as directed**, shape; with projecting rivet **OR** tab **OR** manufacturer's standard, **as directed**, beam-to-post connectors at each end designed to engage posts. Provide beam at each side of each shelf, with center supports as required for load-carrying capacity of shelf.
   a. Steel Thickness, Nominal: 0.075 inch (1.90 mm) **OR** As required for load-carrying capacity per shelf, **as directed**.
   b. Provide top, bottom, and intermediate shelf beams with single **OR** double, **as directed**, beam-to-post connectors.
      OR
      Provide top and bottom shelf beams with double beam-to-post connectors and intermediate shelf beams with single beam-to-post connectors.
   c. Provide beams for the number of shelves required.
      OR
      Provide beams for shelves per shelving unit in addition to top and bottom shelf beams.
5. Particleboard Shelves: 5/8 inch (16 mm) thick; factory **OR** field, **as directed**, cut.
6. Flat Metal Shelves: Fabricated from steel sheet as follows:
   a. Steel-Sheet Thickness, Nominal: 0.030 inch (0.76 mm) **OR** 0.036 inch (0.91 mm) **OR** 0.048 inch (1.21 mm) **OR** As required for load-carrying capacity per shelf, **as directed**.
   b. Metallic-Coated Steel-Sheet Thickness, Nominal: 0.034 inch (0.86 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.052 inch (1.32 mm) **OR** As required for load-carrying capacity per shelf, **as directed**.
   c. Fabricate fronts and backs **OR** fronts, backs, and sides, **as directed**, of shelves with box-formed edges, with corners lapped and welded.
7. Ribbed-Metal-Decking Shelves: Fabricated from 0.036-inch- (0.91-mm-) nominal thickness steel sheet.
8. Wire Shelves: Welded steel wire; with 2-by-4-inch (51-by-102-mm) **OR** Manufacturer's standard, **as directed**, openings.
9. Shelf Quantity: Three **OR** Four **OR** Five **OR** Six, **as directed**, shelves per shelving unit in addition to top and bottom shelf.
10. Overall Unit Width: 36 inches (914 mm) **OR** 48 inches (1219 mm) **OR** 60 inches (1524 mm) **OR** 69 inches (1753 mm) **OR** 72 inches (1829 mm) **OR** 96 inches (2438 mm), **as directed**.
11. Overall Unit Depth: 18 inches (457 mm) **OR** 24 inches (610 mm) **OR** 30 inches (762 mm) **OR** 36 inches (914 mm) **OR** 48 inches (1219 mm), **as directed**.
12. Overall Unit Height: 60 inches (1524 mm) **OR** 72 inches (1829 mm) **OR** 84 inches (2134 mm) **OR** 96 inches (2438 mm), **as directed**.
13. Accessories:
   a. Tie Plates: Cold-rolled steel, finished to match posts; designed for joining posts of adjacent shelving units.
   b. Supports: Back-to-wall **OR** Back-to-back **OR** Back-to-wall and back-to-back, **as directed**, type that bolt to posts; as required for shelving unit stability.
   c. Record Boxes: Knocked-down, corrugated fiberboard with white finish and contrasting contents legend; with prepunched handles and matching separate lid.
      1) Letter/Legal-Size Boxes: 12-1/2 inches wide by 16 inches deep by 10-1/2 inches high (318 mm wide by 406 mm deep by 267 mm high) for letter-size material stored left to right and legal-size material stored front to back.

2) Letter-Size Boxes: 12-1/2 inches wide by 24 inches deep by 10-1/2 inches high (318 mm wide by 610 mm deep by 267 mm high) for letter-size material stored left to right.

d. Record Box Support Rails: 1-1/2-by-1-1/2-inch (38-by-38-mm) metal angle, with length to match depth of shelving unit; fabricated from same material and with same finish as beams.

14. Finish: Baked enamel **OR** Powder coat, **as directed**.
    a. Color and Gloss: As selected from manufacturer's full range.

E. Fabrication

1. Shop Fabrication: Prefabricate shelving components in shop to greatest extent possible to minimize field fabrication; temporarily preassemble shelving components where necessary to ensure that field-assembled components fit together properly. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
2. Fabricate metal storage shelving square and rigid, with posts plumb and true and shelves flat and free of dents or distortion. Fabricate connections to form a rigid structure, free of buckling and warping.
    a. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
    b. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Locate joints where least conspicuous.
    c. Build in straps, plates, brackets, and other reinforcements as needed to support shelf loading.
    d. Cut, reinforce, drill, and tap metal fabrications to receive hardware, fasteners, and similar items.
3. Form metal in maximum lengths to minimize joints. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work. Form backs of shelving units up to 48 inches (1219 mm) wide from one piece, **as directed**.
4. Form edges and corners free of sharp edges or rough areas. Fold back and crimp exposed edges of unsupported sheet metal to form a 1/2-inch- (13-mm-) wide hem on the concealed side; ease edges of metal plate to radius of approximately 1/32 inch (0.8 mm). Shear and punch metals cleanly and accurately. Remove burrs.
5. Weld corners and seams continuously to develop strength, minimize distortion, and maintain the corrosion resistance of base metals. At exposed locations, finish welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface. Weld before finishing components to greatest extent possible. Remove weld spatter and welding oxides from exposed surfaces before finishing.

F. General Finish Requirements

1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

G. Metallic-Coated Steel-Sheet Finishes

1. Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint, complying with SSPC-Paint 20, to comply with ASTM A 780.
2. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry thickness.

H. Steel Finishes

1. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning" or SSPC-SP 8, "Pickling."
2. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry thickness.

I. Stainless-Steel Finishes
1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
   a. Run grain of directional finishes with long dimension of each piece.
   b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
   c. Directional Satin Finish: No. 4.

1.3 EXECUTION

A. Preparation
1. Vacuum finished floor and wet mop resilient flooring over which metal storage shelving is to be installed.

B. Installation
1. Install metal storage shelving level, plumb, square, rigid, true, and with shelves flat and free of dents or distortion. Make connections to form a rigid structure, free of buckling and warping.
   a. Install exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.
   b. Install braces, straps, plates, brackets, and other reinforcements as needed to support shelf loading and as required for stability.
   c. Adjust post-base bolt leveler to achieve level and plumb installation.
   d. Anchor shelving units to floor with floor anchors through floor plate. Shim floor plate to achieve level and plumb installation.
   e. Install seismic restraints.
   f. Connect side-to-side and back-to-back shelving units together.
   g. Install shelves in each shelving unit at spacing indicated on Drawings or, if not indicated, at equal spacing.
      1) Case-Type Metal Storage Shelving: Install adjustable shelf clips at front and back of each shelf.
      2) Four-Post Metal Storage Shelving: Install four clips, one at each post, for support of each shelf, with clips fully engaged in post perforations.
      3) Post-and-Beam Metal Storage Shelving: Install beams with beam-to-post connectors fully engaged in post perforations.
2. Accessories:
   a. Install finished end panels and trim at exposed ends of shelving units.
   b. Shelf Dividers: Install full-height dividers per shelf **OR** angle dividers per shelf **OR** tapered dividers per shelf **OR** sliding dividers per shelf **OR** dividers of types and locations indicated on Drawings, **as directed**.
   c. Bins: Install per shelf **OR** at locations indicated on Drawings, **as directed**.
   d. Shelf-Label Holders: Install one on each shelf, centered **OR** vertically aligned **OR** at locations indicated on Drawings, **as directed**, within each shelving unit.
   e. Record Box Support Rails: Provide two for each record storage box.
   f. Shelf Inlays: Install one per shelf **OR** at locations indicated on Drawings, **as directed**.
   g. Storage Baskets: Install per shelf **OR** at locations indicated on Drawings, **as directed**.
   h. Back Ledges: Install one per shelf **OR** at locations indicated on Drawings, **as directed**.
   i. Side Ledges: Install on each side of each shelf **OR** at locations indicated on Drawings, **as directed**.

j. Garment Hanger Tubes: Install one per shelving unit **OR** more where directed **OR** at locations indicated on Drawings, **as directed**.

C. Erection Tolerances

1. Erect case-type and four-post metal storage shelving to a maximum tolerance from vertical of 1/2 inch (13 mm) in up to 10 feet (3 m) of height, not exceeding 1 inch (25 mm) for heights taller than 10 feet (3 m).
2. Erect post-and-beam metal storage shelving to a maximum tolerance from vertical of 1/4 inch (6 mm) in 84 inches (2134 mm) of height.

D. Adjusting

1. Adjust metal storage shelving so that connectors and other components engage accurately and securely.
2. Adjust and lubricate operable components to operate smoothly and easily, without binding or warping. Check and readjust operating hardware.
3. Touch up marred finishes or replace metal storage shelving that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by metal storage shelving manufacturer.
4. Replace metal storage shelving that has been damaged or has deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 10 56 13 16

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Task	Specification	Specification Description
10 56 16 00	06 05 23 00a	Miscellaneous Carpentry

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SECTION 10 71 13 13 - EXTERIOR SHUTTERS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for exterior shutters. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. Product Data:
      a. Manufacturer's data.
      b. For wood-preservative-treated materials and finishes indicated.
   2. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
   3. Samples: For lumber for exterior wood stain finish and lumber and panel products for shop-applied opaque finish, for each finish system and color, with one-half of exposed surface finished.
   4. LEED Submittals:
      a. Credit MR 7: Certificates of chain-of-custody signed by manufacturers certifying that products specified to be made from certified wood were made from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC 1.2, "Principles and Criteria."
   5. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates **OR** WIC-certified compliance certificates, **as directed**.

C. Quality Assurance
   1. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" **OR** WIC's "Manual of Millwork," **as directed.**
   2. Forest Certification: Provide exterior architectural woodwork produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC 1.2, "Principles and Criteria."

D. Delivery, Storage, and Handling
   1. Do not deliver shutters until painting and similar operations that could damage shutters have been completed in installation areas.

1.2 PRODUCTS

A. Wood Shutters
   1. Materials
      a. Preservative Treatment by Nonpressure Process: Comply with AWPA N1 using the following preservative for woodwork items indicated to receive water-repellent preservative treatment:
         1) Water-Repellent Preservative: Formulation containing 3-iodo-2-propynyl butyl carbamate (IPBC) complying with AWPA P8 as its active ingredient.
         2) Water-Repellent Preservative/Insecticide: Formulation containing 3-iodo-2-propynyl butyl carbamate (IPBC) as its active ingredient, combined with an insecticide containing chlorpyrifos as its active ingredient, both complying with AWPA P8.
   2. Fabrication
      a. Wood Moisture Content: 9 to 15 **OR** 10 to 15 **OR** 7 to 12, **as directed,** percent.
      b. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible, before shipment to Project site. Disassemble components only as

necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

c. Woodwork for Transparent Finish:
   1) Grade: Premium **OR** Custom **OR** Economy, **as directed**.
   2) Wood Species: Teak **OR** African mahogany **OR** White oak **OR** All-heart redwood **OR** Western red cedar **OR** Eastern white pine, **as directed**.

d. Woodwork for Opaque Finish:
   1) Grade: Premium **OR** Custom **OR** Economy, **as directed**.
   2) Wood Species: All-heart redwood **OR** Western red cedar **OR** Ponderosa pine **OR** Eastern white pine, sugar pine, or western white pine **OR** Spanish Cedar, **OR** Cyprus, **OR** Cedar, **OR** Any closed-grain hardwood, **as directed**.

e. Backout or groove backs of flat trim members and kerf backs of other wide, flat members, except for members with ends exposed in finished work.

f. Shop Priming: Shop prime woodwork for paint finish with one coat of wood primer specified in Division 07.
   1) Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to surfaces installed in contact with concrete or masonry and to end-grain surfaces.

B. Thermo-Plastic Shutters
   1. Provide high impact resistant, minimum 1-inch thick, pressure molded plastic shutters, shop assembled.
      a. Color shall be throughout material, with acrylic top layer to provide fade and UV protection. Color as directed. Provide lifetime warranty against fading.

C. Installation Materials
   1. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

D. Fabrication, General
   1. Fabricate shutters to dimensions, profiles, and details indicated.
   2. Complete fabrication, including assembly, and hardware application, to maximum extent possible, before shipment to Project site.

E. Size
   1. Sizes shall be as directed.

F. Configuration: As directed.
   1. Louvered decorative shutters.
   2. Raised panel decorative shutters.
   3. Board-and-Batten shutters.

1.3 EXECUTION

A. Preparation
   1. Before installing shutters, examine for completion, including removal of packing and backpriming.

B. Installation
   1. Before installation, condition wood shutters to average prevailing humidity conditions in installation areas. Before installing shutters, examine shop-fabricated work for completion and complete work as required.
   2. Preservative-Treated Wood: Where cut or drilled in field, treat cut ends and drilled holes according to AWPA M4.

3. Install shutters in accordance with manufacturer’s instructions.
4. Install shutters level, plumb, true, and straight.
5. Anchor shutters to anchors or blocking built in or directly attached to substrates.
6. Fill nail and screw holes with matching filler where exposed.
7. Refer to Division 07 for final finishing of installed shutters.

END OF SECTION 10 71 13 13

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Task	Specification	Specification Description
10 71 13 13	01 22 16 00	No Specification Required

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SECTION 10 73 13 13 - AWNINGS

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for awnings. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Fixed awnings.
b. Retractable awnings, manually operated and motorized.

C. Definitions
1. Awning: An architectural projection that provides weather protection, identity, or decoration and is wholly supported by the building to which it is attached. An awning is comprised of a lightweight, rigid skeleton structure over which a rigid covering is attached.
2. Retractable Awning: A cover with a frame that retracts against a building or other structure to which it is entirely supported.

D. Performance Requirements
1. General: Design, fabricate, and install awnings to withstand loads from gravity, wind, snow, ponding, drift, seismic, and structural movement, including thermally induced movement; and to resist, without failure, other conditions of in-service use, including exposure to weather.
2. Structural Performance: Provide awnings capable of withstanding the effects of gravity loads and loads and stresses within limits and under conditions required for the location of the Work.
3. Seismic Performance: Provide awnings capable of withstanding the effects of earthquake motions determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."
4. Thermal Movements: Provide awnings that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, tearing of fabric, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

E. Submittals
1. Product Data: Include styles, material descriptions, construction details, fabrication details, dimensions of individual components and profiles, hardware, fittings, mounting accessories, features, finishes, and operating instructions for awnings.
a. Motorized Awning Operators: Include operating instructions.
b. Motors: Show nameplate data, ratings, characteristics, and mounting arrangements.
2. Shop Drawings: Show location and extent of awnings. Include elevations, sections, and details not shown in Product Data. Show materials, fabrication, dimensions, mounting heights, connections, anchorages, installation details, attachments to other work, operational clearances, and relationship to adjoining work. Show colors and graphic layout and content.
3. Samples: For each of the following products and for the full range of color, texture, and pattern variations required, prepared on Samples of size indicated below. If finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.
a. Awning Fabric: 12-inch- (300-mm-) square section of fabric from dye lot to be used for the Work, with specified treatments applied. Mark face of fabric.

b. Graphics: Not less than 12-inch- (300-mm-) square section showing graphics application method.
c. Seam, Edge, and Corner Condition: Not less than 12-inch- (300-mm-) long section showing seam, edge, and corner treatment.
d. Valance: Full-size unit, not less than 12 inches (300 mm) long.
e. Frame Finish: Not less than 6-inch (150-mm) lengths.
f. Frame Corner and Three **OR** Four, **as directed**,-Way Truss Intersection: Not less than 12-inch (300-mm) sections showing finished joint construction and fabric and valance attachment to awning frame.
g. Exposed Hardware Finishes: Manufacturer's standard-size unit, not less than 3 inches (76 mm) square.
h. Accessories: Manufacturer's full-size unit.

4. Welding certificates.
5. Maintenance Data: For awnings to include in maintenance manuals.

F. Quality Assurance

1. Welding: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code--Steel."
   b. AWS D1.2, "Structural Welding Code--Aluminum."
2. Regulatory Requirements: Provide awnings complying with or exceeding requirements of authorities having jurisdiction>.
3. Fire-Test-Response Characteristics: Provide awning fabrics with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
   a. Flame-Resistance Ratings: Passes NFPA 701 **OR** California Code of Regulations, Title 19, **as directed**.
   b. Permanently attach label to each awning fabric indicating whether fabric is inherently and permanently flame resistant, or treated with flame-retardant chemicals, and whether it will require retreatment after designated time period or cleaning.
4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

G. Warranty: Manufacturer's standard form in which manufacturer and fabricator agree to repair or replace components of awnings that fail in materials or workmanship within specified warranty period.

1. Awning Warranty Period: Five years from date of Final Completion.
2. Fabric Warranty Period: Three **OR** Five **OR** Eight **OR** 12, **as directed**, years from date of Final Completion.
3. Thread Warranty Period: Five **OR** Eight, **as directed**, years from date of Final Completion.
4. Graphics Warranty Period: Outdoor durability not less than five **OR** three, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Source Limitations: Obtain awnings from single source from single manufacturer.

B. Awning Fabrics

1. Fabric Fiber Content: Vinyl-laminated or -coated polyester mesh **OR** Vinyl-laminated or -coated polyester **OR** Acrylic-coated polyester **OR** Resin-coated polyester **OR** Vinyl-coated polyester/cotton blend **OR** Acrylic-coated polyester/cotton blend **OR** Resin-coated polyester/cotton blend **OR** Solution-dyed acrylic **OR** Solution-dyed modacrylic, **as directed**.
2. Style:

a. Bottom Hem: Straight **OR** Scalloped, evenly spaced pattern **OR** As indicated by manufacturer's designation **OR** As indicated in an awning schedule, **as directed**.
b. Trim: As indicated by manufacturer's designation for style and color **OR** As indicated in a window treatment schedule, **as directed**.
c. Fringe: As indicated by manufacturer's designation for style and color **OR** As indicated in an awning schedule, **as directed**.
d. Color: Match samples **OR** As selected from manufacturer's full range **OR** As indicated in an awning schedule, **as directed**.
e. Applied Treatment: Stain resistant **OR** Mildew resistant **OR** Polymer, flame resistant **OR** Water repellent **OR** Lamination, **as directed**.
f. Performance Characteristics: As follows:
   1) Mildew Resistance: Showing no growth when tested per ASTM G 21.
   2) Shrinkage: Not greater than 0.1 **OR** 0.5 **OR** 1, **as directed**, percent per ASTM D 1204.
   3) Stretch Factor: Not less than 0.4 **OR** 1 **OR** 4, **as directed**, percent per ASTM D 4851.

3. Graphic Application: Hand painting **OR** Silk-screen printing **OR** Heat color transfer **OR** Vinyl film with pressure-sensitive adhesive backing **OR** PVDF film with pressure-sensitive adhesive backing **OR** PVF film with pressure-sensitive adhesive backing **OR** Radio-frequency, heat-sealed vinyl film **OR** Eradication **OR** Cut-out lettering, **as directed**.
   a. Text Message: As indicated on Drawings **OR** As indicated in an awning schedule, **as directed**.
      1) Text Font: Arial, **unless directed otherwise**.
      2) Character Size: Minimum 1-inch- (25.4-mm-) **OR** 1-foot- (0.3048-m-), **as directed**, high characters.
   b. Vinyl Film: Calendered-vinyl film, not less than 3 mils (0.076 mm) thick, with pressure-sensitive adhesive backing **OR** Cast-vinyl film, not less than 2 mils (0.051 mm) thick, with pressure-sensitive adhesive backing **OR** Cast-vinyl reflective film, not less than 2 mils (0.051 mm) thick, with pressure-sensitive adhesive backing, **as directed**.
4. Inset Fabric: Heat-sealed **OR** Sewn-in, **as directed**, process, and as follows:
   a. Colors: Match samples **OR** As selected from manufacturer's full range **OR** As indicated in an awning schedule, **as directed**.
   b. Applied Treatment: Stain resistant **OR** Mildew resistant **OR** Polymer, flame resistant **OR** Water repellent, **as directed**.

C. Thread: 100 percent expanded PTFE **OR** 100 percent bonded polyester, **as directed**, UV-light, mildew, and rot resistant.

D. Awning Frames
1. Steel Frames:
   a. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
   b. Cold-Formed Steel Tubing: ASTM A 500, grade as required by structural loads.
   c. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40) unless another weight is indicated or required by structural loads.
   d. Steel Mechanical Tubing: Cold-rolled, electric-resistance-welded carbon or alloy steel tubing complying with ASTM A 513 or steel tubing fabricated from steel complying with ASTM A 1011/A 1011M and complying with dimensional tolerances in ASTM A 500.
   e. Steel Finish: Manufacturer's standard galvanized and corrosion-resistant mill **OR** Manufacturer's standard decorative **OR** Baked-enamel **OR** Powder-coat, **as directed**, finish complying with finish manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.
2. Aluminum Frames: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated and with not less than the strength and durability properties of alloy and temper required by structural loads.
   a. Aluminum Plate and Sheet: ASTM B 209 (ASTM B 209M).
   b. Aluminum Extrusions: ASTM B 221 (ASTM B 221M).

c. Extruded Structural Pipe and Round Tubing: ASTM B 429, standard weight (Schedule 40) unless another weight is indicated or required by structural loads.
d. Drawn Seamless Tubing: ASTM B 210 (ASTM B 210M).
e. Aluminum Finish: Mill **OR** Manufacturer's standard decorative **OR** Baked-enamel **OR** Powder-coat, **as directed**, finish complying with finish manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

3. Anchors, Fasteners, Fittings, Hardware, and Installation Accessories: Complying with performance requirements indicated and suitable for exposure conditions, supporting structure, anchoring substrates, and installation methods indicated. Corrosion-resistant or noncorrodible units; weather-resistant, tamperproof, vandal- and theft-resistant, compatible, nonstaining materials. Provide as required for awning assembly, mounting, and secure attachment. Number as needed to comply with performance requirements and to maximize appearance; evenly spaced. Where exposed to view, with finish and color as selected by Architect from manufacturer's full range.
   a. Wood Screws: ASME B18.6.1.
   b. Lag Bolts: ASME B18.2.1. (ASME B18.2.3.8M).
   c. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.
   d. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
      1) Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).
   e. Adhesive-Bonded Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 1512 conducted by a qualified independent testing and inspecting agency.
      1) Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).
   f. Grommets: Zinc-coated brass, No. 2 **OR** Stainless steel, No. 2, **as directed**.
      1) Grommet Spacing: 6-inch (150-mm) o.c.
   g. Lacing: 100 percent polyester, braided No. 4.
4. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.
5. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

E. Awning Fabrication
1. Fabrics: Reinforce wear points and hardware attachment points with nonwoven **OR** mesh **OR** polypropylene mesh, **as directed**, webbing.
   a. Fabric Edges and Seams:
      1) Fold and stitch selvedge, and cut fabric edges.
      2) Hot cut and sealed.
      3) Radio-frequency welded.
      4) Adhesively bonded.
      5) Manufacturer's standard hemming and seaming methods.
2. Decorative Trims: Borders **OR** Braid and bindings **OR** Cords **OR** Fringe **OR** Patterned edge; scalloped **OR** Patterned edge; V-shaped **OR** Streamers **OR** Tassels **OR** Welting, **as directed**.

a. Colors: As indicated by manufacturer's designations **OR** Match samples **OR** Matching or coordinating with awning fabric color **OR** As selected from manufacturer's full range **OR** As indicated in an awning schedule, **as directed**.

3. Frames: Preassemble awning frames in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
   a. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
   b. Form exposed work true to line and level with accurate angles and surfaces and straight edges.
   c. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Fabricate slip-fit connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
   d. Weld corners and connections continuously. Obtain fusion without undercut or overlap. Remove welding flux immediately. At exposed corners and connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
   e. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications in place and to properly transfer loads.
4. Colors of Metal and Plastic Components Exposed to View: As indicated by manufacturer's designations **OR** Match samples **OR** Matching or coordinating with awning fabric color **OR** As selected from manufacturer's full range **OR** As indicated in an awning schedule, **as directed**.

F. Retractable Awning Operators
1. Manual Operation: With gear and crank operator.
   a. Manual Operation Assist Mechanism: Manufacturer's standard spring assist for operating heavy awnings.
   b. Crank Handle: One **OR** Two, **as directed**, detachable.
   c. Awning Coupler System: Designed for simultaneously operating two **OR** three, **as directed**, awnings with a single crank. Provide system for each group of awnings **OR** where indicated on Drawings **OR** where indicated in an awning schedule, **as directed**.
   d. Operating Function: Stop and hold awning at any position in ascending or descending travel **OR** Stop and hold awning at either fully open or fully closed positions only, **as directed**.
2. Motorized Operation: Provide factory-assembled motorized retractable awning operation systems designed for retracing awnings of type, size, weight, construction, use, and operation frequency indicated. Provide operation systems of size and capacity and with features, characteristics, and accessories suitable for Project conditions and recommended by awning manufacturer, complete with electric motors and factory-prewired motor controls, remote-control stations, remote-control devices, power disconnect switches, enclosures protecting controls and all operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
3. Comply with NFPA 70.
4. Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6 with NFPA 70, Class 2 control circuit, maximum 24-V ac or dc.
5. Electric Motors: UL-approved or -recognized, totally enclosed, insulated motor, complying with NEMA MG 1, with thermal-overload protection and internal limit switches; sized by awning manufacturer to start and operate size and weight of awning considering service factor or considering Project's service conditions without exceeding nameplate ratings.
   a. Service Factor: According to NEMA MG 1, unless otherwise indicated.
   b. Motor Characteristics: Single phase, 24 **OR** 110 **OR** 220, **as directed**, V, 60 Hz.
   c. Coordinate wiring requirements and electrical characteristics of motors with building electrical system.
   d. Motor Mounting: Within manufacturer's standard roller enclosure.

6. Remote Controls: Electric controls with NEMA ICS 6, Type 1 **OR** 4, **as directed**, enclosure for surface **OR** recessed or flush, **as directed**, mounting. Provide the following devices for remote-control activation of awnings:
    a. Control Stations:
        1) Keyed, maintained **OR** momentary, **as directed**,-contact, three-position, switch-operated control station with open, close, and off functions. Provide two keys per station.
        OR
        Maintained **OR** Momentary, **as directed**,-contact, three-position, toggle **OR** rocker, **as directed**,-style, wall switch-operated control station with open, close, and center off functions.
        2) Color: Ivory **OR** White **OR** As indicated in an awning schedule, **as directed**.
    b. Group Control Stations: Maintained **OR** Momentary, **as directed**,-contact, three-position, rocker-style, wall switch-operated control station with open, close, and center-off functions for single-switch group control.
        1) Color: Ivory **OR** White **OR** As indicated in an awning schedule, **as directed**.
    c. Individual/Group Control Stations: Maintained **OR** Momentary, **as directed**,-contact, three-position, rocker-style, wall switch-operated control station with open, close, and center-off functions for individual and group control.
        1) Color: Ivory **OR** White **OR** As indicated in an awning schedule, **as directed**.
    d. Sun Sensor Controls: Programmable system activated by LEDs detecting daylight intensity and responding by automatically adjusting awnings.
    e. Radio Controls: Digital system consisting of code-compatible universal coaxial receiver, one per awning **OR** where indicated on Drawings, **as directed**, and two portable single-channel transmitters for operating a single motor with a single button to open and close awning.
    f. Radio Controls: Digital system consisting of code-compatible universal coaxial receiver, one per awning **OR** where indicated on Drawings **OR** where indicated in an awning schedule, **as directed**, and two portable multiple-channel transmitters for operating two **OR** four **OR** up to 12, **as directed**, awnings individually, each with a single button to open and close awnings.
    g. Timer Controls: Clock timer, 24-hour **OR** seven-day, **as directed**, programmable for regular events.
    h. Microprocessor Controls: Electronic programmable means for setting, changing, and adjusting control features. Provide unit isolated from voltage spikes and surges.
7. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop awning at fully raised and fully lowered positions.
8. Operating Function: Stop and hold awning at any position **OR** Stop and hold awning at three predetermined positions including open, closed, and one user-programmed position, **as directed**.
9. Operating Features: Include the following:
    a. Group switching with integrated switch control; single face plate for multiple switch cut-outs.
    b. Capable of accepting input from building automation control system.
    c. Override switch.
    d. Backup gear and crank operator for manual operation during power failures with detachable handle, 6 feet (1.8 m) long **OR** manufacturer's standard length **OR** length required to make operation convenient from ground level **OR** length as indicated on Drawings, **as directed**.
10. Awning Hood: Sheet metal enclosure sized to fit awning roller and operating hardware inside and designed for UV-light, dust, weather, and vandal protection. Finish and color to match awning framing **OR** as indicated on Drawings **OR** as indicated in an awning schedule, **as directed**.

1.3 EXECUTION

A. Installation, General
1. General: Install awnings and motor controls at locations and in position indicated, securely connected to supports, free of rack, and in proper relation to adjacent construction. Use mounting methods of types described and in compliance with Shop Drawings and fabricator's written instructions.
2. Install awnings after other finishing operations, including joint sealing and painting, have been completed.
3. Attach fabric to frames as recommended by fabricator, by stapling into slotted track in frame **OR** using lacing method as required to conceal ends of lacing OR using fabric hem pockets, **as directed**, to ensure tight, wrinkle-free fit of fabric to frame.
4. Slip fit frame connections accurately together to form hairline joints and tighten to secure.
5. Weld frame connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
    a. Field Welding: Comply with the following requirements:
        1) Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
        2) Obtain fusion without undercut or overlap.
        3) Remove welding flux immediately.
        4) At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
6. Anchoring to In-Place Construction: Use anchors, fasteners, fittings, hardware, and installation accessories where necessary for securing awnings to structural support and for properly transferring load to in-place construction.
7. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.
8. Coordinate awning installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed exterior wall and roof assemblies.
9. Connections: Connect motorized operators to building electrical system.

B. Adjusting
1. Adjust awnings to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

C. Cleaning And Protection
1. Clean awning surfaces after installation, according to manufacturer's written instructions.
2. Touchup Painting: Immediately after erection, clean field welds, connections, and abraded areas. Paint uncoated and abraded areas with same or compatible material as used for shop-applied finish painting.
    a. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.
3. Galvanized Surfaces: Clean field welds, connections, and abraded areas and repair galvanizing to comply with ASTM A 780.
4. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that awnings are without damage or deterioration at time of Final Completion.
5. Replace damaged awnings that cannot be repaired, in a manner approved, before time of Final Completion.

END OF SECTION 10 73 13 13

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Task	Specification	Specification Description
10 73 13 23	10 73 13 13	Awnings

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SECTION 10 73 26 13 - EXTRUDED ALUMINUM WALKWAY COVER

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of mesh or netting for extruded aluminum walkway cover. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals

1. Product Data: Submit manufacturer’s product information, specifications and installation instructions for building components and accessories.
2. Shop Drawings: Submit complete shop drawings including all necessary plan dimensions, elevations and details. Contractor shall verify all dimensions and provide elevations at each column, finish floor, and related soffit prior to manufacturer for fabrication.
3. Certification: Submit design calculations signed by a Registered Professional Engineer, licensed in the project state. Design calculations shall state that the walkway cover system design complies with the wind requirements of ASCE 7-95, the stability criteria of applicable building code, and all other governing criteria.

C. Quality Assurance

1. Walkway cover shall be wholly produced by a recognized manufacturer with at least 5 years experience in the design and fabrication of extruded aluminum walkway cover systems. Components shall be assembled in shop to the greatest extent possible to minimize field assembly. Walkway system shall be installed by manufacturer. Walkway system, including material and workmanship, shall be warranted from defects for a period of one year from Final Completion of installation.

1.2 PRODUCTS

A. Design

1. Walkway cover shall be all welded extruded aluminum system complete with internal drainage. Non-welded systems are not acceptable. Roll formed deck is not acceptable. Expansion joints shall be included to accommodate temperature changes of 120 degrees F. Expansion joints shall have no metal to metal contact.

B. Materials

1. Aluminum Members: Extruded aluminum 6063 alloy, heat treated to T-6 temper.
2. Fasteners: Aluminum, 18-8 stainless steel or 300 series stainless steel.
3. Protective coating: Aluminum columns embedded in concrete shall be protected with clear acrylic coating.
4. Grout: 2000 psi compressive strength, 1 part Portland cement to 3 parts masonry sand. Add water to grout mixture to produce pouring consistency.
5. Gaskets: Dry seal santoprene or neoprene, pressure type.

C. Components

1. Columns: Radius-cornered tubular extrusion of size indicated with cutout and internal diverter for drainage where indicated. Circular downspout openings in columns are not acceptable.
2. Beams: Open-top tubular extrusion of size and shape indicated, top edges thickened for strength and designed to receive deck members in self-flashing manner. Structural ties shall be installed in tops of beams.

3. Deck: Extruded self-flashing sections interlocking into a composite unit. Closures at deck ends shall be welded plates.
4. Fascia: Manufacturer's standard shape. Size as directed.
5. Flashing: Minimum 0.040-inch thick aluminum.

D. Fabrication
1. Internal Drainage: Water flow shall be directed from deck to beams to columns, as indicated by the shop drawings, for discharge out "weepholes" at ground level. Should underground drainage be required, proper coordination of trades shall be by Contractor.
2. Bent Construction: Beams and columns shall be factory welded with neatly mitered corners into rigid, one-piece units. All welds shall be smooth and uniform using an inert gas shielded arc. Suitable edge preparation shall be provided to assure 100 percent penetration. Grind welds only where interfering with adjoining structure to allow for flush connection. Field welding is not permitted. When size of bent does not permit shipment as a welded unit, rigid mechanical joints may be utilized.
3. Deck Construction: Extruded self-flashing deck sections shall interlock into a composite unit, spanning double-bays. Interlocking joints shall be positively fastened at 8-inches on centers, creating a monolithic structural unit capable of developing the full strength of the sections. The fastenings shall have minimum shear strength of 350 pounds each. Deck shall be assembled with sufficient camber to offset dead load deflection.

E. Finish
1. Clear anodized 204-R1, per AA-M10C22A21 (AAMA 607.1) **OR** bronze, amber or black anodizing per AA-M10C22A42 (AAMA 606.1), **as directed**, color to be selected,
OR
Painted finish shall be baked acrylic enamel (AAMA 603.8) over chromate conversion pretreatment or wash-etch primer **OR** polyester powder coating **OR** high-performance fluoropolymer coating (AAMA 605.2), **as directed**, on deck and fascia.

F. Light Fixture
1. Surface mounted to roof deck as shown on the drawings. Construction shall be of a welded weatherproof, extruded housing, high impact FR grade white acrylic diffuser tethered to housing by wire cables, including 1/2-inch conduit coupling and "Weldnuts" for attachment to roof deck. Finish shall match the extruded roof deck. Ballast shall be class P of voltage required, 0 degree F start. Sockets shall receive dual lamps. Fixtures shall occur at each bay of deck. All penetrations will be covered with a bed of silicone caulking. Caulking shall be applied to a clean and dry surface.

G. Accessories
1. Provide all accessories, fasteners, flashings and other items as necessary for a complete installation.

1.3 EXECUTION

A. Erection
1. Concrete Footings: Provide manufacturer's standard column sleeves (styrofoam block-outs).
2. Surface Mount: Bents shall be anchored to top of existing walks. In canopy runs where lengths exceed 100 ft., the next proceeding bent shall be set into a concrete footing.

B. Installation
1. Walkway cover shall be erected true to line, level, and plumb. Aluminum columns embedded in concrete shall be protected with clear acrylic. Downspout columns shall be filled with grout to the discharge level to prevent standing water. Non-draining columns shall have weep holes installed at top of concrete to remove condensation.

C. Cleaning
   1. All walkway cover components shall be cleaned promptly after installation.

D. Protection
   1. Extreme care shall be taken to protect materials during and after installation.

END OF SECTION 10 73 26 13

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Task	Specification	Specification Description
10 73 26 13	01 22 16 00	No Specification Required

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SECTION 10 75 16 00 - FLAGPOLES

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for flagpoles. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes ground-mounted, wall-mounted, and roof-mounted flagpoles made from aluminum, copper alloy (bronze), fiberglass, stainless steel, and steel.

C. Performance Requirements
1. Structural Performance: Flagpole assemblies, including anchorages and supports, shall withstand the effects of gravity loads, and the following loads and stresses within limits and under conditions indicated according to the following design criteria:
   a. Seismic Loads: <**Insert seismic criteria**> according to SEI/ASCE 7.
   b. Wind Loads: <**Insert wind speed and exposure factor**> according to NAAMM FP 1001, "Guide Specifications for Design of Metal Flagpoles" **OR** SEI/ASCE 7, **as directed**.
   c. Base flagpole design on polyester **OR** nylon or cotton, **as directed**, flags of maximum standard size suitable for use with flagpole or flag size indicated, whichever is more stringent.

D. Submittals
1. Product Data: For each type of product indicated.
2. Delegated-Design Submittal: For flagpole assemblies indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   a. Include loads, point reactions, and locations for attachment of flagpoles to building's structure.
3. Operation and Maintenance Data: For flagpoles to include in operation and maintenance manuals.

E. Delivery, Storage, And Handling
1. General: Spiral wrap flagpoles with heavy paper and enclose in a hard fiber tube or other protective container.

1.2 PRODUCTS

A. Flagpoles
1. Flagpole Construction, General: Construct flagpoles in one piece if possible. If more than one piece is necessary, comply with the following:
   a. Fabricate shop and field joints without using fasteners, screw collars, or lead calking.
   b. Provide flush hairline joints using self-aligning, snug-fitting, internal sleeves.
   OR
   Provide self-aligning, snug-fitting joints.
2. Exposed Height: 20 feet (6 m) **OR** 25 feet (7.5 m) **OR** 30 feet (9 m) **OR** 35 feet (11 m) **OR** 40 feet (12 m) **OR** 45 feet (13.5 m) **OR** 50 feet (15 m) **OR** 60 feet (18 m) **OR** 70 feet (21 m) **OR** 80 feet (24 m), **as directed**.

3. Aluminum Flagpoles: Provide cone **OR** entasis, **as directed**,-tapered flagpoles fabricated from seamless extruded tubing complying with ASTM B 241/B 241M, Alloy 6063, with a minimum wall thickness of 3/16 inch (4.8 mm).
4. Copper-Alloy (Bronze) Flagpoles: Provide cone **OR** entasis, **as directed**,-tapered flagpoles fabricated from seamless pipe or tube complying with ASTM B 43 or ASTM B 135 (ASTM B 135M), Alloy UNS C23000 (red brass, 85 percent copper).
5. Fiberglass Flagpoles: Provide cone **OR** entasis, **as directed**,-tapered flagpoles fabricated from polyester resin reinforced with woven glass-fiber roving with 75 percent of glass fibers parallel to length of flagpole.
6. Stainless-Steel Flagpoles: Provide cone **OR** entasis, **as directed**,-tapered flagpoles fabricated from pipe, tube, or plate complying with ASTM A 312/A 312M, ASTM A 269, or ASTM A 666, Alloy UNS S30400 **OR** Alloy UNS S31603, **as directed**.
7. Steel Flagpoles: Provide cone-tapered **OR** stepped-sectional, **as directed**, flagpoles fabricated from standard-weight, seamless steel pipe complying with ASTM A 53/A 53M, Type S, Grade B or steel tube complying with ASTM A 513.
8. Metal Foundation Tube: Manufacturer's standard corrugated-steel foundation tube, not less than 0.064-inch- (1.6-mm-) nominal wall thickness. Provide with 3/16-inch (4.8-mm) steel bottom plate and support plate; 3/4-inch- (19-mm-) diameter, steel ground spike; and steel centering wedges welded together. Galvanize steel after assembly. Provide loose hardwood wedges at top of foundation tube for plumbing pole.
   a. Provide flashing collar of same material and finish as flagpole.
   b. Provide steel ground protectors extending 12 inches (300 mm) aboveground and 6 inches (150 mm) belowground for steel flagpoles where flashing collars are not provided.
9. Sleeve for Fiberglass **OR** Aluminum, **as directed**, Flagpole: Fiberglass or PVC pipe foundation sleeve, made to fit flagpole, for casting into concrete foundation.
   a. Provide flashing collar of same material and finish as flagpole.
10. Cast-Metal Shoe Base: For anchor-bolt mounting; provide with anchor bolts.
   a. Provide units made from aluminum **OR** steel, **as directed**, with same finish and color as flagpoles.
   b. Provide ground spike at grade-mounted flagpoles for metal flagpoles or fiberglass flagpoles with metal halyards.
   c. Provide connector to building's lightning protection system conductor at roof-mounted flagpoles for metal flagpoles or fiberglass flagpoles with metal halyards.
11. Hinged Baseplate: Cast-metal tilting hinged base and anchored plate joined by permanently secured pivot rod for aluminum and fiberglass flagpoles 30 to 40 feet (9 to 12 m) or less in height. Provide with stainless-steel screws for securing tilting base to anchored plate when not tilted; provide with anchor bolts.
   a. Finish base to match flagpole.
   b. Provide aluminum base or aluminum flashing collar finished to match flagpole.
   c. Provide ground spike at grade-mounted flagpoles for metal flagpoles or fiberglass flagpoles with metal halyards.
   d. Provide connector to building's lightning protection system conductor at roof-mounted metal flagpoles for metal flagpoles or fiberglass flagpoles with metal halyards.
12. Pivoting Tilt Base: Steel baseplate with channel or rectangular tube uprights, pivot bolt, and locking device for tilting flagpole. Provide tilting flagpole with steel counterweight box and weights, or provide with internal counterweight. Provide base with anchor bolts.
   a. Finish base to match flagpole.
   b. Provide ground spike at grade-mounted flagpoles.
      OR
      Provide connector to building's lightning protection system conductor at roof-mounted metal flagpoles.
13. Vertical Wall Mount: Cast-aluminum **OR** Cast-copper-alloy (bronze), **as directed**, mounting bracket complete with escutcheon, **as directed**, mounting plate and through-wall anchorage.
   a. Provide units with same finish as flagpole for copper-alloy (bronze) or aluminum units.

b. Provide units with gold anodic **OR** bronze powder-coated **OR** black powder-coated, **as directed**, finish for aluminum units.

14. Outrigger Wall Mount: Aluminum **OR** Copper-alloy (bronze), **as directed**, mounting bracket complete with escutcheon, **as directed**, mounting plate and through-wall anchorage.
    a. Provide units with same finish as flagpole for copper-alloy (bronze) or aluminum units.
    b. Provide units with gold anodic **OR** bronze powder-coated **OR** black powder-coated, **as directed**, finish for aluminum units.
15. Braced Roof Mount: Roof-mounted flagpole socket and either rod or tubular braces with turnbuckles and mounting bases. Provide as a complete assembly with anchor bolts and connector for lightning protection system.
    a. Provide braces, turnbuckles, and connectors made from same metal and with same finish as flagpoles.

B. Fittings
1. Finial Ball: Manufacturer's standard flush-seam ball, sized as indicated or, if not indicated, to match flagpole-butt diameter.
    a. 0.063-inch (1.6-mm) spun aluminum, finished to match flagpole **OR** with gold anodic finish, **as directed**.
    b. 20-oz. (0.70-mm) copper with 23-karat gold leaf finish.
    c. Spun stainless steel, finished to match flagpole.
    d. Spun copper alloy, finished to match flagpole.
2. Finial Eagle: Manufacturer's standard, sized as indicated **OR** as standard with manufacturer for flagpole size indicated, **as directed**.
    a. Cast aluminum, finished to match flagpole **OR** with gold anodic finish, **as directed**.
    OR
    20-oz. (0.70-mm) copper with 23-karat gold leaf finish.
3. Internal Halyard, Winch System: Manually operated winch with control stop device and removable handle, stainless-steel cable halyard, and concealed revolving truck assembly with plastic-coated counterweight and sling. Provide flush access door secured with cylinder lock. Finish truck assembly to match flagpole.
    a. Halyard Flag Snaps: Provide two chromium-plated bronze **OR** stainless-steel **OR** bronze **OR** nylon, **as directed**, swivel snap hooks per halyard.
        1) Provide with neoprene or vinyl covers.
    b. Plastic Halyard Flag Clips: Made from injection-molded, UV-stabilized, acetal resin (Delrin). Clips attach to flag and have two eyes for inserting both runs of halyards. Provide two flag clips per halyard.
4. Internal Halyard, Cam Cleat System (for flagpoles 40 feet (12 m) or less in height): 5/16-inch- (8-mm-) diameter, braided polypropylene halyard; cam cleat; and concealed revolving truck assembly with plastic-coated counterweight and sling. Provide flush access door secured with cylinder lock. Finish truck assembly to match flagpole.
    a. Halyard Flag Snaps: Provide two chromium-plated bronze **OR** stainless-steel **OR** bronze **OR** nylon, **as directed**, swivel snap hooks per halyard.
        1) Provide with neoprene or vinyl covers.
    b. Plastic Halyard Flag Clips: Made from injection-molded, UV-stabilized, acetal resin (Delrin). Clips attach to flag and have two eyes for inserting both runs of halyards. Provide two flag clips per halyard.
5. External Halyard: Ball-bearing, nonfouling, revolving truck assembly of cast metal with continuous 5/16-inch- (8-mm-) diameter, braided polypropylene halyard and 9-inch (228-mm) cast-metal cleats with fasteners. Finish exposed metal surfaces to match flagpole.
    a. Provide one halyard and one cleat **OR** two halyards and two cleats, **as directed**, at each flagpole.
    b. Provide cast-metal cleat covers, finished to match flagpole, secured with cylinder locks.
    c. Provide halyard covers consisting of a 2-inch (50-mm) channel, 60 inches (1500 mm) long, finished to match flagpole.
    d. Halyard Flag Snaps: Provide two chromium-plated bronze **OR** stainless-steel **OR** bronze **OR** nylon, **as directed**, swivel snap hooks per halyard.

1) Provide with neoprene or vinyl covers.

e. Plastic Halyard Flag Clips: Made from injection-molded, UV-stabilized, acetal resin (Delrin). Clips attach to flag and have two eyes for inserting both runs of halyards. Provide two flag clips per halyard.

C. Miscellaneous Materials

1. Nonshrink, Nonmetallic Grout (for baseplate-mounted flagpoles): Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107.
2. Drainage Material (for ground-set flagpoles with foundations): Crushed stone, or crushed or uncrushed gravel; coarse aggregate.
3. Sand (for ground-set, foundation-tube-mounted flagpoles): ASTM C 33, fine aggregate.
4. Elastomeric Joint Sealant (for ground-set, foundation-tube-mounted flagpoles): Multicomponent nonsag urethane **OR** Single-component nonsag urethane **OR** Single-component neutral- and basic-curing silicone **OR** Single-component neutral-curing silicone, **as directed**, joint sealant complying with requirements in Division 07 Section "Joint Sealants" for Use NT (nontraffic) and for Use M, G, A, and, as applicable to joint substrates indicated, for Use O.
5. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

D. General Finish Requirements

1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

E. Aluminum Finishes

1. Natural Satin Finish: AA-M32, fine, directional, medium satin polish; buff complying with AA-M20; seal aluminum surfaces with clear, hard-coat wax.
2. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
3. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black, **as directed**.
   b. Color: Match sample **OR** As selected from full range of industry colors and color densities, **as directed**.
4. Gold Anodic Finish: AAMA 611, AA-M32C22A43 Class I, 0.018 mm or thicker; gold color.
5. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
6. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.

F. Steel Finishes

1. Flagpole Interior Finish: Apply one coat of bituminous paint on interior of flagpole or otherwise treat to prevent corrosion.
2. Galvanized Finish: Hot-dip galvanize after fabrication to comply with ASTM A 123/A 123M.
3. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning" **OR** SSPC-SP 8, "Pickling," **as**

directed. After cleaning, apply a conversion coating suited to the organic coating to be applied over it, **as directed**.

4. Polyurethane Enamel Finish: Immediately after cleaning, apply manufacturer's standard primer and two-coat, high-gloss, high-build polyurethane-enamel finish.
   a. Color: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
5. Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).
   a. Color and Gloss: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.

G. Stainless-Steel Finishes
1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
   a. Run grain of directional finishes with long dimension of each piece.
   b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
   c. Directional Satin Finish: No. 4.

H. Copper-Alloy Finishes
1. Buffed Finish, Lacquered: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear organic, air drying, as specified below).
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
2. Medium Satin Finish, Lacquered: M32-O6x (Mechanical Finish: medium satin; Coating: clear organic, air drying, as specified below).
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
3. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide).
   a. Color: Match sample.

I. Fiberglass Finishes
1. Fiberglass: UV-light stable, hard, high-gloss gel coat or high-gloss, high-build polyurethane or polyester coating.
   a. Color: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.

1.3 EXECUTION

A. Preparation
1. Prepare uncoated metal flagpoles that are set in foundation tubes by painting below-grade portions with a heavy coat of bituminous paint.
2. Foundation Excavation: Excavate to neat clean lines in undisturbed soil. Remove loose soil and foreign matter from excavation and moisten earth before placing concrete. Place and compact drainage material at excavation bottom.
3. Provide forms where required due to unstable soil conditions and for perimeter of flagpole base at grade. Secure and brace forms to prevent displacement during concreting.
4. Place concrete, as specified in Division 03 Section "Cast-in-place Concrete". Compact concrete in place by using vibrators. Moist-cure exposed concrete for not less than seven days or use nonstaining curing compound.

5. Trowel exposed concrete surfaces to a smooth, dense finish, free of trowel marks, and uniform in texture and appearance. Provide positive slope for water runoff to perimeter of concrete base.

B. Flagpole Installation
1. General: Install flagpoles where shown and according to Shop Drawings and manufacturer's written instructions.
2. Ground Set: Place foundation tube, sleeve, center, and brace to prevent displacement during concreting. Place concrete. Plumb and level foundation tube **OR** sleeve, **as directed**, and allow concrete to cure. Install flagpole, plumb, in foundation tube **OR** sleeve, **as directed**.
   a. Foundation Tube: Place tube seated on bottom plate between steel centering wedges and install hardwood wedges to secure flagpole in place. Place and compact sand in foundation tube and remove hardwood wedges. Seal top of foundation tube with a 2-inch (50-mm) layer of elastomeric joint sealant and cover with flashing collar.
3. Baseplate: Cast anchor bolts in concrete foundation. Install baseplate on washers placed over leveling nuts on anchor bolts and adjust until flagpole is plumb. After flagpole is plumb, tighten retaining nuts and fill space under baseplate solidly with nonshrink, nonmetallic grout. Finish exposed grout surfaces smooth and slope 45 degrees away from edges of baseplate.
4. Mounting Brackets and Bases: Anchor brackets and bases securely through to structural support with fasteners as indicated on Shop Drawings.

END OF SECTION 10 75 16 00

Task	Specification	Specification Description
10 75 23 00	10 75 16 00	Flagpoles

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SECTION 10 81 13 00 - ORIENTED FLEXIBLE NETTING BIRD BARRIER

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of oriented flexible netting bird barrier. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCTS

A. Material

1. Polyethylene twine netting attached to pre-installed cable system and steel installation hardware.
2. Netting shall be high density polyethylene knitted into sheets with mesh sizes of 3/4" **OR** 1-1/8" **OR** 2", **as directed.** Polyethylene shall be UV treated, color stable, and flame-retardant.
3. Color shall be selected from manufacturer's standard colors.
4. Installation hardware shall include corner and intermediate attachments, perimeter cable, turnbuckles, ferrules or clamps and net rings.

1.3 EXECUTION

A. Installation

1. Comply with manufacturer's printed instructions.

END OF SECTION 10 81 13 00

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SECTION 10 86 00 00 - DETENTION FURNITURE

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for detention furniture. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Gun lockers.
      b. Security key cabinets.
      c. Detention bunks.
      d. Detention mattresses.
      e. Detention desks.
      f. Detention tables.
      g. Detention seating.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittal:
      a. Product Data for Credit EQ 4.1: For security sealants, including printed statement of VOC content.
   3. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   4. Samples: For factory-applied color finishes.
   5. Samples for Verification:
      a. Furniture: Full-size units. Approved Samples may become part of the completed Work.
      b. Detention Mattresses: Not less than 6 inches (152 mm) square by full depth, including core and cover fabric.
   6. Welding certificates.
   7. Product certificates.
   8. Maintenance data.
   9. Other Informational Submittals:
      a. Field quality-control reports documenting inspections of installed products.
      b. Field quality-control certification signed by Contractor and Detention Specialist, **as directed**.

D. Quality Assurance
   1. Welding Qualifications: Qualify procedures and personnel according to the following:
      a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
      b. AWS D1.3, "Structural Welding Code - Sheet Steel."
      c. AWS D1.6, "Structural Welding Code - Stainless Steel."
   2. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage And Handling
   1. Detention Mattresses: Deliver wrapped to provide protection during transit and Project-site storage. Protect from contact with moisture.

1.2 PRODUCTS

A. Materials

1. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
2. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, CS (Commercial Steel), Type B; suitable for exposed applications.
3. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, CS (Commercial Steel), Type B; free of scale, pitting, or surface defects; pickled and oiled.
4. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666 or ASTM A 240/A 240M, austenitic stainless steel, Type 304.
5. Steel Tubing: ASTM A 513, Type B unless otherwise indicated; thickness indicated or required by structural loads.
6. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless another weight is indicated or required by structural loads.
7. Concealed Bolts: ASTM A 307, Grade A unless otherwise indicated.
8. Cast-in-Place Anchors in Concrete: Fabricated from corrosion-resistant materials capable of sustaining, without failure, a load equal to four times the load imposed, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency; of type indicated below.
    a. Threaded or wedge type; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed; hot-dip galvanized per ASTM A 153/A 153M or ASTM F 2329.
9. Embedded Plate Anchors: Fabricated from steel shapes and plates, minimum 3/16 inch (4.8 mm) thick; with minimum 1/2-inch- (12.7-mm-) diameter headed studs welded to back of plate.
10. Proprietary Built-in Masonry Anchors: Fabricated from 0.134-inch (3.42-mm) nominal-thickness steel sheet **OR** 1/4-inch (6-mm) nominal-thickness steel plate **OR** 1/2-inch (12.7-mm) nominal-thickness steel plate, **as directed**, into 6-inch- (152-mm-) **OR** 8-inch- (203-mm-), **as directed**, deep blocks matching size of concrete masonry units; with weld nuts attached on inside to receive field-bolted attachments, **as directed**.
    a. Finish: Factory primed for field painting for anchors with field-welded attachments **OR** Polyester powder coat for anchors with bolted attachments **OR** Epoxy paint for anchors with bolted attachments, **as directed**.
11. Welding Rods and Bare Electrodes: Select according to AWS specifications.

B. Security Sealants
1. Manufacturer's standard, high-modulus, nonsag, two-part, pick-proof, epoxy sealant, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), recommended for sealing nonmoving interior joints in security applications.

C. Security Fasteners
1. Fasteners operable only by tools produced by fastener manufacturer or other licensed fabricator for use on specific type of fastener.
2. Provide drive-system type, head style, material, and protective coating as required for assembly, installation, and strength, and as follows:
    a. Drive-System Type: Pinned Torx-Plus **OR** Pinned Torx, **as directed**.
    b. Fastener Strength: 120,000 psi (827 MPa).
    c. Socket Button Head Fasteners:
        1) Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
        2) Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.
    d. Socket Flat Countersunk Head Fasteners:
        1) Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
        2) Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.
    e. Socket Head Cap Fasteners:
        1) Heat-treated alloy steel, ASTM A 574 (ASTM A 574M).
        2) Stainless steel, ASTM F 837 (ASTM F 837M), Group 1 CW.
    f. Protective Coatings for Heat-Treated Alloy Steel:
        1) Zinc and clear trivalent chromium where indicated.
        2) Zinc phosphate with oil, ASTM F 1137, Grade I, or black oxide unless otherwise indicated.

D. Gun Lockers
1. Pistol Lockers:
a. Cabinet: Minimum 20 inches (508 mm) wide by 15 inches (381 mm) high by 10 inches (254 mm) deep; formed from 0.134-inch (3.42-mm) **OR** 0.075-inch (1.90-mm), **as directed**, nominal-thickness steel sheet. Line each compartment with mothproofed felt or nonabsorbing, closed-cell padding.
1) Compartments: Six.
b. Doors: Formed from same material as cabinet, supported by heavy-duty continuous bottom hinge.
c. Locks: Snap **OR** Cylinder, **as directed**, type, keyed differently and master keyed, **as directed**; provide one lock for each compartment.
d. Mounting: Surface **OR** Recessed, with mounting flange formed from same material as body, **as directed**.
e. Finish: Factory primed for field painting **OR** Baked enamel or powder coat, **as directed**.
2. Tilt-Out, Pistol Locker:
a. Cabinet: Minimum 39 inches (991 mm) wide by 15 inches (381 mm) high by 6 inches (152 mm) deep; formed from 0.134-inch (3.42-mm) **OR** 0.075-inch (1.90-mm), **as directed**, nominal-thickness steel sheet. Line each compartment with mothproofed felt or nonabsorbing, closed-cell padding.
1) Compartments: Six.
b. Doors: Formed from same material as cabinet, supported by heavy-duty continuous bottom hinge, with attached tilt-out compartment with formed metal sides.
c. Locks: Snap **OR** Cylinder, **as directed**, type, keyed differently and master keyed, **as directed**; provide one lock for each compartment.
d. Mounting: Surface **OR** Recessed, with mounting flange formed from same material as body, **as directed**.
e. Finish: Factory primed for field painting **OR** Baked enamel or powder coat, **as directed**.

E. Security Key Cabinets
1. Cabinet: Minimum 16 inches (406 mm) wide by 24 inches (610 mm) high by 6-1/2 inches (165 mm) deep; formed from 0.134-inch (3.42-mm) nominal-thickness steel sheet. Provide 0.060-inch (1.52-mm) nominal-thickness, steel sheet interior panels, supported on pivots, for mounting 150 **OR** 300, **as directed**, paracentric or mogul keys.
2. Doors: Formed from same material as cabinet, supported by heavy-duty continuous side hinge welded to cabinet and door; with tumbler deadlock.
3. Cross-Index System: Set up by key control manufacturer; include labels, two sets of key tags with self-locking key holders, key-gathering envelopes, temporary and permanent markers, and the following:
a. Card Index: Furnish four sets of index cards for recording key information. Include three receipt forms for each key-holding hook.
b. Computer Software: Furnish cross-index software for recording and reporting key-holder listings, tracking keys and lock and key history, and printing receipts for transactions. Include instruction manual.
4. Finish: Factory primed for field painting **OR** Baked enamel or powder coat, **as directed**.

F. Detention Bunks
1. Freestanding Single Bunks:
a. Bunk Pan: Formed from 0.134-inch (3.42-mm) **OR** 0.105-inch (2.66-mm), **as directed** nominal-thickness steel sheet, perforated with at least six holes, **as directed**.
1) Size: Minimum 27 inches (689 mm) wide by 76 inches (1930 mm) long with bunk pan 14 inches (356 mm) above floor.
2) Turn up edges of back and sides and turn down edge of front **OR** back, sides, and front, **as directed**, with minimum 2-inch (51-mm) flanges.
b. Drawer: Minimum 21 inches (533 mm) wide by 24 inches (610 mm) deep by 5 inches (127 mm) high, with full-width integral pull formed from steel sheet **OR** solid-steel bar pull, **as directed**; formed from 0.134-inch (3.42-mm) nominal-thickness steel sheet.

c. Legs and Frames: Formed from 2-by-2-by-3/16-inch (51-by-51-by-4.8-mm) steel angle welded at connections to each other and to bunk pan; provide four legs for each bunk.
d. Mounting Plates: Formed from 1/4-inch- (6-mm-) thick steel plate punched with one hole for floor anchorage; provide one mounting plate for each leg.
e. Finish: Factory primed for field painting **OR** Baked enamel or powder coat, **as directed**.

2. Freestanding Double Bunks:
   a. Bunk Pan: Formed from 0.134-inch (3.42-mm) **OR** 0.105-inch (2.66-mm), **as directed**, nominal-thickness steel sheet, each pan perforated with at least six holes, **as directed**.
      1) Size: Minimum 27 inches (689 mm) wide by 76 inches (1930 mm) long with lower bunk pan 14 inches (356 mm) above floor and upper bunk pan at least 49 inches (1245 mm) above floor.
      2) Upper and Lower Bunks: Turn up edges of back and sides and turn down edge of front **OR** back, sides, and front, **as directed**, with minimum 2-inch (51-mm) flanges.
      3) Upper Bunk: Turn up edges of back and sides and turn down edge of front **OR** back, sides, and front, **as directed**, with minimum 2-inch (51-mm) flanges.
      4) Lower Bunk: Turn up edges of back and sides and turn down edge of front, with minimum 2-inch (51-mm) flanges.
   b. Drawers: Two; minimum 21 inches (533 mm) wide by 24 inches (610 mm) deep by 5 inches (127 mm) high, with full-width integral pull formed from steel sheet **OR** solid-steel bar pull, **as directed**; formed from 0.134-inch (3.42-mm) nominal-thickness steel sheet.
   c. Legs and Frames: Formed from 2-by-2-by-3/16-inch (51-by-51-by-4.8-mm) steel angle welded at connections to each other and to bunk pan; provide four legs for each bunk.
   d. Mounting Plates: Formed from 1/4-inch- (6-mm-) thick steel plate punched with one hole for floor anchorage; provide one mounting plate for each leg.
   e. Assembly: Factory assembled **OR** Knocked down for field assembly, **as directed**.
   f. Finish: Factory primed for field painting **OR** Baked enamel or powder coat, **as directed**.
3. Wall-Mounted Bunks:
   a. Bunk Pan: Formed from 0.134-inch (3.42-mm) **OR** 0.105-inch (2.66-mm), **as directed**, nominal-thickness steel sheet, perforated with at least six holes, **as directed**.
      1) Size: Minimum 27 inches (689 mm) wide by 76 inches (1930 mm) long with bunk pan 2 inches (51 mm) from wall.
      2) Turn up edges of back and sides and turn down edge of front **OR** back, sides, and front, **as directed**, with minimum 2-inch (51-mm) flanges.
   b. Drawer: Minimum 21 inches (533 mm) wide by 24 inches (610 mm) deep by 5 inches (127 mm) high, with full-width integral pull formed from steel sheet **OR** solid-steel bar pull, **as directed**; formed from 0.134-inch (3.42-mm) nominal-thickness steel sheet.
   c. Combination End Panel/Mounting Plate: Formed from 3/16-inch- (0.048-mm-) thick steel sheet welded at connections to bunk pan, with 2-inch (51-mm) flange for wall mounting; provide two end panel/mounting plates for each bunk.
   d. Finish: Factory primed for field painting **OR** Baked enamel or powder coat, **as directed**.

G. Detention Mattresses
1. General: Comply with 16 CFR 1632 and California Technical Bulletin 121 as determined by testing identical products by a testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
2. Core: Fire-resistive solid foam **OR** Fire-resistive densified polyester **OR** Cotton, with 10 percent boric acid treatment, tufted to nylon netting to retain shape, **as directed**.
3. Cover Fabric: Vinyl bonded to nylon scrim; with a minimum total weight of 10 oz./sq. yd. (339 g/sq. m). Fabricate cover of four-corner box construction with seams facing inside of detention mattress except end closing seam located at foot of mattress; sew with nylon thread in a double-lock stitch.
4. Thickness: 4 inches (102 mm) **OR** 6 inches (152 mm), **as directed**.

H. Detention Desks

1. Single-Seat, Floor-Mounted Desks:
   a. Desk Top: Formed from 0.134-inch (3.42-mm) nominal-thickness steel **OR** 0.105-inch (2.66-mm) nominal-thickness steel **OR** 0.141-inch- (3.57-mm-) thick, stainless-steel **OR** 0.062-inch- (1.59-mm-) thick, stainless-steel, **as directed**, sheet, with minimum 1-1/2-inch (38-mm) flanged edges.
   b. Pedestal: Provide two storage shelves with sides and shelves formed from 0.134-inch (3.42-mm) nominal-thickness steel.
   c. Legs: Formed from 1-1/2-inch-square by 3/16-inch- (38-mm-square by 4.8-mm-) thick steel tubing welded to desk top and mounting plate for an overall desk height of not less than 30 inches (762 mm).
   d. Seat: 12-inch (305-mm) diameter, formed from 0.134-inch (3.42-mm) nominal-thickness steel **OR** 0.075-inch (1.90-mm) nominal-thickness steel **OR** 0.141-inch- (3.57-mm-) thick, stainless-steel **OR** 0.062-inch- (1.59-mm-) thick, stainless-steel, **as directed**, sheet; reinforced with 0.134-inch (3.42-mm) nominal-thickness steel sheet, with minimum 1-1/2-inch (38-mm) flanged edges.
   e. Swivel Seat Support: Formed from 1-by-2-by-0.075-inch (25-by-51-by-1.90-mm) nominal-thickness steel tubing, 2-inch-OD-by-0.075-inch (51-mm-OD-by-1.90-mm) nominal-thickness steel tubing, or 3/8-inch- (9.5-mm-) thick, steel plate bar; with 1/2-inch (12.7-mm) pivot pin welded to legs.
   f. Towel Bar: Formed from 1/4-by-1-1/2-inch (6-by-38-mm) steel **OR** stainless-steel, **as directed**, plate, mounted on one side of desk.
   g. Mounting Plates: Formed from 1/4-inch- (6-mm-) thick steel plate punched with one hole for floor anchorage; provide one mounting plate for each leg.
   h. Steel Finish: Factory primed for field painting **OR** Baked enamel or powder coat, **as directed**.
   i. Stainless-Steel Finish: No. 3.
      1) Size: Minimum 36 inches (914 mm) wide by 15-1/2 inches (381 mm) deep.
2. Wall-Mounted Desk and Seat:
   a. Desk: Formed from 0.134-inch (3.42-mm) nominal-thickness steel **OR** 0.141-inch- (3.57-mm-) thick, stainless-steel, **as directed**, sheet, with minimum 1-1/2-inch (38-mm) flanged edges.
      1) Size: Minimum 12 inches (305 mm) wide by 18 inches (457 mm) deep **OR** 18 inches (457 mm) wide by 18 inches (457 mm) deep **OR** 24 inches (610 mm) wide by 18 inches (457 mm) deep **OR** 30 inches (762 mm) wide by 20 inches (508 mm) deep, **as directed**.
   b. Seat: Minimum 12 inches (305 mm) wide by 16 inches (406 mm) **OR** 18 inches (457 mm), **as directed**, deep; formed from 0.134-inch (3.42-mm) nominal-thickness steel **OR** 0.141-inch- (3.57-mm-) thick, stainless-steel, **as directed**, sheet, with minimum 1-1/2-inch (38-mm) flanged edges.
   c. Steel Finish: Factory primed for field painting **OR** Baked enamel or powder coat, **as directed**.
   d. Stainless-Steel Finish: No. 3.

I. Detention Tables
1. Pedestal-Style Table:
   a. Tabletop: Formed from 0.134-inch (3.42-mm) nominal-thickness steel **OR** 0.105-inch (2.66-mm) nominal-thickness steel **OR** 0.109-inch- (2.78-mm-) thick, stainless-steel **OR** 0.078-inch- (1.98-mm-) thick, stainless-steel **OR** 0.062-inch- (1.59-mm-) thick, stainless-steel, **as directed**, sheet; reinforced with steel shapes or steel plate, with minimum 1-1/2-inch (38-mm) flanged edges.
      1) Size: Minimum 30 inches (762 mm) **OR** 40 inches (1016 mm), **as directed**, wide by length required for capacity by 30 inches (762 mm) **OR** 35 inches (889 mm), **as directed**, high.
      2) Game Top: Engrave, or otherwise integrally incorporate, checkerboard into tabletop.

b. Seats: 12-inch (305-mm) diameter, formed from 0.105-inch (2.66-mm) nominal-thickness steel **OR** 0.075-inch (1.90-mm) nominal-thickness steel **OR** 0.078-inch- (1.98-mm-) thick, stainless-steel **OR** 0.062-inch- (1.59-mm-) thick, stainless-steel, **as directed**, sheet; reinforced with 0.134-inch (3.42-mm) nominal-thickness steel plate, with minimum 1-1/2-inch (38-mm) flanged edges.
c. Pedestal Supports: Formed from 3-inch-square by 3/16-inch- (76-mm-square by 4.8-mm-) **OR** 4-inch-square by 0.134-inch- (102-mm-square by 3.42-mm-), **as directed**, thick steel tubing welded to top and base plate. Provide two pedestals for tables with capacity of more than four persons.
d. Seat Framing: Formed from 3-inch-square by 0.134-inch- (76-mm-square by 3.42-mm-) **OR** 3-by-2-by-3/16-inch- (76-by-51-by-4.8-mm-), **as directed**, thick steel tubing welded to pedestal supports.
e. Base Plate: Minimum 16-inch- (406-mm-) square, 1/4-inch- (6-mm-) thick steel plate punched with four holes for floor anchorage.
f. Capacity: Four persons **OR** Six persons **OR** Eight persons **OR** As indicated on Drawings, **as directed**.
g. Steel Finish: Factory primed for field painting **OR** Baked enamel or powder coat, **as directed**.
h. Stainless-Steel Finish: No. 3.

2. Bench-Style Table:
a. Tabletop: Formed from 0.134-inch (3.42-mm) nominal-thickness steel **OR** 0.105-inch (2.66-mm) nominal-thickness steel **OR** 0.109-inch- (2.78-mm-) thick, stainless-steel, **as directed**, sheet; reinforced with steel channel frame or steel plate, with minimum 1-1/2-inch (38-mm) flanged edges.
1) Size: Minimum 24 inches (610 mm) wide by length required for capacity by 30 inches (762 mm) **OR** 35 inches (889 mm), **as directed**, high.
b. Benches: 12 inches (305 mm) deep by length of tabletop, formed from 0.134-inch (3.42-mm) nominal-thickness steel **OR** 0.105-inch (2.66-mm) nominal-thickness steel **OR** 0.109-inch- (2.78-mm-) thick, stainless-steel **OR** 0.062-inch- (1.59-mm-) thick, stainless-steel, **as directed**, sheet, with minimum 1-1/2-inch (38-mm) flanged edges.
c. Vertical Supports: Formed from 8-inch (203-mm) hot-rolled steel channels or 0.164-inch- (4.18-mm-) thick, formed-steel channels; braced and welded, with steel base plates punched for floor anchorage. Provide three supports for tables with capacity of more than four persons.
d. Bench Supports: Formed from 2-by-2-1/2-by-1/4-inch- (51-by-64-by-6-mm-) thick steel angle or 2-inch-square by 1/4-inch- (51-mm-square by 6-mm-) thick steel tubing; welded to vertical supports.
e. Floor Anchor: Formed from steel angle punched for floor anchorage.
f. Capacity: Four persons **OR** Six persons **OR** Eight persons **OR** As indicated on Drawings, **as directed**.
g. Steel Finish: Factory primed for field painting **OR** Baked enamel or powder coat, **as directed**.
h. Stainless-Steel Finish: No. 3.

J. Detention Seating
1. Floor-Mounted Stool:
a. Seats: Minimum 12-inch (305-mm) diameter, formed from 0.134-inch (3.42-mm) nominal-thickness steel **OR** 0.075-inch (1.90-mm) nominal-thickness steel **OR** 0.125-inch- (3.18-mm-) thick, stainless-steel **OR** 0.062-inch- (1.59-mm-) thick, stainless-steel, **as directed**, sheet; reinforced with 0.134-inch- (3.42-mm-) thick steel sheet cut to interior dimension of seat, with minimum 1-1/2-inch (38-mm) flanged edges.
b. Seat Support: Formed from steel pipe or 2-inch-OD-by-0.075-inch- (51-mm-OD-by-1.90-mm-) thick steel tubing welded to seat reinforcement and base plate for an overall stool height of not less than 18 inches (457 mm).

c. Base Plate: Minimum 6-by-1/4-inch- (152-by-6-mm-) thick, square **OR** round, **as directed**, steel punched with four holes for floor anchorage.
d. Steel Finish: Factory primed for field painting **OR** Baked enamel or powder coat, **as directed**.
e. Stainless-Steel Finish: No. 3.

2. Wall-Mounted Stool:
   a. Seat: Minimum 12-inch (305-mm) diameter, formed from 0.134-inch (3.42-mm) nominal-thickness steel **OR** 0.075-inch (1.90-mm) nominal-thickness steel **OR** 0.125-inch- (3.18-mm-) thick, stainless-steel **OR** 0.078-inch- (1.98-mm-) thick, stainless-steel, **as directed**, sheet; reinforced with 0.134-inch- (3.42-mm-) thick steel sheet cut to interior dimension of seat, with minimum 1-1/2-inch (38-mm) flanged edges.
   b. Seat Support: Formed from 1-by-2-by-0.075-inch- (25-by-51-by-1.90-mm-) thick steel tubing, 2-inch-OD-by-0.075-inch- (51-mm-OD-by-1.90-mm-) thick steel tubing or 3/8-inch- (9.5-mm-) thick, steel plate bar; welded to seat reinforcement and wall bracket.
   c. Swivel Wall Bracket: Minimum 1/2-inch (12.7-mm) pivot pin, with 3/8-inch- (9.5-mm-) thick steel plate for welding to embedded steel plate **OR** for welding to steel wall **OR** punched with four holes for wall anchorage, **as directed**.
   d. Steel Finish: Factory primed for field painting **OR** Baked enamel or powder coat, **as directed**.
   e. Stainless-Steel Finish: No. 3.
3. Floor-Mounted Bench:
   a. Bench Top: Formed from 0.134-inch (3.42-mm) nominal-thickness steel **OR** 0.105-inch (2.66-mm) nominal-thickness steel **OR** 0.141-inch- (3.57-mm-) thick, stainless-steel **OR** 0.109-inch- (2.78-mm-) thick, stainless-steel, **as directed**, sheet, with minimum 1-1/2-inch (38-mm) flanged edges.
      1) Size: Minimum 12 inches (305 mm) deep by 48 inches (1219 mm) **OR** 60 inches (1524 mm) **OR** 72 inches (1829 mm) **OR** 96 inches (2438 mm), **as directed**, long.
   b. Supports: Formed from 0.164-inch- (4.18-mm-) thick, formed-steel channels 2-1/2-inch-OD-by-0.0677-inch- (64-mm-OD-by-1.7-mm-) thick steel tubing; welded to bench and base plate for an overall bench height of not less than 18 inches (457 mm). Provide three supports for benches with length of more than 72 inches (1829 mm).
   c. Base Plates: Minimum 8-inch-square by 1/4-inch- (203-mm-square by 6-mm-) thick steel plate punched with four holes for floor anchorage.
   d. Capacity: Four persons **OR** Six persons **OR** Eight persons **OR** As indicated on Drawings, **as directed**.
   e. Steel Finish: Factory primed for field painting **OR** Baked enamel or powder coat, **as directed**.
   f. Stainless-Steel Finish: No. 3.

K. Fabrication
1. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
2. Coordinate dimensions and attachment methods of detention furniture with those of adjoining construction to produce integrated assemblies with closely fitting joints and with edges and surfaces aligned unless otherwise indicated.
3. Shear and punch metals cleanly and accurately. Remove burrs.
4. Form and grind edges and corners to be free of sharp edges or rough areas.
   a. Fabricate detention furniture with no more than 1/32-inch (0.8-mm) gap between component materials. Weld edges that cannot be crimped to meet tolerance so as to provide a seamless joint with no place for concealment of contraband.
5. Form metal in maximum lengths to minimize joints. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.
6. Weld corners and seams continuously to comply with referenced AWS standard and the following:

a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
b. Obtain fusion without undercut or overlap.
c. Remove welding flux immediately.
d. Finish exposed welds and surfaces smooth and blended at exposed connections so that no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
e. Weld before finishing components to greatest extent possible. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

7. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure detention furniture rigidly in place and to support expected loads. Build in straps, plates, and brackets as needed to support and anchor fabricated items to adjoining construction. Reinforce formed-metal units as needed to attach and support other construction.
8. Cut, reinforce, drill, and tap detention furniture as indicated to receive hardware, security fasteners, and similar items.
9. Form exposed work true to line and level with accurate angles, surfaces, and straight sharp edges.
10. Form exposed connections with hairline joints, flush and smooth using concealed fasteners where possible. Use exposed security fasteners of type indicated or, if not indicated, flat-head (countersunk) security fasteners. Locate joints where least conspicuous.
11. Attach drawer slides **OR** shelves, **as directed**, to furniture by welding **OR** with security fasteners, **as directed**.

L. Steel Finishes

1. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning" or SSPC-SP 8, "Pickling". After cleaning, apply a conversion coating suited to the organic coating to be applied over it.
2. Factory Prime Finish: Apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
3. Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).
   a. Color and Gloss: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.

M. Stainless-Steel Finishes

1. General: Remove tool and die marks and stretch lines or blend into finish. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
2. Intermediate Polish Finish: No. 3 unless otherwise indicated.
3. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

1.3 EXECUTION

A. Installation

1. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing detention furniture to in-place construction. Include threaded fasteners for concrete and masonry inserts, security fasteners, and other connectors.
2. Cutting, Fitting, and Placement: Obtain manufacturer's written approval for cutting, drilling, and fitting required for installing detention furniture. Set detention furniture accurately in location,

alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

3. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry or similar construction.
4. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
5. Field Welding: Comply with the following requirements:
   a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   b. Obtain fusion without undercut or overlap.
   c. Remove welding flux immediately.
   d. Finish exposed welds and surfaces smooth and blended at exposed connections so that no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
   e. Fillet Welds: Minimum size of 1/8 inch by 1-1/2 inches (3 mm by 38 mm) long, spaced not greater than 12 inches (305 mm) o.c. Fill spaces between welds with security sealant **OR** auto body filler, **as directed**, where weld is exposed.
      OR
      Fillet Welds: Continuous.
6. Adjust doors and latches of detention gun lockers and key cabinets to operate easily without binding. Verify that integral locking devices operate properly.
7. Assemble detention furniture requiring field assembly with security fasteners with no exposed fasteners on exposed faces and frames.
8. Anchor furniture with security fasteners **OR** by welding **OR** as indicated on Drawings, **as directed**, to floors and walls at intervals required by expected loads, but not more than 12 inches (305 mm) o.c.
   a. Install anchors through backup reinforcing plates where necessary to avoid metal distortion.
   b. Use security fasteners with head styles appropriate for installation requirements, strength, and finish of adjacent materials, except that a maximum of two different sets of tools shall be required to operate security fasteners for Project. Provide stainless-steel security fasteners in painted materials.
   c. Weld nuts onto cast-in-place anchors after installation so as to be nonremovable.
9. Apply security sealant **OR** auto body filler, **as directed**, at all exposed gaps between detention furniture and adjacent construction greater than 1/16 inch (1.6 mm).
10. Install one detention mattress for each detention bunk.

B. Field Quality Control
1. Detention Specialist shall inspect **OR** Inspect, **as directed**, installed products to verify compliance with requirements. Prepare inspection reports and indicate compliance with and deviations from the Contract Documents.
2. Prepare field quality-control certification endorsed by Detention Specialist, **as directed**, that states installed products and their installation comply with requirements in the Contract Documents.

C. Cleaning And Protection
1. Touchup Painting: Immediately after erection, clean bolted connections and abraded areas of shop paint, and paint exposed areas with same material used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

END OF SECTION 10 86 00 00

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Task	Specification	Specification Description
10 86 00 00	10 28 13 13a	Detention Toilet Accessories

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Task	Specification	Specification Description
11 12 13 00	01 22 16 00	No Specification Required

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SECTION 11 12 16 00 - PARKING CONTROL EQUIPMENT

1.1 GENERAL

A. Description Of Work
  1. This specification covers the furnishing and installation of materials for parking control equipment. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
  1. Section Includes:
    a. Automatic barrier gates.
    b. Vehicle detectors.
    c. Traffic controllers.
    d. Entry terminal ticket dispensers.
    e. Exit terminals.
    f. Pay stations.
    g. Fee computers.
    h. Parking facility management software.
    i. Access control units.

C. System Description
  1. Parking Control System: Intended to be used for the following types of parking management:
    a. Transient Parking: Hourly rated parking, with fee paid while entering **OR** exiting, **as directed**.
    b. Monthly Parking: Monthly rated parking, with fee paid by the month and access gained by access control card.
    c. Flat-Rate Parking: Unlimited-duration parking, with free gate entry and fixed-fee amount paid while exiting.
    d. Special-Event Parking: Duration-of-event parking, with fee paid while entering with gates up or down.
    e. Limited Date(s) and Time(s) Parking: Limited-duration parking, with predetermined fee access control card.
    f. Merchant Validated Parking: Fee set, reduced, or waived by merchant validation, with free gate entry and fee paid while exiting.
    g. Valet Parking: Assisted parking, with fee paid while entering or exiting.
    h. Hotel Guest Parking: Unlimited access for duration of stay, with access gained by access control card.

D. Submittals
  1. Product Data: For each type of product indicated.
  2. Shop Drawings: For parking control equipment. Include plans, elevations, sections, details, and attachments to other work.
    a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
    b. Wiring Diagrams: For power, signal, and control wiring.
  3. Field quality-control reports.
  4. Operation and Maintenance Data: For parking control equipment to include in emergency, operation, and maintenance manuals.
  5. Software and Firmware Operational Documentation:
    a. Software operating and upgrade manuals.
    b. Program Software Backup: On magnetic media or compact disk, complete with data files.
    c. Device address list.

d. Printout of software application and graphic screens.

E. Quality Assurance
1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Preinstallation Conference: Conduct conference at Project site.

F. Software Service Agreement
1. Technical Support: Beginning with Final Completion, provide software support for two, **as directed**, years.
2. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two, **as directed**, years from date of Final Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
   a. Provide 30, **as directed**, days' notice to the Owner to allow scheduling and access to system and to allow the Owner to upgrade computer equipment if necessary.

1.2 PRODUCTS

A. Materials
1. Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:
   a. Sheet: ASTM B 209 (ASTM B 209M).
   b. Extruded Shapes: ASTM B 221 (ASTM B 221M).
2. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.
3. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, commercial quality, with G60 (Z180) coating designation; mill phosphatized.
4. Stainless-Steel Sheet: ASTM A 666, Type 304.
5. Anchorages: Anchor bolts, hot-dip galvanized according to ASTM A 153/A 153M and ASTM F 2329.

B. Automatic Barrier Gates
1. General: Provide UL-approved parking control device consisting of operator and controller housed in a weathertight, tamper-resistant cabinet enclosure with gate arm. Device shall be activated by a signal from access or revenue control device. Fabricate unit with gate-arm height in down position of not more than 35 inches (889 mm) above pavement to prevent even small vehicles from passing under gate arm.
2. Standard: Provide barrier gates and gate operators that are listed and labeled according to UL 325 by a qualified testing agency. Provide barrier gates that comply with ASTM F 2200, **as directed**.
3. Controller: Factory-sealed, solid-state, plug-in type, with galvanized-steel box for wiring connections.
   a. Type: Noncommunicating.
      1) Capable of logic for one- and two-way lanes.
      2) Separate momentary contacts for transient patrons, monthly patrons, vehicle entries, and vehicle exits.
   b. Type: Communicating.
      1) Real-time communication of lane counts, status messages, and execute commands.
      2) Monitor illegal entries and exits, tailgates, tickets, monthlies, and backouts.
      3) Status messages for gate up too long, backouts, ticket in chute, and gate-arm rebound.

4) Communication commands for resetting loops, turning "Full" signs on/off, raising and lowering gate arm, and disabling ticket dispensers **OR** card readers, **as directed**.

c. Features: Equip unit with the following:

1) Able to store successive inputs and sequentially processing each one.
2) Automatic instant-reversing obstacle detector mechanism that stops downward motion of gate arm if arm contacts or nears an object and that immediately returns arm to upward position. Include a 0- to 60-second, variable-time reset device.
3) On-off power supply switch.
4) Automatic-manual switch.
5) Differential counter.
6) Directional arming logic.
7) RS-422 communication port.
8) Broken gate-arm monitoring.
9) Programmable automatic, **as directed**, timer.
10) Internal resettable **OR** non-resettable, **as directed**, counters.
11) Thermal-overload protection with manual reset.
12) Plug-in connectors for two **OR** three, **as directed**, vehicle loop detectors.
13) Thermostatically controlled heater with on/off/auto switch.
14) Diagnostic mode for on-site testing, with LEDs for inputs and outputs, **as directed**.
15) Automatic and continuous testing of inputs and outputs.
16) Switch to test motor and limit switches.
17) Emergency manual disconnect.
18) Battery backup.
19) Single, 115-V ac grounded power receptacle.
20) Reversible arm capability for right- or left-handed operation.

4. Cabinets: Fabricated from metal sheet with seams welded and ground smooth; approximately 15 inches square by 40 inches tall (381 mm square by 1016 mm tall). Provide single, gasketed access door for each cabinet with flush-mounted locks. Furnish two keys for each lock, all locks keyed alike, **as directed**. Fabricate cabinet with internal reinforcing and four mounting holes accessible only from inside cabinet.

a. Material: Not less than 0.097-inch- (2.5-mm-) thick, galvanized-, **as directed**, steel sheet or 0.125-inch- (3.2-mm-) thick aluminum sheet.

1) Finish cabinet, interior and exterior, with manufacturer's standard white **OR** yellow, **as directed**, baked-enamel finish over primer.

b. Material: Not less than 0.109-inch- (2.8-mm-) thick, stainless-steel sheet.

1) Finish cabinet exterior with No. 4 finish.
OR
Finish cabinet, interior and exterior, with manufacturer's standard white **OR** yellow, **as directed**, baked-enamel finish over primer.

5. Straight Gate Arm: 1-by-4-inch nominal- (19-by-89-mm actual-) size pine or redwood **OR** 0.097-inch- (2.5-mm-) thick steel **OR** Fiberglass, PVC, or polycarbonate **OR** Aluminum, **as directed**, with painted finish and black diagonal stripes on traffic-side face. Provide mounting flange with breakaway feature to ensure clean break if arm is struck by vehicle.

a. Length: 10 feet (3.0 m) **OR** 12 feet (3.7 m) **OR** As indicated on Drawings, **as directed**.

6. Folding Gate Arm: Two pieces of 1-by-4-inch nominal- (19-by-89-mm actual-) size pine or redwood joined together with metal side brackets; with painted finish and black diagonal stripes on traffic-side face. Provide mounting flange with breakaway feature to ensure clean break if arm is struck by vehicle.

a. Length: 10 feet (3.0 m) **OR** 12 feet (3.7 m) **OR** As indicated on Drawings, **as directed**.

7. Straight Gate Arm with Counterbalance: 1-by-6-inch nominal- (19-by-140-mm actual-) size pine or redwood with steel counterweights; with painted finish and black diagonal stripes on traffic-side face. Provide mounting flange with breakaway feature to ensure clean break if arm is struck by vehicle.

a. Length: 16 feet (4.9 m) **OR** As indicated on Drawings, **as directed**.

8. Wishbone-Style Gate Arm: 1-by-4-inch nominal- (19-by-89-mm actual-) size pine or redwood **OR** 0.097-inch- (2.5-mm-) thick steel, **as directed**, formed into wishbone configuration, with steel

counterweights; with painted finish and black diagonal stripes on traffic-side face. Provide mounting flange with breakaway feature to ensure clean break if arm is struck by vehicle.
   a. Length: 14 feet (4.3 m) **OR** As indicated on Drawings, **as directed**.
9. Operator: 1/3 **OR** 1/2, **as directed**, hp; 60-Hz, single-phase, instant-reversing, continuous-duty motor for operating gate arm. Transmit power to gate-arm drive shaft through speed reducer to harmonic-acting crank and connecting rod. Fabricate crank, rod, and drive shaft of galvanized solid bar steel. Provide an operable cam for adjusting arm travel.
   a. Opening Time: Three **OR** Six, **as directed**, seconds.
   b. Inherently adjustable torque limiting clutch for safety.
10. Accessories:
   a. Audible alarm that activates as part of a safety device system.
   b. Additional obstruction detector; noncontact infrared **OR** photoelectric **OR** radio-frequency barrier, **as directed**.
   c. Barrier-arm warning safety signs on both sides of unit limiting traffic to vehicular traffic.
   d. Low-voltage yellow **OR** red, **as directed**, warning lights that illuminate when gate is in down position.
   e. Low-voltage light on cabinet top that flashes or changes from red to green when barrier gate is operating.
   f. Manually operated crank for emergency operation.
   g. Local authorities' emergency access as directed by the Owner.
   h. Gate-arm tip support with electromagnetic lock, **as directed**.

C. Vehicle Detectors
1. Vehicle Loop Detector System: Provide self-tuning electronic presence detector with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light designed to detect presence or transit of a vehicle over an embedded loop of wire and to emit signal activating gate-arm operator. Include automatic closing timer with adjustable time delay before closing, timer cut-off switch, **as directed**, and vehicle loop detector designed to open and close gate arm **OR** hold gate arm open until traffic clears, **as directed**. Provide number of loops consisting of multiple strands of wire, number of turns, loop size, and method of placement at location shown on Drawings, as recommended in writing by detection system manufacturer for function indicated.
   a. Field-Assembled Loop: Wire, in size indicated for field assembly, and sealant; style for pave-over **OR** saw-cut, **as directed**, installation.
   b. Factory-Formed Loop: Wire, preformed in size indicated; style for pave-over **OR** saw-cut, **as directed**, installation.
   c. System Performance: Capable of the following:
      1) Recognize two vehicles within 6 inches (152 mm) of each other on standard-sized loop.
      2) Recognize vehicle direction by detecting vehicle moving from one loop to another.
      3) Generate reverse count if vehicle backs up after generating directional count in forward direction.
      4) Continuous diagnostic monitoring for intermittently operating and failed loops.
      5) Crosstalk test between adjacent loops.
2. Active Infrared Vehicle Detector: Provide retroreflective **OR** emitter/receiver, **as directed**,-type presence detector with adjustable detection zone pattern and sensitivity, designed to detect the presence or transit of vehicle in gate-arm pathway by interrupting infrared beam in zone pattern and to emit signal activating gate-arm operator. Include automatic closing timer with adjustable time delay before closing, timer cut-off switch, **as directed**, and vehicle presence detector designed to open and close gate arm **OR** hold gate arm open until traffic clears, **as directed**.

D. Traffic Controllers
1. Penetrating Type: Provide directional enforcement system consisting of multiple raised teeth that allow vehicular traffic in one direction and that puncture tires of vehicular traffic in the other direction. Fabricate system from steel plate contained in welded steel frame.

a. Mounting: Surface **OR** Recessed, **as directed**.
b. Operation: Manual, with each tooth controlled by torsion spring **OR** Electromechanical **OR** Hydraulic, **as directed**.
c. Latch Down: Allow disarming for two-way traffic flow. Provide one, **as directed**, tool(s) for latch-down operation.
d. Illuminated Warning Signs: Single **OR** Double, **as directed**,-faced warning signs consisting of fluorescent lamps with cold-start ballasts contained in welded steel bodies with baked-enamel finish and fiberglass sign faces. Provide base sleeves and posts for post mounting, **as directed**.
    1) Sign Copy: "Wrong Way, Stop, Severe Tire Damage" **OR** "Warning, Do Not Back Up, Tire Damage," **as directed**.

2. Nonpenetrating Type: Provide directional enforcement system consisting of spring-activated steel curb that allows traffic in only one direction. Fabricate system from steel plate contained in welded steel frame.
    a. Mounting: Surface **OR** Recessed, **as directed**.
    b. Operation: Manual **OR** Electromechanical **OR** Hydraulic, **as directed**.

E. Entry Terminal Ticket Dispensers

1. General: Provide entry terminal ticket dispensers, consisting of ticket-printing and issuing mechanisms, ticket magazines, thermal printers, and controllers housed in cabinet enclosures.
    a. Features: Include the following:
        1) Time and date display.
        2) Time Indicator: 24-hour cycle with A.M. and P.M. **OR** military-time, **as directed**, clock mechanism.
        3) Voice annunciation.
        4) Tickets: Standard paper **OR** Magnetic-stripe **OR** Barcode, **as directed**, type.
        5) Removable ticket tray with capacity of 5000, **as directed**, fan-folded tickets.
        6) Operation: Standalone **OR** Online communication to remote computer, **as directed**.
        7) Battery backup for clock and RAM memory.
        8) RS-422 communication port.
        9) Thermostatically controlled heater with on/off/auto switch.
        10) Access **OR** Credit, **as directed**, card acceptance with activation slot and "Insert Ticket/Card" message.
        11) License plate recognition.
        12) Multiple ticket option for valet parking.
        13) Intercom.

2. System Performance: Activation by button with "Push for Ticket" message **OR** vehicle detector **OR** card reader, **as directed**. On activation, unit automatically records entry time and date on ticket, sounds buzzer, **as directed**, and dispenses ticket.
    a. Automatic ticket validation.
    b. Program ticket numbering.
    c. Low-ticket alarm.
    d. Out-of-ticket alarm.
    e. Ticket jam detection.
    f. Print test ticket.

3. Cabinets: Fabricated from metal sheet with seams welded and ground smooth, approximately 15 inches square by 40 inches tall (381 mm square by 1016 mm tall); consisting of base and top components. Provide single, gasketed access door for each base component with flush-mounted locks. Furnish two keys for each lock, all locks keyed alike, **as directed**. Fabricate cabinet with internal reinforcing and four mounting holes accessible only from inside cabinet. Fabricate top component so it can be unlocked and opened for ticket loading and maintenance. Include flush-mounted lock in rear of top, keyed the same as base component lock.
    a. Material: Not less than 0.097-inch- (2.5-mm-) thick, galvanized-, **as directed**, steel sheet or 0.125-inch- (3.2-mm-) thick aluminum sheet.
        1) Finish cabinet, interior and exterior, with manufacturer's standard white **OR** yellow, **as directed**, baked-enamel finish over primer.

b. Material: Not less than 0.109-inch- (2.8-mm-) thick, stainless-steel sheet.
   1) Finish cabinet exterior with No. 4 finish.
      OR
      Finish cabinet, interior and exterior, with manufacturer's standard white **OR** yellow, **as directed**, baked-enamel finish over primer.

4. Ticket-Dispensing Mechanisms: Removable assembly, with self-sharpening ticket cutter or ticket burster and plug-in controller.

F. Exit Terminals

1. General: Provide exit terminals consisting of ticket collectors, magnetic-stripe ticket readers, LCD, **as directed**, displays, thermal printers, and controllers housed in cabinet enclosures. Provide "Please Insert Ticket" sign on side of cabinet visible to driver.
   a. Features: Include the following:
      1) Operation: Standalone **OR** Online communication to remote computer, **as directed**.
      2) Battery backup for clock and RAM memory.
      3) Thermostatically controlled heater with on/off/auto switch.
      4) RS-422 communication port.
      5) Access **OR** Credit, **as directed**, card acceptance with activation slot and "Insert Ticket/Card" message.
      6) Intercom.
2. System Performance: Capable of the following:
   a. Activated by vehicle detector **OR** card reader, **as directed**.
   b. Print receipts on demand.
   c. Voice annunciation.
   d. Program facility code.
   e. Program grace period.
   f. Program display.
   g. Program timer for closing barrier gate.
   h. Reports for events and exception events.
   i. Built-in service diagnostics.
3. Operation: Inserting exit ticket into exit ticket reader results in the following actions:
   a. Valid Exit Ticket: Exit ticket reader captures ticket and automatically sends signal to raise barrier gate.
   b. Invalid Exit Ticket: Exit ticket reader rejects ticket and displays "Pay Cashier First" message.
   c. Exit Ticket with Elapsed Grace Time: Exit ticket reader rejects ticket and displays "Return to Cashier" message.
4. Cabinets: Fabricated from metal sheet with seams welded and ground smooth; approximately 15 inches square by 40 inches tall (381 mm square by 1016 mm tall). Provide single, gasketed access door for each cabinet with flush-mounted locks. Furnish two keys for each lock, all locks keyed alike, **as directed**. Fabricate cabinet with internal reinforcing and four mounting holes accessible only from inside cabinet.
   a. Material: Not less than 0.097-inch- (2.5-mm-) thick, galvanized-, **as directed**, steel sheet or 0.125-inch- (3.2-mm-) thick aluminum sheet.
      1) Finish cabinet, interior and exterior, with manufacturer's standard white **OR** yellow, **as directed**, baked-enamel finish over primer.
   b. Material: Not less than 0.109-inch- (2.8-mm-) thick, stainless-steel sheet.
      1) Finish cabinet exterior with No. 4 finish.
         OR
         Finish cabinet, interior and exterior, with manufacturer's standard white **OR** yellow, **as directed**, baked-enamel finish over primer.

G. Pay Stations

1. General: Provide self-contained cashiering central **OR** entry **OR** exit, **as directed**, pay stations designed for self-service operation; consisting of magnetic-stripe ticket dispensers and, **as**

directed, readers/validators, LCD, **as directed**, displays, fee computers, controllers, **as directed**, and thermal printers housed in a combined enclosure.

a. Features: Include the following:
   1) Operation: Standalone **OR** Online communication to remote computer, **as directed**.
   2) Battery backup for clock and RAM memory.
   3) Thermostatically controlled heater with on/off/auto switch.
   4) Access card acceptance.
   5) Intercom.

2. System Performance: Capable of the following:
   a. Compute multiple parking fees based on entry times on ticket from ticket dispenser.
   b. Compute multiple taxes by percent and fixed amount.
   c. Program lost ticket function.
   d. Display fee.
   e. Accept payment by cash credit card **OR** debit card **OR** merchant ticket, **as directed**.
   f. Compute change.
   g. Print receipts on demand.
   h. Print validation on ticket.
   i. Voice annunciation.
   j. Print audit trail.
   k. Program six, **as directed**, fee structures.
   l. Program time.
   m. Program merchant validations.
   n. Test mode to verify accuracy of fee structure program.
   o. Built-in service diagnostics.
   p. Print cash audit, revenue, operational, and statistical reports on demand.
   q. Duress alarm output for emergencies.
   r. Battery backup.

3. Cabinets: Fabricated from cold-rolled steel sheet with seams welded and ground smooth, approximately 36 inches wide by 18 inches deep by 60 inches tall (914 mm wide by 457 mm deep by 1524 mm tall). Provide single, gasketed access door with flush-mounted locks. Furnish two keys for each lock, all locks keyed alike, **as directed**. Fabricate cabinet with internal reinforcing and four mounting holes accessible only from inside cabinet.
   a. Finish cabinet, interior and exterior, with manufacturer's standard white **OR** yellow, **as directed**, baked-enamel finish over primer.

H. Fee Computers

1. Fee Computer System: Provide modular PC-based, **as directed**, system consisting of fee computer terminal, cash drawer, **OR** two cash drawers, **as directed**, standard ticket reader, **OR** magnetic-stripe ticket reader, **OR** barcode ticket reader, **as directed**, and detachable printer. Register permanent record of each transaction in computer's memory.
   a. Features: Provide the following:
      1) Battery backup for clock and RAM memory.
      2) RS-422 communication port.
      3) Keyed **OR** Keyless-membrane, **as directed**, keypad.

2. System Performance: Capable of the following:
   a. Compute multiple parking fees based on entry times on ticket from ticket dispenser.
   b. Compute multiple taxes by percent and fixed amount.
   c. Program lost ticket function.
   d. Display fee on remote fee display device.
   e. Accept payment by cash check **OR** credit card **OR** debit card **OR** merchant ticket, **as directed**.
   f. Control independent cash drawer.
   g. Compute change.
   h. Print receipts.
   i. Print validation on ticket.
   j. Print audit trail.

k. Interface to automatic barrier gate.
l. Program six, **as directed**, fee structures.
m. Program time.
n. Program keys.
o. Program special events validations.
p. Program automatic activation for limited date(s) and time(s) validations.
q. Program merchant validations.
r. Program valet parking.
s. Program hotel guest parking.
t. Three levels of security, including cashier, supervisor, and master.
u. Recall last transaction.
v. Test mode to verify accuracy of fee structure program.
w. Built-in service diagnostics.
x. View cash audit, revenue, operational, and statistical reports on screen or print on demand.
y. Duress alarm output for emergencies.
z. Battery backup.

3. Cash Drawer: Fabricated with a removable tray and drawer, with five compartments for paper currency and five compartments for coins.
4. Remote Fee Display: Single-faced signs designed for use with fee computer, consisting of 1-inch- (25-mm-) tall, LCD or LED displays contained in welded steel bodies with baked-enamel finish.
   a. Messages: Amount due, "Thank You," "Closed," and time in A.M./P.M. format.
   b. Mounting: Front of cashier's booth **OR** 42-inch- (1067-mm-) high pedestal, **as directed**.

I. Miscellaneous Parking Control Equipment
1. Lot "Full" Signs: Single-faced signs consisting of illumination source contained in welded steel bodies with extended hood and baked-enamel finish. Sign copy shall be 4 inches (102 mm), **as directed**, tall.
   a. Type: Flashing **OR** Nonflashing, **as directed**.
   b. Operation: Manual by push button **OR** Automatic by barrier gate controller, **as directed**.
   c. Illumination: Traffic signal lamps and colored **OR** Neon tube and clear, **as directed**, fiberglass sign face.
   d. Mounting: Top of barrier gate cabinet **OR** 42-inch- (1067-mm-) high pedestal, **as directed**.

J. Parking Facility Management Software
1. General: Manufacturer's standard software that is compatible with security access control system and that provides automatic facility monitoring, supervision, and remote control of parking control equipment from one or more locations.
   a. System Performance: Capable of the following:
      1) Collect data for revenue and activity reporting.
      2) Collect data for access and space control.
      3) Track tickets.
      4) Program parking control equipment.

K. Access Control Units
1. General: Provide access control unit that activates barrier gates.
   a. Unit Housing: Fabricate from welded cold-rolled steel or aluminum sheet **OR** plastic, **as directed**, with weatherproof front access panel equipped with flush-mounted lock and two keys. Provide face-lighted unit fully visible at night.
      1) Steel Finish: Manufacturer's standard baked-enamel coating system.
2. Card Reader Controlled Unit: Functions only when authorized card is presented.
   a. System: Magnetically coded, single-code system activated by coded card **OR** Programmable, multiple-code capability permitting validating or voiding of individual cards, **as directed**.
      1) Permit four different access time periods.

b. Reader: Swipe type for magnetic-stripe **OR** barcode **OR** Wiegand, **as directed**, cards.
OR
Reader: Insertion type for magnetic-stripe **OR** barcode **OR** Wiegand, **as directed**, cards.
OR
Reader: Proximity type for proximity cards.

c. Operation: Standalone **OR** Online communication to remote parking control system computer **OR** Online communication to remote security access control system computer, **as directed**.

d. Features: Timed antipassback **OR** Limited-time usage **OR** Capable of monitoring and auditing barrier gate activity **OR** LCD display **OR** Programmable by PDA (personal digital assistant) by infrared interface, **as directed**.

e. Mounting: With pedestal **OR** Wall **OR** In enclosed cabinet **OR** As indicated on Drawings, **as directed**.

f. Cards: Provide number as directed by the Owner..
   1) Imprint cards: as directed by the Owner.

3. Digital Keypad Controlled Unit: Functions only when authorized code is entered on keyed **OR** keyless-membrane, **as directed**, keypad.
   a. System: Multiple-code capability of not less than five **OR** 100 **OR** 500, **as directed**, possible individual codes.
   OR
   System: Programmable, multiple-code capability permitting validating or voiding of not less than 100 **OR** 2500 **OR** 10,000, **as directed**, possible individual codes, consisting of one to six, **as directed**, digits, and permitting four different access time periods, **as directed**.
   b. Operation: Standalone **OR** Online communication to remote parking control system computer **OR** Online communication to remote security access control system computer, **as directed**.
   c. Features: Timed antipassback **OR** Limited-time usage **OR** Capable of monitoring and auditing barrier gate activity, **as directed**.
   d. Mounting: With pedestal **OR** Wall **OR** As indicated on Drawings, **as directed**.

4. Radio-Controlled System: Digital access control system consisting of code-compatible universal coaxial receiver, one per barrier gate, **OR**, where indicated on Drawings, **as directed**, remote antenna with coaxial cable and mounting brackets, and one permanently mounted **OR** four portable, **as directed**, transmitter(s) per receiver designed to operate barrier gates. Provide programmable transmitter with multiple-code capability permitting validating or voiding of not less than 1000 **OR** 10,000, **as directed**, codes per channel configured for the following functions:
   a. Transmitters: Single-button operated, with open **OR** open and close, **as directed**, functions.
   OR
   Transmitters: Triple-button operated, with open, close, and stop functions.
      1) Provide transmitters featuring two **OR** three **OR** four, **as directed**, independent channel settings controlling separate receivers for operating more than one barrier gate from each transmitter.

L. Aluminum Finishes

1. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.

M. Steel Finishes

1. Galvanizing: Hot-dip galvanize items as indicated to comply with the following:
   a. ASTM A 123/A 123M for iron and steel parking control equipment.
   b. ASTM A 153/A 153M and ASTM F 2329 for iron and steel hardware for parking control equipment.

2. Galvanized-Steel and Steel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.

N. Stainless-Steel Finishes
1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
   a. Run grain of directional finishes with long dimension of each piece.
   b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

1.3 EXECUTION

A. Preparation
1. Excavation for Traffic Controllers: Saw cut existing pavement for recessed traffic controllers and hand-excavate recesses to dimensions and depths and at locations as required by traffic controller manufacturer's written instructions and as indicated on Drawings.

B. Installation
1. General: Install parking control equipment as required for a complete and integrated installation.
   a. Rough-in electrical connections according to requirements specified in Division 22..
2. Automatic Barrier Gates: Anchor cabinets to concrete bases with anchor bolts or expansion anchors and mount barrier gate arms.
   a. Install barrier gates according to UL 325.
3. Vehicle Loop Detectors: Cut grooves in pavement and bury **OR** Bury, **as directed**, and seal wire loop at locations indicated on Drawings according to manufacturer's written instructions. Connect to parking control equipment operated by detector.
4. Traffic Controllers: Anchor controllers to recessed concrete bases **OR** driveway surfaces, **as directed**, with anchor bolts or expansion anchors.
5. Entry Terminal Ticket Dispensers, Pay Stations and Exit Terminals: Attach cabinets to concrete bases with anchor bolts or expansion anchors.
   a. Connect equipment to remote computer.
   b. Load ticket dispenser with supply of tickets.
6. Fee Computers: Install computers at locations indicated, including connecting to peripheral equipment and remote computers, **as directed**.
7. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
8. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".

C. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
3. Perform tests and inspections.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
4. Tests and Inspections:
   a. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

b. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

5. Parking control equipment will be considered defective if it does not pass tests and inspections.
6. Prepare test and inspection reports.

D. Adjusting

1. Adjust parking control equipment to function smoothly and lubricate as recommended by manufacturer.
2. Confirm that locks engage accurately and securely without forcing or binding.
3. After completing installation of exposed, factory-finished parking control equipment, inspect exposed finishes and repair damaged finishes.

E. Protection

1. Remove barrier gate arms during the construction period to prevent damage, and install them immediately before Final Completion.

END OF SECTION 11 12 16 00

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SECTION 11 12 16 00a - PREFABRICATED CONTROL BOOTHS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for prefabricated control booths. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes prefabricated steel and aluminum control booths.

C. Definition
1. ADA-ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines."

D. Performance Requirements
1. Structural Performance: Control booths shall withstand the effects of gravity loads and the loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

E. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
3. Samples: For control booths with factory-applied color finishes.
4. Delegated-Design Submittal: For control booths indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
5. Welding certificates.
6. Maintenance data.
7. Warranty: Sample of special warranty.

F. Quality Assurance
1. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   c. AWS D1.3, "Structural Welding Code - Sheet Steel."
2. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Safety Glazing Products: Category II materials complying with testing requirements in 16 CFR 1201.
5. Preinstallation Conference: Conduct conference at Project site.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair finish or replace wall panels that fail in materials or workmanship within five years from date of Final Completion.

1.2 PRODUCTS

A. Materials
1. Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:
   a. Sheet: ASTM B 209 (ASTM B 209M).
   b. Extruded Shapes: ASTM B 221 (ASTM B 221M).
   c. Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T4 or Alloy 6061-T6.
2. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, commercial quality, G90 (Z275) coating designation; mill phosphatized.
3. Galvanized, Rolled Steel Tread Plate: ASTM A 786/A 786M, rolled from steel plate complying with ASTM A 572/A 572M, Grade 55 (380); hot-dip galvanized according to ASTM A 123/A 123M.
4. Steel Structural Tubing: ASTM A 500, Grade B.
5. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
6. Steel Mechanical Tubing: ASTM A 513, welded steel mechanical tubing.
7. Zinc-Coated (Galvanized) Steel: Hot-dip galvanized according to ASTM A 123/A 123M.
8. Stainless-Steel Sheet: ASTM A 666, Type 304.
9. Plastic Laminate: NEMA LD 3, HGS or HGL grade.
10. Plywood: DOC PS 1, Exterior grade.
11. Particleboard: ANSI A208.1, Grade M-2.
12. Clear Float Glass: ASTM C 1036, Type I, Class 1, Quality q3.
13. Clear Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Class 1, and Quality q3.
14. Insulating Glass: Units complying with ASTM E 774 for Class CBA and consisting of two lites of 2.5-mm-thick clear float glass and dehydrated air space, with a total overall unit thickness of 7/16 inch (11 mm) and with manufacturer's standard dual seal.
15. Ballistics-Resistant Glazing: Comply with requirements specified in Division 08 Section "Security Glazing".
16. Anchorages: Anchor bolts; hot-dip galvanized according to ASTM A 153/A 153M or ASTM F 2329 **OR** stainless steel, **as directed**.

B. Prefabricated Control Booths, General
1. General: Provide a complete, integrated set of mutually dependent components that form a completely assembled, prefabricated control booth, ready for installation on Project site.
   a. Building Style: Standard square corners **OR** Radius corners **OR** Round corners **OR** Butt-glazed corners **OR** Wraparound type, with single rounded building end **OR** Wraparound type, with both building ends rounded **OR** As indicated on Drawings, **as directed**.
   b. Doors: Sliding door on one side **OR** Sliding doors on both sides **OR** Swinging door on back **OR** As indicated on Drawings, **as directed**.
2. Windows: Extruded-aluminum sash frames glazed with 6-mm-thick, clear tempered glass **OR** clear insulating glass **OR** ballistics-resistant glazing, UL 752 Level **as directed**.
   a. Frame Finish: Mill **OR** Clear anodic, **as directed**.
   b. Provide insect screens for each operable window.
   c. Provide galvanized-steel security screens for each window.
   d. Corner Shape: Square **OR** Round, **as directed**.
3. Horizontal Sliding Windows: Extruded-aluminum sash frames glazed with 3-mm-thick, clear tempered float glass. Equip windows with cam locks, weather stripping, and stainless-steel **OR** nylon, **as directed**, ball-bearing rollers.
   a. Frame Finish: Mill **OR** Clear anodic, **as directed**.
   b. Provide insect screens for each operable window.
   c. Corner Shape: Square **OR** Round, **as directed**.
4. Work Counters: Full width of control booth, reinforced; with 16-inch- (406-mm-) wide storage **OR** cash, **as directed**, drawer below each counter, and an access opening for electrical cords at each rear corner of counter.

a. Material: 0.078-inch- (1.98-mm-) thick, stainless-steel sheet **OR** 0.079-inch (2.01-mm) nominal-thickness, galvanized-steel sheet **OR** 1/2-inch- (13-mm-) thick particleboard with plastic-laminate finish, **as directed**.
b. Depth: 22 inches (559 mm) **OR** 20 inches (508 mm) **OR** 18 inches (457 mm), **as directed**.

5. Electrical Power Service: 125-A, 120/240-V ac, single-phase, three-wire load center, with no fewer than four open circuits **OR** service with 8-16 circuit-breaker panel, **as directed**; located under one end of work counter. Run copper wiring in 1/2-inch (13-mm) EMT conduit.
   a. Provide one 120-V ground-fault circuit interrupter (GFCI) power receptacle(s).
6. Lighting Fixtures: One **OR** Two, **as directed**, ceiling-mounted fluorescent lighting fixture(s), 48 inches (1219 mm) long, with acrylic lens and two 40-W lamps in each fixture. Provide single-pole switch mounted adjacent to door to control lighting fixture.
7. Heating Unit: Wall-mounted **OR** Roof-mounted, **as directed**, thermostatically controlled, 110-V, 1500-W electric heater with fan-forced operation and with capacity of not less than 5000 Btu/h (1465 W). Enclose in enameled-steel cabinet and mount under work counter.
8. Cooling Unit: Wall-mounted **OR** Roof-mounted, **as directed**, thermostatically controlled air conditioner with cooling capacity of not less than 13,500 Btu/h (3956 W). Enclose in enameled-steel cabinet.
9. Accessories: Provide the following for each control booth:
   a. Through-wall transaction drawers and speaking apertures complying with requirements specified in Division 08 Section "Security Windows".
   b. Antifatigue mats.
   c. Exterior stainless-steel counter.
   d. Floor-mounted **OR** Wall-mounted, **as directed**, safe.
   e. Signage: <**Insert requirements**>.
   f. Ventilation fan.
   g. Intercom.
   h. Traffic control lights.

C. Prefabricated Steel Control Booths

1. Structural Framework: Fabricated from 2-by-2-by-0.075-inch (50-by-50-by-1.90-mm) steel structural or mechanical tubing. Connect framework by welding.
2. Base/Floor Assembly: 4-inch- (102-mm-) **OR** 3-inch- (76-mm-), **as directed**, high assembly consisting of perimeter frame welded to structural framework of booth. Fabricate frame from 2-by-4-inch (51-by-102-mm) galvanized-steel structural tubing; 0.108-inch (2.74-mm) nominal-thickness, C-shaped, galvanized-steel sheet channels; or galvanized structural-steel angles. Include anchor clips fabricated from 1/4-inch- (6-mm-) thick galvanized-steel plate, predrilled and welded to exterior of integral floor frame.
   a. Finished Floor: 0.108-inch (2.74-mm) nominal-thickness, galvanized, rolled steel tread plate.
   b. Subfloor and Finished Floor: Assembly consisting of 0.079-inch (2.01-mm) nominal-thickness, galvanized-steel sheet underside with rigid insulation core; covered by 0.125-inch- (3.18-mm-) thick, aluminum rolled tread plate; with overall assembly thickness of 2 inches (51 mm).
      OR
      Subfloor and Finished Floor: Assembly consisting of one **OR** two, **as directed**, layer(s) of 3/4-inch- (19-mm-) thick plywood or oriented strand board with 0.125-inch- (3.18-mm-) thick, aluminum rolled tread plate **OR** vinyl composition flooring **OR** carpeting, **as directed**.

   OR
   Base/Floor Assembly: No perimeter frame, with finished floor fabricated from 0.108-inch (2.74-mm) nominal-thickness, galvanized, rolled steel tread plate.
   OR
   Base/Floor Assembly: No perimeter frame, with surface of supporting concrete base as finished floor.
3. Wall Panel Assembly: Assembly consisting of exterior face panel fabricated from 0.079-inch (2.01-mm) nominal-thickness, galvanized-steel sheet; and interior face panel fabricated from 0.064-inch (1.63-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal-thickness, galvanized-

steel sheet; with 2-inch- (51-mm-) **OR** 3-inch- (76-mm-), **as directed**, thick, rigid fiberglass or polystyrene board insulation in cavity between exterior and interior face panels.

a. Thermal Resistance Value (R-Value): R-7.

4. Flat Roof/Ceiling Assembly: Consisting of exterior roof panels, interior ceiling panels, and insulation between exterior and interior panels; sloped to drain at booth perimeter.
   a. Exterior Roof Panel: Fabricated from 0.079-inch (2.01-mm) **OR** 0.064-inch (1.63-mm), **as directed**, nominal-thickness, galvanized-steel sheet; with painted finish **OR** EPDM membrane, **as directed**, continuously welded seams, and full-perimeter gutter.
   b. Interior Ceiling Panel: Fabricated from 0.079-inch (2.01-mm) nominal-thickness, galvanized-steel sheet; with fiberglass insulation in cavity between ceiling and roof.
      1) Thermal Resistance Value (R-Value): R-17.
   c. Insulated Exterior/Interior Panel: Fabricated from 0.028-inch (0.71-mm) nominal-thickness, galvanized-steel **OR** 0.032-inch- (0.81-mm-) thick, aluminum, **as directed**, sheet faces and expanded-foam insulation core.
      1) Thermal Resistance Value (R-Value): R-17.
   d. Canopy Fascia: Fabricated from 0.079-inch (2.01-mm) nominal-thickness, galvanized-steel sheet, of manufacturer's standard design **OR** custom design indicated on Drawings, **as directed**.
      1) Height: 6 inches (152 mm) **OR** 8 inches (203 mm), **as directed**.
      2) Overhang: 3 inches (76 mm) beyond **OR** Flush with, **as directed**, face of walls below.
   e. Downspouts: Integral, extending 3 inches (76 mm) beyond booth walls.
   f. Roof scuppers.
   g. Rooftop finial.
5. Sliding Door: Top suspended from aluminum track with ball-bearing rollers; 1-3/4 inches (44 mm) thick; tubular-frame design fabricated from clear-anodized aluminum **OR** galvanized steel, **as directed**; with top half of door glazed. Equip door with deadlock, lock support, guide hardware, and full weather stripping.
   a. Glazing: Fixed **OR** Horizontal sliding, **as directed**, unit with 6-mm-thick, clear tempered float glass.
   b. Deadlock: Mortised, laminated-hook bolt type with removable cylinder capable of being master keyed.
6. Swinging Door: 1-3/4 inches (44 mm) thick; tubular-frame design fabricated from clear-anodized aluminum **OR** galvanized steel, **as directed**; with top half of door glazed. Equip door with deadlock, three butt hinges, closer, and full weather stripping.
   a. Glazing: Fixed **OR** Horizontal sliding, **as directed**, unit with 6-mm-thick, clear tempered float glass.
   b. Deadlock: Mortised, with lever handle and removable cylinder capable of being master keyed.
7. Finish: Finish exposed metal surfaces, including structural framework, walls, canopy, and ceiling with rust-inhibitive primer and one finish coat of industrial air-dry acrylic **OR** polyurethane, **as directed**, enamel.
   a. Color: As selected from manufacturer's full range.

D. Prefabricated Aluminum Control Booths

1. Structural Framework: Fabricated from 2-by-2-by-0.125-inch (51-by-51-by-3.18-mm) aluminum tubing, channel, angle, or tee extrusions; with clear **OR** color, **as directed**, anodic finish. Connect framework with exposed, **as directed**, mechanical fasteners.
2. Base/Floor Assembly: 4-inch- (102-mm-) high assembly consisting of perimeter frame welded to structural framework of booth. Fabricate frame from 2-by-4-by-0.125-inch (51-by-102-by-3.18-mm) aluminum tubing or aluminum angles. Include anchor clips fabricated from 1/4-inch- (6-mm-) thick aluminum, predrilled and welded to exterior of integral floor frame.
   a. Subfloor and Finished Floor: Assembly consisting of 0.032-inch- (0.81-mm-) thick, aluminum sheet underside, plywood and rigid insulation core; covered by 0.125-inch-

(3.18-mm-) thick, aluminum rolled tread plate; with overall assembly thickness of 2 inches (51 mm).

OR

Subfloor and Finished Floor: Assembly consisting of one **OR** two, **as directed**, layer(s) of 3/4-inch- (19-mm-) thick plywood or oriented strand board with 0.125-inch- (3.18-mm-) thick, aluminum rolled tread plate **OR** vinyl composition flooring **OR** carpeting, **as directed**.

OR

Base/Floor Assembly: No perimeter frame, with surface of supporting concrete base as finished floor.

3. Wall Panel Assembly: Assembly consisting of exterior face panel fabricated from 0.032-inch- (0.81-mm-) **OR** 0.063-inch- (1.60-mm-), **as directed**, thick aluminum sheet, and interior face panel fabricated from 0.032-inch- (0.81-mm-) **OR** 0.050-inch- (1.27-mm-), **as directed**, thick aluminum sheet; with 2-inch- (51-mm-) thick, polystyrene or polyisocyanurate board insulation in cavity between exterior and interior face panels.
   a. Thermal Resistance Value (R-Value): R-7.
4. Flat Roof/Ceiling Assembly: Consisting of exterior roof panels, interior ceiling panels, and insulation between exterior and interior panels; sloped to drain at booth perimeter.
   a. Exterior Roof Panel: Fabricated from 0.032-inch- (0.81-mm-) thick aluminum sheet with protective plastic sheet finish and full-perimeter gutter.
   b. Interior Ceiling Panel: Fabricated from 0.125-inch- (3.18-mm-) thick hardboard; with polyisocyanurate board insulation in cavity between ceiling and roof.
      1) Thermal Resistance Value (R-Value): R-19.
   c. Insulated Exterior/Interior Panel: Fabricated from 0.032-inch- (0.81-mm-) thick, aluminum **OR** 0.021-inch (0.53-mm) nominal-thickness, galvanized-steel, **as directed**, sheet faces and expanded-foam insulation core.
      1) Thermal Resistance Value (R-Value): R-19.
   d. Canopy Fascia: Fabricated from 0.063-inch- (1.60-mm-) thick aluminum sheet, of manufacturer's standard design **OR** custom design indicated on Drawings, **as directed**.
      1) Height: 6 inches (152 mm) **OR** 8 inches (203 mm), **as directed**.
      2) Overhang: 3 inches (76 mm) beyond **OR** Flush with, **as directed**, face of walls below.
   e. Downspouts: Integral, extending 3 inches (76 mm) beyond booth walls.
   f. Roof scuppers.
   g. Rooftop finial.
5. Sliding Door: Top suspended from aluminum track with ball-bearing rollers; 1-3/4 inches (44 mm) thick; tubular-frame design fabricated from aluminum matching exterior and interior wall panels; with top half of door glazed and with extruded-aluminum door frame. Equip door with deadlock, lock support, guide hardware, and full weather stripping.
   a. Glazing: Fixed **OR** Horizontal sliding, **as directed**, unit with 6-mm-thick, clear tempered float glass.
   b. Deadlock: Mortised, laminated-hook bolt type with removable cylinder capable of being master keyed.
6. Swinging Door: 1-3/4 inches (44 mm) thick; tubular-frame design fabricated from aluminum matching exterior and interior wall panels; with top half of door glazed and with extruded-aluminum door frame. Equip door with deadlock, three butt hinges, closer, and full weather stripping.
   a. Glazing: Fixed **OR** Horizontal sliding, **as directed**, unit with 6-mm-thick, clear tempered float glass.
   b. Deadlock: Mortised, with lever handle and removable cylinder capable of being master keyed.
7. Finish: Finish exposed metal surfaces, including structural framework, walls, canopy, and ceiling with clear anodizing **OR** color anodizing **OR** baked enamel or powder coat, **as directed**.
   a. Color: As selected from manufacturer's full range.

E. Fabrication
   1. Fabricate control booths completely in factory.

2. Preglaze windows and doors at factory.
3. Prewire control booths at factory, ready for connection to service at Project site.
4. Fabricate control booths with forklift pockets in base of booth **OR** removable lifting eye centered in roof, **as directed**.
5. Accessible Control Booths: Where indicated to be accessible, fabricate control booths as follows:
    a. Provide service windows located no higher than 34 inches (865 mm) above exterior grade.
    b. Provide door opening with minimum 32-inch (813-mm) clear width.
    c. Provide minimum 60-inch (1525-mm) clear turning spacing within the booth.
    d. Provide minimum 27-inch (685-mm) clearance beneath interior work surfaces. Locate work surfaces 28 inches (710 mm) minimum and 34 inches (865 mm) maximum above the floor.
    e. Locate controls and operable parts no lower than 15 inches (381 mm) and no higher than 48 inches (1219 mm) above the floor where reach is unobstructed. Where side reach is obstructed, locate controls and operable parts no lower than 15 inches (381 mm) and no higher than 46 inches (1219 mm) above the floor.

F. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

G. Finishes
1. Steel and Galvanized-Steel Factory Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    a. Color and Gloss: As selected from manufacturer's full range.

H. Aluminum Finishes
1. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
2. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
    a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from full range of industry colors and color densities, **as directed**.
3. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
    a. Color and Gloss: As selected from manufacturer's full range.

1.3 EXECUTION

A. Installation
1. Install control booths according to manufacturer's written instructions.
2. Accessible Control Booths: Install with interior floor surface at same elevation as adjacent paved surfaces.
3. Set control booths plumb and aligned. Level baseplates true to plane with full bearing on concrete bases.
4. Fasten control booths securely to cast-in anchor bolts **OR** concrete bases with expansion anchors, **as directed**.
5. Connect electrical power service to power distribution system according to requirements specified in Division 22.

B. Adjusting
1. Adjust doors, operable windows, and hardware to operate smoothly, easily, properly, and without binding. Confirm that locks engage accurately and securely without forcing or binding.
2. Lubricate hardware and other moving parts.
3. After completing installation, inspect exposed finishes and repair damaged finishes.

END OF SECTION 11 12 16 00a

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Task	Specification	Specification Description
11 12 23 00	11 12 16 00	Parking Control Equipment
11 12 23 00	11 12 16 00a	Prefabricated Control Booths
11 12 26 13	11 12 16 00	Parking Control Equipment
11 12 26 13	11 12 16 00a	Prefabricated Control Booths

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SECTION 11 13 13 00 - LOADING DOCK EQUIPMENT

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for loading dock equipment. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Dock levelers.
      b. Truck levelers.
      c. Truck restraints.
      d. Light-communication systems.
      e. Dock bumpers.
      f. Dock lifts (scissors lifts).
      g. Dock seals.
      h. Dock shelters.
      i. Transparent-strip door curtains.

C. Definitions
   1. Operating Range: Maximum amount of travel above and below the loading dock level.
   2. Working Range: Recommended amount of travel above and below the loading dock level for which loading and unloading operations can take place.

D. Submittals
   1. Product Data: For each type of product indicated.
   2. Shop Drawings: For loading dock equipment. Include plans, elevations, sections, details, and attachments to other work.
      a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      b. Wiring Diagrams: For power, signal, and control wiring.
   3. Samples: For each type of dock-seal and -shelter fabric indicated.
   4. Qualification Data: For qualified Installer.
   5. Welding certificates.
   6. Product Test Reports.
   7. Operation and Maintenance Data.
   8. Warranty: Sample of special warranty.

E. Quality Assurance
   1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
   2. Welding Qualifications: Qualify procedures and personnel according to the following:
      a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
      b. AWS D1.3, "Structural Welding Code - Sheet Steel."
   3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   4. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
   1. Store and handle dock seals and shelters in a manner to avoid significant or permanent damage to fabric or frame.

a. Comply with manufacturer's written instructions for minimum and maximum temperature requirements for storage.

G. Project Conditions
1. Field Measurements: Verify actual dimensions of construction contiguous with loading dock equipment, including recessed pit dimensions. slopes of driveways, and heights of loading docks, by field measurements before fabrication.

H. Warranty
1. Special Warranty for Dock Levelers: Manufacturer's standard form in which manufacturer agrees to repair or replace dock-leveler components that fail in materials or workmanship within specified warranty period.
a. Failures include, but are not limited to, the following:
1) Structural failures including cracked or broken structural support members, load-bearing welds, and front and rear hinges.
2) Faulty operation of operators, control system, or hardware.
3) Deck plate failures including cracked plate or permanent deformation in excess of 1/4 inch (6 mm) between deck supports.
4) Hydraulic system failures including failure of hydraulic seals and cylinders.
b. Warranty Period for Structural Assembly: 10 years from date of Final Completion.
c. Warranty Period for Hydraulic System: Five years from date of Final Completion.
d. Warranty shall be for unlimited usage of leveler for the specified rated capacity over the term of the warranty.

1.2 PRODUCTS

A. Materials
1. Steel Plates, Shapes, and Bars: ASTM 36/A 36M.
2. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from steel plate complying with ASTM A 572/A 572M, Grade 55 (380).
3. Steel Tubing: ASTM A 500, cold formed.
4. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
5. Wood: DOC PS 20 dimension lumber, select structural grade, kiln dried.
6. Pressure-Treated Wood: DOC PS 20 dimension lumber, select structural grade, kiln dried, and pressure treated with waterborne preservatives to comply with AWPA C2.

B. Recessed Dock Levelers
1. General: Recessed, hinged-lip-type dock levelers designed for permanent installation in concrete pits preformed in the edge of loading platform; of type, function, operation, capacity, size, and construction indicated; and complete with controls, safety devices, and accessories required.
2. Standard: Comply with MH 30.1, except for structural testing to establish rated capacity, **as directed**.
3. Rated Capacity: Capable of supporting total gross load without permanent deflection or distortion.
4. Platform: Not less than 3/16-inch- (5-mm-) **OR** 1/4-inch- (6-mm-) **OR** 3/8-inch- (9.5-mm-), **as directed**, thick, nonskid steel plate.
a. Platform Size: As indicated on Drawings, **as directed**.
b. Frame: Manufacturer's standard **OR** Clean-pit type, designed to support leveler at sides of pit, with no side-to-side supports at front of pit floor, **as directed**.
c. Toe Guards: Equip open sides of dock leveler over range indicated with metal toe guards.
1) Toe-Guard Range: Entire upper operating **OR** working, **as directed**, range.
5. Hinged Lip: Not less than 1/2-inch- (13-mm-) **OR** 5/8-inch- (16-mm-) **OR** 3/4-inch- (19-mm-) **OR** 1-inch- (25-mm-), **as directed**, thick, nonskid steel plate.

a. Hinge: Full width, piano-type hinge with heavy-wall hinge tube and greased fittings, **as directed**, with gussets on lip and ramp for support.
b. Safety Barrier Lip: Designed to protect material-handling equipment from an accidental fall from loading platform edge of the dock leveler when the leveler is not in use.

6. Function: Dock levelers shall compensate for differences in height between truck bed and loading platform.
   a. Vertical Travel: Operating range above platform level of sufficient height to enable lip to extend and clear truck bed before contact with the following minimum working range:
      1) Above Adjoining Platform: 12 inches (305 mm) **OR** 18 inches (457 mm) **OR** As indicated on Drawings, **as directed**.
      2) Below Adjoining Platform: 12 inches (305 mm) **OR** 14 inches (356 mm) **OR** As indicated on Drawings, **as directed**.
   b. Automatic Vertical Compensation: Floating travel of ramp with lip extended and resting on truck bed shall compensate automatically for upward or downward movement of truck bed during loading and unloading.
   c. Automatic Lateral Compensation: Tilting of ramp with lip extended and resting on truck bed shall compensate automatically for canted truck beds of up to 4 inches (102 mm) over width of ramp.
   d. Lip Operation: Manufacturer's standard mechanism that automatically extends and supports hinged lip on ramp edge with lip resting on truck bed over dock leveler's working range, allows lip to yield under impact of incoming truck, and automatically retracts lip when truck departs.
      1) Length of Lip Extension: 16 inches (406 mm) **OR** 18 inches (457 mm) **OR** 20 inches (508 mm) **OR** As indicated on Drawings, **as directed**.
   e. Automatic Ramp Return: Automatic return of unloaded ramp, from raised or lowered positions to stored position, level with platform, as truck departs.
   f. Interlock: Leveler will not operate while overhead door is in closed position **OR** leveler night lock is engaged **OR** truck restraint is not engaged **OR** inflatable dock seal is not inflated **OR** inflatable dock shelter is not inflated, **as directed**.
7. Mechanical Operating System: Manual control; counterbalance and spring operation. Spring-operated raising and walk-down lowering of unloaded ramp. Equip leveler with an upward-biased-spring counterbalancing mechanism controlled by a hold-down device. Ramp raises to top limit of operating range by operating recessed control handle in ramp to disengage hold-down device. Ramp lowers below platform level with lip retracted by operating auxiliary, recessed control handle to release support legs.
   a. Free-Fall Protection: Manufacturer's standard protection system to limit free fall of loaded ramps with front edge supported by truck bed.
8. Hydraulic Operating System: Electric control from a remote-control station; fully hydraulic operation. Electric-powered hydraulic raising and hydraulic lowering of ramp. Equip leveler with a packaged unit including a unitized, totally enclosed, nonventilated electric motor, pump, manifold reservoir, and valve assembly of proper size, type, and operation for capacity of leveler indicated. Include means for lowering ramp below platform level with lip retracted behind dock bumpers. Provide a hydraulic velocity fuse connected to main hydraulic cylinder to limit loaded ramp's free fall to not more than 3 inches (76 mm).
   a. Remote-Control Station: Weatherproof single **OR** Single, **as directed**,-button station of the constant-pressure type, enclosed in NEMA ICS 6, Type 4 **OR** Type 12, **as directed**, box. Ramp raises by depressing and holding button; ramp lowers at a controlled rate by releasing button.
   b. Remote-Control Station with Emergency Stop: Weatherproof multibutton **OR** Multibutton, **as directed**, control station with an UP button of the constant-pressure type and an emergency STOP button of the momentary-contact type, enclosed in NEMA ICS 6, Type 4 **OR** Type 12, **as directed**, box. Ramp raises by depressing and holding UP button; ramp lowers at a controlled rate by releasing UP button. All ramp movement stops, regardless of position of ramp or lip, by depressing STOP button. Normal operation resumes by engaging a manual reset button or by pulling out STOP button.

1) Dual-Panel Control Station: Remote-control station for operating side-by-side dock levelers.
2) Master Panel: Control panel with integral fused disconnecting means for operating dock leveler, dock door, and truck restraints.

c. Independent Lip Operation: Electric-powered hydraulic raising and hydraulic lowering of lip, controlled independent of raising and lowering of ramp.

9. Electric Operating System: Electric control from a remote-control station; motorized operation. Electric activation for raising of ramp and automatic extending of lip. Equip leveler with a packaged unit including a unitized electric motor and shaft assembly of proper size, type, and operation for capacity of leveler indicated. Include means for lowering ramp below platform level with lip retracted behind dock bumpers.
   a. Remote-Control Station: Weatherproof single **OR** Single, **as directed**,-button station of the constant-pressure type, enclosed in NEMA ICS 6, Type 4 **OR** Type 12, **as directed**, box. Ramp raises by depressing and holding button; ramp lowers at a controlled rate by releasing button.
   b. Remote-Control Station with Emergency Stop: Weatherproof multibutton **OR** Multibutton, **as directed**, control station with an UP button of the constant-pressure type and an emergency STOP button of the momentary-contact type, enclosed in NEMA ICS 6, Type 4 **OR** Type 12, **as directed**, box. Ramp raises by depressing and holding UP button; ramp lowers at a controlled rate by releasing UP button. All ramp movement stops, regardless of position of ramp or lip, by depressing STOP button. Normal operation resumes by engaging a manual reset button or by pulling out STOP button.

10. Air-Bag Operating System: Electric control from a remote-control station; pneumatic operation. High-volume, low-pressure lifting of ramp. Equip leveler with a packaged unit including a PVC-coated, reinforced polyester lifting bag and two-stage, single-speed electric fan of proper size, type, and operation for capacity of leveler indicated. Include dock-leveler supports controlled by release chain for lowering ramp below platform level without extending lip.
    a. Remote-Control Station: Weatherproof single **OR** Single, **as directed**,-button station of the constant-pressure type, enclosed in NEMA ICS 6, Type 4, **as directed**, box. Ramp raises by depressing and holding button; ramp lowers at a controlled rate by releasing button.

11. Construction: Fabricate dock-leveler frame, platform supports, and lip supports from structural- or formed-steel shapes. Weld platform and hinged lip to supports. Fabricate entire assembly to withstand deformation during both operating and stored phases of service. Chamfer lip edge to minimize obstructing wheels of material-handling vehicles.
    a. Cross-Traffic Support: Manufacturer's standard method of supporting ramp at platform level in stored position with lip retracted. Provide a means to release supports to allow ramp to descend below platform level.
    b. Maintenance Strut: Integral strut to positively support ramp in up position during maintenance of dock leveler.

12. Integral Molded-Rubber Dock Bumpers: Fabricated from 4-inch- (102-mm-) **OR** 6-inch- (152-mm-), **as directed**, thick, heavy molded-rubber compound reinforced with nylon, rayon, or polyester cord; with Type A Shore durometer hardness of 80, plus or minus 5, when tested according to ASTM D 2240. Provide two dock bumpers for each recessed dock leveler, attached to face of loading dock with expansion bolts.

13. Integral Laminated-Tread Dock Bumper: Fabricated from 4-1/2-inch- (114-mm-) **OR** 6-inch- (152-mm-), **as directed**, thick, multiple, uniformly thick plies cut from fabric-reinforced rubber tires. Laminate plies under pressure on not less than two 3/4-inch- (19-mm-) diameter, steel supporting rods that are welded at one end to 1/4-inch- (6-mm-) thick, structural-steel end angle and secured with a nut and angle at the other end. Fabricate angles with predrilled anchor holes and sized to provide not less than 1 inch (25 mm) of tread plies extending beyond the face of closure angles.

14. Accessories:
    a. Curb Angles: 3-by-3-by-1/4-inch (76-by-76-by-6-mm) galvanized-steel curb angles for edge of recessed leveler pit, with 1/2-inch- (13-mm-) diameter by 6-inch- (152-mm-) long concrete anchors welded to angle at 6 inches (152 mm) o.c.

b. Self-Forming Pan: Manufacturer's standard prefabricated, self-forming steel form system for poured-in-place construction of concrete pit.
c. Night Locks: Manufacturer's standard means to prevent extending lip and lowering ramp when overhead doors are locked.
d. Side and rear weatherseals.
e. Foam insulation under dock-leveler platform.
f. Abrasive skid-resistant **OR** Smooth, **as directed**, surface.

15. Finish: Paint **OR** Hot-dip galvanize, **as directed**, dock levelers after assembly and testing, **as directed**.
    a. Toe Guards: Paint yellow **OR** orange, **as directed**, to comply with ANSI Z535.1.

C. Edge-Of-Dock Levelers

1. General: Surface-mounted, hinged-lip-type, edge-of-dock levelers designed for permanent installation on face of loading dock platform; of type, function, operation, capacity, size, and construction indicated; and complete with controls, safety devices, and accessories required.
2. Standard: Comply with MH 30.1, except for structural testing to establish rated capacity, **as directed**.
3. Rated Capacity: Capable of supporting total gross load without permanent deflection or distortion.
4. Platform Ramp Width: 66 inches (1676 mm) **OR** 72 inches (1829 mm) **OR** 78 inches (1981 mm) **OR** 84 inches (2134 mm) **OR** As indicated on Drawings, **as directed**.
5. Hinged Lip: Not less than 3/8-inch- (9.5-mm-) **OR** 7/16-inch- (11-mm-) **OR** 1/2-inch- (13-mm-), **as directed**, thick, nonskid steel tread plate.
   a. Hinge: Full width, piano-type hinge with heavy-wall hinge tube and greased fittings, **as directed**, with gussets on lip and ramp for support.
6. Function: Dock levelers shall compensate for differences in height between truck bed and loading platform.
   a. Vertical Travel: Operating range above platform level of sufficient height to enable lip to extend and clear truck bed before contact with the following minimum working range:
      1) Above Adjoining Platform: 5 inches (127 mm) **OR** 6 inches (152 mm) **OR** As indicated on Drawings, **as directed**.
      2) Below Adjoining Platform: 5 inches (127 mm) **OR** As indicated on Drawings, **as directed**.
   b. Automatic Vertical Compensation: Floating travel of ramp with lip extended and resting on truck bed shall compensate automatically for upward or downward movement of truck bed during loading and unloading.
   c. Automatic Lateral Compensation: Tilting of ramp with lip extended and resting on truck bed shall compensate automatically for canted truck beds of up to 3 inches (76 mm) over width of ramp.
   d. Lip Operation: Manufacturer's standard mechanism that automatically extends and supports hinged lip on ramp edge with lip resting on truck bed over dock leveler's working range, allows lip to yield under impact of incoming truck, and automatically retracts lip when truck departs.
      1) Length of Lip Extension: 15 inches (381 mm) **OR** 17 inches (432 mm) **OR** As indicated on Drawings, **as directed**.
   e. Automatic Ramp Return: Automatic return of unloaded ramp, from raised or lowered positions to stored position, level with platform, as truck departs. Leveler shall be capable of retracting to stored position while truck is at loading dock.
7. Mechanical Operating System: Manual control; counterbalance and spring operation. Spring-operated raising and walk-down lowering of unloaded ramp. Equip leveler with a torsion-spring counterbalancing mechanism controlled by a hold-down device.
   a. Lever Handle: Self-storing lever handle for raising unloaded ramp with minimal lifting force by pulling lever back to extend lip and pushing lever forward to lower ramp and lip.
   b. Removable Lifting Handle: For raising unloaded ramp by lifting action.
8. Hydraulic Operating System: Electric control from a remote-control station; fully hydraulic operation. Electric-powered hydraulic raising and hydraulic lowering of ramp. Equip leveler with

a packaged unit including a unitized, totally enclosed, nonventilated electric motor, pump, manifold reservoir, and valve assembly of proper size, type, and operation for capacity of leveler indicated. Provide a hydraulic velocity fuse connected to main hydraulic cylinder to limit loaded ramp's free fall to not more than 3 inches (76 mm).

a. Remote-Control Station: Weatherproof single **OR** Single, **as directed**,-button station of the constant-pressure type, enclosed in NEMA ICS 6, Type 12, **as directed**, box. Ramp and lip raise to vertical position and extend to truck bed by depressing and holding button.

9. Construction: Fabricate dock-leveler frame, platform supports, and lip supports from structural- and formed-steel shapes. Weld platform and hinged lip to supports. Fabricate entire assembly to withstand deformation during both operating and stored phases of service. Chamfer lip edge to minimize obstructing wheels of material-handling vehicles.
   a. Cross-Traffic Support: Manufacturer's standard method of supporting ramp at platform level in stored position with lip retracted. Provide a means to release supports to allow ramp to descend below platform level.
   b. Maintenance Strut: Integral strut to positively support ramp in up position during maintenance of dock leveler.
10. Integral Molded-Rubber Dock Bumpers: Fabricated from 4-inch- (102-mm-) **OR** 6-inch- (152-mm-), **as directed**, thick, heavy molded-rubber compound reinforced with nylon, rayon, or polyester cord; with Type A Shore durometer hardness of 80, plus or minus 5, when tested according to ASTM D 2240. Provide two dock bumpers for each recessed dock leveler, attached to face of loading dock with expansion bolts.
11. Integral Laminated-Tread Dock Bumper: Fabricated from 4-1/2-inch- (114-mm-) **OR** 6-inch- (152-mm-), **as directed**, thick, multiple, uniformly thick plies cut from fabric-reinforced rubber tires. Laminate plies under pressure on not less than two 3/4-inch- (19-mm-) diameter, steel supporting rods that are welded at one end to 1/4-inch- (6-mm-) thick, structural-steel end angle and secured with a nut and angle at the other end. Fabricate angles with predrilled anchor holes and sized to provide not less than 1 inch (25 mm) of tread plies extending beyond the face of closure angles.
12. Accessories:
   a. Self-forming pan.
   b. Cast-in-place design.
   c. Run-off guards.
   d. Ramp approach plate.
13. Dock-Leveler Finish: Painted in manufacturer's standard color.

D. Top-Of-Dock Levelers
1. General: Surface-mounted, hinged-lip-type, top-of-dock levelers designed for permanent installation on top edge of loading dock platform without concrete pit; of type, function, operation, capacity, size, and construction indicated; and complete with controls, safety devices, and accessories required.
2. Standard: Comply with MH 30.1, except for structural testing to establish rated capacity, **as directed**.
3. Rated Capacity: Capable of supporting total gross load without permanent deflection or distortion.
4. Platform Width: 72 inches (1829 mm) **OR** As indicated on Drawings, **as directed**.
5. Hinged Lip: Not less than 3/8-inch- (9.5-mm-) **OR** 7/16-inch- (11-mm-), **as directed**, thick, nonskid steel plate.
   a. Hinge: Full width, piano-type hinge with heavy-wall hinge tube and greased fittings, **as directed**, with gussets on lip and ramp for support.
6. Function: Dock levelers shall compensate for differences in height between truck bed and loading platform.
   a. Vertical Travel: Operating range above platform level of sufficient height to enable lip to extend and clear truck bed before contact with a minimum working range of 10 inches (250 mm), **as directed**, above and 4 inches (102 mm), **as directed**, below adjoining platform level.

b. Automatic Vertical Compensation: Floating travel of ramp with lip extended and resting on truck bed shall compensate automatically for upward or downward movement of truck bed during loading and unloading.

c. Lip Operation: Manufacturer's standard mechanism that automatically extends and supports hinged lip on ramp edge with lip resting on truck bed over dock leveler's working range, allows lip to yield under impact of incoming truck, and automatically retracts lip when truck departs.

1) Length of Lip Extension: 15 inches (381 mm) **OR** As indicated on Drawings, **as directed**.

d. Automatic Ramp Return: Automatic return of unloaded ramp, from raised or lowered positions to stored position, level with platform, as truck departs. Leveler shall be capable of retracting to stored position while truck is at loading dock.

7. Mechanical Operating System: Manual control; counterbalance and spring operation. Spring-operated raising and walk-down lowering of unloaded ramp. Equip leveler with a torsion-spring counterbalancing mechanism controlled by a hold-down device.

a. Removable Lifting Hook: For raising unloaded ramp by lifting action and pushing forward to lower ramp and lip.

8. Hydraulic Operating System: Electric control from a remote-control station, fully hydraulic operation. Electric-powered hydraulic raising and hydraulic lowering of ramp. Equip leveler with a packaged unit including a unitized, totally enclosed, nonventilated electric motor, pump, manifold reservoir, and valve assembly of proper size, type, and operation for capacity of leveler indicated.

a. Remote-Control Station: Weatherproof single **OR** Single, **as directed**,-button station of the constant-pressure type, enclosed in NEMA ICS 6, Type 12, **as directed**, box. Ramp and lip raise to vertical position and extend to truck bed by depressing and holding button.

9. Construction: Fabricate dock-leveler frame, platform supports, and lip supports from structural- or formed-steel shapes. Weld platform and hinged lip to supports. Fabricate entire assembly to withstand deformation during both operating and stored phases of service. Chamfer lip edge to minimize obstructing wheels of material-handling vehicles.

10. Integral Molded-Rubber Dock Bumpers: Fabricated from 4-inch- (102-mm-) **OR** 6-inch- (152-mm-), **as directed**, thick, heavy molded-rubber compound reinforced with nylon, rayon, or polyester cord; with Type A Shore durometer hardness of 80, plus or minus 5, when tested according to ASTM D 2240. Provide two dock bumpers for each recessed dock leveler, attached to face of loading dock with expansion bolts.

11. Integral Laminated-Tread Dock Bumper: Fabricated from 4-1/2-inch- (114-mm-) **OR** 6-inch- (152-mm-), **as directed**, thick, multiple, uniformly thick plies cut from fabric-reinforced rubber tires. Laminate plies under pressure on not less than two 3/4-inch- (19-mm-) diameter, steel supporting rods that are welded at one end to 1/4-inch- (6-mm-) thick, structural-steel end angle and secured with a nut and angle at the other end. Fabricate angles with predrilled anchor holes and sized to provide not less than 1 inch (25 mm) of tread plies extending beyond the face of closure angles.

12. Dock-Leveler Finish: Painted in manufacturer's standard color.

E. Vertical-Storing Dock Levelers

1. General: Recessed, hinged-lip-type, vertical-storing dock levelers designed for permanent installation in shallow concrete pits preformed in the edge of loading platform; of type, function, operation, capacity, size, and construction indicated; and complete with controls, safety devices, and accessories required.

2. Standard: Comply with MH 30.1, except for structural testing to establish rated capacity, **as directed**.

3. Rated Capacity: Capable of supporting total gross load without permanent deflection or distortion.

4. Platform: Not less than 3/16-inch- (5-mm-) **OR** 1/4-inch- (6-mm-), **as directed**, thick, nonskid steel plate.

a. Platform Size: As indicated on Drawings, **as directed**.

5. Hinged Lip: Not less than 1/2-inch- (13-mm-) **OR** 5/8-inch- (16-mm-), **as directed**, thick, nonskid steel plate.

a. Hinge: Full width, piano-type hinge with heavy-wall hinge tube and greased fittings, **as directed**, with gussets on lip and ramp for support.

6. Function: Dock levelers shall compensate for differences in height between truck bed and loading platform.
   a. Vertical Travel: Operating range above platform level of sufficient height to enable lip to extend and clear truck bed before contact with the following minimum working range:
      1) Above Adjoining Platform: 6 inches (152 mm) **OR** 10 inches (250 mm) **OR** 12 inches (305 mm) **OR** As indicated on Drawings, **as directed**.
      2) Below Adjoining Platform: 6 inches (152 mm) **OR** As indicated on Drawings, **as directed**.
   b. Automatic Vertical Compensation: Floating travel of ramp with lip extended and resting on truck bed shall compensate automatically for upward or downward movement of truck bed during loading and unloading.
   c. Automatic Lateral Compensation: Tilting of ramp with lip extended and resting on truck bed shall compensate automatically for canted truck beds of up to 4 inches (102 mm) over width of ramp.
   d. Lip Operation: Manufacturer's standard mechanism that automatically extends and supports hinged lip on ramp edge with lip resting on truck bed over dock leveler's working range, allows lip to yield under impact of incoming truck, and automatically retracts lip when truck departs.
      1) Length of Lip Extension: 16 inches (406 mm) **OR** 18 inches (457 mm) **OR** 20 inches (508 mm) **OR** As indicated on Drawings, **as directed**.
7. Hydraulic Operating System: Electric control from a remote-control station; fully hydraulic operation. Electric-powered hydraulic raising and hydraulic lowering of ramp. Equip leveler with a packaged unit including a unitized, totally enclosed, nonventilated electric motor, pump, manifold reservoir, and valve assembly of proper size, type, and operation for capacity of leveler indicated. Provide a hydraulic velocity fuse connected to main hydraulic cylinder to limit loaded ramp's free fall to not more than 3 inches (76 mm). Provide mechanical lock that prevents leveler from lowering without hydraulic pressure.
   a. Remote-Control Station: Weatherproof single **OR** Single, **as directed**,-button station of the constant-pressure type, enclosed in NEMA ICS 6, Type 12, **as directed**, box. Ramp lowers at a controlled rate.
   b. Remote-Control Station with Emergency Stop: Weatherproof multibutton **OR** Multibutton, **as directed**, control station with an UP button of the constant-pressure type and an emergency STOP button of the momentary-contact type, enclosed in NEMA ICS 6, Type 12, **as directed**, box. Ramp raises by depressing and holding UP button; ramp lowers at a controlled rate by releasing UP button. All ramp movement stops, regardless of position of ramp or lip, by depressing STOP button. Normal operation resumes by engaging a manual reset button or by pulling out STOP button.
      1) Master Panel: Control panel with integral fused disconnecting means for operating dock leveler, dock door, and truck restraints.
   c. Independent Lip Operation: Electric-powered hydraulic raising and lowering of lip, controlled independent of raising and lowering of ramp.
8. Construction: Fabricate dock-leveler frame, platform supports, run-off guards, **as directed,** and lip supports from structural- or formed-steel shapes. Weld platform and hinged lip to supports. Fabricate entire assembly to withstand deformation during both operating and stored phases of service. Chamfer lip edge to minimize obstructing wheels of material-handling vehicles.
9. Integral Molded-Rubber Dock Bumpers: Fabricated from 4-inch- (102-mm-) **OR** 6-inch- (152-mm-), **as directed**, thick, heavy molded-rubber compound reinforced with nylon, rayon, or polyester cord; with Type A Shore durometer hardness of 80, plus or minus 5, when tested according to ASTM D 2240. Provide two dock bumpers for each recessed dock leveler, attached to face of loading dock with expansion bolts.
10. Integral Laminated-Tread Dock Bumper: Fabricated from 4-1/2-inch- (114-mm-) **OR** 6-inch- (152-mm-), **as directed**, thick, multiple, uniformly thick plies cut from fabric-reinforced rubber tires. Laminate plies under pressure on not less than two 3/4-inch- (19-mm-) diameter, steel supporting

rods that are welded at one end to 1/4-inch- (6-mm-) thick, structural-steel end angle and secured with a nut and angle at the other end. Fabricate angles with predrilled anchor holes and sized to provide not less than 1 inch (25 mm) of tread plies extending beyond the face of closure angles.

11. Accessories:
    a. Interlock: Leveler will not operate while overhead door is in closed position **OR** truck restraint is not engaged, **as directed**.
    b. Curb Angles: 3-by-3-by-1/4-inch (76-by-76-by-6-mm) galvanized-steel curb angles for edge of recessed leveler pit, with 1/2-inch- (13-mm-) diameter by 6-inch- (152-mm-) long concrete anchors welded to angle at 6 inches (152 mm) o.c.
12. Finish: Paint **OR** Hot-dip galvanize, **as directed**, dock levelers after assembly and testing, **as directed**.

F. Truck Levelers
1. General: Two-cylinder, hydraulic ramp designed to raise and lower end of truck at loading dock. Equip leveler with a packaged unit including a unitized electric motor, pump, manifold reservoir, and valve assembly of proper size, type, and operation for capacity indicated. Provide manufacturer's standard means for limiting loaded ramp's free fall.
2. Rated Capacity: Capable of supporting total gross load without permanent deflection or distortion.
3. Travel Speed: Leveler raises and lowers at 3 fpm (0.015 m/s), measured at traveling end.
4. Surface-Mounted Units: Designed for mounting on surface of concrete driveway.
5. Shallow-Pit-Mounted Units: Designed for mounting in sloping shallow pit; capable of 18 inches (457 mm) of vertical travel above and below level of driveway.
6. Full-Pit-Mounted Units: Designed for installation in a fully recessed pit, with top of platform in stored position flush with driveway.
    a. Provide removable plate for access to pit for service.
7. Hydraulic Operating System: Electric control from a remote-control station; fully hydraulic operation. Self-contained, electric-powered hydraulic raising and hydraulic lowering of lift.
    a. Remote-Control Station: Weatherproof, multibutton control station of the constant-pressure type with UP and DOWN push buttons. Controller shall consist of magnetic motor starter with three-pole adjustable overloads and 24-V control transformer with 4-A, fused secondary prewired to terminal strips and enclosed in NEMA ICS 6, Type 12, **as directed**, box.
        1) Upper-Travel-Limit Switch: Equip unit with manufacturer's standard, adjustable, upper-travel-limit switch.
8. Construction: Fabricate truck leveler from structural- and formed-steel shapes; fabricate platform from nonskid steel plate. Construct platform with notch at loading-dock end to provide clearance for truck restraint.
    a. Cylinders: Equip truck leveler with not less than two heavy-duty, high-pressure, hydraulic, ram-type cylinders. Rams shall be manufacturer's standard, either direct-displacement plunger or rod-and-piston type with positive internal stops. Cylinder rods shall be chrome plated and polished.
9. Truck-Leveler Finish: Manufacturer's standard finish.

G. Truck Restraints
1. General: Manufacturer's standard device designed to engage truck's rear-impact guard and hold truck at loading dock. Restraint shall consist of an iron or steel restraining arm that raises until contacting rear-impact guard. Arm shall move vertically, automatically adjusting to varying height of truck due to loading and unloading operations.
2. Standard: Comply with MH 30.3.
3. Rated Capacity: Capable of supporting total gross load of <**Insert capacity**> without permanent deflection or distortion.
4. Operating Range: Capable of restraining rear-impact guards within a range from:
    a. Vertical: 12 inches (305 mm) **OR** 30 inches (762 mm) **OR** As indicated on Drawings, **as directed**, above driveway.

b. Horizontal: 12 inches (305 mm) **OR** As indicated on Drawings, **as directed**, in front of dock bumpers.

5. Power Operating System: Manufacturer's standard electromechanical or hydraulic unit.
   a. Remote-Control Station: Single-button station of the constant-pressure type, enclosed in NEMA ICS 6, Type 12, **as directed**, box. Restraint is engaged by depressing and holding button; restraint is released by releasing button.
   b. Interlock: Leveler will not operate while truck restraint is not engaged.
6. Mechanical Operating System: Restraint operates by use of a lifting rod or hook to raise engagement device.
7. Rear-Impact-Guard Sensor: Detects presence of rear-impact guard and automatically returns to stored position if rear-impact guard is not engaged, **as directed**.
8. Caution Signs: Exterior, surface mounted; designed to inform both dock attendant and truck driver; with sign copy as follows. Provide one sign at each truck-restraint location.
   a. Sign Copy in Forward and Reverse Text: Manufacturer's standard text permitting truck movement with green light, **as directed**.
   b. Interior Sign Copy: Manufacturer's standard text permitting truck movement with green light, **as directed**.
9. Light-Communication System: Red and green illuminated signal-light sets, with lens approximately 4 inches (102 mm) in diameter, designed to indicate status to both dock attendant and truck driver. Equip system with steel control panel located at interior of dock that includes illuminated lights indicating **OR** indicates, **as directed**, status of exterior signal lights. Provide signal-light set and control panel at each location indicated for light-communication system. Enclose exterior signal-light sets in steel or plastic housing with sunshade.
   a. Manual Operation: System is activated by push button or switch located on interior **OR** truck-restraint, **as directed**, control panel.
   b. Automatic Operation: System is activated automatically by limit switch **OR** photoelectric sensor **OR** magnetic switch, **as directed**, mounted on overhead door track. Provide on-off switch located on light-communication system **OR** truck-restraint, **as directed**, control panel.
   c. Automatic Operation: System is activated automatically when device engages rear-impact guard. Provide on-off switch located on truck-restraint control panel.
   d. Mounting: Wall **OR** Driveway **OR** Pit, **as directed**.
10. Alarm: Audible **OR** Visual **OR** Audible and visual, **as directed**, system indicating that rear-impact guard is not engaged, with manual reset.
11. Accessories: Interlock to dock leveler **OR** Key switch, **as directed**.
12. Truck-Restraint Finish: Painted **OR** Hot-dip galvanized, **as directed**.

H. Light-Communication Systems

1. General: Provide communication system consisting of signal-light sets, caution signs, alarms, and controls for each location indicated.
2. Caution Signs: Surface mounted; designed to inform both dock attendant and truck driver; with sign copy as follows:
   a. Exterior Sign Copy in Forward and Reverse Text: Manufacturer's standard text permitting truck movement with green light, **as directed**.
   b. Interior Sign Copy: Manufacturer's standard text permitting truck movement with green light, **as directed**.
3. Signal-Light Sets: Red and green illuminated signal-light sets, with lens approximately 4 inches (102 mm) in diameter, designed to indicate status to both dock attendant and truck driver. Equip system with steel control panel that includes illuminated lights indicating **OR** indicates, **as directed**, status of exterior signal lights; located at interior of dock. Provide signal-light set and control panel at each location indicated for light-communication system. Enclose signal lights in steel or plastic housing, with exterior signal-light sets equipped with sunshade.
   a. Manual Operation: Lights are activated by push button or switch located on interior signal-light enclosure **OR** control panel, **as directed**.

b. Automatic Operation: Lights are activated automatically by limit switch **OR** photoelectric sensor **OR** magnetic switch, **as directed**, mounted on overhead door track. Provide on-off switch located on control panel.

I. Dock Bumpers

1. Laminated-Tread Dock Bumper: Fabricated from multiple, uniformly thick plies cut from fabric-reinforced rubber tires. Laminate plies under pressure on not less than two 3/4-inch- (19-mm-) diameter, steel supporting rods that are welded at one end to 1/4-inch- (6-mm-) thick, structural-steel end angle and secured with a nut and angle at the other end. Fabricate angles with predrilled anchor holes and sized to provide not less than 1 inch (25 mm) of tread plies extending beyond the face of closure angles.
   a. Thickness: 4-1/2 inches (114 mm) **OR** 6 inches (152 mm) **OR** As indicated on Drawings, **as directed**.
   b. Horizontal Style: 6 inches (152 mm) **OR** 10 inches (250 mm) **OR** 12 inches (305 mm), **as directed**, high by length indicated on Drawings, **as directed**.
   c. Vertical Style: 8 inches (203 mm) wide by 20 inches (508 mm) high **OR** 24 inches (610 mm) high **OR** 36 inches (914 mm) high **OR** height indicated on Drawings, as directed.
2. Molded-Rubber Bumpers: Fabricated from molded-rubber compound reinforced with nylon, rayon, or polyester cord; with Type A Shore durometer hardness of 80, plus or minus 5, when tested according to ASTM D 2240; of size and configuration indicated. Fabricate units with not less than two predrilled anchor holes.
   a. Configuration: T shape **OR** Inverted-L shape **OR** Square **OR** Rectangular **OR** As indicated on Drawings, **as directed**.
   b. Thickness: 2 inches (50 mm) **OR** 3 inches (76 mm) **OR** 4 inches (102 mm) **OR** 6 inches (152 mm) **OR** As indicated on Drawings, **as directed**.
3. Extruded-Rubber Bumpers: Fabricated from ASTM D 2000, extruded synthetic rubber with Type A Shore durometer hardness of 75, plus or minus 5, when tested according to ASTM D 2240; of size and configuration indicated. Furnish units with predrilled anchor holes and concealed, flat, steel mounting bar.
   a. Configuration: Flat or ribbed, with 2-inch (50-mm) nominal thickness and 9-inch (229-mm) height **OR** 4-1/2-inch- (114-mm-) wide base and 4-inch (102-mm) depth with half-oval shape that compresses and returns to original shape **OR** As indicated on Drawings, **as directed**.
4. Steel-Face, Laminated-Tread Bumpers: Fabricated from multiple, uniformly thick plies cut from fabric-reinforced rubber tires and with 3/8-inch (9.5-mm) steel face plate of same size as rubber surface. Laminate plies under pressure on not less than two 3/4-inch- (19-mm-) diameter, steel supporting rods that are welded at one end to 1/4-inch- (6-mm-) thick, structural-steel end angle and secured with a nut and angle at the other end. Fabricate angles with predrilled anchor holes and sized to provide not less than 1 inch (25 mm) of tread plies extending beyond the face of closure angles. Weld face plate to two steel support brackets, which shall extend back to and engage 3/4-inch- (19-mm-) diameter support rods in elongated holes, allowing steel face to float on impact.
   a. Thickness: 4-1/2 inches (114 mm) **OR** 6 inches (152 mm) **OR** As indicated on Drawings, **as directed**.
   b. Horizontal Style: 6 inches (152 mm) **OR** 10 inches (250 mm) **OR** 12 inches (305 mm), **as directed**, high by length indicated, **as directed**.
   c. Vertical Style: 8 inches (203 mm) wide by 20 inches (508 mm) high **OR** 24 inches (610 mm) high **OR** 36 inches (914 mm) high **OR** height indicated, **as directed**.
5. Anchorage Devices: Hot-dip galvanized-steel anchor bolts, nuts, washers, bolts, sleeves, cast-in-place plates, and other anchorage devices as required to fasten bumpers securely in place and to suit installation type indicated.

J. Dock Lifts

1. General: Built-in, scissors-type, single-leg, hydraulic dock lift of capacity, size, and construction indicated; complete with controls, safety devices, and accessories required.
2. Standard: MH 29.1.

3. Rated Capacity: Lifting capacity of not less than 8000 lb (3629 kg) with 6500-lb (2948-kg) **OR** indicated on Drawings, **as directed**, axle load at ends and 5000-lb (2268-kg) **OR** indicated on Drawings, **as directed**, axle load at sides.
4. Platform: Nonskid, safety-tread **OR** Smooth-surface, **as directed**, heavy steel deck plate.
   a. Platform Size: As indicated on Drawings, **as directed**.
   b. Platform Guarding: Bevel toe guards **OR** Toe sensor **OR** Indicator bar **OR** Skirts **OR** Enclosure, **as directed**, to comply with requirements in MH 29.1.
   c. Removable **OR** Fixed, **as directed**, Handrails: Equip lift with handrails on two sides of platform with a single, removable chain across each end. Provide handrails not less than 39 inches (991 mm) high with midrail and 4-inch- (102-mm-) high kick plate at bottom. Mount rail sockets flush with platform surface, **as directed**.
5. Bridge: Nonskid, safety-tread steel **OR** High-tensile aluminum, **as directed**, plate.
   a. Hinged Bridge: Hinged, throw-over bridge bolted to full-length, heavy-duty, piano-type hinge welded to toe guard at end of platform. Provide bridge complete with heavy-duty lifting chains. Chamfer edge of bridge to minimize obstructing wheels of material-handling vehicles.
   b. Size: 18 inches (457 mm) long by 60 inches (1524 mm) wide **OR** 18 inches (457 mm) long by 72 inches (1829 mm) wide **OR** As indicated on Drawings, **as directed**.
   c. Locations: Ends **OR** Sides **OR** As indicated on Drawings, **as directed**.
6. Function: Dock lifts shall compensate for differences in height between truck bed and loading platform.
   a. Vertical Travel: Maximum of 60 inches (1524 mm), **as directed**, from a lowered height of 12 inches (305 mm), **as directed**, for a total raised height of 72 inches (1829 mm), **as directed**.
   b. Travel Speed: Nominal raising speed of 8 fpm (0.04 m/s) **OR** 10 fpm (0.05 m/s) **OR** 12 fpm (0.06 m/s), **as directed**.
   c. Vertical Travel and Travel Speed: As indicated on Drawings, **as directed**.
   d. Hinged Throw-Over Bridges Operation: Manual **OR** Manual-assist bridge winch **OR** Automatic powered, **as directed**.
7. Hydraulic Operating System: Self-contained, electric, hydraulic power unit for raising and lowering lift; of size, type, and operation needed for capacity of lift indicated; controlled from a remotely located push-button station.
   a. Power Unit: Consisting of continuous-duty motor, high-pressure gear pump, valve manifold, oil-line filters, and oil reservoir.
      1) Equip manifold with relief valve, check valve, pressure-compensated flow-control valve, and solenoid valve and with provisions for lowering lift manually if power fails.
      2) Equip reservoir, valve manifold, and pressure line with oil-line filters.
   b. Cylinders: Equip lift with not less than two heavy-duty, high-pressure, hydraulic, ram-type cylinders. Rams shall be manufacturer's standard, either direct-displacement plunger or rod-and-piston type with positive internal stops. Cylinder rods shall be chrome plated and polished.
      1) Rate of Descent Protection: Pressure-compensated flow control or hydraulic velocity fuse to limit down speed for each cylinder.
   c. Remote-Control Station: Multibutton control station of the constant-pressure type with UP and DOWN push buttons. Controller shall consist of magnetic motor starter with three-pole adjustable overloads and 24-V control transformer with 4-A, fused secondary prewired to terminal strips and enclosed in NEMA ICS 6, Type 12, **as directed**, box.
      1) Upper-Travel-Limit Switch: Equip unit with manufacturer's standard, adjustable, upper-travel-limit switch.
8. Construction: Fabricate lift from structural-steel shapes rigidly welded and reinforced for maximum strength, safety, and stability. Design assembly to withstand deformation during both operating and stored phases of service. Provide mounting brackets and removable lifting eyes for ease of installation.
   a. Scissors Mechanism: Fabricate leg members from heavy, steel-formed tube or plate members to provide maximum strength and rigidity.

b. Scissors Configuration: Single leg **OR** Multiple width **OR** Multiple length, **as directed**.
c. Bearings: Pivot points with permanently lubricated antifriction bushings or sealed ball-bearings for minimum maintenance.
d. Maintenance Leg: Removable, safety maintenance leg or hinged, safety maintenance bars.
e. Mounting: Surface **OR** Pit, **as directed**.

9. Dock Lift Finish: Painted **OR** Hot-dip galvanized, **as directed**.
   a. Toe Guards: Paint yellow **OR** orange, **as directed**, to comply with ANSI Z535.1.

K. Foam-Pad Dock Seals

1. General: Dock seals consisting of fabric-covered foam pads designed to compress 4 to 5 inches (102 to 127 mm) under pressure of truck body to form an airtight seal at jambs and head of loading dock openings; of type, size, and construction indicated.
2. Door Opening Size: As indicated on Drawings, **as directed**.
3. Stationary Head Pad: 8 inches (203 mm) **OR** 12 inches (305 mm) **OR** 18 inches (457 mm) **OR** 24 inches (610 mm), **as directed**, high and same depth as jamb pads; beveled, **as directed**; sized for opening width.
4. Adjustable Head Pad: 18 inches (457 mm) **OR** 24 inches (610 mm) **OR** 30 inches (762 mm), **as directed**, high and same depth as jamb pads; sized for opening width; with manufacturer's standard hardware and tension spring or counterweight mechanism for adjusting height of pad.
5. Jamb Pads: Square **OR** Beveled; tapered to reduce opening width, **as directed**.
   a. Nominal Size: 12 inches (305 mm) **OR** As indicated on Drawings, **as directed**, wide and sized for opening height.
6. Construction: Consisting of single- or double-ply, coated, fabric-covered, urethane-foam core with supporting frame. Fabricate jamb and head pads of same depth and sized for opening width.
   a. Pressure-Treated, **as directed**, Wood Support Frame: Factory painted; with steel mounting hardware.
   b. Steel Support Frame: Steel channel frame of manufacturer's standard weight, shape, and finish; with steel mounting hardware.
   c. Tapered Side Panels: Taper side panels to angle required to accommodate sloped loading dock approach grades and make sealing edge of dock shelter parallel to back edge of truck. Taper for declined **OR** inclined, **as directed**, approach.
   d. Cover Fabric: Vinyl-coated nylon or polyester with minimum total weight of 22 oz./sq. yd. (746 g/sq. m) **OR** 40 oz./sq. yd. (1356 g/sq. m), **as directed**.
      1) Color: Black **OR** Green **OR** Blue **OR** Brown **OR** Tan **OR** As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
   e. Cover Fabric: Neoprene-coated nylon with minimum total weight of 16 oz./sq. yd. (543 g/sq. m) **OR** 40 oz./sq. yd. (1356 g/sq. m) **OR** 45 oz./sq. yd. (1526 g/sq. m), **as directed**.
      1) Color: Black **OR** Green **OR** Blue **OR** Brown **OR** Tan **OR** As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
   f. Cover Fabric: Hypalon-coated nylon with minimum total weight of 16 oz./sq. yd. (543 g/sq. m) **OR** 40 oz./sq. yd. (1356 g/sq. m), **as directed**.
      1) Color: Black **OR** Green **OR** Blue **OR** Brown **OR** Tan **OR** As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
   g. Cover Fabric: Manufacturer's proprietary cover fabric complying with the following minimum requirements:
      1) Tearing strength of not less than 300 by 300 lbf (1334 by 1334 N) when tested according to ASTM D 2261.
      2) Abrasion resistance of not less than 6000 cycles when tested according to FED-STD-191A-5306.
      3) Tensile strength of not less than 1200 by 1200 lbf (5338 by 5338 N) when tested according to FED-STD-191A-5100.1.

4) Cold resistance to minus 40 deg F (minus 40 deg C) when tested according to FED-STD-191A-5874.
5) Color: Black **OR** Green **OR** Blue **OR** Brown **OR** Tan **OR** As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.

h. Guide Strips: 4-inch- (102-mm-) wide, coated, nylon guide strips on jamb pads.

i. Pleated Protectors: On face of jamb pads of overlapping layers of coated fabric attached to base fabric; 4-inch (102-mm) **OR** 8-inch (203-mm) **OR** 16-inch (406-mm), **as directed**, wear exposure.

L. Inflatable Dock Seals

1. General: Inflatable dock seals consisting of one-piece jamb, sill, **as directed**, and header seals designed to inflate by motor/blower and compress against truck bodies to form airtight seals at loading dock openings; of type, size, and construction indicated.
2. Door Opening Size: As indicated on Drawings, **as directed**.
3. Head Members: One **OR** Two, **as directed**.
4. Jamb Members: One **OR** Two, **as directed**.
5. Construction: Fabricate header seal full width over jamb seals. Mount seals on pressure-treated wood frame with hot-dip galvanized-steel mounting hardware. Inflate seals by use of 1/2-hp motor/blower with on-off switch, mounted above header seal in galvanized-steel hood. Provide bottom of header and jamb seals with grommets to allow for release of moisture and excess air.

a. Fabric: Neoprene-coated nylon with minimum total weight of 14 oz./sq. yd. (475 g/sq. m).

1) Color: Black **OR** Gray **OR** Blue **OR** Brown **OR** As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.

b. Fabric: Manufacturer's proprietary fabric complying with the following minimum requirements:

1) Tearing strength of not less than 110 by 85 lbf (489 by 378 N) when tested according to ASTM D 2261.
2) Abrasion resistance of not less than 490 cycles when tested according to FED-STD-191A-5306.
3) Tensile strength of not less than 500 by 440 lbf (2224 by 1957 N) when tested according to FED-STD-191A-5100.1.
4) Cold resistance to minus 40 deg F (minus 40 deg C) when tested according to FED-STD-191A-5874.
5) Color: Black **OR** Gray **OR** Blue **OR** Brown **OR** As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.

M. Frame-Type Dock Shelters

1. General: Dock shelters designed to form a seal with sides and top of truck body while leaving entire width and height of truck's rear opening unobstructed; of type, size, and construction indicated.
2. Door Opening Size: As indicated on Drawings, **as directed**.
3. Rigid-Frame Type: Fabricated from translucent, fabric-covered **OR** fiberglass, **as directed**, side and top panels attached to fixed supporting framework. Provide head and side curtains with built-in flexible stays, wind straps between head curtain and side frame, pleated protectors on head curtain, and a yellow aim patch on side curtains. Slope head frame from center for drainage. Provide replaceable, fabric-covered, tapered, foam-bottom pads and protective steel bumpers of size and type required for application shown.
4. Flexible-Frame Type: Fabricated from fabric-covered side and top panels attached to retractable supporting framework with independent spring-tension extension arms. Provide head and side curtains with built-in flexible stays, pleated protectors on head curtain, and a yellow aim patch on side curtains. Provide replaceable, fabric-covered, tapered, foam-bottom pads of size and type required for application shown.

5. Head-Pad Height: 12 inches (305 mm) **OR** 18 inches (457 mm) **OR** 24 inches (610 mm) **OR** 30 inches (762 mm), **as directed**.
6. Construction: Fabricate framework, pads, bumpers, fabric for curtains and panels, and other components to sizes and shapes indicated or required to fit door opening sizes shown and allow for not less than 18 inches (457 mm) of truck-body penetration when truck is docked.
   a. Wood Framework: Factory painted, mechanically fastened together using nails and lag bolts or metal connectors to form a rigid assembly.
   b. Steel Framework: Zinc-plated steel tubing of size and thickness standard with manufacturer, with joints welded.
   c. Top and Side Panels: White, translucent fiberglass, 0.045 inch (1.1 mm) thick, weighing 6 oz./sq. ft. (1831 g/sq. m).
   d. Top and Side Panels: White, translucent vinyl, weighing 14 oz./sq. ft. (4272 g/sq. m).
   e. Tapered Side Panels: Taper side panels to angle required to accommodate sloped loading dock approach grades and make sealing edge of dock shelter parallel to back edge of truck. Taper for declined **OR** inclined, **as directed,** approach.
   f. Cover Fabric: Vinyl-coated nylon with minimum total weight of 22 oz./sq. yd. (746 g/sq. m) **OR** 40 oz./sq. yd. (1356 g/sq. m), **as directed**.
      1) Color: Black **OR** Green **OR** Blue **OR** Brown **OR** Tan **OR** As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
   g. Cover Fabric: Polyurethane-coated nylon with minimum total weight of 25 oz./sq. yd. (848 g/sq. m).
      1) Color: Black **OR** Green **OR** Blue **OR** Brown **OR** Tan **OR** As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
   h. Cover Fabric: Neoprene-coated nylon with minimum total weight of 16 oz./sq. yd. (543 g/sq. m) **OR** 40 oz./sq. yd. (1356 g/sq. m) **OR** 45 oz./sq. yd. (1526 g/sq. m), **as directed**.
      1) Color: Black **OR** Green **OR** Blue **OR** Brown **OR** Tan **OR** As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
   i. Cover Fabric: Hypalon-coated nylon with minimum total weight of 16 oz./sq. yd. (543 g/sq. m) **OR** 40 oz./sq. yd. (1356 g/sq. m), **as directed**.
      1) Color: Black **OR** Green **OR** Blue **OR** Brown **OR** Tan **OR** As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
   j. Cover Fabric: Manufacturer's proprietary cover fabric complying with the following minimum requirements:
      1) Tearing strength of not less than 300 by 300 lbf (1334 by 1334 N) when tested according to ASTM D 2261.
      2) Abrasion resistance of not less than 6000 cycles when tested according to FED-STD-191A-5306.
      3) Tensile strength of not less than 1200 by 1200 lbf (5338 by 5338 N) when tested according to FED-STD-191A-5100.1.
      4) Cold resistance to minus 40 deg F (minus 40 deg C) when tested according to FED-STD-191A-5874.
      5) Color: Black **OR** Green **OR** Blue **OR** Brown **OR** Tan **OR** As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
   k. Pleated Protectors: Overlapping layers of same fabric as cover.
7. Accessories:
   a. Buffer flaps.
   b. Bottom filler curtain.
   c. Bottom seal pads.

N. Inflatable Dock Shelters

1. General: Inflatable dock shelters designed to inflate by motor/blower and compress against truck bodies to form airtight seals at loading dock openings; of type, size, and construction indicated.
2. Door Opening Size: As indicated on Drawings, **as directed**.
3. Rigid Canopy: Consisting of rigid canopy, fabric-covered header curtain, and one-piece inflatable header and jamb seals. Fabricate canopy from white, translucent plastic attached to rigid support framework.
4. Rigid Canopy and Sides: Consisting of rigid canopy and sides, fabric-covered header curtain, and one-piece, inflatable header and jamb seals. Fabricate canopy and sides from white, translucent plastic attached to rigid support framework.
5. Construction: Fabricate header seal full width over jamb seals. Mount seals on pressure-treated wood frame with hot-dip galvanized-steel mounting hardware. Provide header curtain with built-in flexible stays and two yellow aim patches. Slope canopy frame from center for drainage. Provide two protective steel bumpers of size and type required for application shown. Inflate seals by use of a 1/2-hp motor/blower with on-off switch, mounted under canopy frame. Provide bottom of header and jamb seals with grommets to allow for release of moisture and excess air.
   a. Shape and Size: Fabricate framework, fabric for curtains, and other components to sizes and shapes indicated or required to fit door opening sizes shown and allow for not less than 12 inches (305 mm) of truck-body penetration when truck is docked.
   b. Wood Framework: Fasten members together mechanically using nails and lag bolts or metal connectors to form a rigid assembly.
   c. Steel Framework: Zinc-plated steel tubing of size and thickness standard with manufacturer, with joints welded.
   d. Fabric: Polyurethane **OR** Vinyl, **as directed**,-coated nylon with minimum total weight of 14 oz./sq. yd. (475 g/sq. m).
      1) Color: Black **OR** Green **OR** Blue **OR** Brown **OR** As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
   e. Fabric: Manufacturer's proprietary fabric complying with the following minimum requirements:
      1) Tearing strength of not less than 110 by 85 lbf (489 by 378 N) when tested according to ASTM D 2261.
      2) Abrasion resistance of not less than 490 cycles when tested according to FED-STD-191A-5306.
      3) Tensile strength of not less than 500 by 440 lbf (2224 by 1957 N) when tested according to FED-STD-191A-5100.1.
      4) Cold resistance to minus 40 deg F (minus 40 deg C) when tested according to FED-STD-191A-5874.
      5) Color: Black **OR** Green **OR** Blue **OR** Brown **OR** As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.

O. Transparent-Strip Door Curtains
1. General: Door curtains consisting of overlapping strips suspended from top of opening to form a sealed door curtain. Provide strips of length required to suit opening height and with sufficient number in unit to close opening width with overlap indicated.
2. Strip Material: Curved, clear, transparent, extruded PVC. Fabricate strips for manufacturer's standard method of attachment to overhead mounting system indicated.
   a. Standard Grade: Designed to withstand temperature range of 0 to plus 150 deg F (minus 18 to plus 66 deg C).
   b. Low-Temperature Grade: USDA accepted, designed to withstand temperature range of minus 30 to plus 150 deg F (minus 34 to plus 66 deg C).
   c. Strip Width and Thickness:
      1) 6 inches (152 mm) wide and 0.060 inch (1.5 mm) thick.
         OR
         8 inches (203 mm) wide and 0.080 inch (2 mm) thick.

OR
12 inches (305 mm) wide and 0.120 inch (3 mm) thick.
OR
16 inches (406 mm) wide and 0.160 inch (4 mm) thick.

d. Overlap: None **OR** One-third **OR** One-half **OR** Two-thirds **OR** Three-quarters **OR** Full, **as directed**.

3. Header Mounting: Consisting of an angle bolted or welded to opening lintel; equip angle with permanently attached mounting pins and a steel-angle or -plate retaining strip attached to angle with wing nuts.
4. Wall Surface Mounting:
   a. Consisting of a steel plate bolted to side of lintel; equip plate with permanently attached, threaded, mounting pins and steel-angle or -plate retaining strip attached to plate with wing nuts.
   OR
   Consisting of steel pipe attached to side of lintel by manufacturer's standard, winged-U-type suspension brackets.
   OR
   Consisting of a rigid, vinyl wall-mounting unit bolted to side of lintel above opening; equip unit with a similarly formed, rigid, vinyl retainer attached to unit with wing nuts.

P. General Finish Requirements
1. Finish loading dock equipment after assembly and testing.

Q. Steel Finishes
1. Galvanizing: Hot-dip galvanize components as indicated to comply with the following:
   a. ASTM A 123/A 123M for iron and steel loading dock equipment.
   b. ASTM A 153/A 153M or ASTM F 2329 for iron and steel hardware for loading dock equipment.
2. Galvanized-Steel and Steel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat in manufacturer's standard color.

1.3 EXECUTION

A. Preparation
1. Coordinate size and location of loading dock equipment indicated to be attached to or recessed into concrete or masonry, and furnish anchoring devices with templates, diagrams, and instructions for their installation.
2. Set curb angles in concrete edges of dock-leveler recessed pits with tops flush with loading platform. Fit exposed connections together to form hairline joints.
3. Set curb angles in concrete edges of truck-leveler recessed pits with tops flush with driveway. Fit exposed connections together to form hairline joints.
4. Place self-forming pan system for recessed dock **OR** edge-of-dock, **as directed**, levelers in proper relation to loading platform before pouring concrete.
5. Clean recessed pits of debris.

B. Installation
1. General: Install loading dock equipment, including motors, pumps, control stations, wiring, safety devices, light-communication systems, and accessories as required for a complete installation.
   a. Rough-in electrical connections according to requirements specified in Division 22..
2. Recessed Dock Levelers: Attach dock levelers securely to loading dock platform, flush with adjacent loading dock surfaces and square to recessed pit.
3. Edge **OR** Top, **as directed**,-of-Dock Levelers: Attach dock levelers to loading dock platform in a manner that complies with requirements indicated for arrangement and position relative to top of platform.

a. Weld anchor holes in contact with continuous embedded loading dock edge channel. Weld or bolt bumper blocks to face of loading dock.
4. Truck Levelers: Attach truck levelers securely to driveway construction with expansion anchors and bolts.
5. Truck Restraints: Attach truck restraints in a manner that complies with requirements for arrangement and height required for device to engage vehicle rear-impact guard. Interconnect control panel and signals with dock leveler, **as directed**.
    a. Wall-Mounted Units: Weld truck restraints to steel curb angle **OR** edge channel **OR** mounting plate, **as directed**, embedded in loading dock edge.
    b. Wall-Mounted Units: Anchor truck restraints to face of loading dock with expansion anchors and bolts.
    c. Driveway-Mounted Units: Anchor truck restraints to driveway with expansion anchors and bolts.
    d. Pit-Mounted Units: Anchor truck restraints to concrete pit with expansion anchors and bolts.
6. Dock Bumpers: Attach dock bumpers to face of loading dock in a manner that complies with requirements indicated for spacing, arrangement, and position relative to top of platform and anchorage.
    a. Welded Attachment: Plug-weld anchor holes in contact with steel inserts and fillet weld at other locations.
    b. Bolted Attachment: Attach dock bumpers to preset anchor bolts embedded in concrete or to cast-in-place inserts or threaded studs welded to embedded-steel plates or angles. If preset anchor bolts, cast-in-place inserts, or threaded studs welded to embedded-steel plates or angles are not provided, attach dock bumpers by drilling and anchoring with expansion anchors and bolts.
    c. Screw Attachment: Attach dock bumpers to wood construction with lag bolts as indicated.
7. Dock Lifts: Attach dock lifts securely to loading platform **OR** floor of recessed pit **OR** surface of driveway, **as directed**.
8. Dock Seals: Attach dock-seal support frames securely to building structure in proper relation to openings, dock bumpers, and dock levelers to ensure compression of dock seals when trucks are positioned against dock bumpers.
9. Dock Shelters: Attach dock shelters securely to building structure in proper relation to openings, dock bumpers, and dock levelers to ensure an effective seal of dock-shelter curtains with sides and top of truck body when trucks are positioned against dock bumpers.
10. Transparent-Strip Door Curtains: Attach door-curtain mounting system to lintel with screw anchors or toggle bolts. Mount curtain strips to achieve overlap indicated.

C. Adjusting
1. Adjust loading dock equipment to function smoothly and safely, and lubricate as recommended by manufacturer.
2. Test dock levelers and lifts for vertical travel within operating range indicated.
3. After completing installation of exposed, factory-finished loading dock equipment, inspect exposed finishes and repair damaged finishes.

END OF SECTION 11 13 13 00

Task	Specification	Specification Description
11 13 16 13	11 13 13 00	Loading Dock Equipment
11 13 16 23	11 13 13 00	Loading Dock Equipment
11 13 19 13	11 13 13 00	Loading Dock Equipment
11 13 19 26	11 13 13 00	Loading Dock Equipment
11 13 19 33	11 13 13 00	Loading Dock Equipment
11 13 23 23	11 13 13 00	Loading Dock Equipment
11 13 26 00	11 13 13 00	Loading Dock Equipment

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SECTION 11 14 13 16 - TURNSTILES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of turnstiles. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. Shop Drawings: Drawings showing individual turnstile construction, overall dimensions for installation, and installation details including trim and accessories.
   2. Materials List showing major components, materials and material thicknesses.
   3. Product Sample: Manufacturer shall demonstrate field up-gradability of the rotary gates from mechanical control to electronic control.

C. Product Handling: Store turnstiles in a dry well ventilated place in the original crating and protective wrappings and protect all finished from damage during handling.

1.2 PRODUCTS

A. Security Turnstiles
   1. Type B Rotary Gate
      a. Mechanism: All steel and machined cast iron with two ratchets each 1-1/4" thick hardened steel. Two locking pawls 1-1/4" thick hardened steel. Automatic control with free turning one direction **OR** free turning both directions, **as directed**.
      b. Arms: Hot dip galvanized steel tubing, wall thickness of 0.105" and 1.31" o.d.. Arm ends spun closed under heat and pressure, for a smooth safe finish. Heel guards on bottom arms of rotor "U" shaped sheet steel channels surrounding the lower arms and extending to the flooring.
      c. Rotor and Barrier Vertical Members: 1/4" thick steel angles, hot dip galvanized. Arms pinned into rotor with malleable iron clamps. Non-welded construction.
      d. Vertical Passage Members: Tubing with 1/8" wall thickness and 1" o.d., hot dip galvanized.
      e. Bottom Bearing: Machined grey iron casting 1-1/2" thick, 12" diameter.
      f. Height: As required to meet project requirements.
   2. Type AA Rotary Gate
      a. Mechanism: All steel and machined cast iron. Two control ratchets each 1-1/4" thick hardened steel. Two locking pawls each 1-1/4" thick hardened steel. Automatic control with free turning one direction **OR** free turning both directions, **as directed**.
      b. Arms: Square steel tubing, walls 0.097" thick, ends spun closed, bottom arms with heel guards.
      c. Rotor and Barrier Columns: Five angles of 1/4" thick steel, sixty-three malleable cast iron clamps, non-welded construction.
      d. Vertical Cage Members: 3 "U" channels 0.097" wall thickness, passage sheet 4' high by 5'2" length of 0.048" thick steel, 7 reinforcing bands of 0.38" thick steel.
      e. Bottom Bearing: Machined grey iron casting 1-1/2" thick, 12" diameter.
      f. Ceiling: Full round steel sheet 0.052" thick with 1" x 1" circular reinforcing angle at edge.
      g. Height: As required to meet project requirements.
   3. Type SA Rotary Gate
      a. Mechanism: All steel and machine cast iron. Two control ratchets each 1-1/4" thick hardened steel. Two locking pawls each 1-1/4" thick hardened steel. Time delay and power

relays with 10 amp contact ratings and ten million operation life. One-way operation **OR** two-way, **as directed**, agent operated.

b. Arms: ANSI 304 stainless steel (brushed finish); 4" reinforcing plugs at rotor end, spun closed ends, walls 0.065" thick.

c. Rotor: One piece solid aluminum extrusion weighing 140 lbs., three wing cross section, anodized.

d. Vertical Columns: One barrier support column of 3" by 3" solid aluminum, three passageway support columns of 2" by 2" aluminum tubing with 1/8" wall thickness.

e. Passageway Sheeting: ANSI 304 stainless steel (brushed finish) 0.065” thick **OR** 1/4” thick curved polycarbonate sheet, **as directed**, rising from 4” above floor level to 4” below mechanism housing.

f. Ceiling: Full ceiling 6 ft. diameter, 5" deep.

g. Height: As required to meet project requirements.

4. Type Dual Rotary Gate

a. Mechanism: All steel and machine cast iron. Two control ratchets each 1.25" thick hardened steel. Two locking pawls each 1-1/4" thick hardened steel. Time delay and power relays with 10 amp contact ratings and ten million operation life. One-way operation **OR** two-way, **as directed**, agent operated.

b. Arms: ANSI 304 stainless steel (brushed finish); 4" reinforcing plugs at rotor end, spun closed ends, walls 0.065" thick. Press fit 3.5" into rotor sockets.

c. Rotors: One piece solid aluminum extrusions weighing 140 lbs. each, three wing cross section, clear anodized.

d. Barriers: Two columns of 2" by 2" solid aluminum, 21 arms 54" in length bent 1" o.d. ANSI 302 Tubing with 0.080" wall thickness, force fit and pin secured.

e. Passageway Columns: Four columns of 2" by 2" clear anodized aluminum tubing with 1/8" wall thickness.

f. Passageway Sheeting: ANSI 304 stainless steel (brushed finish) 0.065” thick **OR** 1/4” thick curved polycarbonate sheet, **as directed**, rising from 4” above floor level to 4” below mechanism housing.

g. Ceiling: Full ceiling 8' by 4'6", 5" deep.

h. Height: As required to meet project requirements.

5. 24” Diameter Manual Turnstiles

a. Cover: Deep drawn ANSI #304 stainless steel (brushed finish), 0.078" thick, corners with 1-3/8" radii.

b. Frame: ANSI #304 stainless steel (brushed finish) **OR** painted mild steel, **as directed**. Welded double wall (cavity) construction. Each wall 0.078" thick. 2" blending outer wall radii, 1/4" thick stainless steel base plate.

c. Mechanical Mechanism: Ratchet of 1" x 6-1/2" machined cast iron. Use aided by springs of 0.175" diameter spring steel. Motion stabilized by large rotary shock absorber and cast iron two-lobe cam. Self centered by 1/2" steel compression shoe.

1) Unlocking Controls: One continuous-duty rated 24VDC solenoid with 620% of required strength. Solenoid shall operate for 45 milliseconds per passage. All unlocking elements shall be mechanical. No time relays or transformers.

2) Mechanism shall be field upgradable from mechanical counting to electronic counting both local and remote, without cutting, filing or other structural modifications. Mechanism shall be field upgradable from mechanical unlocking control to electronic unlocking control, both single passage and escrow control, without cutting, filing or other structural modifications.

d. Arms: ANSI #304 stainless steel tubing (brushed finish), 0.049" thick walls, spun closed ends. Arms shall be press fit into grey cast iron hub and held to main shaft with drill rod taper pin.

e. Hub: Grey cast iron, taper pin mounting.

f. Portable: 0.063" thick machined cast iron floor tread, force fit ANSI #304 stainless steel railing (brushed finish), with 0.0112” wall thickness hand-grip loops, 3-1/2" diameter solid rubber wheels recessed into cabinet.

1.3 EXECUTION:

A. Installation: Install turnstiles in accordance with manufacturer's instructions.

END OF SECTION 11 14 13 16

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Task	Specification	Specification Description
11 14 13 19	11 14 13 16	Turnstiles

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SECTION 11 21 63 00 - FOOD SERVICE EQUIPMENT

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for food service equipment. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Fabricated equipment.
   b. Food waste machines.
   c. Cooking equipment.
   d. Self-contained refrigeration equipment.
   e. Walk-in refrigeration equipment.
   f. Powered food-preparation equipment.
   g. Warewashing equipment.
   h. Serving equipment.
   i. Utility distribution systems.
2. Owner-Furnished Equipment: Where indicated, the Owner will furnish equipment for installation by Contractor.

C. Submittals
1. Product Data: For each type of product indicated. Include the following:
   a. Manufacturer's model number.
   b. Accessories and components that will be included for Project.
   c. Clearance requirements for access and maintenance.
   d. Utility service connections for water, drainage, power, and fuel; include roughing-in dimensions.
2. Shop Drawings: For fabricated equipment. Include plans, elevations, sections, roughing-in dimensions, fabrication details, utility service requirements, and attachments to other work.
3. Samples: For each factory-applied color finish required, in manufacturer's standard sizes.
4. Coordination Drawings: For foodservice facilities.
   a. Indicate locations of foodservice equipment and connections to utilities.
   b. Key equipment using same designations as indicated on Drawings.
   c. Include plans and elevations; clearance requirements for equipment access and maintenance; details of equipment supports; and utility service characteristics.
   d. Include details of seismic bracing for equipment.
5. Operation and Maintenance Data: For foodservice equipment to include in emergency, operation, and maintenance manuals. Include the following:
   a. Product Schedule: For each foodservice equipment item, include the following:
      1) Designation indicated on Drawings.
      2) Manufacturer's name and model number.
      3) List of factory-authorized service agencies including addresses and telephone numbers.
6. Warranty: Samples of special warranty.

D. Quality Assurance
1. NSF Standards: Provide equipment that bears NSF Certification Mark or UL Classification Mark certifying compliance with applicable NSF standards.
2. BISSC Standards: Provide bakery equipment that complies with BISSC/Z50.2.

a. Provide BISSC-certified equipment, with certification verified by a third-party agency, **as directed**.

3. UL Certification: Provide electric and fuel-burning equipment and components that are evaluated by UL for fire, electric shock, and casualty hazards according to applicable safety standards, and that are UL certified for compliance and labeled for intended use.
4. Steam Equipment: Provide steam-generating and direct-steam heating equipment that is fabricated and labeled to comply with ASME Boiler and Pressure Vessel Code.
5. Regulatory Requirements: Install equipment to comply with the following:
   a. ASHRAE 15, "Safety Code for Mechanical Refrigeration."
   b. NFPA 54, "National Fuel Gas Code."
   c. NFPA 70, "National Electrical Code."
   d. NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operations."
6. Seismic Restraints: Comply with SMACNA's "Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines," Appendix A, "Seismic Restraint Details," unless otherwise indicated.
7. Preinstallation Conference: Conduct conference at Project site.

E. Project Conditions
1. Field Measurements: Verify actual dimensions of construction contiguous with foodservice equipment by field measurements before fabrication. Indicate measurements on Coordination Drawings.

F. Coordination
1. Coordinate foodservice equipment layout and installation with other work, including layout and installation of lighting fixtures, HVAC equipment, and fire-suppression system components.
2. Coordinate locations and requirements of utility service connections.
3. Coordinate sizes, locations, and requirements of the following:
   a. Overhead equipment supports.
   b. Equipment bases.
   c. Floor depressions.
   d. Insulated floors.
   e. Floor areas with positive slopes to drains.
   f. Floor sinks and drains serving foodservice equipment.
   g. Roof curbs, equipment supports, and penetrations.

G. Warranty
1. Refrigeration Compressor Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace compressors that fail in materials or workmanship within specified warranty period.
   a. Failure includes, but is not limited to, inability to maintain set temperature.
   b. Warranty Period: Five years from date of Final Completion.

1.2 PRODUCTS

A. Fabricated Equipment
1. Stainless-Steel Sinks:
   a. Description: One **OR** Two **OR** Three **OR** Four, **as directed**,-compartment sink(s). Fabricate units of welded stainless steel, sound deadened.
      1) Bowls: Stainless steel, Type 304, 0.078 inch (1.98 mm) **OR** 0.062 inch (1.59 mm), **as directed**, thick.
      2) Integral Drainboards: Stainless steel, Type 304, 0.078 inch (1.98 mm) **OR** 0.062 inch (1.59 mm), **as directed**, thick.
      3) Body: Stainless steel, Type 304, 0.078 inch (1.98 mm) **OR** Type 304, 0.062 inch (1.59 mm) **OR** Type 430, 0.062 inch (1.59 mm), **as directed**, thick.

a) Back Splash: Manufacturer's standard height **OR** 13 inches (330 mm) **OR** 18 inches (457 mm), **as directed**.
b) Side Splash: Manufacturer's standard height **OR** 13 inches (330 mm) **OR** 18 inches (457 mm), **as directed**.
4) Legs and Feet: Stainless-steel tubing legs with adjustable bullet feet.
5) Accessories:
a) Faucets and Spouts: as directed by the Owner.
b) Prerinse Faucet: as directed by the Owner.
c) Vacuum breaker.
d) Lever waste with **OR** without, **as directed**, overflow.
e) Basket strainer.
f) Continuous waste.
g) Scrap trough.
h) Control bracket for food waste disposer controls.
i) Scrap block and hole.
j) Stainless-steel pot rack.
b. Stainless-Steel Sheet: ASTM A 240/A 240M, austenitic stainless steel, type as indicated.
c. Fabrication: Prepare sink for installation of the following equipment items:
1) Water heater.
2) Food waste disposer; weld disposer cone or collar into sink.
3) Undercounter dishwasher.
d. Stainless-Steel Finish: Directional satin finish, No. 4.
2. Stainless-Steel Tables:
a. Description: Flat-countertop **OR** Prep **OR** Equipment-stand **OR** Mixer-stand **OR** Dish, **as directed**, table.
1) Tops: Stainless steel, Type 304, 0.078 inch (1.98 mm) **OR** Type 304, 0.062 inch (1.59 mm) **OR** Type 430, 0.062 inch (1.59 mm), **as directed**, thick, reinforced and sound deadened.
a) Back Splash: Manufacturer's standard height **OR** 1-1/2 inches (38 mm) **OR** 5 inches (127 mm), **as directed**.
b) Edge: Bullnose on four sides **OR** Bullnose on front edge, straight on sides and back **OR** Marine edge, **as directed**.
2) Welded **OR** Adjustable, **as directed**, Undershelf: Stainless steel, Type 304, 0.050 inch (1.27 mm) thick **OR** Metallic-coated steel, 0.052-inch (1.32-mm) nominal thickness, **as directed**.
3) Crossbracing: Stainless-steel **OR** Metallic-coated steel, **as directed**, tubing, bolted **OR** welded, **as directed**, to legs.
4) Cabinet:
a) Body: Stainless steel, Type 430, 0.050 inch (1.27 mm) thick.
b) Doors: Sliding **OR** Hinged, **as directed**, stainless steel, Type 304, 0.038 inch (0.95 mm) thick.
c) Drawers: Stainless-steel drawer and faceplate **OR** Galvanized-steel drawer and stainless-steel faceplate **OR** Stainless-steel front and liner **OR** Stainless-steel front and galvanized-steel liner, **as directed**.
5) Sink: Stainless steel, Type 304, 0.078 inch (1.98 mm) thick, welded into tabletop and including the following:
a) Faucet and Spout: as directed by the Owner.
b) Vacuum breaker.
c) Leverwaste with **OR** without, **as directed**, overflow.
d) Basket strainer.
e) Tail piece.
6) Legs: Stainless-steel **OR** Metallic-coated steel, **as directed**, tubing.
7) Feet: Stainless-steel adjustable bullets **OR** Plastic adjustable bullets **OR** Stainless-steel, flanged, adjustable bullets **OR** Casters, **as directed**.
8) Accessories:
a) Control panel.

b) Control bracket for food waste disposer controls.
c) Aluminum pan rack slides, six **OR** three, **as directed**, slides each.
d) Urn trough.
e) Spice bins.

b. Materials:
1) Stainless-Steel Sheet: ASTM A 240/A 240M, austenitic stainless steel, type as indicated.
2) Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G90 (Z275) coating.

c. Fabrication: Prepare table for installation of the following equipment items:
1) Food waste disposer; weld disposer cone or collar into sink.
2) Heat lamp.

d. Stainless-Steel Finish: Directional satin finish, No. 4.

3. Stainless-Steel Shelf Units:
a. Description: Table mounted, single deck **OR** Table mounted, double deck **OR** Wall mounted, **as directed**. Fabricate units of stainless steel, Type 304, 0.062 inch (1.59 mm) **OR** Type 304, 0.050 inch (1.27 mm) **OR** Type 430, 0.050 inch (1.27 mm), **as directed**, thick.
b. Stainless-Steel Sheet: ASTM A 240/A 240M, austenitic stainless steel, type as indicated.
c. Stainless-Steel Finish: Directional satin finish, No. 4.

4. Pot Racks:
a. Description: Wall mounted **OR** Ceiling hung **OR** Corner, **as directed**. Fabricate units of stainless steel **OR** painted, cold-rolled steel, **as directed**.
1) Bars: Double **OR** Single, **as directed**.
2) Hooks: 18 per unit.

b. Materials:
1) Stainless-Steel Sheet: ASTM A 240/A 240M, austenitic stainless steel, Type 304.
2) Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B, suitable for exposed applications.

c. Finishes:
1) Stainless Steel: Directional satin finish, No. 4.
2) Cold-Rolled Steel: Powder-coat painted finish.

5. Stainless-Steel Hand Sinks:
a. Description: Lavatory sink. Fabricate units of stainless steel, Type 304, 0.050 inch (1.27 mm) **OR** 0.038 inch (0.95 mm), **as directed**, thick.
1) Operation: Electronic **OR** Knee valve **OR** Foot pedal **OR** Wrist handle **OR** Handle, **as directed**.
2) Faucet and Spout: as directed by the Owner.
3) Accessories:
a) Chrome-plated tail piece and P trap, NPS 1-1/2 (DN 40), with 0.045-inch (1.1-mm) minimum wall thickness.
b) Strainer basket with metal post.
c) Liquid soap dispenser, splash **OR** deck, **as directed**, mounted.
d) Liquid soap and towel dispenser.
e) Towel dispenser.
f) Tubular wall supports.
g) Skirt assembly for support.
h) Side splashes.

b. Stainless-Steel Sheet: ASTM A 240/A 240M, austenitic stainless steel, type as indicated.
c. Stainless-Steel Finish: Directional satin finish, No. 4.

6. Floor Troughs **OR** Water Receptacles, **as directed**:
a. Description: 4-inch (102-mm) **OR** 2-inch (50-mm), **as directed**, nominal depth excluding tailpiece.
1) Body: Stainless steel, Type 304, 0.078 inch (1.98 mm) thick.
2) Grate: Stainless-steel bar, Type 304 **OR** Fiberglass, **as directed**.

3) Waste Connection: NPS 3 (DN 80).

b. Materials:

1) Stainless-Steel Sheet: ASTM A 240/A 240M, austenitic stainless steel, type as indicated.

2) Stainless-Steel Bars: ASTM A 276, austenitic stainless steel, type as indicated.

c. Stainless-Steel Finish: Directional satin finish, No. 4.

B. Food Waste Machines

1. Food Waste Disposer Units:

a. Description: 3 **OR** 5 **OR** 7, **as directed**, hp, with dual-direction shredding elements, and the following:

1) Stainless-steel **OR** Corrosion-resistant, **as directed**, housing.

2) Flow control.

3) Solenoid valve.

4) Vacuum breaker.

5) Fixed nozzle.

6) Control Panel:

a) Autoreversing and internal timed water flush.

b) Stainless-steel mounting bracket.

7) Prerinse: Backsplash mounted with hot- and cold-water mixing valve and with stainless-steel **OR** corrosion-resistant, **as directed**, exposed metal parts and the following:

a) Wall support bracket.

b) Flexible, 3/8-inch (10-mm) metal-encased hose with a minimum length of 29 inches (737 mm) and supported by spiral spring.

c) Spray-head assembly with lockable lever handle.

8) Accessories:

a) Collar adaptor for sink **OR** trough, **as directed**.

b) Cone with adaptor ring.

i. Size: 12 inches (305 mm) **OR** 15 inches (381 mm) **OR** 18 inches (457 mm), **as directed**.

c) Cone cover in size that matches cone.

d) Silver accumulator.

9) Electrical Service: Equip unit for connection to service indicated on Drawings.

2. Food Waste Pulper and Water Extractor Systems:

a. Description: Stainless-steel pulper unit, extractor unit, and control panel with water-level control and push-button start.

1) Capacity: Not less than 600 lb (272 kg) **OR** 700 lb (318 kg) **OR** 900 lb (408 kg), **as directed**, of waste per hour.

2) Accessories:

a) Feed trough connection.

b) Feed tray.

c) Feed hood assembly.

d) Under-dish-table lid.

e) Remote Water Extractor:

i. Dam, to prevent siphoning of water from pulper tank.

ii. Remote piping system, overhead **OR** below floor, **as directed**.

3) Electrical Service: Equip unit for connection to service indicated on Drawings.

3. Food Waste Grinder and Water Extractor Systems:

a. Description: Stainless-steel construction; with off and on controls on unit, food waste hopper, silver saver, internal disposer, removable water extraction auger with internal water sprays, and discharge chute.

1) Capacity: Not less than 600 lb (272 kg) **OR** 700 lb (318 kg), **as directed**, of waste per hour.

2) Accessories:

a) Reel rinse unit with spray valve.

b) Recirculation water pump.
c) Trough mount.
3) Electrical Service: Equip unit for connection to service indicated on Drawings.
4. Undercounter Food Waste Grinder and Water Extractors:
a. Description: Stainless-steel, undercounter, cleanable assembly including the following:
1) Capacity: Not less than 600 lb (272 kg) **OR** 700 lb (318 kg), **as directed**, of waste per hour.
2) Separate water-extractor and disposer units.
a) Disposer: Corrosion-resistant housing, dual-direction shredding elements.
3) Piping between disposer and water extractor.
4) Vacuum breaker.
5) Solenoid valve.
6) Flow control.
7) Time-delayed relay.
8) Control Panel:
a) Autoreversing and internal timed water flush.
b) Stainless-steel mounting bracket.
9) Prerinse: Backsplash mounted with hot- and cold-water mixing valve and with stainless-steel **OR** corrosion-resistant, **as directed**, exposed metal parts and the following:
a) Wall support bracket.
b) Flexible, 3/8-inch (10-mm) metal-encased hose with a minimum length of 29 inches (737 mm) and supported by spiral spring.
c) Spray-head assembly with lockable lever handle.
10) Accessories:
a) Cone with adaptor ring.
i. Size: 12 inches (305 mm) **OR** 15 inches (381 mm) **OR** 18 inches (457 mm), **as directed**.
b) Cone cover in size that matches cone.
c) Silver sorter.
d) Trough collar connection.
11) Electrical Service: Equip unit for connection to service indicated on Drawings.

C. Cooking Equipment
1. Ranges:
a. Description:
1) Top Configuration:
a) Open-Burner Unit:
i. Standard Burners: Four **OR** Six **OR** Eight **OR** Four, step-up type, **as directed**.
ii. Wok **OR** Saute, **as directed**, Head: as directed by the Owner.
b) Griddle: Flat **OR** Raised, **as directed**.
c) Radiant Broiler: as directed by the Owner.
2) Base Configuration:
a) Standard Oven(s): One **OR** Two, **as directed**.
b) Convection Oven(s): One **OR** Two, **as directed**.
c) Storage Base: One.
3) Accessories:
a) High **OR** Double-deck, **as directed**, back shelf.
b) Stainless-steel sides.
c) Stainless-steel back.
d) Legs for curb base.
e) Toe Base: 4 inches (102 mm) high.
f) Casters: as directed by the Owner.
g) Oven Rack(s): One for each oven.

4) Electrical Service: Equip unit for connection to service indicated on Drawings.
5) Gas Service: Natural **OR** Liquefied propane, **as directed**, gas.

2. Deep Fat Fryers:
   a. Description: Electric fryer, solid-state controls **OR** Electric, programmable computer controls **OR** Gas fryer, **as directed**.
      1) Oil Capacity: 40 lb (18 kg) **OR** 85 lb (39 kg), **as directed**.
      2) Accessories:
         a) Stainless-steel sides.
         b) Stainless-steel fry tank.
         c) Stainless-steel fry tank cover.
         d) Casters: as directed by the Owner.
         e) Automatic basket lifts.
         f) Single Fry Baskets: as directed by the Owner.
         g) Twin Fry Baskets: as directed by the Owner.
         h) Triple Fry Baskets: as directed by the Owner.
         i) Quick gas-service disconnect and flexible hose.
      3) Electrical Service: Equip unit for connection to service indicated on Drawings.
      4) Gas Service: Natural **OR** Liquefied propane, **as directed**, gas.
3. Steam Jacketed Kettles:
   a. Description: Stainless steel, Type 304.
      1) Type: Stationary **OR** Tilting, **as directed**.
      2) Steam Source: Electrically heated, self-contained **OR** Direct, **as directed**.
         a) Maximum **OR** Operating, **as directed**, Steam Pressure: 50 psig (345 kPa) **OR** 25 psig (172 kPa), **as directed**.
      3) Capacity: 10 quarts (9.5 L) **OR** 20 gal. (76 L), **as directed**.
      4) Accessories:
         a) Basket insert.
         b) Lift-off cover.
         c) Single **OR** Double, **as directed**,-pantry water filler.
         d) Tangent Drawoff: 2 inches (50 mm) **OR** 3 inches (76 mm), **as directed**.
         e) Disc Strainer: 1/8 inch (3 mm), perforated **OR** solid, **as directed**.
         f) Interior Finish: Manufacturer's standard **OR** Stainless steel, Type 316, **as directed**.
         g) Cold-water jacket cooling.
         h) Steam trap assemblies.
         i) Kettle brush kit.
      5) Electrical Service: Equip unit for connection to service indicated on Drawings.
   b. Stainless-Steel Sheet: ASTM A 240/A 240M, austenitic stainless steel, type as indicated.
   c. Stainless-Steel Finish: Directional satin finish, No. 4.
4. Ovens:
   a. Description: Electric convection **OR** Gas convection **OR** Rotisserie, **as directed**.
      1) Single deck **OR** Double deck **OR** Single deck with open stand, **as directed**.
      2) Accessories:
         a) Oven Rack(s): One per oven chamber.
         b) Stainless-steel drip pan.
         c) Down-draft flue diverter.
         d) Stacking kit.
      3) Electrical Service: Equip unit for connection to service indicated on Drawings.
      4) Gas Service: Natural **OR** Liquefied propane, **as directed**, gas.
5. Microwave Ovens:
   a. Description: 1200-W cooking power.
      1) Electrical Service: Equip unit with plug and cord for 120-V service.
6. Coffee Urns:
   a. Description: Single **OR** Twin **OR** Triple, **as directed**, urn.
      1) Capacity: 3 gal. (11 L) **OR** 6 gal. (23 L) **OR** 10 gal. (38 L), **as directed**, per liner.
      2) Type: Electric **OR** Gas **OR** Steam, **as directed**, heated.

3) Agitator: Automatic **OR** Push button, **as directed**.
4) Spray Arm: With **OR** Without, **as directed**, bypass.
5) Timer: Digital **OR** Electromechanical, **as directed**.
6) Accessories:
   a) Fill/Dispense: as directed by the Owner.
   b) Multiple Faucet: as directed by the Owner.
   c) Filtering: Permanent, stainless-steel, woven-wire cloth **OR** Disposable filter paper, **as directed**.
   d) Finish: Manufacturer's standard **OR** Brass body and trim **OR** Copper body and brass trim, **as directed**.

b. Electrical Service: Equip unit for connection to service indicated on Drawings.
c. Gas Service: Natural **OR** Liquefied propane, **as directed**, gas.
d. Operating Steam Pressure: As indicated on Drawings **OR** As directed.

D. Self-Contained Refrigeration Equipment

1. Refrigerators **OR** Freezers, **as directed**:
   a. Description: Reach-in **OR** Roll-in **OR** Pass-through, **as directed**, type.
      1) Exterior Finish: Stainless steel.
      2) Interior Finish: Stainless steel **OR** Manufacturer's standard, **as directed**.
      3) Doors: Full length **OR** Half length **OR** In configuration shown on Drawings, **as directed**.
      4) Accessories:
         a) Casters.
         b) Stainless-steel back with rear louvers.
         c) Re-hinging feature for doors.
         d) Hinged glass doors and fluorescent fixtures.
         e) Tray Slides: For sheet pans.
         f) Chrome-Plated **OR** Stainless-Steel, **as directed**, Shelves: Quantity, as directed by the Owner.
         g) Loading Rack: as directed by the Owner.
         h) Transfer Carriage: as directed by the Owner.
      5) Electrical Service: Equip unit with plug and cord for service indicated on Drawings.
2. Undercounter Refrigerators **OR** Freezers, **as directed**:
   a. Description: Compact unit with rear-mounted, self-contained refrigeration system.
      1) Accessories:
         a) Stainless-steel top with backsplash.
         b) Stainless-steel back panel.
         c) Casters: 6 inches (152 mm) **OR** 4 inches (102 mm) **OR** 3-1/2 inches (89 mm), **as directed**, high.
         d) Utility Base: 6 inches (152 mm) high.
         e) Shelves: Description and quantity, as directed by the Owner.
         f) Stacking kit.
      2) Electrical Service: Equip unit with plug and cord for service indicated on Drawings.
3. Merchandiser Refrigeration Units:
   a. Description: Curved-glass, self-contained refrigerator **OR** Sliding-glass, self-contained refrigerator **OR** Sliding-glass, self-contained freezer, **as directed**.
      1) Exterior Finish: Manufacturer's standard **OR** Stainless steel, **as directed**.
      2) Interior Finish: Manufacturer's standard **OR** Stainless steel **OR** White, **as directed**.
      3) Accessories:
         a) Door locks.
         b) Fluorescent Light Fixtures: Quantity, as directed by the Owner.
         c) Base: as directed by the Owner.
         d) Casters: as directed by the Owner.
         e) Legs: as directed by the Owner.
         f) Chrome-Plated Shelves: Quantity, as directed by the Owner.

4) Electrical Service: Equip unit with plug and cord for service indicated on Drawings.
4. Ice-Making Machine:
   a. Description: Undercounter **OR** Freestanding, **as directed**, units.
      1) Production: Ice cubes **OR** cubes, dice **OR** cubes, half dice **OR** flakes **OR** chiplets (compacted flake ice), **as directed**.
      2) Capacity: as directed by The Owner per 24-hour period.
      3) Accessories:
         a) Storage Bin: as directed by the Owner..
            i. Stainless-steel stand and legs.
         b) Water filter.
      4) Electrical Service: Equip unit for connection to service indicated on Drawings.

E. Walk-In Refrigeration Equipment
1. Walk-in Refrigeration Units:
   a. Description: Cooler **OR** Freezer **OR** Two-compartment unit, with cooler and freezer compartments, **as directed**.
      1) Wall and Ceiling Panels: Interlocking insulating panels.
      2) Floors: Insulated floor panels **OR** Field installed; provide manufacturer's standard insulated floor screed, **as directed**.
      3) Doors:
         a) Hinges: Two per door **OR** Self-closing and spring loaded; three per door,. **As directed**.
         b) Latch: Edge-mounted, positive-type latch with cylinder lock.
         c) Include an accessible safety-release handle that opens door from inside when door is locked per building code.
      4) Door Accessories:
         a) Vision port: Install per building code. The bottom of the glass not higher than 43" AFF.
         b) Pressure relief port.
         c) Threshold: Stainless steel, factory installed per building code.
         d) Anticondensate heater at freezer doors.
      5) Vaporproof Lighting Fixtures: Incandescent fixture with 100-W lamp.
         a) Control: Neon pilot light and toggle switch located on exterior of door panel.
         b) Quantity: One per compartment, located on door panel.
      6) Refrigeration System: Self-contained, mounted on unit **OR** Remote system with preassembled condensing unit and evaporator assemblies.
         a) Exterior Condensing Units: Include winter control, crankcase heater, and enclosed weatherproof housing.
         b) Operating Temperature: as directed by the Owner.
      7) Temperature Monitoring System: Electronic monitoring and remote audible alarm system that warns when temperatures register 10 deg F (6 deg C) above or below set temperature.
      8) Closure Panels and Trim: Include closure panels and trim.
      9) Electrical Service: Equip unit for connection to service indicated on Drawings.
   b. Finishes:
      1) Exposed Exterior Finish: Stucco-patterned aluminum **OR** Smooth, mill-finished aluminum **OR** White-painted aluminum, **as directed**.
      2) Unexposed Exterior Finish: Stucco-patterned, metallic-coated steel.
      3) Interior Finish: Stucco-patterned aluminum **OR** Smooth, mill-finished aluminum **OR** White-painted aluminum, **as directed**.
      4) Closure Panels and Trim: Matched to exposed exterior finish of panels.

F. Powered Food-Preparation Equipment
1. Mixers **OR** Slicers **OR** Meat Saws **OR** Peelers, **as directed**:
   a. Description: as directed by the Owner.
   b. Accessories: as directed by the Owner.

c. Electrical Service: Equip unit with plug and cord for service indicated on Drawings.

G. Warewashing Equipment
1. Warewashing Machines:
a. Description: Dishwashing, single tank **OR** Dishwashing, double tank **OR** Dishwashing, rackless conveyor **OR** Dishwashing, with circular conveyor table **OR** Pot and pan washing, two racks **OR OR** Pot and pan washing, one rack, **as directed**.
1) Capacity: as directed by the Owner.
2) Accessories: as directed by the Owner.
3) Electrical Service: Equip unit for connection to service indicated on Drawings.

H. Serving Equipment
1. Modular Counters:
a. Description: Hot food **OR** Refrigerated salad **OR** Ice-cooled salad **OR** Sliding-glass door refrigerated **OR** Frost-top **OR** Sandwich **OR** Pizza **OR** Refrigerated-chest **OR** Dual-temperature **OR** Tray-starter **OR** Storage **OR** Cashier, **as directed**, module.
1) Cabinet Face Panels: Manufacturer's standard.
2) Accessories:
a) Tray slide.
b) Work shelf.
c) Casters.
d) Electrical receptacle.
e) Cam-action latch locks with trigger release to mate with adjoining modular counters.
f) Tempered-glass, food-protector shield.
3) Electrical Service: Equip unit for connection to service indicated on Drawings.
4) Color: As selected from manufacturer's full range.
5) Install serving counters, tray slides, heights and reach depths per building code.

I. Utility Distribution Systems
1. Utility Distribution Systems:
a. Description: Overhead **OR** Counter **OR** Island **OR** Tray-slide **OR** Steam **OR** Wall-mounted, **as directed**, system.
b. Accessories: as directed by the Owner.

J. Miscellaneous Materials
1. Installation Accessories, General: NSF certified for end-use application indicated.
2. Elastomeric Joint Sealant: ASTM C 920; silicone **OR** urethane, **as directed**. Type S (single component), Grade NS (nonsag), Class 25, Use NT (nontraffic) related to exposure, and Use M, G, A, or O as applicable to joint substrates indicated.
a. Public Health and Safety Requirements:
1) Sealant is certified for compliance with NSF standards for end-use application indicated.
2) Washed and cured sealant complies with the FDA's regulations for use in areas that come in contact with food.
b. Cylindrical Sealant Backing: ASTM C 1330, Type C, closed-cell polyethylene, in diameter greater than joint width.

K. Finishes
1. Stainless-Steel Finishes:
a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
b. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
1) Run grain of directional finishes with long dimension of each piece.

2) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2. Powder-Coat Finishes: Immediately after cleaning and pretreating, electrostatically apply manufacturer's standard, baked-polymer, thermosetting powder finish. Comply with resin manufacturer's written instructions for application, baking, and minimum dry film thickness.

1.3 EXECUTION

A. Installation
1. Install foodservice equipment level and plumb, according to manufacturer's written instructions.
    a. Connect equipment to utilities.
    b. Provide cutouts in equipment, neatly formed, where required to run service lines through equipment to make final connections.
2. Complete equipment assembly where field assembly is required.
    a. Provide closed butt and contact joints that do not require a filler.
    b. Grind field welds on stainless-steel equipment until smooth and polish to match adjacent finish.
3. Install equipment with access and maintenance clearances that comply with manufacturer's written installation instructions and with requirements of authorities having jurisdiction.
4. Install cabinets and similar equipment on bases in a bed of sealant.
5. Install closure-trim strips and similar items requiring fasteners in a bed of sealant.
6. Install joint sealant in joints between equipment and abutting surfaces with continuous joint backing unless otherwise indicated. Produce airtight, watertight, vermin-proof, sanitary joints.

B. Cleaning And Protecting
1. After completing installation of equipment, repair damaged finishes.
2. Clean and adjust equipment as required to produce ready-for-use condition.
3. Protect equipment from damage during remainder of the construction period.

C. Demonstration
1. Train the Owner's maintenance personnel to adjust, operate, and maintain foodservice equipment.

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SECTION 11 30 13 13 - RESIDENTIAL APPLIANCES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for residential appliances. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes:
a. Cooking appliances.
b. Kitchen exhaust ventilation.
c. Refrigeration appliances.
d. Cleaning appliances
e. Trash compactors.

C. Submittals
1. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, dimensions, furnished accessories, and finishes for each appliance.
2. LEED Submittal:
a. Product Data for Credit EA 1.4 or LEED for Homes Credit EA9: For appliances, documentation indicating that products are ENERGY STAR rated.
3. Samples: For each exposed finish.
4. Product Schedule: For appliances; use same designations indicated on Drawings.
5. Qualification Data: For qualified Installer or manufacturer.
6. Product Certificates: For each type of appliance, from manufacturer.
7. Field quality-control reports.
8. Operation and Maintenance Data: For each residential appliance to include in operation and maintenance manuals.
9. Warranties: Special warranties specified in this Section.

D. Quality Assurance
1. Manufacturer Qualifications: Maintains a service center capable of providing training, parts, and emergency maintenance repairs.
2. Installer Qualifications: An employer of workers trained and approved by manufacturer for installation and maintenance of units required for this Project.
3. Source Limitations: Obtain residential appliances from single source and each type of residential appliance from single manufacturer.
4. High-Altitude and Propane Conversion: Provide gas-operated appliances with manufacturer's conversion kit installed by a qualified service agency according to manufacturer's written instructions for Project location and type of fuel.
5. Regulatory Requirements: Comply with the following:
a. NFPA: Provide electrical appliances listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
b. ANSI: Provide gas-burning appliances that comply with ANSI Z21 Series standards.
6. Accessibility: Where residential appliances are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1," **as directed**.
7. Preinstallation Conference: Conduct conference at Project site.

E. Warranty

1. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace residential appliances or components that fail in materials or workmanship within specified warranty period.
   a. Warranty Period: Two **OR** Five years, **as directed,** from date of Final Completion.
2. Electric Cooktop **OR** Range: Full warranty including parts and labor **OR** Limited warranty including parts and labor for first year and parts thereafter for on-site service on surface-burner elements, **as directed**.
   a. Warranty Period: Two **OR** Five years, **as directed,** from date of Final Completion.
3. Microwave Oven: Full warranty including parts and labor **OR** Limited warranty including parts and labor for first year and parts thereafter for on-site service on the magnetron tube, **as directed**.
   a. Warranty Period: Two **OR** Five years, **as directed,** from date of Final Completion.
4. Refrigerator/Freezer **OR** Freezer **OR** Icemaker, Sealed System: Full warranty including parts and labor **OR** Limited warranty including parts and labor for first year and parts thereafter for on-site service on the product, **as directed**.
   a. Warranty Period for Sealed Refrigeration System: Two **OR** Five years, **as directed,** from date of Final Completion.
   b. Warranty Period for Other Components: Two years from date of Final Completion.
5. Dishwasher: Full warranty including parts and labor **OR** Limited warranty including parts and labor for first year and parts thereafter for on-site service on the product, **as directed**.
   a. Warranty Period for Deterioration of Tub and Metal Door Liner: Three **OR** Five **OR** 10 years, **as directed,** from date of Final Completion.
   b. Warranty Period for Other Components: Two years from date of Final Completion.
6. Clothes Washer: Full warranty including parts and labor **OR** Limited warranty including parts and labor for first year and parts thereafter for on-site service on the product, **as directed**.
   a. Warranty Period: Two **OR** Three years, **as directed,** from date of Final Completion.

1.2 PRODUCTS

A. Cooktops:
1. Electric Cooktop:
   a. Width: 12 inches (305 mm) **OR** 30 inches (762 mm) **OR** 36 inches (914 mm), **as directed**.
   b. Electric Burner Elements: Two **OR** Four **OR** Six, **as directed**.
   c. Coil Type: Manufacturer's standard **OR** Two 1200 W and two 2200 W **OR** One 1200 W, one 2200-W dual element, and two 2200 W, **as directed**.
   d. Radiant Type: Two 1500 W and two 2000 W **OR** One 1200-W element, dual 1500-W/1500-W bridge element, and one 1200-W/2500-W expandable element **as directed**.
   e. Induction Type: Manufacturer's standard **OR** Two 1200 W and two 1800 W **OR** One 1200 W, one 1800 W, one 2700 W, and one 3300 W, **as directed**.
   f. Controls: Digital panel controls, located on front **OR** on left side **OR** on right side **OR** remotely, where indicated, **as directed**.
   g. Downdraft Ventilation: Manufacturer's standard **OR** 550 cfm (260 L/s) **as directed**, built-in downdraft ventilation, with remote blower and exterior weatherproof wall cap.
   h. Other Features: Grill **OR** deep fryer **OR** wok burner and wok ring, **as directed**.
   i. Electric Power Supply: 240 V, 60 Hz, 1 phase, 30 A, **as directed**.
   j. Top Material: Manufacturer's standard **OR** Ceramic glass **OR** Porcelain-enamel steel **OR** Stainless steel, **as directed**.
      1) Color/Finish: White **OR** Black, **as directed**.
2. Gas Cooktop
   a. Width: 12 inches (300 mm) **OR** 30 inches (760 mm) **OR** 36 inches (915 mm), **as directed**.
   b. Gas Burners: Two **OR** Four **OR** Six, **as directed**.
      1) Power Ratings: Manufacturer's standard **OR** One 5000 Btu/h (1500 W), two 9100 Btu/h (2700 W), and one 12,000 Btu/h (3500 W), **as directed**.
      2) Grates: Individual **OR** Continuous, **as directed**.

c. Controls: Digital panel **OR** Manual-dial controls, located on front **OR** left side **OR** right side, **as directed**.
d. Downdraft Ventilation: Manufacturer's standard **OR** 550 cfm (260 L/s), **as directed**, with remote, **as directed**, blower and exterior weatherproof wall cap.
e. Other Features: Sealed burners **OR** Auto-reigniting **OR** Grill **OR** deep fryer **OR** wok burner and wok ring, **as directed**.
f. Electric Power Supply: 120 V, 60 Hz, 1 phase, 30 A, **as directed**.
g. Top Materials: Porcelain-enamel steel **OR** Ceramic glass **OR** glass **OR** Stainless steel **OR** Manufacturer's standard, **as directed**.
   1) Color/Finish: White **OR** Black, **as directed**.

B. Range:
1. Electric Range: Freestanding **OR** Slide-in **OR** Drop-in range, **as directed**, with one **OR** two oven(s), **as directed** and complying with AHAM ER-1.
   a. Width: 30 inch (762 mm) **OR** 36 inch (914 mm), **as directed**.
   b. Electric Burner Elements: Four **OR** Six, **as directed**.
      1) Coil Type: Manufacturer's standard **OR** Two 1200 W and two 2200 W **OR** One 1200 W, one 2200-W dual element, and two 2200 W, **as directed**.
      2) Radiant Type: Two 1500 W and two 2000 W **OR** One 1200-W element, dual 1500-W/1500-W bridge element, and one 1200-W/2500-W expandable element, **as directed**.
      3) Induction Type: Manufacturer's standard **OR** Two 1200 W and two 1800 W **OR** One 1200 W, one 1800 W, one 2700 W, and one 3300 W, **as directed**.
      4) Controls: Digital panel controls, located on front **OR** left side **OR** right side **OR** splash panel at rear of rangetop, **as directed**.
   c. Oven Features:
      1) Capacity: 3.3 cu. ft. (0.09 cu. m).
      2) Operation: Baking **OR** convection **as directed**, and self-cleaning.
      3) Broiler: Located in top of oven **OR** separate roll-out drawer on bottom **as directed**.
      4) Oven Door(s): Counterbalanced, removable, with observation window and full-width handle.
      5) Electric Power Rating:
         a) Oven(s): Manufacturer's standard **OR** 2400 W **as directed**.
         b) Broiler: Manufacturer's standard **OR** 3500 W **as directed**.
      6) Controls: Digital panel controls and timer display, located on front **OR** left side **OR** right side **OR** splash panel at rear of rangetop, **as directed**.
   d. Anti-Tip Device: Manufacturer's standard.
   e. Electric Power Supply: 240 V, 60 Hz, 1 phase, 30 A.
   f. Material Porcelain-enamel **OR** Stainless, **as directed**, with manufacturer's standard, **as directed**, cooktop.
         a) Color/Finish: White **OR** Black, **as directed**.

2. Gas Range: Freestanding **OR** Slide-in range with one **OR** two ovens, **as directed**.
   a. Width: 30 inch (762 mm) **OR** 36 inch (914 mm), **as directed**.
   b. Gas Burners: Four **OR** Six, **as directed**.
      1) Power Ratings: Manufacturer's standard **OR** One 5000 Btu/h (1500 W), **as directed**, two 9100 Btu/h (2700 W), and one 12,000 Btu/h (3500 W).
      2) Controls: Digital panel **OR** Manual-dial controls, **as directed** located on front **OR** left side **OR** right side **OR** splash panel at rear of rangetop, **as directed**.
      3) Grates: Individual **OR** Continuous, **as directed**.
      4) Other Feature(s): Sealed burners **OR** auto-re-igniting burners, **as directed**, and grill.
   c. Oven Features:
      1) Capacity: 3.3 cu. ft. (0.09 cu. m).
      2) Operation: Baking **OR** convection **as directed**, and self-cleaning.
      3) Broiler: Located in top of oven **OR** separate roll-out drawer on bottom **as directed**.

4) Oven Door(s): Counterbalanced, removable, with observation window and full-width handle.
5) Electric Power Rating:
   a) Oven(s): Manufacturer's standard **OR** 9100 Btu/h (2700 W) **as directed**.
   b) Broiler: Manufacturer's standard **OR** 14,500 Btu/h (4200 W) **as directed**.
6) Controls: Digital panel controls and timer display, located on front **OR** left side **OR** right side **OR** splash panel at rear of rangetop, **as directed**.

d. Anti-Tip Device: Manufacturer's standard.
e. Electric Power Supply: 240 V, 60 Hz, 1 phase, 15 A.
f. Material Porcelain-enamel **OR** Stainless, **as directed**, with manufacturer's standard, **as directed**, cooktop.
   a) Color/Finish: White **OR** Black, **as directed**.

3. Dual Fuel Range Freestanding **OR** Slide-in range, **as directed**, with gas burners and one **OR** two electric ovens, **as directed**.
   a. Width: 30 inch (762 mm) **OR** 36 inch (914 mm), **as directed**.
   b. Gas Burners: Four **OR** Six, **as directed**.
      1) Power Ratings: Manufacturer's standard **OR** One 5000 Btu/h (1500 W), **as directed**, two 9100 Btu/h (2700 W), and one 12,000 Btu/h (3500 W)
      2) Controls: Digital panel **OR** Manual-dial controls, **as directed** located on front **OR** left side **OR** right side **OR** splash panel at rear of rangetop, **as directed**.
      3) Grates: Individual **OR** Continuous, **as directed**.
      4) Other Feature(s): Sealed burners **OR** auto-re-igniting burners, **as directed**, and grill.
   c. Oven Features:
      1) Capacity: 3.3 cu. ft. (0.09 cu. m).
      2) Operation: Baking **OR** convection **as directed**, and self-cleaning.
      3) Broiler: Located in top of oven **OR** separate roll-out drawer on bottom **as directed**.
      4) Oven Door(s): Counterbalanced, removable, with observation window and full-width handle.
      5) Electric Power Rating:
         a) Oven(s): Manufacturer's standard **OR** 2400 W **as directed**.
         b) Broiler: Manufacturer's standard **OR** 3500 W **as directed**.
      6) Controls: Digital panel controls and timer display, located on front **OR** left side **OR** right side **OR** splash panel at rear of rangetop, **as directed**.
   d. Anti-Tip Device: Manufacturer's standard.
   e. Electric Power Supply: 240 V, 60 Hz, 1 phase, 30 A.
   f. Material Porcelain-enamel **OR** Stainless, **as directed**, with manufacturer's standard, **as directed**, cooktop.
      1) Color/Finish: White **OR** Black, **as directed**.

C. Wall Oven:
1. Electric Wall Oven(s): One **OR** Two-oven unit, **as directed**.
   a. Mounting: Built-in wall **OR** undercounter .
   b. Capacity: 3.3 cu. ft. (0.09 cu. m).
   c. Operation: Baking **OR** convection and self-cleaning, **as directed**.
   d. Broiler: Located in top of oven **OR** separate roll-out drawer on bottom, **as directed**.
   e. Oven Door(s): Counterbalanced, removable, with observation window and full-width handle.
   f. Electric Power Rating:
      1) Oven(s): Manufacturer's standard **OR** 2400 W, **as directed**.
      2) Broiler: Manufacturer's standard **OR** 3500 W, **as directed**.
   g. Electric Power Supply: 240 V, 60 Hz, 1 phase, 30 A
   h. Controls: Digital panel **OR** Manual-dial controls and timer display, **as directed**.

i. Material: Porcelain-enameled steel **OR** Stainless steel **OR** Manufacturer's standard, **as directed**.
1) Color/Finish: White **OR** Black, **as directed**.

2. Gas Wall Oven(s): One **OR** Two-oven unit, **as directed**.
a. Mounting: Built-in wall **OR** undercounter .
b. Capacity: 3.3 cu. ft. (0.09 cu. m).
c. Operation: Baking **OR** convection and self-cleaning, **as directed**.
d. Broiler: Located in top of oven **OR** separate roll-out drawer on bottom, **as directed**.
e. Oven Door(s): Counterbalanced, removable, with observation window and full-width handle.
f. Electric Power Rating:
1) Oven(s): Manufacturer's standard **OR** 9100 Btu/h (2700 W), **as directed**.
2) Broiler: Manufacturer's standard **OR** 14,500 Btu/h (4200 W), **as directed**.
g. Electric Power Supply: 240 V, 60 Hz, 1 phase, 30 A
h. Controls: Digital panel **OR** Manual-dial controls and timer display, **as directed**.
i. Material: Porcelain-enameled steel **OR** Stainless steel **OR** Manufacturer's standard, **as directed**.
1) Color/Finish: White **OR** Black, **as directed**.

D. Microwave Oven:
1. Microwave Oven(s):
a. Mounting: Undercabinet **OR** Wall cabinet, **as directed**.
b. Type: Conventional **OR** Convection, **as directed**.
c. Dimensions:
1) Width: 24 inches (610 mm) **OR** 30 inches (762 mm), **as directed**.
2) Depth: 19-1/2 inches (495 mm), **as directed**.
3) Height: 14 inches (356 mm) **OR** 18 inches (457 mm), **as directed**.
d. Capacity: 1.5 cu. ft. (0.04 cu. m) **OR** 2.0 cu. ft. (0.06 cu. m), **as directed**.
e. Oven Door: Door with observation window and pull handle **OR** and push-button latch release, **as directed**.
f. Exhaust Fan: Variable **OR** Two **OR** Four-speed fan, , **as directed**, vented to outside **OR** nonvented, **as directed**, recirculating type with charcoal filter and with manufacturer's standard **OR** 300-cfm (140-L/s) capacity, **as directed**.
g. Microwave Power Rating: Manufacturer's standard **OR** 1000 W, **as directed**.
1) Convection Element Power Rating: Manufacturer's standard **OR** 1450 W, **as directed**.
h. Electric Power Supply: 120 V, 60 Hz, 1 phase, 15 A.
i. Controls: Digital panel controls and timer display.
j. Other Features: Turntable **OR** temperature probe, **as directed**, and lock-out feature.
k. Material: Porcelain-enameled steel **OR** Stainless steel **OR** Manufacturer's standard, **as directed**.
1) Color/Finish: White **OR** Black, **as directed**.

E. Kitchen Exhaust Ventilation:
1. Overhead Exhaust Hood
a. Type: Wall-mounted, **OR** Suspended-island-canopy, exhaust-hood system, **as directed**.
b. Dimensions:
1) Width: 30 inches (762 mm) **OR** 36 inches (914 mm) **OR** 48 inches (1219 mm), **as directed**.
2) Depth: 30 inches (762 mm) **OR** 36 inches (914 mm) **OR** 48 inches (1219 mm), **as directed**.
c. Exhaust Fan: Variable **OR** Two **OR** Three-speed fan, **as directed**, built into hood **OR** remotely located, , **as directed**, with separate housing and with manufacturer's standard **OR** 500-cfm (236-L/s) **OR** 900-cfm (425-L/s) capacity, **as directed**.
1) Venting: Vented to outside through roof with weatherproof roof cap, backdraft damper, and rodent-proof screening **OR** Vented to outside through wall with

weatherproof wall cap, backdraft damper, and rodent-proof screening **OR** Nonvented, recirculating type with charcoal filter, **as directed**.

2) Fan Control: Hood **OR** Wall-mounted touch-pad to control fan switch, with separate hood-light control switch, **as directed**.

d. Duct Type: Manufacturer's standard **OR** 7-inch- (175-mm-) diameter round **OR** 3-1/4 by 10 inches (82 by 250 mm) rectangular, **as directed**.

e. Finish: Baked enamel **OR** Stainless steel, **as directed**.

1) Color: White **OR as directed**.

f. Features:

1) Permanent, washable aluminum mesh **OR** stainless-steel mesh **OR** baffle-type filter(s), **as directed**.

2) Built-in halogen **OR** incandescent **OR** fluorescent lighting, **as directed**.

3) Warming lamp socket(s).

2. Downdraft Exhaust:

a. Type: Retractable-downdraft exhaust system.

b. Width: 30 inches (762 mm) **OR** 36 inches (914 mm), **as directed**.

c. Exhaust Fan: Variable **OR** Two **OR** Three-speed fan built into cabinet below countertop **OR** remotely located, **as directed**, with separate housing and with manufacturer's standard **OR** 500-cfm (236-L/s) **OR** 900-cfm (425-L/s) capacity, **as directed**.

1) Venting: Vented to outside through roof with weatherproof roof cap, backdraft damper, and rodent-proof screening **OR** Vented to outside through wall with weatherproof wall cap, backdraft damper, and rodent-proof screening **OR** Nonvented, recirculating type with charcoal filter, **as directed**.

2) Fan Control: Countertop-mounted touch-pad to control fan switch.

d. Duct Type: Manufacturer's standard **OR** 7-inch- (175-mm-) diameter round **OR** 3-1/4 by 10 inches (82 by 250 mm) rectangular, **as directed**.

e. Finish: Baked enamel **OR** Stainless steel, **as directed**.

1) Color: White **OR as directed**.

f. Features:

1) Permanent, washable aluminum mesh **OR** stainless-steel mesh **OR** baffle-type filter(s), **as directed**.

F. Refrigerator/Freezers

1. Refrigerator/Freezer One-door refrigerator with inside freezer compartment **OR** Two-door, side-by-side refrigerator/freezer **OR** Two-door refrigerator/freezer with freezer on top **OR** Two-door refrigerator/freezer with freezer on bottom, **as directed** and complying with AHAM HRF-1.

a. Type: Freestanding **OR** Built in **OR** Undercounter.

b. Dimensions:

1) Width: 16 inches (406 mm) **OR** 24 inches (610 mm) **OR** 27 inches (686 mm) **OR** 30 inches (762 mm) **OR** 36 inches (914 mm) **OR** 42 inches (1067 mm) **OR** 48 inches (1220 mm), **as directed**.

2) Depth: 24 inches (610 mm) **OR** 27 inches (686 mm) **OR** 33-1/4 inches (845 mm), **as directed**.

3) Height: 34-1/2 inches (876 mm) **OR** 70 inches (1778 mm) **OR** 73 inches (1854 mm) **OR** 84 inches (2134 mm), **as directed**.

c. Storage Capacity:

1) Refrigeration Compartment Volume: 15.6 cu. ft. (0.44 cu. m).

2) Freezer Volume: 5.13 cu. ft. (0.15 cu. m).

3) Shelf Area: Three adjustable wire **OR** glass shelves, **as directed**, 26 sq. ft. (2.42 sq. m).

d. General Features:

1) Door Configuration: Framed **OR** Overlay.

2) Revise first option in first subparagraph below if either crushed or cubed ice is required.

3) Dispenser in door for ice and cold water dispenser lock.

4) Built-in water filtration system.
5) Dual refrigeration systems.
6) Separate touch-pad temperature controls for each compartment.

e. Refrigerator Features:
1) Interior light in refrigeration compartment.
2) Compartment Storage: Wine racks **OR** vegetable crisper **OR** meat compartment, **as directed**.
3) Door Storage: Glazed door without storage **OR** Modular compartments **OR** Gallon (3.8 L-) milk-container storage, **as directed**.
4) Temperature-controlled meat/deli bin.

f. Freezer Features: One **OR** Two freezer compartment(s) with door(s) **OR** configured as pull-out drawer(s), **as directed**.
1) Automatic **OR** Manual defrost, **as directed**.
2) Interior light in freezer compartment.
3) Automatic icemaker and storage bin.

g. Energy Performance, ENERGY STAR: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program.

h. Front Panel(s): Manufacturer's standard **OR** Wood panel(s) to match kitchen cabinets **OR** Porcelain enamel **OR** Stainless steel **OR** Wood-panel insert(s) specified in Division 06 Section "Interior Architectural Woodwork" to match kitchen cabinets **OR** Wood-panel insert(s) specified in Division 12 Section "Residential Casework" to match kitchen cabinets **OR** Reversible panel(s) with choice of colors, **as directed**.
1) Panel Color: White **OR** Black, **as directed**.

i. Appliance Color/Finish: White **OR** Black **OR** Stainless steel, **as directed**.

G. Freezers

1. Freezer One **OR** Two freezer compartment(s) with door(s) **OR** configured as pull-out drawer(s), **as directed** and complying with AHAM HRF-1.

a. Type: Freestanding **OR** Built in **OR** Undercounter.

b. Dimensions:
1) Width: 27 inches (686 mm) **OR** 30 inches (762 mm) **OR** 36 inches (914 mm), **as directed**.
2) Depth: 24 inches (610 mm) **OR** 27 inches (686 mm), **as directed**.
3) Height: 34-1/2 inches (876 mm) **OR** 70 inches (1778 mm) **OR** 73 inches (1854 mm) **OR** 84 inches (2134 mm), **as directed**.

c. Storage Capacity:
1) Volume: 5.13 cu. ft. (0.15 cu. m) **OR** 15.0 cu. ft. (0.42 cu. m), **as directed**.
2) Shelf Area: Three adjustable wire **OR** glass shelves, **as directed**, 26 sq. ft. (2.42 sq. m).

d. Features:
1) Door Configuration: Framed **OR** Overlay, **as directed**.
2) Automatic **OR** Manual defrost, **as directed**.
3) Interior light in compartment.
4) Automatic icemaker and storage bin.
5) Temperature touch-pad controls for each compartment.
6) Defrost drain.
7) Lock with key.

e. Energy Performance, ENERGY STAR: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program.

f. Front Panel(s): Manufacturer's standard **OR** Wood panel(s) to match kitchen cabinets **OR** Porcelain enamel **OR** Stainless steel **OR** Wood-panel insert(s) specified in Division 06 Section "Interior Architectural Woodwork" to match kitchen cabinets **OR** Wood-panel insert(s) specified in Division 12 Section "Residential Casework" to match kitchen cabinets, **as directed**.
1) Panel Color: White **OR** Black, **as directed**.

g. Appliance Color/Finish: White **OR** Black **OR** Stainless steel, **as directed**.

H. Icemakers

1. Icemaker:
    - a. Type: Undercounter.
    - b. Dimensions:
        - 1) Width: 14-3/4 inches (375 mm) **OR** 15-1/4 inches (387 mm), **as directed**.
        - 2) Depth: 24 inches (610 mm) **OR** 25-1/4 inches (641 mm), **as directed**.
        - 3) Height: 33-5/8 inches (386 mm) **OR** 34-1/2 inches (876 mm), **as directed**.
    - c. Ice Capacity:
        - 1) Production: 30 lb (13.6 kg) **OR** 50 lb (22.7 kg) per day, **as directed**.
        - 2) Storage: 25 lb (11.3 kg) **OR** 35 lb (15.9 kg), **as directed**.
    - d. Features:
        - 1) Door Configuration: Framed **OR** Overlay, **as directed**.
        - 2) Automatic defrost.
        - 3) Automatic shutoff.
        - 4) Defrost drain with pump.
    - e. Front Panel: Manufacturer's standard **OR** Wood panel to match kitchen cabinets **OR** Porcelain enamel **OR** Stainless steel **OR** Wood-panel insert specified in Division 06 Section "Interior Architectural Woodwork" to match kitchen cabinets **OR** Wood-panel insert specified in Division 12 Section "Residential Casework" to match kitchen cabinets, **as directed**.
        - a) Panel Color: White **OR** Black, **as directed**.
    - f. Appliance Color/Finish: White **OR** Black **OR** Stainless steel, **as directed**.

I. Dishwashers

1. Dishwasher Complying with AHAM DW-1 and ASSE 1006.
    - a. Type: Built-in undercounter **OR** Built-in under sink **OR** Portable, **as directed**.
    - b. Dimensions:
        - 1) Width: 18 inches (457 mm) **OR** 24 inches (610 mm), **as directed**.
        - 2) Depth: 23 inches (584 mm) **OR** 25-3/4 inches (654 mm), **as directed**.
        - 3) Height: 34-1/2 inches (876 mm), **as directed**.
    - c. Capacity:
        - 1) International Place Settings of China: Eight **OR** 12 **OR** 14, **as directed**.
        - 2) Water Consumption for Full Load: 3.2 gal. (12 L) per cycle.
    - d. Sound Level: Maximum 42 **OR** 48 dB, **as directed**.
    - e. Tub and Door Liner: Manufacturer's standard **OR** Porcelain-enameled steel **OR** Stainless steel **OR** Porcelain-enameled steel tub and molded-plastic door liner, **as directed** with sealed detergent and automatic rinsing-aid dispensers.
    - f. Rack System: Nylon **OR** PVC-coated sliding dish racks, **as directed**, with removable cutlery basket **OR** top cutlery tray **as directed**.
    - g. Controls: Touch-pad **OR** Rotary-dial controls, **as directed**, with four wash cycles and hot-air and heat-off drying cycle options.
    - h. Features:
        - 1) Features in first three subparagraphs below are standard with most models.
        - 2) Waste food disposer.
        - 3) Self-cleaning food-filter system.
        - 4) Hot-water booster heater for 140 deg F (60 deg C) **OR** 160 deg F (71 deg C) wash water with incoming water at 100 deg F (38 deg C).
        - 5) Lock-out feature.
        - 6) Half-load option.
        - 7) Delay-wash option.
        - 8) Digital display panel.
        - 9) Water softener.
        - 10) Soil-sensing water use control system.

i. Energy Performance, ENERGY STAR: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program.

j. Front Panel: Manufacturer's standard **OR** Wood panel to match kitchen cabinets **OR** Porcelain enamel **OR** Stainless steel **OR** Wood-panel insert specified in Division 06 Section "Interior Architectural Woodwork" to match kitchen cabinets **OR** Wood-panel insert specified in Division 12 Section "Residential Casework" to match kitchen cabinets **OR** Reversible panel with choice of colors, **as directed**.

1) Panel Color: White **OR** Black, **as directed**.

k. Appliance Color/Finish: White **OR** Black **OR** Stainless steel, **as directed** .

J. Clothes Washers And Dryers

1. Clothes Washer Complying with ASSE 1007:

a. Type: Freestanding **OR** Stacking **OR** Undercounter, top **OR** front-loading unit.

b. Dimensions:

1) Width: 23-1/2 inches (597 mm) **OR** 27 inches (686 mm) **OR** 30 inches (762 mm), **as directed**.

2) Depth: 24 inches (610 mm) **OR** 29 inches (737 mm) **OR** 31 inches (787 mm), **as directed**.

3) Height: 34-1/2 inches (876 mm) **OR** 38 inches (965 mm) **OR** 45 inches (1143 mm), **as directed**.

c. Drum: Manufacturer's standard **OR** Perforated porcelain-enameled steel **OR** Perforated stainless steel, **as directed**.

1) Capacity: 2.7 cu. ft. (0.08 cu. m) **OR** 3.2 cu. ft. (0.09 cu. m) **OR** 3.8 cu. ft. (0.11 cu. m).

d. Controls: Touch-pad **OR** Rotary-dial controls, **as directed**, for water-fill levels, wash/rinse water temperatures, and variable-speed and fabric selectors.

1) Wash Cycles: Four **OR** Six **OR** 10 wash cycles, **as directed**, including regular, delicate, and permanent press.

2) Wash Temperatures: Three settings.

3) Speed Combinations: Two **OR** Four **OR** Five, **as directed**.

e. Electrical Power: 120 V, 60 Hz, 1 phase.

f. Motor: Manufacturer's standard with built-in overload protector.

g. Features:

1) Agitator: Center spindle **OR** Impeller (without spindle), **as directed**.

2) Self-cleaning lint filter.

3) Unbalanced-load compensator.

4) Inlet Hoses: Minimum length 60 inches (1525 mm).

5) Drain Hoses: Minimum length 48 inches (1220 mm).

6) Self-leveling legs.

7) Automatic dispenser for bleach **OR** fabric softener **OR** and **OR** detergent, **as directed**.

8) Spin-cycle safety switch.

9) End-of-cycle signal.

10) Extra-rinse option.

11) Delay-wash option.

12) Electronic temperature control.

13) Water levels automatically set.

14) Pedestal: 8-inch- (203-mm-) high **OR** 15-inch- (381-mm-) high **OR** Manufacturer's standard height laundry pedestal , **as directed**, with storage drawer, matching appliance finish.

h. Energy Performance, ENERGY STAR: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program.

i. Water-Efficient Clothes Washer: Provide clothes washer with modified energy factor greater than or equal to 2.0 and water factor less than 5.5.

j. Appliance Finish: Porcelain enamel on top and lid; baked enamel on front and sides **OR** Stainless steel, **as directed**.

1) Color: White **OR** Almond, **as directed**.

k. Front-Panel Finish: Manufacturer's standard **OR** Wood panel to match kitchen cabinets **OR** Porcelain enamel **OR** Stainless steel **OR** Wood-panel insert specified in Division 06 Section "Interior Architectural Woodwork" to match kitchen cabinets **OR** Wood-panel insert specified in Division 12 Section "Residential Casework" to match kitchen cabinets, **as directed**.

1) Panel Color: White **OR** Black, **as directed**.

2. Clothes Dryer Complying with AHAM HLD-1:

a. Type: Freestanding **OR** Stacking **OR** Undercounter, **as directed**, frontloading, gas **OR** electric **OR** electric, ventless unit, **as directed**..

b. Dimensions:

1) Width: 23-1/2 inches (597 mm) **OR** 27 inches (686 mm), **as directed**.

2) Depth: 24 inches (610 mm) **OR** 31 inches (787 mm), **as directed**.

3) Height: 34-1/2 inches (876 mm) **OR** 36 inches (914 mm), **as directed**.

c. Drum: Manufacturer's standard **OR** Perforated porcelain-enameled steel **OR** Perforated stainless steel, **as directed**.

1) Capacity: 5.7 cu. ft. (0.16 cu. m) **OR** 7.0 cu. ft. (0.20 cu. m), **as directed**.

d. Controls: Touch-pad **OR** Rotary-dial controls for drying cycle, **as directed**, temperatures, and fabric selectors.

e. Electric-Dryer Power: 240 V, 60 Hz, 1 phase, 30 A.

f. Gas-Dryer Power: 120 V, 60 Hz, 1 phase, 15 A electric; 22,000-Btu/h (6400-W) gas.

g. Features:

1) Features in first five subparagraphs below are standard with most manufacturers.

2) Removable lint filter.

3) Electronic temperature and moisture level sensor control.

4) End-of-cycle signal.

5) Interior drum light.

6) Self-leveling legs.

7) Antibacterial cycle.

8) Auxiliary drying rack.

9) Built-in electrical power fuse.

10) Stacking kit to stack dryer over washer.

11) Pedestal: 8-inch- (203-mm-) high **OR** 15-inch- (381-mm-) high **OR** Manufacturer's standard height laundry pedestal, **as directed**, with storage drawer, matching appliance finish.

h. Appliance Finish: Porcelain enamel on top and lid; baked enamel on front and sides **OR** Stainless steel, **as directed**.

1) Color: White **OR** Almond, **as directed**.

i. Front-Panel Finish: Manufacturer's standard **OR** Wood panel to match kitchen cabinets **OR** Porcelain enamel **OR** Stainless steel **OR** Wood-panel insert specified in Division 06 Section "Interior Architectural Woodwork" to match kitchen cabinets **OR** Wood-panel insert specified in Division 12 Section "Residential Casework" to match kitchen cabinets.

1) Panel Color: White **OR** Black, **as directed**.

K. Clothes Washer/Dryer Combinations

1. Clothes Washer/Dryer Combination Complying with ASSE 1007.

a. Type: Freestanding washer/dryer unit with dual-drum design and electric dryer **OR** dual-drum design and gas dryer **OR** all-in-one, single-drum design, **as directed**; washer is top **OR** front loading, **as directed**.

b. Dimensions:

1) Width: 23-1/2 inches (597 mm) **OR** 27 inches (686 mm), **as directed**.

2) Depth: 25 inches (635 mm) **OR** 32 inches (813 mm), **as directed**.

3) Height: 34-1/2 inches (876 mm) **OR** 71-1/2 inches (1816 mm), **as directed**.

c. Washer and Dryer Drums: Manufacturer's standard **OR** Perforated porcelain-enameled steel **OR** Perforated stainless steel, **as directed**.

1) Washer-Drum Capacity: 1.5 cu. ft. (0.04 cu. m) **OR** 2.0 cu. ft. (0.06 cu. m) **OR** 2.6 cu. ft. (0.07 cu. m), **as directed**.
2) Dryer-Drum Capacity: 2.0 cu. ft. (0.06 cu. m) **OR** 3.4 cu. ft. (0.10 cu. m) **OR** 5.9 cu. ft. (0.17 cu. m), **as directed**.

d. Washer/Dryer Drum: Manufacturer's standard **OR** Perforated stainless steel, **as directed**.
1) Drum Capacity: 2.3 cu. ft. (0.07 cu. m).

2. Washer Controls: Touch-pad **OR** Rotary-dial controls for water-fill levels, **as directed**, wash/rinse water temperatures and variable-speed and fabric selectors.
3. Dryer Controls: Touch-pad **OR** Rotary-dial controls for drying cycle, **as directed**, temperatures and fabric selectors.
a. Wash Cycles: Three wash cycles including regular, delicate, and permanent press.
b. Wash Temperatures: Three settings.
c. Speed Combinations: Two.
4. Electric Washer/Dryer Power: 240 V, 60 Hz, 1 phase, 30 A **OR** 120 V, 60 Hz, 1 phase, 15 A, **as directed**.
5. Gas Washer/Dryer Power: 120 V, 60 Hz, 1 phase, 15 A electric; 22,000-Btu/h (6400-W) gas.
6. Motor: Manufacturer's standard with built-in overload protector.
7. Washing Features:
a. Self-cleaning lint filter.
b. Unbalanced-load compensator.
c. Inlet Hoses: Minimum length 60 inches (1525 mm).
d. Drain Hoses: Minimum length 48 inches (1220 mm).
e. Self-leveling legs.
f. Automatic dispenser for bleach, fabric softener and **OR** detergent.
g. Spin-cycle safety switch.
8. Drying Features:
a. Removable lint filter.
b. Electronic temperature and moisture level sensor control.
c. End-of-cycle signal.
d. Interior drum light.
9. Energy Performance, ENERGY STAR: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program.
10. Water-Efficient Clothes Washer: Provide clothes washer with modified energy factor greater than or equal to 2.0 and water factor less than 5.5.
11. Appliance Finish: Porcelain enamel on top and lid; baked enamel on front and sides **OR** Stainless steel, **as directed**.
1) Color: White **OR** Almond, **as directed**.

L. Trash Compactors
a. Type: Built in **OR** Convertible, **as directed**.
b. Width: 15 inches (381 mm) **OR** 18 inches (457 mm), **as directed**.
c. Capacity: 1.4 cu. ft. (0.04 cu. m) **OR** 1.7 cu. ft. (0.05 cu. m), **as directed**.
d. Features:
1) Key-operated starting switch.
2) Rear wheels.
3) Removable bag carrier.
4) Retainer for disposable bags.
5) Odor-control mechanism.
6) Foot-operated drawer operator.

e. Front Panel: Manufacturer's standard **OR** Wood panel to match kitchen cabinets **OR** Enameled steel **OR** Stainless steel **OR** Wood-panel insert specified in Division 06 Section "Interior Architectural Woodwork" to match kitchen cabinets **OR** Wood-panel insert specified in Division 12 Section "Residential Casework" to match kitchen cabinets, **as directed**.
a) Panel Color: White **OR** Black, **as directed**.

M. General Finish Requirements
1. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
2. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

1.3 EXECUTION

A. Examine
1. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, power connections, and other conditions affecting installation and performance of residential appliances.
2. Examine roughing-in for piping systems to verify actual locations of piping connections before appliance installation.
3. Examine walls, ceilings, and roofs for suitable conditions where overhead exhaust hoods **OR** downdraft exhaust and microwave ovens with vented exhaust fans will be installed.
4. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
5. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation, General
1. General: Comply with manufacturer's written instructions.
2. Built-in Equipment: Securely anchor units to supporting cabinets or countertops with concealed fasteners. Verify that clearances are adequate for proper functioning and rough openings are completely concealed.
3. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.
4. Range Anti-Tip Device: Install at each range according to manufacturer's written instructions
5. Utilities: Refer to Division 21 AND Division 26 for plumbing and electrical requirements.

C. Field Quality Control
1. Perform tests and inspections.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Tests and Inspections:
   a. Perform visual, mechanical, and electrical inspection and testing for each appliance according to manufacturers' written recommendations. Certify compliance with each manufacturer's appliance-performance parameters.
   b. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
   c. Operational Test: After installation, start units to confirm proper operation.
   d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and components.
3. An appliance will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

END OF SECTION 11 30 13 13

SECTION 11 30 13 13a - REFRIGERATORS

1.1 GENERAL

A. Summary
1. Section Includes:
   a. Remove existing refrigerators.
   b. Refrigerators supply and deliver only or supply and install as scheduled.
2. Related Requirements: Comply with requirements of following sections:
   a. Contractor Use of Premises and Work Sequence
   b. Section "Alteration Project Procedures."
3. Related Sections:
   a. Kitchen Renovation Requirements; "Summary of Work"
   b. Reference Standards: Section "References."

B. References
1. Reference Standards: See Section "References." Comply with following:
   a. Association of Home Appliance Manufacturers (AHAM) HRF-1 - Standard for Household Refrigerators and Household Freezers, 1988.
      1) ASTM B 117 - Salt Spray (Fog) Testing.
   b. ANSI/UL 250 - Household Refrigerators and Freezers, 1991.
   c. Certification:
      1) ANSI Z34.2 - Certification, Self-Certification by Producer or Supplier, 1987.

C. Definitions
1. Configurations:
   a. SD: Single Door.
   b. TF: Top Freezer.
   c. BF: Bottom Freezer.
   d. SS: Side-by-Side.
2. Defrost System:
   a. M: Manual Defrost: Defrost system in which defrosting action for refrigerated surfaces is initiated manually.
   b. P: Partial Automatic: Defrost system in which defrosting action for refrigerated surfaces in refrigerator compartment is initiated and terminated automatically and defrosting action for refrigerated surfaces in freezer is initiated manually.
   c. A: Automatic Defrost: Defrost system in which defrosting action for all refrigerated surfaces is initiated and terminated automatically.
3. Efficiency Standards:
   a. Refrigerator: Cabinet designed for refrigerated storage of food at temperatures above 0 degrees C (32 degrees F) and may include compartment for freezing and storage of food at temperatures below 0 degrees C (32 degrees F), but does not provide separate low temperature compartment designed for freezing and storage of food at temperatures below minus 13 degrees C (8 degrees F).
   b. Refrigerator-freezer: Cabinet with two or more compartments with at least one compartment designed for refrigerated storage of food at temperatures above 0 degrees C (32 degrees F) and with at least one compartment designed for freezing and storage of food at temperatures below minus 13 degrees C (8 degrees F).
   c. AV: Adjusted Volume:
      1) Refrigerator: [1.44 x freezer volume (cubic feet)] + refrigerator volume (cubic feet).
      2) Refrigerator-freezer: [1.63 x freezer volume (cubic feet)] + refrigerator volume (cubic feet).
4. Supply and Delivery Only: Include supply and delivery to site(s) FOB destination freight prepaid. Unless otherwise specified or scheduled, unloading and handling at site is by PHA/IHA.

D. System Description
1. Performance Requirements: Comply with following:
a. Refrigerators: Capable of producing average cabinet air temperature in general food storage compartment of 2.2 degrees C (36 degrees F) in ambient of 21.1 degrees C (70 degrees F), and 3.3 degrees C (38 degrees F) in ambient of 43.3 degrees C (110 degrees F).
1) Performance Test Procedures: As specified in AHAM HRF-1.
b. Plastic Compartment and Door Liners: Not show any cracks or crazing when tested under Environment Cracking Resistance Test specified in AHAM HRF-1.
1) Single-Piece Liners Testing: As specified in AHAM HRF-1, paragraph 10.6.
2. Efficiency Standards: Provide refrigerators which do not exceed following annual energy consumption in kWh:
a. Refrigerators and Refrigerator-freezers with Manual Defrost: 13.5 AV plus 299.
b. Refrigerator-freezers with Partial Automatic Defrost: 10.4 AV plus 398.
c. Refrigerator-freezers with Automatic Defrost with Top Mounted Freezer without Through-the-door Ice Service: 16.0 AV plus 355.
d. Refrigerator-freezers with Automatic Defrost with Side Mounted Freezer without Through-the-door Ice Service: 11.8 AV plus 501.
e. Refrigerator-freezers with Automatic Defrost with Bottom Mounted Freezer without Through-the-door Ice Service: 16.5 AV plus 367.

E. Submittal
1. Product Data: Submit to Contracting Officer.
2. Samples:
a. Production Sample: When requested, provide sample refrigerator to Contracting Officer for examination as to compliance with specifications.
b. Color Samples: Submit samples of manufacturer s standard colors to Contracting Officer for selection.
3. Quality Assurance/Control Submittals: Submit following to Contracting Officer:
a. Certificates: Manufacturer's written self certification that refrigerators meet or exceed specified requirements.
b. Manufacturer's installation instructions.
4. Closeout Submittals: Submit following to Contracting Officer:
a. Operation and Maintenance: Provide use and care information with each refrigerator. Include parts manual with diagrams and part numbers.
b. Special warranty.

F. Quality Assurance
1. Qualifications: Manufacturer: Stock and sell parts for refrigerators supplied for five years from time of delivery.
2. Regulatory Requirements: Comply with following:
a. EPA regulations regarding refrigerant.
b. Accessibility:
1) Architectural Barriers Act of 1968 as amended (42 USC 4151-4157) and HUD implementing regulations (24 CFR Part 40).
a) Uniform Federal Accessibility Standards (UFAS).
2) Section 504 of the Rehabilitation Act of 1973 as amended (29 USC 794) and HUD implementing regulations 24 CFR Part 8.
3) Fair Housing Accessibility Guidelines (24 CFR Chapter 1).
4) Americans with Disabilities Act of 1990 (ADA) (42 USC §§ 12101, et seq.) and implementing regulations (28 CFR Part 35).
3. Appliances shall meet or exceed requirements established by the Energy Star program and bear the Energy Star logo. Visit www.energystar.gov for a listing of products that qualify. Energy Star® is a voluntary partnership that includes the U.S. Department of Energy, the U.S. Environmental Protection Agency, product manufacturers, local utilities, and retailers, helps

promote efficient products by labeling them with the Energy Star logo and educating consumers about the benefits of energy efficiency.

G. Delivery, Storage, And Handling
1. Packing, Shipping, Handling, and Unloading: In accordance with standard commercial practices.
2. Acceptance at Site: Inspect refrigerators upon delivery. Replace damaged or defective appliances before installation.

H. Scheduling
1. Scheduling and Completion: Comply with requirements of Division 1.

I. Warranty
1. Special Warranties: Provide following written special warranties:
a. Plastic parts of cabinet for period of two years.
b. Sealed refrigerator cooling system for five years.
1) Provide new or reconditioned cooling system units or components, replacing units and/or parts which become defective (excluding damage due to visible abuse) during five year period.
c. Entire refrigerator for one year.
2. Special Warranty Periods: If refrigerator becomes inoperative, as defined in following paragraph, repair or replace and install any part (except enamel, porcelain or lacquer) necessary to make refrigerator operative within five working days of notification.
a. Inoperative Refrigerator: When interior cabinet temperature rises above 10.0 degrees C (50 degrees F) and remains at such temperature for six or more consecutive hours after usual normal adjustments have been made or other mechanical and electrical trouble affecting normal operations has been corrected.
3. Special Warranties: Include labor, material and equipment to provide replacements and make repairs to refrigerators at no additional cost to PHA/IHA.
a. Defective Units and/or Parts: Become property of Contractor.
b. Submit name and address of local agent who will furnish service and replacement parts in connection with warranties to PHA/IHA.
1) Charges by local service agent to PHA/IHA for services covered under special warranties not allowed.

1.2 PRODUCT

A. Refrigerators - General Requirements
1. Refrigerators: Household type, self-contained with electric-motor-driven condensing units and comply with Performance Requirements and Energy Standard Requirements.
2. Types, Sizes and Grades: As specified and scheduled.
3. Total Storage Volumes, Shelf Areas and Dimensions: In accordance with descriptions and computed in accordance with AHAM HRF-1.

B. Refrigerators Cabinets
1. Outer Shells (including Doors): Carbon-steel sheet finished in baked synthetic enamel.
a. Colors: As scheduled from manufacturer s standard colors.
2. Exterior Doors: Provide with reversible hinges for right or left hand swing except on side-by-side (SS) configuration.
a. Construction of Freezer or Evaporator Door and Hinging: Door may be operated without breaking, cracking, or distorting when freezer or evaporator is free from or has maximum thickness of 6 mm (1/4 inch) of frost on outer surface of evaporator adjacent to door.
b. Exterior Doors: Equipped with magnetic gasket.
c. Doors: Contain shelves.
3. Interior Liners of (including General and Low-Temperature) Storage Compartments and Doors: Porcelain enamel on carbon-steel or molded plastic.

a. Carbon-Steel Sheet Inner Liners: Porcelain enamel or baked synthetic enamel finish.
b. Color of Plastic Inner Liners: White or pastel.
c. Plastic Liners in Conjunction with Foamed-In-Place Polyurethane Employing Fluorinated Hydrocarbons: Isolate liner material from polyurethane foam or fabricate of acrylonitrile butadiene styrene (ABS) or High Impact Polystyrene (HIPS).
d. Breaker Strips: ABS plastic, polypropylene, or HIPS when insulation is foamed-in-place polyurethane with fluorinated hydrocarbons.

4. Drawers and Trays:
a. Vegetable Drawers or Crisper Trays: Provide one or more trays occupying full width of food compartment and readily removable.
b. Drawers or Trays: Constructed of steel finished with porcelain enamel, anodized aluminum, or durable plastic; durable glass; or non-corrosive metal.
c. Ice Cube Trays: Provide minimum of two standard size ice cube trays.
d. Defrosting or Chiller Tray: Made of material suitable for intended service and of adequate size to receive drip from cooling unit during defrosting.

5. Hardware Components: Sturdy construction and made of material that are durable and structurally correct for application.
a. Hardware Attachment Devices (screws, bolts and nuts): Of material and finish consistent with material of components and parts which they are used.
b. Hardware Finish: Remain intact after being subjected to salt spray test for period of 25 hours in accordance with ASTM B 117.
1) Center Section of Door Handle: Vinyl covered steel is acceptable.
c. Food Compartment Door Hinges: May be same finish as specified for outer panel of food compartment door.
d. Hardware: Securely attached in substantial manner and to extent that removal may not be accomplished without use of tools.

6. Manual Defrost and Partial Defrost Refrigerators: Provide clear and legible caution similar to following: Do not use implements to defrost or to remove ice trays or other material from freezer section.
a. Location: Print or impress on freezer door or on name plate securely fastened in another prominent position easily read by user.

C. Refrigerators Components
1. Electrical Components and Parts: Locate and mount controls, lamp socket, relay, switches, thermostat, wiring harness, cables and leads and their accessories in manner that their replacement may be readily accomplished.
a. Electrical Assemblies and Harness: Design and manufacture so that replacement of complete assembly or harness is not necessary when any component part of assembly becomes defective or inoperative.
b. Individual Components and Parts of Assemblies and Harness: Obtainable for relatively simple replacement purposes.

2. Temperature Control: Equip refrigerators with off position and contact points or setting positions for wide range of degrees of temperature, which may be selected by readily accessible knob, properly marked with settings available, mounted on temperature control shaft.
a. Relay: Quality and rating which under normal operating conditions shall function properly for at least one year period and which is consistent with requirements specified and its companion components and parts in electrical circuit.

3. Motor: For 115 volt, plus or minus 10 percent, 60 HZ, single phase, alternating current operation and capable of starting in ambient temperature of 37.8 degrees C (100 degrees F) on voltages between 90 percent and 100 percent of rated voltage.
a. Thermal Overload Protection: Automatic re-set type to prevent excess temperature rise of motor windings.
b. Three-Wire Cord with Three-Prong Attachment Plug: Provide grounding of refrigerator and extend five feet to nine feet beyond point at which it is attached to back of cabinet.

c. Motor: Type, speed, load and horsepower ratings consistent with other requirements specified.

4. Refrigeration Unit: Compressor, motor and housing of hermetically sealed type with reciprocating or rotary-type compressor.
   a. Compressor: Equipped with means of unloading, such as automatic unloader or capillary tube.
   b. Sealed Refrigerating System: Serviceable by complete unit replacement or replacement of component parts such as motor compressor assembly, evaporator, condenser and heat exchanger.
   c. Hermetic Compressor Unit: Quiet in operation, free from excessive vibration and entirely automatic in operation.

D. Workmanship
1. Welding and Brazing: Complete; uniform and properly fused; with no holes, slag inclusions, scale, or flux deposits; and not cracked, fractured or undercut.
2. Soldering: Complete, clean, adherent and without pin-holes.
3. Fasteners: Not be broken, fractured, stripped, or loose.
   a. Structural Parts Subject to Vibration: Provide lock washers or self-locking washers.

1.3 EXECUTION

A. Examination
1. Site Verification of Conditions:
   a. Utilities: Verify that required utilities are available, in proper locations, and ready for use.

B. Preparation
1. Existing Refrigerators: Remove existing refrigerators and debris from site.

C. Installation
1. General: Install refrigerators in accordance with manufacturer's recommendations.
   a. Make adjustments to feet of refrigerators for a level installation.
   b. Install in manner to ensure proper ventilation space is present.

D. Cleaning
1. Cleaning: Comply with requirements of Section 01120.

E. Schedules
1. Provide refrigerators as selected in following schedule:

______ Remove existing refrigerators.

______ Supply and Deliver Only to____.

______ Unloading and handling included.

______ Supply and Install.

SELECTION	SIZE	COLOR	TYPE
__________	0.28 cu m (10.0 CU FT) Minimum	________	SD/M/S: Small, Single Door, Manual Defrost.
__________	0.37 cu m (13.0 CU FT) Minimum	________	SD/M/L: Large, Single Door, Manual Defrost.
__________	0.28 - 0.34 cu m (10.0 - 11.9) CU FT	________	TF/P/S: Small, Top Freezer, Partial Automatic Defrost.
__________	0.34 - 0.39 cu m (12.0 - 13.9 CU FT)	________	TF/P/M: Medium, Top Freezer, Partial Automatic Defrost.

___________	0.40 cu m (14.0 CU FT) Minimum	_________	TF/P/L: Large, Top Freezer, Partial Automatic Defrost.
___________	0.28 - 0.34 cu m (10.0 - 11.9 CU FT)	_________	TF/A/S: Small, Top Freezer, Automatic Defrost.
___________	0.34 - 0.39 cu m (12.0 - 13.9 CU FT)	_________	TF/A/M: Medium, Top Freezer, Automatic Defrost.
___________	0.40 - 0.45 cu m (14.0 - 15.9 CU FT)	_________	TF/A/ML: Medium/Large, Top Freezer, Automatic Defrost.
___________	0.45 - 0.51 cu m (16.0 - 17.9 CU FT)	_________	TF/A/L: Large, Top Freezer, Automatic Defrost.
___________	0.51 cu m (18.0 CU FT) Minimum	_________	TF/A/EL: Extra Large, Top Freezer, Automatic Defrost.
___________	0.45 cu m (16.0 CU FT) Minimum	_________	BF/A for Accessible Units: Bottom Freezer, Automatic Defrost in accordance with UFAS requirements.
___________	0.45 cu m (16.0 CU FT) Minimum	_________	SS/A for Accessible Units: Side-by-Side, Automatic Defrost in accordance with UFAS requirements.

END OF SECTION11 30 13 13a

SECTION 11 30 13 13b - GAS RANGES

GENERAL

Summary

1. Section Includes:
   a. Remove existing ranges.
   b. Gas ranges, supply and deliver only or supply and install as scheduled.
2. Related Requirements: Comply with requirements of following sections:
   a. Contractor Use of Premises and Work Sequence; "Summary of Work"
   b. Section "Alteration Project Procedures."
3. Related Sections:
   a. Kitchen Renovation Requirements: Section "Summary of Work"
   b. Reference Standards: Section "References."
   c. Electric Ranges: Section "Electric Ranges."
   d. Gas Line Relocation: Section "Plumbing."

References

4. Reference Standards: See Section "References." Comply with following:
   a. American National Standard Institute (ANSI) Z21.1 - Household Cooking Gas Appliances,1990, including addenda Z21.1a, 1991.
      1) ANSI Z21.20 - Automatic Gas Ignition Systems and Components, 1989, including addenda Z21.20a, 1991, and Z21.20b, 1992.
   b. Certification:
      1) ANSI Z34.1 - Certification, Third-Party Certification Program, 1987.
      2) ANSI Z34.2 - Certification, Self-Certification by Producer or Supplier, 1987.

Definitions

5. Types:
   a. Type A: Economy or Builder's Model
   b. Type C: Quality Model with hinged top.
6. Supply and Delivery Only: Include supply and delivery to site(s) FOB destination freight prepaid. Unless otherwise specified or scheduled, unloading and handling at site is by PHA/IHA.

Submittals

7. Product Data: Submit to the Owner.
8. Samples:
   a. Production Sample: When requested, provide sample gas range to the Owner for examination as to compliance with specifications.
   b. Color Samples: Submit samples of manufacturer's standard colors to the Owner for selection.
9. Quality Assurance/Control Submittals: Submit following to the Owner:
   a. Certificates: Manufacturer's written certification that ranges have been tested and comply with ANSI Z21.1 for operation with natural or LP gas.
      1) Certification by American Gas Association (AGA) Laboratories, or Third Party Certifier in accordance with ANSI Z34.1.
      2) Acceptable Evidence of Meeting Applicable Requirements of Standard: Photostatic copy of American Gas Association (AGA) Laboratories Appliance Certificate or listing including igniter device in American Gas Association (AGA) Laboratories Directory of Certified Appliances and Accessories.
   b. Manufacturer's installation instructions.

10. Closeout Submittals: Submit following to the Owner:

a. Operation and Maintenance: Provide use and care information with each gas range. Include parts manual with diagrams and part numbers.
b. Special warranty.

Quality Assurance

11. Qualifications: Manufacturer: Stock and sell parts for ranges supplied for five years from time of delivery.
12. Regulatory Requirements: Comply with and following:
    a. Gas Connections: Comply with applicable codes and regulations.
    b. Accessibility:
        1) Architectural Barriers Act of 1968 as amended (42 USC 4151-4157) and HUD implementing regulations (24 CFR Part 40).
            a) Uniform Federal Accessibility Standards (UFAS).
        2) Section 504 of the Rehabilitation Act of 1973 as amended (29 USC 794) and HUD implementing regulations 24 CFR Part 8.
        3) Fair Housing Accessibility Guidelines (24 CFR Chapter 1).
        4) Americans with Disabilities Act of 1990 (ADA) (42 USC §§ 12101, et seq.) and implementing regulations (28 CFR Part 35).
13. Appliances shall meet or exceed requirements established by the Energy Star program and bear the Energy Star logo. Visit www.energystar.gov for a listing of products that qualify. Energy Star® is a voluntary partnership that includes the U.S. Department of Energy, the U.S. Environmental Protection Agency, product manufacturers, local utilities, and retailers, helps promote efficient products by labeling them with the Energy Star logo and educating consumers about the benefits of energy efficiency.

Delivery, Storage, And Handling

14. Packing, Shipping, Handling, and Unloading: In accordance with standard commercial practices.
15. Acceptance at Site: Inspect gas ranges upon delivery. Replace damaged or defective appliances before installation.

Scheduling

16. Scheduling and Completion: Comply with requirements of Division 1.

Warranty

17. Special Warranties: Provide following written special warranties:
    a. Entire gas range for one year.
18. Special Warranties: Include labor, material and equipment to provide replacements and make repairs to gas ranges at no additional cost to PHA/IHA.
    a. Defective Units and/or Parts: Become property of Contractor.
    b. Submit name and address of local agent who will furnish service and replacement parts in connection with warranties to PHA/IHA.
        1) Charges by local service agent to PHA/IHA for services covered under special warranties not allowed.

PRODUCTS

Gas Ranges - General Requirements

19. Ranges: ANSI Z21.1, current standard models of manufacturer except for additional requirements specified.
    a. Ranges: Floor mounted, free standing flush-to-wall, domestic gas ranges with open cooking top, oven and broiler below.
    b. Ranges of Same Size: Identical, including parts and assemblies.
20. Gas Valves: Provide with either:
    a. Convertible orifice set for gas specified on purchase order .

b. Fixed orifice hood for use with gas specified on order.
21. Convertible Gas Pressure Regulators: Provide with each range.

Type A Ranges (Economy Or Builder S Model)

22. Burners: Provide cooking top with four burners.
    a. Each Burner: Rated at no less than 2 650 W (9000 BTU/H) for natural gas and 2 350 W (8000 BTU/H) for LP.
23. Manual Gas Valves: Limited displacement type complying with ANSI Z21.1.
24. Grates: Provide each top burner with porcelain enameled cast iron or steel grate.
25. Ignition: One of following:
    a. Automatic Ignition: Equip burners with means for automatic ignition of gas. Failure of oven burner pilot shall activate means for shutting off gas to oven burner.
    b. 2. Intermittent Ignition: Equip burners with means for automatic electric ignition of gas complying with applicable requirements of ANSI Z21.20. Electric Ignition System: May be either spark, coil, glow bar, or combination of these.
26. Oven Thermostat Control: Provide oven thermostat control for controlling oven temperatures down to "hold warm temperature", approximately 77 degrees C (170 degrees F).
27. F. Insulation: Glass fiber blanket type, installed in manner to prevent sagging, and of sufficient thermal efficiency to meet surface and handle temperature tests specified in ANSI Z21.1.
28. Oven and Broiler Sections: Porcelain enamel-coated steel.
    a. Broiling Section: Either drop door type, pull-out-type, or swing-door type with 3-position smokeless broiler pan and grill sliding on stationary runners.
    b. Provide stops so that oven racks cannot be completely pulled out by accident.
29. Oven Vents: Provide ovens with vent designed to deflect moisture and fumes away from wall behind range.
30. Oven Doors: Drop-shelf type, counter-balanced and provided with device to hold door fully closed.
    a. Hinges: Permit ready removal and replacement of hinge brackets and parts subject to wear.
    b. Provide oven doors with means for adjusting misaligned door.
31. Burner Bowls (Aeration Bowls): Corrosion-resisting steel, plated steel, or steel coated with porcelain enamel.
    a. Bowls: May be separate bowls or integral part of top.
32. Exterior Surfaces: Porcelain enamel, except body sides and front panels (including oven door) may be finished in synthetic baked-on enamel capable of withstanding 121 degrees C (250 degrees F).
    a. Trim: In accordance with manufacturer's standard practice.
    b. Backguard, Manifold Shield, Aeration Bowls, and Burners: May be porcelain enamel.
    c. Range Body Back Panel, Legs, and/or Base: Porcelain enamel, baked-on enamel, galvanized, or aluminized steel.
    d. Colors: As scheduled from manufacturer s standard colors.
33. Backguards: Equip each range with back guards not less than 100 mm (4 inches) higher than top cooking surface and extending full width of range top.
34. Equipment and Accessories: Provide accessories such as oven and broiler racks normally supplied with manufacturer's standard production for type range scheduled.
35. Name Plate: Permanent record of manufacturer's name and address, range model and serial number, and manufacturer's normal hourly W (BTU/H) input rating for oven, broiler and top burners.
    a. Securely fasten nameplate to main part of each range in accessible place.

Type C Ranges (Quality Model)

36. General Requirements: Comply with requirements for Type A Ranges except as modified by following requirements.
37. B. Range Top: Hinged at back or lift off for easy cleaning and access to burners, valves, and pilots.

a. Hinge Top: May have supporting rod to hold top in raised position or be removable. Design supporting rod, when in raised position, to prevent accidental closing of range top. Counterbalanced top is also acceptable.

38. Cooking Top Burners/Low Setting: Equip each range with burners with low settings not in excess of 400 W (1400 BTU/H).
39. Leg levelers: Equip each range with at least two leg levelers.
40. Manifold Shield: Provide recessed or slanted manifold shield to minimize burning of burner knobs from heat from open oven doors.
41. Oven Door: Provide 610 mm (24 inch), 760 mm (30 inch) and 910 mm (36 inch) ranges with removable oven door.

EXECUTION

Examination

42. Site Verification of Conditions:
    a. Utilities: Verify that required utilities are available, in proper locations, and ready for use.

Preparation

43. Existing Ranges: Remove existing ranges and debris from site.

Installation

44. General: Install gas ranges in accordance with manufacturer's recommendations.
    a. Make connection to gas line in accordance with applicable codes.
    b. Make adjustments to feet of ranges for a level installation.

Cleaning

45. Cleaning: Comply with requirements of Division 1.

Schedules

46. Provide gas ranges as selected in following schedule:

_______ Remove existing ranges.

_______ Supply and Deliver Only to ____.

_______ Unloading and handling included.

_______ Supply and Install.

SELECTION	NUMBER OF	SIZE	COLOR	TYPE BURNERS
_____	4 Burner	510 mm (20 Inch)	___________	Type A Economy or Builders Model.
_____	4 Burner	610 mm (24 Inch)	___________	Type A Economy or Builders Model.
_____	4 Burner	760 mm (30 Inch)	___________	Type A Economy or Builders Model.
_____	4 Burner	910 mm (36 Inch)	___________	Type A Economy or Builders Model.
_____	4 Burner	510 mm (20 Inch)	___________	Type C Quality Model.
_____	4 Burner	610 mm (24 Inch)	___________	Type C Quality Model.
_____	4 Burner	760 mm (30 Inch)	___________	Type C Quality Model.
_____	4 Burner	910 mm (36 Inch)	___________	Type C Quality Model.

END OF SECTION11 30 13 13b

SECTION 11 30 13 13c - ELECTRIC RANGES

GENERAL

Summary

1. Section Includes:
   a. Remove existing ranges.
   b. Electric ranges, supply and deliver only or supply and install as scheduled.
2. Related Requirements: Comply with requirements of following sections:
   a. Contractor Use of Premises and Work Sequence: Section "Summary of Work."
   b. Section "Alteration Project Procedures."
3. Related Sections:
   a. Kitchen Renovation Requirements: Section "Summary of Work."
   b. Reference Standards: Section "References."
   c. Gas Ranges: Section "Gas Ranges."
   d. Electrical Renovation: Section "Electrical Renovation."

References

4. Reference Standards: See Section "References." Comply with following:
   a. Association of Home Appliance Manufacturers (AHAM) ER-1 - American National Standard Household Electric Ranges, 1992.
   b. Federal Specification (FS): WR-101F dated March 13, 1970, and Interim Amendment 2 dated December 31, 1970.
   c. Underwriter's Laboratories (UL): ANSI/UL 858 - Household Electric Ranges, 1986.
   d. Certification:
      1) ANSI Z34.1 - Certification, Third-Party Certification Program, 1987.
      2) ANSI Z34.2 - Certification, Self-Certification by Producer or Supplier, 1987.

Definitions

5. Standard Ranges: Four Surface Cooking Units: Three - 150 mm (6 inch) and one - 200 mm (8 inch) with oven and broiler below.
   a. Type, Style, and Sizes as defined in FS W-R-101F:
      1) Type I: Freestanding range.
      2) Type II: Build-in (slide-in) range.
      3) Style 1: Single oven.
      4) Style 2: Double oven 1 020 mm (40 inches) wide.
      5) Size 1: 1 020 mm (40 inches) wide.
      6) Size 2: 910 mm (36 inches) wide.
      7) Size 3: 760 mm (30 inches) wide.
      8) Size 4: 610 mm (24 inches) wide.
      9) Size 5: 510 mm (20 inches) wide.
6. Supply and Delivery Only: Include supply and delivery to site(s) FOB destination freight prepaid. Unless otherwise specified or scheduled, unloading and handling at site is by PHA/IHA.

Submittals

7. Product Data: Submit to the Owner.
8. Samples:
   a. Production Sample: When requested, provide sample electric range to the Owner for examination as to compliance with specifications.
   b. Color Samples: Submit samples of manufacturer s standard colors to the Owner for selection.
9. Quality Assurance/Control Submittals: Submit following to the Owner:
   a. Certificates: Manufacturer's written certification that electric ranges meet or exceed specified requirements including UL requirements and requirements of FS WR-101F.

b. Manufacturer's installation instructions.
10. Closeout Submittals: Submit following to the Owner:
a. Operation and Maintenance Instructions: Provide use and care information with each range. Include parts manual with diagrams and part numbers.
b. Special warranty.

Quality Assurance
11. Qualifications: Manufacturer: Stock and sell parts for ranges supplied for five years from time of delivery.
12. Regulatory Requirements: Comply with following:
a. Accessibility:
1) Architectural Barriers Act of 1968 as amended (42 USC 4151-4157) and HUD implementing regulations (24 CFR Part 40).
a) Uniform Federal Accessibility Standards (UFAS).
2) Section 504 of the Rehabilitation Act of 1973 as amended (29 USC 794) and HUD implementing regulations 24 CFR Part 8.
3) Fair Housing Accessibility Guidelines (24 CFR Chapter 1).
4) Americans with Disabilities Act of 1990 (ADA) (42 USC §§ 12101, et seq.) and implementing regulations (28 CFR Part 35).
13. Appliances shall meet or exceed requirements established by the Energy Star program and bear the Energy Star logo. Visit www.energystar.gov for a listing of products that qualify. Energy Star® is a voluntary partnership that includes the U.S. Department of Energy, the U.S. Environmental Protection Agency, product manufacturers, local utilities, and retailers, helps promote efficient products by labeling them with the Energy Star logo and educating consumers about the benefits of energy efficiency.

Delivery, Storage, And Handling
14. Packing, Shipping, Handling, and Unloading: In accordance with standard commercial practices.
15. Acceptance at Site: Inspect electric ranges upon delivery. Replace damaged or defective appliances before installation.

Scheduling
16. Scheduling and Completion: Comply with requirements of Division 1.

Warranty
17. Special Warranties: Provide following written special warranties:
a. Entire electric range for one year.
18. Special Warranties: Include labor, material and equipment to provide replacements and make repairs to electric ranges at no additional cost to PHA/IHA.
a. Defective Units and/or Parts: Become property of Contractor.
b. Submit name and address of local agent who will furnish service and replacement parts in connection with warranties to PHA/IHA.
1) Charges by local service agent to PHA/IHA for services covered under special warranties not allowed.

PRODUCTS

Electric Ranges
19. Ranges: AHAM ER-1, ANSI/UL 858, and FS WR-101F, current standard models of manufacturer except for additional requirements specified.
a. Ranges: Floor mounted, free standing flush-to-wall, domestic electric ranges with open cooking top, oven and broiler below.
b. Ranges of Same Classification: Identical, including parts and assemblies.

c. Ranges: UL listed and bear UL label.

20. Operating Service: 115/230 volts or 120/208 volts, 3-wire, single-phase, 60-HZ.
    a. Type of Service: As scheduled.
21. Ranges:
    a. Each Range: Equipped with at least two leg levelers.
    b. Oven Door: Equip 610 mm (24 inch), 760 mm (30 inch), and 910 mm (36 inch) ranges with removable oven door.
    c. Ranges without Storage Drawer: May be equipped with only one oven rack.

Ranges For Elderly Housing

22. Ranges for Elderly Housing: Same as above, Type I or II, Style 1, Sizes 4 and 5, standard electric ranges but, as minimum, include following additional items:
    a. Location of Controls for Ranges and Cook-Tops: Not require reaching across burners.
    b. Burner Indicator Lights: Provide light for each top burner and oven unit that will clearly indicate when burner is on.
        1) Indicator Light: Integral part of, or adjacent to, each control switch or adjacent to each top burner unit.
    c. Oven Interior Light: Provide light in each oven that will clearly illuminate interior when oven door is open.

EXECUTION

Examination

23. Site Verification of Conditions:
    a. Utilities: Verify that required utilities are available, in proper locations, and ready for use.

Preparation

24. Existing Ranges: Remove existing ranges and debris from site.

Installation

25. General: Install electric ranges in accordance with manufacturer's recommendations.
    a. Make adjustments to feet of ranges for a level installation.
    b. Electrical Renovation: See Section 16095.

Cleaning

26. Cleaning: Comply with requirements of Division 1.

Schedules

27. Provide electric ranges as selected in following schedule:

_____Remove existing ranges.

_____Supply and Deliver Only to_______________________________________.

_____Unloading and handling included.

_____Supply and Install.

SELECTION	NUMBER BURNERS	ELECTRIC SERVICE	COLOR	TYPE AND SIZE
_____	4 Burner	__________	_________	Type I, Style I, Size 1, 1 020 mm (40 inches) wide).
_____	4 Burner	__________	_________	Type I, Style I, Size 2, 910 mm (36 inches) wide.
_____	4 Burner	__________	_________	Type I, Style I, Size 3, 760 mm (30 inches) wide.
_____	4 Burner	__________	_________	Type I, Style I, Size 4, 610 mm (24 inches) wide.
_____	4 Burner	__________	_________	Type I, Style I, Size 5, 510 mm (20 inches) wide.

_____	4 Burner	_________	________	Type I or II, Style I, Size 5, 510 mm (20 inches) wide with specified elderly housing requirements.
_____	4 Burner	_________	________	Type I or II, Style I, Size 4, 610 mm (24 inches) wide with specified elderly housing requirements.

END OF SECTION11 30 13 13c

SECTION 11 30 13 13d - RANGE HOODS

GENERAL

Summary

1. Section Includes:
   a. Remove existing range hoods.
   b. Range hoods, supply and deliver only or supply and install as scheduled.
2. Related Requirements: Comply with requirements of following sections:
   a. Contractor Use of Premises and Work Sequence: Section "Summary of Work."
   b. Section "Alteration Project Procedures."
3. Related Sections:
   a. Kitchen Renovation Requirements: Section "Summary of Work."
   b. Reference Standards: Section "References."
   c. Gas Ranges: Section "Gas Ranges."
   d. Electric Ranges: Section "Electric Ranges."
   e. Residential Cabinets: Section "Residential Cabinets."
   f. Electrical Hook-up: Section " Electrical Renovation."

References

4. Reference Standards: See Section "References." Comply with following:
   a. National Fire Protection Association (NFPA): NFPA 70 - National Electrical Code (NEC).
   b. Certification:
      1) ANSI Z34.1 - Certification, Third-Party Certification Program, 1987.
      2) ANSI Z34.2 - Certification, Self-Certification by Producer or Supplier, 1987.

Definitions

5. Supply and Delivery Only: Include supply and delivery to site(s) FOB destination freight prepaid. Unless otherwise specified or scheduled, unloading and handling at site is by PHA/IHA.

Submittals

6. Product Data: Submit to the Owner.
7. Samples: Submit to the Owner.
   Production Sample: When requested, provide sample range hood to the Owner for examination as to compliance with specifications.
   a. Color Samples: Samples of manufacturer s standard colors for selection.
8. Quality Assurance/Control Submittals: Submit following to the Owner:
   a. Certificates: Manufacturer's written certification that range hoods meet or exceed specified requirements including UL requirements.
   b. Manufacturer's installation instructions.
   c. Appliances shall meet or exceed requirements established by the Energy Star program and bear the Energy Star logo. Visit www.energystar.gov for a listing of products that qualify. Energy Star® is a voluntary partnership that includes the U.S. Department of Energy, the U.S. Environmental Protection Agency, product manufacturers, local utilities, and retailers, helps promote efficient products by labeling them with the Energy Star logo and educating consumers about the benefits of energy efficiency.
   d. Closeout Submittals: Submit following to the Owner:
      1) Operation and Maintenance Instructions: Provide use and care information with each range hood. Include parts manual with diagrams and part numbers.
   e. Special warranty.

Quality Assurance

9. Qualifications: Manufacturer: Stock and sell parts for range hoods supplied for five years from time of delivery.
10. Regulatory Requirements: Comply with following:
    a. Accessibility:
        1) Architectural Barriers Act of 1968 as amended (42 USC 4151-4157) and HUD implementing regulations (24 CFR Part 40).
            a) Uniform Federal Accessibility Standards (UFAS).
        2) Section 504 of the Rehabilitation Act of 1973 as amended (29 USC 794) and HUD implementing regulations 24 CFR Part 8.
        3) Fair Housing Accessibility Guidelines (24 CFR Chapter 1).
        4) Americans with Disabilities Act of 1990 (ADA) (42 USC §§ 12101, et seq.) and implementing regulations (28 CFR Part 35).

Delivery, Storage, And Handling

11. Packing, Shipping, Handling, and Unloading: In accordance with standard commercial practices.
12. Acceptance at Site: Inspect range hoods upon delivery. Replace damaged or defective appliances before installation.

Scheduling

13. Scheduling and Completion: Comply with requirements of Division 1.

Warranty

14. Special Warranties: Provide following written special warranties:
    a. Entire range hood for one year.
15. Special Warranties: Include labor, material and equipment to provide replacements and make repairs to range hoods at no additional cost to PHA/IHA.

PRODUCTS

Range Hoods

16. Range Hoods: Ductless type with fan.
    a. Size: 610 mm (24 inches) or 760 mm (30 inches) wide as scheduled, by 150 mm (6 inches) high by 445 mm (17.5 inches) deep.
    b. Hoods: UL listed and bear UL label.
    c. Fan: 120 V, 60 HZ, two speed, 2.0 A fan.
    d. Light: Enclosed 75 watt.
    e. Filter: Washable filter.
    f. Color: As selected from manufacturer s standard colors.
17. Range Hood Shell: Same as range hoods above without fan and without light.
    a. Size: 610 mm (24 inches) or 760 mm (30 inches) wide as scheduled, by 150 mm (6 inches) high by 445 mm (17.5 inches) deep.
    b. Color: As selected from manufacturer standard colors.

EXECUTION

Examination

18. Site Verification of Conditions:
    a. Utilities: Verify that required utilities are available, in proper locations, and ready for use.
    b. Cabinets: Verify that adjacent residential cabinets and range hood are coordinated.

Preparation

19. Existing Range Hoods: Remove existing range hoods and debris from site.

Installation

20. General: Install range hoods in accordance with manufacturer's recommendations.
    a. Electrical Hook-up: See electrical specifications.

Cleaning

21. Cleaning: Comply with requirements of Division 1.

Schedules

22. Provide range hoods as selected in following schedule:

______Remove existing range hoods.

______Supply and Deliver Only to ____.

______Unloading and handling included.

______Supply and Install.

______Range Hood (with fan, filter, and light).

______760 mm (30 inches) wide.

______610 mm (24 inches) wide.

______Range Hood Shell.

______760 mm (30 inches) wide.

______610 mm (24 inches) wide.

END OF SECTION11 30 13 13d

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Task	Specification	Specification Description
11 30 13 23	11 30 13 13	Residential Appliances
11 30 33 00	01 22 16 00	No Specification Required

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SECTION 11 32 13 00 - UNIT KITCHENS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for unit kitchens. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section includes factory-fabricated and -assembled unit kitchens with metal, laminate-clad and wood cabinets, countertops, fixtures, appliances, and accessories.

C. Submittals
   1. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, finishes, furnished specialties, and accessories. Include rated capacities, operating characteristics, and utility requirements of appliances.
   2. LEED Submittals:
      a. Product Data for Credit EQ 4.4: For composite wood products, documentation indicating that product contains no urea formaldehyde.
      b. Certificates for Credit MR 7: Chain-of-custody certificates certifying that cabinets and countertops comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating costs for each certified wood product.
      c. Product Data for Credit EA 1.4: For appliances, documentation indicating that products are ENERGY STAR rated.
   3. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
      a. Wiring Diagrams: For power, signal, and control wiring.
   4. Samples: For each type of exposed finish required, prepared on Samples of size indicated below:
      a. Metal finish for cabinets and countertops, 8 by 10 inches (200 by 250 mm).
      b. Wood finish for cabinets, 8 by 10 inches (200 by 250 mm).
      c. Plastic laminate for cabinets and countertops, 8 by 10 inches (200 by 250 mm).
      d. Solid surfacing for countertops, 6 inches (150 mm) square.
      e. One full-size unit of each type of exposed hardware.
   5. Product Certificates: For each type of unit kitchen, from manufacturer.
   6. Manufacturer Certificate: Signed by manufacturer certifying that units comply with requirements.
   7. Maintenance Data: For unit kitchen appliances to include in maintenance manuals.
   8. Warranty: Sample of special warranty.

D. Quality Assurance
   1. Manufacturer Qualifications: A qualified manufacturer that fabricates unit kitchens and their components.
   2. Source Limitations: Obtain unit kitchens from single source from single manufacturer.
   3. Regulatory Requirements: Where unit kitchens are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines, ICC/ANSI A117.1 and HUD's "Fair Housing Accessibility Guidelines".
   4. Forest Certification: Provide cabinets and countertops made from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
   5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

a. Built-in Refrigerators: Listed and labeled for recessed installation. Mount label to be visible after installation of unit; include electrical rating, type of refrigerant, and minimum installation clearances.
b. Refrigerated Unit Kitchens and Wet Bars: Listed and labeled for entire unit as a single integrated system. Mount label to be visible after installation of unit; include electrical rating, type of refrigerant, and minimum installation clearances.

6. Wood and Laminate-Clad Cabinet Fabrication Standard:
   a. KCMA A161.1. Provide cabinets with KCMA's "Certified Cabinet" seal affixed to a semiexposed location of each unit and showing compliance with standard.
   b. AWI 400B, Custom grade.
   c. Either fabrication standard above.
7. Appliance Standards:
   a. Refrigerators and Freezers: UL 250 or AHAM ER-1.
   b. Electric Ranges: UL 858 or AHAM HRF-1.
   c. Microwave Ovens: UL 923.
   d. Gas-Burning Appliances: ANSI Z21 Series, and certified by CSA International, UL, or another testing and inspecting agency acceptable to authorities having jurisdiction.
8. ENERGY STAR Rating: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program.

E. Delivery, Storage, And Handling
1. Deliver factory-assembled units, individually factory packaged and protected. Label with manufacturer's name, product name, and model number.

F. Project Conditions
1. Environmental Limitations: Do not deliver or install unit kitchens until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Field Measurements: Verify actual dimensions of construction contiguous with unit kitchens by field measurements before fabrication.

G. Coordination
1. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that unit kitchens can be supported and installed as indicated.
2. Coordinate wiring requirements and current characteristics of unit kitchens with building electrical system. See Division 22.
3. Coordinate layout and installation of plumbing, mechanical, and electrical services for unit kitchens.

H. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace hermetically sealed refrigerator compressor system of unit kitchens that fail within specified warranty period.
   a. Warranty Period: Five years from date of Final Completion.

1.2 PRODUCTS

A. Materials
1. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B, suitable for exposed applications.

2. Porcelain-Enamel-Finished Steel Sheet: ASTM A 424, enameling-grade steel, uncoated thickness indicated; with exposed face and edges coated with primer, ground coat, and color cover coat; and concealed face coated with primer and ground coat; acid resistant.
3. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.
4. Medium-Density Fiberboard: ANSI A208.2, Grade 130, made with binder containing no urea-formaldehyde resin.
5. Particleboard: ANSI A208.1, Grade M-2 **OR** Grade M-2-Exterior Glue **OR** Grade M-2, made with binder containing no urea-formaldehyde resin, **as directed**.
6. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1, Type I, made with adhesive containing no urea formaldehyde.
7. Solid Wood: Clear hardwood lumber of species indicated, free of defects, selected for compatible grain and color, and kiln dried to 7 percent moisture content.
8. High-Pressure Decorative Laminate: NEMA LD 3.
9. Solid-Surfacing Material: Homogenous solid sheets fabricated from reacted monomers and resins, mineral fillers, and pigments; in thickness indicated; complying with ISSFA-2.
10. Adhesives: Do not use adhesives that contain urea formaldehyde.

B. Metal Cabinets
1. Steel Base Cabinets: Fabricate frames and sides from 0.036-inch (0.91-mm) **OR** 0.030-inch (0.76-mm), **as directed**, nominal-thickness, cold-rolled steel sheet; welded and reinforced with internal gussets and bracing; with baked-enamel finish.
   a. Door and Drawer Fronts: 0.036-inch (0.91-mm) **OR** 0.030-inch (0.76-mm), **as directed**, nominal-thickness, cold-rolled steel sheet, textured or smooth; welded, reinforced, and sound-deadened; with baked-enamel finish.
   OR

   Door and Drawer Fronts: 0.038-inch- (0.95-mm-) thick, stainless-steel sheet; welded, reinforced, and sound deadened.
2. Stainless-Steel Base Cabinets: Fabricate frames and sides from 0.038-inch- (0.95-mm-) thick, stainless-steel sheet; welded and reinforced with internal gussets and bracing.
   a. Door and Drawer Fronts: 0.038-inch- (0.95-mm-) thick, stainless-steel sheet; welded, reinforced, and sound deadened.
3. Undercounter Storage Cabinet: Same material and finish as base cabinets, with adjustable shelf and drawer or with two drawers.
4. Wall Cabinets: Same material and finish as base cabinets, with flush double bottoms and adjustable shelves.
   a. Wall Shields: Fabricated from textured, cold-rolled steel sheet with baked-enamel finish, color to match cabinets **OR** textured, cold-rolled steel sheet with baked-enamel finish, color to match countertop **OR** stainless-steel sheet, **as directed**. Provide wall shields for back wall and side walls, **as directed**, between countertop splash and wall cabinets.
5. Shelves: Manufacturer's standard rolled-front shelves, fixed **OR** adjustable, **as directed**, of same material and finish as cabinets.
6. Wire Pulls: Brushed-chrome **OR** Polished-chrome **OR** Brushed-brass **OR** Polished-brass, **as directed**, finish.

C. Laminate-Clad Cabinets
1. Framed-Style Base Cabinets:
   a. Face Frames: 3/4-inch- (19-mm-) thick plywood or solid wood.
   b. Back Panels: 3/8-inch- (10-mm-) thick particleboard with melamine bonded to inside surface.
   c. Top, Bottom, and End Panels: 3/8-inch- (10-mm-) thick particleboard with melamine bonded to both sides.
   d. Door and Drawer Fronts: 3/4-inch- (19-mm-) thick, medium-density fiberboard with 16-mil- (0.4-mm-) thick vinyl film (Thermofoil) bonded to exposed surfaces and melamine bonded to inside surfaces.
   OR

Door and Drawer Fronts: 5/8-inch- (16-mm-) thick particleboard with melamine bonded to both sides.

e. Drawers: Four sided, with 1/2-inch- (13-mm-) thick particleboard fronts, backs, and sides, and 1/4-inch- (6-mm-) thick particleboard bottom.

f. Shelves: 5/8-inch- (16-mm-) thick particleboard with melamine bonded to both sides and PVC edges.

2. Frameless-Style Base Cabinets:

a. Back Panels: 1/4-inch- (6-mm-) thick plywood or particleboard with melamine bonded to inside surface.

b. Top and Bottom Panels: 3/4-inch- (19-mm-) thick particleboard with melamine bonded to both sides.

c. End Panels: 5/8-inch- (16-mm-) thick particleboard with melamine bonded to both sides.

d. Door and Drawer Fronts: 3/4-inch- (19-mm-) thick plywood with Grade HGS high-pressure decorative laminate bonded to front and edges, and Grade CLS high-pressure decorative laminate bonded to inside surface.
OR
Door and Drawer Fronts: 5/8-inch- (16-mm-) thick particleboard with melamine bonded to both sides.
OR
Door and Drawer Fronts: 5/8-inch- (16-mm-) thick particleboard with melamine bonded to both sides. Provide continuous bevel edge at tops and bottoms of doors and bottom of drawer fronts in wood-grain laminate **OR** solid wood, **as directed**.

e. Drawers: Four sided, with 1/2-inch- (13-mm-) thick particleboard fronts, backs, and sides, and 1/4-inch- (6-mm-) thick particleboard bottom.

f. Shelves: 3/4-inch- (19-mm-) thick particleboard with melamine bonded to both sides and PVC edges.

3. Wall Cabinets: Same material and finish as base cabinets, with adjustable shelves.

a. Wall Shields: Fabricated from high-pressure decorative laminate of grade and color to match cabinets **OR** high-pressure decorative laminate of grade and color to match countertop **OR** stainless-steel sheet, **as directed**. Provide wall shields for back wall and side walls, **as directed**, between countertop splash and wall cabinets.

4. Scribe Strips for Recessed Cabinets: Same material, finish, and color as cabinet.

5. Wire Pulls: Brushed-chrome **OR** Polished-chrome **OR** Brushed-brass **OR** Polished-brass, **as directed**, finish.

D. Wood Cabinets

1. Base Cabinets: Birch **OR** Maple **OR** Oak **OR** Cherry **OR** Ash, **as directed**.

a. Face Frames: 3/4-inch- (19-mm-) thick, hardwood-veneer plywood or solid wood.

b. Back Panels: 3/8-inch- (10-mm-) thick particleboard with melamine bonded to inside surface.

c. Top, Bottom, and End Panels: 3/8-inch- (10-mm-) thick particleboard with melamine bonded to both sides.

d. Shelves: 5/8-inch- (16-mm-) thick particleboard with melamine bonded to both sides and PVC edges.

e. Door and Drawer Fronts: 5/8-inch- (16-mm-) thick, hardwood-veneer plywood with matching hardwood edges.
OR
Door and Drawer Fronts: 3/4-inch- (19-mm-) thick, solid wood stiles and rails, with solid wood center panels.

2. Wall Cabinets: Same material and finish as base cabinets, with adjustable shelves.

a. Wall Shields: Fabricated from high-pressure decorative laminate of grade and color to match countertop **OR** stainless-steel sheet, **as directed**. Provide wall shields for back wall and side walls, **as directed**, between countertop splash and wall cabinets.

3. Scribe Strips for Recessed Cabinets: Same material, finish, and color as cabinet.

4. Wire Pulls: Brushed-chrome **OR** Polished-chrome **OR** Brushed-brass **OR** Polished-brass, **as directed**, finish.

E. Countertops
1. Countertop and Integral Sink: Seamless, one-piece countertop and sink with integral embossed drainboard and backsplash and side splashes, **as directed**.
    a. Stainless Steel: 0.038-inch- (0.95-mm-) thick sheet bonded to 3/4-inch (19-mm) plywood.
    b. Porcelain-Enamel-Finished Steel: 0.0677 inch (1.7 mm) thick.
    c. Solid-Surfacing Material: Minimum 1/2 inch (13 mm) thick.
2. Countertop **OR** Countertop for Drop-in Sink, **as directed**: Seamless, one-piece countertop with integral backsplash and side splashes, **as directed**.
    a. Stainless Steel: 0.038-inch- (0.95-mm-) thick sheet bonded to 3/4-inch (19-mm) plywood.
    b. High-Pressure Decorative Laminate: Grade HGS, bonded to 3/4-inch (19-mm) plywood.
    OR
    High-Pressure Decorative Laminate: Grade HGP, post formed, bonded to 3/4-inch (19-mm) particleboard with Grade BKL unfinished backing sheet bonded to reverse side.
3. Countertop **OR** Countertop for Undercounter-Mounted Sink, **as directed**: Seamless, one-piece countertop with integral backsplash and side splashes, **as directed**; fabricated from 1/2-inch- (13-mm-) thick, solid-surfacing material.

F. Fixtures
1. Stainless-Steel Drop-in Sinks: 0.050 inch (1.27 mm) **OR** 0.038 inch (0.95 mm), **as directed**, thick; seamless; single compartment.
2. Porcelain-Enamel-Finished Steel Drop-in Sinks: 0.043 inch (1.09 mm) thick; seamless; single compartment.
3. Undercounter-Mounted Sinks: Solid-surfacing material; seamless; single compartment.
4. Supplies: NPS 3/8 (DN 12) **OR** NPS 1/2 (DN 15), **as directed**, chrome-plated copper with stops.
5. Sink Faucet: Single-lever control; polished chrome-plated mixing **OR** European-style, pull-out spray, **as directed**, faucet with limited-swing spout and aerator.
    OR
    Sink Faucet: Separate hot and cold controls with wrist-blade handles, **as directed**; polished chrome-plated mixing faucet with limited-swing spout **OR** gooseneck spout, **as directed**, and aerator.
6. Sink Outlet with Disposer: 3-1/2-inch- (89-mm-) diameter outlet.
7. Sink Outlet without Disposer: 3-1/2-inch- (89-mm-) diameter outlet with stainless-steel cup strainer and 1-1/2-inch- (38-mm-) diameter tailpiece.
8. Drain Piping: NPS 1-1/2 (DN 40) chrome-plated cast-brass trap, tubular brass waste to wall, and wall escutcheon.
9. Bar Sink Outlet: 2-inch- (51-mm-) diameter outlet with stainless-steel grid strainer.
10. Disposers: Continuous-feed, household, food-waste disposers. Include 115-V ac, 1725-rpm, 1/2-hp motor with overload protection and reset button; three-conductor, grounded power cord; wall switch; corrosion-resistant chamber with jam-resistant, cutlery- or stainless-steel grinder or shredder; NPS 1-1/2 (DN 40) outlet; quick-mounting, stainless-steel sink flange; antisplash guard; and combination cover/stopper.
11. Hot-Water Dispensers: Household type with instant on-off control; insulated, corrosion-resistant-metal storage tank that is open to atmosphere; electric, 115-V ac, heating element; three-conductor, grounded power cord; chrome-plated faucet or spout; removable strainer; thermostat control for water temperature up to 190 deg F (88 deg C); thermal-overload protection; and minimum 1/2-gal. (1.9-L) tank capacity dispensing approximately 60 cups (240 mL) of water per hour.

G. Appliances
1. Built-in Refrigerators: Fabricated with one-piece seamless steel or ABS plastic inner liner; refrigerator compartment with slide-out or removable shelves and meat tray; adjustable automatic temperature control; door with magnetic gaskets and storage shelves; interior light; closed

compartment for 25-lb (11-kg) minimum storage of prefrozen food and two ice cube trays; 115-V ac.

   a. Minimum Capacity: 3.2 cu. ft. (0.091 cu. m) **OR** 5.5 cu. ft. (0.156 cu. m) **OR** 6.0 cu. ft. (0.169 cu. m), **as directed**.
   b. Defrost System: Automatic defrost timer **OR** Push button or manual, **as directed**.
   c. Compressor: Cushion-mounted, self-oiling, and hermetically sealed compressor; fan or gravity cooled.
   d. Finish Panel: Manufacturer's standard door trim kit with filler panel or integral finish panel; match material and finish of base cabinets.

2. Freestanding, Upright Refrigerator-Freezers: Two-door combination unit with one-piece seamless steel or ABS plastic inner liner; automatic defrost; closed freezer compartment with two adjustable shelves and two ice cube trays, **as directed**; full-width vegetable crisper; dairy compartment; interior light; adjustable automatic temperature control; door with magnetic gaskets and storage shelves; 115-V ac, with three-conductor, grounded power cord.
   a. Minimum Capacity: 12-cu. ft. (0.340-cu. m) refrigerator capacity with 100-lb (45-kg) freezer capacity **OR** 14-cu. ft. (0.396-cu. m) refrigerator capacity with 125-lb (57-kg) freezer capacity, **as directed**.
   b. Icemaker: Built-in automatic unit, **as directed**.
   c. Finish Panel: Manufacturer's standard door trim kit with filler panel or integral finish panel; match material and finish of base cabinets.
3. Automatic Icemakers: Built-in undercounter unit; capable of producing 22 lb (10 kg) of ice per day; with 12-lb (5.4-kg) **OR** 35 lb (15.9 kg) of ice per day; with 26-lb (11.8-kg) **OR** 50 lb (22.6 kg) of ice per day; with 35-lb (15.9-kg), **as directed**, storage bin; 115-V ac, with three-conductor, grounded power cord; with plumbed water supply.
4. Electric Cooktops: Porcelain-enamel-finished steel; coil-element burners with removable rings and reflector bowls, infinitely adjustable heating controls, and individual signal lights; with wiring terminated at factory-installed junction box.
   a. Cooktop Burner: One element rated at 900 W; 115 **OR** 1250 W; 208/240, **as directed**,-V ac.

      OR

      Cooktop Burners: One element rated at 550 W and one element rated at 950 W; 115-V ac.

      OR

      Cooktop Burners: Two elements, each rated at 1250 W; 115 **OR** 208/240, **as directed**,-V ac.

      OR

      Cooktop Burners: Two elements rated at 1250 W and one element rated at 2100 W; 208/240-V ac.
5. Built-in Electric Ovens: Porcelain-enamel-finished steel exterior surfaces; coil-element burners with removable rings and reflector bowls, infinitely adjustable heating controls, and individual signal lights. Oven interior fabricated from one-piece porcelain-enamel-finished steel with rounded corners, with "Bake" and "Broil" oven elements, automatic heat control, signal light, and removable wire oven rack; textured baked-enamel- or porcelain-enamel-finished steel oven door; 208/240-V ac, with wiring terminated at factory-installed junction box.
   a. Cooktop Burners: Three elements, each rated at 1250 W.
   b. Oven Elements: 1500 W bake; 2000 W broil **OR** Manufacturer's standard, **as directed**.
6. Freestanding Electric Ranges: Porcelain-enamel-finished steel exterior surfaces; coil-element burners with removable rings and reflector bowls, infinitely adjustable heating controls, and individual signal lights; anti-tip anchors. Oven interior fabricated from one-piece porcelain-enamel-finished steel with rounded corners, with "Bake" and "Broil" oven elements, automatic heat control, signal light, two removable wire oven racks, and porcelain-on-steel broiler pan; textured baked-enamel- or porcelain-enamel-finished steel oven door; 208/240-V ac, with wiring terminated at factory-installed junction box.
   a. Cooktop Burners: Three elements, each rated at 1250 W, and one element rated at 2100 W.
   b. Oven Elements: Manufacturer's standard.

7. Gas Cooktops: Porcelain-enamel-finished steel; surface burners with removable cast-iron grates, lift-out burner bowls, and 115-V ac electronic ignition; with wiring terminated at factory-installed junction box, and burner control panel mounted at front of unit.
   a. Cooktop Burners: Two elements, each rated at 8000 Btu/h (8440 kJ) **OR** 10,000 Btu/h (10 550 kJ), **as directed**, for natural gas.
8. Built-in Gas Ovens: Stainless-steel **OR** Porcelain-enamel-finished steel, **as directed**, exterior surfaces; surface burners with removable cast-iron grates, lift-out burner bowls, and 115-V ac electronic ignition; with wiring terminated at factory-installed junction box. Oven interior fabricated from porcelain-enamel-finished steel with rounded corners; removable wire oven rack, automatic heat control, and combination surface burner and oven control panel mounted above oven door at front of unit.
   a. Cooktop Burners: Three elements, each rated at 5000 Btu/h (5275 kJ) for natural gas.
      OR
      Cooktop Burners: Four elements, each rated at 9000 Btu/h (9495 kJ) for natural gas.
   b. Oven Burner: Rated at 9000 Btu/h (9495 kJ) **OR** 18,000 Btu/h (18 990 kJ), **as directed**, for natural gas.
9. Freestanding Gas Ranges: Porcelain-enamel-finished steel exterior surfaces; surface burners with removable grates, lift-out burner bowls, and 115-V ac electronic ignition; with three-conductor, grounded power cord; anti-tip anchors. Oven interior fabricated from porcelain-enamel-finished steel with rounded corners; two removable wire oven racks, porcelain-on-steel broiler pan, automatic heat control, and combination surface burner and oven control panel mounted above oven door at front of unit.
   a. Cooktop Burners: Four elements, each rated at 9000 Btu/h (9495 kJ) for natural gas.
   b. Oven Burner: Rated at 18,000 Btu/h (18 990 kJ) for natural gas.
10. Freestanding Microwave Ovens: 0.7-cu. ft. (0.020-cu. m) capacity with 600 W **OR** 0.8-cu. ft. (0.023-cu. m) capacity with 700 W, **as directed**, cooking power; electronic touch controls, variable power control, digital clock timer, interior light, turntable, and tempered glass door; 115-V ac, with three-conductor, grounded power cord.
11. Built-in Microwave Ovens with Exhaust Hood: Undercabinet mounted, minimum 1.0-cu. ft. (0.028-cu. m) capacity with 800-W cooking power; electronic touch controls, variable power control, digital clock timer, interior light, turntable, tempered glass door, and exhaust hood with integral light and two-speed fan control; 115-V ac, with three-conductor, grounded power cord.
   a. Exhaust Hood: Recirculating, nonventing type, with replaceable charcoal filter.
      OR
      Exhaust Hood: Ventilating type, with permanent washable filter. Provide exhaust duct and wall **OR** roof, **as directed**, cap and shutter. See Division 23 Section "Metal Ducts".
12. Built-in Microwave/Convection Ovens with Exhaust Hood: Undercabinet mounted, minimum 1.0-cu. ft. (0.028-cu. m) capacity with 800-W cooking power; electronic touch controls, variable power control, digital clock timer, interior light, turntable, convection rack, tempered glass door, and exhaust hood with integral light and two-speed fan control; 115-V ac, with three-conductor, grounded power cord.
   a. Exhaust Hood: Recirculating, nonventing type, with replaceable charcoal filter.
   b. Exhaust Hood: Ventilating type, with permanent washable filter. Provide exhaust duct and wall **OR** roof, **as directed**, cap and shutter. See Division 23 Section "Metal Ducts".
13. Ventilating Exhaust Hoods: Undercabinet mounted, 24 inches (610 mm) wide, stainless **OR** baked-enamel, **as directed**, steel; two-speed fan control, permanent washable filter, and built-in lighting; 115-V ac, with wiring terminated at factory-installed junction box.
   a. Provide exhaust duct and wall **OR** roof, **as directed**, cap and shutter. See Division 23 Section "Metal Ducts".
14. Recirculating, Nonventilating Exhaust Hoods: Undercabinet mounted, 24 inches (610 mm) wide, stainless **OR** baked-enamel, **as directed**, steel; two-speed fan control, replaceable charcoal filter, and built-in lighting; 115-V ac, with wiring terminated at factory-installed junction box.
15. Dishwashers: Built-in undercounter unit, 18 inches (457 mm) wide **OR** 24 inches (610 mm) wide **OR** width as indicated, **as directed**; multiple wash cycles, coated roll-out racks, detergent dispenser, and insulated cavity walls and door; 115-V ac, with wiring terminated at factory-installed junction box.

16. Automatic Coffeemakers: Stainless steel, with capacity for three pots of coffee; automatic brewing, nonstick warmer plates, and lighted on-off switch; 115-V ac, with three-conductor, grounded power cord; designed for permanent installation in countertop, with plumbed water supply. Provide glass coffee decanters in number to match capacity.

H. Accessories
1. Locks: Brass-cylinder type; furnish two keys per lock. Provide where indicated **OR** on base cabinet doors **OR** on refrigerator, **as directed**.
2. Fluorescent Light Fixtures: Surface mounted to underside of overhead cabinet; with 15-W lamp, on-off switch, grounded convenience receptacle, and translucent plastic lens.
3. Cutlery Drawers: Concealed drawer in undercounter storage compartment with pull-out divided tray.
4. Cutting Boards: Pull-out hardwood board.
5. Heat Shields: Minimum 12 inches high by 24 inches (305 mm high by 610 mm) wide, 0.025-inch- (0.64-mm-) thick stainless steel over 1/4-inch- (6-mm-) thick board insulation.

I. Fabrication
1. General: Factory fabricate and assemble unit kitchens, with base cabinets, sink **OR** refrigerator, **as directed**, and countertop shipping as a one-piece assembly. Securely fasten components, fixtures, and appliances together.
   a. Provide manufacturer's standard hardware including concealed, adjustable plated-steel hinges; steel drawer slides with nylon rollers; and catches and rubber bumpers on doors and drawers. Unless otherwise indicated, provide chromium-plated metal or satin-finished stainless steel for exposed hardware.
2. Accessible Units: Fabricate unit kitchens to comply with accessibility regulations as follows:
   a. Standard, Accessible Countertops: Fabricate unit kitchens with one-piece countertop located at height of 34 inches (864 mm) above floor.
      OR
      Adjustable, Accessible Countertops: Fabricate unit kitchens with two-piece countertop that allows countertop over sink, including backsplash, side splashes, and sink assembly, to be adjusted between 29 and 36 inches (735 and 915 mm) above finished floor.
   b. Removable, Accessible Cabinets: Fabricate cabinet under sink to allow removal for future accessibility conversion. Fabricate cabinet to allow access to plumbing and electrical connections after conversion.
   c. Knee and Toe Clearance: Provide minimum 30-inch- (760-mm-) wide open space beneath countertop with a minimum clear height of 27 inches (685 mm) above floor for first 8 inches (205 mm) of depth, then reduce clearance at a rate of 1 inch (25 mm) in depth for each 6 inches (150 mm) in height, to a minimum clear height of 9 inches (230 mm) above floor at a depth of 11 inches (280 mm).
   d. Pipe Enclosure Panels: Provide manufacturer's standard panels to enclose plumbing under countertop, of same material and finish as cabinets. Install panel to prevent exposure of sharp or abrasive surfaces under countertop.
   e. Operable Parts: Locate operable parts no higher than 48 inches (1219 mm) and no lower than 15 inches (380 mm) above floor. Provide operable parts that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22.2 N).
   f. Range or Cooktop: Provide top surface 34 inches (865 mm) above floor, with controls that do not require reaching across burners. Provide knee and toe clearance beneath range or cooktop; insulate underside of cooktop to prevent burns, shocks, or abrasions.
   g. Refrigerator/Freezer: Provide 50 percent of freezer space no higher than 54 inches (1370 mm) off floor.
   h. Oven: Provide work surface adjacent to one side of bottom-hinged doors. Locate controls on front panel.

J. General Finish Requirements

1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

K. Finishes
1. Stainless-Steel Finishes: Remove tool and die marks and stretch lines, or blend into finish. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
   a. Bright, Directional Polish: No. 4 finish.
2. Wood Finishes: Factory finished with manufacturer's standard stain, sealer, and clear finish coat. Defer only final touchup until after installation.

1.3 EXECUTION

A. Examination
1. Examine walls and floors, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
2. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
3. Examine walls and partitions for proper backing for unit kitchens.
4. Examine roughing-in for electrical power plumbing and mechanical system(s) to verify actual locations of connections before installation of unit kitchens.
5. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation
1. General: Install level, plumb, and true; shim as required, using concealed shims. Provide fasteners, clips, backing materials, brackets, anchors, fillers, scribes, trim, and accessories necessary for complete installation.
   a. Anchor unit kitchens at ends and at intervals recommended by manufacturer, but not more than 36 inches (910 mm) o.c. Install anchors through backup reinforcing plates, channels, or blocking as required to prevent material distortion; use concealed fasteners.
   b. Freestanding Ranges: Install anti-tip anchors at locations recommended by manufacturer.
2. Comply with requirements specified in Division 14 AND Division 21 for connecting unit kitchens to plumbing and mechanical system(s).
3. Comply with requirements specified in Division 22 for connecting unit kitchens to electrical power system.

C. Adjusting And Cleaning
1. Test, adjust, and verify operation of each appliance, plumbing fixture, and component of unit kitchens. Repair or replace items found to be defective or operating below rated capacity.
2. Verify that operating parts work freely and fit neatly and that clearances are adequate to properly and freely operate appliances.
3. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding. Verify that locking devices operate properly.
4. After completing unit kitchen installation, remove protective coverings if any.
5. Repair or replace damaged parts, dents, buckles, abrasions, and other defects affecting appearance or serviceability. Touch up factory-applied finishes to restore damaged or soiled areas.

END OF SECTION 11 32 13 00

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Task	Specification	Specification Description
11 41 13 00	11 21 63 00	Food Service Equipment
11 41 23 00	11 21 63 00	Food Service Equipment
11 41 31 00	11 21 63 00	Food Service Equipment

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SECTION 11 41 33 00 - RESIDENTIAL CASEWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. [**Kitchen**] [**and**] [**vanity**] cabinets.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood blocking for anchoring casework.
2. Section 092216 "Non-Structural Metal Framing" for reinforcements in metal-framed partitions for anchoring casework.
3. Section 123623.13 "Plastic-Laminate-Clad Countertops."
4. Section 123640 "Stone Countertops."
5. Section 123661.13 "Cultured Marble Countertops."
6. Section 123661.16 "Solid Surfacing Countertops."
7. Section 123661.19 "Quartz Agglomerate Countertops."

1.2 DEFINITIONS

A. Concealed Surfaces of Casework: Surfaces not usually visible after installation, including sleepers, web frames, dust panels, bottoms of drawers, and ends of casework installed directly against and completely concealed by walls or other casework, and tops of wall cabinets and utility cabinets.

B. Exposed Surfaces of Casework: Surfaces visible when doors and drawers are closed, including visible surfaces in open cabinets or behind glass doors.

C. Semiexposed Surfaces of Casework: Surfaces behind opaque doors or drawer fronts, including interior faces of doors, interiors and sides of drawers, and bottoms of wall cabinets.

1.3 COORDINATION

A. Coordinate layout and installation of blocking and reinforcement in partitions for support of casework.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components, and profiles and finishes for casework.
2. Include rated capacities, operating characteristics, profiles, and finishes for hardware.

B. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for recycled content.>
2. <Double click to insert sustainable design text for regional materials.>

3. <Double click to insert sustainable design text for certified wood.>
4. <Double click to insert sustainable design text for certified wood.>
5. <Double click to insert sustainable design text for adhesives.>
6. <Double click to insert sustainable design text for composite wood.>

C. Shop Drawings: For residential casework.

1. Include plans, elevations, details, and attachments to other work.
2. Show materials, finishes, filler panels, and hardware.
3. Indicate manufacturer's catalog numbers for casework.

D. Samples: For casework and hardware finishes.

E. Samples for Initial Selection: For casework and hardware finishes.

F. Samples for Verification: For the following:

1. Casework Finishes: 8-by-10-inch (200-by-250-mm) Samples for each type of casework finish.
2. Hardware: One full-size Sample of each type of exposed hardware in each finish required.
3. Base Cabinet: One full-size, [**16-inch- (406-mm-)**] <**Insert dimension**> wide, finished base cabinet complete with hardware, doors, and drawers but without countertop.
4. Wall Cabinet: One full-size, [**12-inch- (304-mm-)**] <**Insert dimension**> wide, finished wall cabinet complete with hardware, doors, and adjustable shelves.
5. Full-Size Samples: Maintain at Project site during construction in an undisturbed condition as a standard for judging the completed Work. Unless otherwise indicated, approved sample units may become part of the completed Work if in undisturbed condition at time of Substantial Completion. Notify Architect of their exact locations.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Product Certificates: For casework.

1.6 QUALITY ASSURANCE

A. <Double click to insert sustainable design text for manufacturer qualifications.>

B. <Double click to insert sustainable design text for vendor qualifications.>

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install casework until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

B. Established Dimensions: Where casework is indicated to fit to other construction, establish dimensions for areas where casework is to fit. Coordinate construction to ensure that actual dimensions correspond to established dimensions. Provide fillers and scribes to allow for trimming and fitting.

C. Field Measurements: Where casework is indicated to fit to existing construction, verify dimensions of existing construction by field measurements before fabrication and indicate measurements on Shop Drawings. Provide fillers and scribes to allow for trimming and fitting.

D. Locate concealed framing, blocking, and reinforcements that support casework by field measurements before enclosing them, and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 CABINETS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Quality Standard: Provide cabinets that comply with KCMA A161.1.

1. KCMA Certification: Provide cabinets with KCMA's "Certified Cabinet" seal affixed in a semiexposed location of each unit and showing compliance with KCMA A161.1.

C. <Double click to insert sustainable design text for regional wood materials.>

D. <Double click to insert sustainable design text for certified wood.>

E. Door and Drawer Face Style: [**Flush overlay; faces cover cabinet fronts**] [**Reveal overlay; faces partially cover cabinet fronts**] [**Lipped overlay; faces rabbeted and partially inset within cabinet fronts, lips of rabbets overlap cabinet fronts**] [**Flush inset; faces set within and flush with cabinet fronts**].

1. Door and Drawer Fronts:

a. Solid-wood stiles and rails, 5/8 inch (16 mm) thick, with 3/4-inch- (19-mm-) thick, solid-wood center panels.
b. Solid-wood stiles and rails, 3/4 inch (19 mm) thick, with 1/4-inch- (6.4-mm-) thick, veneer-faced plywood center panels.
c. 1/2-inch- (13-mm-) thick, veneer-faced plywood.
d. 1/2-inch- (13-mm-) thick, plastic-laminate-faced particleboard[**, with continuous solid-wood pulls on one edge**][**, with PVC edgebanding**].
e. 1/2-inch- (13-mm-) thick, thermoset decorative panels[**, with continuous solid-wood pulls on one edge**].
f. 1/2-inch- (13-mm-) thick, thermoformed-vinyl-faced panels with vinyl overlay on [**faces and edges and with thermoset decorative panel backs**] [**faces, backs, and edges**].

F. Cabinet Style: [**Face frame**] [**Frameless**].

1. Face Frames:

a. 3/4-by-1-5/8-inch (19-by-41-mm) solid wood[**with glued mortise and tenon or doweled joints**].
b. 5/8-inch- (16-mm-) thick particleboard with plastic laminate on exposed and semiexposed surfaces.
c. 5/8-inch- (16-mm-) thick, thermoset decorative panel material.
d. 1/2-inch- (13-mm-) thick, thermoformed-vinyl-faced panels with vinyl overlay on exposed and semiexposed surfaces.

G. Exposed Cabinet End Finish: [**Wood veneer**] [**Plastic laminate**] [**Thermoset decorative panels**] [**Thermoformed-vinyl-faced panels**].

H. Cabinet End Construction: [**5/8-inch- (16-mm-) thick particleboard or 1/2-inch- (13-mm-) thick plywood**] [**1/2-inch- (13-mm-) thick particleboard or 3/8-inch- (9.5-mm-) thick plywood**].

I. Cabinet Tops and Bottoms: [**5/8-inch- (16-mm-) thick particleboard or 1/2-inch- (13-mm-) thick plywood**] [**1/2-inch- (13-mm-) thick particleboard or 3/8-inch- (9.5-mm-) thick plywood**].

1. Fully support in rabbets in and secure to end panels[**, front frame,**] and back rail.

J. Back, Top, and Bottom Rails: 3/4-by-2-1/2-inch (19-by-63-mm) solid wood, interlocking with end panels and rabbeted to receive top and bottom panels. Back rails secured under pressure with glue and with mechanical fasteners.

K. Wall-Hung-Unit Back Panels: 3/16-inch- (4.8-mm-) thick plywood fastened to rear edge of end panels and to top and bottom rails.

L. Base-Unit Back Panels: [**3/16-inch- (4.8-mm-) thick plywood**] [**1/8-inch- (3.2-mm-) thick hardboard**] fastened to rear edge of end panels and to top and bottom rails.

M. Front Frame Drawer Rails: 3/4-by-1-1/4-inch (19-by-32-mm) solid wood mortised and fastened into face frame.

N. Drawers: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.

1. Join subfronts, backs, and sides with [**glued rabbeted joints supplemented by mechanical fasteners**] [**or**] [**glued dovetail joints**].
2. Subfronts, Backs, and Sides: [**3/4-inch- (19-mm-) thick solid wood**] [**1/2-inch- (13-mm-) thick solid wood**] [**1/2-inch- (13-mm-) thick solid wood or 3/8-inch- (9.5-mm-) thick plywood**].
3. Bottoms: [**1/4-inch- (6.4-mm-) thick plywood**] [**3/16-inch- (4.8-mm-) thick plywood**] [**1/4-inch- (6.4-mm-) thick hardboard**].

O. Shelves: [**3/4-inch- (19-mm-) thick particleboard or 5/8-inch- (16-mm-) thick plywood**] [**5/8-inch- (16-mm-) thick particleboard or 1/2-inch- (13-mm-) thick plywood**].

P. Joinery: Rabbet backs flush into end panels and secure with concealed mechanical fasteners. Connect tops and bottoms of wall cabinets and bottoms and stretchers of base cabinets to ends and dividers with mechanical fasteners. Rabbet tops, bottoms, and backs into end panels.

Q. Factory Finishing: Finish cabinets at factory.

2.2 CABINET MATERIALS

A. Hardwood Lumber: Kiln dried to 7 percent moisture content.

B. Softwood Lumber: Kiln dried to 10 percent moisture content.

C. <Double click to insert sustainable design text for composite wood products.>

D. Hardwood Plywood: HPVA HP-1.

E. Particleboard: ANSI A208.1, Grade M-2.

1. <Double click to insert sustainable design text for recycled content.>

F. MDF: Medium-density fiberboard, ANSI A208.2, Grade MD.

1. <Double click to insert sustainable design text for recycled content.>

G. Hardboard: ANSI A135.4, Class 1 tempered.

1. <Double click to insert sustainable design text for recycled content.>

H. <Double click to insert sustainable design text for adhesives.>

I. Exposed Materials:

1. Exposed Wood Species: [**Oak**] [**Maple**] [**Alder**] [**Birch**] [**Hickory**] [**Cherry**] [**Manufacturer's standard domestic hardwood species**] <**Insert requirements**>.

   a. Select materials for compatible color and grain. Do not use two adjacent exposed surfaces that are noticeably dissimilar in color, grain, figure, or natural character markings.
   b. Staining and Finish: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**].

2. Solid Wood: Clear hardwood lumber of species indicated, free of defects.
3. Plywood: Hardwood plywood with face veneer of species indicated, with Grade A faces and Grade C backs of same species as faces.

   a. Edge band exposed edges with [**a minimum of 1/8-inch- (3-mm-) thick, solid-wood**] [**veneer**] edging of same species as face veneer.

4. Plastic Laminate: Particleboard faced with high-pressure decorative laminate complying with NEMA LD 3, [**Grade VGS**] [**Grade HGL**] and edgebanded.

   a. Colors, Textures, and Patterns: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from cabinet manufacturer's full range**] <**Insert requirements**>.
   b. Plastic-Laminate Edgebanding: Of same grade, pattern, color, and texture of plastic laminate as for faces.
   c. PVC Edgebanding: Rigid PVC extrusions, through color with satin finish, [**3 mm thick at doors and drawer fronts, and 1 mm thick elsewhere**] [**1 mm thick**].

      1) Color: [**As indicated by manufacturer's designation**] [**Match Architect's sample**] [**As selected by Architect from cabinet manufacturer's full range**] <**Insert requirements**>.

5. Thermoset Decorative Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper.

   a. Provide material finished on both sides for doors and drawer fronts.
   b. Provide [**PVC or polyester edgebanding**] [**PVC edge molding**] on components with exposed or semiexposed edges.
   c. Colors: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from cabinet manufacturer's full range**] <**Insert requirements**>.

6. Thermoformed-Vinyl-Faced Panels: MDF, milled to required shapes, with a thermoformed vinyl overlay applied in a vacuum or membrane press.

a. Color: [**White**] [**As indicated by manufacturer's designation**] [**Match Architect's sample**] [**As selected by Architect from cabinet manufacturer's full range**] <**Insert requirements**>.

J. Semiexposed Materials: Unless otherwise indicated, provide the following:

1. Solid Wood: Sound hardwood lumber, selected to eliminate appearance defects. Same species as exposed surfaces[**or stained to be compatible with exposed surfaces**].
2. Plywood: Hardwood plywood with Grade C faces and not less than Grade 3 backs of same species as faces. Face veneers of same species as exposed surfaces[**or stained to be compatible with exposed surfaces**].
3. Plastic Laminate: Particleboard faced with high-pressure decorative laminate complying with NEMA LD 3, [**Grade VGS**] [**Grade CLS**].

   a. For backs of doors and drawer fronts faced with plastic laminate, provide same grade, pattern, color, and texture of plastic laminate as for faces.
   b. For face frames faced with plastic laminate, provide plastic-laminate edges of same grade, pattern, color, and texture of plastic laminate as for faces.
   c. For shelves faced with plastic laminate, provide [**plastic-laminate edges of same grade, pattern, color, and texture of plastic laminate as for faces**] [**PVC edge molding, 1 mm thick**].
   d. Colors, Textures, and Patterns: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from cabinet manufacturer's full range**] <**Insert requirements**>.

4. Thermoset Decorative Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper.

   a. Provide material finished on both sides for shelves, dividers, drawer bodies, and other components with two semiexposed surfaces.
   b. Provide [**PVC or polyester edgebanding**] [**PVC edge molding**] on components with semiexposed edges.
   c. Colors: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from cabinet manufacturer's full range**] <**Insert requirements**>.

5. Vinyl-Faced Particleboard: MDF with[**embossed, wood-grain-patterned**] vinyl film adhesively bonded to particleboard.

   a. Provide vinyl film on both sides of shelves, dividers, drawer bodies, and other components with two semiexposed surfaces and on semiexposed edges.
   b. Colors, Textures, and Patterns: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from cabinet manufacturer's full range**] <**Insert requirements**>.

K. Concealed Materials: Solid wood or plywood, of any hardwood or softwood species, with no defects affecting strength or utility; particleboard; MDF; or hardboard.

2.3 CABINET HARDWARE

A. General: Manufacturer's standard units complying with BHMA A156.9, of type, size, style, material, and finish [**as indicated by manufacturer's designations**] [**matching Architect's sample**] [**as selected by Architect from manufacturer's full range**] <**Insert requirements**>.

B. Pulls: [**Surface-mounted decorative pulls**] [**Back-mounted decorative pulls**] [**Back-mounted decorative pulls with backing plates**] [**Wire pulls**] [**Back-mounted knobs**] [**Surface-mounted porcelain knobs**] <**Insert requirements**>.

C. Hinges: [**Decorative full-surface hinges**] [**Concealed butt hinges**] [**Semiconcealed (wraparound) butt hinges for overlay doors**] [**Pivot (knife) hinges**] [**Concealed European-style, self-closing hinges**] <**Insert requirements**>.

D. Drawer Guides: Epoxy-coated-metal, self-closing drawer guides; designed to prevent rebound when drawers are closed; with nylon-tired, ball-bearing rollers; and complying with BHMA A156.9, Type B05011 or Type B05091.

E. Door and Drawer Bumpers: Self-adhering, clear silicone rubber.

1. Doors: Provide one bumper at top and bottom of closing edge of each swinging door.
2. Drawers: Provide one bumper on back side of drawer front at each corner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of framing and reinforcements, and other conditions affecting performance of casework.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install casework with no variations in adjoining surfaces; use concealed shims. Where casework abuts other finished work, scribe and cut for accurate fit. Provide filler strips, scribe strips, and moldings in finish to match casework.

B. Install casework without distortion so doors and drawers fit the openings, are aligned, and are uniformly spaced. Complete installation of hardware and accessories as indicated.

C. Install casework level and plumb to a tolerance of 1/8 inch in 8 feet (3 mm in 2.4 m).

D. Fasten casework to adjacent units and to backing.

1. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches (400 mm) o.c.

    a. Fasteners: [**No. 10 wafer-head screws sized for not less than 1-1/2-inch (38-mm) penetration into wood framing, blocking, or hanging strips**] [**No. 10 wafer-head sheet metal screws through the metal backing or metal framing behind the wall finish**] [**Toggle bolts through the metal backing or metal framing behind the wall finish**].

3.3 ADJUSTING AND CLEANING

A. Adjust hardware so doors and drawers are centered in openings and operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

B. Clean casework on exposed and semiexposed surfaces. Touch up as required to restore damaged or soiled areas to match original factory finish, as approved by Architect.

END OF SECTION 11 41 33 00

Task	Specification	Specification Description
11 41 33 00	11 21 63 00	Food Service Equipment
11 42 13 00	11 21 63 00	Food Service Equipment
11 42 16 00	11 21 63 00	Food Service Equipment
11 44 13 00	11 21 63 00	Food Service Equipment
11 44 16 00	11 21 63 00	Food Service Equipment
11 44 19 00	11 21 63 00	Food Service Equipment
11 46 13 00	11 21 63 00	Food Service Equipment
11 46 16 00	11 21 63 00	Food Service Equipment
11 46 19 00	11 21 63 00	Food Service Equipment
11 46 83 00	11 21 63 00	Food Service Equipment
11 48 13 00	11 21 63 00	Food Service Equipment
11 48 16 00	11 21 63 00	Food Service Equipment

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SECTION 11 52 13 13 - PROJECTION SCREENS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for projection screens. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Manually operated projection screens.
      b. Electrically operated projection screens and controls.
      c. Rigid rear-projection screens.

C. Definitions
   1. Gain of Front-Projection Screens: Ratio of light reflected from screen material to that reflected perpendicularly from a magnesium carbonate surface as determined per SMPTE RP 94.
   2. Gain of Rear-Projection Screens: Ratio of light refracted by screen material to that reflected perpendicularly from a magnesium carbonate surface as determined per SMPTE RP 94, except that for measuring luminance of test screen, projection lamp shall be placed behind screen same distance as it was placed in front of magnesium carbonate surface for measuring luminance of reference standard.
   3. Half-Gain Angle: The angle, measured from the axis of the screen surface to the most central position on a perpendicular plane through the horizontal centerline of the screen where the gain is half of the peak gain.

D. Submittals
   1. Product Data: For each type of product indicated.
   2. Shop Drawings: For projection screens. Show layouts and types of projection screens. Include the following:
      a. For manually operated projection screens:
         1) Drop lengths.
         2) Anchorage details.
         3) Accessories.
      b. For electrically operated projection screens and controls:
         1) Location of screen centerline relative to ends of screen case.
         2) Location of wiring connections for electrically operated units.
         3) Location of seams in viewing surfaces.
         4) Drop lengths.
         5) Anchorage details, including connection to supporting structure for suspended units.
         6) Details of juncture of exposed surfaces with adjacent finishes.
         7) Accessories.
         8) Wiring diagrams.
      c. For rigid rear-projection screens:
         1) Frame details.
         2) Anchorage details.
         3) Details of juncture of exposed surfaces with adjacent finishes.
         4) Accessories.
   3. Maintenance Data: For projection screens to include in maintenance manuals.

E. Quality Assurance

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Delivery, Storage, And Handling
1. Environmental Limitations: Do not deliver or install projection screens until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Store rear-projection screens in manufacturer's protective packaging and according to manufacturer's written instructions.

1.2 PRODUCTS

A. Manually Operated Projection Screens
1. General: Manufacturer's standard spring-roller-operated units, consisting of case, screen, mounting accessories, and other components necessary for a complete installation.
   a. Screen Mounting: Top edge securely anchored to a 3-inch- (75-mm-) diameter, rigid steel roller; bottom edge formed into a pocket holding a tubular metal slat, with ends of slat protected by plastic caps, and with a saddle and pull attached to slat by screws.
   b. Tab Tensioning: Provide units that have a durable low-stretch cord, such as braided polyester, on each side of screen connected to edge of screen by tabs to pull screen flat horizontally. In lieu of tab tensioning, screens may be constructed from vinyl-coated screen cloth that contains horizontal stiffening monofilaments to resist edge curling, **as directed**.
2. Bracket-Mounted or Ceiling-Suspended, Metal-Encased, Manually Operated Screens: Units designed and fabricated for suspending from wall brackets or ceiling, fabricated from formed-steel sheet not less than 0.027 inch (0.7 mm) thick or from aluminum extrusions; with vinyl covering or baked-enamel finish and matching end caps. Provide mounting brackets unless otherwise indicated.
3. Surface-Mounted, Metal-Encased, Manually Operated Screens: Units designed and fabricated for surface mounting on wall or ceiling, fabricated from formed-steel sheet not less than 0.027 inch (0.7 mm) thick or from aluminum extrusions; with flat back design and vinyl covering or baked-enamel finish. Provide units with matching end caps and concealed mounting.
4. Surface-Mounted, Wood-Finished, Manually Operated Screens: Units designed and fabricated for surface mounting on wall or ceiling; with flat back design, hardwood finish, and concealed mounting brackets.
   a. Hardwood: Oak **OR** Walnut **OR** Cherry **OR** As selected from manufacturer's full range of species, **as directed**.
   b. Finish: As selected from manufacturer's full range.

B. Electrically Operated Projection Screens
1. General: Manufacturer's standard units consisting of case, screen, motor, controls, mounting accessories, and other components necessary for a complete installation. Provide units that are listed and labeled as an assembly by UL or another testing and inspecting agency acceptable to authorities having jurisdiction, **as directed**.
   a. Controls: Remote, key-operated, **as directed**, three-position control switch installed in recessed device box with flush cover plate matching other electrical device cover plates in room where switch is installed.
      1) Provide two **OR** three, **as directed**, control switches for each screen.
      2) Provide number of control switches indicated for each screen.
      3) Provide power supply for low-voltage systems if required.
      4) Provide locking cover plates for switches.
      5) Provide key-operated, power-supply switch.

6) Provide infrared **OR** radio-frequency, **as directed**, remote control consisting of battery-powered transmitter and receiver.
7) Provide video interface control for connecting to projector. Projector provides signal to raise or lower screen.

b. Motor in Roller: Instant-reversing motor of size and capacity recommended by screen manufacturer; with permanently lubricated ball bearings, automatic thermal-overload protection, preset limit switches to automatically stop screen in up and down positions, and positive-stop action to prevent coasting. Mount motor inside roller with vibration isolators to reduce noise transmission.

c. End-Mounted Motor: Instant-reversing, gear-drive motor of size and capacity recommended by screen manufacturer; with permanently lubricated ball bearings, automatic thermal-overload protection, preset limit switches to automatically stop screen in up and down positions, and positive-stop action to prevent coasting. Locate motor in its own compartment on right end of screen unless otherwise indicated **OR** on left end of screen unless otherwise indicated **OR** on end of screen indicated, **as directed**.

d. Screen Mounting: Top edge securely anchored to rigid metal roller and bottom edge formed into a pocket holding a 3/8-inch- (9.5-mm-) diameter metal rod with ends of rod protected by plastic caps.
1) Roller for end-mounted motor supported by self-aligning bearings in brackets.
2) Roller for motor in roller supported by vibration- and noise-absorbing supports.

e. Tab Tensioning: Provide units that have a durable low-stretch cord, such as braided polyester, on each side of screen connected to edge of screen by tabs to pull screen flat horizontally. In lieu of tab tensioning, screens may be constructed from vinyl-coated screen cloth that contains horizontal stiffening monofilaments to resist edge curling.

2. Surface-Mounted, Metal-Encased, Electrically Operated Screens: Motor-in-roller **OR** End-mounted motor, **as directed**, units designed and fabricated for surface mounting on wall or ceiling, fabricated from formed-steel sheet not less than 0.027 inch (0.7 mm) thick or from aluminum extrusions; with flat back design and vinyl covering or baked-enamel finish. Provide with matching end caps and concealed mounting.

3. Surface-Mounted, Wood-Finished, Electrically Operated Screens: Motor in roller units designed and fabricated for surface mounting on wall or ceiling; with flat back design, hardwood finish, and concealed mounting brackets.
a. Hardwood: Oak **OR** Walnut **OR** Cherry **OR** As selected from manufacturer's full range of species, **as directed**.
b. Finish: As selected from manufacturer's full range.

4. Suspended, Electrically Operated Screens without Ceiling Closure: Motor-in-roller **OR** End-mounted motor, **as directed**, units designed and fabricated for suspended mounting, with bottom of case entirely or partially open under screen compartment.
a. Provide metal or metal-lined motor enclosure on units with end-mounted motor.
b. Provide metal or metal-lined wiring compartment on units with motor in roller.
c. Screen Case: Made from metal **OR** metal and fire-retardant materials **OR** metal, wood, wood products, and fire-retardant materials, **as directed**.
d. Provide screen case with trim flange to receive ceiling finish **OR** constructed to be installed with underside flush with ceiling **OR** constructed to be installed with ceiling finish applied to underside, **as directed**.
e. Finish on Exposed Surfaces: Prime painted **OR** Vinyl covering or baked enamel, **as directed**.

5. Suspended, Electrically Operated Screens with Automatic Ceiling Closure: Motor-in-roller **OR** End-mounted motor, **as directed**, units designed and fabricated for suspended mounting; with bottom of case composed of two panels, fully enclosing screen, motor, and wiring; one panel hinged and designed to open and close automatically when screen is lowered and fully raised, the other removable or openable for access to interior of case.
a. Provide metal or metal-lined motor enclosure on units with end-mounted motor.
b. Provide metal or metal-lined wiring compartment on units with motor in roller.
c. Screen Case: Made from metal **OR** metal and fire-retardant materials **OR** metal, wood, wood products, and fire-retardant materials, **as directed**.

d. Provide screen case with trim flange to receive ceiling finish **OR** constructed to be installed with underside flush with ceiling **OR** constructed to be installed with ceiling finish applied to underside, **as directed**.

e. Finish on Exposed Surfaces: Prime painted **OR** Vinyl covering or baked enamel, **as directed**.

C. Front-Projection Screen Material

1. Matte-White Viewing Surface: Peak gain not less than 0.9, and gain not less than 0.8 at an angle of 50 degrees from the axis of the screen surface.
2. Matte-Gray Viewing Surface: Peak gain not less than 0.8, and half-gain angle of not less than 50 degrees from the axis of the screen surface.
3. Glass-Beaded Viewing Surface: Peak gain not less than 2.0, and half-gain angle of at least 15 degrees from the axis of the screen surface.
4. Matte Reflective Viewing Surface: Peak gain not less than 1.3, and half-gain angle of at least 40 degrees from the axis of the screen surface.
5. Wide-Angle Reflective Viewing Surface: Peak gain not less than 1.5, and half-gain angle of at least 35 degrees from the axis of the screen surface.
6. Multipurpose Reflective Viewing Surface: Peak gain not less than 1.8, and half-gain angle of at least 25 degrees from the axis of the screen surface.
7. High-Gain Reflective Viewing Surface: Peak gain not less than 2.5, and half-gain angle of at least 20 degrees from the axis of the screen surface.
8. Material: Vinyl-coated, glass-fiber fabric or vinyl sheet.
9. Mildew-Resistance Rating: 0 or 1 when tested according to ASTM G 21.
10. Flame Resistance: Passes NFPA 701.
11. Flame-Spread Index: Not greater than 75 when tested according to ASTM E 84.
12. Seams: Where length of screen indicated exceeds maximum length produced without seams in material specified, provide screen with horizontal seam placed as follows:
    a. At top **OR** bottom, **as directed**, of screen at juncture between extra drop length and viewing surface.
    b. In location indicated.
13. Seamless Construction: Provide screens, in sizes indicated, without seams.
14. Edge Treatment: Black **OR** Without black, **as directed**, masking borders.
15. Size of Viewing Surface: 50 by 50 inches (1270 by 1270 mm) **OR** 60 by 60 inches (1524 by 1524 mm) **OR** 70 by 70 inches (1778 by 1778 mm) **OR** 84 by 84 inches (2133 by 2133 mm) **OR** 48 by 65 inches (1219 by 1651 mm) **OR** 54 by 72 inches (1371 by 1828 mm) **OR** 58 by 79 inches (1473 by 2006 mm) **OR** 72 by 96 inches (1828 by 2438 mm), **as directed**.
16. Provide extra drop length of dimensions and at locations indicated.
    a. Color: Same as viewing surface **OR** Black, **as directed**.

D. Flexible Rear-Projection Screen Material

1. Wide-Angle Screens: Peak gain not less than 1.0, and half-gain angle of at least 35 degrees from the axis of the screen surface.
2. Moderate-Gain Screens: Peak gain not less than 1.3, and half-gain angle of at least 30 degrees from the axis of the screen surface.
3. High-Gain Screens: Peak gain not less than 1.8, and half-gain angle of at least 15 degrees from the axis of the screen surface.
4. Material: Coated vinyl sheet.
5. Mildew-Resistance Rating: 0 or 1 when tested according to ASTM G 21.
6. Flame Resistance: Passes NFPA 701.
7. Flame-Spread Index: Not greater than 75 when tested according to ASTM E 84.
8. Seamless Construction: Provide screens, in sizes indicated, without seams.
9. Size of Viewing Surface: 50 by 50 inches (1270 by 1270 mm) **OR** 60 by 60 inches (1524 by 1524 mm) **OR** 70 by 70 inches (1778 by 1778 mm) **OR** 84 by 84 inches (2133 by 2133 mm) **OR** 48 by 65 inches (1219 by 1651 mm) **OR** 54 by 72 inches (1371 by 1828 mm) **OR** 58 by 79 inches (1473 by 2006 mm) **OR** 72 by 96 inches (1828 by 2438 mm), **as directed**.

10. Provide extra drop length of dimensions and at locations indicated.
    a. Color: Same as viewing surface **OR** Black, **as directed**.

E. Optically Coated Rigid Rear-Projection Screens
1. Screen Substrate: Optically clear substrate complying with the following requirements:
    a. Clear float glass complying with ASTM C 1036 for Type I (transparent glass, flat), Class 1 (clear), and Quality q3 (glazing select), 6.0 mm thick **OR** 10.0 mm thick **OR** 12.0 mm thick **OR** thickness as indicated, **as directed**.
    b. Colorless, transparent, cast-acrylic sheet with a luminous transmittance of 92 percent per ASTM D 1003 and complying with ASTM D 4802, Category A-1 (cell cast), Finish 1 (smooth or polished), 1/4 inch (6.4 mm) thick **OR** 3/8 inch (9.5 mm) thick **OR** 1/2 inch (12.7 mm) thick **OR** thickness as indicated, **as directed**.
    c. Fresnel lens cast from colorless, transparent, acrylic with a luminous transmittance of 92 percent per ASTM D 1003 and complying with ASTM D 4802, Category A-1 (cell cast), Finish 1 (smooth or polished) on one side and Finish 2 (patterned) on other side, 1/4 inch (6.4 mm) thick **OR** 3/8 inch (9.5 mm) thick **OR** 1/2 inch (12.7 mm) thick **OR** thickness as indicated, **as directed**.
2. Optical Coating: Durable, washable coating bonded to one side of substrate.
3. Wide-Angle Screens: Peak gain not less than 1.0, and half-gain angle of at least 35 degrees from the axis of the screen surface.
4. Moderate-Gain Screens: Peak gain not less than 1.3, and half-gain angle of at least 30 degrees from the axis of the screen surface.
5. General-Purpose Screens: Peak gain of not less than 1.8, and half-gain angle of at least 28 degrees from the axis of the screen surface.
6. High-Gain Screens: Peak gain not less than 2.0, and half-gain angle of at least 20 degrees from the axis of the screen surface.
7. Optical Tint: High-contrast dark gray **OR** Medium neutral gray **OR** Neutral white **OR** Manufacturer's standard, **as directed**.
8. Protective Coating: Provide formulation designed by screen manufacturer as a permanent topcoat over optical coatings to protect against normal abrasion before, during, and after installation.
9. Writing-Surface Coating: Provide screen manufacturer's protective coating, designed as a writing surface for dry-erase markers, on front of screen.
10. Size of Viewing Surface: 40 by 54 inches (1016 by 1371 mm) **OR** 43 by 57 inches (1092 by 1447 mm) **OR** 50 by 67 inches (1270 by 1701 mm) **OR** 54 by 72 inches (1371 by 1828 mm) **OR** 60 by 80 inches (1524 by 2032 mm) **OR** 72 by 96 inches (1828 by 2438 mm), **as directed**.

F. High-Performance Rigid Rear-Projection Screens
1. High-Performance Screens, General: Acrylic screen with Fresnel lens on rear surface and linear lenses on front surface.
    a. Screen Substrate: Optically clear acrylic with a luminous transmittance of 92 percent per ASTM D 1003 and complying with ASTM D 4802, Category A-1 (cell cast), Finish 2 (patterned), 1/4 inch (6.4 mm) thick **OR** 3/8 inch (9.5 mm) thick **OR** 1/2 inch (12.7 mm) thick **OR** thickness as indicated, **as directed**.
2. Performance:
    a. Peak gain not less than 3.0 **OR** 4.0, **as directed**, and horizontal half-gain angle of at least 50 degrees from the axis of the screen surface.
    b. Peak gain of 3.5 **OR** 4.0, **as directed**, and horizontal half-gain angle of at least 30 degrees from the axis of the screen surface.
    c. Performance: Peak gain of 5.0, and horizontal half-gain angle of at least 25 degrees from the axis of the screen surface.
    d. Performance: Peak gain not less than 1.5 **OR** 3.0, **as directed**, and horizontal half-gain angle of at least 20 degrees from the axis of the screen surface.
3. Size of Viewing Surface: 40 by 54 inches (1016 by 1371 mm) **OR** 43 by 57 inches (1092 by 1447 mm) **OR** 50 by 67 inches (1270 by 1701 mm) **OR** 54 by 72 inches (1371 by 1828 mm) **OR** 60 by 80 inches (1524 by 2032 mm) **OR** 72 by 96 inches (1828 by 2438 mm), **as directed**.

G. Rigid Rear-Projection Screen Accessories
1. Factory Frames: Screen manufacturer's standard frames of profile indicated, fabricated to sizes required to fit screens from aluminum extrusions complying with ASTM B 221 (ASTM B 221M) for 6063-T5 alloy and temper.
   a. Class II, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.
   b. Class II, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, integrally colored or electrolytically deposited color coating 0.010 mm or thicker) complying with AAMA 611.
      1) Color: Black **OR** Dark bronze **OR** Either black or dark bronze, as standard with manufacturer, **as directed**.
2. Glazing Accessories for Factory Frames: Provide gaskets and setting blocks with proven record of compatibility with screen and frame surfaces, of sizes and shapes to accommodate thickness of screen indicated and to fit glazing channel provided.
3. Glazing Accessories for Field-Framed Screens: Provide materials compatible with screen and frame surfaces while complying with applicable requirements in Division 08 Section "Glazing".

1.3 EXECUTION

A. Front-Projection Screen Installation
1. Install front-projection screens at locations indicated to comply with screen manufacturer's written instructions.
2. Install front-projection screens with screen cases in position and in relation to adjoining construction indicated. Securely anchor to supporting substrate in a manner that produces a smoothly operating screen with vertical edges plumb and viewing surface flat when screen is lowered.
   a. Install low-voltage controls according to NFPA 70 and complying with manufacturer's written instructions.
      1) Wiring Method: Install wiring in raceway except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
   b. Test electrically operated units to verify that screen controls, limit switches, closures, and other operating components are in optimum functioning condition.
   c. Test manually operated units to verify that screen-operating components are in optimum functioning condition.

B. Rigid Rear-Projection Screen Installation
1. Install rear-projection screens at locations indicated to comply with screen manufacturer's written instructions. Handle screens carefully during installation using procedures and tools recommended by screen manufacturer; do not abrade screen surfaces.
2. Install optically coated rear-projection screens with optical coating toward projector **OR** audience, **as directed**.
3. Install high-performance, rear-projection screens with orientation as indicated in manufacturer's written instructions.
4. Install factory-framed, rear-projection screens in prepared wall openings. Securely anchor frames to surrounding construction so frames are plumb and level and screen surfaces are flat.
5. Install rear-projection screens with glass substrates, in frames specified in other Sections, to comply with applicable requirements in Division 08 Section "Glazing" and with screen manufacturer's written instructions. Set projection screen with surfaces flat and edges plumb and level.

6. Install rear-projection screens with plastic substrates, in frames specified in other Sections, to comply with screen manufacturer's written instructions. Clamp units only at top edge and allow for expansion and contraction of plastic glazing material by providing frame with adequate bite and edge clearances.

C. Protecting And Cleaning Rigid Rear-Projection Screens
1. Provide temporary covering of rear-projection screens until time of Final Completion. Use type of covering approved by screen manufacturer that will effectively protect screen from abrasion, breakage, or other damage.
2. Clean rear-projection screens on both faces immediately before date scheduled for inspection intended to establish date of Final Completion. Use methods and cleaning materials recommended by screen manufacturer, taking care not to scratch or damage optical coatings or screen substrates.

D. Projection Screen Schedule
1. Manually Operated, Front-Projection Screen Type: Surface mounted, metal encased **OR** Surface mounted, wood finished, **as directed**.
   a. Screen Surface: Matte white **OR** Matte gray **OR** Glass beaded **OR** Matte reflective **OR** Wide-angle reflective **OR** Multipurpose reflective **OR** High-gain reflective, **as directed**.
   b. Viewing Surface Size: 50 by 50 inches (1270 by 1270 mm) **OR** 60 by 60 inches (1524 by 1524 mm) **OR** 70 by 70 inches (1778 by 1778 mm) **OR** 84 by 84 inches (2133 by 2133 mm) **OR** 48 by 65 inches (1219 by 1651 mm) **OR** 54 by 72 inches (1371 by 1828 mm) **OR** 58 by 79 inches (1473 by 2006 mm) **OR** 72 by 96 inches (1828 by 2438 mm), **as directed**.
   c. Extra Drop Length: As needed at top of screen for bottom of screen to be 36 inches (900 mm) above floor and 36 inches (900 mm) at bottom of screen, **as directed**.
2. Electrically Operated, Front-Projection Screen Type: Surface mounted, metal encased **OR** Surface mounted, wood finished **OR** Suspended, without ceiling closure **OR** Suspended, with automatic ceiling closure, **as directed**.
   a. Motor Configuration: Motor in roller **OR** End-mounted motor on right end of screen **OR** End-mounted motor on left end of screen **OR** End-mounted motor on end of screen indicated, **as directed**.
   b. Screen Surface: Matte white **OR** Matte gray **OR** Glass beaded **OR** Matte reflective **OR** Wide-angle reflective **OR** Multipurpose reflective **OR** High-gain reflective, **as directed**.
   c. Viewing Surface Size: 50 by 50 inches (1270 by 1270 mm) **OR** 60 by 60 inches (1524 by 1524 mm) **OR** 70 by 70 inches (1778 by 1778 mm) **OR** 84 by 84 inches (2133 by 2133 mm) **OR** 48 by 65 inches (1219 by 1651 mm) **OR** 54 by 72 inches (1371 by 1828 mm) **OR** 58 by 79 inches (1473 by 2006 mm) **OR** 72 by 96 inches (1828 by 2438 mm), **as directed**.
   d. Extra Drop Length: As needed at top of screen for bottom of screen to be 36 inches (900 mm) above floor and 36 inches (900 mm) at bottom of screen, **as directed**.
3. Manually Operated, Rear-Projection Screen Type: Surface mounted, metal encased **OR** Surface mounted, wood finished, **as directed**.
   a. Screen Type: Wide angle **OR** Moderate gain **OR** High gain, **as directed**.
   b. Viewing Surface Size: 50 by 50 inches (1270 by 1270 mm) **OR** 60 by 60 inches (1524 by 1524 mm) **OR** 70 by 70 inches (1778 by 1778 mm) **OR** 84 by 84 inches (2133 by 2133 mm) **OR** 48 by 65 inches (1219 by 1651 mm) **OR** 54 by 72 inches (1371 by 1828 mm) **OR** 58 by 79 inches (1473 by 2006 mm) **OR** 72 by 96 inches (1828 by 2438 mm), **as directed**.
   c. Extra Drop Length: As needed at top of screen for bottom of screen to be 36 inches (900 mm) above floor and 36 inches (900 mm) at bottom of screen, **as directed**.
4. Electrically Operated, Rear-Projection Screen Type: Surface mounted, metal encased **OR** Surface mounted, wood finished **OR** Suspended, without ceiling closure **OR** Suspended, with automatic ceiling closure, **as directed**.
   a. Motor Configuration: Motor in roller **OR** End-mounted motor on right end of screen **OR** End-mounted motor on left end of screen **OR** End-mounted motor on end of screen indicated, **as directed**.
   b. Screen Type: Wide angle **OR** Moderate gain **OR** High gain, **as directed**.

c. Viewing Surface Size: 50 by 50 inches (1270 by 1270 mm) **OR** 60 by 60 inches (1524 by 1524 mm) **OR** 70 by 70 inches (1778 by 1778 mm) **OR** 84 by 84 inches (2133 by 2133 mm) **OR** 48 by 65 inches (1219 by 1651 mm) **OR** 54 by 72 inches (1371 by 1828 mm) **OR** 58 by 79 inches (1473 by 2006 mm) **OR** 72 by 96 inches (1828 by 2438 mm), **as directed**.
d. Extra Drop Length: As needed at top of screen for bottom of screen to be 36 inches (900 mm) above floor and 36 inches (900 mm) at bottom of screen, **as directed.**

5. Rigid Rear-Projection Screen Type: Optically coated screen.
   a. Screen Substrate: Glass **OR** Acrylic, **as directed.**
   b. Screen Type: Wide angle **OR** Moderate gain **OR** General purpose **OR** High gain, **as directed**.
   c. Optical Tint: High-contrast dark gray **OR** Medium neutral gray **OR** Neutral white, **as directed**.
   d. Size of Viewing Surface: 40 by 54 inches (1016 by 1371 mm) **OR** 43 by 57 inches (1092 by 1447 mm) **OR** 50 by 67 inches (1270 by 1701 mm) **OR** 54 by 72 inches (1371 by 1828 mm) **OR** 60 by 80 inches (1524 by 2032 mm) **OR** 72 by 96 inches (1828 by 2438 mm), **as directed**.
   e. Additional Features: Protective coating **OR** Writing surface coating **OR** Factory frame, **as directed**.
6. Rigid Rear-Projection Screen Type: High-performance screen.
   a. Gain: Not less than 1.5 **OR** 3 **OR** 3.5 **OR** 4 **OR** 5, **as directed**.
   b. Horizontal Half-Gain Angle: At least 20 **OR** 25 **OR** 30 **OR** 50, **as directed**, degrees from screen axis.
   c. Size of Viewing Surface: 40 by 54 inches (1016 by 1371 mm) **OR** 43 by 57 inches (1092 by 1447 mm) **OR** 50 by 67 inches (1270 by 1701 mm) **OR** 54 by 72 inches (1371 by 1828 mm) **OR** 60 by 80 inches (1524 by 2032 mm) **OR** 72 by 96 inches (1828 by 2438 mm), **as directed**.
   d. Additional Features: Factory frame.

END OF SECTION 11 52 13 13

Task	Specification	Specification Description
11 52 13 13	01 22 16 00	No Specification Required
11 52 16 26	01 22 16 00	No Specification Required
11 53 43 00	01 22 16 00	No Specification Required

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SECTION 11 66 13 00 - PLAYGROUND EQUIPMENT AND STRUCTURES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for playground equipment and structures. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
    a. Freestanding playground equipment and structures.
    b. Composite playground equipment and structures.

C. Definitions
1. Fall Height: According to ASTM F 1487, "the vertical distance between a designated play surface and the protective surfacing beneath it."
2. HDPE: High-density polyethylene.
3. IPEMA: International Play Equipment Manufacturers Association.
4. LLDPE: Linear low-density polyethylene.
5. MDPE: Medium-density polyethylene.
6. Use Zone: According to ASTM F 1487, "the area beneath and immediately adjacent to a play structure that is designated for unrestricted circulation around the equipment and on whose surface it is predicted that a user would land when falling from or exiting the equipment."

D. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Show fabrication and installation details for playground equipment and structures.
3. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
    a. Extent of surface systems and use zones for equipment.
    b. Critical heights for playground surface, or fall heights for equipment.
4. Samples: For each type of exposed finish.
5. LEED Submittals:
    a. Product Data for Credit MR 4.1 and MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
        1) Include statement indicating costs for each product having recycled content.
    b. Certificates for Credit MR 7: Chain-of-custody certificates certifying that products specified to be made from certified wood comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
        1) Include statement indicating costs for each certified wood product.
6. Product Certificates: For each type of playground equipment, signed by product manufacturer.
7. Material Certificates: For the following items, signed by manufacturers:
    a. Shop finishes.
    b. Wood Preservative Treatment: Include certification by treating plant that states type of preservative solution and pressure process used, net amount of preservative retained, and compliance with applicable standards.
    c. Recycled plastic.
8. Field quality-control test reports.

9. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for playground equipment.
10. Maintenance Data: For playground equipment and finishes to include in maintenance manuals.
11. Warranty: Special warranty specified in this Section.

E. Quality Assurance
1. Installer Qualifications: An employer of workers trained and approved by manufacturer.
2. Manufacturer Qualifications: A firm whose playground equipment components have been certified by IPEMA's third-party product certification service.
3. Forest Certification: Fabricate designated playground equipment with wood components produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
4. Safety Standards: Provide playground equipment complying with or exceeding requirements in the following:
    a. ASTM F 1487.
    b. CPSC No. 325.
5. Preinstallation Conference: Conduct conference at Project site.

F. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of playground equipment that fail in materials or workmanship within specified warranty period.
    a. Failures include, but are not limited to, the following:
        1) Structural failures.
        2) Deterioration of metals, metal finishes, and other materials beyond normal weathering.
    b. Warranty Period: Two **OR** Five, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Materials
1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
    a. Extruded Bars, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
    b. Cast Aluminum: ASTM B 179.
    c. Flat Sheet: ASTM B 209 (ASTM B 209M).
2. Steel: Comply with the following:
    a. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M, hot-dip galvanized.
    b. Steel Pipe: ASTM A 53/A 53M or ASTM A 135/A 135M standard-weight, hot-dip galvanized.
    c. Steel Tubing: ASTM A 513, cold formed, hot-dip galvanized.
    d. Steel Sheet: ASTM A 1011/A 1011M, hot-dip galvanized not less than G60 (Z180) coating designation.
    e. Perforated Metal: Steel sheet not less than 0.075-inch (1.9-mm) **OR** 0.090-inch (2.3-mm) **OR** 0.120-inch (3.0-mm) uncoated thickness; hot-dip galvanized; manufacturer's standard perforation pattern.
    f. Expanded Metal: Manufacturer's standard carbon-steel sheets complying with ASTM F 1267, Type II (expanded and flattened); deburred after expansion.
    g. Woven Wire Mesh: Manufacturer's standard, with wire complying with ASTM A 510 (ASTM A 510M).
3. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666; Type 304, finished on exposed faces with No. 2B finish.
4. Wood: Surfaced smooth on all sides and all edges rounded, Douglas fir, preservative treated after fabrication **OR** Pine, preservative treated after fabrication **OR** [Western red cedar, as directed.

5. Softwood Plywood: DOC PS 1, Exterior; smooth surfaced with rounded edges**;** preservative treated after fabrication.
6. Opaque Plastic: Color impregnated, UV stabilized, and mold resistant.
   a. Polyethylene: Fabricated from virgin **OR** 96 percent recycled, purified, fractional-melt plastic resin; rotationally molded HDPE, LLDPE, or MDPE with not less than 1/4-inch (6-mm) wall thickness.
7. Transparent Plastic: Abrasion-resistant, UV-stabilized monolithic polycarbonate sheet; clear, colorless; not less than 3/16 inch (5 mm) thick.
8. Chain and Fittings: ASTM A 467/A 467M, Class CS, 4/0 or 5/0, welded-straight-link coil chain; hot-dip galvanized **OR** zinc plated **OR** PVC coated, **as directed**. With commercial-quality, hot-dip galvanized **OR** zinc-plated, **as directed**, steel connectors and swing or ring hangars.
9. Castings and Hangers: Malleable iron, ASTM A 47/A 47M, Grade 32510, hot-dip galvanized.
10. Post Caps: Cast aluminum **OR** color-impregnated, UV-stabilized, mold-resistant polyethylene or polypropylene, **as directed**; color to match posts.
11. Platform Clamps and Hangers: Cast aluminum **OR** zinc-plated steel, not less than 0.105-inch- (2.7-mm-) nominal thickness, **as directed**.
12. Hardware: Manufacturer's standard; commercial-quality; corrosion-resistant; hot-dip galvanized steel and iron, stainless steel, or aluminum; of a secure and vandal-resistant design.
13. Fasteners: Manufacturer's standard; corrosion-resistant; hot-dip galvanized or plated steel and iron, or stainless steel; permanently capped, and theft resistant.

B. Wood-Preservative-Treated Materials
1. Preservative Treatment: Pressure-treat wood according to AWPA C2 (lumber) and AWPA C9 (plywood).
   a. Use preservative chemicals acceptable to authorities having jurisdiction and containing no arsenic or chromium. Use chemical formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
   b. Kiln-dry lumber and plywood after treatment to a maximum moisture content, respectively, of 19 and 15 percent. Do not use materials that are warped or do not comply with requirements for untreated materials.

C. Playground Equipment Fabrication
1. General: Provide sizes, strengths, thicknesses, wall thickness, and weights of components as indicated but not less than required to comply with structural performance and other requirements in ASTM F 1487. Factory drill components for field assembly. Unnecessary holes in components, not required for field assembly, are not permitted. Provide complete play structure, including supporting members and connections, means of access and egress, designated play surfaces, barriers, guardrails, handrails, handholds, and other components indicated or required to comply with referenced standards for equipment indicated.
   a. Composite Play Structure: Provide complete play structure, designed to be modular, linked, and expandable, forming one integral unit for more than one play activity.
2. Metal Frame: Fabricate main-frame upright support posts from metal pipe or tubing with cross-section profile and dimensions as indicated. Unless otherwise indicated, provide each pipe or tubing main-frame member with manufacturer's standard drainable bottom plate or support flange. Fabricate secondary frame members, bracing, and connections from either steel or aluminum.
3. Wood Frame: Fabricate main-frame upright support posts from wood species and with profile and dimensions as indicated. Fabricate secondary frame members, bracing, and connections from wood, steel, or aluminum.
4. Composite Frame: Fabricate main-frame upright support posts from metal and plastic with profile and dimensions as indicated. Fabricate secondary frame members, bracing, and connections from either steel or aluminum.
5. Play Surfaces: Provide manufacturer's standard elevated drainable decks, platforms, landings, walkways, ramps, and similar transitional play surfaces, designed to withstand loads; fabricated from perforated or expanded metal **OR** molded plastic **OR** plastic panel or plank **OR** recycled

polyethylene panel or plank **OR** wood plank, **as directed**, made into floor units with slip-slip-resistant foot surfaces. Fabricate units in manufacturer's standard modular sizes and shapes to form assembled play surfaces indicated.

a. Elevated Play Surfaces: Provide protective devices, completely surrounding play surface except for access openings, if play-surface heights above protective surfacing exceed requirements in ASTM F 1487 **OR** CPSC No. 325**, as directed**.

b. Stepped Play Surfaces: Provide protective infill between stepped platforms.

6. Protective Barriers: Fabricated such that openings within the barrier and between the barrier and the play surface preclude passage of the torso probe according to ASTM F 1487 **OR** CPSC No. 325, **as directed**. Provide barriers designed to minimize the possibility of climbing, free of hand- and footholds, and configured to completely surround the protected area except for access openings. Extend barriers above the protected elevated surface for use by age group indicated. Fabricate from the following:
   a. Welded metal pipe or tubing with vertical bars.
   b. Steel sheet with openings for vision and ventilation.
   c. Metal-pipe or -tubing frame with wire mesh infill panels.
   d. Opaque **OR** Transparent as directed, solid plastic panels with openings.
   e. Vertical wood balusters with metal pipe or tubing or wood frame.
   f. Wood panels with openings for vision and ventilation.
7. Guardrails: Provide guardrails configured to completely surround the protected area except for access openings. Fabricate from welded metal pipe or tubing **OR** metal pipe or tubing, and wood, as directed. Extend guardrails to comply with requirements for use by age group indicated.
8. Handrails: Welded metal pipe or tubing, OD between **0.095 to 1.55 inches (24.1 to 39.4 mm) OR 0.125 inch (3.2 mm)**.
   a. Provide handrails at heights to comply with requirements for use by age group indicated according to ASTM F 1487 **OR** CPSC No. 325.
9. Roofs and Canopies: Manufacturer's standard, designed to be positioned overhead and to discourage and minimize climbing by users.
   a. Fabricated from metal **OR** metal-pipe or -tubing-framed, welded wire **OR** opaque plastic **OR** clear polycarbonate plastic **OR** recycled polyethylene **OR** wood, as directed.
10. Signs: Manufacturer's standard sign panels, fabricated from opaque plastic with graphics molded in **OR** wood with painted graphics, as directed, attached to upright support posts.
   a. Text: As directed.
   b. Colors: As directed.

D. Freestanding Playground Equipment And Structures
1. Swings, Single **OR** Multiple, **as directed**, Axis:
   a. Frame: Galvanized steel **OR** Aluminum pipe or tubing connected frame sections.
      1) Leg Upright(s): Not less than **1-7/8-inch (48-mm) OR 2-3/8-inch (60-mm) OR 3-1/2-inch (89-mm) OR 4-1/2-inch (114-mm) OR 5-inch (127-mm), as directed**
      2) Overhead Beam: Match leg upright **OR** Not less than **2-3/8-inch (60-mm) OR** Not less than **3-1/2-inch (89-mm), as directed.**
      3) Color: As selected from manufacturer's full range].
   b. Frame: Wood connected frame sections with leg upright(s) and overhead beam not less than 4 inches (100 mm) square **OR** 6 inches (152 mm) square **OR** 6 inches (152 mm) round, **as directed**, for legs.
   c. Overhead Beam Height: 96 inches (2440 mm) **OR** 10 feet (3 m) **OR** Height as indicated on Drawings, **as directed**, from pivot point above protective surfacing.
   d. Chain: Standard link **OR** Short link not permitting finger penetration **OR** Manufacturer's standard, **as directed.**
      1) Color: As indicated by manufacturer's designations **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.
   e. Swing Connector: S-hook **OR** Double clevis and bolt link, **as directed**.
   f. Swing Hanger: Galvanized stamped steel clamp and ductile-iron pivot **OR** heavy-duty ductile iron **OR** manufacturer's standard, **as directed**.

g. Swing Seats: Enclosed, full-bucket infant/tot **OR** Half-bucket **OR** U-shaped flexible belt **OR** Rigid rectangular **OR** Rigid disk **OR** Tire seat made from rubber **OR** plastic, as directed.
h. Swing Seats: EPDM rubber **OR** Injection molded plastic, **as directed**, enclosed infant seat **OR** flexible seat **OR** tire, **as directed**.
   1) Color: As indicated by manufacturer's designations **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.
i. Age Appropriateness: Two through five years **OR** 5 through 12 years, **as directed**.

2. Slides: Fabricated from stainless steel **OR** opaque plastic **OR** aluminum, **as directed**.
   a. Configuration: Straight-aligned **OR** Quarter-turn **OR** Half-turn **OR** Three-quarter-turn **OR** Full-turn spiral **OR** S-shaped **OR** Squiggle-shaped descending chute(s), **as directed.**
   b. Access: Stair or step ladder with handrails **OR** Vertical ladder **OR** Vertical ladder with side handrails, **as directed.**
   c. Sit-Down Entrance: With protective barriers **OR** opaque plastic panel barriers **OR** canopy or hood enclosure, **as directed** and overhead handhold and side handholds.
   d. Frame: Manufacturer's standard galvanized-steel pipe or tubing **OR** aluminum pipe or tubing **OR** wood, **as directed**.
   e. Sliding Surface: Inclined **OR** Wavy **OR** Washboard rollers, **as directed**.
   f. Sliding Surface Construction: Flat, continuous stainless-steel sheet with integral, full-length side rails **OR** U-shaped, continuous stainless-steel sheet with integral, full-length side rails **OR** [One-piece plastic with integral, full-length side rails **OR** Plastic tube, ID not less than **24 inches (610 mm) OR** [Plastic tube, ID not less than **30 inches (760 mm), as directed.**
   g. Colors: As selected from manufacturer's full range.
   h. Age Appropriateness: Two through five years **OR** 5 through 12 years, **as directed.**
      1) Color: As indicated by manufacturer's designations **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.
   i. Tube, round, not less than 24-inch (610-mm) **OR** 30-inch (760-mm), **as directed**, diameter.

3. Merry-Go-Rounds: Rotating platform **OR** seating, **as directed**, around a vertical axis.
   a. Rotating Mechanism: Permanently sealed and lubricated ball bearings with hydraulic-speed **OR** mechanical-speed, **as directed**, limiting device.
   b. Platform: Round, dish-shaped **OR** flat **OR** flat, dimpled, **as directed**, steel sheet, not less than 0.1196-inch- (3.038-mm-) nominal thickness, with slip-resistant footing.
      1) Color: As indicated by manufacturer's designations **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.
   c. Handholds and Handrails: Metal pipe or tubing.
      1) Color: As indicated by manufacturer's designations **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.
   d. Capacity: Single user **OR** Two users **OR** Five users, **as directed**.

4. Tunnels (Crawl Tubes): Fabricated from stainless steel **OR** opaque plastic, **as directed**.
   a. Shape: Straight **OR** Curved, quarter turn, **as directed**.
   b. Tube, round, not less than 24-inch (610-mm) **OR** 30-inch (760-mm), **as directed**, diameter.
      1) Color: As indicated by manufacturer's designations **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.

5. Climbers: Fabricated from steel with galvanized **OR** PVC-plastisol, **as directed**, finish.
   a. Horizontal ladder with hand rings, **as directed**.
   b. Vertical fence.
   c. Chain or cable ladder **OR** walks, **as directed**.
      1) Color: As indicated by manufacturer's designations **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.

6. Spring Rocking-Rider **OR** Seesaw, **as directed**:
   a. Seat: Cast aluminum **OR** Molded HDPE or other plastic **OR** Wood, **as directed**; with handholds **OR** handholds and footrests, **as directed**.
      1) Seat Style: as directed by the Owner.
      2) Color: As indicated by manufacturer's designations **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.
   b. Base: One **OR** Two, **as directed**, coil spring(s) with steel base plate.

c. Capacity: Single user **OR** Two users, **as directed**.

E. Composite Playground Equipment And Structures
1. Composite Structure: Fabricated from steel **OR** wood **OR** opaque plastic, **as directed**.
a. Frame: Galvanized steel pipe or tubing frame sections connected with bolts **OR** clamps, **as directed**.
1) Pipe or Tubing: Not less than 4-inch (102-mm) **OR** 5-inch (127-mm), **as directed**, OD legs.
2) Color: As indicated by manufacturer's designations **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.
b. Frame: Wood frame sections connected with bolts.
1) Wood not less than 4 inches (102 mm) square **OR** 6 inches (152 mm) round, **as directed**, for legs.
c. Horizontal Ladder Beam Height: 60 inches (1524 mm) **OR** 84 inches (2130 mm) **OR** Height as indicated on Drawings, **as directed**, above protective surfacing.
1) Steel overhead beam, 2-3/8-inch (60-mm) OD.
2) Wood overhead beam, 6 inches (152 mm) square.
d. Platforms: Perforated metal **OR** Wood **OR** Manufacturer's standard, **as directed**.
1) Color: As indicated by manufacturer's designations **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.
e. Roofs: Perforated metal **OR** Wood **OR** Manufacturer's standard, **as directed**.
1) Color: As indicated by manufacturer's designations **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.
f. Equipment: Include the following play event components:
1) Slide.
2) Crawl tube with spy holes, **as directed**.
3) Horizontal ladder.
4) Log roll.
5) Color: As indicated by manufacturer's designations **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.
g. Accessories: as directed by the Owner.
h. Arrangement: As indicated **OR** Manufacturer's standard, **as directed**.
i. Capacity: 10 **OR** 20, **as directed**, users.
j. Age Appropriateness: 2 through 5 years **OR** 5 through 12 years, **as directed**.

F. Cast-In-Place Concrete
1. Concrete Materials and Properties: Comply with requirements in Division 03 Section "Cast-in-place Concrete" **OR** ACI 301, **as directed**, to produce normal-weight, air-entrained, **as directed**, concrete with a minimum 28-day compressive strength of 3000 psi (20.7 MPa), 3-inch (75-mm) slump, and 1-inch- (25-mm-) maximum-size aggregate.
2. Concrete Materials and Properties: Dry-packaged concrete mix complying with ASTM C 387 and mixed at site with potable water, according to manufacturer's written instructions, to produce normal-weight concrete with a minimum 28-day compressive strength of 3000 psi (20.7 MPa), 3-inch (75-mm) slump, and 1-inch- (25-mm-) maximum-size aggregate.

G. Aluminum Finishes
1. Baked-Enamel Finish: Prepare, treat, and coat metal to comply with paint manufacturer's written instructions and as follows:
a. Thermosetting, modified-acrylic enamel primer/topcoat system complying with AAMA 2603 except with a minimum dry film thickness not less than 1.5 mils (0.04 mm) **OR** 3 to 5 mils (0.076 to 0.127 mm), **as directed**, medium gloss.
2. PVC Finish: Manufacturer's standard, UV-stabilized, mold-resistant, slip-resistant, matte-textured, dipped or sprayed-on, PVC-plastisol finish, with flame retardant added, complying with coating manufacturer's written instructions for pretreatment, application, and minimum dry film thickness of 80 mils (2 mm) **OR** 100 mils (2.5 mm), **as directed**.

3. Color: As indicated by manufacturer's designations **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.

H. Iron And Steel Finishes
1. Galvanizing: Hot-dip galvanize products made from rolled-, pressed-, and forged-steel shapes, castings, plates, bars, and strips indicated to be galvanized to comply with ASTM A 123/A 123M.
   a. Hot-dip galvanize steel and iron hardware indicated to be galvanized to comply with ASTM A 153/A 153M.
   b. Galvanized Steel Sheet: Commercial steel sheet, hot-dip galvanized, complying with ASTM A 653/A 653M for not less than G60 (Z180) coating designation; mill phosphatized.
2. Powder-Coat Finish: Prepare, treat, and coat ferrous metal to comply with resin manufacturer's written instructions and as follows:
   a. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils (0.04 mm).
3. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).
4. PVC Finish: Manufacturer's standard, UV-stabilized, mold-resistant, slip-resistant, matte-textured, dipped or sprayed-on, PVC-plastisol finish, with flame retardant added, complying with coating manufacturer's written instructions for pretreatment, application, and minimum dry film thickness of 80 mils (2 mm) **OR** 100 mils (2.5 mm), **as directed**.
5. Color: As indicated by manufacturer's designations **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.

I. Stainless-Steel Finishes
1. Remove tool and die marks and stretch lines or blend into finish.
2. Bright, Cold-Rolled, Unpolished Finish: No. 2B finish on exposed faces.

1.3 EXECUTION

A. Installation, General
1. General: Comply with manufacturer's written installation instructions, unless more stringent requirements are indicated. Anchor playground equipment securely, positioned at locations and elevations indicated.
   a. Maximum Equipment Height: Coordinate installed heights of equipment and components with finished elevations of protective surfacing. Set equipment so fall heights and elevation requirements for age group use and accessibility are within required limits. Verify that playground equipment elevations comply with requirements for each type and component of equipment.
2. Post and Footing Excavation: Excavate holes for posts and footings as indicated in firm, undisturbed or compacted subgrade soil.
3. Post Set on Subgrade: Level bearing surfaces with drainage fill to required elevation.
4. Post Set with Concrete Footing: Comply with ACI 301 for measuring, batching, mixing, transporting, forming, and placing concrete.
   a. Set equipment posts in **OR** on, **as directed**, concrete footing. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at the correct angle, alignment, height, and spacing.
      1) Place concrete around posts and vibrate or tamp for consolidation. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.
   b. Embedded Items: Use setting drawings and manufacturer's written instructions to ensure correct installation of anchorages for equipment.
   c. Concrete Footings: Smooth top, and shape to shed water.

B. Field Quality Control
1. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
2. Arrange for playground equipment manufacturer's technical personnel to inspect playground and playground equipment and components during installation and, **as directed**, at final completion and to certify compliance with the following:
   a. ASTM F 1487.
   b. CPSC No. 325.
3. Notify the Owner 48 hours in advance of date and time of final inspection.

END OF SECTION 11 66 13 00

SECTION 11 68 13 00 - RECREATIONAL FACILITIES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of recreational facilities. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. Shop Drawings and/or Catalogue Cuts shall be submitted for approval prior to any installation.

1.2 PRODUCTS

A. Materials shall be resistant to corrosion and degradation by ultraviolet rays. Hardware and fittings shall be at least as corrosion-resistant as the materials fastened.
   1. Steel Plates, Pipe, Tubing, Sheets, Wire Ropes, Chains, and Miscellaneous Shapes shall be stainless steel or galvanized steel, even if painted or coated with vinyl or other protective finish. All open pipe and tube ends shall have rain caps.
   2. Wood shall be all-heart cedar, cypress, or redwood or shall be treated with a non-toxic preservative. Wood shall not be used where it will be in direct contact with the ground, unless approved by the Owner.
   3. Fiberglass shall be smooth fiberglass-reinforced polyester with gelcoat coating and shall meet the following minimum physical properties: 22,000 psi (1,550 kg/sq cm) flexural strength, 15,000 psi (1,055 kg/sq cm) tensile strength, and 20,000 psi (1,410 kg sq cm) compressive strength.
   4. Aluminum shall be anodized.
   5. Foundations shall be 3,200 psi (225 kg/sq cm) compressive strength concrete, enforced as required. Provide embedded anchorage items as required,

B. Playground Equipment, including see-saws, slides, swings, whirlers, and monkey bars, shall be prefabricated and designed to withstand the anticipated structural loads.
   1. Exposed Surfaces shall be smooth (except where required to be nonslip) seamless, and nonsplintering.
   2. Steps, Platforms, and Other Flat Surfaces Subject to Foot Traffic shall be non-slip, but not abrasive and shall be formed to exclude or drain away water.
   3. Fastening shall be flush, concealed, or otherwise formed or located to prevent injury to children playing on the equipment.
   4. Slides shall have stainless steel sliding surfaces.

C. Bike Racks shall be mounted, and sections (if rack is sectional) shall be attached with tamper-proof fasteners.

D. Fiberglass Shelters shall be reinforced with steel, aluminum, or wood framework as required. Shelter roof shall be sloped to drain. Fiberglass edges shall be returned so that they are not exposed, Shelters shall be prefabricated and designed to withstand the anticipated live, dead, and wind loads.

1.3 EXECUTION

A. Recreational facilities shall be installed plumb, aligned, and securely anchored to the ground. Adjust equipment with moving parts until operation is smooth and easy.

END OF SECTION 11 68 13 00

Task	Specification	Specification Description
11 68 13 00	11 66 13 00	Playground Equipment And Structures

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SECTION 11 68 23 13 - PLAYING FIELDS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for repair and maintenance of playing fields. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product/material indicated.
2. Shop drawings shall be submitted for approval.

1.2 PRODUCTS

A. Fills required to bring the subgrade of playing surfaces up to required elevation shall be placed in horizontal layers of not more than 8 in. (200 mm) in loose thickness. The top layer of all fills and excavated areas under the playing surfaces shall be compacted to 95 percent maximum density in accordance with ASTM D 698.

B. Sand-Clay Playing Surfaces shall consist of a stone foundation course, a clay foundation course, a wearing course and, where equipped, a drainage filter course, constructed on the prepared subgrade.
1. Stone Foundation Course: A layer at least 3 in. (75 mm) thick of 3/4- to 1-1/2 in. (19 to 38 mm) crushed stone shall be spread over the subgrade or over the drainage filter course constructed thereon and shall be given preliminary compaction by rolling, followed by a filler consisting of 1/4- to 1/2-in. (6 to 13 mm) crushed stone to fill voids in the underlying stone. The stone foundation course shall be compacted to a minimum of 95 percent maximum density in accordance with ASTM D 698.
2. Clay Foundation Course: Selected inorganic fat clay (CH) shall be evenly spread on the stone foundation course to produce a compacted layer not less than 3 in. (75 mm) thick. The clay layer shall be compacted to a minimum of 90 percent of CE 55 maximum density in accordance with ASTM D 698.
3. Wearing Course: The approved inorganic clay-silt mixture of approximately 50 percent each of clay and silt shall be screened through a 1/4-in. (6 mm) mesh screen. The wearing course shall be mixed in proportions of 1 part sand to 2 parts clay-silt by volume. The wearing course shall be compacted to at least 95 percent maximum density in accordance with ASTM D 698 and shall range from 1 to 1-1/2 in. (25 to 38 mm) in thickness.
4. Drainage Filter Course: The drainage filter course shall consist of a well-graded aggregate course encased in a geotextile material and laid in such a manner to allow water to freely drain from the playing surfaces. The geotextile material shall be a woven or non-woven filter material with a minimum permeability of 0.008 in./sec (0.02 cm/sec). The material shall be resistant to mildew, ratting, insects, rodents, and chemicals normally encountered in a subsurface drainage system.

C. Bituminous Concrete Playing Surfaces shall consist of a base course, prime coat, bituminous leveling course, tack coat, surface course, color coating and, where required, a drainage filter course, all constructed on a prepared subgrade. The stabilized-aggregate base course shall be compacted at optimum moisture to at least 95 percent maximum density in accordance with ASTM D 698. Marshall stability shall not be less than 500 pounds (190 kg) and the flow shall not be greater than 20/100 in. (12.7 mm). The bituminous mixture shall be compacted until the voids in the total mix are reduced to less than 4.0 percent by volume.

1. Thickness of Courses: Base course shall be 4 in. (400 mm) thick after compaction. Leveling course shall be 1-1/2 in. (38 mm) thick after compaction unless directed otherwise. Surface course shall be 1 in. (100 mm) thick after Compaction.
2. Color Coating and Marking Paint: After curing of the bituminous surface course, the entire playing surface shall be covered with a color coat as required.

D. Portland Cement Concrete Playing Surfaces:
   1. Aggregate: The nominal aggregate size shall be 1-1/2 in. (38 mm) to No. 4 sieve size and shall conform to ASTM C 33.
   2. Portland Cement: The cement shall conform to ASTM C 150, Type IA or IIA; or ASTM C 595, Type IP-A.
   3. Thickness: Horizontal Portland cement concrete playing surfaces shall consist of concrete slabs 4 inches thick.

E. Maintenance of Sand-Clay Surfaces: Prior to final acceptance, the Contractor shall make one application of 3/4 lb/sq yd (0.4 kg/sq m) of calcium chloride to the sand-clay surface of the entire playing area.

F. Portable Outdoor Bleachers:
   1. Bleachers shall be designed to support a uniformly distributed live load of 100 lb/sq ft (490 kg/sq m) of gross horizontal projection and a horizontal wind load of 30 lbs/sq ft (150 kg/sq ft) of gross vertical projection. All seat and foot plank members shall be designed to support not less than 120 lb/lin ft (150 kg/m).
   2. Wood Seating and Walk Boards shall be preservative-treated and painted.

G. Steel Basketball Poles: Minimum diameter 3-1/2 in. (88 mm); galvanized pipe.

H. Running Track: Gravel and cinders over stone base; compaction to 95 percent of maximum density in accordance with ASTM D 698. One hundred percent by weight of the gravel and cinders shall pass the 3/4-in. (19 mm) screen, and 90 percent of the gravel and cinders shall be retained on the No. 4 screen.

1.3 EXECUTION (Not Used)

END OF SECTION 11 68 23 13

Task	Specification	Specification Description
11 71 00 00	01 22 16 00	No Specification Required

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SECTION 11 82 19 00 - PACKAGED INCINERATORS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of packaged incinerators. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Definitions
   1. Waste Type
      a. Type 0, Trash: A mixture of highly combustible waste such as paper, cardboard cartons, wood boxes, and floor sweepings from commercial and industrial activities. The mixture consists of up to 10 percent by weight plastic bags, coated paper, laminated paper, treated corrugated cardboard, oily rags, and plastic or rubber scraps. This type of waste contains up to 10 percent moisture and not more than 5 percent non-combustible solids, and has a heating value of 8,500 BTU per pound (19,805 kJ/kg) as fired.
      b. Type 1, Rubbish: A mixture of combustible waste such as paper, cardboard cartons, wood scraps, foliage, and floor sweepings from domestic, commercial, and industrial activities. The mixture consists of up to 20 percent by weight restaurant waste, but contains little or no treated paper, plastic, or rubber wastes. This type of waste contains up to 25 percent moisture and not more than 10 percent incombustible solids, and has a heating value of 6,500 BTU per pound (15,145 kJ/kg) as fired.
      c. Type 2, Refuse: An approximately even mixture of rubbish and garbage by weight. This type of waste, common to apartment and residential occupancy, consists of up to 50 percent moisture and not more than 7 percent incombustible solids, and has a heating value of 4,300 BTU per pound (10,019 kJ/kg) as fired.
      d. Type 3, Garbage: Garbage such as animal and vegetable wastes from restaurants, hotels, hospitals, markets, and similar installations. This type of waste contains up to 70 percent moisture and up to not more than 5 percent incombustible solids, and has a heating value of 2,500 BTU per pound (5825 kJ/kg) as fired.
      e. Type 4, Pathological: Human and animal remains, such as organs, animal carcasses, and solid organic wastes from hospitals, laboratories, slaughterhouses, animal pounds, and similar sources. This type of waste contains up to 85 percent moisture and not more than 5 percent incombustible solids, and has a heating value as low as 1,000 BTU per pound (2330 kJ/kg) as fired.
      f. Type 5, Classified: A mixture of highly combustible waste such as paper, plastics, or other items that have been used for intelligence purposes, or deemed sensitive to completing a sensitive mission on behalf of our National security. This mixture consists of up to 10 per cent by weight plastic bags, coated paper, laminated paper, and plastic products. This type waste has approximately zero percent moisture content and non-combustible solids, and has a heating value of 7,000 to 10,000 BTU per pound (16,310 to 23,300 kJ/kg) as fired.

C. Submittals:
   1. Shop Drawings: Equipment installation.
   2. Product Data:
      a. Incinerator
      b. Controls and instruments
   3. Test Reports:
      a. Instrument readings
      b. Computations
      c. Methods

d. Performance
4. Certificates: Incinerator
5. Operation and Maintenance Data: Incinerator

D. Special Tools
1. Equipment specified under this section requiring special tools for assembly, adjustment, setting, or maintenance thereof shall be furnished as standard accessories.

1.2 PRODUCTS

A. Incinerator (Manufactured Units): Provide packaged type controlled-air incinerator capable of burning Type as required to meet project requirements waste suitable for indoor installation, As required to meet project requirements, outdoor installation including totally enclosed electric motors, and corrosion and moisture protection, and equipped for manual **OR** mechanical, **as directed**, loading and operation.

B. Capacity: Burn rate shall be as required to meet project requirements. Ash removal shall be an entire clean-out. Incinerator shall require no more than three ash clean-outs per week. Burnout and cool-down for ash removal shall be accomplished in not more than 72 hours after first ignition and in not more than 20 hours after final load addition during the weekly time period specified herein.

C. Incineration of Classified Material: Incinerator shall reduce paper content to ash. Oxidize or melt other materials containing classified information, to prevent recovery of information for intelligence purposes. Screening ash, manual stoking, manual agitation, or opening of incinerator doors will not be allowed.

D. Stack Emissions: The incinerator shall conform to all Federal, State and local Environmental Protection Agency (EPA) requirements and regulations.

E. Noise Level: Noise level at one foot from each incinerator component shall not exceed 84 decibels, A scale.

F. Electromagnetic Interference Control: Equipment shall conform to Class IIIC electromagnetic interference control and test limit requirements specified in MIL-STD-461.

G. Primary and Secondary Chambers: Incinerator shall consist of a primary combustion chamber for partial burning and conversion of combustible material to gas and a secondary combustion chamber that shall consume combustible gases and entrained combustible particles. Preassemble and mount incinerator in accordance with the manufacturer's instructions. Packaged unit shall include a combustion air fan, primary and secondary burners, air distribution controls, and burner controls. Unit shall be ready for immediate mounting and ready for attachment of fuel, electrical, and vent and water supply connections. Provide lifting eyes.
1. Primary Chamber: Construct primary chamber casing of steel supported by a steel frame and provided with insulation and refractory. Casing shall be not less than 3/16 inch (4.76 mm) sheet steel conforming to ASTM A 569/A 569M and reinforced to withstand internal pressures without deflection or damage to refractory or other components. Construct frame and reinforcing members of steel conforming to ASTM A 36/A 36M. Frame shall be free standing and support the weight of incinerator components, including doors, burners, breeching, stack connections, and appurtenant assemblies without binding or warping. Provide access doors and ports with seals to prevent emission of smoke or admission of significant amounts of air during incinerator operation. Primary chamber shall have no grates, ash clean-out doors, or other openings which would permit leakage of waste fluids.
a. Insulation:
1) The values for minimum thickness of insulation are in the following table:

INSULATION THICKNESS VS. CAPACITY

Capacity (pounds/hour)	(grams/second)	Min. Insulation Thickness (inches)	(mm)
For Walls	For Walls		
Up to 500	Up to 63	2	50.80
500 to 2,000	63 to 252	2 1/2	63.50
For Hearths			
Indoors			
Up to 500	Up to 63	2 1/2	63.50
500 to 2,000	63 to 252	4	101.60
Outdoors		1 1/2	38.10

2) Class 5 block conforming to ASTM C 612, containing no asbestos material, and of such thickness to prevent damage to the foundation due to excessive heat. Insulating cement shall conform to ASTM C 195 or ASTM C 196.

b. Refractory:

1) Values for minimum thickness of refractory:

REFRACTORY THICKNESS VS. CAPACITY

Capacity (pounds/hour)	(grams/second)	Min. Insulation Thickness (inches)	(mm)
For Walls	For Walls		
Up to 500	Up to 63	4 1/4	108
500 to 2,000	63 to 252	4 1/4	108
For Hearths			
Indoors			
Up to 500	Up to 63	4 1/2	114
500 to 2,000	63 to 252	4 1/2	114
Outdoors		2 1/2	63.50

2) Heat-resistant non-asbestos containing clay, plastic or castable type. Attach refractory walls to casing with alloy steel or refractory anchors to form a monolithic structure which will resist heat and support walls with a safety factor of 4.

c. Doors: Provide doors for stoking, clean-out, and charging areas of the incinerator. Construct doors and door frames of cast iron conforming to ASTM A 319 or steel conforming to ASTM A 569/A 569M or ASTM A 36/A 36M. Line doors exposed to flame or direct heat of combustion gases with the same type and thickness of refractory and insulation used in the combustion chamber. Attach refractory to doors to prevent sagging. Refractory shall have tapered edges to clear door frames during movement of swinging doors. Weld alloy steel hooked bars to the door cover to anchor the refractory. Doors shall be safely operable by one person. Temperature of door handles shall permit operation of door without gloves or other protective devices. Interlock charging doors with burners and air supply so that burners and blowers disconnect when door opens. Door closure gasket shall be non-asbestos high-temperature resistant material capable of withstanding expected temperatures. Vertically operated doors shall be counterweighted to require a manual operating force of 30 pounds (134 N) maximum. Guillotine type doors shall lift completely off the seals prior to movement. Provide full swing type doors with an integral smaller feed door having a minimum rectangular clear opening of 24 by 24 inches (610 by 610 mm) or a minimum circular clear opening of 30 inches (762 mm) diameter. Provide doors with hasps or brackets to permit locking. Furnish a lock and two keys for each door on classified waste incinerators.

1) Manual Charging Doors: Provide full swing type doors for batch feeding; guillotine type doors for continuous feeding. Minimum door size of 24 by 24 inches (610 by 610 mm).

2) Mechanical Charging Doors: Guillotine type or sweep type. Provide an inner and outer door. The inner or charging door shall open with operation of the charger. Interlock the inner and outer doors to prevent simultaneous opening during operation of incinerator. Insulate door to combustion chamber of incinerator. Line door with refractory material and anchor as specified herein for refractory. Construct outer door of same materials as exterior casing of incinerator. Provide doors with means for manual operation.

3) Clean-out Doors: Clean-out doors shall provide access for total clean-out and visual inspection of the entire interior of the incinerator and shall not permit leakage of waste fluids.

d. Observation Ports: Provide two observation ports in the primary combustion chamber. Furnish ports with a heat-resistant glass cover or angular steel frame and closure plate with handle for operation without gloves or other protective devices. Ports shall extend from casing exterior to not less than one-half the thickness of the refractory lining. Observation ports shall be gas tight.

e. Test Holes: Fit test holes with standard weight, 2 inch (50 mm) **OR** 4 inch (100 mm), **as directed**, diameter, black steel pipe sleeve welded to casing. Extend sleeve from casing exterior to not less than one-half the thickness of the refractory lining. Form refractory opening from the pipe sleeve end to the interior wall surface to shield the sleeve end from reflected heat. Fit sleeve with a brass screw cap.

f. Solid Hearth: Construct of non-asbestos heat-resistant clay, plastic or castable type. Provide solid hearth for incinerators burning pathological wastes. Provide refractory of sufficient thickness and strength to prevent heat transfer to casing or foundation, not less than 4 1/2 inches (114 mm) in thickness and able to withstand temperatures of 3000 degrees F (1649 degrees C). Hearth shall support not less than twice the hourly burn rate load and shall not permit leakage of waste fluids.

g. Draft Equipment: Capability of providing the correct amount of air to permit controlled combustion through operating range. Equipment shall include forced draft fans, draft gages, dampers, damper actuators, and linkage.

1) Air Ducts: Introduce air for combustion to the primary chamber below the waste material through perforated under-fire air pipes or ducts. Over-fire air shall be controlled with automatic modulating air intake ports for completing combustion of combustible materials in gases, or for reducing operating temperatures. Ducts shall be constructed of sheet steel conforming to ASTM A 569/A 569M. Seams shall be air tight.

2) Fan: Forced draft, multi-blade, forward curved, centrifugal type conforming to CID A-A-59222. Fan shall comply with standards of AMCA 99, applicable to centrifugal furnace fans, and rated for flow rate, pressure, power, speed of rotation, and efficiency in accordance with ANSI/AMCA 210.

3) Damper: Controller-actuated to regulate air to the fan. Construct of wrought sheet steel conforming to ASTM A 569/A 569M, and no less than 1/16 inch (1.59 mm) thick. Damper shall operate without noise or flutter. Actuators shall be electric motor operated, 115 volts ac.

2. Secondary Chamber: Provide with an exterior casing not less than 3/16 inch (4.76 mm steel) conforming to ASTM A 569/A 569M. Refractory lining shall be same type and thickness required for primary chamber walls. Insulation shall be of the same class and thickness used in the primary chamber. Minimum retention time of one second shall be allowed for conditions within normal operating limits.

H. Burners

1. Insert appropriate fuel oil or gas specification section(s) associated with this project. Only allow direct electric spark ignition for burners up to 2,500,000 BTU/hour (732,500 watt). Values of minimum burner input capacity:

SIZE OF BURNERS, (x1000) Watts
Primary Burners

Capacity of Incinerator, (grams/sec)	2490 Min. kJ/kg Refuse	1905 Min. kJ/kg Refuse	1260 Min. kJ/kg Refuse	733 Min. kJ/kg Refuse	293 Min. kJ/kg Refuse	Secondary Burners All Refuse
6.30	350	350	582	815	990	466
12.60	466	466	1282	1631	1980	699
18.90	582	559	1514	2330	3262	932
31.50	699	699	1748	2680	3728	1514
63.00	1282	1282	2563	3845	5126	2330
94.50	1748	1748	3495	5242	6990	3029
126.00	2097	2047	3961	5592	7223	3961
189.00	2563	2563	5126	7689	10252	4893
252.00	3728	3728	7689	11650	15378	6291

SIZE OF BURNERS, (x1000) BTU/Hr
Primary Burners

Capacity of Incinerator, (lb/hr)	8500 Min. BTU/lb Refuse	6500 Min. BTU/lb Refuse	4300 Min. BTU/lb Refuse	2500 Min. BTU/lb Refuse	1000 Min. BTU/lb Refuse	Secondary Burners All Refuse
50	150	150	250	350	425	200
100	200	200	550	700	850	300
150	250	240	650	1,000	1,400	400
250	300	300	750	1,150	1,600	650
500	550	550	1,100	1,650	2,200	1,000
750	750	750	1,500	2,250	3,000	1,300
1,000	900	900	1,700	2,400	3,100	1,700
1,500	1,100	1,100	2,200	3,300	4,400	2,100
2,000	1,600	1,600	3,300	5,000	6,600	2,700

2. Provide gas **OR** oil **OR** combination gas and oil, **as directed**, burners for the primary and secondary combustion chambers. Design burners for natural type gas or No. 2 fuel oil conforming to ASTM D 396. Fuel oil **OR** Gas, **as directed**, piping is covered in Division 23 Section(s) "Facility Fuel-oil Piping" OR "Facility Natural-gas Piping" OR "Facility Liquefied-petroleum Gas Piping", **as directed**. Each burner shall be a complete burner assembly including fuel, control systems, and accessories. Secondary burner shall be capable of maintaining a minimum continuous temperature in the secondary chamber of 1,600 degrees F (871 degrees). Minimum continuous temperature of 1,400 degrees F (760 degrees C) shall be maintained at the roof near the exit of the primary chamber. Burners shall be interrupted type with gas-electric or electrically spark-ignited and regulated by a variable set point indicator-controller adjustable from zero to 3000 degrees F (1649 degrees C) to operate within temperature limits recommended by the manufacturer. Controllers shall be actuated by a thermocouple. Mounting, flame shape, and characteristics of each burner shall be suitable for the incinerator chamber in which the burner is installed. Flame impingement on the incinerator wall will not be permitted. Each burner shall be Factory Mutual listed in FM P7825 and furnished with flame failure protection. Flame safeguard sensor shall be sighted to detect only the burner flame for which it is designed. Furnish burners with manufacturer recommended appurtenances, for a complete installation. Burners shall be removable for inspection, cleaning, adjustment, and maintenance. Locate thermocouples in the

primary and secondary chambers capable of operating at a maximum temperature of 3000 degrees F (1649 degrees C).

I. Controls And Instruments: Control equipment and instruments shall include burners and fan controls, time clocks, relays, operating switches, indicating lights, gages, motor starters, fuses, alarms, circuit elements of control system, and other instruments required for operation. Mount controls and instruments on a single control panel. Control system shall provide on-off control or proportioning control of the primary air supply and fuel supply to the secondary burner. Temperature indicator shall provide a visual indication for safe loading of the incinerator and excessive high temperature conditions which may require control by the operator. Interlock control circuit systems to prevent hazardous conditions, air pollution, and made fail safe.

1. Control Panel: Sheet steel, weather tight, conforming to UL 50. Flush mount controls, instruments, and other equipment at the factory and test the assembly prior to shipment. Furnish a lock and two keys. Identify controls and instruments with nameplates conforming to MIL-DTL-15024. Provide a heater to prevent condensation.
2. Draft Gages: ANSI/ASME B40.1, diaphragm or bellows actuating system and circular scale. The gages shall have a zero adjustment screw. Provide shut-off cocks.
3. Pressure Gages: ANSI/ASME B40.1, single Bourdon tube style, suitable for measuring air pressure.
4. Thermocouples: Provide to measure gas passage temperatures and control burner operation. Provide thermocouples which operation up to 3000 degrees F (1649 degrees C), and accurate within one-half percent of the operating and indicating temperature range.
5. Emissions Monitoring Instrumentation: Provide incinerator and stack monitoring instrumentation for acceptance tests, emissions tests, and monitoring.

J. Stack: Stack shall meet local building and fire protection codes, including local, state, and federal regulations conforming to NFPA 211. Attach a corrosion-resistant steel spark arrestor not less than No. 18 gage, and with 1/2 inch (15 mm) mesh wire screen extending to top of stack and a corrosion-resistant steel weather cap. Provide tests ports for acceptance testing and/or emissions testing and monitoring.

K. Connectors: Provide to connect the incinerator to the stack in accordance with NFPA 211. Locate the connector at a minimum clear vertical distance of eight feet (2.45 mm) above the floor **OR** ground, **as directed**.

L. Charging Method:

1. Manual: Incinerators having a capacity of less than 300 pounds per hour (38 grams per second) should be manually charged. Manual charger shall include a front loading door with minimum dimensions of 24 by 24 inches (610 by 610 mm). Combustion chamber shall operate at negative air pressure when the loading door is open to prevent injury to the operator and the escape of smoke and gases. Provide an interlock to prevent operation of the charger when a predetermined safe operating temperature is exceeded. Locate the charger on the end **OR** side **OR** top, **as directed**, of the incinerator.
2. Mechanical: Incinerators having a capacity of 300 pounds per hour (38 grams per second) or more should be mechanically charged. Provide an automatic mechanical loading device compatible with the incinerator. Flange loader to incinerator. Construct loading device of plate steel conforming to ASTM A 36/A 36M. The loader shall include a single **OR** dual, **as directed**, hydraulic power pack driven by an electric motor conforming to NEMA MG 1. Loader shall include a guillotine type fire door lined with the same thickness refractory as the combustion chamber. The charging chamber shall have a capacity of not less than one cubic yard (0.76 cubic meter). Locate charging chamber access door on top of the loader and hinged. Provide a temperature actuated automatic sprinkler device located inside the loader. Integrate operation of the automatic loader with the control system. An indicating light shall indicate when the incinerator can be charged. Mount light on control box, visible to the operator. When charging chamber door is closed and light on; indicating the incinerator can be charged, the following sequence shall take place when the loader is actuated in the charge mode: (1) fire door opens,

(2) ram pushes material into the incinerator, (3) ram retracts, (4) fire door closes, (5) indicator light signals the loader is ready to be charged. When loader is in the automatic mode of operation, fire door and charging chamber door shall not be allowed to open at the same time. Provide a manual override system so that ram, fire door, or charging chamber door can be operated independently.

3. Firing Tools: Provide firing tools, including shovel, hoe, rake, slice bar, used for firing the incinerator, and firing tool rack. Locate as indicated. Rack shall be steel and include hooks or other means for storing tools.

1.3 EXECUTION

A. Equipment Installation: NFPA 82, as applicable. Combustion air supply and ventilation shall be in accordance with NFPA 54 **OR** NFPA 31, **as directed**.

B. Utility Services Connections: Connect to utility services as directed.

C. Foundation: Foundation shall be of size and strength to support incinerator and extend not less than 3 feet (one meter) beyond incinerator sides, and not less than 8 feet (2.45 meters) on front or side where ashes are removed.

D. Fuel Supply: Install gas appliances and piping in accordance with NFPA 54, as applicable. Install oil burning equipment to conform to the applicable requirements of NFPA 31.

E. Stack Support: Stack support shall be in accordance with paragraph entitled "Stack" of this section, NFPA 82 and NFPA 211, as applicable. Adequate vertical and lateral supports for exterior chimneys shall withstand wind forces of 106 miles per hour (171 km per hour), **unless directed otherwise.**

F. Lubrication: Provide lubrication means for parts of equipment normally requiring lubrication. Where use of high pressure will damage grease seals or other parts, provide pressure release fittings.

G. Treatment And Painting: Provide manufacturer's standard factory applied finish suitable for exterior service.

H. Identification: Fasten an aluminum, brass, or corrosion-resistant steel nameplate to the equipment in a visible location by means of rivets or sheet metal screws. The nameplate shall contain data such as the manufacturer's name, model, or series number; electrical requirements; and serial number. The information shall be indented or embossed in the metal. The nameplate shall not be painted over.

I. Field Quality Control

1. General: Upon delivery to the job site, equipment and materials shall receive a preliminary inspection by the the Owner. Inspection will be continued during installation, after installation, and during tests. Inspections shall be made to assure equipment and installation comply with local, state, federal, and utility requirements for equipment, air pollution, and safety. Furnish labor, equipment, apparatus, and materials for testing, except waste materials used for testing. the Owner will supply waste material, fuel oil, gas, water, and electricity. Rectify defects disclosed by tests, and repeat tests. Two instruction manuals shall be available during tests. Perform tests under direct supervision of the start-up engineer employed by the Contractor. The the Owner shall be present for tests. Reports certifying instrument readings indicated are actual, computations required for testing are accurate, acceptable methods were used, and units satisfactory performed in accordance with requirements shall be furnished.
2. Tests
   a. Fuel Systems: Remove gages and apparatus that may be damaged by test pressure from the system prior to testing. Maintain required test pressure for not less than two hours to provide sufficient time for inspection of joints and connections. Correct defects which

develop during testing and retest piping system until system shows no defects or weakness.

1) Oil: Test oil piping systems with a hydrostatic pressure of one and one-half times the maximum working pressure.

2) Gas: Pneumatically test gas piping systems tested at operating pressure. Use the soap bubble method to verify the tightness of the system.

b. Performance: Preheat incinerator for four hours to reach the firing temperature of 1800 degrees F (982 degrees C). Weight the waste charges and provide a record of the total charge weight. Charge incinerator with the Owner provided waste at rated capacity in lb/hr (kg/sec) for a period of four hours. Operate incinerator in accordance with manufacturer's written instructions. Waste shall be reduced to a fine ash residual. Follow normal burnout procedure. Weigh residue after incinerator has cooled. Weight of residue shall not exceed 5.0 percent charge weight.

1) Clean-out: Residue from burning classified material shall be hand sorted or screened into three categories; totally oxidized white or off-white ash, unburned materials, and blackened or partially burned paper fragments. Clean-out and sorting shall be witnessed by the the Owner. Inspect materials to verify that the requirements in paragraph entitled "Incineration" of Classified Materials, are met. After clean-out, inspect incinerator for deterioration such as slagged or spalling refractory, warping of parts, and discolored exterior paint. Unit will be rejected until these conditions are repaired and do not recur in retesting. Such procedures that may create respirable dust shall require use of a OSHA certified dust respirator.

c. Control: Test incinerator under actual firing conditions. Test shall verify controls function within maximum and minimum limits for temperature or timing. Simulate actual unsafe conditions such as high temperatures and flame failure by reducing settings for the activation of limit and safety controls.

d. Shell Temperature: Operate incinerator under normal load conditions for not less than four hours. Record temperature readings of the outer shell at not less than five random locations of the secondary chamber. Shield incinerators installed outdoors from direct rays of the sun.

END OF SECTION 11 82 19 00

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SECTION 11 82 26 00 - WASTE COMPACTORS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for waste compactors. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes waste compactors and diverters.

C. Definitions
1. WASTEC Rating: The volume of waste material in the charging chamber moved by the ram within the compactor in a single stroke.

D. Submittals
1. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, furnished specialties and accessories, and finishes.
2. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work.
   a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   b. Dimensions locating chutes that interface with waste compactors.
   c. Location and installation details of automatic sprinkler in hopper of each chute-fed compactor.
   d. Equipment access points and required space for equipment service and operation.
   e. Setting drawings, templates, and instructions for installing anchor bolts and other anchorages.
   f. Wiring Diagrams: For power, signal, and control wiring.
3. Qualification Data: For qualified Installer.
4. Product Certificates: For each type of waste compactor, from manufacturer.
5. Field quality-control reports.
6. Operation and Maintenance Data: For waste compactors to include in operation and maintenance manuals.

E. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
2. Waste Compactor Standards: Comply with ANSI Z245.2 and with NFPA 82.
3. Waste Bin and Hopper Standard: Comply with ANSI Z245.30.

F. Maintenance Service
1. Initial Maintenance Service: Beginning at Final Completion, provide 12 months' full maintenance by skilled employees of waste compactor Installer. Include monthly preventive maintenance, repair, or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper waste-compactor operation at rated speed and capacity. Provide parts and supplies the same as those used in the manufacture and installation of original equipment.
2. Continuing Maintenance Proposal: From Installer to the Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.2 PRODUCTS

A. Waste Compactors

1. Waste Compactors: Manufacturer's standard vertical **OR** stationary horizontal **OR** self-contained horizontal **OR** combination-container **OR** vertical **OR** pivoting-ram type, **as directed,** packaged units with components, options, and accessories needed to comply with requirements and provide complete functional systems.
   a. WASTEC Rating Size (Volume): Minimum: 0.14 cu. yd. (0.11 cu. m) **OR** 1.00 cu. yd. (0.77 cu. m) **OR** 1.50 cu. yd. (1.15 cu. m) **OR** 2.00 cu. yd. (1.53 cu. m) **OR** 3.50 cu. yd. (2.68 cu. m) **OR** 5.00 cu. yd. (3.82 cu. m) **OR** 7.50 cu. yd. (5.73 cu. m) **OR** 10.00 cu. yd. (7.65 cu. m), **as directed**.
   b. Clear Top Opening (Length by Width) Minimum: 20 by 28 inches (508 by 711 mm) **OR** 24 by 36 inches (610 by 914 mm) **OR** 30 by 48 inches (762 by 1219 mm) **OR** 60 by 48 inches (1524 by 1219 mm) **OR** 108 by 72 inches (2743 by 1829 mm), **as directed**.
   c. Cycle Time: Maximum 30 **OR** 40 **OR** 50 **OR** 60 **OR** 70 seconds, as directed.
   d. Discharge Opening (Width by Height): Maximum: **As directed.**
   e. Minimum Discharge Opening: **As directed.**
   f. Ground Height: Minimum **As directed.**
   g. Ram Face: **As directed.**
   h. Ram Penetration: 6 inches (152 mm) **OR** 14 inches (355 mm) **OR** 30 inches (762 mm), **as directed**.
   i. Normal/Maximum Result Ram Forces: 20,000/22,000 lbf (89/98 kN) **OR** 36,000/40,000 lbf (160/178 kN) **OR** 70,000/80,000 lbf (311/356 kN) **OR** 125,000/150,000 lbf (556/667 kN), **as directed**.
   j. Normal/Maximum System Pressures: 1600/1800 psi (11.0/12.4 MPa) **OR** 2000/2400 psi (13.8/16.5 MPa) **OR** 2500/2800 psi (17.2/19.3 MPa), **as directed**.
   k. Scale Weight. Maximumt: 2500 lb (1134 kg) **OR** 6000 lb (2722 kg) **OR** 12,000 lb (5443 kg) **OR** 20,000 lb (9072 kg), **as directed**.
   l. Motor Size: 3 hp **OR** 10 hp **OR** 15 hp **OR** 20 hp **OR** 30 hp **OR** 50 hp, **as directed**.
   m. Electrical Power Supply: 120 **OR** 208 **OR** 240 **OR** 480 V, 1 **OR** 3 phase, **as directed**, 60 Hz.
   n. Controls: **As Directed.**
   o. Finish: Manufacturer's standard **OR** as selected by the Owner.
   p. Deodorizing Device: Manufacturer's standard **OR** as selected by the Owner.
2. Diverter: Compactor Manufacturer's standard **OR** as selected by the Owner coordinated with chute dimensions and designed to divert waste from one chute into two compactors, with chute-relay controls and finished to match compactor or as directed by the Owner.
3. Number of Extra Storage Containers: One **OR** Two, **as directed**.

B. Fabrication

1. Fabricate waste compactors with smooth, eased, exposed edges to prevent injury to persons in vicinity of the equipment.
2. Fabricate containers, hoppers, compaction chambers, unit bodies, and similar components of steel with welded joints. Reinforce with steel members sized and spaced to withstand impacts and pressures of normal operations and to prevent deformation.
3. Fabricate equipment with replaceable parts at points of normal wear.
4. Fabricate liquidtight compactor baffles to stop liquid from leaking out.
5. Fabricate diverter to fit chute and properly align with compactor hoppers.

1.3 EXECUTION

A. Examination

1. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, clearances, service rough-ins, and other conditions affecting performance of waste-compactor work.
2. Examine walls, floors, and chutes for suitable conditions where each waste compactor will be installed.
3. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
4. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation
1. Install each waste compactor according to manufacturer's written instructions, ANSI Z245.2, and ANSI Z245.21 including annexes.
2. Install automatic sprinkler in hopper of each chute-fed compactor according to NFPA 82.
3. Set waste compactors level, plumb, properly aligned, and securely in place. Anchor as required for secure operation.
4. Install diverter to chute and properly align with compactor hoppers.

C. Field Quality Control
1. Perform tests and inspections.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Tests and Inspections:
   a. Perform installation and startup checks according to ANSI Z245.21, Annex D, "Tests for Evaluation of Equipment and Performance," and manufacturer's written instructions.
   b. Test and adjust controls, alarms, and safeties. Replace damaged and malfunctioning controls and equipment.
   c. Verify unrestricted access to each firefighting access door or fire port required by ANSI Z245.21 and NFPA 82 for compactor container(s).
   d. Verify correct locations, color-coding, and legibility of caution, warning, and danger markings.
   e. Certify compliance with test parameters.
3. A waste compactor will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

END OF SECTION 11 82 26 00

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Task	Specification	Specification Description
11 82 26 00	11 21 63 00	Food Service Equipment
11 97 26 00	10 86 00 00	Detention Furniture

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SECTION 11 98 12 00 - DETENTION ENCLOSURES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for detention enclosures. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Bar-grille assemblies.
   b. Woven-rod-mesh assemblies.
   c. Security grilles and vents.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
   a. Product Data for Credit MR 4.1 and Credit MR 4.2: Indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content.
      1) Include statement indicating costs for each product having recycled content.
3. Shop Drawings: For detention enclosures. Include plans, elevations, sections, details, and attachments to other work.
   a. Indicate requirements for cast-in anchors to be installed as work of other Sections.
4. Samples: For units with factory-applied color finishes.
5. Samples for Verification:
   a. Include 12-by-12-inch (305-by-305-mm) cut-away corner section of bar-grille assembly, constructed of specified round and flat bars, showing fabrication techniques and workmanship.
   b. Include 12-by-12-inch (305-by-305-mm) cut-away corner section of woven-rod-mesh assembly, constructed of specified framing and woven-rod panel, showing fabrication techniques and workmanship.
   c. Include one full-size security grille and vent unit.
6. Welding certificates.
7. Material Certificates.
8. Material Test Reports: For tool-resisting steel.
9. Mill Certificates: For tool-resisting steel rods.
10. Maintenance Data.
11. Other Informational Submittals:
   a. Examination reports documenting inspections of substrates, areas, and conditions.
   b. Anchor inspection reports documenting inspections of built-in and cast-in anchors.
   c. Field quality-control reports documenting inspections of installed products.
   d. Field quality-control certification signed by Contractor and Detention Specialist.

D. Quality Assurance
1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation and maintenance of units required for this Project.
2. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing tool-resisting steel.
3. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. AWS D1.3, "Structural Welding Code - Sheet Steel."
   c. AWS D1.6, "Structural Welding Code - Stainless Steel."
4. Preinstallation Conference: Conduct conference at Project site.

1.2 PRODUCTS

A. Materials
1. Recycled Content of Steel Products: Provide products with average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 **OR** 60, **as directed**, percent.
2. Mild Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
3. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, CS (Commercial Steel), Type B, suitable for exposed applications.
4. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, CS (Commercial Steel), Type B; free of scale, pitting, or surface defects; pickled and oiled.
5. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, CS (Commercial Steel), Type B; with G60 (Z180) zinc (galvanized) or A60 (ZF180) zinc-iron-alloy (galvannealed) coating designation.
6. Steel Tubing: ASTM A 501 or ASTM A 513, Type B unless otherwise indicated.
7. Tool-Resisting Steel Round and Flat Bars: ASTM A 627.
8. Tool-Resisting Steel Round Rods: Fabricated from material with same chemical and physical properties as tool-resisting steel round bars.
9. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666 or ASTM A 240/A 240M, austenitic stainless steel, Type 304.
10. Security Fasteners: Operable only by tools produced by fastener manufacturer or other licensed fabricator for use on specific type of fastener. Drive-system type, head style, material, and protective coating as required for assembly, installation, and strength, and as follows:
    a. Drive-System Type: Pinned Torx-Plus **OR** Pinned Torx, **as directed**.
    b. Fastener Strength: 120,000 psi (827 MPa).
    c. Socket Button Head Fasteners:
        1) Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
        2) Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.
    d. Socket Flat Countersunk Head Fasteners:
        1) Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
        2) Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.
    e. Socket Head Cap Fasteners:
        1) Heat-treated alloy steel, ASTM A 574 (ASTM A 574M).
        2) Stainless steel, ASTM F 837 (ASTM F 837M), Group 1 CW.
    f. Protective Coatings for Heat-Treated Alloy Steel:
        1) Zinc and clear trivalent chromium where indicated.
        2) Zinc phosphate with oil, ASTM F 1137, Grade I, or black oxide unless otherwise indicated.
11. Concealed Bolts: ASTM A 307, Grade A unless otherwise indicated.
12. Cast-in-Place Anchors in Concrete: Fabricated from corrosion-resistant materials capable of sustaining, without failure, a load equal to four times the load imposed, as determined by testing per ASTM E 488, conducted by a qualified testing agency; of type indicated below.
    a. Threaded or wedge type; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed; hot-dip galvanized per ASTM A 153/A 153M or ASTM F 2329.
13. Embedded Plate Anchors: Fabricated from mild steel shapes and plates, minimum 3/16 inch (4.8 mm) thick; with minimum 1/2-inch- (12.7-mm-) diameter, headed studs welded to back of plate.
14. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Bar-Grille Assemblies
1. Tool-Resisting Steel Bar Grilles: ASTM A 627, Grade 1 **OR** Grade 2, **as directed**.
    a. Vertical Bars: 1-inch- (25.4-mm-) diameter, double-ribbed, round **OR** hexagonal, **as directed**, composite tool-resisting steel bars at 4 inches (102 mm) **OR** 5 inches (127 mm) **OR** 6 inches (152 mm), **as directed**, o.c.

b. Horizontal Flat Bars: 3/8-by-2-1/2-inch (9.6-by-63.5-mm) composite tool-resisting steel flat bars at 12 inches (305 mm) **OR** 18 inches (457 mm), **as directed**, o.c.
c. Perimeter Framing: 3/8-by-2-1/2-inch (9.6-by-63.5-mm) composite tool-resisting steel flat bars.

2. Tool-Resisting Steel Bar Grilles: ASTM A 627, Grade 3.
   a. Vertical Bars: 1-inch- (25.4-mm-) diameter, double-ribbed, round **OR** hexagonal, **as directed**, homogeneous tool-resisting steel bars at 4 inches (102 mm) **OR** 5 inches (127 mm) **OR** 6 inches (152 mm), **as directed**, o.c.
   b. Horizontal Flat Bars: 5/16-by-2-1/4-inch (7.9-by-57.2-mm) homogeneous tool-resisting steel flat bars at 12 inches (305 mm) **OR** 18 inches (457 mm), **as directed**, o.c.
   c. Perimeter Framing: 5/16-by-2-1/4-inch (7.9-by-57.2-mm) homogeneous tool-resisting steel flat bars.
3. Tool-Resisting Steel Bar Grilles: ASTM A 627, Grade 4.
   a. Vertical Bars: 7/8-inch- (22.2-mm-) diameter, double-ribbed, round **OR** hexagonal, **as directed**, homogeneous tool-resisting steel bars at 4 inches (102 mm) **OR** 5 inches (127 mm) **OR** 6 inches (152 mm), **as directed**, o.c.
   b. Horizontal Flat Bars: 1/4-by-2-inch (6.4-by-50.8-mm) homogeneous tool-resisting steel flat bars at 12 inches (305 mm) **OR** 18 inches (457 mm), **as directed**, o.c.
   c. Perimeter Framing: 1/4-by-2-inch (6.4-by-50.8-mm) homogeneous tool-resisting steel flat bars.
4. Mild Steel Bar Grilles:
   a. Vertical Bars: 7/8-inch- (22.2-mm-) diameter, double-ribbed, round **OR** hexagonal, **as directed**, mild steel bars at 4 inches (102 mm) **OR** 5 inches (127 mm) **OR** 6 inches (152 mm), **as directed**, o.c.
   b. Horizontal Flat Bars: 3/8-by-2-1/4-inch (9.5-by-57-mm) mild steel flat bars at 12 inches (305 mm) **OR** 18 inches (457 mm), **as directed**, o.c.
   c. Perimeter Framing: 3/8-by-2-1/4-inch (9.5-by-57-mm) mild steel flat bars.
5. Finish: Factory primed for field painting.

C. Woven-Rod-Mesh Assemblies
1. Main Framing: Formed from 1-1/2-by-2-1/2-inch (38-by-63.5-mm) built-up tubular steel consisting of an open channel with fixed concealment plates.
   a. Open Channel: Formed from 0.134-inch (3.42-mm) **OR** 0.105-inch (2.66-mm), **as directed**, nominal-thickness steel sheet or channel with individual slots along inner edges to support woven-rod panels.
   b. Concealment Plates: Steel sheet to match open channel.
2. Supplementary Framing: Formed from 2-inch-square by 3/16-inch- (51-mm-square by 4.8-mm-) thick steel tubing.
3. Braces: Formed from same material as main framing.
4. Woven-Rod Panels: Formed from double crimped, 1/4-inch- (6-mm-) **OR** 3/8-inch- (9.5-mm-), **as directed**, diameter steel rod, woven horizontally and vertically into a rigid grille with rods at 2 inches (51 mm) o.c.
   a. Steel Rod for Galvanized Assemblies: Mild **OR** Homogeneous tool-resisting, **as directed**, steel.
   b. Steel Rod for Nongalvanized Assemblies: Mild **OR** Homogeneous tool-resisting, **as directed**, steel.
5. Floor Anchor Clips: 2-by-2-by-3/16-inch (51-by-51-by-4.8-mm) mild steel angles for straight framing; 1-1/2-by-1-1/2-by-3/16-inch (38-by-38-by-4.8-mm) mild steel angles for corners.
6. Floor Anchors: 2-inch-square by 3/16-inch- (51-mm-square by 4.8-mm-) thick, mild steel tubing sleeve welded to 6-inch-square by 3/16-inch- (152-mm-square by 4.8-mm-) thick, mild steel plate.
7. Wall and Ceiling Anchorage and Trim: Continuous 2-by-2-by-3/16-inch (51-by-51-by-4.8-mm) mild steel angle with 2-by-3/16-inch (51-by-4.8-mm) mild steel flat bar.
8. Finishes:
   a. Exterior Locations: Hot-dip galvanized after fabrication. Factory primed for field painting.
   b. Interior Locations: Factory primed for field painting. Hot-dip galvanized after fabrication where indicated.

D. Security Grilles And Vents
1. Security Grilles:
a. Face Frame: 3/16-inch- (4.8-mm-) thick, mild **OR** homogeneous tool-resisting, **as directed**, steel flat bar.
b. Wire Mesh: 0.135-inch- (3.5-mm-) diameter steel wire woven into a 3/8-inch (9.5-mm) mesh, attached to perimeter frame by bolts or studs **OR** welding, **as directed**.
c. Perimeter Frame: 3/16-inch- (4.8-mm-) thick, mild steel flat bar with anchor studs **OR** masonry anchors, **as directed**, welded to back.
d. Vertical Bars: 7/8-inch- (22-mm-) **OR** 1-inch- (25-mm-), **as directed**, diameter, double-ribbed, round **OR** hexagonal, **as directed**, homogeneous tool-resisting steel bars at 4 inches (102 mm) o.c., welded to vertical bar supports.
e. Vertical Bar Supports: 2-1/2-by-3/8-inch- (63.5-by-9.5-mm-) thick, mild steel bars welded to perimeter frame.
f. Finish: Factory primed for field painting.
2. Perforated-Plate Security Vents:
a. Faceplate: 3/16-inch- (4.8-mm-) thick, mild steel **OR** stainless-steel, **as directed**, plate; with 5/16-inch (7.9-mm) round holes staggered 7/16 inch (11 mm) o.c. in each direction.
b. Opening Sleeve: 3/16-inch- (4.8-mm-) thick steel plate welded to faceplate.
c. Perimeter Frame: 1-by-1-by-3/16-inch- (25-by-25-by-4.8-mm-) thick, mild steel angles.
d. Provide anchor studs welded to back of faceplate for installation into concrete.
e. Finish: Factory primed for field painting **OR** No. 4 **OR** No. 2B, **as directed**.
f. Damper: Front-operated **OR** Rear-operated, **as directed**, opposed-blade type.
3. Perforated-Plate Security Vents with Wire Mesh:
a. Faceplate: 0.075-inch (1.90-mm) nominal-thickness, mild steel **OR** 0.078-inch- (1.98-mm-) thick, stainless-steel, **as directed**, sheet; with 3/4-inch- (19-mm-) square perforations 1/4 inch (6 mm) apart in each direction.
b. Wire Mesh: 0.062-inch- (1.6-mm-) diameter steel wire woven into a 1/4-inch (6-mm) mesh, welded to opening sleeve behind faceplate.
c. Opening Sleeve: 0.075-inch (1.90-mm) nominal thickness, formed from steel sheet and welded to faceplate.
d. Finish: Factory primed for field painting **OR** No. 4 **OR** No. 2B, **as directed**.
e. Damper: Front-operated **OR** Rear-operated, **as directed**, opposed-blade type.
4. Perforated-Plate Security Vents with Backup Plate:
a. Faceplate: 3/16-inch- (4.8-mm-) thick, mild steel **OR** stainless-steel, **as directed**, plate; with 2-inch- (51-mm-) square perforations 1 inch (25 mm) apart in each direction.
b. Wire Mesh: 0.135-inch- (3.5-mm-) diameter steel wire woven into a 3/8-inch (9.5-mm) mesh, secured between faceplate and backup plate.
c. Backup Plate: 1/4-inch- (6-mm-) thick, mild steel plate with perforations matching faceplate.
d. Perimeter Frame: 1-by-1-by-3/16-inch- (25-by-25-by-4.8-mm-) thick, mild steel angles.
e. Opening Sleeve: 0.134-inch (3.42-mm) nominal thickness, formed from steel sheet and welded to faceplate.
f. Finish: Factory primed for field painting **OR** No. 4 **OR** No. 2B, **as directed**.
g. Damper: Front-operated **OR** Rear-operated, **as directed**, opposed-blade type.
5. Tool-Resisting Steel, Perforated-Plate Security Vents:
a. Faceplate: 1/4-inch- (6-mm-) thick, homogeneous tool-resisting steel plate; with 2-inch- (51-mm-) square perforations 1 inch (25 mm) apart in each direction.
b. Wire Mesh: 0.135-inch- (3.5-mm-) diameter steel wire woven into a 3/8-inch (9.5-mm) mesh, attached to faceplate by bolts or studs.
c. Backup Plate: 1/4-inch- (6-mm-) thick, homogeneous tool-resisting steel plate with perforations matching faceplate.
d. Perimeter Frame: 3/16-inch- (4.8-mm-) thick, mild steel flat bar with anchor studs **OR** masonry anchors, **as directed**, welded to back.
e. Finish: Factory primed for field painting.

6. Anchors: Unless otherwise indicated, provide minimum 1/2-inch- (12.7-mm-) diameter, headed stud anchors at 12 inches (305 mm) o.c.

E. Fabrication, General
1. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
2. Coordinate dimensions and attachment methods of detention enclosures with those of adjoining construction to produce integrated assemblies with closely fitting joints and with edges and surfaces aligned unless otherwise indicated.
3. Shear and punch metals cleanly and accurately. Remove burrs.
4. Form and grind edges and corners to be free of sharp edges or rough areas.
5. Form metal in maximum lengths to minimize joints. Form sheet-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.
6. Weld corners and seams continuously to comply with referenced AWS standard and the following:
   a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   b. Obtain fusion without undercut or overlap.
   c. Remove welding flux immediately.
   d. Finish exposed welds and surfaces smooth and blended at exposed connections so that no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
   e. Weld before finishing components to greatest extent possible. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
7. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure detention enclosures rigidly in place and to support indicated loads. Build in straps, plates, and brackets as needed to support and anchor fabricated items to adjoining construction. Reinforce formed-metal units as needed to attach and support other construction.
8. Cut, reinforce, drill, and tap detention enclosures as indicated to receive hardware, security fasteners, and similar items.
9. Form exposed work true to line and level with accurate angles, surfaces, and straight sharp edges.
10. Form exposed connections with hairline joints flush and smooth using concealed fasteners where possible. Use exposed security fasteners of type indicated or, if not indicated, flat-head (countersunk) security screws. Locate joints where least conspicuous.
11. Exterior Detention Enclosures: Allow for thermal movements from ambient and surface temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
    a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

F. Fabrication Of Bar-Grille Assemblies
1. General: Fabricate bar-grille assemblies with materials and to sizes and configurations indicated, complete with mounting flanges and anchors.
   a. Pass vertical round bars through, and positively interlock them with, horizontal flat bars at each intersection without reducing circumference of round bars at these intersections and without using pipe sleeves, swedging, calking, or interlocks that depend on friction. Weld vertical round bars at each intersection with flat bars.
   b. Pass ends of round bars at least 1 inch (25 mm) through framing, and weld bars to framing from back side of framing.
   c. Fabricate cutouts and openings in bar-grille assemblies for penetrations of sizes and at locations indicated. Frame openings with flat bars of same material and size as horizontal flat bars.

d. Frame connections with plates; use flat bars of same material and size as horizontal flat bars.

2. Partitions: Connect top horizontal flat bar to vertical flat bar framing members with 2-by-2-by-1/4-inch- (51-by-51-by-6-mm-) thick, steel plate angle knee welded into place. Connect intersections of horizontal flat bars with vertical flat bar framing members by 3/16-inch (4.8-mm) fillet welds. Weld vertical bars securely to top and bottom flat bar framing members.
3. Doors: Fabricate swinging **OR** sliding, **as directed**, doors of same type bar-grille assembly as bar-grille partition in which they are installed. Weld lockbox at lock jamb of door, fabricated of steel plate to match horizontal flat bars. Comply with requirements in Division 08 Section "Detention Door Hardware" for detention hinges and detention locks and latches.
   a. Food-Pass Openings: Frame top and sides of opening with flat bar of same quality and size as horizontal flat bars. Weld 1/4-inch- (6-mm-) thick steel plate shelf, of same quality as horizontal flat bars, at bottom of opening.

G. Fabrication Of Woven-Rod-Mesh Assemblies
1. Main Framing: Before inserting woven-rod panels, weld and grind smooth corners of open channel elements. Fabricate partitions taller than 12 feet (3.6 m) from multiple panels stacked on top of one another.
2. Woven-Rod Panels: Insert panels symmetrically in main framing. Extend end of each rod at least 1 inch (25 mm) into main framing and, from inside of channel, weld into each slot where it contacts main framing.
3. Concealment Plates: Weld plates to main framing with minimum 1 inch (25 mm) welds at minimum 10 inches (254 mm) o.c., staggered side to side and ground smooth, to form a fully enclosed tubular steel frame.
4. Anchor Clips: For each enclosure panel, weld one anchor clip to secure side of main framing in line with vertical framing.
5. Swinging Doors: Fabricate doors with framing on four sides of door from same material as adjacent panels and with 2-by-1/4-inch (51-by-6-mm) flat steel bar astragal continuous on lock jamb. Align bottom of door with bottom of adjacent panels. Comply with requirements in Division 08 Section "Detention Door Hardware" for detention hinges and detention locks and latches.
6. Sliding Doors: Fabricate doors with framing on four sides of door from same material as adjacent panels. Align bottom of door with bottom of adjacent panels. Comply with requirements in Division 08 Section "Detention Door Hardware" for sliding detention door device assemblies and detention locks and latches.
7. Hardware Preparation: Mortise, reinforce, drill, and tap doors and main framings for templated hardware to comply with approved Door Hardware Schedule. Frame openings to receive detention door locks.
8. Fabricate joints that will be exposed to weather in a manner to exclude water, and provide weep holes where water may accumulate.

H. Fabrication Of Security Grilles And Vents
1. General: Fabricate security grilles and vents with materials and to sizes and configurations indicated, complete with mounting flanges and anchors.
2. Security Grilles:
   a. Orient axis of ribs of each tool-resisting steel bar to run parallel to airflow.
   b. Pass vertical round bars through, and positively interlock them with, vertical bar supports without reducing circumference of round bars at these intersections and without using pipe sleeves, swedging, calking, or interlocks that depend on friction.
   c. Pass round bars at least 1 inch (25 mm) through vertical bar supports, and weld bars to supports from back side of supports.
3. Where bolts are used to secure wire mesh, batter threads to prevent nut removal.

I. Steel Finishes
1. Steel and Galvanized-Steel Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.

2. Steel and Galvanized-Steel Factory Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.

J. Stainless-Steel Finishes
   1. Surface Preparation: Remove tool and die marks and stretch lines or blend into finish.
   2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
      a. Run grain of directional finishes with long dimension of each piece.
      b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
      c. Directional Satin Finish: No. 4.
   3. Bright, Cold-Rolled, Unpolished Finish: No. 2B.

1.3 EXECUTION

A. Installation, General
   1. Install detention enclosures plumb, rigid, properly aligned, and securely fastened in place, complying with manufacturer's written recommendations.
   2. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing detention enclosures to in-place construction. Include threaded fasteners for inserts, security fasteners, and other connectors.
      a. Proprietary Built-in Masonry Anchors: Install integral with unit masonry. Comply with requirements in Division 04 Section "Unit Masonry".
   3. Cutting, Fitting, and Placement: Obtain manufacturer's written approval for cutting, drilling, and fitting required for installing detention enclosures. Set detention enclosures accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
   4. Provide temporary bracing or anchors in formwork for items that are to be built into adjacent construction.
   5. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
   6. Field Welding: Comply with the following requirements:
      a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
      b. Obtain fusion without undercut or overlap.
      c. Remove welding flux immediately.
      d. Finish exposed welds and surfaces smooth and blended at exposed connections so that no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

B. Installation Of Bar-Grille Assemblies
   1. Wall and Ceiling Anchorage: Weld framing to continuous angles with continuous welds. Anchor angles to embedded anchors by bolting **OR** welding, **as directed**.
   2. Partitions: Weld adjacent framing members to each other with continuous 1/4-inch- (6-mm-) deep welds on both sides; grind smooth.
   3. Doors: Install 2 inches (51 mm) above finish floor. Adjust to operate easily without binding.

C. Installation Of Woven-Rod-Mesh Assemblies
   1. Floor Anchorage: Fasten anchor clips to floor with 3/8-inch- (9.5-mm-) diameter bolts with double-expansion shields.

2. Wall and Ceiling Anchorage: Anchor continuous angle to walls and ceilings with 3/8-inch- (9.5-mm-) diameter, security-type, double-expansion anchor bolts with "break-off" heads **OR** toggle bolts; weld bolt heads to angle, **as directed**.
    a. Weld main framing to wall and ceiling angles with 1-inch (25-mm) welds at 12 inches (305 mm) o.c.
3. Weld adjacent main framing members to each other with 1/4-inch-deep by 3/4-inch- (6-mm- by 19-mm-) long welds at 12 inches (305 mm) o.c. on both sides of framing.
4. Provide supplementary framing at three-way connections and multiple-panel-height partitions. Weld main framing to supplementary framing with 1/8-inch (3-mm) fillet welds 1 inch (25 mm) long at 12 inches (305 mm) o.c. on both sides of framing.
5. Provide additional field bracing as shown or as necessary for rigid, secure installation.
6. Adjust doors to operate easily without binding.

D. Installation Of Security Grilles And Vents
1. Locations: Unless otherwise indicated, install security grilles and vents in penetrations and openings with dimensions exceeding 8 inches (203 mm) in either direction **OR** diameter, **as directed**.
2. Support Frames: Set support frames in adjacent construction.
3. Grilles: Weld vertical bar supports to support frame.
4. Field weld perimeter frames to duct sleeves.

E. Field Quality Control
1. Detention Specialist shall inspect **OR** Inspect, **as directed**, installed products to verify compliance with requirements. Prepare inspection reports and indicate compliance with and deviations from the Contract Documents.
2. Remove and replace detention work if inspections indicate that work does not comply with specified requirements. Remove malfunctioning units; replace with new units.
3. Perform additional inspections to determine compliance of replaced or additional work. Prepare inspection reports.
4. Prepare field quality-control certification endorsed by Detention Specialist, **as directed**, that states installed products and their installation comply with requirements in the Contract Documents.

F. Cleaning And Protection
1. Touchup Painting: Immediately after erection, clean bolted connections and abraded areas of shop paint, and paint exposed areas with same material used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
2. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas; repair galvanizing to comply with ASTM A 780.

END OF SECTION 11 98 12 00

Task	Specification	Specification Description
11 98 12 00	08 34 53 00	Detention Doors And Frames
11 98 12 00	08 71 11 00	Detention Door Hardware
11 98 12 00	10 86 00 00	Detention Furniture
11 98 14 00	08 71 11 00	Detention Door Hardware
11 98 21 00	11 98 12 00	Detention Enclosures
11 98 21 00	10 86 00 00	Detention Furniture

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SECTION 12 01 60 00 - FIXED AUDIENCE SEATING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for fixed audience seating. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes fixed audience seating with the following:
 a. Standard, Beam, and Pedestal mounting.
 b. Upholstered chairs, Molded-plastic chairs and Molded-plastic chairs with upholstered inserts.
 c. Self-rising seat mechanism.
 d. Power and data service to individual seats.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
 a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood and wood-based materials comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
  1) Include statement indicating costs for each certified wood product.
 b. Product Data for Credit EQ 4.4: For each composite wood product, documentation indicating that product contains no urea formaldehyde.
3. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 a. Seating Layout: Show seating layout, aisle widths, row-lettering and chair-numbering scheme, chair widths, and chair spacing in each row.
 b. Accessories: Show accessories, including locations of left- and right-hand tablet arms, electrical devices, accessibility provisions, and attachments to other work.
 c. Wiring Diagrams: For power, signal, and control wiring.
4. Samples: For each seating component and for each color and texture required.
5. Product Certificates: For each type of flame-retardant treatment of fabric, from manufacturer.
6. Maintenance Data.
7. Warranty: Sample of special warranty.

D. Quality Assurance
1. Source Limitations: Obtain fabric of a single dye lot for each color and pattern of fabric required.
2. Forest Certification: Fabricate products with wood components produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
3. Fire-Test-Response Characteristics of Upholstered Chairs:
 a. Fabric: Class 1 according to DOC CS 191 and 16 CFR 1610.61, tested according to California Technical Bulletin 117.
 b. Padding: Comply with California Technical Bulletin 117.
 c. Full-Scale Fire Test: Comply with California Technical Bulletin 133.
4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. Preinstallation Conference: Conduct conference at Project site.

E. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fixed audience seating that fail in materials or workmanship within specified warranty period.
    a. Failures include, but are not limited to, the following:
        1) Structural failures including standards, beams, and pedestals.
        2) Faulty operation of self-rising seat mechanism.
        3) Faulty operation of electrical components.
        4) Wear and deterioration of fabric and stitching beyond normal use.
        5) Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
    b. Warranty Periods: As follows, from date of Final Completion.
        1) Structural: Five years **OR** 10 years **OR** Lifetime, **as directed**.
        2) Operating Mechanisms: Three years **OR** Five years **OR** Lifetime, **as directed**.
        3) Electrical Components: Three **OR** Five, **as directed**, years.
        4) Plastic, Wood, and Paint Components: Two **OR** Three **OR** Five, **as directed**, years.

1.2 PRODUCTS

A. Materials And Finishes
1. Steel: ASTM A 36/A 36M plates, shapes, and bars; ASTM A 513 mechanical tubing; ASTM A 1008/A 1008M cold-rolled sheet; and ASTM A 1011 hot-rolled sheet and strip.
2. Cast Iron: ASTM A 48/A 48M, Class 25 (Class 175), gray iron castings free of blow holes and hot checks with parting lines ground smooth.
3. Cast Aluminum: ASTM B 85 aluminum-alloy die castings.
4. Metal Finish: Finish exposed metal parts with manufacturer's standard polyurethane **OR** baked-on **OR** minimum 1.5-mil- (0.04-mm-) thick, polyester baked-on powder **OR** minimum 1.5-mil- (0.04-mm-) thick, epoxy baked-on powder, **as directed**, coating.
    a. Color: As selected from manufacturer's full range.
5. Medium-Density Fiberboard: ANSI A208.2, Grade MD, made with binder containing no urea formaldehyde.
6. Concealed Plywood: HPVA HP-1 hardwood plywood, made with adhesive containing no urea formaldehyde, or DOC PS 1 softwood plywood, as standard with manufacturer.
7. Exposed Plywood: HPVA HP-1, Face Grade A, hardwood veneer core with color-matched hardwood-veneer faces, made with adhesive containing no urea formaldehyde.
8. Hardwood Lumber and Veneer Faces: American black walnut **OR** Red oak **OR** Teak **OR** Birch **OR** Cherry **OR** Maple, **as directed**, selected to be free of visible defects.
    a. Stain and Finish: As selected from manufacturer's full range.
9. Plastic Laminate: NEMA LD 3, Grade VGS for vertical surfaces and Grade HGS for horizontal surfaces.
    a. Color and Pattern: As selected from manufacturer's full range.
10. Fabric: Manufacturer's standard 100 percent nylon **OR** 100 percent polyolefin, **as directed**, with flame-retardant treatment.
    a. Weight: 12 oz./linear yd. (0.37 kg/linear m) **OR** 16 oz./linear yd. (0.50 kg/linear m) **OR** 18 oz./linear yd. (0.56 kg/linear m) **OR** 20 oz./linear yd. (0.62 kg/linear m), **as directed**.
    b. Color and Pattern: As selected from manufacturer's full range.
11. Upholstery Padding: Flexible, cellular, molded or slab polyurethane foam.
12. Molded Plastic: High-density polyethylene or polypropylene, blow or injection molded, with smooth or textured surface that is mar and dent resistant.
    a. Provide with UV inhibitors to retard fading where exposed to sunlight.
    b. Color and Texture: As selected from manufacturer's full range.

B. Fixed Audience Seating
1. Chair Mounting Standards: Floor **OR** Riser, **as directed**, attached of the following material:

a. Steel: One-piece heavy-tube or reinforced sheet with welded mounting plate and welded connections for seat pivots, backs, armrests, and end panels.
b. Cast Iron **OR** Aluminum, **as directed**: One-piece castings with integral mounting points and attachment anchoring points for seat pivots, backs, and armrests.
c. Molded Plastic: One-piece, solid injection-molded plastic with integral reinforcing ribs and attachment anchoring points for seat pivots, backs, and armrests.

2. Chair Mounting Beam: Steel horizontal beam mounted on floor-attached **OR** riser-attached, **as directed**, steel support pedestals spaced at intervals of 2 to 2-1/2 chair widths.
3. Chair Mounting Pedestal: Floor-attached pedestal, manufacturer's standard jury base with swivel **OR** diffuser pedestal, **as directed**.
4. End Panels:
   a. Material: Steel **OR** Cast iron with design **OR** Cast aluminum with design **OR** Plastic laminate **OR** Hardwood-veneer plywood **OR** Solid hardwood **OR** Fabric upholstered **OR** Molded plastic, **as directed**.
      1) Cast-Metal Design: As selected from manufacturer's full range.
   b. Decorative Insert: Plastic laminate **OR** Hardwood-veneer plywood **OR** Solid hardwood **OR** Fabric upholstered **OR** Molded plastic **OR** Customized medallion, **as directed**.
   c. Style: Rectangular **OR** Oval **OR** Teardrop **OR** Tapered **OR** Panel to floor (pew), **as directed**, with square **OR** rounded, **as directed**, corners.
5. Fabric Upholstered Chairs:
   a. Backs:
      1) Padding Thickness: 1-1/4 inches (32 mm) **OR** 2 inches (51 mm) **OR** 3 inches (76 mm), **as directed**.
      2) Rear Panel: Steel **OR** Molded plastic **OR** Fabric upholstered with 1/4-inch (6-mm) padding **OR** Plastic laminate **OR** Hardwood-veneer plywood, **as directed**.
      3) Top Corners: Square **OR** Rounded, **as directed**.
      4) Upholstery Options: Tufting **OR** Decorative stitching, **as directed**.
   b. Seats: Two part **OR** One part with slip-on upholstered padding **OR** One part, fully upholstered, **as directed**, and as follows:
      1) Padding Thickness: Minimum 1-1/2 inches (38 mm) **OR** 3 inches (76 mm) **OR** 4 inches (102 mm), **as directed**, at front and rear edge.
      2) Seat Underside: Steel sheet seat pan **OR** Perforated steel sheet seat pan with acoustical insulation **OR** Hardwood-veneer-faced, formed plywood shell **OR** Molded-plastic shell **OR** Fabric upholstered with padding, **as directed**.
6. Plastic Chairs: One-piece **OR** Two-piece, **as directed**, molded plastic and as follows:
   a. Back: Smooth surface **OR** Textured surface **OR** Formed slats **OR** Smooth surface with upholstered inserts, **as directed**, with square **OR** rounded, **as directed**, top corners.
   b. Seat: Smooth surface **OR** Textured surface **OR** With simulated slats **OR** Smooth surface with upholstered inserts, **as directed**.
   c. Upholstered Inserts: Padding and fabric covering over 1/8-inch (3-mm) plywood or fiberboard backing board, recessed 3/16 inch (5 mm) into seat and back, centered, and attached with hidden, vandal-resistant fasteners.
7. Chair Width: Vary chair widths to accommodate sightlines and row lengths **OR** Single width chair in each row, **as directed**, with minimum chair width of 18 inches (457 mm) **OR** 19 inches (483 mm) **OR** 20 inches (508 mm) **OR** 22 inches (559 mm) **OR** 23 inches (584 mm) **OR** 24 inches (610 mm), **as directed**, from center to center of armrests.
8. Back Height: Standard-style **OR** High-style **OR** Planetarium-style, **as directed**, backs, 31 inches (787 mm) **OR** 32-1/2 inches (826 mm) **OR** 35 inches (889 mm) **OR** 38 inches (965 mm) **OR** 40 inches (1016 mm) **OR** 44 inches (1117 mm), **as directed**, high.
9. Back Pitch: Fixed **OR** Variable, hinged (rocker), **as directed**.
10. Chair Seat Hinges: Self-lubricating, compensating type with noiseless self-rising seat mechanism passing ASTM F 851 and with positive internal stops cushioned with rubber or neoprene.
11. Chair Back Hinges: Self-lubricating type with noiseless mechanism that raises back to vertical position when chair is unoccupied.
12. Self-Rising Seat Mechanism: Spring-actuated, three-quarter fold **OR** Spring-actuated, full fold **OR** Gravity-actuated, full fold, **as directed**.

13. Armrests: Plastic **OR** Hardwood **OR** Upholstered **OR** Plastic laminate on medium-density fiberboard **OR** Integral scrolled cast iron, **as directed**, with rounded edges, concealed mounting, and integral cup holder, **as directed**.
14. Aisle Lighting Fixtures: Manufacturer's standard round **OR** rectangular louvered **OR** concealed in armrest, **as directed**, fixtures.
    a. Bulb: LED **OR** Incandescent, **as directed**.
    b. Power: 24 **OR** 120, **as directed**, V.
    c. For low-voltage lighting, provide manufacturer's voltage-reduction device housed in safety enclosure equipped with fuses, terminal blocks, and safety disconnect.
15. Power and Data Service Package: Manufacturer's standard service **OR** Service, **as directed**, to individual seats including terminal devices and wiring with 18 inches (457 mm) of extra length and as follows.
    a. Power Receptacles: 120 V with wiring and receptacle as specified in Division 22.
    b. Data Ports: Data port terminal with wiring and receptacle jack as specified in Division 23.
    c. Location: Manufacturer's standard location **OR** On raceway beneath the seating **OR** In the armrest **OR** Beneath the armrest on front or side of the standard **OR** In back panel of seat in front, **as directed**.
16. Row-Letter and Chair-Number and Donor Plates: Manufacturer's standard.
    a. Material: Aluminum **OR** Bronze **OR** Stainless steel, **as directed**, with black embossed characters.
    b. Attachment: Manufacturer's standard method **OR** Adhesive **OR** Minimum of two mechanical fasteners, **as directed**.
17. Tablet Arms: Manufacturer's standard-size **OR** Manufacturer's oversize, **as directed**, fixed **OR** foldaway, **as directed**, tablet arm with plastic-laminate writing surface over medium-density fiberboard or plywood core and with rounded, matching PVC edges.
    a. Mounting: Right-hand mounted unless otherwise indicated.
    b. Fold-Away Mechanism: Cast-iron or steel hinge and swivel mechanism that gives positive support in open position and semiautomatic return to stored position below arm block and parallel to chair.
18. Accessible Seating:
    a. Provide removable **OR** rollaway **OR** swing-away, **as directed**, chairs where wheelchair spaces are indicated.
    b. Provide chairs without **OR** with retractable **OR** with foldup, **as directed**, arm on aisle side in locations indicated, but not less than 5 percent of aisle seats. Identify these seats with a sign or marker.

C. Fabrication
1. Floor Attachments: Fabricate to conform to floor slope, if any, so that standards and pedestals are plumb and chairs are maintained at same angular relationship to vertical throughout Project.
2. For beam-mounted chairs in curved patterns, curve the beam to the various radii required for the rows.
3. Upholstery: Fabricate fabric-covered cushions with molded padding beneath fabric and with fabric covering free of welts, creases, stretch lines, and wrinkles. For each upholstered component, install pile and pattern run in a consistent direction.
4. Upholstered Chairs: Fabricate as follows:
    a. Two-Part Upholstered Back: In length required to protect seat in raised position, with padded cushion glued to a curved steel, plywood, or molded-plastic support panel covered with easily replaceable fabric, and with curved rear shell that fully encloses upholstery edges.
    b. Two-Part Seats: Upper part, an upholstered cushion with molded padding over no fewer than five serpentine springs attached to reinforced steel frame, with weight-distributing and abrasion-resistant sheeting separating padding from springs, and removable for reupholstering without removing seat from chair. Lower part, steel pan reinforced at stress points and completely enclosing hinges and self-rising mechanism.
    OR

Two-Part Seats: Upper part, an upholstered cushion with formed padding over a five-ply plywood panel with fabric cover conforming to shape of cushion to conceal inner seat structure and hinge mechanism. Lower part, molded-plastic shell.

c. One-Part Seats: Double-wall plastic shells fitted with a padded upholstered cushion and covered with easily replaceable fabric **OR** padded and fully upholstered, **as directed**.

5. Two-Piece, Molded-Plastic Chairs: Fabricate contoured seat and back separately with double-wall, blow-molded plastic. Fabricate back in length required to protect seat in raised position. Reinforce plastic with steel plates at attachment points.
6. One-Piece, Molded-Plastic Chairs: Provide contoured plastic shell with smoothly rolled edges and reinforcing ribs on underside of shell. Fabricate for attachment of chair to support with self-threading, corrosion-resistant screws.

1.3 EXECUTION

A. Installation

1. Install seating in locations indicated and fastened securely to substrates according to manufacturer's written installation instructions.
   a. Use installation methods and fasteners that produce fixed audience seating assemblies with individual chairs capable of supporting an evenly distributed 600-lb (272-kg) static load without failure or other conditions that might impair the chair's usefulness.
   b. Install standards and pedestals plumb.
2. Install seating with chair end standards aligned from first to last row and with backs and seats varied in width **OR** spacing **OR** width and spacing, **as directed**, to optimize sightlines.
3. Install riser-mounted attachments to maintain uniform chair heights above floor.
4. Install chairs in curved rows at a smooth radius.
5. Install seating so moving components operate smoothly and quietly.
6. Install wiring conductors and cables concealed in components of seating and accessible for servicing.

B. Field Quality Control

1. Perform tests and inspections.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
   b. Tests for Power Receptacles: As specified in Division 22.
   c. Tests for Data Ports: As specified in Division 23.
2. Prepare test and inspection reports.

C. Adjusting

1. Adjust chair backs so that they are aligned with each other in straight **OR** uniformly curved, **as directed**, rows.
2. Adjust self-rising seat mechanisms so seats in each row are aligned when in upright position.
3. Verify that all components and devices are operating properly.
4. Verify that seating returns to correct at-rest position.
5. Repair minor abrasions and imperfections in finishes with coating that matches factory-applied finish.
6. Replace upholstery fabric damaged during installation.

END OF SECTION 12 01 60 00

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Task	Specification	Specification Description
12 01 60 00	01 22 16 00	No Specification Required

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SECTION 12 21 13 13 - HORIZONTAL LOUVER BLINDS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for horizontal louver blinds. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Horizontal louver blinds with aluminum, wood and polymer slats.
   b. Motorized blind operators.

C. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Show fabrication and installation details for horizontal louver blinds and motorized blind operators.
   a. Wiring Diagrams: Power, system, and control wiring.
3. Samples: For each exposed finish.
4. Product certificates **OR** test reports, **as directed**.
5. Maintenance data.

D. Quality Assurance
1. Fire-Test-Response Characteristics: Provide horizontal louver blinds with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
   a. Flame-Resistance Ratings: Passes NFPA 701.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
3. Product Standard: Provide horizontal louver blinds complying with WCSC A 100.1.

E. Delivery, Storage, And Handling
1. Deliver horizontal louver blinds in factory packages, marked with manufacturer and product name, fire-test-response characteristics, lead-free designation, and location of installation using same designations indicated on Drawings and in a window treatment schedule.

1.2 PRODUCTS

A. Horizontal Louver Blinds, Aluminum Slats
1. Slats: Aluminum; alloy and temper recommended by producer for type of use and finish indicated; with crowned profile and radiused corners.
   a. Width: 2 inches (51 mm) **OR** 1 inch (25 mm) **OR** 1/2 to 5/8 inch (13 to 16 mm), **as directed**.
   b. Finish: One color **OR** One color each side **OR** As indicated, **as directed**.
      1) Ionized Coating: Antistatic, dust-repellent, baked polyester finish.
      2) Reflective Coating: Manufacturer's special coating enhancing the reflection of solar energy on the outside-facing slat surface.
   c. Perforated Slats: Openness factor of 6 to 7 percent.

2. Headrail: Formed steel or extruded aluminum; long edges returned or rolled; fully enclosing operating mechanisms on three sides and end plugs.
3. Bottom Rail: Formed-steel or extruded-aluminum tube, with plastic or metal capped ends.
4. Maximum Light-Blocking Blinds: Designed for eliminating all visible light gaps if slats are tilted closed and with minimal-sized rout holes for ladders hidden and placed near back edge for maximum slat overlap; with headrail and bottom rail extended and formed for light-tight joints between rail and adjacent slats or construction.
    a. Finish: Match color, texture, pattern, and gloss of slats **OR** Color, texture, pattern, and gloss differing from slats as indicated by manufacturer's designations **OR** Color, texture, pattern, and gloss differing from slats, matching samples **OR** Color texture, pattern, and gloss differing from slats as selected from manufacturer's full range, **as directed**.
5. Ladders: Evenly spaced to prevent long-term slat sag.
    a. For Blinds with Nominal Slat Width 1 Inch (25 mm) or Less: Braided string.
    b. For Blinds with Nominal Slat Width 1 Inch (25 mm) **OR** 2 Inches (51 mm)\, **as directed**, or More: Braided string **OR** Manufacturer's standard-width reinforced vinyl tapes **OR** Manufacturer's standard-width cloth tapes, **as directed**.
        1) Tape Color, Texture, and Pattern: Color, texture, and pattern as indicated by manufacturer's designations **OR** Color, texture, and pattern matching samples **OR** Color, texture, and pattern as selected from manufacturer's full range, **as directed**.
6. Lift-and-Tilt Control: Motorized operator.
7. Lift Cords: Manufacturer's standard.
8. Tilt Control: Enclosed worm-gear mechanism, slip clutch or detachable wand preventing overrotation, and linkage rod.
9. Lift Operation: Manual.
10. Valance: Two slats **OR** PVC strip **OR** Manufacturer's standard, **as directed**.
11. Mounting: Wall mounting **OR** Ceiling mounting **OR** End mounting **OR** Wall extension brackets **OR** As indicated, **as directed**.
12. Hold-Down Brackets and Hooks or Pins: Manufacturer's standard.
13. Side Channels and Perimeter Light Gap Seals: Manufacturer's standard.
14. Colors, Textures, Patterns, and Gloss: As selected from manufacturer's full range.

B. Horizontal Louver Blinds, Wood Slats
1. Slats: Hardwood, North American **OR** basswood **OR** poplar **OR** ramin, **as directed,** species, flame-retardant treated; with flat profile and radiused corners and beaded edges **OR** and double beaded edges, **as directed**.
    a. Width: 1 inch (25 mm) **OR** 1-3/8 inch (35 mm) **OR** 2 inches (51 mm) **OR** 2-3/8-inch (60-mm), **as directed**.
    b. Finish: Manufacturer's standard colors as indicated, for striped blind with pattern as indicated on Drawings.
2. Headrail: Formed steel or extruded aluminum; long edges returned or rolled; fully enclosing operating mechanisms on three sides and ends.
3. Bottom Rail: Hardwood matching slats.
    a. Finish Color Characteristics: Match color, texture, pattern, and gloss of slats **OR** Match color, texture, pattern, and gloss of valance **OR** Color, texture, pattern, and gloss differing from slats as indicated by manufacturer's designations **OR** Color, texture, pattern, and gloss differing from slats, matching samples **OR** Color texture, pattern, and gloss differing from slats as selected from manufacturer's full range, **as directed**.
4. Maximum Light-Blocking Blinds: Designed for eliminating all visible light gaps if slats are tilted closed and with minimal-sized rout holes for ladders hidden and placed near back edge for maximum slat overlap; with headrail and bottom rail extended and formed for light-tight joints between rail and adjacent slats or construction.
5. Ladders: Braided string **OR** Manufacturer's standard-width cloth tapes, **as directed**. Evenly spaced to prevent long-term louver sag.

a. Tape Color, Texture, and Pattern: Color, texture, and pattern as indicated by manufacturer's designations **OR** Color, texture, and pattern matching samples **OR** Color, texture, and pattern as selected from manufacturer's full range, **as directed**.
6. Tilt Control: Enclosed worm gear mechanism, slip clutch or detachable wand preventing overrotation, and linkage rod.
7. Lift Operation: Manual.
8. Lift Operation: Motorized operator.
9. Valance: Manufacturer's standard.
10. Cornice: as directed by the Owner.
11. Mounting: Wall mounting **OR** Ceiling mounting **OR** End mounting **OR** Wall extension brackets **OR** As indicated, **as directed**.
12. Hold-Down Brackets and Hooks or Pins: Manufacturer's standard, as indicated.
13. Colors, Textures, Patterns, and Gloss: As selected from manufacturer's full range.

C. Horizontal Louver Blinds, Polymer Slats
1. Slats: Lead-free, UV-stabilized, integrally colored, opaque, permanently flexible, extruded PVC **OR** polymer/wood alloy, **as directed,** that will not crack or yellow; antistatic, dust-repellent treated; with crowned **OR** manufacturer's standard, **as directed,** profile.
   a. Width: 2 inches (51 mm) **OR** 2-1/2 inches (64 mm), **as directed**.
      1) Spacing: Manufacturer's standard.
   b. Finish: Wood-tone **OR** Painted, **as directed,** color as indicated.
   c. Finish: Two colors **OR** textures **OR** patterns, **as directed,** as indicated, one per side of slat.
2. Headrail: Formed steel or extruded aluminum; long edges returned or rolled; fully enclosing operating mechanisms on three sides and ends.
3. Bottom Rail: Manufacturers standard **OR** Formed-steel or extruded-aluminum tube, with plastic or metal capped ends **OR** Hardwood matching slats and trapezoid-shaped bottom angled for minimizing light gaps, **as directed**.
4. Ladders: Braided string **OR** Manufacturer's standard-width cloth tapes, **as directed**. Evenly spaced to prevent long-term slat sag.
   a. Tape Color, Texture, and Pattern: Color, texture, and pattern as selected from manufacturer's full range.
5. Tilt Control: Enclosed worm-gear mechanism and linkage rod.
6. Lift Operation: Manual.
7. Lift Operation: Motorized operator.
8. Valance: Manufacturer's standard.
9. Mounting: Wall mounting **OR** Ceiling mounting **OR** End mounting **OR** Wall extension brackets **OR** As indicated, **as directed**.
10. Hold-Down Brackets and Hooks or Pins: Manufacturer's standard, as indicated.
11. Colors, Textures, Patterns, and Gloss: As selected from manufacturer's full range.

D. Horizontal Louver Blind Fabrication
1. Concealed Components: Noncorrodible or corrosion-resistant-coated materials.
   a. Lift-and-Tilt Mechanisms: With permanently lubricated moving parts.
2. Unit Sizes: Obtain units fabricated in sizes to fill window and other openings as follows:
   a. Blind Units Installed between (inside) Jambs: Width equal to 1/4 inch (6 mm) per side or 1/2 inch (13 mm) total, plus or minus 1/8 inch (3.1 mm), less than jamb-to-jamb dimension of opening in which each blind is installed. Length equal to 1/4 inch (6 mm), plus or minus 1/8 inch (3.1 mm), less than head-to-sill dimension of opening in which each blind is installed.
   b. Blind Units Installed outside Jambs: Width and length as indicated, with terminations between blinds of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.
3. Installation Brackets: Designed for easy removal and reinstallation of blind, for supporting headrail, valance, and operating hardware, and for hardware position and blind mounting method indicated.

4. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal noncorrosive to blind hardware and adjoining construction; type designed for securing to supporting substrate; and supporting blinds and accessories under conditions of normal use.
5. Color-Coated Finish:
   a. Metal: For components exposed to view, apply manufacturer's standard baked finish.
   b. Wood: Apply manufacturer's standard opaque **OR** transparent, **as directed,** factory-applied finish.
6. Component Color: Provide rails, cords, ladders, and exposed-to-view metal, wood, and plastic matching or coordinating with slat color, unless otherwise indicated.

E. Motorized Horizontal Louver Blind Operators
1. General: Provide factory-assembled blind operation systems designed for blind type, size, weight, construction, use, and operation frequency indicated, with lift **OR** tilt **OR** lift-and-tilt, **as directed,** functions. Provide operation systems of size and capacity and with features, characteristics, and accessories suitable for Project conditions and recommended by blind manufacturer, complete with electric motors and factory-prewired motor controls, remote-control stations, remote-control devices, power disconnect switches, enclosures protecting controls and all operating parts, headrail, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
2. Comply with NFPA 70.
3. Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6 with NFPA 70, Class 2 control circuit, maximum 24-V ac or dc.
4. Electric Motors: UL-approved or -recognized, totally enclosed, insulated motor, complying with NEMA MG 1, with thermal-overload protection and internal limit switches; sized by blind manufacturer to start and operate size and weight of blind considering service factor or Project's service conditions without exceeding nameplate ratings.
   a. Service Factor: According to NEMA MG 1, unless otherwise indicated.
   b. Motor Characteristics: Single phase, 24 **OR** 110 **OR** 220, **as directed,** V, 60 Hz.
   c. Motor Mounting: Within manufacturer's standard headrail enclosure.
5. Remote Controls: Electric controls with NEMA ICS 6, Type 1 enclosure for surface **OR** recessed or flush **OR** within headrail, **as directed,** mounting. Provide the following devices for remote-control activation of blinds:
   a. Control Stations: Keyed, maintained **OR** momentary, **as directed,**-contact, three-position, switch-operated control station with open, close, and off functions. Provide two keys per station.
   b. Control Stations: Maintained **OR** Momentary, **as directed,**-contact, three-position, toggle **OR** rocker, **as directed,**-style, wall-switch-operated control station with open, close, and center off functions.
      1) Color: Ivory **OR** White **OR** As indicated, **as directed**.
6. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop blind at fully raised and fully lowered positions.
7. Operating Features: as directed by the Owner.
8. Accessories:
   a. Solar Power Unit: For use with control system indicated.

1.3 EXECUTION

A. Installation
1. Install horizontal louver blinds level and plumb and aligned with adjacent units according to manufacturer's written instructions, and located so exterior slat edges in any position are not closer than 1 inch (25 mm) **OR** 2 inches (51 mm), **as directed,** to interior face of glass. Install intermediate support as required to prevent deflection in headrail. Allow clearances between adjacent blinds and for operating glazed opening's operation hardware if any.

2. Flush Mounted: Install horizontal louver blinds with slat edges flush with finish face of opening if slats are tilted open.
3. Jamb Mounted: Install headrail flush with face of opening jamb and head.
4. Head Mounted: Install headrail on face of opening head.
5. Recessed: Install headrail concealed within blind pocket.
6. Connections: Connect motorized operators to building electrical system.
7. Adjust horizontal louver blinds to operate smoothly, easily, safely, and free of binding or malfunction throughout entire operational range.
8. Clean horizontal louver blind surfaces after installation, according to manufacturer's written instructions.

END OF SECTION 12 21 13 13

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SECTION 12 21 13 13a - VERTICAL LOUVER BLINDS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for vertical louver blinds. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Vertical louver blinds, aluminum vanes, PVC vanes, PVC vanes with fabric vane insert and fabric vanes.
      b. Motorized blind operators.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. Shop Drawings: Show fabrication and installation details for vertical louver blinds and motorized operators.
      a. Wiring Diagrams: Power, system, and control wiring.
   3. Samples: For each exposed finish.
   4. Product certificates **OR** test reports, **as directed**.
   5. Maintenance data.

D. Quality Assurance
   1. Fire-Test-Response Characteristics: Provide vertical louver blinds with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
      a. Flame-Resistance Ratings: Passes NFPA 701.
   2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   3. Product Standard: Provide vertical louver blinds complying with WCSC A 100.1.

E. Delivery, Storage, And Handling
   1. Deliver vertical louver blinds in factory packages, marked with manufacturer and product name, fire-test-response characteristics, lead-free designation, and location of installation using same designations indicated on Drawings and in a window treatment schedule.

1.2 PRODUCTS

A. Vertical Louver Blinds, Aluminum Vanes
   1. Rail System: Headrail **OR** Dual system with headrail and bottom rail, **as directed**.
      a. Rails: Extruded aluminum **OR** Formed steel **OR** Manufacturer's standard, **as directed**; long edges returned or rolled; channel-shaped, enclosing operating mechanisms.
         1) Color: Custom color **OR** As selected from manufacturer's standard color range, **as directed**.
         2) Anodized aluminum, clear **OR** color, **as directed,** anodized.

2. Vanes: Aluminum, alloy, and temper recommended by producer for type of use and finish indicated; with crowned profile and not less than 3/8-inch (9.5-mm) overlap when vanes are rotated fully closed.
    a. Nominal Vane Width: 3-1/2 inches (89 mm) wide.
    b. Vane Finish: One color as indicated, **OR** Two colors as indicated, one per side of slat, **as directed**.
3. Vane Directional Control: Manual **OR** Motorized operator, **as directed**.
4. Traversing Control: Manual **OR** Motorized operator, **as directed**.
5. Draw and Stack Position: One way, controls and stack left **OR** One way, controls and stack right **OR** One way, controls left and stack opposite **OR** One way, controls right and stack opposite **OR** Center split, controls left **OR** Center split, controls right **OR** Center stack, controls left **OR** Center stack, controls right **OR** Off center, controls left **OR** Off center, controls right **OR** As indicated on Drawings **OR** As indicated in a window treatment schedule, **as directed**.
6. Cord-Tensioner Mounting: Wall **OR** Floor **OR** Sill **OR** Baseboard **OR** As indicated, **as directed**.
7. Valance: One **OR** Two-tiered, **as directed,** vane insert; with dust cover.
    a. Finish Color Characteristics: Match color, texture, pattern, and gloss of vanes **OR** Color, texture, pattern, and gloss differing from vanes as indicated by manufacturer's designations **OR** Color, texture, pattern, and gloss differing from vanes matching samples **OR** Color texture, pattern, and gloss differing from vanes as selected from manufacturer's full range, **as directed**.
8. Louver Bottom: Connecting or spacing chains.
9. Mounting: Wall mounting **OR** Ceiling mounting **OR** End mounting **OR** Wall extension brackets **OR** As indicated, **as directed**.
10. Stack Release: Permitting stacked vanes to be moved away from stacking position for total access to glazed opening.
11. Colors, Textures, Patterns, and Gloss: As selected from manufacturer's full range.

B. Vertical Louver Blinds, PVC Vanes
1. Rail System: Headrail **OR** Dual system with headrail and bottom rail, **as directed**.
    a. Rails: Extruded aluminum **OR** Formed steel **OR** Manufacturer's standard, **as directed**; long edges returned or rolled; channel-shaped, enclosing operating mechanisms.
        1) Color: Custom color **OR** As selected from manufacturer's standard color range, **as directed**.
        2) Anodized aluminum, clear **OR** color, **as directed,** anodized.
2. Vanes: Lead-free, UV-stabilized, integrally colored, opaque, permanently flexible, extruded PVC that will not crack or yellow; with flat **OR** crowned **OR** ribbed, **as directed,** profile and not less than 3/8-inch (9.5-mm) overlap when vanes are rotated fully closed.
    a. Nominal Vane Width: 2 inches (51 mm) **OR** 3-1/2 inches (89 mm) **OR** 4 inches (100 mm) **OR** 5 inches (125 mm), **as directed**.
    b. Perforated Vanes: Openness factor of 3 **OR** 6 **OR** 8 **OR** 10 **OR** 12, **as directed,** percent.
3. Vane Directional Control: Manual, **OR** Motorized operator, **as directed**.
4. Traversing Control: Manual **OR** Motorized operator, **as directed**.
5. Draw and Stack Position: One way, controls and stack left **OR** One way, controls and stack right **OR** One way, controls left and stack opposite **OR** One way, controls right and stack opposite **OR** Center split, controls left **OR** Center split, controls right **OR** Center stack, controls left **OR** Center stack, controls right **OR** Off center, controls left **OR** Off center, controls right **OR** As indicated on Drawings **OR** As indicated, **as directed**.
6. Cord-Tensioner Mounting: Wall **OR** Floor **OR** Sill **OR** Baseboard **OR** As indicated, **as directed**.
7. Valance: One **OR** Two-tiered, **as directed,** vane insert; with dust cover.
    a. Finish Color Characteristics: Match color, texture, pattern, and gloss of vanes **OR** Color, texture, pattern, and gloss differing from vanes as indicated by manufacturer's designations **OR** Color, texture, pattern, and gloss differing from vanes matching samples **OR** Color texture, pattern, and gloss differing from vanes as selected from manufacturer's full range, **as directed**.
8. Louver Bottom: Connecting or spacing chains.

9. Mounting: Wall mounting **OR** Ceiling mounting **OR** End mounting **OR** Wall extension brackets **OR** As indicated, **as directed**.
10. Stack Release: Permitting stacked vanes to be moved away from stacking position for total access to glazed opening.
11. Colors, Textures, Patterns, and Gloss: As selected from manufacturer's full range.

C. Vertical Louver Blinds, PVC Vanes With Fabric Vane Inserts
1. Rail System: Headrail **OR** Dual system with headrail and bottom rail, **as directed**.
    a. Rails: Extruded aluminum **OR** Formed steel **OR** Manufacturer's standard, **as directed**; long edges returned or rolled; channel-shaped, enclosing operating mechanisms.
        1) Color: Custom color **OR** As selected from manufacturer's standard color range, **as directed**.
        2) Anodized aluminum, clear **OR** color, **as directed,** anodized.
2. Vanes: Lead-free, UV-stabilized, permanently flexible, extruded PVC that will not crack or yellow; with not less than 3/8-inch (9.5-mm) overlap when vanes are rotated fully closed. Provide integrally colored, opaque vane with clear grooves for holding fabric insert.
    a. Nominal Vane Width: 3-1/2 inches (89 mm).
    b. Fabric Insert: Manufacturer's standard; stain and fade resistant.
3. Vane Directional Control: Manual **OR** Motorized operator, **as directed**.
4. Traversing Control: Manual **OR** Motorized operator, **as directed.**
5. Draw and Stack Position: One way, controls and stack left **OR** One way, controls and stack right **OR** One way, controls left and stack opposite **OR** One way, controls right and stack opposite **OR** Center split, controls left **OR** Center split, controls right **OR** Center stack, controls left **OR** Center stack, controls right **OR** Off center, controls left **OR** Off center, controls right **OR** As indicated, **as directed**.
6. Cord-Tensioner Mounting: Wall **OR** Floor **OR** Sill **OR** Baseboard **OR** As indicated on Drawings, **as directed**.
7. Valance: One **OR** Two-tiered, **as directed,** vane insert; with dust cover. Fabric vane insert matching vanes.
8. Louver Bottom: Connecting or spacing chains.
9. Mounting: Wall mounting **OR** Ceiling mounting **OR** End mounting **OR** Wall extension brackets **OR** As indicated, **as directed**.
10. Stack Release: Permitting stacked vanes to be moved away from stacking position for total access to glazed opening.
11. Fabric Colors, Textures, and Patterns: As selected from manufacturer's full range.

D. Vertical Louver Blinds, Fabric Vanes
1. Rail System: Headrail **OR** Dual system with headrail and bottom rail, **as directed**.
    a. Rails: Extruded aluminum **OR** Formed steel **OR** Manufacturer's standard, **as directed**; long edges returned or rolled; channel-shaped, enclosing operating mechanisms.
        1) Color: Custom color **OR** As selected from manufacturer's standard color range, **as directed**.
        2) Anodized aluminum, clear **OR** color, **as directed** anodized.
2. Vanes: Manufacturer's standard **OR** PVC-coated fiberglass mesh **OR** PVC-coated polyester mesh, **as directed,** freehanging fabric with hemmed, nonraveling edges; stain and fade resistant; with not less than 3/8-inch (9.5-mm) overlap when vanes are rotated fully closed.
    a. Nominal Vane Width: 2 inches (51 mm) **OR** 3-1/2 inches (89 mm) **OR** 5 inches (125 mm), **as directed**.
3. Vane Directional Control: Manual.
4. Vane Directional Control: Motorized operator.
5. Traversing Control: Manual.
6. Traversing Control: Motorized operator.
7. Draw and Stack Position: One way, controls and stack left **OR** One way, controls and stack right **OR** One way, controls left and stack opposite **OR** One way, controls right and stack opposite **OR** Center split, controls left **OR** Center split, controls right **OR** Center stack, controls left **OR** Center

stack, controls right **OR** Off center, controls left **OR** Off center, controls right **OR** As indicated, **as directed**.
8. Cord-Tensioner Mounting: Wall **OR** Floor **OR** Sill **OR** Baseboard **OR** As indicated, **as directed**.
9. Valance: One **OR** Two-tiered, **as directed,** vane insert; with dust cover. Fabric vane insert matching vanes.
10. Louver Bottom: Connecting or spacing chains **OR** Weights, **as directed**.
11. Mounting: Wall mounting **OR** Ceiling mounting **OR** End mounting **OR** Wall extension brackets **OR** As indicated, **as directed**.
12. Stack Release: Permitting stacked vanes to be moved away from stacking position for total access to glazed opening.
13. Fabric Colors, Textures, and Patterns: As selected from manufacturer's full range.

E. Vertical Louver Blind Fabrication
1. Product Description: Vertical louver blind consisting of equally spaced, synchronized vanes and rail system with self-aligning carrier mechanisms, carriers, traverse and vane directional mechanisms and controls, and installation hardware.
2. Concealed Components: Noncorrodible or corrosion-resistant-coated materials.
    a. Louver Directional and Traversing Control Mechanisms: With permanently lubricated moving parts.
3. Unit Sizes: Obtain units fabricated in sizes to fill window and other openings as follows:
    a. Blind Units Installed between (inside) Jambs: Width equal to 1/4 inch (6 mm) per side or 1/2 inch (13 mm) total less than jamb-to-jamb dimension of opening in which each blind is installed. Length equal to 1/4 inch (6 mm), plus or minus 1/8 inch (3.1 mm), less than head-to-sill dimension of opening in which each blind is installed.
    b. Blind Units Installed outside Jambs: Width and length as indicated, with terminations between blinds of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.
4. Installation Brackets: Designed for easy removal and reinstallation of blind, for supporting headrail, valance, and operating hardware, and for hardware position and blind mounting method indicated.
5. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal noncorrosive to blind hardware and adjoining construction; type designed for securing to supporting substrate; and supporting blinds and accessories under conditions of normal use.
6. Color-Coated Finish: For metal components exposed to view, unless anodized or plated finish is indicated. Apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.
7. Component Color: Provide cords and exposed-to-view metal and plastic matching or coordinating with vane color, unless otherwise indicated.

F. Motorized Vertical Louver Blind Operators
1. General: Provide factory-assembled blind operation systems designed for blind type, size, weight, construction, use, and operation frequency indicated, with traverse **OR** rotation **OR** traverse and rotation, **as directed** functions. Provide operation systems of size and capacity and with features, characteristics, and accessories suitable for Project conditions and recommended by blind manufacturer, complete with electric motors and factory-prewired motor controls, remote-control stations, remote-control devices, power disconnect switches, enclosures protecting controls and all operating parts, headrail, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with the building electrical system.
2. Comply with NFPA 70.
3. Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6 with NFPA 70, Class 2 control circuit, maximum 24-V ac or dc.
4. Electric Motors: UL-approved or -recognized, totally enclosed, insulated motor, complying with NEMA MG 1, with thermal-overload protection and internal limit switches; sized by blind

manufacturer to start and operate size and weight of blind considering service factor or Project's service conditions without exceeding nameplate ratings.
   a. Service Factor: According to NEMA MG 1, unless otherwise indicated.
   b. Motor Characteristics: Single phase, 24 **OR** 110 **OR** 220, **as directed,** V, 60 Hz.
   c. Motor Mounting: On top of **OR** Behind, **as directed,** track, left **OR** right, **as directed,** side of headrail.
   d. Motor Mounting: As indicated.
5. Remote Controls: Electric controls with NEMA ICS 6, Type 1 enclosure for surface **OR** recessed or flush **OR** within headrail, **as directed,** mounting. Provide the following devices for remote-control activation of blinds:
   a. Control Stations: Keyed, maintained **OR** momentary, **as directed,**-contact, three-position, switch-operated control station with open, close, and off functions. Provide two keys per station.
   b. Control Stations: Maintained **OR** Momentary, **as directed,**-contact, three-position, toggle **OR** rocker, **as directed,**-style, wall-switch-operated control station with open, close, and center off functions.
      1) Color: Ivory **OR** White **OR** As indicated, **as directed**.
6. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop blind at fully traversed, rotated closed and fully retracted, rotated open positions.
7. Operating Features: <**Insert feature.**>
8. Accessories:
   a. Solar Power Unit: For use with control system indicated.

1.3 EXECUTION

A. Installation
1. Install vertical louver blinds level and plumb and aligned with adjacent units according to manufacturer's written instructions, and located so exterior vane edges in any position are not closer than 2 inches (51 mm) to interior face of glass. Install intermediate support as required to prevent deflection in headrail. Allow clearances between adjacent blinds and for operating glazed opening's operation hardware, if any.
2. Flush Mounted: Install vertical louver blinds with vane edges flush with finish face of opening when vanes are tilted open.
3. Jamb Mounted: Install headrail flush with face of opening jamb and head.
4. Head Mounted: Install headrail on face of opening head.
5. Recessed: Install headrail concealed within blind pocket.
6. Connections: Connect motorized operators to building electrical system.
7. Adjust vertical louver blinds to operate smoothly, easily, safely and free of binding or malfunction throughout entire operational range.
8. Clean vertical louver blind surfaces after installation, according to manufacturer's written instructions.

END OF SECTION 12 21 13 13a

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Task	Specification	Specification Description
12 21 13 33	12 21 13 13	Horizontal Louver Blinds
12 21 13 33	12 21 13 13a	Vertical Louver Blinds
12 21 16 13	12 21 13 13	Horizontal Louver Blinds
12 21 16 13	12 21 13 13a	Vertical Louver Blinds
12 21 16 33	12 21 13 13	Horizontal Louver Blinds
12 21 16 33	12 21 13 13a	Vertical Louver Blinds

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SECTION 12 22 13 00 - DRAPERIES AND TRACKS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for draperies and tracks. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes draperies and drapery tracks.

C. Submittals
   1. Product Data: For the following:
      a. Tracks: Include maximum weights of draperies that can be supported.
         1) Motorized Tracks: Indicate motor weights, motor-mounting requirements, and electrical requirements.
      b. Fabrics and textile treatments.
   2. Shop Drawings: For tracks. Show installation and anchorage details, locations of components and controls, and field measurements.
      a. Draperies: Show sizes, locations, and details of installation.
   3. Coordination Drawings: For track installation; reflected ceiling plans drawn to scale and coordinating track installation with openings and ceiling-mounted items.
   4. Samples: For each drapery and for each fabric color and texture required.
   5. Product Schedule: Use same designations indicated on Drawings.
   6. Product Certificates: For each fabric treated with flame retardant, signed by fabric supplier.
   7. Maintenance data.

D. Quality Assurance
   1. Installer Qualifications: For draperies and tracks, fabricator of draperies.
   2. Source Limitations: For draperies, obtain each color and pattern of fabric and trim from one dye lot.
   3. Fire-Test-Response Characteristics: For fabrics treated with fire retardants, provide products that pass NFPA 701 as determined by testing of fabrics that were treated using treatment-application method intended for use for this Project by a testing and inspecting agency acceptable to authorities having jurisdiction.
   4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   5. Corded Window Covering Product Standard: Provide drapery tracks operated by pull cords complying with ANSI A100.1.

1.2 PRODUCTS

A. Drapery Tracks
   1. Manually Operated Track:
      a. Construction: Extruded aluminum, slotted for mounting at interval of not more than 24 inches (610 mm) o.c., and bendable to radii indicated.
         1) Lengths and Configurations: As directed.
         2) Support Capability: Weight of drapery indicated **OR** 30 lb (14 kg) **OR** 45 lb (20 kg) **OR** 60 lb (27 kg) **OR** 80 lb (36 kg) **OR** 140 lb (64 kg) **OR** 210 lb (95 kg), **as directed,** mounted on track length indicated.

3) Finish: Manufacturer's standard **OR** White baked enamel **OR** Clear anodic coating, **as directed**.

b. Mounting Brackets: Aluminum, of type suitable for fastening track to surface indicated and designed to support weight of track assembly and drapery plus force applied to operate track.

1) Mounting Surface: As indicated on Drawings **OR** Wall **OR** Ceiling **OR** Drapery pocket, **as directed**.

c. Installation Fasteners: Sized to support track assembly and drapery, and fabricated from metal compatible with track, brackets, and supporting construction. Provide two fasteners to fasten each bracket to supporting construction.

d. Operation: Baton **OR** Cord **OR** Cord tension pulley, **as directed**.

1) Pulley Mounting Location: Wall **OR** Baseboard **OR** Floor, **as directed**.

2) Draw: One way, stack as indicated on Drawings **OR** One way, stack left **OR** One way, stack right **OR** Two way, center opening, **as directed**.

3) Operating Hardware Location: On stack side **OR** Left **OR** Right **OR** As indicated on Drawings, **as directed**.

e. Carriers: Rollers **OR** Rollers with hooks **OR** Rollers with snaps **OR** Coordinate with drapery headings indicated, **as directed**.

1) Master Carriers: Butt **OR** Overlap, **as directed**.

f. Accessories: <Insert accessories.>

2. Motorized Track:

a. Construction: Extruded aluminum, slotted for mounting at interval of not more than 24 inches (610 mm) o.c., and bendable to radii indicated.

1) Lengths and Configurations: As directed.

2) Support Capability: Weight of drapery indicated **OR** 30 lb (14 kg) **OR** 45 lb (20 kg) **OR** 60 lb (27 kg) **OR** 80 lb (36 kg) **OR** 140 lb (64 kg) **OR** 210 lb (95 kg), **as directed**, mounted on track length indicated.

3) Finish: Manufacturer's standard **OR** White baked enamel **OR** Clear anodic coating, **as directed**.

b. Mounting Brackets: Suitable for fastening track to surface indicated and designed to support weight of track assembly and drapery plus force applied to operate track.

1) Mounting Surface: As indicated on Drawings **OR** Wall **OR** Ceiling **OR** Drapery pocket, **as directed**.

c. Installation Fasteners: Sized to support track assembly and drapery, and fabricated from metal compatible with track, brackets, and supporting construction. Provide two fasteners to fasten each bracket to supporting construction.

d. Motor Operation: Low-voltage motor with built-in low-voltage interface for direct access to control systems, with thermal-overload switch; sized for weight of drapery and track length indicated; and equipped with stops to prevent overdrawing.

1) Control: Wall switch **OR** Remote, infrared **OR** Remote, radio controlled **OR** Digital timer, **as directed**.

2) Draw: One way, stack as indicated on Drawings **OR** One way, stack left **OR** One way, stack right **OR** Two way, center opening, **as directed**.

3) Electrical Requirements: 115 V/60 Hz/120 W/1.10 A **OR** 115 V/60 Hz/140 W/1.20 A **OR** 110 V/60 Hz/150 W/1.0 A **OR** 110 V/60 Hz/550 W/5.0 A, **as directed**.

4) Travel Speed: 6 inches (152 mm) **OR** 8 inches (203 mm) **OR** 12 inches (305 mm), **as directed**, per second.

e. Carriers: Rollers **OR** Rollers with hooks **OR** Rollers with snaps **OR** Coordinate with drapery headings indicated, **as directed**.

1) Master Carriers: Butt **OR** Overlap, **as directed**.

f. Accessories: <**Insert accessories**.>

B. Draperies

1. Drapery:

a. Heading:

1) Pinch (French) Pleats: 100 **OR** 150 **OR** 200, **as directed**, percent fullness.
2) Stack Pleats: 60 **OR** 80 **OR** 100 **OR** 120, **as directed**, percent fullness.
3) Roll Pleats: 60 **OR** 80 **OR** 100 **OR** 120, **as directed**, percent fullness.
4) Accordion Pleats: 40 **OR** 80 **OR** 100 **OR** 120, **as directed**, percent fullness.
5) Pleat Spacing: <**Insert dimension**.>
6) Heading Accessories:
    a) Nonwoven buckram.
    b) Woven snap tape, 7/8 inch (22 mm) wide, with nickel-plated snaps at 4 inches (102 mm) o.c.
    c) Hooks.

b. Drapery Fabric:
1) Manufacturer, Designation, Pattern, Color, and Fiber Content: **As directed**.
2) Orientation: Run right (up the bolt).
3) Width and Pattern Repeat Distance: **As directed**.
4) Textile Treatments: Stain repellent **OR** Flame retardant, polymer type **OR** Stain repellent; and flame retardant, polymer type, **as directed**.

c. Lining Fabric:
1) Lining Type: Blackout; light tight **OR** Water resistant, **as directed**.
2) Manufacturer, Manufacturer's Designation, Color, Fiber Content, and Width: As directed.
3) Textile Treatments: Stain repellent **OR** Flame retardant, polymer type **OR** Stain repellent; and flame retardant, polymer type, **as directed**.

d. Interlining: Acoustical.
1) Manufacturer: **As directed**.

e. Textile Trim and Tiebacks: **As directed.**

f. Hem Weights: 1-inch- (25-mm-) square lead weights **OR** Tape type (string weights), **as directed**.

C. Drapery Fabrication

1. Fabricate draperies in heading styles and fullnesses indicated. Fabricate headings to stand erect. If less than a full width of fabric is required to produce panel of specified fullness, use equal widths of not less than one-half width of fabric located at ends of panel.
    a. One-Way-Stacking Draperies: Add 5 inches (127 mm) to overall width for returns.
    b. Center-Opening Draperies: Add 10 inches (254 mm) to overall width for overlap.
2. Seams: Sew vertical seams with twin-needle sewing machine with selvage trimmed and overlocked. Join widths so that patterns match and vertical seams lay flat and straight without puckering. Horizontal seams are not acceptable.
3. Side Hems: Double-turned, 1-1/2-inch- (38-mm-) wide hems consisting of three layers of fabric, and blindstitched so that stitches are not visible on face of drapery.
4. Bottom Hems: Double-turned, 4-inch- (102-mm-) wide hems consisting of three layers of fabric, and weighted and blindstitched so that weights and stitches are not visible on face of drapery.
    a. Sew in square lead weights at each seam and at panel corners.
5. Interlinings: Extend from top of drapery to within 1/2 inch (13 mm) of lining's bottom hem and to leading edge of side hems to produce full-shadowed appearance.
6. Linings: Equal to widths of drapery fabric and joined to drapery fabric at top by inside invisible seam, and hand stitched at side hems and shadowed with 1-1/2-inch (38-mm) return of face fabric.
    a. Bottom Hem: Hem separately from **OR** Blind stitch to, **as directed,** drapery fabric.

1.3 EXECUTION

A. Drapery Track Installation

1. Install track systems according to manufacturer's written instructions, level and plumb, and at height and location in relation to adjoining openings as indicated on Drawings.

2. Isolate metal parts of tracks and brackets from concrete, masonry, and mortar to prevent galvanic action. Use tape or another method recommended in writing by track manufacturer.

B. Drapery Installation
1. Where draperies abut overhead construction, hang draperies so that clearance between headings and overhead construction is 1/4 inch (6.4 mm).
2. Where draperies extend to floor, install so that bottom hems clear finished floor by not more than 1 inch (25 mm) and not less than 1/2 inch (13 mm).
3. Where draperies extend to windowsill, install so that bottom hems hang above sill line and clear sill line by not more than 1/2 inch (13 mm).

C. Adjusting
1. After hanging draperies, test and adjust each track to produce unencumbered, smooth operation.
2. Steam and dress down draperies as required to produce crease- and wrinkle-free installation.
3. Remove and replace draperies that are stained or soiled.

END OF SECTION 12 22 13 00

Task	Specification	Specification Description
12 22 16 00	12 22 13 00	Draperies and Tracks
12 23 13 00	12 21 13 13	Horizontal Louver Blinds
12 23 13 00	12 21 13 13a	Vertical Louver Blinds

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SECTION 12 24 13 00 - ROLLER SHADES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for roller shades. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes roller shades and motorized shade operators.

C. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Include plans, elevations, sections, details, details of installation, operational clearances, wiring diagrams, and relationship to adjoining Work.
   a. Verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings.
3. Samples: For each exposed finish and for each color and texture required.
4. Window Treatment Schedule: Use same designations indicated on Drawings.
5. Maintenance data.

D. Quality Assurance
1. Fire-Test-Response Characteristics: Provide products passing flame-resistance testing according to NFPA 701 by a testing agency acceptable to authorities having jurisdiction.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
3. Comply with WCMA A 100.1.

E. Delivery, Storage, And Handling
1. Deliver shades in factory packages, marked with manufacturer and product name, fire-test-response characteristics, lead-free designation, and location of installation using same designations indicated on Drawings and in a window treatment schedule.

1.2 PRODUCTS

A. Roller Shades
1. Shade Band Material: PVC-coated fiberglass **OR** PVC-coated polyester **OR** PVC-coated fiberglass and polyester blends **OR** Fiberglass and acrylic blend **OR** Metallized film **OR** Mirror film **OR** Tinted film **OR** Owner-furnished material, **as directed**.
   a. Colors: Match samples **OR** As selected from manufacturer's full range **OR** As indicated in a window treatment schedule, **as directed**.
   b. Material Solar-Optical Properties: **As directed.**
   c. Material Openness Factor: **As directed** percent.
   d. Material UV Blockage: **As directed** percent.
2. Rollers: Electrogalvanized or epoxy primed steel or extruded-aluminum tube of diameter and wall thickness required to support and fit internal components of operating system and the weight and width of shade band material without sagging; designed to be easily removable from support brackets. Provide capacity for one **OR** two, **as directed**, roller shade band(s) per roller.

3. Direction of Roll: Regular, from back of roller **OR** Reverse, from front of roller **OR** Regular, from back of roller, and reverse, from front of roller, as indicated on Drawings for double-roller shades, **as directed**.
4. Mounting Brackets: Galvanized or zinc-plated steel **OR** Fascia end caps, fabricated from steel finished to match fascia or headbox, **as directed**.
5. Fascia: L-shaped, formed-steel sheet or extruded aluminum; long edges returned or rolled; continuous panel concealing front and bottom of shade roller, brackets, and operating hardware and operators; removable design for access.
6. Top/Back Cover: L-shaped; material and finish to match fascia; combining with fascia and end caps to form a six-sided headbox enclosure sized to fit shade roller and operating hardware inside.
7. Pocket-Style Headbox: U-shaped, formed-steel sheet or extruded aluminum; long edges returned or rolled; with a bottom cover consisting of slot opening of minimum dimension to allow lowering and raising of shade and a removable or an openable, continuous metal access panel concealing shade roller, brackets, and operating hardware and operators within.
8. Pocket with Ceiling Slot Opening: Six-sided box units for recessed installation; fabricated from formed-steel sheet, extruded aluminum, or wood; with a bottom consisting of slot opening of minimum dimension to allow lowering and raising of shade and a removable or an openable, continuous metal access panel concealing rollers, brackets, and operating hardware and operators within.
   a. Corner Section: Factory formed and welded.
9. Bottom Bar: Steel or extruded aluminum, with plastic or metal capped ends. Provide exposed-to-view, external **OR** concealed, by pocket of shade material, internal, **as directed**,-type.
10. Audiovisual Light-Blocking Shades: Designed for eliminating all visible light gaps when shades are fully closed; fabricated from blackout shade band material with fascia **OR** headbox **OR** pocket, **as directed**, and bottom bar extended and formed for light-tight joints among shade components and between shade components and adjacent construction.
11. Skylight Shades: Manufacturer's complete system for operable skylight shades, including operator, operating hardware, and accessories for smooth operation, designed for installation in horizontal position **OR** inclined position, slope as indicated on Drawings, **as directed**.
12. Valance: As indicated by manufacturer's designation for style and color **OR** Style matching hem; as indicated by manufacturer's designation color **OR** As indicated in a window treatment schedule, **as directed**.
13. Mounting: Inside **OR** Outside **OR** Ceiling **OR** Recessed in ceiling pocket **OR** Wall extension brackets **OR** Bottom-up brackets **OR** As indicated on Drawings, **as directed**.
14. Shade Operation: Manual; with spring roller **OR** continuous-loop bead-chain, clutch, and cord tensioner and bracket **OR** gear and crank **OR** cordless system, **as directed**, lift operator.
15. Hold-Down Brackets and Hooks or Pins and Side Channels: Manufacturer's standard for fixing shade in place, keeping shade band material taut, and reducing light gaps when shades are closed.
16. Shade Operation: Manual; with spring roller **OR** continuous-loop bead-chain, clutch, and cord tensioner and bracket **OR** gear and crank **OR** cordless system, **as directed**, lift operator.

B. Roller Shade Fabrication
1. Unit Sizes: Obtain units fabricated in sizes to fill window and other openings as follows, measured at 74 deg F (23 deg C):
   a. Shade Units Installed between (Inside) Jambs: Edge of shade not more than 1/4 inch (6 mm) from face of jamb. Length equal to head to sill dimension of opening in which each shade is installed.
   b. Shade Units Installed Outside Jambs: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.
2. Installation Brackets: Designed for easy removal and reinstallation of shade, for supporting fascia, headbox, roller, and operating hardware and for hardware position and shade mounting method indicated.

3. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal noncorrosive to shade hardware and adjoining construction; type designed for securing to supporting substrate; and supporting shades and accessories under conditions of normal use.

C. Motorized Roller Shade Operators
1. General: Provide factory-assembled motorized shade operation systems designed for lifting shades of type, size, weight, construction, use, and operation frequency indicated. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with the building electrical system.
2. Comply with NFPA 70.
3. Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6 with NFPA 70, Class 2 control circuit, maximum 24-V ac or dc.
4. Electric Motors: UL-approved or -recognized, totally enclosed, insulated motor, complying with NEMA MG 1, with thermal-overload protection, brake, permanently lubricated bearings, and limit switches; sized by shade manufacturer to start and operate size and weight of shade considering service factor or considering Project's service conditions without exceeding nameplate ratings.
   a. Service Factor: According to NEMA MG 1, unless otherwise indicated.
   b. Motor Characteristics: Single phase, 24 **OR** 110 **OR** 220, **as directed**, V, 60 Hz.
   c. Motor Mounting: Within manufacturer's standard roller enclosure.
5. Remote Controls: Electric controls with NEMA ICS 6, Type 1 enclosure surface **OR** recessed or flush, **as directed,** mounting. Keyed switch **OR** Toggle-style, wall switch Rocker-style, wall switch **OR** Rocker-style, group-control wall switch **OR** Rocker-style, individual/group-control wall switch **OR** Sun sensor **OR** Radio **OR** Infrared **OR** Timer **OR** Microprocessor, **as directed**.
6. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop shade at fully raised and fully lowered positions.

1.3 EXECUTION

A. Roller Shade Installation
1. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions, and located so shade band is not closer than 2 inches (50 mm) to interior face of glass. Allow clearances for window operation hardware.
2. Connections: Connect motorized operators to building electrical system.
3. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.
4. Clean roller shade surfaces after installation, according to manufacturer's written instructions.

END OF SECTION 12 24 13 00

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SECTION 12 24 13 00a - PLEATED SHADES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for pleated shades. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following types of horizontal-fold shades and accessories:
      a. Z-pleated shades.
      b. Cellular shades.
      c. Motorized shade operators.

C. Definitions
   1. Cellular Shades: Pleated shades with more than one horizontally folded fabric layer forming accordion-folded fabric with enclosed air spaces or cells. Cellular shades may consist of two fabric layers forming a continuous accordion fold of enclosed air spaces or cells for a linear row of cells, one cell wide; three fabric layers forming two interconnected accordion folds of enclosed air spaces or cells for two honeycombed rows of cells, nominally two cells wide; or four fabric layers forming three interconnected accordion folds of enclosed air spaces or cells for three honeycombed rows of cells, nominally three cells wide.
   2. Pleated Shades: Permanently creased, horizontally folded shades. Alternatively, pleated shades are synonymous with Z-pleated shades according to the industry. Z-pleated shades consist of one fabric layer forming Z-folded pleats.

D. Submittals
   1. Product Data: For each type of product indicated.
      a. Motorized Shade Operators: Include operating instructions.
      b. Motors: Show nameplate data, ratings, characteristics, and mounting arrangements.
   2. Shop Drawings: Show location and extent of pleated shades. Include elevations, sections, details, and dimensions not shown in Product Data. Show installation details, mountings, attachments to other work, operational clearances, and relationship to adjoining work.
      a. Motorized Shade Operators: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
      b. Wiring Diagrams: Power, system, and control wiring.
   3. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
      a. Suspended ceiling components.
      b. Structural members to which equipment **OR** suspension systems, **as directed**, will be attached.
      c. Sizes and locations of initial access modules for acoustical tile.
      d. Items penetrating finished ceiling, including the following:
         1) Lighting fixtures.
         2) Air outlets and inlets.
         3) Speakers.
         4) Sprinklers.
         5) Access panels.
      e. Perimeter moldings.
   4. Samples: For the following products:

a. Shade Fabrics: Not less than 3 inches (76 mm) square, with specified treatments applied. Mark face of material.
b. Valance: Full-size unit, not less than 12 inches (300 mm) long.
5. Maintenance Data.

E. Quality Assurance
1. Fire-Test-Response Characteristics: Provide pleated shades with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency:
a. Flame-Resistance Ratings: Passes NFPA 701.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
3. Product Standard: Provide pleated shades complying with WCMA A 100.1.

F. Delivery, Storage, And Handling
1. Deliver shades in factory packages, marked with manufacturer and product name, fire-test-response characteristics, **OR** lead-free designation, **as directed**, and location of installation using same designations indicated on Drawings and in a window treatment schedule.

1.2 PRODUCTS

A. Z-Pleated Shades
1. Z-Pleated Shade Construction: One-fabric thickness, with uniform pleat spacing maintained at all positions.
a. Nominal Pleat Width: 1 inch (25 mm) **OR** 2 inches (50 mm) **OR** 3 inches (76 mm) **OR** 4 inches (100 mm), **as directed**.
2. Shade Fabric: Manufacturer's standard **OR** 100 percent nonwoven polyester with antistatic treatment **OR** PVC-coated polyester mesh **OR** 100 percent spun-woven polyester, **as directed**; stain and fade resistant, width as wide as required for seamless shade.
a. Fabric Width: 36 inches (910 mm) **OR** 48 inches (1220 mm) **OR** 60 inches (1520 mm) **OR** 72 inches (1830 mm) **OR** 84 inches (2130 mm) **OR** 96 inches (2440 mm) **OR** As indicated on Drawings **OR** As indicated in a window treatment schedule, **as directed**.
b. Pattern: as directed by the Owner.
c. Style: as directed by the Owner.
d. Colors: Match samples **OR** As selected from manufacturer's full range **OR** As indicated in a window treatment schedule, **as directed**.
e. **Material Solar-Optical Properties: as directed by the Owner.**
f. Material Openness Factor: percent as directed by the Owner..
g. Material UV Blockage: percent as directed by the Owner..
3. Headrail: Formed steel or extruded aluminum; long edges returned or rolled; fully enclosing operating mechanisms on three sides and ends; capacity for one **OR** two, **as directed**, shade(s) per headrail, unless otherwise indicated on Drawings **OR** in a window treatment schedule, **as directed**.
4. Bottom Rail: Formed-steel or extruded-aluminum tube, sealed with plastic or metal capped ends.
5. Valance: Clear plastic with fabric insert matching fabric shade.
6. R-Value: Not less than 2.22 deg F x h x sq. ft./Btu (0.39 K x sq. m/W) **OR** 4.8 deg F x h x sq. ft./Btu (0.85 K x sq. m/W), **as directed**.
7. Mounting: Wall **OR** Ceiling **OR** End **OR** Wall extension brackets **OR** As indicated on Drawings, **as directed**, mounting permitting easy removal and replacement without damaging shade or adjacent surfaces and finishes; with spacers and shims required for shade placement and alignment indicated.

8. Hold-Down Brackets and Hooks or Pins: Manufacturer's standard, as indicated.
9. Side Channels and Perimeter Seals: Manufacturer's standard for eliminating light gaps when shades are closed.
10. Shade Operation: Manual.
    a. Lift Control: System including lift cord, crash-proof cord lock, and cord joiner ball **OR** System including continuous-cord loop, clutch, and cord tensioner and bracket **OR** Cordless system, **as directed**, designed to hold shade in place unless force is applied to move shade.
    b. Length of Lift Cord **OR** Cord Loop, **as directed**: Manufacturer's standard length **OR** Full length of shade **OR** Length required to make operation convenient from floor level **OR** As indicated on Drawings, **as directed**.
    c. Position of Lift Cord **OR** Cord Loop, **as directed**: As indicated on Drawings **OR** in a window treatment schedule, **as directed**.
    d. Position of Lift Cord **OR** Cord Loop, **as directed**: Left side **OR** Right side **OR** Left end **OR** Right end, **as directed**, of headrail, unless otherwise indicated on Drawings **OR** in a window treatment schedule, **as directed**.
    e. Cord Tensioner Mounting: Wall **OR** Floor **OR** Sill **OR** Baseboard **OR** As indicated on Drawings, **as directed**.
11. Shade Operation: Motorized operator.

B. Cellular Shades
1. Cellular Shade Construction: Two-fabric thicknesses and one row of cells, one cell wide.
    a. Nominal Cell Width: 3/8 to 7/16 inch (10 to 11 mm) **OR** 1/2 inch (13 mm) **OR** 9/16 inch (14.2 mm) **OR** 3/4 inch (19 mm), **as directed**.
2. Cellular Shade Construction: Three-fabric thicknesses and two honeycombed cells, nominally two cells wide.
    a. Nominal Cell Width: 3/8 inch (10 mm).
3. Cellular Shade Construction: Four-fabric thicknesses and three honeycombed cells, nominally three cells wide.
    a. Nominal Cell Width: 3/8 inch (10 mm).
4. Shade Fabric: Manufacturer's standard **OR** 100 percent nonwoven polyester with antistatic treatment **OR** 100 percent spun-woven polyester, **as directed**; stain and fade resistant, width as wide as required for seamless shade.
    a. Fabric Width: 36 inches (910 mm) **OR** 48 inches (1220 mm) **OR** 60 inches (1520 mm) **OR** 72 inches (1830 mm) **OR** 84 inches (2130 mm) **OR** 96 inches (2440 mm) **OR** As indicated on Drawings **OR** As indicated in a window treatment schedule, **as directed**.
    b. Pattern: as directed by the Owner.
    c. Style: as directed by the Owner.
    d. Colors: Match samples **OR** As selected from manufacturer's full range **OR** As indicated in a window treatment schedule, **as directed**.
5. Headrail: Formed steel or extruded aluminum; long edges returned or rolled; fully enclosing operating mechanisms on three sides and ends; capacity for one **OR** two, **as directed**, shade(s) per headrail, unless otherwise indicated on Drawings **OR** in a window treatment schedule, **as directed**.
6. Bottom Rail: Formed-steel or extruded-aluminum tube, sealed with plastic or metal capped ends.
7. Valance: Clear plastic with fabric insert matching fabric shade.
8. R-Value: Not less than 2.22 deg F x h x sq. ft./Btu (0.39 K x sq. m/W) **OR** 4.8 deg F x h x sq. ft./Btu (0.85 K x sq. m/W), **as directed**.
9. Mounting: Wall **OR** Ceiling **OR** End **OR** Wall extension brackets **OR** As indicated on Drawings, **as directed**, mounting permitting easy removal and replacement without damaging shade or adjacent surfaces and finishes; with spacers and shims required for shade placement and alignment indicated.
10. Hold-Down Brackets and Hooks or Pins: Manufacturer's standard, as indicated.
11. Side Channels and Perimeter Seals: Manufacturer's standard for eliminating light gaps when shades are closed.
12. Shade Operation: Manual.

a. Lift Control: System including lift cord, crash-proof cord lock, and cord joiner ball **OR** System including continuous-cord loop, clutch, and cord tensioner and bracket **OR** Cordless system, **as directed**, designed to hold shade in place unless force is applied to move shade.
b. Length of Lift Cord **OR** Cord Loop, **as directed**: Manufacturer's standard length **OR** Full length of shade **OR** Length required to make operation convenient from floor level **OR** As indicated on Drawings, **as directed**.
c. Position of Lift Cord **OR** Cord Loop, **as directed**: As indicated on Drawings **OR** in a window treatment schedule, **as directed**.
d. Position of Lift Cord **OR** Cord Loop, **as directed**: Left side **OR** Right side **OR** Left end **OR** Right end, **as directed**, of headrail, unless otherwise indicated on Drawings **OR** in a window treatment schedule, **as directed**.
e. Cord Tensioner Mounting: Wall **OR** Floor **OR** Sill **OR** Baseboard **OR** As indicated on Drawings, **as directed**.

13. Shade Operation: Motorized operator.

C. Pleated Shade Fabrication
1. Product Description: Pleated shades each consisting of fabric, rails, ladders, lifting mechanism, self-leveling device, and installation hardware.
2. Concealed Components: Noncorrodible or corrosion-resistant-coated materials.
   a. Lifting Mechanism: With permanently lubricated moving parts.
3. Unit Sizes: Obtain units fabricated in sizes to fill window and other openings as follows, measured at 74 deg F (23 deg C):
   a. Shade Units Installed between (Inside) Jambs: Edge of shade not more than 1/4 inch (6 mm) from face of jamb. Length equal to head-to-sill dimension of opening in which each shade is installed.
   b. Shade Units Installed Outside Jambs: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.
4. Installation Brackets: Designed for easy removal and reinstallation of shade, for supporting headrail, valance, **as directed**, and operating hardware and for hardware position and shade mounting method indicated.
5. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal noncorrosive to shade hardware and adjoining construction; type designed for securing to supporting substrate; and supporting shades and accessories under conditions of normal use.
6. Color-Coated Finish: For metal components exposed to view, apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.
7. Component Color: Provide rails and cords, **as directed**, and exposed-to-view ladders, **as directed**, metal and plastic matching or coordinating with fabric color, unless otherwise indicated.

D. Motorized Pleated Shade Operators
1. General: Provide factory-assembled shade operation systems designed for lifting shades of type, size, weight, construction, use, and operation frequency indicated. Provide operation systems of size and capacity and with features, characteristics, and accessories suitable for Project conditions and recommended by shade manufacturer, complete with electric motors and factory-prewired motor controls, remote-control stations, remote-control devices, power disconnect switches, enclosures protecting controls and all operating parts, headrail, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with the building electrical system.
2. Comply with NFPA 70.
3. Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6 with NFPA 70, Class 2 control circuit, maximum 24-V ac or dc, **as directed**.

4. Electric Motors: UL-approved or -recognized, totally enclosed, insulated motor, complying with NEMA MG 1, with thermal-overload protection, brake, permanently lubricated bearings, and internal limit switches; sized by shade manufacturer to start and operate size and weight of shade considering service factor or considering Project's service conditions without exceeding nameplate ratings.
   a. Service Factor: According to NEMA MG 1, unless otherwise indicated.
   b. Motor Characteristics: Single phase, 24 **OR** 110 **OR** 220, **as directed**, V, 60 Hz.
   c. Motor Mounting: Within manufacturer's standard headrail enclosure.
5. Remote Controls: Electric controls with NEMA ICS 6, Type 1 enclosure for surface **OR** recessed or flush **OR** within headrail, **as directed**, mounting. Provide the following devices for remote-control activation of shades:
   a. Control Stations: Keyed, maintained **OR** momentary, **as directed**,-contact, three-position, switch-operated control station with open, close, and off functions. Provide two keys per station.
   b. Control Stations: Maintained **OR** Momentary, **as directed**,-contact, three-position, toggle **OR** rocker, **as directed**,-style, wall switch-operated control station with open, close, and center off functions.
      1) Color: Ivory **OR** White **OR** As indicated in a window treatment schedule, **as directed**.
   c. Group Control Stations: Maintained **OR** Momentary, **as directed**,-contact, three-position, rocker-style, wall switch-operated control station with open, close, and center off functions for single-switch group control.
      1) Color: Ivory **OR** White **OR** As indicated in a window treatment schedule, **as directed**.
   d. Individual/Group Control Stations: Maintained **OR** Momentary, **as directed**,-contact, three-position, rocker-style, wall switch-operated control station with open, close, and center-off functions for individual and group control.
      1) Color: Ivory **OR** White **OR** As indicated in a window treatment schedule, **as directed**.
   e. Sun Sensor Controls: Programmable system activated by LEDs detecting daylight intensity and responding by automatically adjusting shades.
   f. Radio Controls: Digital system consisting of code-compatible universal coaxial receiver, one per shade **OR** one per headrail **OR** where indicated on Drawings, **as directed**, and two, **as directed**, portable, multiple-channel transmitters for operating two **OR** four **OR** up to 12, **as directed**, shades individually, each with a single button to open and close shades.
   g. Infrared Controls: System consisting of concealed receiver complete with external eye and connecting modular cable, and two, **as directed**, portable, multiple-channel transmitters with separate buttons to open and close up to 12, **as directed**, individual shades or groups of shades, to open and close all shades simultaneously, and to stop.
   h. Timer Controls: Clock timer, 24-hour **OR** seven-day, **as directed**, programmable for regular events.
   i. Microprocessor Controls: Electronic programmable means for setting, changing, and adjusting control features. Provide unit isolated from voltage spikes and surges.
6. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop shade at fully raised and fully lowered positions.
7. Operating Features: Include the following:
   a. Group switching with integrated switch control; one face plate for multiple switch cut-outs.
   b. Capable of interface with audiovisual **OR** multiroom, **as directed**, control system.
   c. Capable of accepting input from building automation control system.
   d. Override switch.
8. Accessories: Include the following:
   a. Solar Power Unit: For use with control system indicated.
9. Headrail: Manufacturer's standard formed steel or extruded aluminum; long edges returned or rolled; fully enclosing operating mechanisms on three sides and ends; capacity for one **OR** two,

as directed, shade(s) per headrail, unless otherwise indicated on Drawings **OR** in a window treatment schedule, **as directed**.

a. Color: Match shade **OR** As indicated by manufacturer's designations **OR** As selected from manufacturer's full range **OR** As indicated in a window treatment schedule, **as directed**.

1.3 EXECUTION

A. Pleated Shade Installation

1. Install shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions, and located so pleat edges are not closer than 2 inches (50 mm) to interior face of glass. Install intermediate support as required to prevent deflection in headrail. Allow clearances for window operation hardware.
2. Flush Mounted: Install shades with pleat edges flush with finish face of opening if shade is in fully lowered position.
3. Jamb Mounted: Install headrail flush with face of opening jamb and head.
4. Head Mounted: Install headrail on face of opening head.
5. Recessed: Install headrail concealed within shade pocket.
6. Connections: Connect motorized operators to building electrical system.

B. Adjusting

1. Adjust and balance pleated shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

C. Cleaning And Protection

1. Clean pleated shade surfaces after installation, according to manufacturer's written instructions.
2. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that pleated shades are without damage or deterioration at time of Final Completion.
3. Replace damaged pleated shades that cannot be repaired, in a manner approved, before time of Final Completion.

END OF SECTION 12 24 13 00a

Task	Specification	Specification Description
12 24 13 00	12 21 13 13	Horizontal Louver Blinds
12 24 13 00	12 21 13 13a	Vertical Louver Blinds
12 25 09 00	01 22 16 00	No Specification Required

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SECTION 12 31 16 00 - STONE COUNTERTOPS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for stone countertops. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes stone countertops.

C. Submittals
1. Product Data: For each variety of stone and manufactured products.
2. Shop Drawings: Include plans, sections, details, and attachments to other work.
3. Samples: For each stone type indicated.
4. LEED Submittal:
a. Product Data for Credit EQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
5. Sealant Compatibility Test Report: From sealant manufacturer, complying with requirements in Division 07 Section "Joint Sealants" and indicating that sealants will not stain or damage stone.
6. Maintenance Data: For stone countertops to include in maintenance manuals. Include Product Data for stone-care products used or recommended by Installer, and names, addresses, and telephone numbers of local sources for products.

D. Quality Assurance
1. Installer Qualifications: Fabricator of products.
2. Source Limitations for Stone: Obtain each variety of stone from a single quarry with resources to provide materials of consistent quality in appearance and physical properties.
a. Make stone slabs available for the Owner to examine for appearance characteristics. the Owner will select aesthetically acceptable slabs.

E. Delivery, Storage, And Handling
1. Lift stone with wide-belt slings; do not use wire rope or ropes that might cause staining. Move stone, if required, using dollies with cushioned wood supports.
2. Store stone on wood A-frames or pallets with nonstaining separators and nonstaining, waterproof covers. Ventilate under covers to prevent condensation.

F. Project Conditions
1. Field Measurements: Verify dimensions of construction to receive stone countertops by field measurements before fabrication.

1.2 PRODUCTS

A. Granite
1. Granite: Comply with ASTM C 615.
2. Cut stone from contiguous, matched slabs in which natural markings occur, **as directed**.
3. Finish: Polished **OR** Honed **OR** Thermal **OR** As indicated **OR** Match the Owner's sample, **as directed**.

B. Marble
1. Marble: Comply with ASTM C 503.

a. Stone Abrasion Resistance: Minimum value of 10, based on testing according to ASTM C 241 or ASTM C 1353.
2. Cut stone from contiguous, matched slabs in which natural markings occur, **as directed**.
3. Finish: Polished **OR** Honed **OR** As indicated **OR** Match the Owner's sample, **as directed**.

C. Serpentine
1. Serpentine: Comply with ASTM C 1526, Classification I Exterior **OR** II Interior, **as directed**.
   a. Stone Abrasion Resistance: Minimum value of 10, based on testing according to ASTM C 241 or ASTM C 1353.
2. Cut stone from contiguous, matched slabs in which natural markings occur, **as directed**.
3. Finish: Polished **OR** Honed **OR** As indicated **OR** Match the Owner's sample, **as directed**.

D. Slate
1. Slate: Comply with ASTM C 629, Classification I Exterior **OR** II Interior, **as directed**, with a fine, even grain and unfading color, from clear, sound stock.
   a. Stone Abrasion Resistance: Minimum value of 8, based on testing according to ASTM C 241 or ASTM C 1353.
2. Finish: Honed **OR** Sand rubbed **OR** Natural cleft **OR** As indicated **OR** Match the Owner's sample, **as directed**.

E. Adhesives, Grout, Sealants, And Stone Accessories
1. General: Use only adhesives formulated for stone and ceramic tile and recommended by their manufacturer for the application indicated.
2. Water-Cleanable Epoxy Adhesive: ANSI A118.3, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Water-Cleanable Epoxy Grout: ANSI A118.3, chemical-resistant, water-cleanable, tile-setting and -grouting epoxy.
4. Stone Adhesive: 2-part epoxy or polyester adhesive, formulated specifically for bonding stone to stone, with an initial set time of not more than 2 hours at 70 deg F (21 deg C), and with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   a. Color: Clear **OR** Match stone, **as directed**.
5. Sealant for Countertops: Manufacturer's standard sealant of characteristics indicated below that comply with applicable requirements in Division 07 Section "Joint Sealants" and will not stain the stone it is applied to.
   a. Single-component, neutral-curing **OR** acid-curing, **as directed**, silicone sealant.
   b. Color: Clear **OR** As selected by the Owner from manufacturer's full range, **as directed**.
   c. Use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Stone Joint Splines: Stainless-steel or brass washers approximately 1 inch (25 mm) in diameter and of thickness to fit snugly in saw-cut kerf in edge of stone units.
7. Stone Cleaner: Cleaner specifically formulated for stone types, finishes, and applications indicated, as recommended by stone producer and, if a sealer is specified, by sealer manufacturer. Do not use cleaning compounds containing acids, caustics, harsh fillers, or abrasives.
8. Stone Sealer: Colorless, stain-resistant sealer that does not affect color or physical properties of stone surfaces, as recommended by stone producer for application indicated.

F. Stone Fabrication, General
1. Select stone for intended use to prevent fabricated units from containing cracks, seams, and starts that could impair structural integrity or function.
   a. Repairs that are characteristic of the varieties specified are acceptable provided they do not impair structural integrity or function and are not aesthetically unpleasing, as judged by the Owner.
2. Grade and mark stone for final locations to produce assembled countertop units with an overall uniform appearance.

3. Fabricate stone countertops in sizes and shapes required to comply with requirements indicated, including details on Drawings and Shop Drawings.
   a. For granite, comply with recommendations in NBGQA's "Specifications for Architectural Granite."
   b. For marble and serpentine, comply with recommendations in MIA's "Dimension Stone--Design Manual."
   c. Clean sawed backs of stones to remove rust stains and iron particles.
   d. Dress joints straight and at right angle to face, unless otherwise indicated.
   e. Cut and drill sinkages and holes in stone for anchors, supports, and attachments.
   f. Provide openings, reveals, and similar features as needed to accommodate adjacent work.
   g. Fabricate molded edges with machines having abrasive shaping wheels made to reverse contour of edge profile to produce uniform shape throughout entire length of edge and with precisely formed arris slightly eased to prevent snipping, and matched at joints between units. Form corners of molded edges as indicated with outside corners slightly eased, unless otherwise indicated.
   h. Finish exposed faces of stone to comply with requirements indicated for finish of each type of stone required and to match approved Samples and mockups. Provide matching finish on exposed edges of countertops, splashes, and cutouts.
4. Carefully inspect finished stone units at fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units.

G. Stone Countertops
1. General: Comply with recommendations in MIA's "Dimension Stone - Design Manual."
2. Nominal Thickness: Provide thickness indicated, but not less than 3/4 inch (20 mm) **OR** 7/8 inch (22 mm) **OR** 1-1/4 inches (32 mm), **as directed**. Gage backs to provide units of identical thickness.
3. Edge Detail: Straight, slightly eased at top **OR** 3/8-inch (10-mm) bevel **OR** 3/4-inch (20-mm) full bullnose **OR** 1-1/4-inch (20-mm) full bullnose **OR** 3/8-inch (10-mm) radius with 2-inch (50-mm) apron **OR** 1-1/2-inch (40-mm) laminated bullnose **OR** As indicated, **as directed**.
4. Splashes: Provide 3/4-inch- (20-mm-) thick backsplashes **OR** end splashes **OR** backsplashes and end splashes, **as directed**, unless otherwise indicated.
5. Joints: Fabricate countertops without joints.
   OR
   Fabricate countertops in sections for joining in field, with joints at locations indicated and as follows:
   a. Bonded Joints: 1/32 inch (0.8 mm) or less in width.
   b. Grouted Joints: 1/16 inch (1.5 mm) in width.
   c. Sealant-Filled Joints: 1/16 inch (1.5 mm) in width.
   d. Splined Joints: Accurately cut kerfs in edges at joints for insertion of metal splines to maintain alignment of surfaces at joints where indicated. Make width of cuts slightly more than thickness of splines to provide snug fit. Provide at least three splines in each joint.
6. Cutouts and Holes:
   a. Undercounter Fixtures: Make cutouts for undercounter fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.
      1) Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting 3/16 inch (5 mm) into fixture opening.
      2) Provide vertical edges, rounded to 3/8-inch (10-mm) radius at juncture of cutout edges with top surface of countertop, slightly eased at bottom, and projecting 3/16 inch (5 mm) into fixture opening.
      3) Provide 3/4-inch (20-mm) full bullnose edges projecting 3/8 inch (10 mm) into fixture opening.
   b. Counter-Mounted Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
   c. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.

1.3 EXECUTION

A. Preparation
1. Advise installers of other work about specific requirements for placement of inserts and similar items to be used by stone countertop Installer for anchoring stone countertops. Furnish installers of other work with Drawings or templates showing locations of these items.
2. Clean dirty or stained stone surfaces by removing soil, stains, and foreign materials before setting. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives. Allow stone to dry before installing.

B. Construction Tolerances
1. Variation from Plumb: For vertical lines and surfaces, do not exceed 1/16 inch in 48 inches (1.5 mm in 1200 mm).
2. Variation from Level: Do not exceed 1/8 inch in 96 inches (3 mm in 2400 mm), 1/4 inch (6 mm) maximum.
3. Variation in Joint Width: Do not vary joint thickness more than 1/4 of nominal joint width.
4. Variation in Plane at Joints (Lipping): Do not exceed 1/64-inch (0.4-mm) difference between planes of adjacent units.
5. Variation in Line of Edge at Joints (Lipping): Do not exceed 1/64-inch (0.4-mm) difference between edges of adjacent units, where edge line continues across joint.

C. Installation Of Countertops
1. General: Install countertops over plywood subtops with full spread of water-cleanable epoxy adhesive.
   OR
   Install countertops by adhering to supports with water-cleanable epoxy adhesive.
2. Do not cut stone in field, unless otherwise indicated. If stone countertops or splashes require additional fabrication not specified to be performed at Project site, return to fabrication shop for adjustment.
   OR
   Do necessary field cutting as stone is set. Use power saws with diamond blades to cut stone. Cut lines straight, true, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
3. Set stone to comply with requirements indicated on Drawings and Shop Drawings. Shim and adjust stone to locations indicated, with uniform joints of widths indicated and with edges and faces aligned according to established relationships and indicated tolerances. Install anchors and other attachments indicated or necessary to secure stone countertops in place.
4. Bond joints with stone adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.
5. If joints are allowed, space joints with 1/16-inch (1.5-mm) gap for filling with grout **OR** sealant, **as directed**. Use temporary shims to ensure uniform spacing.
   a. Install metal splines in kerfs in stone edges at joints where indicated. Fill kerfs with stone adhesive **OR** setting adhesive **OR** sealant, **as directed**, before inserting splines and remove excess immediately after adjoining units are drawn into position.
   b. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.
6. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Use power saws with diamond blades to cut stone. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
7. Install backsplash and end splash by adhering to wall with water-cleanable epoxy adhesive and to countertops with stone adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
   OR

Install backsplash and end splash by adhering to countertops with stone adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Leave 1/16-inch (1.5-mm) gap between splash and wall for filling with sealant. Use temporary shims to ensure uniform spacing.

OR

Install backsplash and end splash by adhering to wall with water-cleanable epoxy adhesive. Leave 1/16-inch (1.5-mm) gap between countertop and splash for filling with sealant. Use temporary shims to ensure uniform spacing.

8. If grouted joints are acceptable, grout joints to comply with ANSI A108.10. Remove temporary shims before grouting. Tool grout uniformly and smoothly with plastic tool.
9. Apply sealant to joints and gaps specified for filling with sealant; comply with Division 07 Section "Joint Sealants". Remove temporary shims before applying sealant.

D. Adjusting And Cleaning

1. In-Progress Cleaning: Clean countertops as work progresses. Remove adhesive, grout, mortar, and sealant smears immediately.
2. Remove and replace stone countertops of the following description:
    a. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved by the Owner.
    b. Defective countertops.
    c. Defective joints, including misaligned joints.
    d. Interior stone countertops and joints not matching approved Samples and mockups.
    e. Interior stone countertops not complying with other requirements indicated.
3. Replace in a manner that results in stone countertops matching approved Samples and mockups, complying with other requirements, and showing no evidence of replacement.
4. Clean stone countertops not less than six days after completion of sealant installation **OR** installation, **as directed**, using clean water and soft rags. Do not use wire brushes, acid-type cleaning agents, cleaning compounds with caustic or harsh fillers, or other materials or methods that could damage stone.
5. Sealer Application: Apply stone sealer to comply with stone producer's and sealer manufacturer's written instructions.

END OF SECTION 12 31 16 00

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SECTION 12 31 16 00a - KITCHEN CASEWORK, STAINLESS STEEL CABINETS

1.1 GENERAL

A. Description of Work

1. This specification covers the furnishing and installation of materials for kitchen casework, stainless steel cabinets. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Quality Assurance

1. Comply with all provisions of specifications for the design, quality testing. Manufacturing and installation of metal kitchen cabinets and specified equipment.
2. All kitchen cabinetry and equipment herein specified and shown on the drawings shall meet the standards, quality of materials, construction, workmanship and finish of Innovative Laboratory Systems Co., 1336 Industrial Rd., Omaha Nebraska, (402) 333-0679. Equal manufacturers acceptable.
3. All metal cabinetry and equipment herein shall be the product of one manufacturer and be the one on which this specification is based or approved of substitutes must be obtained in writing from the Owner ten days prior to the bid due date. All manufacturers other than the specified product shall provide evidence of having a minimum of five years experience in the manufacturing and installation of stainless steel kitchen cabinetry.
4. The manufacturer shall, from one year to date of installation, warrant parts or products manufactured and finished against manufacturing defects in material and any such parts which under normal use prove defective within one year form date of installation, shall be repaired or replaced without charge to the Owner.
5. Wood shall not be used in any portion of the casework construction whether exposed or hidden from view.

C. Submittals

1. Shop Drawings
   a. Identify location of metal cabinetry and related items.
   b. Detail cabinets, shelving, countertops, etc, in related and dimensional position, with sections. Locations for roughing-in of plumbing, including sinks, faucets, strainers, cocks, etc. shall be included
2. Certificates: All bidders shall provide to the Owner independent test results from a nationally recognized testing laboratory on the finishes required for this project with the bid.

1.2 PRODUCTS

A. Material

1. All metal cabinetry shall be fabricated to Type 304 stainless steel free of scales buckles or other defects.
2. Minimum metal gauge: All minimum thickness of metal referred to herein shall be U.S. standard gauge.
   a. 20 Gauge: Inner door panels, inner and outer drawer panels, drawer body, and shelves.
   b. 18 Gauge: Outer door panels, sides, backs, bottoms, and tops.
   c. 16 Gauge: Top rails, cross rails, drawer slides.
   d. 14 Gauge: Leveling and corner gussets.

B. Fabrications

1. Cabinet Grade: Premium and complying with the following.
   a. Align sides, top rails, bottoms and vertical stiles, at intersections, without overlap.

   b. Rounded edges.
   c. Full welded seams.
   d. Grind exposed welds flush and smooth.
2. Cases: The sides of cabinets shall be formed to make a rabbeted stile 1-1/8” wide. Top of case stiles shall be closed by a mitered 45-degree bend from tip of case side. Stiles shall be closed by welded channel, which contains front shelf adjustment louvers. All case members including intermediate cross rails shall be welded for maximum strength. Use of sheet metal screws to hold intermediate cross rails in place is not acceptable. Sides of all cabinets shall be free from any holes to prevent dust and bacteria from entering the cabinet. Pre-punched holes in the side of any cabinet will not be allowed. All drawer cabinets and cupboard cabinets shall have full backs and bottoms welded into place. Any cabinet without any backs or bottoms will be rejected. All interior bottoms of base and tall cabinets shall be turned down to provide a clean, flush interior free from dust catching ledges and preventing bacterial accumulation. Bottoms of all wall units shall be flushed; recessed bottoms are not acceptable.
3. Doors
   a. Doors shall be double panel reinforced construction 5/8” thick and sound deadened with vertical steel battens. Door fronts and liners shall be welded together for added strength. Door fronts and cases shall be slotted to receive hinges. Hinge wings must be concealed when doors open. Wrap around type hinges are not acceptable. All doors shall have soft rubber bumpers for quiet closing. Rubber bumpers must be securely locked in place. Rubber Bumpers attached by adhesives are not acceptable. All corners of doors shall be welded and ground smooth.
   b. Sliding doors shall be double panel reinforced construction 5/8” thick and operate on nylon rollers suspended from stainless steel track at top of unit and center guide at bottom. Sliding doors shall have recessed door pulls.
4. Drawers
   a. Drawers front shall be double panel reinforced construction with 5/8” thick fronts and sound deadened with vertical steel battens. Drawers shall be all welded construction. All drawers shall have soft rubber bumpers for quiet closing. Rubber bumpers must be securely locked in place. Rubber bumpers attached by adhesives are not acceptable. All edges of drawer fronts shall be closed.
   b. Drawer bodies shall be formed from a single sheet of steel including the bottom, two sides, back and inner front. Interior bottoms of drawers shall be fully covered on four sides for ease in cleaning. The top front of the inner drawer shall be offset to interlock with the outer drawer front.
   c. Flanges on the top of drawer body shall be fully formed channel and bent at a 6-degree angle for maximum strength. Flanges shall be formed to leave the inside of the drawer free form sharp edges. Drawer slide shall be welded to drawer body and be part of a “Z” shaped member in a wrap around design to support drawer body. Drawer slides shall have a 15/16” nylon tired ball bearing roller. Drawer slide shall be roller type, positive in action permitting drawer to be fully opened; yet preventing drawer from accidental removal. Case slides shall be a formed piece of galvanized steel with 15/16” nylon tired ball bearing roller at front of slide. All ball bearing rollers for drawer slide and case slide shall be pre-lubricated to guarantee a smooth, quiet operation. All drawers shall rise upward when opened to prevent engaging of drawers and doors below. Drawers shall have self-closing design during the last 5” of travel.
5. Shelves: Shelves shall be formed from a single sheet of stainless steel with 7/8” face turned back and up at a 30-degree angle and edge of flange shall make firm contact with underside of shelf for sound deadening. All shelves in cabinets shall be adjustable on 1-1/2” center and supported by stainless steel clips placed in embossed louvers. All shelves shall be solid.
6. Hardware: Door catch shall be positive type latch located at upper inside edge of door. Stainless steel strike bracket shall be installed inside of door with accessible removable screws. Bolt shall be nylon self-closing type tested for 300,000 opening and closing cycles. Complete bolt housing shall be recessed behind cross rail. Roller catches and/or friction catches are not acceptable.

7. Hinges: Hinges shall be institutional type, 2-1/2" long, with a metal thickness of least 0.090", containing 5-knuckles, and centered 3" above bottom and below top of door. Doors 45" high and over shall have an additional hinge in center. Hinges shall be stainless steel with smooth rounded joints for easy cleaning. When door is closed, only the joint shall be exposed. Both hinge wings shall be encased, one within the door, the other within the case. Hinges shall be attached to the door and the case by screws. Hinges welded to door and/or case are not acceptable.
8. Door and Drawer Pull: Door and drawer pull shall be stainless steel with a brushed satin finish. Shoulder screws shall be used so that when handles are mounted they do not cause the door to buckle or cave. Sliding doors shall have recessed door pulls.
9. Base Cabinet Legs: All base cabinets and sink units shall be furnished with integral stainless steel legs with adjustable levelers. Bottom of base cabinets shall be approximately 6" above the floor.
10. Locking Mechanism: All cabinet doors shall be provided with stainless steel angle hasps, with half-inch diameter holes for pad locking, as shown on the drawings. The left door of each door pair shall have a sliding flush bolt on the inside face, as shown on the drawings, to prevent the pair of doors from swinging open when pad locked.

C. Steel Cabinet Finish
1. Test Procedure: Chemical spot tests shall be made by applying 10 to 15 drops (approximately 0.5 cubic cm) of each reagent listed in Table 1 to the surface to be tested. Each reagent spot shall be open to the atmosphere. Ambient temperature is 68-72 degrees F (20-22 degrees C). After one hour, chemicals shall be flushed away with cold water and the surface, washed with detergent and warm water at 150 degrees F (65 degrees C). Surface shall be examined under 100-foot candles of illumination.

D. Kitchen Cabinets Performance Requirements
1. Base Cabinets.
   a. Cabinets Load Test: A 48" wide standing height combination cupboard and drawer cabinet shall be freestanding with installed counter top. Cabinet shall sit 1" off the floor on all four leveling screws and be capable of supporting a uniform distributed load of 2,000 lbs. Door and drawer operation shall not be affected by the load.
   b. Leveling device for floor mounted cabinets shall be capable of supporting a load of 500 lbs. Without failure and capable of adjustment after load is removed.
   c. Cabinet Door Test: An open door shall withstand a load of 200 lbs. applied directly at the outer edge. Door shall be moved through a 180 degree arc and weight removed. Operation of the door after test shall be normal without distortion that will adversely affect operation for the door catch.
   d. Life Cycle Test.
      1) Door hinge shall operate for 300,000 opening and closing cycles without a failure.
      2) Positive door catch shall operate for 300,000 opening and closing cycles without failure.
      3) Drawer shall be tested and operated with a load of 100 lbs. for a minimum of 150,000 opening and closing cycles. After test, drawers shall operate freely without evidence of dragging or scraping.
2. Wall Cabinets
   a. A 48" wide, 30" high, 12 ¾" deep hinged wall case shall support a load of 1lbs. on cabinet bottom and 100 lbs. on each adjustable shelf for a total of 300 lbs. Cabinet shall not show any significant permanent defection of cabinet, cabinet bottom or shelves. Doors shall operate smoothly when cabinet is fully loaded.
   b. An adjustable shelf shall support a uniformly distributed load of 100 lbs. When load is removed, shelf should show no significant permanent distortion.
   c. Performance of hinge and catch shall be the same as used on base cabinets.

E. Working Surfaces
1. Stainless Steel: Sink and counter tops shall be fabricated of 16 gauge, Type 304, 18-8 solid stainless steel formed down and back making a 1 ½" high face on all exposed edges.

Drainboards and cabinet tops shall be rigidly reinforced the full length of the top. Drainboards shall be two-way pitched to the bowl to provide drainage without channeling or grooving. Drainboards, flanges and splashes shall be integral, being formed from one sheet of metal. Raised edge surrounding unit shall be seamless die formed at front and ends of unit. Sink bowls shall be fabricated of 16 gauge, Type 304, 18-8 solid stainless steel seamless electrically welded to drainboard. All joints shall be electrically welded, ground and polished to a satin finish. Entire units shall be thoroughly sound deadened on under surface with sprayed or trowelled undercoating. Wood shall not be used. All tops shall have stainless steel runners to facilitate fastening to cabinets.

1.3 EXECUTION

A. Insulations
1. Install cabinets, shelves, counter tops and other equipment level and square. Install sink units to provide positive drainage of bottom surface of the sinks.
2. Wall cabinets shall be hung from the metal stud framing system wherever possible. If the wall cabinets must be hung from the wall surfacing at any location, proper anchors shall be used. Install wall cabinets level and aligned.
3. Install base cabinets firmly on ground. Level all the surfaces by adjusting the leg levelers. Attached countertops to inslatted base cabinets with stainless steel screws as required. Caulk with silicone all around counter tops where it interfaces with the existing walls. Install the flat back panels to the wall surfaces by the most appropriate method and caulk as required.
4. All work, including installation of new casework, flooring, ceiling, ductwork, etc., as well as the demolition of the existing casework, flooring, etc. shall be completed within three (3) consecutive days of work start. Hours of work shall be between 7:30 a.m. 9:00 p.m. All work, including work noted on Punch List, shall be completed by 9:00 p.m. of the third work day after work starts.

B. Temporary Work Station
1. During the period of demolition and new casework installation (3 days maximum) the contractor shall provide a temporary cabinet assembly for use by the Owner. The temporary assembly shall have a 6-foot section of cabinets with countertop, sink and faucet. The faucet shall be temporary connected to an apparatus hose bib for providing cold water to the sink. The sink shall be temporarily connected to a sewer line or floor drain if possible for the discharge or to another approved system of temporary discharge by means of a suitable container. For the latter method, the Contractor shall be responsible for periodically disposing of the waste container’s contents. The temporary cabinet assembly shall be located reasonably close to the existing kitchens and/or dining areas being remodeled. the Owner shall approve the location of the temporary cabinets.

C. Inspection
1. Inspect installed work of other trades and installation conditions for acceptability. Inform the Owner of discrepancies that will jeopardize a complete and proper installation
2. Cleaning: Touching up marred and/or abraded finished surfaces, clean components to post construction accepted levels, remove crating and packing material, broom sweep premises.

END OF SECTION 12 31 16 00a

Task	Specification	Specification Description
12 31 16 00	01 22 16 00	No Specification Required
12 31 16 00	06 41 13 00	Interior Architectural Woodwork
12 35 70 13	01 22 16 00	No Specification Required
12 36 23 13	06 41 13 00	Interior Architectural Woodwork

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SECTION 12 36 61 16 - SOLID POLYMER FABRICATIONS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for cast, mineral filled, nonporous, solid polymer material used for countertops, vanity tops, sinks, bowls, window sills, tub and shower walls, and other applications where a hard, durable, stain resistant surface is desired. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals

1. Shop Drawings: Fabrications; indicate joints, shapes, dimensions, accessories and installation details.
2. Product Data: Solid polymer fabrications; panel adhesive; joint adhesive; sealant; heat reflective tape.
3. Samples: Solid polymer fabrications; where colors and patterns are not indicated, submit at least 3 different samples of manufacturer's standard colors and patterns for selection.
4. Test Reports: Tensile strength; hardness; flammability; thermal expansion; boiling water resistance; high temperature resistance; liquid absorption; mold and mildew growth; bacteria growth; impact resistance; sanitation.
5. Operation and Maintenance Data: Solid polymer fabrications; provide manuals indicating manufacturer's care and maintenance data, including repair and cleaning instructions. Provide maintenance kit(s) for selected finish(es).

C. Quality Assurance: Do not change source of supply for materials after work has started if the appearance of finished work would be affected. Variation in component size and location of openings to be plus or minus 1/8 inch (3 mm).

D. Delivery: Do not deliver until areas are ready for installation. Deliver components and materials to the site undamaged in containers, clearly marked and labeled with manufacturer's name. Store in dry, weathertight enclosure. Protect materials to prevent damage to finished surfaces. Provide protective coverings to prevent physical damage or staining after installation until completion of the project.

E. Warranty: Provide the solid surface material manufacturer's 10 year warranty, from date of acceptance of the work.

1.2 PRODUCTS

A. Solid Polymer Fabrications: Provide fabrication of cast, solid polymer material composed of acrylic polymer, mineral fillers and pigments. Material shall not be coated or laminated to substrates. Polymer thickness to be as indicated but not less than 1/4 inch (6 mm). Superficial damage to a depth of 0.010 inch (0.25 mm) shall be repairable by sanding or polishing.

1. Performance Requirements
   a. Tensile strength, ASTM D 638: 5800 psi (40 Mpa) minimum
   b. Hardness, ASTM D 2583: Barcol Impressor 55 minimum
   c. Flammability, ASTM E 84: Class I/A, flame spread 25 maximum; smoke developed 30 maximum
   d. Thermal Expansion, ASTM D 696: 0.00002 in/in/F (0.000036 mm/mm/K) maximum
   e. Boiling water resistance, NEMA LD 3: No effect
   f. High temperature resistance, NEMA LD 3: No effect
   g. Liquid absorption, ASTM D 570 (24 hours): 0.10 percent maximum

h. Mold and mildew growth, ASTM G 21: No growth, no effect
i. Bacteria growth, ASTM G 22: No growth, no effect
j. Sanitation, NSF 51: "Food Contact" approval for food area applications
k. Impact resistance, NEMA LD 3 (1/2 lb. (0.227 kg) ball drop): 1/4 inch (6 mm) material, 36 inch (914 mm) drop, no failure **OR** 1/2 inch (13 mm) material, 120 inch (3048 mm) drop, no failure, **as directed**.

2. Joint Adhesive: Two part acrylic joint adhesive as recommended by the solid polymer manufacturer to form inconspicuous, non-porous joints by chemical bond.
3. Panel Adhesive: Neoprene based panel adhesive as recommended by the solid polymer manufacturer, UL listed.
4. Sealant: Mildew resistant, FDA compliant and UL listed, silicone sealant as recommended by the solid polymer manufacturer.
5. Heat Reflective Tape: Heat reflective tape as recommended by the solid polymer manufacturer for use with cutouts for heat sources.
6. Mounting Hardware: Provide mounting hardware including sink/bowl clips, inserts and fasteners for attachment of undermount sinks and lavatories.

B. Fabrications: Fabrication requirements.
1. Factory fabricate components to the greatest extent possible to the sizes and shapes indicated, in accordance with approved shop drawings. Where indicated, factory fabricate side and back splashes with 1/2 inch (13 mm) cove at intersections.
2. Form joints between components using manufacturer's standard acrylic joint adhesive. Joints shall be inconspicuous, non-porous, and reinforced with strips of solid polymer material in accordance with the manufacturer's printed instructions.
3. Provide factory cutouts for plumbing and accessories as indicated. Reinforce heated or cooled cutouts in accordance with approved shop drawings and the manufacturer's printed instructions. Support all cutouts in accordance with approved shop drawings and the manufacturer's printed instructions.
4. Cut and finish component edges with clean returns. Round edges of cutouts to 1/8 inch (3 mm) radius. Round corners of cutouts with 1/2 inch (13 mm) minimum radius. Use router to form all cutouts. Provide thick edges where indicated using strips of solid polymer material and manufacturer's acrylic joint adhesive. All joints to be inconspicuous and non-porous. All exposed surfaces to have uniform finish and gloss.

1.3 EXECUTION

A. Installation: Deliver fabrications to the locations indicated. Assemble and install complete with accessories and hardware.
1. Assembly Requirements
a. Install components plumb and level and scribed to adjacent finishes in accordance with approved shop drawings and data.
b. Fasten and support fabrications to walls, brackets, and partitions as indicated. Fasteners shall be appropriate for use with adjoining construction.
c. Form field joints using manufacturer's recommended acrylic adhesive. Joints shall be inconspicuous and non-porous. Keep components and hands clean when forming joints. Seal flexible joints using manufacturer's recommended sealant.
d. Provide integral backsplashes and sidesplashes as indicated. Attach splashes with silicone or joint adhesive as indicated.
e. Keep components and hands clean during installation. Remove excessive adhesive and sealants. Clean finished surfaces of all dirt and stains.
2. Protection: Provide protective coverings to prevent physical damage or staining following installation.

END OF SECTION 12 36 61 16

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Task	Specification	Specification Description
12 36 61 16	06 41 13 00	Interior Architectural Woodwork
12 36 61 16	12 31 16 00	Stone Countertops
12 36 61 19	06 41 13 00	Interior Architectural Woodwork
12 36 61 19	12 31 16 00	Stone Countertops
12 36 61 19	12 36 61 16	Solid Polymer Fabrications

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SECTION 12 48 13 13 - FLOOR MATS AND FRAMES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for floor mats and frames. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Roll-up mats in recessed and surface-mounted frames.
      b. Entrance mats in recessed and surface-mounted frames.
      c. Entrance tiles in recessed and surface-mounted frames.

C. Submittals
   1. Product Data: For each type of floor mat and frame.
   2. Shop Drawings: Show the following:
      a. Items penetrating floor mats and frames, including the following:
         1) Door control devices.
      b. Divisions between mat sections.
      c. Perimeter floor moldings.
      d. Custom Graphics: Scale drawing indicating colors.
   3. Samples: For each floor mat, tread rail, and frame member.
   4. Maintenance Data.

D. Quality Assurance
   1. Accessibility Requirements: Provide installed floor mats that comply with Section 4.5 in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" **OR** Sections 302 and 303 in ICC A117.1, **as directed**.

1.2 PRODUCTS

A. Roll-Up Mats
   1. Roll-up, Vinyl-Rail Hinged Mats: Vinyl-acrylic tread rails 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, wide by 3/8 inch (9.5 mm) thick, with slotted or perforated vinyl **OR** aluminum, **as directed**, hinges.
      a. Tread Inserts: Textured-surface, resilient vinyl **OR** Ribbed-design-surface, resilient vinyl **OR** Mineral abrasive particles bonded to or embedded in vinyl **OR** Aluminum-oxide or silicon-carbide grit in epoxy matrix **OR** 1/4-inch- (6-mm-) high, 28-oz./sq. yd. (950-g/sq. m) weight, level-cut, nylon-pile, fusion-bonded carpet, **as directed**.
      b. Colors, Textures, and Patterns of Inserts: As selected from manufacturer's full range.
      c. Rail Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from manufacturer's full range, **as directed**.
      d. Mat Size: As indicated **OR as directed**.
   2. Roll-up, Aluminum-Rail Hinged Mats: Extruded-aluminum tread rails 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, wide by 3/8 inch (9.5 mm) thick, sitting on continuous vinyl cushions.
      a. Tread Inserts: Plain serrated aluminum treads **OR** Textured-surface, resilient vinyl **OR** Ribbed-design-surface, resilient vinyl **OR** Mineral abrasive particles bonded to or embedded in vinyl **OR** Aluminum-oxide or silicon-carbide grit in epoxy matrix **OR** 1/4-inch-

(6-mm-) high, 28-oz./sq. yd. (950-g/sq. m) weight, level-cut, nylon-pile, fusion-bonded carpet, **as directed**.
  b. Colors, Textures, and Patterns of Inserts: As selected from manufacturer's full range.
  c. Rail Color: Mill-finish **OR** Clear **OR** Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from manufacturer's full range, **as directed**.
  d. Hinges: Plastic **OR** Aluminum, **as directed**.
  e. Mat Size: As indicated **OR as directed**.
3. Surface-Mounted Frames:
  a. Tapered Frames: Tapered flexible vinyl edge-frame **OR** aluminum frame, **as directed**, members, not less than 1-1/2 inches (38 mm) wide, attached to mat at all 4 edges, with welded mitered corners.
  b. Color: Mill finish **OR** Clear **OR** Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from manufacturer's full range, **as directed**.
4. Recessed Frames:
  a. Extruded Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6061-T6 or Alloy 6063-T5, T6, or T52.
  b. Color: Mill finish **OR** Clear **OR** Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from manufacturer's full range, **as directed**.
  c. Architectural Bronze: ASTM B 455, Alloy UNS No. C38500.
5. Structural Performance (if floor mats must withstand heavy wheeled-cart loads): Provide roll-up mats and frames capable of withstanding the following loads and stresses within limits and under conditions indicated:
  a. Uniform floor load of 300 lbf/sq. ft. (14.36 kN/sq. m) **OR as directed**.
  b. Wheel load of 350 lb (159 kg) per wheel **OR as directed**.

B. Entrance Mats
1. Resilient Link Mats: 3/8-inch- (9.5-mm-) **OR** 7/16-inch- (11-mm-), **as directed**, thick, reversible vinyl **OR** rubber **OR** rubber-tire, **as directed**, link mats with galvanized spring-steel **OR** stainless-steel, **as directed**, wire link rods, vulcanized edge-nosing trim, steel-reinforced end trim, and links consisting of rectangular units or continuous strips in a heel-proof, solid-weave pattern with no openings between links **OR** heel-proof, close-weave pattern with openings between links not exceeding 1/8 inch (3 mm) wide by 1 inch (25.4 mm) long **OR** open-weave pattern with openings between links about 1/2 inch (13 mm) wide by 1 inch (25.4 mm) long, **as directed**.
  a. Color: As selected from manufacturer's full range.
  b. Mat Size: As indicated **OR asa directed**.
2. Rubber **OR** Vinyl, **as directed**, Mats: 1/4-inch- (6-mm-) **OR** 3/8-inch- (9.5-mm-) **OR** 7/16-inch- (11-mm-) **OR** 1/2-inch- (13-mm-), **as directed**, thick mats; with square edges for recessed installations **OR** beveled edges for surface applications, **as directed**, and with solid sheet (no perforations) style **OR** perforated style, 1/4-inch (6-mm) diameter on standard spacing **OR** perforated style, 3/16 by 3/4 inch (5 by 19 mm) on standard spacing, **as directed**, standard pyramid design **OR** standard wide-wale corrugated **OR** hi-rib, narrow-wale corrugated, **as directed**, top profile, and low-rib, narrow-wale corrugated **OR** standard knob-base **OR** flat-base, **as directed**, bottom surface.
  a. Color: As selected from manufacturer's full range.
  b. Mat Size: As indicated, **OR as directed**.
3. Cocoa Mats: Constructed from cocoa fiber yarn permanently bonded to PVC backing for dimensional stability and resistance to shedding; 5/8- to 3/4-inch (16- to 19-mm) overall thickness; 1.5-lb/sq. ft (7.3-kg/sq. m) **OR** 1-inch (25.4-mm) overall thickness; 2.0-lb/sq. ft (10-kg/sq. m) **OR** 1-1/4-inch (32-mm) overall thickness; 2.5-lb/sq. ft (12-kg/sq. m), **as directed**, weight.
  a. Color: As selected from manufacturer's full range.
  b. Mat Size: As indicated, **as directed**.
4. Rubber-Tire Mats: Units of edge-grain-laminated and chenille-buffed, rubber-tire wall cuts; bonded to sheet rubber or other durable flexible backing sheet to form 3/8- to 7/16-inch- (9.5- to

11-mm-) thick, 12-inch- (300-mm-) square tile **OR** wide, continuous linear strip up to 25 feet (7.6 m) long, **as directed**.
   a. Mat Size: As indicated **OR as directed**.
5. Carpet-Type Mats: Nylon **OR** Polypropylene **OR** Olefin **OR** Polyester, **as directed**, carpet bonded to 1/8- to 1/4-inch- (3- to 6-mm-) thick, flexible vinyl backing to form mats 3/8 or 7/16 inch (9.5 or 11 mm) thick with nonraveling edges.
   a. Colors, Textures, and Patterns: As selected from manufacturer's full range.
   b. Mat Size: As indicated **OR as directed**.
6. Loop Filament Mats: 3M's "Nomad" loop filament vinyl material 3/8 inch (9.5 mm) **OR** 1/2 inch (13 mm), **as directed**, thick, with solid vinyl sheet **OR** foam sheet, **as directed**, backing and with built-in chemical agents to reduce fungus and mildew.
   a. Color: As selected from manufacturer's full range.
   b. Mat Size: As indicated **OR as directed**.
7. Nuway Mats: Nylon-reinforced, 1/2-inch- (13-mm-) wide by 7/16-inch- (11-mm-) **OR** 11/16-inch- (17.4-mm-), **as directed**, thick, vulcanized laminated rubber strips alternating with 9/16-inch- (14-mm-) wide, profile shapes assembled on 0.1055-inch- (2.7-mm-) diameter, galvanized steel wire, 1-1/2 inches (38 mm) o.c. Fibered surface buffed on rubber strips for interior **OR** unbuffed on rubber strips for exterior, **as directed**, installations.
   a. Semiopen construction incorporating a 1/8-inch- (3-mm-) thick, PVC spacer on each wire between each profile shape and rubber strip to allow dirt, grit, and water to drop through.
   b. Profile Shape Finish: Extruded-aluminum, mill finish **OR** Solid architectural-quality brass **OR** High-impact, solid PVC in color selected, **as directed**.
   c. Color: As selected from manufacturer's full range.
   d. Mat Size: As indicated **OR as directed**.
8. Surface-Mounted Frames:
   a. Tapered Frames: Tapered flexible vinyl edge-frame **OR** aluminum frame, **as directed**, members, not less than 2 inches (50 mm) **OR** 1-1/2 inches (38 mm), **as directed**, wide, attached to mat at all 4 edges, **as directed**, with welded mitered corners.
   b. Color: Mill finish **OR** Clear **OR** Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from manufacturer's full range, **as directed**.
9. Recessed Frames:
   a. Extruded Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6061-T6 or Alloy 6063-T5, T6, or T52.
   b. Color: Mill-finish **OR** Clear **OR** Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from manufacturer's full range, **as directed**.
   c. Architectural Bronze: ASTM B 455, Alloy UNS No. C38500.
10. Graphics: Custom inlaid or woven-in graphic design **OR** logo **OR** emblem **OR** characters, **as directed**, as indicated.

C. Entrance Tiles
1. Rubber-Tire Tiles: Units of edge-grain-laminated and chenille-buffed, rubber-tire wall cuts; bonded to sheet rubber or other durable flexible backing sheet to form 3/8- to 7/16-inch- (9.5- to 11-mm-) thick, square tile **OR** continuous linear strip, **as directed**.
   a. Colors, Textures, and Patterns: As selected from manufacturer's full range.
   b. Tile Size: 12 inches (300 mm) **OR** As indicated, **as directed**.
2. Rubber **OR** Vinyl, **as directed**, Tiles: 5/8-inch- (16-mm-) **OR** 7/16-inch- (11-mm-), **as directed**, thick, solid **OR** open-grid, **as directed**, rubber **OR** vinyl, **as directed**, compound molded tiles with concealed interlocking joint tabs **OR** 1/4-inch- (6-mm-) deep, serpentine-grooved top face and knob-base back face on solid tile, **as directed**.
   a. Colors, Textures, and Patterns: As selected from manufacturer's full range.
   b. Tile Size: As indicated **OR as directed**.
3. Carpet-Type Tiles: Nylon **OR** Polypropylene **OR** Olefin **OR** Polyester, **as directed**, carpet bonded to 1/8- to 1/4-inch- (3- to 6-mm-) thick, flexible vinyl backing to form mats 3/8 or 7/16 inch (9.5 or 11 mm) thick with nonraveling edges.
   a. Colors, Textures, and Patterns: As selected from manufacturer's full range.
   b. Tile Size: As indicated **OR as directed**.

4. Surface-Mounted Frames:
   a. Tapered Frames: Tapered flexible vinyl edge-frame **OR** aluminum frame, **as directed**, members, not less than 2 inches (50 mm) **OR** 1-1/2 inches (38 mm), **as directed**, wide, attached to mat at all 4 edges, **as directed**, with welded mitered corners.
   b. Color: Mill finish **OR** Clear **OR** Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from manufacturer's full range, **as directed**.
5. Recessed Frames: Manufacturer's standard extrusion.
   a. Extruded Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6061-T6 or Alloy 6063-T5, T6, or T52.
   b. Color: Mill-finish **OR** Clear **OR** Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from manufacturer's full range, **as directed**.

D. Concrete Fill And Grout Materials
1. Provide concrete grout and fill equivalent in strength to cast-in-place concrete slabs for recessed mats and frames. Use aggregate no larger than one-third fill thickness.

E. Fabrication
1. Floor Mats: Shop fabricate units to greatest extent possible in sizes indicated. Unless otherwise indicated, provide single unit for each mat installation; do not exceed manufacturer's recommended maximum sizes for units that are removed for maintenance and cleaning. Where joints in mats are necessary, space symmetrically and away from normal traffic lanes. Miter corner joints in framing elements with hairline joints or provide prefabricated corner units without joints.
2. Surface-Mounted Frames: As indicated for permanent surface-mounted installation, complete with corner connectors, splice plates or connecting pins, and postinstalled expansion anchors.
3. Recessed Frames: As indicated, for permanent recessed installation, complete with corner pins or reinforcement and anchorage devices.
   a. Fabricate edge-frame members in single lengths or, where frame dimensions exceed maximum available lengths, provide minimum number of pieces possible, with hairline joints equally spaced and pieces spliced together by straight connecting pins.
4. Coat surfaces of aluminum frames that will contact cementitious material with manufacturer's standard protective coating.

F. Aluminum Finishes
1. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
3. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.
4. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
5. Class II, Color Anodic Finish: AA-M12C22A32/A34 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, integrally colored or electrolytically deposited color coating 0.010 mm or thicker) complying with AAMA 611.
6. Class I, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

G. Copper-Alloy (Bronze) Finishes

1. Finish designations prefixed by CDA comply with the system established by the Copper Development Association for designating copper-alloy finishes, as defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."
    a. Remove tool and die marks and stretch lines or blend into finish.
    b. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
2. CDA Mechanical Finish Designation: M11, specular, as fabricated **OR** M32, directionally textured, medium satin, **as directed**.

1.3 EXECUTION

A. Installation
1. Install recessed mat frames to comply with manufacturer's written instructions. Set mat tops at height recommended by manufacturer for most effective cleaning action; coordinate top of mat surfaces with bottom of doors that swing across mats to provide clearance between door and mat.
    a. For installation in terrazzo flooring areas, provide allowance for grinding and polishing of terrazzo without grinding surface of recessed frames. Coordinate with other trades as required.
    b. Install necessary shims, spacers, and anchorages for proper location and secure attachment of frames.
    c. Install grout and fill around frames and, if required to set mat tops at proper elevations, in recesses under mats. Finish grout and fill smooth and level.
2. Install surface-type units to comply with manufacturer's written instructions at locations indicated; coordinate with entrance locations and traffic patterns.
    a. Anchor fixed surface-type frame members to floor with devices spaced as recommended by manufacturer.

B. Protection
1. After completing frame installation and concrete work, provide temporary filler of plywood or fiberboard in recesses and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and Project is near Final Completion.

END OF SECTION 12 48 13 13

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SECTION 12 48 13 13a - FOOT GRILLES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for foot grilles. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the Work.

B. Summary
   1. This Section includes recessed foot grilles and frames.

C. Performance Requirements
   1. Structural Performance: Provide foot grilles and frames capable of withstanding the following loads and stresses:
      a. Uniform floor load of 300 lbf/sq. ft. (14.36 kN/sq. m) **OR as directed**.
      b. Wheel load of 350 lb (159 kg) **OR as directed,** per wheel.

D. Submittals
   1. Product Data: For each type of foot grille and frame.
   2. Shop Drawings: Show the following:
      a. Items penetrating foot grilles and frames, including the following:
         1) Door control devices.
      b. Divisions between grille sections.
      c. Perimeter floor moldings.
   3. Samples: For each type of product involving color selection.
      a. Foot Grille: 12-inch- (300-mm-) square assembled sections.
      b. Frame Members: 12-inch- (300-mm-) long Sample of each type and color.
   4. Maintenance data.

E. Quality Assurance
   1. Accessibility Requirements: Provide installed foot grilles that comply with Section 4.5 in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" **OR** Sections 302 and 303 in ICC A117.1., **as directed**

1.2 PRODUCTS

A. Materials
   1. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B, with A60 (ZF180) zinc-iron-alloy (galvannealed) coating or with G60 (Z180) mill-phosphatized zinc coating; stretcher-leveled standard of flatness; with minimum thickness indicated representing specified thickness according to ASTM A 924/A 924M.
   2. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304.
   3. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than strength and durability properties of Alloy 5005-H15.
   4. Extruded Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6061-T6 or Alloy 6063-T5, T6, or T52 as standard with manufacturer. Coat surface of frame in contact with cementitious materials with manufacturer's standard protective coating.
   5. Extruded Architectural Bronze: ASTM B 455, Alloy No. C38500.
   6. Stainless-Steel Angles: ASTM A 276 or ASTM A 479/A 479M, corrosion resistant, Type 304.

B. Foot Grilles
1. General: Provide manufacturer's standard foot-grille assemblies consisting of treads of type and profile indicated, interlocked or joined together by cross members, and with support legs (if any) and other components needed to produce a complete installation.
2. Aluminum **OR** Bronze, **as directed**, Foot Grilles: Provide manufacturer's standard foot grilles with extruded members, top-surfaced tread rails, and as follows:
   a. Tread Rails: Extruded-aluminum **OR** Extruded-bronze, **as directed**, tread rails with extruded-aluminum frame, **as directed**.
   b. Tread Rail Spacing: 1-1/2 inches (38 mm) o.c. with 1/8- to 3/16-inch- (3- to 4.8-mm-) **OR** 2 inches (50 mm) o.c. with 1/4-inch- (6-mm-), **as directed**, wide openings between treads.
   c. Aluminum Finish: Mill **OR** Anodized, **as directed**.
      1) Colors: Clear natural aluminum **OR** Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from manufacturer's full range, **as directed**.
   d. Top Surface: Serrated aluminum **OR** Serrated bronze **OR** Serrated vinyl cap with UV stabilizer and antifungal additive **OR** Textured-surface, resilient vinyl insert **OR** Aluminum-oxide or silicon-carbide grit in epoxy matrix **OR** Abrasive particles bonded to or imbedded in vinyl insert **OR** Fusion-bonded, level-cut-pile nylon carpet insert; 1/4 inch (6 mm) high, 28 oz./sq. yd. (950 g/sq. m), **as directed**.
      1) Colors: As selected from manufacturer's full range, **as directed**.
   e. Grille Size: As indicated **OR as directed**.
3. Stainless-Steel Foot Grille: Type 304.
   a. Surface Treads: 0.071-by-0.177-inch (1.8-by-4.49-mm) wire with 0.125-inch- (3.17-mm-) **OR** 0.090-by-0.172-inch (2.2-by-4.37-mm) wire with 0.145-inch- (3.68-mm-) **OR** 0.093-by-0.156-inch (2.36-by-3.96-mm) wire with 0.125-inch- (3.17-mm-), **as directed**, wide openings between wires.
   b. Support Rods: Spaced 1 inch (25 mm) o.c., welded to each wire.
   c. Mat Grating: 5/8 inch (16 mm) deep.
   d. Pit Grating: 1-1/8 inches (28.5 mm) deep.
   e. Stainless-Steel Finish: Mill **OR** No. 4, **as directed**, finish.
   f. Grille Size: As indicated **OR as directed**.
4. PVC Foot Grille: 1/8-by-1-1/2-by-1-inch (3-by-38-by-25-mm) ribbed top, PVC tread bars joined with 3/8-inch (10-mm) stainless-steel rods with 1-1/16-inch- (27-mm-) long nylon spacers at 12 inches (300 mm) o.c. Provide PVC frame with nylon anchors.
   a. Colors: As selected from manufacturer's full range.
   b. Grille Size: As indicated **OR as directed**.
5. Lockdown: Manufacturer's standard **OR** Hidden **OR** In view, **as directed**.

C. Frames
1. Provide manufacturer's standard frames of size and style for grille type, for permanent recessed installation in subfloor, complete with installation anchorages and accessories. Unless otherwise indicated, fabricate frame of same material and finish as grilles.

D. Support System
1. Level Bed Applications: Provide manufacturer's standard, vinyl cushion support system.
2. Drainage Pit Applications: Provide manufacturer's special deep-pit frame and support extrusion system with intermediate support beams, sized and spaced as recommended by manufacturer for indicated spans and equipped with vinyl support cushions.

E. Drain Pans
1. Provide manufacturer's standard, 0.060-inch- (1.52-mm-) thick, **as directed**, metallic-coated steel **OR** aluminum **OR** stainless-steel, **as directed**, sheet drain pan with NPS 2 (DN 50) drain outlet for each floor grille unit. Coat bottom of pan with protective coating recommended by manufacturer.

F. Fabrication

1. Shop fabricate foot grilles to greatest extent possible in sizes as indicated. Unless otherwise indicated, provide each grille as a single unit; do not exceed manufacturer's recommended maximum sizes for units that are removed for maintenance and cleaning. Where joints in grilles are necessary, space symmetrically and away from normal traffic lanes.
2. Fabricate frame members in single lengths or, where frame dimensions exceed maximum available lengths, provide minimum number of pieces possible, with hairline joints equally spaced and pieces spliced together by straight connecting pins.

G. Finishes, General
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

H. Aluminum Finishes
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Mill Finish: AA-M10 (Mechanical Finish: as fabricated); grind and buff as required to remove scratches, welding, or abrasions produced in fabrication process.
3. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.
4. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
5. Class II, Color Anodic Finish: AA-M12C22A32/A34 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, integrally colored or electrolytically deposited color coating 0.010 mm or thicker).
6. Class I, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

I. Stainless-Steel Finishes
1. Mill finish.
2. Directional Satin Finish: No. 4.
   a. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

J. Copper-Alloy (Bronze) Finishes
1. Finish designations for copper alloys comply with the system established for designating copper-alloy finish systems defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."
   a. Remove tool and die marks and stretch lines or blend into finish.
   b. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
2. Mechanical Finish Designation: M11, specular, as fabricated **OR** M32, directionally textured, medium satin, **as directed**.

1.3 EXECUTION

A. Installation
1. Install recessed foot grilles and frames and drain pans to comply with manufacturer's written instructions at locations indicated and with top of foot grilles and frames in relationship to one another and to adjoining finished flooring as recommended by manufacturer. Set foot-grille tops

at height for most effective cleaning action. Coordinate top of foot-grille surfaces with doors that swing across grilles to provide clearance under door.

B. Protection

1. After completing frame installations, provide temporary filler of plywood or fiberboard in foot-grille recesses and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and Project is near Final Completion.

END OF SECTION 12 48 13 13a

Task	Specification	Specification Description
12 48 13 16	12 48 13 13	Floor Mats And Frames
12 48 13 16	12 48 13 13a	Foot Grilles
12 55 13 00	10 86 00 00	Detention Furniture
12 55 16 00	10 86 00 00	Detention Furniture
12 55 19 00	10 86 00 00	Detention Furniture
12 55 23 00	10 86 00 00	Detention Furniture
12 55 26 00	10 28 13 13a	Detention Toilet Accessories
12 55 26 00	10 86 00 00	Detention Furniture
12 55 86 00	10 86 00 00	Detention Furniture

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SECTION 12 56 53 00 - LABORATORY CASEWORK

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for laboratory casework. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Metal laboratory casework, with wood doors and drawer fronts.
b. Wood laboratory casework.
c. Plastic-laminate laboratory casework.
d. Utility-space framing at backs of base cabinets and between backs of base cabinets.
e. Filler and closure panels.
f. Laboratory casework system that includes support and utility-space framing, filler and closure panels, wall panels, undercabinet lighting, and modular countertops.
g. Laboratory countertops.
h. Tables.
i. Shelves.
j. Laboratory sinks and troughs.
k. Laboratory accessories.
l. Water, laboratory gas, and electrical service fittings.

C. Definitions
1. MDF: Medium-density fiberboard.
2. Exposed Surfaces of Casework: Surfaces visible when doors and drawers are closed, including bottoms of cabinets more than 48 inches (1200 mm) above floor, and visible surfaces in open cabinets or behind glass doors.
a. Ends of cabinets, including those installed directly against walls or other cabinets, are defined as "exposed."
OR
Ends of cabinets indicated to be installed directly against and completely concealed by walls or other cabinets are defined as "concealed."
3. Semiexposed Surfaces of Casework: Surfaces behind opaque doors, such as cabinet interiors, shelves, and dividers; interiors and sides of drawers; and interior faces of doors. Tops of cabinets 78 inches (1980 mm) or more above floor are defined as "semiexposed."
4. Concealed Surfaces of Casework: Include sleepers, web frames, dust panels, and other surfaces not usually visible after installation.
5. Hardwood Plywood: A panel product composed of layers or plies of veneer, or of veneers in combination with lumber core, hardboard core, MDF core, or particleboard core, joined with adhesive and faced both front and back with hardwood veneers.

D. Performance Requirements
1. System Structural Performance: Laboratory casework and support framing system shall withstand the effects of the following gravity loads and stresses without permanent deformation, excessive deflection, or binding of drawers and doors:
a. Support Framing System: 600 lb/ft. (900 kg/m).
b. Suspended Base Cabinets (Internal Load): 160 lb/ft. (240 kg/m).
c. Work Surfaces (Including Tops of Suspended Base Cabinets): 160 lb/ft. (240 kg/m).
d. Wall Cabinets (Upper Cabinets): 160 lb/ft. (240 kg/m).
e. Shelves: 40 lb/sq. ft. (200 kg/sq. m).

2. Delegated Design: Design laboratory casework, including comprehensive engineering analysis by a qualified professional engineer, using seismic performance requirements and design criteria indicated.
3. Seismic Performance: Laboratory casework and support framing system, including attachments to other work, shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
    a. Component Importance Factor is 1.5 **OR** 1.0, **as directed**.

E. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
    a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that cabinets **OR** cabinets, countertops, and shelves, **as directed**, comply with forest certification requirements.
        1) Include evidence that casework manufacturer is certified for chain of custody by an FSC-accredited certification body.
        2) Include statement indicating costs for each certified wood product.
    b. Product Data for Credit EQ 4.4: For adhesives and composite wood products, documentation indicating that product contains no urea formaldehyde.
3. Shop Drawings: For laboratory casework. Include plans, elevations, sections, details, and attachments to other work.
4. Samples: For each type of cabinet finish.
5. Delegated-Design Submittal: For laboratory casework indicated to comply with seismic performance requirements, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
6. Product Test Reports for Casework: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of laboratory casework with requirements of specified product standard and system structural performance specified in "Performance Requirements" Article.
7. Product Test Reports for Countertop Surface Material: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of laboratory countertop surface materials with requirements specified for chemical and physical resistance.

F. Quality Assurance
1. Manufacturer Qualifications: A qualified manufacturer that produces casework of types indicated for this Project that has been tested for compliance with SEFA 8 and is certified for chain of custody by an FSC-accredited certification body.
2. Source Limitations: Obtain laboratory casework from single source from single manufacturer unless otherwise indicated.
3. Product Designations: Drawings indicate sizes and configurations of laboratory casework by referencing designated manufacturer's catalog numbers. Other manufacturers' laboratory casework of similar sizes and similar door and drawer configurations and complying with the Specifications may be considered.
4. Casework Product Standard: Comply with SEFA 8, "Laboratory Furniture - Casework, Shelving and Tables - Recommended Practices."
5. Flammable Liquid Storage: Where cabinets are indicated for solvent or flammable liquid storage, provide units that are listed and labeled as complying with requirements in NFPA 30 by a testing and inspecting agency acceptable to authorities having jurisdiction **OR** FM Approvals, **as directed**.
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
7. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling

1. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.

1.2 PRODUCTS

A. Metal Cabinet And Table Materials
1. Metal: Cold-rolled, commercial steel (CS) sheet, complying with ASTM A 1008/A 1008M; matte finish; suitable for exposed applications.
2. Nominal Metal Thickness:
   a. Sides, Ends, Fixed Backs, Bottoms, Tops, Soffits, and Items Not Otherwise Indicated: 0.048 inch (1.21 mm). Except for flammable liquid storage cabinets, bottoms may be 0.036 inch (0.91 mm) if reinforced.
   b. Back Panels, Doors, Drawer Fronts and Bodies, and Shelves: 0.036 inch (0.91 mm) except 0.048 inch (1.21 mm) for back panels and doors of flammable liquid storage cabinets and for unreinforced shelves more than 36 inches (900 mm) long.
   c. Intermediate Horizontal Rails, Table Aprons and Cross Rails, Center Posts, and Top Gussets: 0.060 inch (1.52 mm).
   d. Drawer Runners, Sink Supports, and Hinge Reinforcements: 0.075 inch (1.90 mm).
   e. Leveling and Corner Gussets: 0.105 inch (2.66 mm).
3. Wood Door and Drawer Front Materials:
   a. General: Provide materials that are selected and arranged for compatible grain and color. Do not use materials adjacent to one another that are noticeably dissimilar in color, grain, figure, or natural character markings.
   b. Wood Species: Red oak **OR** White birch **OR** Alder **OR** White maple **OR** Hickory **OR** Cherry, **as directed**.
   c. Certified Wood Materials: Provide wood door and drawer fronts obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
   d. Adhesives: Do not use adhesives that contain urea formaldehyde.
   e. Hardwood Plywood: HPVA HP-1, either veneer core or particleboard core, unless otherwise indicated, made without urea formaldehyde with face veneer of species indicated, selected for compatible color and grain. Grade A exposed faces at least 1/50 inch (0.5 mm) thick, and Grade J crossbands. Provide backs of same species as faces.
      1) Face Veneer Cut: Plain sliced **OR** Quarter sliced **OR** Rift cut **OR** Rotary cut, **as directed**.
      2) Particleboard: ANSI A208.1, Grade M-2.
      3) Particleboard: ANSI A208.1, Grade M-2, made with binder containing no urea formaldehyde **OR** straw-based particleboard complying with ANSI A208.1, Grade M-2, except for density, made with binder containing no urea formaldehyde, **as directed**.
   f. Solid Wood: Clear hardwood lumber of species indicated and selected for grain and color compatible with exposed hardwood plywood, selected for compatible grain and color, with moisture content not more than 7 percent.
   g. Edgebanding for Wood-Veneered Construction: Minimum 1/8-inch- (3-mm-) thick, solid wood of same species as face veneer **OR** Wood veneer of same species as face veneer **OR** Rigid PVC extrusions, through color with satin finish, 3 mm thick, **as directed**.
      1) Colors: As selected from manufacturer's full range.

B. Wood Cabinet And Table Materials
1. General:
   a. Certified Wood Materials: Provide cabinets with not less than 70 percent of wood products **OR** all wood products, **as directed**, obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
   b. Adhesives: Do not use adhesives that contain urea formaldehyde.

c. Maximum Moisture Content for Lumber: 7 percent for hardwood and 12 percent for softwood.
d. Hardwood Plywood: HPVA HP-1, either veneer core or particleboard core, unless otherwise indicated, made without urea formaldehyde.
e. MDF: ANSI A208.2, Grade 130, made with binder containing no urea formaldehyde.
f. Particleboard: ANSI A208.1, Grade M-2.
g. Particleboard: ANSI A208.1, Grade M-2, made with binder containing no urea formaldehyde **OR** straw-based particleboard complying with ANSI A208.1, Grade M-2, except for density, made with binder containing no urea formaldehyde, **as directed**.
h. Hardboard: AHA A135.4, Class 1 Tempered.
i. Edgebanding for Wood-Veneered Construction: Minimum 1/8-inch- (3-mm-) thick, solid wood of same species as face veneer **OR** Wood veneer of same species as face veneer **OR** Rigid PVC extrusions, through color with satin finish, 3 mm thick at doors and drawer fronts, 1 mm thick elsewhere, **as directed**.
    1) Colors: As selected from manufacturer's full range.

2. Exposed Materials:
    a. General: Provide materials that are selected and arranged for compatible grain and color. Do not use materials adjacent to one another that are noticeably dissimilar in color, grain, figure, or natural character markings.
    b. Wood Species: Red oak **OR** White birch **OR** Alder **OR** White maple **OR** Hickory **OR** Cherry, **as directed**.
    c. Plywood: Hardwood plywood with face veneer of species indicated, selected for compatible color and grain. Grade A exposed faces at least 1/50 inch (0.5 mm) thick, and Grade J crossbands. Provide backs of same species as faces.
    d. Face Veneer Cut: Plain sliced **OR** Quarter sliced **OR** Rift cut **OR** Rotary cut, **as directed**.
    e. Solid Wood: Clear hardwood lumber of species indicated and selected for grain and color compatible with exposed hardwood plywood, selected for compatible grain and color.
3. Semiexposed Materials:
    a. Solid Wood: Sound hardwood lumber, selected to eliminate appearance defects, of any species similar in color and grain to **OR** same species as, **as directed**, exposed solid wood.
    b. Plywood: Hardwood plywood of any species similar in color and grain to **OR** same species as, **as directed**, exposed plywood. Grade B **OR** Grade C, **as directed**, faces and Grade J crossbands. Provide backs of same species as faces.
    c. Provide solid wood or hardwood plywood for semiexposed surfaces unless otherwise indicated.
    d. Metal for Steel Drawer Pans: Cold-rolled, carbon-steel sheet complying with ASTM A 1008/A 1008M; matte finish; suitable for exposed applications.
4. Concealed Materials:
    a. Solid Wood: Any species, with no defects affecting strength or utility.
    b. Plywood: Hardwood plywood. Provide backs of same species as faces.
    c. Particleboard.
    d. MDF.
    e. Hardboard.

C. Plastic-Laminate Cabinet Materials
1. General:
    a. Certified Wood Materials: Provide cabinets with not less than 70 percent of wood products **OR** all wood products, **as directed**, obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
    b. Adhesives: Do not use adhesives that contain urea formaldehyde.
    c. Hardwood Plywood: HPVA HP-1, either veneer core or particleboard core, unless otherwise indicated, made without urea formaldehyde.
    d. MDF: ANSI A208.2, Grade 130, made with binder containing no urea formaldehyde.

e. Particleboard: ANSI A208.1, Grade M-2.
f. Particleboard: ANSI A208.1, Grade M-2, made with binder containing no urea formaldehyde **OR** straw-based particleboard complying with ANSI A208.1, Grade M-2, except for density, made with binder containing no urea formaldehyde, **as directed**.
g. Hardboard: AHA A135.4, Class 1 Tempered.
h. Plastic Laminate: High-pressure decorative laminate complying with NEMA LD 3.
i. Thermoset Decorative Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.
j. Edgebanding for Plastic Laminate: Plastic laminate matching adjacent surfaces **OR** Rigid PVC extrusions, through color with satin finish, 3 mm thick at doors and drawer fronts, 1 mm thick elsewhere, **as directed**.
   1) Colors: As selected from manufacturer's full range.
k. Edgebanding for Thermoset Decorative Panels: PVC or polyester edge banding complying with LMA EDG-1 and matching thermoset decorative panels.

2. Exposed Materials:
   a. Plastic Laminate: Grade HGS **OR** Grade HGL **OR** Grade VGS, **as directed**.
      1) Colors: As selected from manufacturer's full range.
3. Semiexposed Materials:
   a. Plastic Laminate: Grade VGS **OR** Grade CLS, **as directed**.
      1) Colors: As selected from manufacturer's full range.
      2) Provide plastic laminate for semiexposed surfaces unless otherwise indicated.
      OR
      Provide plastic laminate for interior faces of doors and drawer fronts and where indicated.
   b. Thermoset Decorative Panels: Provide thermoset decorative panels for semiexposed surfaces unless otherwise indicated.
      1) Colors: As selected from manufacturer's full range.
   c. Solid Wood: Sound hardwood lumber, selected to eliminate appearance defects.
   d. Plywood: Hardwood plywood. Grade B **OR** Grade C, **as directed**, faces and Grade J crossbands. Provide backs of same species as faces.
   e. Metal for Steel Drawer Pans: Cold-rolled, carbon-steel sheet complying with ASTM A 1008/A 1008M; matte finish; suitable for exposed applications.
4. Concealed Materials:
   a. Solid Wood: Any species, with no defects affecting strength or utility.
   b. Plywood: Hardwood plywood.
   c. Plastic Laminate: Type BKL.
   d. Particleboard.
   e. MDF.
   f. Hardboard.

D. Auxiliary Cabinet Materials
1. Acid Storage-Cabinet Lining: 1/4-inch- (6-mm-) thick, glass-fiber cement board complying with ASTM C 1186 **OR** polyethylene or polypropylene **OR** polyethylene, polypropylene, epoxy, or phenolic-composite lining material, **as directed**.
2. Glass for Glazed Doors: Clear float glass complying with ASTM C 1036, Type I, Class 1, Quality-Q3; not less than 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**, thick.
3. Glass for Glazed Doors: Clear tempered glass complying with ASTM C 1048, Kind FT, Condition A, Type I, Class 1, Quality-Q3; not less than 5.0 mm thick.
   OR
   Glass for Glazed Doors: Clear laminated tempered glass complying with ASTM C 1172, Kind LT, Condition A, Type I, Class I, Quality-Q3; with 2 lites not less than 3.0 mm thick and with clear, polyvinyl butyral interlayer.
4. Frameless Glass Doors: Clear tempered glass complying with ASTM C 1048, Kind FT, Condition A, Type I, Class 1, Quality-Q3; not less than 5.0 **OR** 6.0, **as directed**, mm thick; with exposed edges seamed before tempering.

E. Countertop Table Top, Shelf, Trough, And Sink Materials
1. Plastic Laminate: High-pressure decorative laminate complying with NEMA LD 3.
a. Colors, Patterns, and Finishes: As selected from casework manufacturer's full range.
2. Chemical-Resistant Plastic Laminate:
a. High-pressure decorative laminate, complying with NEMA LD 3, that has the following ratings when tested with indicated reagents according to NEMA LD 3, Test Procedure 3.4.5:
1) No Effect: Acetic acid (98 percent), acetone, ammonium hydroxide (28 percent), amyl acetate, benzene, butyl alcohol, carbon tetrachloride, chloroform, dimethyl formamide, dioxane, ethyl acetate, ethyl alcohol, ethyl ether, formaldehyde (37 percent), gasoline, gentian violet, hydrogen peroxide (3 percent), methyl alcohol, methyl ethyl ketone, methylene chloride, mono chlorobenzene, naphthalene, toluene, trichloroethylene, xylene, and zinc chloride (saturated). Hydrochloric acid (37 percent), methyl red, nitric acid (30 percent), phenol (90 percent), phosphoric acid (75 percent), silver nitrate (saturated), sodium hydroxide (20 percent), and sulfuric acid (77 percent), **as directed**.
2) Slight Effect: Cresol and tincture of iodine, sodium sulfide (15 percent). Phenol (90 percent), sodium hydroxide (20 percent), and methyl red, **as directed**.
3) Moderate Effect: Hydrochloric acid (37 percent), nitric acid (30 percent), phosphoric acid (75 percent), silver nitrate (saturated), and sulfuric acid (77 percent), **as directed**.
b. Color: Black **OR** As indicated by manufacturer's designations **OR** As selected from chemical-resistant, plastic-laminate manufacturer's full range, **as directed**.
3. Core Materials for Plastic Laminate:
a. Particleboard: ANSI A208.1, Grade M-2.
b. Urea-Formaldehyde-Free Particleboard: ANSI A208.1, Grade M-2, made with binder containing no urea formaldehyde.
c. Exterior-Glue Particleboard: ANSI A208.1, Grade M-2, Exterior Glue.
d. Straw-Based Particleboard: ANSI A208.1, Grade M-2, except for density, made with binder containing no urea formaldehyde.
e. Exterior Plywood: DOC PS 1, Exterior A-C **OR** Exterior B-C, **as directed**, with fully sanded face.
4. Adhesive for Bonding Plastic Laminate: Resorcinol **OR** Urea formaldehyde **OR** Contact adhesive **OR** Manufacturer's standard waterproof adhesive **OR** Manufacturer's standard waterproof, urea-formaldehyde-free adhesive, **as directed**.
5. Epoxy: Factory-molded, modified epoxy-resin formulation with smooth, nonspecular finish.
a. Physical Properties:
1) Flexural Strength: Not less than 10,000 psi (70 MPa).
2) Modulus of Elasticity: Not less than 2,000,000 psi (1400 MPa).
3) Hardness (Rockwell M): Not less than 100.
4) Water Absorption (24 Hours): Not more than 0.02 percent.
5) Heat Distortion Point: Not less than 260 deg F (127 deg C).
b. Chemical Resistance: Epoxy-resin material has the following ratings when tested with indicated reagents according to NEMA LD 3, Test Procedure 3.4.5:
1) No Effect: Acetic acid (98 percent), acetone, ammonium hydroxide (28 percent), benzene, carbon tetrachloride, dimethyl formamide, ethyl acetate, ethyl alcohol, ethyl ether, methyl alcohol, nitric acid (70 percent), phenol, sulfuric acid (60 percent), and toluene.
2) Slight Effect: Chromic acid (60 percent) and sodium hydroxide (50 percent).
c. Color: Black **OR** Gray **OR** Beige **OR** As selected from manufacturer's full range, **as directed**.
6. Phenolic Composite: Solid, high-pressure decorative laminate, complying with NEMA LD 3, Grade CGS.
a. Chemical Resistance: Composite countertop material has the following ratings when tested with indicated reagents according to NEMA LD 3, Test Procedure 3.4.5:

1) No Effect: Acetic acid (98 percent), acetone, ammonium hydroxide (28 percent), benzene, carbon tetrachloride, dimethyl formamide, ethyl acetate, ethyl alcohol, formaldehyde (37 percent), furfural, hydrochloric acid (37 percent), hydrofluoric acid (48 percent), nitric acid (30 percent), phosphoric acid (85 percent), sodium hydroxide (20 percent), sulfuric acid (33 percent), toluene, and zinc chloride, **as directed**.

b. Color: Black **OR** White **OR** Gray **OR** Beige **OR** As selected from manufacturer's full range, **as directed**.

7. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304 **OR** Type 316L, **as directed**.

F. Metal Cabinets And Tables

1. Fabrication: Assemble and finish units at point of manufacture. Use precision dies for interchangeability of like-size drawers, doors, and similar parts. Perform assembly on precision jigs to provide units that are square. Reinforce units with angles, gussets, and channels. Except where otherwise specified, integrally frame and weld cabinet bodies to form dirt and vermin-resistant enclosures. Where applicable, reinforce base cabinets for sink support. Maintain uniform clearance around door and drawer fronts of 1/16 to 3/32 inch (1.5 to 2.4 mm).
2. Flush Doors: Outer and inner pans that nest into box formation, with full-height channel reinforcements at center of door. Fill doors with noncombustible, sound-deadening material.
3. Glazed Doors: Hollow-metal stiles and rails of similar construction as flush doors, with glass held in resilient channels or gasket material.
4. Hinged Doors: Mortise for hinges and reinforce with angles welded inside inner pans at hinge edge.
5. Drawers: Fronts made from outer and inner pans that nest into box formation, with no raw metal edges at top. Sides, back, and bottom fabricated in one piece with rolled or formed top of sides for stiffening and comfortable grasp for drawer removal. Provide drawers with rubber bumpers, polymer roller slides, and positive stops to prevent metal-to-metal contact or accidental removal.
6. Wood Doors: 3/4 inch (19 mm) thick, with particleboard or MDF cores, solid hardwood stiles and rails, and hardwood face veneers and crossbands.
7. Drawers with Wood Fronts: Fronts made from 3/4-inch- (19-mm-) thick, hardwood plywood or solid hardwood. Subfronts, sides, back, and bottom fabricated in one piece with rolled or formed top of sides for stiffening and comfortable grasp for drawer removal. Provide drawers with rubber bumpers, polymer roller slides, and positive stops to prevent metal-to-metal contact or accidental removal.
8. Design of Wood Doors and Drawer Fronts: Lipped overlay with radiused edges **OR** Reveal overlay with square edges **OR** Reveal overlay with radiused edges, **as directed**.
   a. Provide 1/8-inch (3.2-mm) reveals between adjacent doors and adjacent drawers and between adjacent cabinets.
9. Grain Direction for Wood Doors and Drawer Fronts: Vertical on doors, horizontal on drawer fronts **OR** on both doors and drawer fronts, with continuous vertical matching, **as directed**.
10. Veneer Matching for Wood Doors and Drawer Fronts:
    a. None required; select and arrange veneers for compatible grain and color.
    b. Provide veneers for each cabinet from a single flitch, book and running matched **OR** slip and running matched **OR** book or slip and running matched **OR** book and balance matched **OR** slip and balance matched **OR** book or slip and balance matched, **as directed**.
       1) Provide continuous matching of adjacent drawer fronts within each cabinet.
    c. Provide veneers for each elevation from a single flitch, book and running matched **OR** slip and running matched **OR** book or slip and running matched **OR** book and balance matched **OR** slip and balance matched **OR** book or slip and balance matched, **as directed**.
       1) Provide continuous matching of adjacent drawer fronts within each cabinet and end matching between drawer fronts of adjacent cabinets.
11. Adjustable Shelves: Front, back, and ends formed down, with edges returned horizontally at front and back to form reinforcing channels.
12. Toe Space: Fully enclosed, 4 inches (100 mm) high by 3 inches (75 mm) deep, with no open gaps or pockets.

13. Tables: Welded tubing legs, not less than 2 inches (50 mm) square with channel stretchers as needed to comply with product standard. Weld or bolt stretchers to legs and cross-stretchers, and bolt legs to table aprons. Provide leveling device welded to bottom of each leg.
    a. Leg Shoes: Black vinyl or rubber **OR** Satin-finished stainless steel, **as directed**, open-bottom, slip-on type.
14. Utilities: Provide space, cutouts, and holes for pipes, conduits, and fittings in cabinet bodies to accommodate utility services and their support-strut assemblies.
    a. Provide base cabinets with removable backs for access to utility space.
15. Utility-Space Framing: Laboratory casework manufacturer's standard steel framing units consisting of 2 steel slotted channels complying with MFMA-4, not less than 1-5/8 inches (41 mm) square by 0.105-inch (2.66-mm) nominal thickness, and connected at top and bottom by U-shaped brackets made from 1-1/4-by-1/4-inch (32-by-6-mm) steel flat bars. Framing units may be made by welding specified channel material into rectangular frames instead of using U-shaped brackets.
16. Filler and Closure Panels: Provide where indicated and as needed to close spaces between cabinets and walls, ceilings, and indicated equipment. Fabricate from same material and with same finish as cabinets and with hemmed or flanged edges unless otherwise indicated.
    a. Provide utility-space closure panels at spaces between base cabinets where utility space would otherwise be exposed, including spaces below countertops.
    b. Provide closure panels at ends of utility spaces where utility space would otherwise be exposed.
    c. Provide knee-space panels (modesty panels) at spaces between base cabinets, where cabinets are not installed against a wall or where space is not otherwise closed **OR** indicated, **as directed**. Fabricate from back-to-back panels or of hollow construction to eliminate exposed hemmed or flanged edges.

G. Wood Cabinets And Tables

1. Design: Lipped overlay with radiused edges **OR** Reveal overlay with square edges **OR** Reveal overlay with radiused edges, **as directed**.
    a. Provide 1/8-inch (3.2-mm) reveals between doors and drawers that are adjacent.
2. Grain Direction:
    a. Vertical on both doors and drawer fronts, with continuous vertical matching.
       OR
       Vertical on doors, horizontal on drawer fronts.
    b. Lengthwise on face frame members.
    c. Vertical on end panels.
    d. Side to side on bottoms and tops of units.
    e. Vertical on knee-space panels.
    f. Horizontal on aprons and table frames.
3. Veneer Matching:
    a. None required; select and arrange veneers for compatible grain and color.
       OR
       Provide veneers for each cabinet from a single flitch, book and running matched **OR** slip and running matched **OR** book or slip and running matched **OR** book and balance matched **OR** slip and balance matched **OR** book or slip and balance matched, **as directed**.
        1) Provide continuous matching of adjacent drawer fronts within each cabinet.
       OR
       Provide veneers for each elevation from a single flitch, book and running matched **OR** slip and running matched **OR** book or slip and running matched **OR** book and balance matched **OR** slip and balance matched **OR** book or slip and balance matched, **as directed**.
        1) Provide continuous matching of adjacent drawer fronts within each cabinet and end matching between drawer fronts of adjacent cabinets.
4. Construction: Provide wood-faced laboratory casework of the following minimum construction:
    a. Bottoms of Base Cabinets and Tall Cabinets: 3/4-inch- (19-mm-) thick hardwood plywood **OR** veneer-core hardwood plywood, **as directed**.

b. Tops and Bottoms of Wall Cabinets and Tops of Tall Cabinets: 1-inch- (25-mm-) thick veneer-core hardwood plywood.
c. Ends of Cabinets: 3/4-inch- (19-mm-) thick hardwood plywood.
d. Shelves: 1-inch- (25-mm-) thick veneer-core hardwood plywood.
e. Base Cabinet Top Frames: 3/4-by-2-inch (19-by-50-mm) solid wood with mortise and tenon or doweled connections, glued and pinned or screwed.
f. Base Cabinet Stretchers: 3/4-by-4-1/2-inch (19-by-114-mm) panel product strips or solid wood boards at front and back of cabinet, glued and pinned or screwed. May be provided as an option to base cabinet top frames.
g. Base Cabinet Subtops: 3/4-inch- (19-mm-) thick panel product glued and pinned or screwed. May be provided as an option to base cabinet top frames.
h. Backs of Cabinets: 3/4-inch- (19-mm-) thick, hardwood plywood **OR** particleboard- or MDF-core hardwood plywood, **as directed**, where exposed, 1/4-inch- (6.4-mm-) thick hardboard **OR** 1/4-inch- (6.4-mm-) thick, hardwood plywood **OR** 1/2-inch- (12.7-mm-) thick, hardwood plywood, **as directed**, dadoed into sides, bottoms, and tops where not exposed.
i. Drawer Fronts: 3/4-inch- (19-mm-) thick, hardwood plywood **OR** particleboard- or MDF-core hardwood plywood, **as directed**, or solid hardwood.
j. Drawer Sides and Backs: 1/2-inch- (12.7-mm-) thick, solid hardwood or hardwood plywood **OR** veneer-core hardwood plywood, **as directed**, with glued dovetail or multiple-dowel joints.
k. Drawer Bottoms: 1/4-inch- (6.4-mm-) thick, veneer-core hardwood plywood glued and dadoed into front, back, and sides of drawers. Use 1/2-inch- (12.7-mm-) thick material for drawers more than 24 inches (600 mm) wide.
l. Drawer Bodies: Steel drawer pans formed from 0.036-inch- (0.91-mm-) thick metal, metallic phosphate treated, and finished with manufacturer's standard 2-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat and 2 mils (0.05 mm) for system.
m. Doors 48 Inches (1200 mm) High or Less: 3/4 inch (19 mm) thick, with particleboard or MDF cores, solid hardwood stiles and rails, and hardwood face veneers and crossbands.
n. Doors More Than 48 Inches (1200 mm) High: 1-1/16 inches (27 mm) thick, with honeycomb cores, solid hardwood stiles and rails, and hardwood face veneers and crossbands.
OR
Doors More Than 48 Inches (1200 mm) High: 1-1/8 inches (29 mm) thick, with particleboard cores and hardwood face veneers and crossbands.
o. Stiles and Rails of Glazed Doors 48 Inches (1200 mm) High or Less: 3/4-inch- (19-mm-) thick, solid hardwood.
OR
Stiles and Rails of Glazed Doors 48 Inches (1200 mm) High or Less: 3/4-inch- (19-mm-) thick particleboard with hardwood face veneers and crossbands.
p. Stiles and Rails of Glazed Doors More Than 48 Inches (1200 mm) High: 1-1/16-inch- (27-mm-) thick, solid wood with hardwood face veneers.
OR
Stiles and Rails of Glazed Doors More Than 48 Inches (1200 mm) High: 1-1/8 inches (29 mm) thick, with particleboard cores and hardwood face veneers and crossbands.

5. Tables: Solid hardwood legs, not less than 2 inches (50 mm) square with solid hardwood stretchers as needed to comply with product standard. Bolt stretchers to legs and cross-stretchers, and bolt legs to table aprons. Provide leveling device at bottom of each leg.
   a. Leg Shoes: Black vinyl or rubber, open-bottom, slip-on type.
6. Utility-Space Framing: Laboratory casework manufacturer's standard steel framing units consisting of 2 steel slotted channels complying with MFMA-4, not less than 1-5/8 inches (41 mm) square by 0.105-inch (2.66-mm) nominal thickness, and connected at top and bottom by U-shaped brackets made from 1-1/4-by-1/4-inch (32-by-6-mm) steel flat bars. Framing units may be made by welding specified channel material into rectangular frames instead of using U-shaped brackets.

7. Filler and Closure Panels: Provide where indicated and as needed to close spaces between cabinets and walls, ceilings, and indicated equipment. Fabricate from same material and with same finish as adjacent exposed cabinet surfaces unless otherwise indicated.
   a. Provide utility-space closure panels at spaces between base cabinets where utility space would otherwise be exposed, including spaces below countertops.
   b. Provide closure panels at ends of utility spaces where utility space would otherwise be exposed.
   c. Provide knee-space panels (modesty panels) at spaces between base cabinets, where cabinets are not installed against a wall or where space is not otherwise closed **OR** indicated, **as directed**. Fabricate from same material and with same finish as exposed cabinet backs.

H. Plastic-Laminate Cabinets
1. Design: Reveal **OR** Flush, **as directed**, overlay.
2. Construction: Provide plastic-laminate-faced laboratory casework of the following minimum construction:
   a. Bottoms and Ends of Cabinets, and Tops of Wall Cabinets and Tall Cabinets: 3/4-inch- (19-mm-) thick particleboard, plastic-laminate faced on exposed surfaces, thermoset decorative panels on semiexposed surfaces, **as directed**.
   b. Shelves: 3/4-inch- (19-mm-) thick thermoset decorative panels.
   OR
   Shelves: 3/4-inch- (19-mm-) thick particleboard, plastic-laminate faced on exposed surfaces, thermoset decorative panels on semiexposed surfaces, **as directed**.
   OR
   Shelves: 3/4-inch- (19-mm-) thick plywood, plastic-laminate faced.
   c. Backs of Cabinets: 1/2-inch- (12.7-mm-) thick particleboard, plastic-laminate faced on exposed surfaces, thermoset decorative panels on semiexposed surfaces, **as directed**.
   d. Drawer Fronts: 3/4-inch- (19-mm-) thick particleboard, plastic-laminate faced.
   e. Drawer Sides and Backs: 1/2-inch- (12.7-mm-) thick solid-wood or veneer-core hardwood plywood **OR** thermoset decorative panels, **as directed**, with glued dovetail or multiple-dowel joints.
   f. Drawer Bottoms: 1/4-inch- (6.4-mm-) thick hardwood plywood **OR** thermoset decorative panels **OR** hardboard, **as directed**, glued and dadoed into front, back, and sides of drawers. Use 1/2-inch- (12.7-mm-) thick material for drawers more than 24 inches (600 mm) wide.
   g. Drawer Bodies: Steel drawer pans formed from 0.036-inch- (0.91-mm-) thick metal, metallic phosphate treated, and finished with manufacturer's standard 2-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat and 2 mils (0.05 mm) for system.
   h. Doors 48 Inches (1200 mm) High or Less: 3/4 inch (19 mm) thick, with particleboard or MDF cores and solid-wood stiles and rails, plastic-laminate faced.
   i. Doors More Than 48 Inches (1200 mm) High: 1-1/16 inches (27 mm) thick, with honeycomb cores and solid hardwood stiles and rails, plastic-laminate faced.
   OR
   Doors More Than 48 Inches (1200 mm) High: 1-1/8 inches (29 mm) thick, with particleboard cores, plastic-laminate faced.
   j. Stiles and Rails of Glazed Doors 48 Inches (1200 mm) High or Less: 3/4 inch (19 mm) thick, with particleboard cores, plastic-laminate faced.
   k. Stiles and Rails of Glazed Doors More Than 48 Inches (1200 mm) High: 1-1/16-inch- (27-mm-) thick, solid wood, plastic-laminate faced.
   OR
   Stiles and Rails of Glazed Doors More Than 48 Inches (1200 mm) High: 1-1/8 inches (29 mm) thick, with particleboard cores, plastic-laminate faced.
3. Utility-Space Framing: Laboratory casework manufacturer's standard steel framing units consisting of 2 steel slotted channels complying with MFMA-4, not less than 1-5/8 inches (41 mm)

square by 0.105-inch (2.66-mm) nominal thickness, and connected at top and bottom by U-shaped brackets made from 1-1/4-by-1/4-inch (32-by-6-mm) steel flat bars. Framing units may be made by welding specified channel material into rectangular frames instead of using U-shaped brackets.

4. Filler and Closure Panels: Provide where indicated and as needed to close spaces between cabinets and walls, ceilings, and indicated equipment. Fabricate from same material and with same finish as adjacent exposed cabinet surfaces unless otherwise indicated.
   a. Provide utility-space closure panels at spaces between base cabinets where utility space would otherwise be exposed, including spaces below countertops.
   b. Provide closure panels at ends of utility spaces where utility space would otherwise be exposed.
   c. Provide knee-space panels (modesty panels) at spaces between base cabinets, where cabinets are not installed against a wall or where space is not otherwise closed **OR** indicated, **as directed**. Fabricate from same material and with same finish as exposed cabinet backs.

I. Laboratory Casework System

1. Provide casework manufacturer's standard integrated system that includes support framing, suspended modular cabinets, filler and closure panels, wall panels, undercabinet task-lighting fixtures, countertops, and fittings needed to assemble system. System includes hardware and fasteners for securing support framing to permanent construction.
   a. Cabinet Construction: Metal **OR** Metal with wood doors and drawer fronts **OR** Wood, **as directed**.
   b. Cabinets can be removed and reinstalled without use of special tools for relocation within system.
   c. Base cabinets can be removed without providing temporary support for, or removing, countertops.
   d. Sinks are supported independent of base cabinets.
   e. Support framing has provision for fastening pipe supports at utility space in not more than 1-inch (25-mm) increments.
   f. System includes filler and closure panels to close spaces between support framing, cabinets, shelves, countertops, floors, and walls unless otherwise indicated. Fabricate panels from same material and with same finish as metal cabinets and with hemmed or flanged edges.
2. Support Framing: Casework manufacturer's standard system consisting of vertical supports and connecting braces and rails as follows:
   a. Cabinets, shelves, and countertops are supported from vertical supports except where floor-supported base cabinets are indicated. Vertical positioning of supported cabinets, shelves, and countertops can be varied in 1-inch (25-mm) increments through full height of supports.
   b. Vertical supports rest on adjustable leveling bases and are secured to floor with metal clips fastened to floor.
   c. Vertical supports are installed with braces and rails connecting them to each other and to permanent building walls to create a stable, rigid structure with framed utility spaces where indicated.
   d. Vertical supports are braced at floor with cantilevered horizontal leg members where indicated.
3. Undercabinet Task-Light Fixtures: Single-tube fluorescent fixtures with switch and heavy-duty cord and plug.
   a. Finish: Baked enamel.
   b. Diffusers: Virgin acrylic with high resistance to yellowing and other changes due to aging, heat, and UV radiation.
   c. Ballast Sound Rating: A.
4. Countertops: Provide in modular lengths indicated, without seams.

J. Metal Cabinet Finish

1. General: Prepare, treat, and finish welded assemblies after assembling. Prepare, treat, and finish components that are to be assembled with mechanical fasteners before assembling. Prepare, treat, and finish concealed surfaces same as exposed surfaces.
2. Preparation: After assembly, clean surfaces of mill scale, rust, oil, and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it.
3. Chemical-Resistant Finish: Immediately after cleaning and pretreating, apply laboratory casework manufacturer's standard two-coat, chemical-resistant, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).
   a. Chemical and Physical Resistance of Finish System: Finish complies with acceptance levels of cabinet surface finish tests in SEFA 8. Acceptance level for chemical spot test shall be no more than four Level 3 conditions.
   b. Colors for Metal Laboratory Casework Finish: As selected from manufacturer's full range.

K. Wood Finish
1. Preparation: Sand lumber and plywood before assembling. Sand edges of doors, drawer fronts, and molded shapes with profile-edge sander. Sand after assembling for uniform smoothness at least equivalent to that produced by 220-grit sanding and without machine marks, cross sanding, or other surface blemishes.
2. Staining: Remove fibers and dust and apply stain to exposed and semiexposed surfaces as necessary to match approved Samples. Apply stain in a manner that will produce a consistent appearance. Apply wash-coat sealer before applying stain to closed-grain wood species.
   a. Stain Color: As selected from manufacturer's full range.
3. Chemical-Resistant Finish: Apply laboratory casework manufacturer's standard two-coat **OR** three-coat, **as directed**, chemical-resistant, transparent finish. Sand and wipe clean between coats. Topcoat(s) may be omitted on concealed surfaces.
   a. Chemical and Physical Resistance of Finish System: Finish complies with acceptance levels of cabinet surface finish tests in SEFA 8. Acceptance level for chemical spot test shall be no more than four Level 3 conditions.

L. Hardware
1. General: Provide laboratory casework manufacturer's standard, commercial-quality, heavy-duty hardware complying with requirements indicated for each type.
2. Hinges: Stainless-steel **OR** Epoxy-coated steel, **as directed**, 5-knuckle hinges complying with BHMA A156.9, Grade 1, with antifriction bearings and rounded tips. Provide 2 for doors 48 inches (1200 mm) high or less and 3 for doors more than 48 inches (1200 mm) high.
3. Hinges for Wood and Plastic-Laminate Cabinets: Frameless concealed hinges (European type) complying with BHMA A156.9, Type B01602, 100 **OR** 135 **OR** 170, **as directed**, degrees of opening, self-closing, **as directed**.
4. Hinged Door and Drawer Pulls: Solid aluminum, stainless steel, or chrome-plated brass **OR** Epoxy-coated steel, **as directed**, back-mounted pulls. Provide 2 pulls for drawers more than 24 inches (600 mm) wide.
   a. Design: Wire pulls **OR** Rectangular loop pulls **OR** Rectangular loop pulls with rounded corners **OR** As selected from manufacturer's full range **OR** As indicated, **as directed**.
   b. Overall Size: 1 by 4-1/2 inches (25 by 114 mm) **OR** 1-1/4 by 4-1/2 inches (32 by 114 mm) **OR** 1-3/8 by 5-1/2 inches (35 by 140 mm) **OR** As selected from manufacturer's full range **OR** As indicated, **as directed**.
5. Sliding Door Pulls: Stainless-steel or chrome-plated **OR** Epoxy-coated steel, **as directed**, recessed flush pulls.
   a. Design and Size: Round, 3/4-inch (19-mm) diameter by 1/8 inch (3 mm) deep **OR** Round, 3/4-inch (19-mm) diameter by 3/16 inch (5 mm) deep **OR** Oval, 1 by 3 inches (25 by 76 mm), 3/8 inch (10 mm) deep **OR** As selected from manufacturer's full range **OR** As indicated, **as directed**.
6. Pulls: Recessed aluminum **OR** polypropylene, **as directed**, pulls. Provide 2 pulls for drawers more than 24 inches (600 mm) wide.

7. Pulls for Metal Cabinets: Full-width, recessed channel pulls; integrally formed from front pan of doors and drawer fronts.
8. Pulls for Wood Cabinets: Full-width, recessed solid hardwood channels; matching exposed wood of cabinets.
9. Pulls for Plastic-Laminate Cabinets: Full-width, recessed aluminum **OR** solid hardwood, **as directed**, channel pulls.
10. Door Catches: Nylon-roller spring **OR** Dual, self-aligning, permanent magnet, **as directed**, catches. Provide 2 catches on doors more than 48 inches (1200 mm) high.
11. Drawer Slides: Side mounted, epoxy-coated steel, self-closing; designed to prevent rebound when drawers are closed; complying with BHMA A156.9, Type B05091.
    a. Provide Grade 1 **OR** Grade 1HD-100, **as directed**; for drawers not more than 6 inches (150 mm) high and 24 inches (600 mm) wide.
    b. Provide Grade 1HD-100 **OR** Grade 1HD-200, **as directed**; for drawers more than 6 inches (150 mm) high or 24 inches (600 mm) wide.
    c. Standard Duty (Grade 1): Full-extension **OR** Partial-extension, **as directed**, type, with polymer rollers.
    d. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Full-extension **OR** Full-overtravel-extension, **as directed**, ball-bearing type.
12. Drawer Slides for Wood and Plastic-Laminate Cabinets: Hardwood runners under centers of drawers with polymer guides fastened to backs of drawers.
13. Label Holders: Stainless steel, aluminum, or chrome plated; sized to receive standard label cards approximately 1 by 2 inches (25 by 50 mm), attached with screws or rivets. Provide where indicated **OR** on all drawers, **as directed**.
14. Locks for Metal Cabinets: Cam or half-mortise type with 5-pin tumbler, **as directed**, brass with chrome-plated finish; complying with BHMA A156.11, Type E07281, E07261, E07111, or E07021.
    a. Provide a minimum of two keys per lock and two master keys.
    b. Provide where indicated **OR** on all drawers and doors, **as directed**.
    c. Keying: Key locks alike within each room; key each room separately **OR** each lock separately **OR** locks as directed, **as directed**.
    d. Master Key System: Key all locks to be operable by master key.
15. Locks for Wood and Plastic-Laminate Cabinets: Cam type with 5-pin tumbler, **as directed**, brass with chrome-plated finish; complying with BHMA A156.11, Type E07281 or E07261.
    a. Provide a minimum of two keys per lock and two master keys.
    b. Provide where indicated **OR** on all drawers and doors, **as directed**.
    c. Keying: Key locks within each room alike, key each room separately **OR** each lock separately **OR** locks as directed, **as directed**.
    d. Master Key System: Key all locks to be operable by master key.
16. Sliding-Door Hardware Sets: Laboratory casework manufacturer's standard, to suit type and size of sliding-door units.
17. Adjustable Shelf Supports for Wood and Plastic-Laminate Cabinets: Powder-coated steel shelf rests complying with BHMA A156.9, Type B04013.
    OR
    Adjustable Shelf Supports for Wood and Plastic-Laminate Cabinets: Mortise-type, powder-coated steel standards and shelf rests complying with BHMA A156.9, Types B04071 and B04091.
18. Adjustable Wall Shelf Supports: Surface-type steel standards and steel shelf brackets, with epoxy powder-coated finish, complying with BHMA A156.9, Types B04102 and B04112.

M. Countertops, Table Tops, Shelves, Troughs, And Sinks
1. Countertops, General: Provide units with smooth surfaces in uniform plane free of defects. Make exposed edges and corners straight and uniformly beveled. Provide front and end overhang of 1 inch (25 mm), with continuous drip groove on underside 1/2 inch (13 mm) from edge.
2. Sinks, General: Provide sizes indicated or laboratory casework manufacturer's closest standard size of equal or greater volume, as approved by the Owner.
    a. Outlets: Provide with strainers and tailpieces, NPS 1-1/2 (DN 40), unless otherwise indicated.

b. Overflows: For each sink except cup sinks, **OR** Where indicated, **as directed**, provide overflow of standard beehive or open-top design with separate strainer. Height 2 inches (50 mm) less than sink depth. Provide in same material as strainer.

3. Plastic-Laminate Countertops, Table Tops and Shelves:
   a. Countertops: Plastic laminate **OR** Chemical-resistant plastic laminate, **as directed**, shop bonded to top surface and exposed edges of 3/4-inch- (19-mm-) **OR** 1-inch- (25-mm-) **OR** 1-3/16-inch- (30-mm-), **as directed**, thick core with plastic-laminate backing bonded to bottom surface. Sand surfaces to which plastic laminate is to be bonded.
      1) Backsplash Core Thickness: 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**.
      2) Countertop Core: Particleboard **OR** Urea-formaldehyde-free particleboard **OR** Exterior-glue particleboard **OR** straw-based particleboard **OR** exterior plywood, **as directed**
      3) Countertop Core for Counters Containing Sinks: Exterior-glue particleboard **OR** straw-based particleboard **OR** exterior plywood, **as directed**.
      4) Countertop Configuration: Flat, with square edges, and flat backsplashes and end splashes. Finish faces and exposed edges of splashes with same plastic laminate as top.
         OR
         Countertop Configuration: Postformed, with raised, **as directed**, rolled edge and integral coved backsplash with rolled top edge. Construct top and backsplash from one piece of plastic laminate. Where indicated, provide separate end splashes of same material as top and fitted to top.
      5) Plastic-Laminate Grade for Flat Countertops: HGS **OR** HGL **OR** HDS, **as directed**.
      6) Plastic-Laminate Grade for Postformed Countertops: HGP.
      7) Plastic-Laminate Grade for Backing: BKL.
   b. Table Tops: Plastic laminate **OR** Chemical-resistant plastic laminate, **as directed**, shop bonded to top surface and exposed edges of 3/4-inch- (19-mm-) **OR** 1-inch- (25-mm-) **OR** 1-3/16-inch- (30-mm-), **as directed**, thick core with plastic-laminate backing bonded to bottom surface. Sand surfaces to which plastic laminate is to be bonded.
      1) Table-Top Core: Particleboard **OR** Urea-formaldehyde-free particleboard **OR** Exterior-glue particleboard **OR** straw-based particleboard **OR** exterior plywood, **as directed**.
      2) Plastic-Laminate Grade for Tables: HGS **OR** HGL **OR** HDS, **as directed**.
      3) Plastic-Laminate Grade for Backing: BKL.
   c. Plastic-Laminate Shelves: Plastic laminate **OR** Chemical-resistant plastic laminate, **as directed**, shop bonded to both faces and all edges of 3/4-inch- (19-mm-) **OR** 1-inch- (25-mm-), **as directed**, thick core. Sand surfaces to which plastic laminate is to be bonded.
      1) Shelf Core: Particleboard **OR** Urea-formaldehyde-free particleboard **OR** Exterior-glue particleboard **OR** straw-based particleboard **OR** exterior plywood, **as directed**.
      2) Plastic-Laminate Grade for Shelves: HGL.

4. Epoxy Countertops, Table Tops, and Sinks:
   a. Countertop Fabrication: Fabricate with factory cutouts for sinks, holes for service fittings and accessories, and with butt joints assembled with epoxy adhesive and concealed metal splines.
      1) Countertop Configuration: Flat, 5/8 inch (16 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick, with beveled **OR** rounded, **as directed**, edge and corners, and with drip groove and integral coved **OR** applied, **as directed**, backsplash.
         OR
         Countertop Configuration: Raised (marine) edge, 5/8-inch (16-mm) **OR** 3/4-inch (19-mm) **OR** 1-inch (25-mm), **as directed**, minimum thickness, with integral or applied raised edge having beveled **OR** rounded, **as directed**, edge and corners, and with integral coved **OR** applied, **as directed**, backsplash.
         OR
         Countertop Configuration: As indicated.

2) Countertop Construction: Uniform throughout full thickness **OR** Epoxy composition not less than 1/4 inch (6 mm) thick, laminated to backing, **as directed**.
3) Product Option: Phenolic-composite countertops may be substituted for epoxy countertops at Contractor's option.

b. Table-Top Fabrication:
1) Table-Top Configuration: Flat, 5/8 inch (16 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick, with beveled **OR** rounded, **as directed**, edge and corners, and with drip groove at perimeter.
OR
Table-Top Configuration: Raised (marine) edge, 5/8-inch (16-mm) **OR** 3/4-inch (19-mm) **OR** 1-inch (25-mm), **as directed**, minimum thickness, with integral or applied raised edge having beveled **OR** rounded, **as directed**, edge and corners.
2) Table-Top Construction: Uniform throughout full thickness **OR** Epoxy composition not less than 1/4 inch (6 mm) thick, laminated to backing, **as directed**.
3) Product Option: Phenolic-composite table tops may be substituted for epoxy table tops at Contractor's option.

c. Sink Fabrication: Molded in 1 piece with smooth surfaces, coved corners, and bottom sloped to outlet; 1/2-inch (13-mm) minimum thickness.
1) Provide with polypropylene strainers and tailpieces.
2) Provide sinks for drop-in installation with 1/4-inch- (6-mm-) thick lip around perimeter of sink.
3) Provide integral sinks in epoxy countertops, bonded to countertops with invisible joint line.
4) Provide manufacturer's recommended adjustable support system for table- and cabinet-type installations.

5. Phenolic-Composite Countertops, Table Tops, and Shelves:
a. Countertop Fabrication: Fabricate with cutouts for sinks, holes for service fittings and accessories, and with butt joints assembled with epoxy adhesive and concealed metal splines.
1) Countertop Configuration: Flat, 1/2 inch (13 mm) **OR** 5/8 inch (16 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick, with beveled **OR** rounded, **as directed**, edge and corners, and with drip groove and integral coved backsplash.
OR
Countertop Configuration: Raised (marine) edge, 1/2-inch (13-mm) **OR** 5/8-inch (16-mm) **OR** 3/4-inch (19-mm) **OR** 1-inch (25-mm), **as directed**, minimum thickness, with beveled **OR** rounded, **as directed**, edge and corners, and with integral coved backsplash.
OR
Countertop Configuration: As indicated.

b. Table-Top Fabrication:
1) Table-Top Configuration: Flat, 1/2 inch (13 mm) **OR** 5/8 inch (16 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick, with beveled **OR** rounded, **as directed**, edge and corners, and with drip groove at perimeter.
OR
Table-Top Configuration: Raised (marine) edge, 5/8-inch (16-mm) **OR** 3/4-inch (19-mm) **OR** 1-inch (25-mm), **as directed**, minimum thickness, with integral or applied raised edge having beveled **OR** rounded, **as directed**, edge and corners.

c. Shelf Configuration: Flat, 5/8 inch (16 mm) **OR** 3/4 inch (19 mm), **as directed**, thick, with beveled **OR** rounded, **as directed**, edge and corners.

6. Stainless-Steel Countertops: Made from stainless-steel sheet, not less than 0.062-inch (1.59-mm) nominal thickness, with No. 4 satin finish.
a. Extend top down 1 inch (25 mm) at edges with a 1/2-inch (13-mm) return flange under frame. Apply heavy coating of heat-resistant, sound-deadening mastic to undersurface.
b. Form backsplash coved to and integral with top surface.
c. Provide raised (marine) edge around perimeter of countertops containing sinks; pitch two ways to sink to provide drainage without channeling or grooving.

d. Provide raised (marine) edge around perimeter of countertops at sinks, where indicated; pitch two ways to sink to provide drainage without channeling or grooving.
e. Punch holes for service fittings at factory.
f. Reinforce underside of countertop with channels or use thicker metal sheet where necessary to insure rigidity without deflection.
g. Weld shop-made joints.
h. Where field-made joints are required, provide hairline butt-joints mechanically bolted through continuous channels welded to underside at edges of joined ends. Keep field jointing to a minimum.
i. Where stainless-steel sinks or cup sinks occur in stainless-steel countertops, factory weld into one integral unit.
j. After fabricating and welding, grind surfaces smooth and polish as needed to produce uniform, directionally textured finish with no evidence of welds and free of cross scratches. Passivate and rinse surfaces; remove embedded foreign matter and leave surfaces clean.

7. Stainless-Steel Shelves: Made from stainless-steel sheet, not less than 0.050-inch (1.27-mm) nominal thickness, with No. 4 satin finish. Weld shop-made joints. Fold down **OR** up, **as directed**, front edge 3/4 inch (19 mm); fold up back edge 3 inches (75 mm). Provide integral stiffening brackets, formed by folding up ends 3/4 inch (19 mm) and welding to upturned back edge **OR** front and back edges, **as directed**. After fabricating, grind welds smooth and polish as needed to produce uniform, directionally textured finish with no evidence of welds and free of cross scratches. Passivate and rinse surfaces; remove embedded foreign matter and leave surfaces clean.
8. Stainless-Steel Sinks: Made from stainless-steel sheet, not less than 0.050-inch (1.27-mm) nominal thickness. Fabricate with corners rounded and coved to at least 5/8-inch (16-mm) radius. Slope sink bottoms to outlet. Provide double-wall construction for sink partitions with top edge rounded to at least 1/2-inch (13-mm) diameter. Provide continuous butt-welded joints. After fabricating and welding, grind surfaces smooth and polish as needed to produce uniform finish with no evidence of welds and free of cross scratches. Passivate and rinse surfaces; remove embedded foreign matter and leave surfaces clean.
   a. Punch holes for fittings at factory.
   b. Provide with stainless-steel strainers and tailpieces.
   c. Provide with integral rims except where located in stainless-steel countertops.
   d. Apply 1/8-inch- (3-mm-) thick coating of heat-resistant, sound-deadening mastic to undersink surfaces.
9. Cup Sinks: Epoxy **OR** Polypropylene **OR** Stainless steel, **as directed**, 3-by-6-inch (75-by-150-mm) oval **OR** 3-by-9-inch (75-by-228-mm) oval **OR** 5-inch (127-mm) diameter, **as directed**.
   a. Provide with polypropylene **OR** stainless-steel, **as directed**, strainers and integral tailpieces.
10. Cup Sinks: Material and size as indicated.
   a. Provide epoxy and polypropylene cup sinks with polypropylene strainers and integral tailpieces.
   b. Provide stainless-steel cup sinks with stainless-steel strainers and integral tailpieces.
11. Troughs: Epoxy **OR** Stainless steel, **as directed**. Pitch to drains not less than 1/8 inch/foot (10 mm/m). Except where troughs empty into sinks, provide NPS 1-1/2 (DN 40) outlets with strainers and tailpieces.
   a. Epoxy Troughs: Molded in 1 piece with smooth surfaces and coved corners; 1/2-inch (13-mm) **OR** 5/8-inch (16-mm) **OR** 3/4-inch (19-mm), **as directed**, minimum thickness. Provide polypropylene strainers and tailpieces.
   b. Stainless-Steel Troughs: Made from stainless-steel sheet, not less than 0.050-inch (1.27-mm) **OR** 0.062-inch (1.59-mm), **as directed**, nominal thickness. Fabricate with corners rounded and coved to at least 5/8-inch (16-mm) radius. Provide continuous butt-welded joints. After fabricating and welding, grind surfaces smooth and polish as needed to produce uniform finish with no evidence of welds and free of cross scratches. Passivate and rinse surfaces; remove embedded foreign matter and leave surfaces clean. Provide stainless-steel strainers and tailpieces.

N. Laboratory Accessories
1. Reagent Shelves: Provide as indicated, fabricated from same material as adjacent countertop, unless otherwise indicated.
2. Burette Rods: Aluminum or stainless-steel rods, 1/2 inch (13 mm) in diameter and 18 inches (450 mm) long, threaded on 1 end to fit tapered plug adapter for flush socket receptacle. Provide with tapered plug adapter and receptacle.
3. Upright Rod Assembly and Metal Crossbar: Aluminum or stainless steel. Two vertical rods and 1 horizontal crossbar, 3/4 inch (19 mm) in diameter and 36 inches (900 mm) long, unless otherwise indicated; 2 flush socket receptacles and 2 crossbar clamps. Ends of vertical rods are tapered to fit receptacles; all other rod ends are rounded.
4. Greenlaw Arm Assembly: Aluminum or stainless-steel vertical rod, tapered on one end to fit flush socket receptacle. Adjustable crossbar of hardwood with black, acid-resistant finish, secured to upright with adjustable clamp. Provide with receptacle.
5. Lattice Assembly: Aluminum or stainless-steel, vertical and horizontal rod lattice assembly with 3/4-inch- (19-mm-) diameter rods at approximately 12 inches (300 mm) o.c. with 2 flush socket receptacles for mounting.
   a. Size: 36 inches (900 mm) **OR** 48 inches (1200 mm), **as directed**, wide by 24 inches (600 mm) **OR** 36 inches (900 mm), **as directed**, high.
6. Pegboards: Polypropylene, epoxy, or phenolic-composite pegboards with removable polypropylene pegs and stainless-steel drip troughs with drain outlet.
7. Pegboards: Stainless-steel pegboards with removable polypropylene pegs and stainless-steel drip troughs with drain outlet.

O. Water And Laboratory Gas Service Fittings
1. Service Fittings: Provide units that comply with SEFA 7, "Laboratory and Hospital Fixtures - Recommended Practices." Provide fittings complete with washers, locknuts, nipples, and other installation accessories. Include wall and deck flanges, escutcheons, handle extension rods, and similar items.
   a. Provide units that comply with "Vandal-Resistant Faucets and Fixtures" recommendations in SEFA 7.
2. Materials: Fabricated from cast or forged red brass unless otherwise indicated.
   a. Reagent-Grade Water Service Fittings: Polypropylene, PVC, or PVDF for parts in contact with water.
3. Finish: Chromium plated **OR** Chromium plated unless otherwise indicated **OR** Acid- and solvent-resistant powder coating complying with requirements in SEFA 7 for corrosion-resistant finishes, **as directed**.
   a. Provide chemical-resistant powder coating in laboratory casework manufacturer's standard metallic brown, aluminum, white, or other color as approved by the Owner.
4. Water Valves and Faucets: Provide units complying with ASME A112.18.1, with renewable seats, designed for working pressure up to 80 psig (550 kPa).
   a. Vacuum Breakers: Provide ASSE 1035 vacuum breakers on water fittings with serrated outlets.
   b. Aerators: Provide aerators on water fittings that do not have serrated outlets.
   c. Self-Closing Valves: Provide self-closing valves where indicated.
5. Ground-Key Cocks: Tapered core and handle of one-piece forged brass, ground and lapped, and held in place under constant spring pressure. Provide units designed for working pressure up to 40 psig (280 kPa), with serrated outlets.
6. Ball Valves: Chrome-plated ball and PTFE seals. Handle requires no more than 5 lbf (22 N) to operate. Provide units designed for working pressure up to 75 psig (520 kPa), with serrated outlets.
   a. Where ball valves are indicated for fuel-gas use, provide locking safety handles that must be pushed in **OR** pulled up, **as directed**, before being turned on unless otherwise indicated.
7. Steam Valves: Stainless-steel seat and PTFE seat disc. Provide units designed for steam working pressure up to 20 psig (140 kPa), with serrated outlets.

8. Needle Valves: Provide units with renewable, self-centering, floating cones and renewable seats of stainless steel or Monel metal, with removable serrated outlets.
   a. Provide units designed for working pressure up to 60 psig (410 kPa) **OR** 100 psig (690 kPa) **OR** 125 psig (860 kPa), **as directed**.
9. Hand of Fittings: Furnish right-hand fittings unless fitting designation is followed by "L."
10. Remote-Control Valves: Provide needle valves, straight-through or angle type as indicated for fume hoods and where indicated.
11. Handles: Provide three- or four-arm, forged-brass **OR** three- or four-wing, molded plastic or powder-coated metal, **as directed**, handles for valves unless otherwise indicated.
   a. Provide lever-type handles for ground-key cocks. Lever handle aligns with outlet when valve is closed and is perpendicular to outlet when valve is fully open.
   b. Provide lever-type handles for ball valves unless otherwise indicated. Lever handle aligns with outlet when valve is closed and is perpendicular to outlet when valve is fully open.
   c. Provide heat-resistant plastic handles for steam valves.
   d. Provide knurled, molded plastic handles for needle valves.
12. Service-Outlet Identification: Provide color-coded plastic discs with embossed identification, secured to each service-fitting handle to be tamper resistant. Comply with SEFA 7 for colors and embossed identification.

P. Electrical Service Fittings
1. Service Fittings, General: Provide units complete with metal housings, receptacles, terminals, switches, pilot lights, device plates, accessories, and gaskets required for mounting on laboratory casework.
2. Receptacles: Comply with NEMA WD 1, NEMA WD 6, and UL 498. Duplex type, Configuration 5 20R.
   a. Receptacle Grade: Hospital **OR** General, **as directed**, grade unless otherwise indicated.
   b. Color of Receptacles: Brown **OR** Ivory **OR** As selected, **as directed**, unless otherwise indicated or required by NFPA 70.
   c. GFCI Receptacles: Straight blade, feed-through **OR** non-feed-through, **as directed**, type. Comply with UL 943, Class A, Hospital **OR** General, **as directed**, grade, and include indicator light that is lighted when device is tripped.
   d. TVSS (Transient Voltage Surge Suppressor) Receptacles: Comply with UL 1449, with integral TVSS in line to ground, line to neutral, and neutral to ground.
      1) TVSS Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and a minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
      2) Active TVSS Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."
      3) Receptacle Type: Hospital **OR** General, **as directed**, grade, with isolated-ground terminal, **as directed**.
      4) Identification: Distinctive marking on face of device to denote TVSS-type unit.
      5) Color of TVSS Receptacles: Blue.
3. Switches: Comply with NEMA WD 1 and UL 20. Provide single-pole, double-pole, or 3-way switches as required; rated 120 to 277-V ac; and in amperage capacities to suit units served.
   a. Color of Switches: Brown **OR** Ivory **OR** As selected, **as directed**, unless otherwise indicated or required by NFPA 70.
   b. Provide pilot light adjacent to switch or neon-lighted handle, illuminated when switch is "ON," where noted as "PL" next to switch identification.
   c. Provide key-operated switch where noted as "KEY" next to switch identification.
   d. Provide thermal-overload switches, single or double pole, as required, with maximum overcurrent trip setting to suit particular motor controlled.
4. Service Fittings, General: Provide units with metal housings and gaskets required for mounting on laboratory casework. Receptacles, terminals, switches, pilot lights, device plates, and accessories are specified in Division 26 Section "Wiring Devices".

5. Pedestal-Type Fittings: Cast-aluminum housings with sloped single face or two faces, as indicated, with neoprene gasket under base and with concealed mounting holes in base for attaching to laboratory casework. Provide holes tapped for conduits.
6. Line-Type Fittings: Provide with cast-metal boxes with threaded holes for mounting on rigid steel conduit. Provide cover plates same size as boxes.
7. Recessed-Type Fittings: Provide with galvanized-steel boxes.
8. Finishes for Service-Fitting Components: Provide housings or boxes for pedestal- and line-type fittings with manufacturer's standard baked-on, chemical-resistant enamel in color as selected from manufacturer's full range.
9. Cover Plates: Provide satin finish, chrome-plated **OR** Type 304, stainless-steel, **as directed**, cover plates with formed, beveled edges.
10. Cover-Plate Identification: Use 1/4-inch- (6-mm-) high letters unless otherwise indicated. For stainless steel or chrome-plated metal, stamp or etch plate and fill in letters with black enamel.
    a. Provide on all cover plates **OR** at the following locations, **as directed**:
        1) Receptacles other than standard 125-V duplex, grounding type.
        2) Switches and thermal-overload switches.
        3) Pilot lights when located remotely from associated equipment or switch, where function is not obvious.
        4) Receptacles, switches, and other locations indicated.
    b. Provide the following information:
        1) Voltage and phase for receptacles other than standard 125-V duplex, grounding type.
        2) Indicate equipment being controlled by switches and thermal-overload switches.
        3) Indicate equipment being controlled for pilot lights when located remotely from associated equipment or switch, where function is not obvious.
        4) Number of breaker in panelboard that controls device.

1.3 EXECUTION

A. Installation Of Cabinets
1. Comply with installation requirements in SEFA 2.3. Install level, plumb, and true; shim as required, using concealed shims. Where laboratory casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical. Do not exceed the following tolerances:
    a. Variation of Tops of Base Cabinets from Level: 1/16 inch in 10 feet (1.5 mm in 3 m).
    b. Variation of Bottoms of Upper Cabinets from Level: 1/8 inch in 10 feet (3 mm in 3 m).
    c. Variation of Faces of Cabinets from a True Plane: 1/8 inch in 10 feet (3 mm in 3 m).
    d. Variation of Adjacent Surfaces from a True Plane (Lippage): 1/32 inch (0.8 mm).
    e. Variation in Alignment of Adjacent Door and Drawer Edges: 1/16 inch (1.5 mm).
2. Utility-Space Framing: Secure to floor with two fasteners at each frame. Fasten to partition framing, wood blocking, or metal reinforcements in partitions and to base cabinets.
3. Base Cabinets: Fasten cabinets to utility-space framing, partition framing, wood blocking, or reinforcements in partitions with fasteners spaced not more than 24 inches (600 mm) o.c. Bolt adjacent cabinets together with joints flush, tight, and uniform.
    a. Where base cabinets are installed away from walls, fasten to floor at toe space at not more than 24 inches (600 mm) o.c. and at sides of cabinets with not less than 2 fasteners per side.
4. Wall Cabinets: Fasten to hanging strips, masonry, partition framing, blocking, or reinforcements in partitions. Fasten each cabinet through back, near top, at not less than 24 inches (600 mm) o.c.
5. Install hardware uniformly and precisely. Set hinges snug and flat in mortises.
6. Adjust laboratory casework and hardware so doors and drawers align and operate smoothly without warp or bind and contact points meet accurately. Lubricate operating hardware as recommended by manufacturer.

B. Installation Of Countertops
1. Install counters' heights that allow for installation of self-rimming, drop-in sinks per building code.
2. Comply with installation requirements in SEFA 2.3. Abut top and edge surfaces in one true plane with flush hairline joints and with internal supports placed to prevent deflection. Locate joints only where shown on Shop Drawings.
3. Field Jointing: Where possible, make in same manner as shop-made joints using dowels, splines, fasteners, adhesives, and sealants recommended by manufacturer. Prepare edges in shop for field-made joints.
   a. Use concealed clamping devices for field-made joints in plastic-laminate countertops. Locate clamping devices within 6 inches (150 mm) of front and back edges and at intervals not exceeding 24 inches (600 mm). Tighten according to manufacturer's written instructions to exert a uniform heavy pressure at joints.
4. Fastening:
   a. Secure countertops, except for epoxy countertops, to cabinets with Z-type fasteners or equivalent, using two or more fasteners at each cabinet front, end, and back.
   b. Secure epoxy countertops to cabinets with epoxy cement, applied at each corner and along perimeter edges at not more than 48 inches (1200 mm) o.c.
   c. Where necessary to penetrate countertops with fasteners, countersink heads approximately 1/8 inch (3 mm) and plug hole flush with material equal to countertop in chemical resistance, hardness, and appearance.
5. Provide required holes and cutouts for service fittings.
6. Seal unfinished edges and cutouts in plastic-laminate countertops with heavy coat of polyurethane varnish.
7. Provide scribe moldings for closures at junctures of countertop, curb, and splash with walls as recommended by manufacturer for materials involved. Match materials and finish to adjacent laboratory casework. Use chemical-resistant, permanently elastic sealing compound where recommended by manufacturer.
8. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

C. Installation Of Sinks
1. Comply with installation requirements in SEFA 2.3.
2. Underside Installation of Epoxy Sinks: Use laboratory casework manufacturer's recommended adjustable support system for table- and cabinet-type installations. Set top edge of sink unit in sink and countertop manufacturers' recommended chemical-resistant sealing compound or adhesive and firmly secure to produce a tight and fully leakproof joint. Adjust sink and securely support to prevent movement. Remove excess sealant or adhesive while still wet and finish joint for neat appearance.
3. Semiflush Installation of Stainless-Steel Sinks: Before setting, apply sink and countertop manufacturers' recommended sealant under rim lip and along top. Remove excess sealant while still wet and finish joint for neat appearance.
4. Drop-in Installation of Epoxy Sinks: Rout groove in countertop to receive sink rim if not prepared in shop. Set sink in adhesive and fill remainder of groove with sealant or adhesive. Use procedures and products recommended by sink and countertop manufacturers. Remove excess adhesive and sealant while still wet and finish joint for neat appearance.
5. Drop-in Installation of Epoxy and Polypropylene Cup Sinks: Rout groove in countertop to receive sink rim if not prepared in shop. Set sink in adhesive and fill remainder of groove with sealant or adhesive. Use procedures and products recommended by sink and countertop manufacturers. Remove excess adhesive and sealant while still wet and finish joint for neat appearance.
6. Surface Installation of Epoxy and Polypropylene Cup Sinks: Set sink in sealant or adhesive. Use procedures and products recommended by sink and countertop manufacturers. Remove excess sealant or adhesive while still wet and finish joint for neat appearance.

D. Installation Of Laboratory Accessories
1. Install accessories according to Shop Drawings, installation requirements in SEFA 2.3, and manufacturer's written instructions.

2. Securely fasten adjustable shelving supports, stainless-steel shelves, and pegboards to partition framing, wood blocking, or reinforcements in partitions.
3. Install shelf standards plumb and at heights to align shelf brackets for level shelves. Install shelving level and straight, closely fitted to other work where indicated.
4. Securely fasten pegboards to partition framing, wood blocking, or reinforcements in partitions.

E. Installation Of Service Fittings
1. Comply with requirements in Division 14 AND Division 22 for installing water and laboratory gas service fittings and electrical devices.
2. Install fittings according to Shop Drawings, installation requirements in SEFA 2.3, and manufacturer's written instructions. Set bases and flanges of sink- and countertop-mounted fittings in sealant recommended by manufacturer of sink or countertop material. Securely anchor fittings to laboratory casework unless otherwise indicated.

F. Cleaning And Protecting
1. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by the Owner.
2. Protect countertop surfaces during construction with 6-mil (0.15-mm) plastic or other suitable water-resistant covering. Tape to underside of countertop at a minimum of 48 inches (1200 mm) o.c.

G. Service-Fitting Schedule
1. Water Service Fitting:
   a. Type of Fitting: Swing-spout mixing faucet **OR** Rigid, gooseneck mixing faucet **OR** Rigid, gooseneck, single-service faucet **OR** Remote-control, rigid, gooseneck, single-service faucet **OR** Single-service hose bibb, **as directed**.
   b. Outlet: Aerator **OR** Vacuum breaker and removable serrated outlet, **as directed**.
   c. Mounting: Wall **OR** Deck **OR** Line, **as directed**, mounted.
   d. Additional Requirements: Self-closing valves **OR** For reagent-grade water, **as directed**.
2. Laboratory Gas Service Fitting:
   a. Service: Air **OR** Gas (fuel gas) **OR** Vacuum, **as directed**.
   b. Type of Fitting: Turret **OR** Line mounted **OR** Flange type **OR** Remote-control turret **OR** Remote-control flange type, **as directed**.
   c. Outlets: One **OR** Two, at 90 degrees **OR** Two, at 180 degrees **OR** Three **OR** Four, **as directed**.
   d. Outlet Type: Straight **OR** Angled, **as directed**.
   e. Valve Type: Ground-key cock **OR** Ball valve **OR** Needle valve, **as directed**.
3. Electrical Service Fitting:
   a. Type of Fitting: Pedestal, single faced **OR** Pedestal, double faced **OR** Recessed **OR** Line mounted, **as directed**.
   b. Device: One duplex receptacle **OR** Two duplex receptacles **OR** Four duplex receptacles **OR** One switched receptacle **OR** One duplex receptacle, switch, and pilot light, **as directed**.
   c. Additional Requirements: GFCI **OR** TVSS, **as directed**, receptacles.

END OF SECTION 12 56 53 00

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Task	Specification	Specification Description
12 59 16 00	01 22 16 00	No Specification Required
12 61 13 00	12 01 60 00	Fixed Audience Seating
12 61 16 00	12 01 60 00	Fixed Audience Seating
12 61 19 00	12 01 60 00	Fixed Audience Seating

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SECTION 12 62 23 00 - PORTABLE BLEACHERS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of portable bleachers. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. Product Data: For each type of product indicated.

C. Warranty
   1. Contractor shall warranty any and all materials or workmanship covered by these specifications for a period of one (1) year. Defects shall be corrected by the Contractor at once without charge to the Owner.

1.2 PRODUCTS

A. Design:
   1. The design shall be in accordance with the generally accepted standards as published by The American Institute of Steel Construction and The Aluminum Association.
   2. Design Loads:
      a. A uniformly distributed live load of not less than 100 psf of gross horizontal projection of the bleachers.
      b. Bleachers shall be designed to withstand, with or without live loads, the horizontal and uplift pressures due to the wind. Wind pressures shall be derived from ANSI/ASCE 7-93, Minimum Design Loads in Buildings and Other Structures.
      c. A horizontal swaying force applied to the seats, in a direction parallel to the length of the seats, of 24 lbs./ft.
      d. A horizontal swaying force applied to the seats, in a direction perpendicular to the length of the seats, of 10 lb./ft.
      e. All seat and footboard members shall be designed for live loads of not less than 120 lb. per lineal foot.
      f. Guardrails shall be capable of sustaining a vertical load of 100 plf and a horizontal thrust of 50 plf. Acting outwardly at the top of the rail.
      g. Under these loads, stresses shall now exceed those allowed in the "Specifications for Structural Steel Buildings, June 1, 1989" as adopted by the American Institute of Steel Construction.
   3. Shop Connections: Welded and capable of carrying stress put upon them as per AWS standards.
   4. Supporting Members (Framework):
      a. Main supporting members are to be of a welded angle frame design.
      b. Spaced at 6'-0" centers (maximum).
      c. Constructed of a minimum 2 x 2 x 3/16" angle.
      d. Every frame shall be laterally supported with cross-bracing to the adjacent frame.
   5. Dimensions:
      a. Length of Unit: 15” **OR** 21” **OR**.27,” **as directed**.
      b. Number of rows: 2 **OR** 3 **OR** 4 **OR** 5 **OR** 10, **as directed**.
      c. Seat Height: 17 inches.
      d. Typical Stands: 8" Rise with a 24" row depth.
   6. Deck Arrangements:

a. Seats: Nominal 2 x 10, anodized aluminum.
b. Footboards: Nominal 2 x 10 mill finish aluminum. (Optional 2 @ 2 x 10 mill finish aluminum on 2, 3, 4, 5 row units; Standard on 10 row units).
c. Riser: Optional on 2,3,4 & 5 row units, Standard on 10 row units
d. Vertical aisles with handrails as required by code.

7. Guardrails:
   a. Furnished on sides of any bleacher that is 5 rows high or higher per code. (Optional on 2, 3, & 4 row units).
   b. All pipes shall be 1 5/8" O.D. anodized aluminum pipe with end plugs and elbows at corners. Secured to angle rail posts with galvanized fasteners.
   c. Rails not less than 42" vertically above the center of the seatboard surface shall be provided at the back and sides of the bleacher.
   d. Included on all sides of the bleacher shall be 2" x 9 gauge galvanized chain link fencing fastened in place with aluminum ties and galvanized tension bars and aluminum rail clamps.
8. Mudsills: 2 x 4 pressure treated wood shall be provided on all frames.
9. Transporting Options:
   a. Galvanized steel angle tow bar
   b. Pneumatic wheels with axles
10. Tip-N-Roll Package: Optional on 2, 3, & 4 row units up to 21'-0" long.
   a. Non-marking rubber grommets shall be provided on all frames.
   b. Caster wheels shall be 4" diameter, swivel mounted, non-marking soft rubber.

B. Materials
1. Steel: ASTM A572 (Hot-Dipped Galvanized), ASTM A586 (Weathering Steel).
2. Aluminum: Extruded alloy 6063-T6.
3. Accessories:
   a. High Strength Bolts and Nuts - ASTM A325 steel.
   b. Ordinary Bolts and Nuts - ASTM A307.
   c. Hold-Down Clip Assemblies - Aluminum alloy 6063-T6.
   d. End Caps - Channel aluminum alloy 6063-T6.

C. Finishes
1. Steel: Galvanized Steel and Weathering Steel.
2. Aluminum:
   a. Anodized: Seat planks, backrest, stanchions and also risers if requested clear anodized 204R1, AA-M10C22A31, Class II.
   b. Mill Finish: Footboards and riser boards (6063-T6).
   c. Paint: Electrostatically applied, baked-on siliconized acrylic or siliconized polyester enamel.

1.3 EXECUTION

A. Installation
1. Install bleacher unit in accordance with manufacturer's installation procedures.

END OF SECTION 12 62 23 00

Task	Specification	Specification Description
12 62 23 00	01 22 16 00	No Specification Required

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Task	Specification	Specification Description
13 11 46 00	01 22 16 00	No Specification Required

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SECTION 13 12 13 00 - WATER DISTRIBUTION

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for water distribution. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes water-distribution piping and related components outside the building for water service **OR** fire-service mains **OR** combined water service and fire-service mains, **as directed**.
2. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

C. Definitions
1. EPDM: Ethylene propylene diene terpolymer rubber.
2. LLDPE: Linear, low-density polyethylene plastic.
3. PA: Polyamide (nylon) plastic.
4. PE: Polyethylene plastic.
5. PP: Polypropylene plastic.
6. PVC: Polyvinyl chloride plastic.
7. RTRF: Reinforced thermosetting resin (fiberglass) fittings.
8. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

D. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.
   a. Wiring Diagrams: Power, signal, and control wiring for alarms.
3. Field quality-control test reports.
4. Operation and Maintenance Data.

E. Quality Assurance
1. Regulatory Requirements:
   a. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
   b. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
   c. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.
2. Piping materials shall bear label, stamp, or other markings of specified testing agency.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
4. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.
5. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.
6. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.
7. NSF Compliance:

a. Comply with NSF 14 for plastic potable-water-service piping. Include marking "NSF-pw" on piping.
b. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

F. Delivery, Storage, And Handling
1. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:
a. Ensure that valves are dry and internally protected against rust and corrosion.
b. Protect valves against damage to threaded ends and flange faces.
c. Set valves in best position for handling. Set valves closed to prevent rattling.
2. During Storage: Use precautions for valves, including fire hydrants, according to the following:
a. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
b. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.
3. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
4. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
5. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
6. Protect flanges, fittings, and specialties from moisture and dirt.
7. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

G. Project Conditions
1. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:
a. Notify the Owner no fewer than two days in advance of proposed interruption of service.
b. Do not proceed with interruption of water-distribution service without the Owner's written permission.

H. Coordination
1. Coordinate connection to water main with utility company.

1.2 PRODUCTS

A. Copper Tube And Fittings
1. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed,** water tube, annealed temper.
a. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
b. Copper, Pressure-Seal Fittings:
1) NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
2) NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
2. Hard Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**, water tube, drawn temper.
a. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
b. Copper, Pressure-Seal Fittings:

1) NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
2) NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

B. Ductile-Iron Pipe And Fittings
1. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   a. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   b. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
2. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   a. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   b. Gaskets: AWWA C111, rubber.
3. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, rounded-grooved ends.
   a. Grooved-End, Ductile-Iron Pipe Appurtenances:
      1) Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
      2) Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.
4. Flanges: ASME 16.1, Class 125, cast iron.

C. PE Pipe And Fittings
1. PE, ASTM Pipe: ASTM D 2239, SIDR No. 5.3, 7, or 9; with PE compound number required to give pressure rating not less than 160 psig (1100 kPa) **OE** 200 psig (1380 kPa), **as directed**.
   a. Insert Fittings for PE Pipe: ASTM D 2609, made of PA, PP, or PVC with serrated male insert ends matching inside of pipe. Include bands or crimp rings.
   b. Molded PE Fittings: ASTM D 3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.
2. PE, AWWA Pipe: AWWA C906, DR No. 7.3, 9, or 9.3; with PE compound number required to give pressure rating not less than 160 psig (1100 kPa) **OR** 200 psig (1380 kPa), **as directed**.
   a. PE, AWWA Fittings: AWWA C906, socket- or butt-fusion type, with DR number matching pipe and PE compound number required to give pressure rating not less than 160 psig (1100 kPa) **OR** 200 psig (1380 kPa), **as directed**.
3. PE, Fire-Service Pipe: ASTM F 714, AWWA C906, or equivalent for PE water pipe; FMG approved, with minimum thickness equivalent to FMG Class 150 and Class 200.
   a. Molded PE Fittings: ASTM D 3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.

D. PVC Pipe And Fittings
1. PVC, Schedule 40 Pipe: ASTM D 1785.
   a. PVC, Schedule 40 Socket Fittings: ASTM D 2466.
2. PVC, Schedule 80 Pipe: ASTM D 1785.
   a. PVC, Schedule 80 Socket Fittings: ASTM D 2467.
   b. PVC, Schedule 80 Threaded Fittings: ASTM D 2464.
3. PVC, AWWA Pipe: AWWA C900, Class 150 **OR** Class 200, **as directed**, with bell end with gasket, and with spigot end.
   a. Comply with UL 1285 for fire-service mains if indicated.

b. PVC Fabricated Fittings: AWWA C900, Class 150 **OR** Class 200, **as directed**, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
c. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
d. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   1) Gaskets: AWWA C111, rubber.
e. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   1) Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

E. Fiberglass Pipe And Fittings
1. AWWA RTRP: AWWA C950, Class 150 **OR** Class 200 **OR** Class 250, **as directed**, Type I **OR** II, **as directed**, Grade 1, epoxy **OR** Grade 2, polyester, **as directed**, with bell-and-spigot ends for bonded **OR** with gasket or seal for gasketed, **as directed**, joints. Liner is optional, unless otherwise indicated. Include FMG approval if used for fire-service mains.
   a. RTRF: AWWA C950, similar to pipe in material, pressure class, and joining method.
2. UL RTRP: UL 1713, Class 150 **OR** Class 200 **OR** Class 250, **as directed**, with bell-and-spigot ends with gasket or seal for gasketed joints. Liner is optional, unless otherwise indicated.
   a. RTRF: Similar to pipe in material, pressure class, and joining method.

F. Special Pipe Fittings
1. Ductile-Iron Rigid Expansion Joints:
   a. Description: Three-piece, ductile-iron assembly consisting of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
      1) Pressure Rating: 250 psig (1725 kPa) minimum.
      2) Expansion Required: As directed by the manufacturer or as directed by the Owner.
2. Ductile-Iron Flexible Expansion Joints:
   a. Description: Compound, ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections. Assemble components for offset and expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
      1) Pressure Rating: 250 psig (1725 kPa) minimum.
      2) Offset: As directed by the manufacturer or as directed by the Owner.
      3) Expansion Required: As directed by the manufacturer or as directed by the Owner.
3. Ductile-Iron Deflection Fittings:
   a. Description: Compound, ductile-iron coupling fitting with sleeve and 1 or 2 flexing sections for up to 15-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
      1) Pressure Rating: 250 psig (1725 kPa) minimum.

G. Joining Materials
1. Refer to Division 33 Section "Common Work Results For Utilities" for commonly used joining materials.
2. Brazing Filler Metals: AWS A5.8, BCuP Series.
3. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.
4. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

H. Piping Specialties

1. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
2. Tubular-Sleeve Pipe Couplings:
   a. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.
      1) Standard: AWWA C219.
      2) Center-Sleeve Material: Manufacturer's standard **OR** Carbon steel **OR** Stainless steel **OR** Ductile iron **OR** Malleable iron, **as directed**.
      3) Gasket Material: Natural or synthetic rubber.
      4) Pressure Rating: 150 psig (1035 kPa) **OR** 200 psig (1380 kPa), **as directed**, minimum.
      5) Metal Component Finish: Corrosion-resistant coating or material.
3. Split-Sleeve Pipe Couplings:
   a. Description: Metal, bolted, split-sleeve-type, reducing or transition coupling with sealing pad and closure plates, O-ring gaskets, and bolt fasteners.
      1) Standard: AWWA C219.
      2) Sleeve Material: Manufacturer's standard **OR** Carbon steel **OR** Stainless steel, **as directed**.
      3) Sleeve Dimensions: Of thickness and width required to provide pressure rating.
      4) Gasket Material: O-rings made of EPDM rubber, unless otherwise indicated.
      5) Pressure Rating: 150 psig (1035 kPa) **OR** 200 psig (1380 kPa), **as directed**, minimum.
      6) Metal Component Finish: Corrosion-resistant coating or material.
4. Flexible Connectors:
   a. Nonferrous-Metal Piping: Bronze hose covered with bronze wire braid; with copper-tube, pressure-type, solder-joint ends or bronze flanged ends brazed to hose.
   b. Ferrous-Metal Piping: Stainless-steel hose covered with stainless-steel wire braid; with ASME B1.20.1, threaded steel pipe nipples or ASME B16.5, steel pipe flanges welded to hose.
5. Dielectric Fittings: Combination of copper alloy and ferrous; threaded, solder, or plain end types; and matching piping system materials.
   a. Dielectric Unions: Factory-fabricated union assembly, designed for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C). Include insulating material that isolates dissimilar metals and ends with inside threads according to ASME B1.20.1.
   b. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure to suit system pressures.
   c. Dielectric-Flange Insulation Kits: Field-assembled companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
      1) Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure to suit system pressures.
   d. Dielectric Couplings: Galvanized-steel couplings with inert and noncorrosive thermoplastic lining, with threaded ends and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
   e. Dielectric Nipples: Electroplated steel nipples with inert and noncorrosive thermoplastic lining, with combination of plain, threaded, or grooved end types, and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

I. Corrosion-Protection Piping Encasement
1. Encasement for Underground Metal Piping:
   a. Standards: ASTM A 674 or AWWA C105.
   b. Form: Sheet **OR** Tube, **as directed**.
   c. Material: LLDPE film of 0.008-inch (0.20-mm) minimum thickness.
   d. Material: LLDPE film of 0.008-inch (0.20-mm) minimum thickness, or high-density, crosslaminated PE film of 0.004-inch (0.10-mm) minimum thickness.

e. Material: High-density, crosslaminated PE film of 0.004-inch (0.10-mm) minimum thickness.
f. Color: Black **OR** Natural, **as directed**.

J. Gate Valves
1. AWWA, Cast-Iron Gate Valves:
a. Nonrising-Stem, Metal-Seated Gate Valves:
1) Description: Gray- or ductile-iron body and bonnet; with cast-iron or bronze double-disc gate, bronze gate rings, bronze stem, and stem nut.
a) Standard: AWWA C500.
b) Minimum Pressure Rating: 200 psig (1380 kPa).
c) End Connections: Mechanical joint.
d) Interior Coating: Complying with AWWA C550.
b. Nonrising-Stem, Resilient-Seated Gate Valves:
1) Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
a) Standard: AWWA C509.
b) Minimum Pressure Rating: 200 psig (1380 kPa).
c) End Connections: Mechanical joint.
d) Interior Coating: Complying with AWWA C550.
c. Nonrising-Stem, High-Pressure, Resilient-Seated Gate Valves:
1) Description: Ductile-iron body and bonnet; with bronze or ductile-iron gate, resilient seats, bronze stem, and stem nut.
a) Standard: AWWA C509.
b) Minimum Pressure Rating: 250 psig (1725 kPa).
c) End Connections: Push on or mechanical joint.
d) Interior Coating: Complying with AWWA C550.
d. OS&Y, Rising-Stem, Metal-Seated Gate Valves:
1) Description: Cast- or ductile-iron body and bonnet, with cast-iron double disc, bronze disc and seat rings, and bronze stem.
a) Standard: AWWA C500.
b) Minimum Pressure Rating: 200 psig (1380 kPa).
c) End Connections: Flanged.
e. OS&Y, Rising-Stem, Resilient-Seated Gate Valves:
1) Description: Cast- or ductile-iron body and bonnet, with bronze or gray- or ductile-iron gate, resilient seats, and bronze stem.
a) Standard: AWWA C509.
b) Minimum Pressure Rating: 200 psig (1380 kPa).
c) End Connections: Flanged.
2. UL/FMG, Cast-Iron Gate Valves:
a. UL/FMG, Nonrising-Stem Gate Valves:
1) Description: Iron body and bonnet with flange for indicator post, bronze seating material, and inside screw.
a) Standards: UL 262 and FMG approved.
b) Minimum Pressure Rating: 175 psig (1207 kPa).
c) End Connections: Flanged.
b. OS&Y, Rising-Stem Gate Valves:
1) Description: Iron body and bonnet and bronze seating material.
a) Standards: UL 262 and FMG approved.
b) Minimum Pressure Rating: 175 psig (1207 kPa).
c) End Connections: Flanged.
3. Bronze Gate Valves:
a. OS&Y, Rising-Stem Gate Valves:
1) Description: Bronze body and bonnet and bronze stem.
a) Standards: UL 262 and FMG approved.

b) Minimum Pressure Rating: 175 psig (1207 kPa).
c) End Connections: Threaded.

b. Nonrising-Stem Gate Valves:
1) Description: Class 125, Type 1, bronze with solid wedge, threaded ends, and malleable-iron handwheel.
a) Standard: MSS SP-80.

K. Gate Valve Accessories And Specialties
1. Tapping-Sleeve Assemblies:
a. Description: Sleeve and valve compatible with drilling machine.
1) Standard: MSS SP-60.
2) Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
3) Valve: AWWA, cast-iron, nonrising-stem, metal **OR** resilient, **as directed**,-seated gate valve with one raised face flange mating tapping-sleeve flange.
2. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches (125 mm) in diameter.
a. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.
3. Indicator Posts: UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

L. Check Valves
1. AWWA Check Valves:
a. Description: Swing-check type with resilient seat. Include interior coating according to AWWA C550 and ends to match piping.
1) Standard: AWWA C508.
2) Pressure Rating: 175 psig (1207 kPa).
2. UL/FMG, Check Valves:
a. Description: Swing-check type with pressure rating; rubber-face checks, unless otherwise indicated; and ends matching piping.
1) Standards: UL 312 and FMG approved.
2) Pressure Rating: 175 psig (1207 kPa) **OR** 250 psig (1725 kPa), **as directed**.

M. Detector Check Valves
1. Detector Check Valves:
a. Description (with water meter): Galvanized cast-iron body, bolted cover with air-bleed device for access to internal parts, and flanged ends. Include one-piece bronze disc with bronze bushings, pivot, and replaceable seat. Include threaded bypass taps in inlet and outlet for bypass meter connection. Set valve to allow minimal water flow through bypass meter when major water flow is required.
1) Standards: UL 312 and FMG approved.
2) Pressure Rating: 175 psig (1207 kPa).
3) Water Meter: AWWA C700, disc type, at least one-fourth size of detector check valve. Include meter, bypass piping, gate valves, check valve, and connections to detector check valve.
b. Description (without water meter): Iron body, corrosion-resistant clapper ring and seat ring material, flanged ends, with connections for bypass and installation of water meter.
1) Standards: UL 312 and FMG approved.
2) Pressure Rating: 175 psig (1207 kPa).

N. Butterfly Valves
1. AWWA Butterfly Valves:

a. Description: Rubber seated.
1) Standard: AWWA C504.
2) Body: Cast or ductile iron.
3) Body Type: Wafer **OR** Flanged, **as directed**.
4) Pressure Rating: 150 psig (1035 kPa).
2. UL Butterfly Valves:
a. Description: Metal on resilient material seating.
1) Standards: UL 1091 and FMG approved.
2) Body: Cast or ductile iron.
3) Body Type: Wafer **OR** Flanged, **as directed**.
4) Pressure Rating: 175 psig (1207 kPa).

O. Plug Valves
1. Plug Valves:
a. Description: Resilient-seated eccentric.
1) Standard: MSS SP-108.
2) Body: Cast iron.
3) Pressure Rating: 175-psig (1207-kPa) minimum CWP.
4) Seat Material: Suitable for potable-water service.

P. Corporation Valves And Curb Valves
1. Service-Saddle Assemblies: Comply with AWWA C800. Include saddle and valve compatible with tapping machine.
a. Service Saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.
b. Corporation Valve: Bronze body and ground-key plug, with AWWA C800, threaded inlet and outlet matching service piping material.
c. Manifold (if utility company requires multiple connections): Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.
2. Curb Valves: Comply with AWWA C800. Include bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.
3. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately 3 inches (75 mm) in diameter.
a. Shutoff Rods: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

Q. Water Meters
1. Water meters will be furnished by utility company.
NOTE: If water meters are specified in this Section, delete paragraph above and retain and edit paragraphs and subparagraphs below.
2. Displacement-Type Water Meters:
a. Description: With bronze main case.
1) Standard: AWWA C700.
2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
3. Turbine-Type Water Meters:
a. Description:
1) Standard: AWWA C701.
2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
4. Compound-Type Water Meters:
a. Description:
1) Standard: AWWA C702.
2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.

5. Remote Registration System:
   a. Description: Utility company standard; direct-reading type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.
      1) Standard: AWWA C706.
      2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
6. Remote Registration System:
   a. Description: Utility company standard; encoder type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.
      1) Standard: AWWA C707.
      2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
      3) Data-Acquisition Units: Comply with utility company requirements for type and quantity.
         OR
         Visible Display Units: Comply with utility company requirements for type and quantity.

R. Detector-Type Water Meters
1. Detector-Type Water Meters
2. Description: Main line, proportional meter with second meter on bypass. Register flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
   a. Standards: AWWA C703, UL listed, and FMG approved.
   b. Pressure Rating: 150 psig (1035 kPa).
   c. Bypass Meter: AWWA C701, turbine **OR** AWWA C702, compound, **as directed**,-type, bronze case.
      1) Size: At least one-half nominal size of main-line meter.
3. Description: Main-line turbine meter with strainer and second meter on bypass. Register flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
   a. Standards: AWWA C703, UL listed, and FMG approved.
   b. Pressure Rating: 175 psig (1207 kPa).
   c. Bypass Meter: AWWA C701, turbine-type, bronze case.
      1) Size: At least NPS 2 (DN 50).
4. Remote Registration System:
   a. Description: Utility company standard; direct-reading type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.
      1) Standard: AWWA C706.
      2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
5. Remote Registration System:
   a. Description: Utility company standard; encoder type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.
      1) Standard: AWWA C707.
      2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
      3) Data-Acquisition Units: Comply with utility company requirements for type and quantity.
         OR
         Visible Display Units: Comply with utility company requirements for type and quantity.

S. Pressure-Reducing Valves
1. Water Regulators:
   a. Standard: ASSE 1003.
   b. Pressure Rating: Initial pressure of 150 psig (1035 kPa).
   c. Size: As directed by the manufacturer or as directed by the Owner.
   d. Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
   e. Design Inlet Pressure: As directed by the manufacturer or as directed by the Owner.
   f. Design Outlet Pressure Setting: As directed by the manufacturer or as directed by the Owner.

g. Body: Bronze with chrome-plated finish, **as directed**, for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved, **as directed**, for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).
h. Valves for Booster Heater Water Supply: Include integral bypass.
i. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).

2. Water Control Valves:
   a. Description: Pilot-operation, diaphragm-type, single-seated main water control valve with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot control valve, restrictor device, specialty fittings, and sensor piping.
      1) Pressure Rating: Initial pressure of 150 psig (1035 kPa) minimum.
      2) Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.
         a) Size: As directed by the manufacturer or as directed by the Owner.
         b) Pattern: Angle **OR** Globe, **as directed**,-valve design.
         c) Trim: Stainless steel.
      3) Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
      4) Design Inlet Pressure: As directed by the manufacturer or as directed by the Owner.
      5) Design Outlet Pressure Setting: As directed by the manufacturer or as directed by the Owner.
      6) End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged, **as directed**, for NPS 2-1/2 (DN 65) and larger.

T. Relief Valves

1. Air-Release Valves:
   a. Description: Hydromechanical device to automatically release accumulated air.
      1) Standard: AWWA C512.
      2) Pressure Rating: 300 psig (2070 kPa), **as directed**.
      3) Body Material: Cast iron, **as directed**.
      4) Trim Material: Stainless steel, brass, or bronze, **as directed**.
      5) Water Inlet Size: As directed by the manufacturer or as directed by the Owner.
      6) Air Outlet Size: As directed by the manufacturer or as directed by the Owner.
      7) Orifice Size: As directed by the manufacturer or as directed by the Owner.
      8) Design Air-Release Capacity: As directed by the manufacturer or as directed by the Owner.
2. Air/Vacuum Valves:
   a. Description: Direct-acting, float-operated, hydromechanical device with large orifice to automatically release accumulated air or to admit air during filling of piping.
      1) Standard: AWWA C512.
      2) Pressure Rating: 300 psig (2070 kPa), **as directed**.
      3) Body Material: Cast iron, **as directed**.
      4) Trim Material: Stainless steel, brass, or bronze\, **as directed**.
      5) Inlet and Outlet Size: As directed by the manufacturer or as directed by the Owner.
      6) Orifice Size: As directed by the manufacturer or as directed by the Owner.
      7) Design Air Capacity: As directed by the manufacturer or as directed by the Owner.
3. Combination Air Valves:
   a. Description: Float-operated, hydromechanical device to automatically release accumulated air or to admit air.
      1) Standard: AWWA C512.
      2) Pressure Rating: 300 psig (2070 kPa), **as directed**.
      3) Body Material: Cast iron, **as directed**.
      4) Trim Material: Stainless steel, brass, or bronze, **as directed**.
      5) Inlet and Outlet Size: As directed by the manufacturer or as directed by the Owner.
      6) Orifice Size: As directed by the manufacturer or as directed by the Owner.
      7) Design Air Capacity: As directed by the manufacturer or as directed by the Owner.

U. Vacuum Breakers
1. Pressure Vacuum Breaker Assembly:
a. Standard: ASSE 1020.
b. Operation: Continuous-pressure applications.
c. Pressure Loss: 5 psig (35 kPa), **as directed,** maximum, through middle 1/3 of flow range.
d. Size: As directed by the manufacturer or as directed by the Owner.
e. Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
f. Selected Unit Flow Range Limits: As directed by the manufacturer or as directed by the Owner.
g. Pressure Loss at Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
h. Accessories: Ball valves on inlet and outlet.

V. Backflow Preventers
1. Reduced-Pressure-Principle Backflow Preventers:
a. Standard: ASSE 1013 **OR** AWWA C511, **as directed**.
b. Operation: Continuous-pressure applications.
c. Pressure Loss: 12 psig (83 kPa), **as directed**, maximum, through middle 1/3 of flow range.
d. Size: As directed by the manufacturer or as directed by the Owner.
e. Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
f. Selected Unit Flow Range Limits: As directed by the manufacturer or as directed by the Owner.
g. Pressure Loss at Design Flow Rate: As directed by the manufacturer or as directed by the Owner.for NPS 2 (DN 50) and smaller; As directed by the manufacturer or as directed by the Owner.for NPS 2-1/2 (DN 65) and larger.
h. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved **OR** steel with interior lining complying with AWWA C550 or that is FDA approved **OR** stainless steel, **as directed**, for NPS 2-1/2 (DN 65) and larger.
i. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged, **as directed**, for NPS 2-1/2 (DN 65) and larger.
j. Configuration: Designed for horizontal, straight through **OR** vertical inlet, horizontal center section, and vertical outlet **OR** vertical, **as directed**, flow.
k. Accessories:
1) Valves: Ball type with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; OS&Y gate type with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.
2) Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.
2. Double-Check, Backflow-Prevention Assemblies:
a. Standard: ASSE 1015 **OR** AWWA C510, **as directed**.
b. Operation: Continuous-pressure applications, unless otherwise indicated.
c. Pressure Loss: 5 psig (35 kPa), **as directed**, maximum, through middle 1/3 of flow range.
d. Size: As directed by the manufacturer or as directed by the Owner.
e. Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
f. Selected Unit Flow Range Limits: As directed by the manufacturer or as directed by the Owner.
g. Pressure Loss at Design Flow Rate: As directed by the manufacturer or as directed by the Owner.for NPS 2 (DN 50) and smaller; As directed by the manufacturer or as directed by the Owner.for NPS 2-1/2 (DN 65) and larger.
h. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved **OR** steel with interior lining complying with AWWA C550 or that is FDA approved **OR** stainless steel, **as directed**, for NPS 2-1/2 (DN 65) and larger.
i. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged, **as directed**, for NPS 2-1/2 (DN 65) and larger.

j. Configuration: Designed for horizontal, straight through, **as directed**, flow.
k. Accessories: Ball valves with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; OS&Y gate valves with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.

3. Reduced-Pressure-Detector, Fire-Protection Backflow Preventer Assemblies:
   a. Standards: ASSE 1047 and UL listed or FMG approved.
   b. Operation: Continuous-pressure applications.
   c. Pressure Loss: 12 psig (83 kPa), **as directed**, maximum, through middle 1/3 of flow range.
   d. Size: As directed by the manufacturer or as directed by the Owner.Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
   e. Selected Unit Flow Range Limits: As directed by the manufacturer or as directed by the Owner.
   f. Pressure Loss at Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
   g. Body: Cast iron with interior lining complying with AWWA C550 or that is FDA approved **OR** Steel with interior lining complying with AWWA C550 or that is FDA approved **OR** Stainless steel, **as directed**.
   h. End Connections: Flanged.
   i. Configuration: Designed for horizontal, straight through **OR** vertical inlet, horizontal center section, and vertical outlet **OR** vertical, **as directed**, flow.
   j. Accessories:
      1) Valves: UL 262, FMG-approved, OS&Y gate type with flanged ends on inlet and outlet.
      2) Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.
      3) Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.
4. Double-Check, Detector-Assembly Backflow Preventers:
   a. Standards: ASSE 1048 and UL listed or FMG approved.
   b. Operation: Continuous-pressure applications.
   c. Pressure Loss: 5 psig (35 kPa), **as directed**, maximum, through middle 1/3 of flow range.
   d. Size: As directed by the manufacturer or as directed by the Owner.
   e. Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
   f. Selected Unit Flow Range Limits: As directed by the manufacturer or as directed by the Owner.
   g. Pressure Loss at Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
   h. Body: Cast iron with interior lining complying with AWWA C550 or that is FDA approved **OR** Steel with interior lining complying with AWWA C550 or that is FDA approved **OR** Stainless steel, **as directed**.
   i. End Connections: Flanged.
   j. Configuration: Designed for horizontal, straight through **OR** vertical inlet, horizontal center section, and vertical outlet **OR** vertical, **as directed**, flow.
   k. Accessories:
      1) Valves: UL 262, FMG-approved, OS&Y gate type with flanged ends on inlet and outlet.
      2) Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.
5. Backflow Preventer Test Kits:
   a. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

W. Water Meter Boxes
1. Description: Cast-iron body and cover for disc-type water meter, with lettering "WATER METER" in cover; and with slotted, open-bottom base section of length to fit over service piping.

a. Option: Base section may be cast-iron, PVC, clay, or other pipe.
2. Description: Cast-iron body and double cover for disc-type water meter, with lettering "WATER METER" in top cover; and with separate inner cover; air space between covers; and slotted, open-bottom base section of length to fit over service piping.
3. Description: Polymer-concrete body and cover for disc-type water meter, with lettering "WATER" in cover; and with slotted, open-bottom base section of length to fit over service piping. Include vertical and lateral design loadings of 15,000 lb minimum over 10 by 10 inches (6800 kg minimum over 254 by 254 mm) square.
   a. Use of this meter box is permitted in walks or unpaved areas away from traffic; do not use in roadways.

X. Concrete Vaults
1. Description: Precast, reinforced-concrete vault, designed for A-16 load designation according to ASTM C 857 and made according to ASTM C 858.
   a. Ladder: ASTM A 36/A 36M, steel or polyethylene-encased steel steps.
   b. Manhole: ASTM A 48/A 48M Class No. 35A minimum tensile strength, gray-iron traffic frame and cover.
      1) Dimension: 24-inch (610-mm) minimum diameter, unless otherwise indicated.
   c. Manhole: ASTM A 536, Grade 60-40-18, ductile-iron traffic frame and cover.
      1) Dimension: 24-inch- (610-mm-) minimum diameter, unless otherwise indicated.
   d. Drain: ASME A112.6.3, cast-iron floor drain with outlet of size indicated. Include body anchor flange, light-duty cast-iron grate, bottom outlet, and integral or field-installed bronze ball or clapper-type backwater valve.

Y. Protective Enclosures
1. Freeze-Protection Enclosures:
   a. Description: Insulated enclosure designed to protect aboveground water piping, equipment, or specialties from freezing and damage, with heat source to maintain minimum internal temperature of 40 deg F (4 deg C) when external temperatures reach as low as minus 34 deg F (minus 36 deg C).
      1) Standard: ASSE 1060.
      2) Class I: For equipment or devices other than pressure or atmospheric vacuum breakers.
      3) Class I-V: For pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.
         a) Housing: Reinforced-aluminum **OR** -fiberglass, **as directed**, construction.
            i. Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
            ii. Drain opening for units with drain connection.
            iii. Access doors with locking devices.
            iv. Insulation inside housing.
            v. Anchoring devices for attaching housing to concrete base.
         b) Electric heating cable or heater with self-limiting temperature control.
2. Weather-Resistant Enclosures:
   a. Description: Uninsulated enclosure designed to protect aboveground water piping, equipment, or specialties from weather and damage.
      1) Standard: ASSE 1060.
      2) Class III: For equipment or devices other than pressure or atmospheric vacuum breakers.
      3) Class III-V: For pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.
            i. Housing: Reinforced-aluminum **OR** -fiberglass, **as directed**, construction.
            ii. Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
            iii. Drain opening for units with drain connection.

iv. Access doors with locking devices.
v. Anchoring devices for attaching housing to concrete base.

3. Expanded-Metal Enclosures:
   a. Description: Enclosure designed to protect aboveground water piping, equipment, or specialties from damage.
      1) Material: ASTM F 1267, expanded metal side and top panels, of weight and with reinforcement of same metal at edges as required for rigidity.
      2) Type: Type I, expanded **OR** II, expanded and flattened, **as directed**.
      3) Class: Class 1, uncoated carbon steel **OR** 2, hot-dip, zinc-coated carbon steel **OR** 3, corrosion-resisting steel, **as directed**.
      4) Finish: Manufacturer's enamel paint.
      5) Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
      6) Locking device.
      7) Lugs or devices for securing enclosure to base.
4. Enclosure Bases:
   a. Description: 4-inch- (100-mm-) **OR** 6-inch- (150-mm-), **as directed**, minimum thickness precast concrete, of dimensions required to extend at least 6 inches (150 mm) beyond edges of enclosure housings. Include openings for piping.

Z. Fire Hydrants
1. Dry-Barrel Fire Hydrants:
   a. Description (for AWWA dry-barrel fire hydrants): Freestanding, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, 5-1/4-inch (133-mm) main valve, drain valve, and NPS 6 (DN 150) mechanical-joint inlet. Include interior coating according to AWWA C550. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.
      1) Standard: AWWA C502.
      2) Pressure Rating: 150 psig (1035 kPa) minimum **OR** 250 psig (1725 kPa), **as directed**.
      3) Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
      4) Operating and Cap Nuts: Pentagon, 1-1/2 inches (38 mm) point to flat.
      5) Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.
      6) Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.
   b. Description (for UL/FMG, dry-barrel fire hydrants): Freestanding, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, 5-1/4-inch (133-mm) main valve, drain valve, and NPS 6 (DN 150) mechanical-joint inlet. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.
      1) Standards: UL 246, FMG approved.
      2) Pressure Rating: 150 psig (1035 kPa) minimum **OR** 250 psig (1725 kPa), **as directed**.
      3) Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
      4) Operating and Cap Nuts: Pentagon, 1-1/2 inches (38 mm) point to flat.
      5) Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.
      6) Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.
2. Wet-Barrel Fire Hydrants:
   a. Description (for AWWA wet-barrel fire hydrants): Freestanding, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, NPS 6 (DN 150) threaded or flanged inlet, and base section with NPS 6 (DN 150) mechanical-joint inlet. Include interior coating according to AWWA C550.
      1) Standard: AWWA C503.

2) Pressure Rating: 150 psig (1035 kPa) minimum.
3) Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
4) Operating and Cap Nuts: Pentagon, 1-1/2 inches (38 mm) point to flat.
5) Direction of Opening: Open hydrant valves by turning operating nut to left or counterclockwise.
6) Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.

b. Description (for UL/FMG, wet-barrel fire hydrants): Freestanding, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, NPS 6 (DN 150) threaded or flanged inlet, and base section with NPS 6 (DN 150) mechanical-joint inlet.
1) Standards: UL 246 and FMG approved.
2) Pressure Rating: 150 psig (1035 kPa) minimum.
3) Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
4) Operating and Cap Nuts: Pentagon, 1-1/2 inches (38 mm) point to flat.
5) Direction of Opening: Open hydrant valves by turning operating nut to left or counterclockwise.
6) Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.

AA. Flushing Hydrants
1. Post-Type Flushing Hydrants:
a. Description: Nonfreeze and drainable, of length required for shutoff valve installation below frost line.
1) Pressure Rating: 150 psig (1035 kPa) minimum.
2) Outlet: One, with horizontal discharge.
3) Hose Thread: NPS 2-1/2 (DN 65), with NFPA 1963 external hose thread for use by local fire department, and with cast-iron cap with brass chain.
4) Barrel: Cast-iron or steel pipe with breakaway feature.
5) Valve: Bronze body with bronze-ball or plunger closure, and automatic draining.
6) Security: Locking device for padlock.
7) Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.
8) Inlet: NPS 2 (DN 50) minimum.
9) Operating Wrench: One for each unit.
2. Ground-Type Flushing Hydrants:
a. Description: Nonfreeze and drainable, of length required for shutoff valve installation below frost line.
1) Pressure Rating: 150 psig (1035 kPa) minimum.
2) Outlet: One, with vertical **OR** angle, **as directed**, discharge.
3) Hose Thread: NPS 2-1/2 (DN 65), with NFPA 1963 external hose thread for use by local fire department, and with cast-iron cap with brass chain.
4) Barrel: Cast-iron or steel pipe.
5) Valve: Bronze body with bronze-ball or plunger closure, and automatic draining.
6) Inlet: NPS 2 (DN 50) minimum.
7) Hydrant Box: Cast iron with cover, for ground mounting.
8) Operating Wrench: One for each unit.
3. Post-Type Sampling Station:
a. Description: Nonfreeze and drainable, of length required for shutoff valve installation below frost line.
1) Pressure Rating: 100 psig (690 kPa) minimum.
2) Sampling Outlet: One unthreaded nozzle with handle.
3) Valve: Bronze body with bronze-ball or plunger closure. Include operating handle.
4) Drain: Tubing with separate manual vacuum pump.
5) Inlet: NPS 3/4 (DN 20) minimum.
6) Housing: Weatherproof material with locking device. Include anchor device.
7) Operating Wrench: One for each unit.

BB. Fire Department Connections

1. Fire Department Connections:
   a. Description: Freestanding, with cast-bronze body, thread inlets according to NFPA 1963 and matching local fire department hose threads, and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch- (460-mm-) high brass sleeve; and round escutcheon plate.
      1) Standard: UL 405.
      2) Connections: Two NPS 2-1/2 (DN 65) inlets and one NPS 4 (DN 100) **OR** NPS 6 (DN 150), **as directed**, outlet.
      3) Connections: Three **OR** Four, **as directed**, NPS 2-1/2 (DN 65) inlets and one NPS 6 (DN 150) outlet.
      4) Connections: Six NPS 2-1/2 (DN 65) inlets and one NPS 6 (DN 150) **OR** NPS 8 (DN 200), **as directed**, outlet.
      5) Inlet Alignment: Inline, horizontal **OR** Square, **as directed**.
      6) Finish Including Sleeve: Polished chrome-plated **OR** Rough chrome-plated **OR** Polished bronze, **as directed**.
      7) Escutcheon Plate Marking: "AUTO SPKR" **OR** "STANDPIPE" **OR** "AUTO SPKR & STANDPIPE."

CC. Alarm Devices

1. Alarm Devices, General: UL 753 and FMG approved, of types and sizes to mate and match piping and equipment.
2. Water-Flow Indicators (can be used with wet-barrel fire hydrants): Vane-type water-flow detector, rated for 250-psig (1725-kPa) working pressure; designed for horizontal or vertical installation; with 2 single-pole, double-throw circuit switches to provide isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal when cover is removed.
3. Supervisory Switches: Single pole, double throw; designed to signal valve in other than fully open position. Mount on stem of OS&Y gate valves and on indicator posts.
4. Pressure Switches: Single pole, double throw; designed to signal increase in pressure. Mount on barrel of dry-barrel fire hydrants.

1.3 EXECUTION

A. Earthwork

1. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

B. Piping Applications

1. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.
2. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.
3. Do not use flanges or unions for underground piping.
4. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.
5. Underground water-service piping NPS 3/4 to NPS 3 (DN 20 to DN 80), **as directed**, shall be selected from the following, **as directed**:
   a. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; wrought-copper, solder-joint fittings; and brazed **OR** copper, pressure-seal fittings; and pressure-sealed, **as directed**, joints.
   b. PE, ASTM pipe; insert fittings for PE pipe; and clamped **OR** molded PE fittings; and heat-fusion, **as directed**, joints.
   c. PVC, Schedule 40 pipe; PVC, Schedule 40 **OR** Schedule 80 pipe; PVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.

d. NPS 1 to NPS 3 (DN 25 to DN 80) fiberglass, AWWA RTRP, Class 150 **OR** 200 **OR** 250, **as directed**; RTRF; and bonded joints.

e. Fiberglass, AWWA RTRP, Class 150 **OR** 200 **OR** 250, **as directed**; RTRF; and bonded joints.

6. Underground water-service piping NPS 4 to NPS 8 (DN 100 to DN 200), **as directed**, shall be selected from the following, **as directed**:

a. Soft copper tube, ASTM B 88, Type K (ASTM B 88M,Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; wrought-copper, solder-joint fittings; and brazed joints.

b. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed **OR** mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical **OR** grooved-end pipe; ductile-iron-pipe appurtenances; and grooved, **as directed**, joints.

c. PE, AWWA pipe; PE, AWWA fittings; and heat-fusion joints.

d. PVC, Schedule 40 pipe; PVC, Schedule 40 **OR** Schedule 80 pipe; PVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.

e. NPS 4 and NPS 6 (DN 100 and DN 150): NPS 6 (DN 150) PVC, AWWA Class 150 pipe; PVC, AWWA Class 150 fabricated **OR** molded, **as directed**, fittings; and gasketed joints.

f. NPS 8 (DN 200): PVC, AWWA Class 200 pipe; PVC, AWWA Class 200 fabricated **OR** push-on-joint, ductile-iron **OR** mechanical-joint, ductile-iron, **as directed**, fittings; and gasketed joints.

g. Fiberglass, AWWA RTRP, Class 150 **OR** 200 **OR** 250, **as directed**; RTRF; and bonded joints.

7. Water Meter Box Water-Service Piping NPS 3/4 to NPS 2 (DN 20 to DN 50), **as directed**, shall be same as underground water-service piping.

8. Aboveground and Vault, **as directed**, Water-Service Piping NPS 3/4 to NPS 3 (DN 20 to DN 80), **as directed**, shall be selected from the following:

NOTE: Water-service piping materials listed in subparagraphs below are for potable-water service. They may not be suitable for fire-service mains.

a. Hard copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; wrought-copper, solder-joint fittings; and brazed **OR** copper, pressure-seal fittings; and pressure-sealed, **as directed**, joints.

b. PVC, Schedule 80 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented **OR** threaded fittings; and threaded, **as directed**, joints.

c. NPS 1 to NPS 2 (DN 25 to DN 50) fiberglass, AWWA RTRP, Class 150 **OR** 200 **OR** 250, **as directed**; RTRF; and bonded joints.

9. Aboveground and vault, **as directed**, water-service piping NPS 4 to NPS 8 (DN 100 to DN 200), **as directed**, shall be selected from the following:

a. Hard copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; wrought-copper, solder-joint fittings; and brazed joints.

b. Ductile-iron, grooved-end pipe; ductile-iron, grooved-end appurtenances; and grooved joints.

c. PVC, Schedule 80 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented **OR** threaded fittings; and threaded, **as directed**, joints.

d. Fiberglass, AWWA RTRP, Class 150 **OR** 200 **OR** 250, **as directed**; RTRF; and bonded joints.

10. Underground Fire-Service-Main Piping NPS 4 to NPS 12 (DN 100 to DN 300), **as directed**, shall be selected from the following:

NOTE: Fire-service-main piping materials listed in subparagraphs below are for fire-protection water service. They may not be suitable for potable-water service.

a. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed **OR** mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical **OR** grooved-end pipe; ductile-iron-pipe appurtenances; and grooved, **as directed**, joints.

b. PE, Class 150 **OR** 200, **as directed**, fire-service pipe; molded PE fittings; and heat-fusion joints.

c. PVC, AWWA Class 150 pipe listed for fire-protection service; PVC Class 150 fabricated or molded fittings; and gasketed joints.
d. PVC, AWWA Class 200 pipe listed for fire-protection service; PVC Class 200 fabricated fittings; and gasketed joints.
e. Fiberglass, AWWA, FMG-approved RTRP, Class 150 **OR** 200, **as directed**; RTRF; and gasketed joints.
f. Fiberglass, UL RTRP, Class 150 **OR** 200 **OR** 250, **as directed**; RTRF; and gasketed joints.

11. Aboveground and Vault, **as directed**, Fire-Service-Main Piping NPS 4 to NPS 12 (DN 100 to DN 300), **as directed**, shall be ductile-iron, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.
12. Underground Combined Water-Service and Fire-Service-Main Piping NPS 6 to NPS 12 (DN 150 to DN 300), **as directed**, shall be selected from the following:
    a. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed **OR** mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical **OR** grooved-end pipe; ductile-iron-pipe appurtenances; and grooved, **as directed**, joints.
    b. PVC, AWWA Class 150 **OR** 200, **as directed**, pipe listed for fire-protection service; PVC fabricated or molded fittings of same class as pipe; and gasketed joints.
    c. Fiberglass, AWWA, FMG-approved RTRP, Class 150 **OR** 200, **as directed**; RTRF; and gasketed joints.
13. Aboveground and Vault, **as directed**, Combined Water Service and Fire-Service-Main Piping NPS 6 to NPS 12 (DN 150 to DN 300), **as directed**, shall be ductile-iron, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.

C. Valve Applications
1. General Application: Use mechanical-joint-end valves for NPS 3 (DN 80) and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 (DN 50) and smaller installation.
2. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
    a. Underground Valves, NPS 3 (DN 80) and Larger: AWWA, cast-iron, nonrising-stem, metal **OR** resilient **OR** high-pressure, resilient, **as directed**,-seated gate valves with valve box.
    b. Underground Valves, NPS 4 (DN 100) and Larger, for Indicator Posts: UL/FMG, cast-iron, nonrising-stem gate valves with indicator post.
    c. Use the following for valves in vaults and aboveground:
        1) Gate Valves, NPS 2 (DN 50) and Smaller: Bronze, nonrising **OR** rising, **as directed**, stem.
        2) Gate Valves, NPS 3 (DN 80) and Larger: AWWA, cast iron, OS&Y rising stem, metal seated **OR** AWWA, cast iron, OS&Y rising stem, resilient seated **OR** UL/FMG, cast iron, OS&Y rising stem, **as directed**.
        3) Check Valves: AWWA C508 **OR** UL/FMG, **as directed**, swing type.
    d. Pressure-Reducing Valves: Use for water-service piping in vaults and aboveground to control water pressure.
    e. Relief Valves: Use for water-service piping in vaults and aboveground.
        1) Air-Release Valves: To release accumulated air.
        2) Air/Vacuum Valves: To release or admit large volume of air during filling of piping.
        3) Combination Air Valves: To release or admit air.
    f. Detector Check Valves: Use for water-service piping in vaults and aboveground to detect unauthorized use of water.

D. Piping Systems - Common Requirements
1. See Division 22 Section "Common Work Results For Plumbing" for piping-system common requirements.

E. Piping Installation

1. Water-Main Connection (if tap is made by utility company): Arrange with utility company for tap of size and in location indicated in water main.
2. Water-Main Connection (if tap is made by Contractor): Tap water main according to requirements of water utility company and of size and in location indicated.
3. Make connections larger than NPS 2 (DN 50) with tapping machine according to the following:
   a. Install tapping sleeve and tapping valve according to MSS SP-60.
   b. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
   c. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
   d. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.
4. Make connections NPS 2 (DN 50) and smaller with drilling machine according to the following:
   a. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company standards.
   b. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
   c. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
   d. Install corporation valves into service-saddle assemblies.
   e. Install manifold for multiple taps in water main.
   f. Install curb valve in water-service piping with head pointing up and with service box.
5. Comply with NFPA 24 for fire-service-main piping materials and installation.
   a. Install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.
   b. Install copper tube and fittings according to CDA's "Copper Tube Handbook."
6. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
   a. If required, install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.
7. Install PE pipe according to ASTM D 2774 and ASTM F 645.
8. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.
9. Install fiberglass AWWA pipe according to AWWA M45.
10. Bury piping with depth of cover over top at least 30 inches (750 mm), **as directed**, with top at least 12 inches (300 mm), **as directed**, below level of maximum frost penetration, and according to the following:
    a. Under Driveways: With at least 36 inches (910 mm), **as directed**, cover over top.
    b. Under Railroad Tracks: With at least 48 inches (1220 mm), **as directed**, cover over top.
    c. In Loose Gravelly Soil and Rock: With at least 12 inches (300 mm), **as directed**, additional cover.
11. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.
12. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.
    a. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.
13. Sleeves are specified in Division 22 Section "Common Work Results For Plumbing".
14. Mechanical sleeve seals are specified in Division 22 Section "Common Work Results For Plumbing".
15. For piping with gasketed joints: Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.
16. See Division 21 Section "Common Work Results For Fire Suppression" for fire-suppression-water piping inside the building.
17. See Division 22 Section "Common Work Results For Plumbing" for potable-water piping inside the building.

F. Joint Construction
1. See Division 22 Section "Common Work Results For Plumbing" for basic piping joint construction.
2. Make pipe joints according to the following:
   a. Copper-Tubing, Pressure-Sealed Joints: Use proprietary crimping tool and procedure recommended by copper, pressure-seal-fitting manufacturer.
   b. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
   c. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
   d. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.
   e. PE Piping Insert-Fitting Joints: Use plastic insert fittings and fasteners according to fitting manufacturer's written instructions.
   f. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
   g. Fiberglass Piping Bonded Joints: Use adhesive and procedure recommended by piping manufacturer.
   h. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure. Refer to Division 22 Section "Common Work Results For Plumbing" for joining piping of dissimilar metals.

G. Anchorage Installation
1. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
   a. Concrete thrust blocks.
   b. Locking mechanical joints.
   c. Set-screw mechanical retainer glands.
   d. Bolted flanged joints.
   e. Heat-fused joints.
   f. Pipe clamps and tie rods.
2. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
   a. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
   b. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
   c. Bonded-Joint Fiberglass, Water-Service Piping: According to AWWA M45.
   d. Fire-Service-Main Piping: According to NFPA 24.
3. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

H. Valve Installation
1. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.
2. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.
3. UL/FMG, Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.
4. UL/FMG, Valves Other Than Gate Valves: Comply with NFPA 24.
5. MSS Valves: Install as component of connected piping system.
6. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.
7. Pressure-Reducing Valves: Install in vault or aboveground between shutoff valves. Install full-size valved bypass, **as directed**.
8. Relief Valves: Comply with AWWA C512. Install aboveground with shutoff valve on inlet.

I. Detector-Check Valve Installation

1. Install in vault or aboveground.
2. Install for proper direction of flow. Install bypass with water meter, gate valves on each side of meter, and check valve downstream from meter.
3. Support detector check valves, meters, shutoff valves, and piping on brick or concrete piers.

J. Water Meter Installation
1. If water meters are provided by the Contractor: Install water meters, piping, and specialties according to utility company's written instructions.
2. Water Meters: Install displacement **OR** turbine, **as directed**,-type water meters, NPS 2 (DN 50) and smaller, in meter boxes with shutoff valves on water meter inlets. Include valves on water meter outlets and valved bypass around meters unless prohibited by authorities having jurisdiction.
3. Water Meters: Install compound **OR** turbine, **as directed**,-type water meters, NPS 3 (DN 80) and larger, in meter vaults. Include shutoff valves on water meter inlets and outlets and valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.
4. Water Meters: Install detector-type water meters in meter vault according to AWWA M6. Include shutoff valves on water meter inlets and outlets and full-size valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.

K. Roughing-In For Water Meters
1. If Contractor is to rough-in for water meters to be installed by utility company: Rough-in piping and specialties for water meter installation according to utility company's written instructions.

L. Vacuum Breaker Assembly Installation
1. Install pressure vacuum breaker assemblies of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.
2. Do not install pressure vacuum breaker assemblies in vault or other space subject to flooding.

M. Backflow Preventer Installation
1. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.
2. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.
3. Do not install bypass piping around backflow preventers.
4. Support NPS 2-1/2 (DN 65) and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

N. Water Meter Box Installation
1. Install water meter boxes in paved areas flush with surface.
2. Install water meter boxes in grass or earth areas with top 2 inches (50 mm), **as directed**, above surface.

O. Concrete Vault Installation
1. Install precast concrete vaults according to ASTM C 891.

P. Protective Enclosure Installation
1. Install concrete base level and with top approximately 2 inches (50 mm), **as directed**, above grade.
2. Install protective enclosure over valves and equipment.
3. Anchor protective enclosure to concrete base.

Q. Fire Hydrant Installation
1. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.

2. Wet-Barrel Fire Hydrants: Install with valve below frost line. Provide for drainage.
3. AWWA Fire Hydrants: Comply with AWWA M17.
4. UL/FMG Fire Hydrants: Comply with NFPA 24.

R. Flushing Hydrant Installation
1. Install post-type flushing hydrants with valve below frost line and provide for drainage. Support in upright position. Include separate gate valve or curb valve and restrained joints in supply piping.
2. Install ground-type flushing hydrants with valve below frost line and provide for drainage. Install hydrant box flush with grade. Include separate gate valve or curb valve and restrained joints in supply piping.
3. Install sampling stations with valve below frost line and provide for drainage. Attach weather-resistant housing and support in upright position. Include separate curb valve in supply piping.

S. Fire Department Connection Installation
1. Install ball drip valves at each check valve for fire department connection to mains.
2. Install protective pipe bollards on two sides of **OR** on three sides of, **as directed**, each fire department connection. Pipe bollards are specified in Division 05 Section "Metal Fabrications".

T. Alarm Device Installation
1. General: Comply with NFPA 24 for devices and methods of valve supervision. Underground valves with valve box do not require supervision.
2. Supervisory Switches: Supervise valves in open position.
   a. Valves: Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.
   b. Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.
3. Locking and Sealing: Secure unsupervised valves as follows:
   a. Valves: Install chain and padlock on open OS&Y gate valve.
   b. Post Indicators: Install padlock on wrench on indicator post.
4. Pressure Switches: Drill and thread hole in exposed barrel of fire hydrant. Install switch.
5. Water-Flow Indicators: Install in water-service piping in vault. Select indicator with saddle and vane matching pipe size. Drill hole in pipe, insert vane, and bolt saddle to pipe.
6. Connect alarm devices to building fire alarm system. Wiring and fire-alarm devices are specified in Division 28.

U. Connections
1. Piping installation requirements are specified in other Division 22. Drawings indicate general arrangement of piping, fittings, and specialties.
2. See Division 22 Section "Common Work Results For Plumbing" for piping connections to valves and equipment.
3. Connect water-distribution piping to utility water main **OR** existing water main, **as directed**. Use tapping sleeve and tapping valve **OR** service clamp and corporation valve, **as directed**.
4. Connect water-distribution piping to interior domestic water **OR** fire-suppression, **as directed**, piping.
5. Connect waste piping from concrete vault drains to sanitary sewerage system. See Division 22 for connection to sanitary-sewer **OR** storm-drainage system. See Division 23 for connection to storm-sewer, **as directed**, piping.
6. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
7. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

V. Field Quality Control

1. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
2. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.
    a. Increase pressure in 50-psig (350-kPa) increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig (0 kPa). Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts (1.89 L) per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.
3. Prepare reports of testing activities.

W. Identification
1. Install continuous underground detectable, **as directed**, warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Division 31 Section "Earth Moving".
2. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel. See Division 22 Section "Common Work Results For Plumbing" for identifying devices.

NOTE: Delete paragraph above if metallic water-service piping without electrically insulated fittings will be used.

X. Cleaning
1. Clean and disinfect water-distribution piping as follows:
    a. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
    b. If fire-protection-water piping is not connected to potable-water supply, use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
    c. If fire-protection-water piping is connected to potable-water supply, use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
        1) Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours **OR** Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours, **as directed**.
        2) After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
        3) Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.
2. Prepare reports of purging and disinfecting activities.

END OF SECTION 13 12 13 00

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SECTION 13 34 16 13 - FIXED WOOD BLEACHERS (EXTERIOR)

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of fixed wood bleachers (exterior). Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Hardware, Brackets, Fasteners, and Connectors
1. Zinc-coated or hot-dipped galvanized steel or aluminum. Nails, brads, staples, and spikes shall comply with ASTM F 547.

B. Lumber and Timber Members
1. Repair or replacement bleacher components shall be of the species and grades complying with National Design Specification for Wood Construction and its Fastenings (National Forest Products Association). Sizes shall comply with American Lumber Standards Committee PS20. Lumber materials shall bear a mark of recognized inspection agency identifying the species, grade, and compliance with the applicable standard. Wood preservatives shall be pressure-applied and shall comply with ASTM D 1760. Creosote or arsenate treatments shall not be used.
   a. Seatboard Lumber shall be kiln-dried Dense No. 1 Douglas fir or Dense No. 1 Southern yellow pine boards.
   b. Footboard Lumber shall be kiln-dried Dense No. 1 Douglas fir or Dense No. 1 Southern yellow pine boards.
   c. Support Member and Timber shall be Dense No. 1 Douglas fir or Dense No. 1 Southern yellow pine timbers or boards.

C. Ready-Mixed Concrete
1. Comply with ASTM C 94 with compressive strength of 3,000 pounds per square inch (210.9 kgs per square cm) at 28 days and shall be protected from freezing for seven days after placement.

D. Reinforcement for Concrete
1. Comply with ASTM A 184, A 1064, or A 615 as indicated.

1.3 EXECUTION

A. Repair or replace bleacher components using methods complying with the approved practices as referenced in American Institute of Timber Construction Timber Construction Manual.

END OF SECTION 13 34 16 13

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SECTION 13 34 16 13a - DEMOUNTABLE BLEACHERS (EXTERIOR)

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of demountable bleachers (exterior). Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Hardware and Accessories
   1. Zinc-coated or hot-dipped galvanized steel or aluminum.

B. Lumber
   1. Seat-board and foot-board repair or replacement lumber shall be species and grades complying with National Forest Products Association National Design Specification for Wood Construction and Its Fastenings. Sizes shall comply with American Lumber Standards Committee PS20. Lumber materials shall bear the mark of a recognized inspection agency identifying the species, grade, and compliance with the applicable standard. Wood preservatives shall be pressure-applied and shall comply with ASTM D 1760. Creosote or arsenate treatments shall not be used.
      a. Seat-board Lumber shall be kiln-dried Dense No. 1 Douglas fir or Dense No. 1 Southern yellow pine boards.
      b. Foot-board Lumber shall be kiln-dried Dense No. 1 Douglas fir or Dense No. 1 Southern yellow pine boards.

C. Steel Structural Members
   1. Comply with ASTM A36.

D. Aluminum Structural Members
   1. Comply with ASTM B308.

1.3 EXECUTION

A. Repair or replace bleacher components using methods complying with the approved practices as referenced in American Institute of Timber Construction Timber Construction Manual.

END OF SECTION 13 34 16 13a

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SECTION 13 34 16 13b - GRANDSTANDS AND BLEACHERS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of grandstands and bleachers. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings: Shop Drawings submitted shall be Designed and Detailed under the direct supervision of a licensed, in house, Professional Engineer. The Professional Engineer shall be present during the time the design and detailing is completed unless all details are included on the approval drawings bearing his/her seal.

C. Warranty

1. Contractor shall warranty any and all materials or workmanship covered by these specifications for a period of one (1) year. Defects shall be corrected by the Contractor at once without charge to the Owner.

1.2 PRODUCTS

A. Design:

1. The design shall be in accordance with the generally accepted standards as published by The American Institute of Steel Construction and The Aluminum Association.
2. Design Loads:
   a. A uniformly distributed live load of not less than 100 psf of gross horizontal projection of the grandstand.
   b. Grandstands and bleachers shall be designed to withstand, with or without live loads, the horizontal and uplift pressures due to the wind. Wind pressures shall be derived from ANSI/ASCE 7-93, Minimum Design Loads in Buildings and Other Structures.
   c. A horizontal swaying force applied to the seats, in a direction parallel to the length of the seats, of 24 lbs./ft.
   d. A horizontal swaying force applied to the seats, in a direction perpendicular to the length of the seats, of 10 lb./ft.
   e. All seat and footboard members shall be designed for live loads of not less than 120 lb. per lineal foot.
   f. Guardrails shall be capable of sustaining a vertical load of 100 plf and a horizontal thrust of 50 plf. Acting outwardly at the top of the rail.
   g. Under these loads, stresses shall now exceed those allowed in the "Specifications for Structural Steel Buildings, June 1, 1989" as adopted by the American Institute of Steel Construction.
3. Shop Connections: Welded and capable of carrying stress put upon them as per AWS standards.
4. Steel Members for Grandstands:
   a. Stringers: Wide flange beams spaced at 6'-0" on center.
   b. Columns: Wide flange beams spaced at 18'-0" on center longitudinally and transversely they will be spaced according to the size of the stand with a maximum of 24'-0" on center.
   c. Cross Beams: Horizontal cross beams shall be wide flange beams and run "continuously" for the length of the stand.

    d. Cross-Bracing: Front to back bracing shall be structural steel angle, bolted at ends and centers. Rod bracing shall be used for side to side bracing. On columns requiring 2 or more sets of cross-bracing, the connecting strut shall run continuously for the entire length of the stand.

5. Supporting Members (Framework) for Bleachers:
    a. Main supporting members are to be of a welded angle frame design.
    b. Spaced at 6'-0" centers (maximum).
    c. Constructed of a minimum 2 x 2 x 3/16" angle.
    d. Every frame shall be laterally supported with cross-bracing to the adjacent frame.
6. Dimensions:
    a. Length of Unit: As required to meet Project requirements.
    b. Number of rows: As required to meet Project requirements.
    c. Net seating capacity: As required to meet Project requirements.
    d. Bleacher seats: As required to meet Project requirements.
    e. Wheelchair spaces: As required to meet Project requirements, A.D.A. or Local Codes
    f. Front Walkways: 66 inches clear width
    g. Seat Height:
        1) Grandstands: 17 to 18 inches.
        2) Bleachers: 17 inches.
    h. Walkway Elevation:
        1) Grandstands: 42 to 49 inches.
        2) Bleachers: 30 to 42 inches.
    i. Aisle Width: 48" minimum clear width, unless directed otherwise.
7. Typical Stands:
    a. Grandstands:
        1) 8" Rise or 10" Rise with a 24" **OR** 28", **as directed**, row spacing.
        2) 12" Rise with 30" row spacing (Min. required for backrest).
    b. Bleachers: Standard 8" Rise with a 24" row depth
8. Deck Arrangements:
    a. Walkways: Six 2 x 12 planks.
    b. Seats: Standard 2 x 10, unless directed otherwise.
    c. Aisle Steps: Standard 2 x 12 plank **OR** 2 x 12 plank with 1" contrasting nosing to delineate the leading edge, **as directed**.
    d. Footboard and Riser plank arrangement: Semi-closed (SC), Fully Closed Deck Plank Arrangement (CD), and Interlocked Deck (IL).
9. Guardrails:
    a. Furnished on sides of the bleacher including stairs, ramps, portals and landings.
    b. All pipes shall be 1 5/8" O.D. anodized aluminum pipe with end plugs and elbows at corners. Secured to angle rail posts with galvanized fasteners.
    c. Rails not less than 42" vertically above the center of the seatboard surface shall be provided at the back and sides of the bleacher.
    d. Rails are not to be less than 42" above the elevated front footrests.
    e. Included on all sides of the bleacher shall be 2" x 9 gauge galvanized chain link fencing fastened in place with aluminum ties and galvanized tension bars and aluminum rail clamps.
10. Stairs: Per applicable codes and/or drawings.
    a. 2 x 12 aluminum plank with a maximum rise of 7".
    b. Stairs shall have a multi-pipe rail system that conforms to the 4" ball rule. Top rail shall be 42" above the leading edge of the treads.
11. Mudsills: 2 x 4 pressure treated wood shall be provided on all frames.
12. Handicap Provisions:
    a. Wheelchair pockets inset into the front rows of seating shall be provided to comply with local codes and ADA for wheelchair accessibility.
    b. Handicapped seating will be enclosed on all three sides with no exposed vertical rise allowed.

c. Front platform shall be accessible from a ramp with a maximum gradient of 1:12.
d. Ramp width shall be minimum 5'-0" for two-way traffic.
e. Ramp shall have a 3-pipe rail system consisting of 1 5/8" O.D. anodized aluminum pipe with 2 x 9 gauge galvanized fence. Top rail will be 42" above the ramp surface.
f. A handrail 36" above the ramp surface shall be provided.

13. Pressbox
a. Grandstands: Pressbox Support Structure will be independently supported but connected to the rear of the grandstand.
b. Bleachers: Pressbox Support Structure will be independently supported on its own poured concrete piers and connected to bleacher by means of stairs off bleacher aisle.
c. Support Structure to be 8'-0" wide and in increments of 6'-0" in length.
d. Pressbox specifications as required to meet Project requirements.

B. Materials
1. Steel: ASTM A572 (Hot-Dipped Galvanized), ASTM A586 (Weathering Steel).
2. Aluminum: Extruded alloy 6063-T6.
3. Ready-Mixed Concrete shall comply with ASTM C94 with compressive strength of 3,000 pounds per square inch (210.9 kgs per square cm) at 28 days and shall be protected from freezing for seven days after placement.
4. Reinforcement for Concrete shall comply with ASTM A184, A1064, or A615 as indicated.
5. Accessories:
a. High Strength Bolts and Nuts - ASTM A325 steel.
b. Ordinary Bolts and Nuts - ASTM A307.
c. Hold-Down Clip Assemblies - Aluminum alloy 6063-T6.
d. End Caps - Channel aluminum alloy 6063-T6.

C. Finishes
1. Steel: Galvanized Steel and Weathering Steel.
2. Aluminum:
a. Anodized: Seat planks, backrest, stanchions and also risers if requested clear anodized 204R1, AA-M10C22A31, Class II.
b. Mill Finish: Footboards and riser boards (6063-T6).
c. Paint: Electrostatically applied, baked-on siliconized acrylic or siliconized polyester enamel.

1.3 EXECUTION

A. Installation
1. All work will be performed by factory-trained technicians experienced in bleacher seating installation.
2. Complete installation as per approved shop drawings and manufacturers instructions.
3. Bleachers shall be sufficiently anchored to the ground to withstand the wind loads for their particular areas.
4. After installation, unit shall be inspected for proper alignment and function.

B. Foundations/Piers
1. Piers for the pressbox shall be designed to provide sufficient bearing area to support the total live and dead loads of the pressbox without exceeding the allowable soil bearing pressure.
2. Footings for the grandstand shall be designed to provide sufficient bearing area to support the total live and dead loads of the grandstand without exceeding the allowable soil bearing pressure.
3. Design and depth of footings shall be determined from the Owner supplied geotechnical report indicating local soil conditions.
4. Hot-Dipped galvanized anchor bolts shall be used, secured in the concrete footings.
5. Concrete shall attain a working strength of 3,000 psi.

END OF SECTION 13 34 16 13b

SECTION 13 34 19 00 - METAL BUILDING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural-steel framing.
2. Metal roof panels.
3. Metal wall panels.
4. Foamed-insulation-core metal wall panels.
5. Metal soffit panels.
6. Thermal insulation.
7. Personnel doors and frames.
8. Horizontal sliding doors.
9. Windows.
10. Translucent panels.
11. Accessories.

B. Related Requirements:

1. Section 077253 "Snow Guards" for prefabricated devices designed to hold snow on the roof surface.
2. Section 083323 "Overhead Coiling Doors" for coiling vehicular doors in metal building systems.
3. Section 083613 "Sectional Doors" for sectional vehicular doors in metal building systems.

1.2 DEFINITIONS

A. Terminology Standard: See MBMA's "Metal Building Systems Manual" for definitions of terms for metal building system construction not otherwise defined in this Section or in standards referenced by this Section.

1.3 COORDINATION

A. Coordinate sizes and locations of concrete foundations and casting of anchor-rod inserts into foundation walls and footings. Anchor rod installation, concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate metal panel assemblies with rain drainage work, flashing, trim, and construction of supports and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**>.

1. Review methods and procedures related to metal building systems including, but not limited to, the following:

a. Condition of foundations and other preparatory work performed by other trades.
b. Structural load limitations.
c. Construction schedule. Verify availability of materials and erector's personnel, equipment, and facilities needed to make progress and avoid delays.
d. Required tests, inspections, and certifications.
e. Unfavorable weather and forecasted weather conditions and impact on construction schedule.

2. Review methods and procedures related to metal roof panel assemblies including, but not limited to, the following:

a. Compliance with requirements for purlin and rafter conditions, including flatness and attachment to structural members.
b. Structural limitations of purlins and rafters during and after roofing.
c. Flashings, special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect metal roof panels.
d. Temporary protection requirements for metal roof panel assembly during and after installation.
e. Roof observation and repair after metal roof panel installation.

3. Review methods and procedures related to metal wall panel assemblies including, but not limited to, the following:

a. Compliance with requirements for support conditions, including alignment between and attachment to structural members.
b. Structural limitations of girts and columns during and after wall panel installation.
c. Flashings, special siding details, wall penetrations, openings, and condition of other construction that will affect metal wall panels.
d. Temporary protection requirements for metal wall panel assembly during and after installation.
e. Wall observation and repair after metal wall panel installation.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of metal building system component.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Metal roof panels.
b. Metal wall panels.
c. Foamed-insulation-core metal panels.
d. Metal soffit panels.
e. Thermal insulation and vapor-retarder facings.
f. Personnel doors and frames.
g. Windows.
h. Translucent roof panels.
i. Roof ventilators.
j. Louvers.

B. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for roofing.>
2. <Double click to insert sustainable design text for recycled content.>

C. Shop Drawings: Indicate components by others. Include full building plan, elevations, sections, details and the following:

1. Anchor-Rod Plans: Submit anchor-rod plans and templates before foundation work begins. Include location, diameter, and minimum required projection of anchor rods required to attach metal building to foundation. Indicate column reactions at each location.
2. Structural-Framing Drawings: Show complete fabrication of primary and secondary framing; include provisions for openings. Indicate welds and bolted connections, distinguishing between shop and field applications. Include transverse cross-sections.

    a. Show provisions for attaching [**mezzanines**] [**roof curbs**] [**service walkways**] [**platforms**] [**and**] [**pipe racks**].

3. Metal [**Roof**] [**and**] [**Wall**] Panel Layout Drawings: Show layouts of panels including methods of support. Include details of edge conditions, joints, panel profiles, corners, anchorages, clip spacing, trim, flashings, closures, and special details. Distinguish between factory- and field-assembled work; show locations of exposed fasteners.

    a. Show roof-mounted items including roof hatches, equipment supports, pipe supports and penetrations, lighting fixtures, and items mounted on roof curbs.
    b. Show wall-mounted items including personnel doors, vehicular doors, windows, louvers, and lighting fixtures.
    c. Show translucent panels.

4. Accessory Drawings: Include details of the following items, at a scale of not less than [**1-1/2 inches per 12 inches (1:8)**] <**Insert scale**>:

    a. Flashing and trim.
    b. Gutters.
    c. Downspouts.
    d. Service walkways.

D. Samples for Initial Selection: For units with factory-applied finishes.

E. Samples for Verification: For the following products:

1. Panels: Nominal 12 inches (300 mm) long by actual panel width. Include fasteners, closures, and other exposed panel accessories.
2. Flashing and Trim: Nominal 12 inches (300 mm) long. Include fasteners and other exposed accessories.
3. Vapor-Retarder Facings: Nominal 6-inch- (150-mm-) square Samples.
4. Windows: Full-size, nominal 12-inch- (300-mm-) long frame Samples showing typical profile.
5. Accessories: Nominal 12-inch- (300-mm-) long Samples for each type of accessory.

F. Door Schedule: For doors and frames. Use same designations indicated on Drawings. Include details of reinforcement.

1. Door Hardware Schedule: Include details of fabrication and assembly of door hardware. Organize schedule into door hardware sets indicating complete designations of every item required for each door or opening.
2. Keying Schedule: Detail Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

G. Delegated Design Submittals: For metal building systems.

1. Include analysis data indicating compliance with performance requirements and design data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**erector**] [**manufacturer**] [**land surveyor**].

B. Welding certificates.

C. Letter of Design Certification: Signed and sealed by a qualified professional engineer. Include the following:

1. Name and location of Project.
2. Order number.
3. Name of manufacturer.
4. Name of Contractor.
5. Building dimensions including width, length, height, and roof slope.
6. Indicate compliance with AISC standards for hot-rolled steel and AISI standards for cold-rolled steel, including edition dates of each standard.
7. Governing building code and year of edition.
8. Design Loads: Include dead load, roof live load, collateral loads, roof snow load, deflection, wind loads/speeds and exposure, seismic design category or effective peak velocity-related acceleration/peak acceleration, and auxiliary loads (cranes).
9. Load Combinations: Indicate that loads were applied acting simultaneously with concentrated loads, according to governing building code.
10. Building-Use Category: Indicate category of building use and its effect on load importance factors.

D. Erector Certificates: For qualified erector, from manufacturer.

E. Material Test Reports: For each of the following products:

1. Structural steel including chemical and physical properties.
2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
3. Tension-control, high-strength, bolt-nut-washer assemblies.
4. Shop primers.
5. Nonshrink grout.

F. Source quality-control reports.

G. Field quality-control reports.

H. Surveys: Show final elevations and locations of major members. Indicate discrepancies between actual installation and the Contract Documents. Have surveyor who performed surveys certify their accuracy.

I. Sample Warranties: For special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panel finishes[**and door hardware**] to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer.

1. Accreditation: Manufacturer's facility accredited according to IAS AC472, "Accreditation Criteria for Inspection Programs for Manufacturers of Metal Building Systems."
2. Engineering Responsibility: Preparation of comprehensive engineering analysis and Shop Drawings by a professional engineer who is legally qualified to practice in jurisdiction where Project is located.

B. Erector Qualifications: An experienced erector who specializes in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3, "Structural Welding Code - Sheet Steel."

D. Land Surveyor Qualifications: A professional land surveyor who practices in jurisdiction where Project is located and who is experienced in providing surveying services of the kind indicated.

E. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup of typical wall area as shown on Drawings.
2. Build mockups for typical wall metal panel including accessories.

   a. Size: [**48 inches (1200 mm) long by 48 inches (1200 mm)**] <**Insert dimensions**>.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, sheets, panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Protect foam-plastic insulation as follows:

1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver foam-plastic insulation materials to Project site before installation time.
3. Complete installation and concealment of foam-plastic materials as rapidly as possible in each area of construction.

1.10 FIELD CONDITIONS

A. Weather Limitations: Proceed with panel installation only when weather conditions permit metal panels to be installed according to manufacturers' written instructions and warranty requirements.

1.11 WARRANTY

A. Special Warranty on Metal Panel Finishes: Manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: [**25**] [**20**] [**10**] <**Insert number**> years from date of Substantial Completion.

B. Special Weathertightness Warranty for Standing-Seam Metal Roof Panels: Manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that leak or otherwise fail to remain weathertight within specified warranty period.

1. Warranty Period: [**20**] <**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. <u><Double click here to find, evaluate, and insert list of manufacturers and products.></u>

B. Source Limitations: Obtain metal building system components, including primary and secondary framing and metal panel assemblies, from single source from single manufacturer.

2.2 SYSTEM DESCRIPTION

A. Provide a complete, integrated set of mutually dependent components and assemblies that form a metal building system capable of withstanding structural and other loads, thermally induced movement, and exposure to weather without failure or infiltration of water into building interior.

B. Primary-Frame Type:

1. Rigid Clear Span: Solid-member, structural-framing system without interior columns.
2. Rigid Modular: Solid-member, structural-framing system with interior columns.
3. Truss-Frame Clear Span: Truss-member, structural-framing system without interior columns.
4. Truss-Frame Modular: Truss-member, structural-framing system with interior columns.
5. Lean-to: Solid- or truss-member, structural-framing system, designed to be partially supported by another structure.

C. End-Wall Framing:

1. Manufacturer's standard, for buildings not required to be expandable, consisting of [**primary frame, capable of supporting one-half of a bay design load, and end-wall columns**] [**load-bearing end-wall and corner columns and rafters**].
2. Engineer end walls to be expandable. Provide primary frame, capable of supporting full-bay design loads, and end-wall columns.

D. Secondary-Frame Type: Manufacturer's standard purlins and joists and [**flush-framed**] [**partially inset-framed**] [**exterior-framed (bypass)**] girts.

E. Eave Height: [**16 feet (4.9 m)**] [**20 feet (6.1 m)**] [**24 feet (7.3 m)**] [**28 feet (8.5 m)**] [**Manufacturer's standard height, as indicated by nominal height on Drawings**] <**Insert dimension**>.

F. Bay Spacing: [**20 feet (6.1 m)**] [**25 feet (7.6 m)**] [**30 feet (9.1 m)**] [**As determined by manufacturer**] [**As indicated on Drawings**] <**Insert dimension**>.

G. Roof Slope: [**1/4 inch per 12 inches (1:48)**] [**1/2 inch per 12 inches (1:24)**] [**1 inch per 12 inches (1:12)**] [**4 inches per 12 inches (1:3)**] [**Manufacturer's standard for frame type required**] <**Insert slope**>.

H. Roof System: Manufacturer's standard [**standing-seam, vertical-rib,**] [**standing-seam, trapezoidal-rib,**] [**lap-seam, tapered-rib**] metal roof panels.

1. Liner Panels: Tapered rib.

I. Exterior Wall System: Manufacturer's standard [**exposed-fastener, tapered-rib,**] [**exposed-fastener, reverse-rib,**] [**concealed-fastener, flush-profile,**] [**foamed-insulation-core**] metal wall panels.

1. Liner Panels: [**Tapered rib**] [**Flush profile**].

2.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design metal building system.

B. Structural Performance: Metal building systems to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to procedures in MBMA's "Metal Building Systems Manual."

1. Design Loads: [**As indicated on Drawings**] <**Insert applicable code requirement**>.
2. Deflection and Drift Limits:

a. Design metal building system assemblies to withstand serviceability design loads without exceeding deflections and drift limits recommended in AISC Steel Design Guide No. 3 "Serviceability Design Considerations for Steel Buildings."
b. No greater than the following:

1) Purlins and Rafters: Vertical deflection of [**1/150**] [**1/240**] [**1/360**] <**Insert limit**> of the span.
2) Girts: Horizontal deflection of [**1/120**] [**1/180**] [**1/240**] <**Insert limit**> of the span.
3) Metal Roof Panels: Vertical deflection of [**1/150**] [**1/240**] [**1/360**] <**Insert limit**> of the span.
4) Metal Wall Panels: Horizontal deflection of [**1/180**] [**1/240**] <**Insert limit**> of the span.
5) Design secondary-framing system to accommodate deflection of primary framing and construction tolerances, and to maintain clearances at openings.

6) Lateral Drift: Maximum of [**1/60**] [**1/100**] [**1/200**] [**1/400**] <**Insert limit**> of the building height.

C. Seismic Performance: Metal building system to withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**] <**Insert requirement**>.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**] <**Insert temperature change**>.

E. Fire-Resistance Ratings: Where assemblies are indicated to have a fire-resistance rating, provide metal panel assemblies identical to those of assemblies tested for fire resistance per ASTM E119 or ASTM E108 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory," FM Global's "Approval Guide," or from the listings of another qualified testing agency.

F. Fire Propagation Characteristics: Exterior wall assemblies containing foam plastics pass NFPA 285 fire test.

G. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

H. Structural Performance for Metal Roof[**and Wall**] Panels: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:

1. Wind Loads: As indicated on Drawings.

I. Air Infiltration for Metal Roof Panels: Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) when tested according to ASTM E1680[**or ASTM E283**] at the following test-pressure difference:

1. Test-Pressure Difference: [**1.57 lbf/sq. ft. (75 Pa)**] [**6.24 lbf/sq. ft. (300 Pa)**].

J. Air Infiltration for Metal Wall Panels: Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) when tested according to ASTM E283 at the following test-pressure difference:

1. Test-Pressure Difference: [**1.57 lbf/sq. ft. (75 Pa)**] [**6.24 lbf/sq. ft. (300 Pa)**].

K. Water Penetration for Metal Roof Panels: No water penetration when tested according to ASTM E1646[**or ASTM E331**] at the following test-pressure difference:

1. Test-Pressure Difference: [**2.86 lbf/sq. ft. (137 Pa)**] [**6.24 lbf/sq. ft. (300 Pa)**].

L. Water Penetration for Metal Wall Panels: No water penetration when tested according to ASTM E331 at the following test-pressure difference:

1. Test-Pressure Difference: [**2.86 lbf/sq. ft. (137 Pa)**] [**6.24 lbf/sq. ft. (300 Pa)**].

M. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.

1. Uplift Rating: [**UL 30**] [**UL 60**] [**UL 90**].

N. FM Global Listing: Provide metal roof panels and component materials that comply with requirements in FM Global 4471 as part of a panel roofing system and that are listed in FM Global's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.

1. Fire/Windstorm Classification: Class 1A-[**60**] [**75**] [**90**] [**105**] [**120**] <**Insert number**>.
2. Hail Resistance: [**MH**] [**SH**].

O. <Double click to insert sustainable design text for solar reflectance index.>

P. Energy Star Listing: Roof panels that are listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for [**low**] [**steep**]-slope roof products.

Q. Energy Performance: Provide roof panels according to one of the following when tested according to CRRC-1:

1. Three-year, aged, solar reflectance of not less than [**0.55**] <**Insert value**> and emissivity of not less than [**0.75**] <**Insert value**>.
2. Three-year, aged, Solar Reflectance Index of not less than [**64**] <**Insert value**> when calculated according to ASTM E1980.

R. Thermal Performance for Opaque Elements: Provide the following maximum U-factors and minimum R-values when tested according to ASTM C1363 or ASTM C518:

1. Roof:

   a. U-Factor: <**Insert value**>.
   b. R-Value: <**Insert value**>.

2. Walls:

   a. U-Factor: <**Insert value**>.
   b. R-Value: <**Insert value**>.

2.4 STRUCTURAL-STEEL FRAMING

A. <Double click to insert sustainable design text for recycled content.>

B. Structural Steel: Comply with AISC 360, "Specification for Structural Steel Buildings."

C. Bolted Connections: Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts."

D. Cold-Formed Steel: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" for design requirements and allowable stresses.

E. Primary Framing: Manufacturer's standard primary-framing system, designed to withstand required loads and specified requirements. Primary framing includes transverse and lean-to frames; rafters, rake, and canopy beams; sidewall, intermediate, end-wall, and corner columns; and wind bracing.

1. General: Provide frames with attachment plates, bearing plates, and splice members. Factory drill for field-bolted assembly. Provide frame span and spacing indicated.

a. Slight variations in span and spacing may be acceptable if necessary to comply with manufacturer's standard, as approved by Architect.

2. Rigid Clear-Span Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are not permitted.
3. Rigid Modular Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Provide interior columns fabricated from round steel pipes or tubes, or shop-welded, built-up steel plates.
4. Truss-Frame, Clear-Span Frames: Rafter frames fabricated from joist girders, and I-shaped column sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are not permitted.
5. Truss-Frame Modular Frames: Rafter frames fabricated from joist girders, and I-shaped column sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Provide interior columns fabricated from round steel pipes or tubes, or shop-welded, built-up steel plates.
6. Long-Bay Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Provide interior columns fabricated from round steel pipes or tubes, or shop-welded, built-up steel plates.
7. Frame Configuration: [**Single gable**] [**One-directional, sloped**] [**Lean-to, with high side connected to and supported by another structure**] [**Multiple gable**] [**Load-bearing wall**] [**Multistory**].
8. Exterior Column: [**Uniform depth**] [**Tapered**].
9. Rafter: [**Uniform depth**] [**Tapered**].

F. End-Wall Framing: Manufacturer's standard primary end-wall framing fabricated for field-bolted assembly to comply with the following:

1. End-Wall and Corner Columns: I-shaped sections fabricated from structural-steel shapes; shop-welded, built-up steel plates; or C-shaped, cold-formed, structural-steel sheet.
2. End-Wall Rafters: C-shaped, cold-formed, structural-steel sheet; or I-shaped sections fabricated from shop-welded, built-up steel plates or structural-steel shapes.

G. Secondary Framing: Manufacturer's standard secondary framing, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Unless otherwise indicated, fabricate framing from either cold-formed, structural-steel sheet or roll-formed, metallic-coated steel sheet, prepainted with coil coating, to comply with the following:

1. Purlins:

a. C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; minimum 2-1/2-inch- (64-mm-) wide flanges.
b. Steel joists of depths indicated on Drawings.

1) Depth: [**As indicated on Drawings**] [**As needed to comply with system performance requirements**] <**Insert dimension**>.

2. Girts: C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes. Form ends of Z-sections with stiffening lips angled 40 to 50 degrees from flange, with minimum 2-1/2-inch- (64-mm-) wide flanges.

a. Depth: [**As indicated on Drawings**] [**As required to comply with system performance requirements**] <**Insert dimension**>.

3. Eave Struts: Unequal-flange, C-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; to provide adequate backup for metal panels.
4. Flange Bracing: Minimum 2-by-2-by-1/8-inch (51-by-51-by-3-mm) structural-steel angles or 1-inch- (25-mm-) diameter, cold-formed structural tubing to stiffen primary-frame flanges.
5. Sag Bracing: Minimum 1-by-1-by-1/8-inch (25-by-25-by-3-mm) structural-steel angles.
6. Base or Sill Angles: Manufacturer's standard base angle, minimum 3-by-2-inch (76-by-51-mm), fabricated from zinc-coated (galvanized) steel sheet.
7. Purlin and Girt Clips: Manufacturer's standard clips fabricated from steel sheet. Provide galvanized clips where clips are connected to galvanized framing members.
8. Framing for Openings: Channel shapes; fabricated from cold-formed, structural-steel sheet or structural-steel shapes. Frame head and jamb of door openings and head, jamb, and sill of other openings.
9. Miscellaneous Structural Members: Manufacturer's standard sections fabricated from cold-formed, structural-steel sheet; built-up steel plates; or zinc-coated (galvanized) steel sheet; designed to withstand required loads.

H. Canopy Framing: Manufacturer's standard structural-framing system, designed to withstand required loads; fabricated from shop-welded, built-up steel plates or structural-steel shapes. Provide frames with attachment plates and splice members, factory drilled for field-bolted assembly.

1. Type: [**Straight-beam, eave type**] [**Purlin-extension type**] [**Tapered-beam, below-eave type**] [**As indicated**].

I. Bracing: Provide adjustable wind bracing [**using any method**] as follows:

1. Rods: ASTM A36/A36M; ASTM A572/A572M, Grade 50 (345); or ASTM A529/A529M, Grade 50 (345); minimum 1/2-inch- (13-mm-) diameter steel; threaded full length or threaded a minimum of 6 inches (152 mm) at each end.
2. Cable: ASTM A475, minimum 1/4-inch- (6-mm-) diameter, extra-high-strength grade, Class B, zinc-coated, seven-strand steel; with threaded end anchors.
3. Angles: Fabricated from structural-steel shapes to match primary framing, of size required to withstand design loads.
4. Rigid Portal Frames: Fabricated from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.
5. Fixed-Base Columns: Fabricated from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.
6. Diaphragm Action of Metal Panels: Design metal building to resist wind forces through diaphragm action of metal panels.

J. Anchor Rods: Headed anchor rods as indicated in Anchor Rod Plan for attachment of metal building to foundation.

K. Materials:

1. W-Shapes: ASTM A992/A992M; ASTM A572/A572M, Grade 50 or 55 (345 or 380); or ASTM A529/A529M, Grade 50 or 55 (345 or 380).
2. Channels, Angles, M-Shapes, and S-Shapes: ASTM A36/A36M; ASTM A572/A572M, Grade 50 or 55 (345 or 380); or ASTM A529/A529M, Grade 50 or 55 (345 or 380).
3. Plate and Bar: ASTM A36/A36M; ASTM A572/A572M, Grade 50 or 55 (345 or 380); or ASTM A529/A529M, Grade 50 or 55 (345 or 380).
4. Steel Pipe: ASTM A53/A53M, Type E or S, Grade B.
5. Cold-Formed Hollow Structural Sections: ASTM A500, Grade B or C, structural tubing.

6. Structural-Steel Sheet: Hot-rolled, ASTM A1011/A1011M, Structural Steel (SS), Grades 30 through 55 (205 through 380), or High-Strength Low-Alloy Steel (HSLAS) or High-Strength Low-Alloy Steel with Improved Formability (HSLAS-F), Grades 45 through 70 (310 through 480); or cold-rolled, ASTM A1008/A1008M, Structural Steel (SS), Grades 25 through 80 (170 through 550), or HSLAS, Grades 45 through 70 (310 through 480).
7. Metallic-Coated Steel Sheet: ASTM A653/A653M, SS, Grades 33 through 80 (230 through 550), or HSLAS or HSLAS-F, Grades 50 through 80 (340 through 550); with G60 (Z180) coating designation; mill phosphatized.
8. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, SS, Grades 33 through 80 (230 through 550), or HSLAS or HSLAS-F, Grades 50 through 80 (340 through 550); with G90 (Z275) coating designation.
    b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/A792M, SS, Grade 50 or 80 (340 or 550); with Class AZ50 (AZM150) coating.

9. Joist Girders: Manufactured according to "Standard Specifications for Joist Girders," in SJI's "Standard Specifications and Load Tables for Steel Joists and Joist Girders"; with steel-angle, top- and bottom-chord members, and end- and top-chord arrangements as indicated on Drawings and required for primary framing.
10. Steel Joists: Manufactured according to "Standard Specifications for Open Web Steel Joists, K-Series," in SJI's "Standard Specifications and Load Tables for Steel Joists and Joist Girders"; with steel-angle, top- and bottom-chord members, and end- and top-chord arrangements as indicated on Drawings and required for secondary framing.
11. Non-High-Strength Bolts, Nuts, and Washers: ASTM A307, Grade A, carbon-steel, hex-head bolts; ASTM A563 (ASTM A563M) carbon-steel hex nuts; and ASTM F844 plain (flat) steel washers.

    a. Finish: [**Plain**] [**Hot-dip zinc coating, ASTM F2329, Class C**] [**Mechanically deposited zinc coating, ASTM B695, Class 50**].

12. High-Strength Bolts, Nuts, and Washers, Grade A325 (Grade A325M): ASTM F3125/F3125M, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, (ASTM A563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

    a. Finish: [**Plain**] [**Hot-dip zinc coating, ASTM F2329, Class C**] [**Mechanically deposited zinc coating, ASTM B695, Class 50**].

13. High-Strength Bolts, Nuts, and Washers, Grade A490 (Grade A490M): ASTM F3125/F3125M, Type 1, heavy-hex steel structural bolts[**or Grade F2280 tension-control, bolt-nut-washer assemblies with splined ends**]; ASTM A563, Grade DH, (ASTM A563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
14. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, [**heavy-hex**] [**round**] head assemblies consisting of steel structural bolts with splined ends; ASTM A563, Grade DH, (ASTM A563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1 hardened carbon-steel washers.

    a. Finish: [**Plain**] [**Mechanically deposited zinc coating, ASTM B695, Class 50**] [**Mechanically deposited zinc coating, ASTM B695, Class 50, baked-epoxy coated**].

15. Unheaded Anchor Rods: [**ASTM F1554, Grade 36**] [**ASTM A572/A572M, Grade 50 (345)**] [**ASTM A36/A36M**] [**ASTM A307, Grade A**].

a. Configuration: Straight.
b. Nuts: ASTM A563 (ASTM A563M) [**heavy-**]hex carbon steel.
c. Plate Washers: ASTM A36/A36M carbon steel.
d. Washers: ASTM F436 (ASTM F436M) hardened carbon steel.
e. Finish: [**Plain**] [**Hot-dip zinc coating, ASTM F2329, Class C**] [**Mechanically deposited zinc coating, ASTM B695, Class 50**].

16. Headed Anchor Rods: [**ASTM F1554, Grade 36**] [**ASTM A307, Grade A**].

    a. Configuration: Straight.
    b. Nuts: ASTM A563 (ASTM A563M) [**heavy-**]hex carbon steel.
    c. Plate Washers: ASTM A36/A36M carbon steel.
    d. Washers: ASTM F436 (ASTM F436M) hardened carbon steel.
    e. Finish: [**Plain**] [**Hot-dip zinc coating, ASTM F2329, Class C**] [**Mechanically deposited zinc coating, ASTM B695, Class 50**].

17. Threaded Rods: [**ASTM A193/A193M**] [**ASTM A572/A572M, Grade 50 (345)**] [**ASTM A36/A36M**] [**ASTM A307, Grade A**].

    a. Nuts: ASTM A563 (ASTM A563M) [**heavy-**]hex carbon steel.
    b. Washers: [**ASTM F436 (ASTM F436M) hardened**] [**ASTM A36/A36M**] carbon steel.
    c. Finish: [**Plain**] [**Hot-dip zinc coating, ASTM F2329, Class C**] [**Mechanically deposited zinc coating, ASTM B695, Class 50**].

L. Finish: Factory primed. Apply specified primer immediately after cleaning and pretreating.

1. Clean and prepare in accordance with SSPC-SP2.
2. Coat with manufacturer's standard primer. Apply primer to primary and secondary framing to a minimum dry film thickness of 1 mil (0.025 mm).

    a. Prime secondary framing formed from uncoated steel sheet to a minimum dry film thickness of 0.5 mil (0.013 mm) on each side.

2.5 METAL ROOF PANELS

A. Standing-Seam, Vertical-Rib, Metal Roof Panels <**Insert drawing designation**>: Formed with vertical ribs at panel edges and [**intermediate stiffening ribs symmetrically spaced**] [**flat pan**] between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Exterior Finish: [**Two-coat fluoropolymer**] [**Three-coat fluoropolymer**] [**Siliconized polyester**].
    b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**] <**Insert color**>.

2. Clips: [**One-piece fixed**] [**Two-piece floating**] to accommodate thermal movement.
3. Joint Type: [**Panels snapped together**] [**Mechanically seamed**].
4. Panel Coverage: [**16 inches (406 mm)**] <**Insert dimension**>.
5. Panel Height: [**2 inches (51 mm)**] <**Insert dimension**>.

B. Standing-Seam, Trapezoidal-Rib, Metal Roof Panels <**Insert drawing designation**>: Formed with raised trapezoidal ribs at panel edges and [**intermediate stiffening ribs symmetrically spaced**] [**flat pan**] between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Exterior Finish: [**Two-coat fluoropolymer**] [**Three-coat fluoropolymer**] [**Siliconized polyester**].
    b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**] <**Insert color**>.

2. Clips: [**One-piece fixed**] [**Two-piece floating**] to accommodate thermal movement.
3. Joint Type: [**Panels snapped together**] [**Mechanically seamed**].
4. Panel Coverage: [**24 inches (610 mm)**] <**Insert dimension**>.
5. Panel Height: [**3 inches (76 mm)**] <**Insert dimension**>.
6. Uplift Rating: [**UL 30**] [**UL 60**] [**UL 90**].

C. Exposed Fastener, Tapered-Rib, Metal Roof Panels <**Insert drawing designation**>: Formed with raised, trapezoidal major ribs and [**intermediate stiffening ribs symmetrically spaced**] [**flat pan**] between major ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Exterior Finish: [**Two-coat fluoropolymer**] [**Three-coat fluoropolymer**] [**Siliconized polyester**].
    b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**] <**Insert color**>.

2. Major-Rib Spacing: [**6 inches (152 mm)**] [**12 inches (305 mm)**] <**Insert dimension**> o.c.
3. Panel Coverage: [**36 inches (914 mm)**] <**Insert dimension**>.
4. Panel Height: [**0.75 inch (19 mm)**] [**1.125 inches (29 mm)**] [**1.188 inches (30 mm)**] [**1.25 inches (32 mm)**] [**1.5 inches (38 mm)**] <**Insert dimension**>.

D. Exposed-Fastener, Tapered-Rib, Metal Liner Panels <**Insert drawing designation**>: Formed with raised, trapezoidal major ribs and [**intermediate stiffening ribs symmetrically spaced**] [**flat pan**] between major ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Exterior Finish: [**Two-coat fluoropolymer**] [**Three-coat fluoropolymer**] [**Siliconized polyester**].
    b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**] <**Insert color**>.

2. Major-Rib Spacing: [**6 inches (152 mm)**] [**12 inches (305 mm)**] <**Insert dimension**> o.c.
3. Panel Coverage: [**36 inches (914 mm)**] <**Insert dimension**>.

4. Panel Height: [**1.25 inches (32 mm)**] [**1.5 inches (38 mm)**] <**Insert dimension**>.

E. Finishes:

1. Exposed Coil-Coated Finish:

    a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    b. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    c. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a minimum dry film thickness of 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.

2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

2.6 METAL WALL PANELS

A. Exposed-Fastener, Tapered-Rib, Metal Wall Panels <**Insert drawing designation**>: Formed with raised, trapezoidal major ribs and [**intermediate stiffening ribs symmetrically spaced**] [**flat pan**] between major ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Exterior Finish: [**Two-coat fluoropolymer**] [**Three-coat fluoropolymer**] [**Siliconized polyester**].
    b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**] <**Insert color**>.

2. Major-Rib Spacing: [**6 inches (152 mm)**] [**12 inches (305 mm)**] <**Insert dimension**> o.c.
3. Panel Coverage: [**36 inches (914 mm)**] <**Insert dimension**>.
4. Panel Height: [**0.75 inch (19 mm)**] [**1.125 inches (29 mm)**] [**1.188 inches (30 mm)**] [**1.25 inches (32 mm)**] [**1.5 inches (38 mm)**] <**Insert dimension**>.

B. Exposed-Fastener, Reverse-Rib, Metal Wall Panels <**Insert drawing designation**>: Formed with recessed, trapezoidal major valleys and [**intermediate stiffening valleys symmetrically spaced**] [**flat pan**] between major valleys; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Exterior Finish: [**Fluoropolymer**] [**Siliconized polyester**].
    b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**] <**Insert color**>.

2. Major-Rib Spacing: [**12 inches (305 mm)**] <**Insert dimension**> o.c.
3. Panel Coverage: [**36 inches (914 mm)**] <**Insert dimension**>.
4. Panel Height: [**1.125 inches (29 mm)**] [**1.188 inches (30 mm)**] [**1.25 inches (32 mm)**] [**1.5 inches (38 mm)**] <**Insert dimension**>.

C. Concealed-Fastener, Flush-Profile, Metal Wall Panels <**Insert drawing designation**>: Formed with vertical panel edges and [**a single wide recess, centered between panel edges**] [**flush surface**]; with flush joint between panels; with 1-inch- (25-mm-) wide flange for attaching interior finish; designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners[**and factory-applied sealant**] in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Exterior Finish: [**Fluoropolymer**] [**Siliconized polyester**].
    b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**] <**Insert color**>.

2. Panel Coverage: [**16 inches (406 mm)**] <**Insert dimension**>.
3. Panel Height: [**3 inches (76 mm)**] <**Insert dimension**>.

D. Tapered-Rib, Metal Liner Panels <**Insert drawing designation**>: Formed with raised, trapezoidal major ribs and [**intermediate stiffening ribs symmetrically spaced**] [**flat pan**] between major ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Exterior Finish: [**Siliconized polyester**] [**Acrylic enamel**].
    b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**] <**Insert color**>.

2. Major-Rib Spacing: [**6 inches (152 mm)**] [**12 inches (305 mm)**] <**Insert dimension**> o.c.
3. Panel Coverage: [**36 inches (914 mm)**] <**Insert dimension**>.
4. Panel Height: [**1.25 inches (32 mm)**] [**1.5 inches (38 mm)**] <**Insert dimension**>.

E. Flush-Profile, Metal Liner Panels <**Insert drawing designation**>: [**Solid**] [**Perforated**] panels formed with vertical panel edges and [**intermediate stiffening ribs symmetrically spaced**] [**flat pan**] between panel edges; with flush joint between panels; designed for interior side of metal wall panel assemblies and installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners[**and factory-applied sealant**] in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Exterior Finish: [**Siliconized polyester**] [**Polyester**] [**Acrylic enamel**].
    b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**] <**Insert color**>.

2. Sound Absorption: NRC not less than [**0.65**] [**0.85**] [**1.00**] <**Insert value**> when tested according to ASTM C423.

3. Panel Coverage: [**12 inches (305 mm)**] <**Insert dimension**>.
4. Panel Height: [**1.5 inches (38 mm)**] <**Insert dimension**>.

F. Finishes:

1. Exposed Coil-Coated Finish:

   a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   b. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   c. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a minimum dry film thickness of 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.

2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

2.7 FOAMED-INSULATION-CORE METAL WALL PANELS

A. Concealed-Fastener, Foamed-Insulation-Core Metal Wall Panels <**Insert drawing designation**>: Formed with tongue-and-groove panel edges; designed for sequential installation by interlocking panel edges and mechanically attaching panels to supports using concealed clips or fasteners.

1. Panel Thermal-Resistance Value (R-Value): <**Insert R-value**>.
2. Facing Material: Fabricate panel with exterior and interior facings of same material and thickness. Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

   a. Exterior Surface: [**Smooth, flat**] [**Striated**] [**Shallow ribs**] [**Shallow V grooves**].
   b. Exterior Finish: [**Two-coat fluoropolymer**] [**Three-coat fluoropolymer**] [**Siliconized polyester**].
   c. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**] <**Insert color**>.

3. Panel Coverage: [**36 inches (914 mm)**] [**42 inches (1067 mm)**] <**Insert dimension**> nominal.
4. Panel Thickness: [**2 inches (51 mm)**] [**2.5 inches (64 mm)**] [**3 inches (76 mm)**] [**4 inches (102 mm)**] [**5 inches (127 mm)**] [**6 inches (152 mm)**] <**Insert dimension**>.
5. Insulation Core: Modified polyisocyanurate or polyurethane foam using a non-CFC blowing agent, foamed-in-place or board type, with maximum flame-spread and smoke-developed indexes of 25 and 450, respectively.

   a. Closed-Cell Content: 90 percent when tested according to ASTM D6226.
   b. Density: 2.0 to 2.6 lb/cu. ft. (32 to 42 kg/cu. m) when tested according to ASTM D1622.
   c. Compressive Strength: Minimum 20 psi (140 kPa) when tested according to ASTM D1621.
   d. Shear Strength: 26 psi (179 kPa) when tested according to ASTM C273/C273M.

6. Fire-Test-Response Characteristics: Class A according to ASTM E108.

7. Surface-Burning Characteristics: Flame-spread index of 25 or less and a smoke-developed index of 450 or less, per ASTM E84.

B. Finishes:

1. Exposed Coil-Coated Finish:

   a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   b. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   c. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a minimum dry film thickness of 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.

2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

2.8 METAL SOFFIT PANELS

A. General: Provide factory-formed metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners[**and factory-applied sealant**] in side laps. Include accessories required for weathertight installation.

B. Metal Soffit Panels: Match profile and material of metal [**roof**] [**wall**] panels.

1. Finish: [**Match finish and color of metal roof panels**] [**Match finish and color of metal wall panels**] [**As indicated on Drawings**].

C. Exposed-Fastener, Tapered-Rib-Profile, Metal Soffit Panels <**Insert drawing designation**>: Formed with raised, trapezoidal major ribs and [**intermediate stiffening ribs symmetrically spaced**] [**flat pan**] between major ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

   a. Exterior Finish: [**Two-coat fluoropolymer**] [**Three-coat fluoropolymer**] [**Siliconized polyester**].
   b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**] <**Insert color**>.

2. Major-Rib Spacing: [**6 inches (152 mm)**] [**12 inches (305 mm)**] <**Insert dimension**> o.c.
3. Panel Coverage: [**36 inches (914 mm)**] <**Insert dimension**>.
4. Panel Height: [**0.75 inch (19 mm)**] [**1.125 inches (29 mm)**] [**1.188 inches (30 mm)**] [**1.25 inches (32 mm)**] [**1.5 inches (38 mm)**] <**Insert dimension**>.

D. Concealed-Fastener, Flush-Profile, Metal Soffit Panels <**Insert drawing designation**>: Formed with vertical panel edges and [**a single wide recess, centered between panel edges**] [**flush surface**]; with flush joint between panels; with 1-inch- (25-mm-) wide flange for attaching interior finish; designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners[**and factory-applied sealant**] in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Exterior Finish: [**Fluoropolymer**] [**Siliconized polyester**].
    b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**] <**Insert color**>.

2. Panel Coverage: [**12 inches (305 mm)**] [**16 inches (406 mm)**] <**Insert dimension**>.
3. Panel Height: [**1 inch (25 mm)**] [**1.5 inches (38 mm)**] <**Insert dimension**>.

2.9 THERMAL INSULATION

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Faced Metal Building Insulation: ASTM C991, Type II, glass-fiber-blanket insulation; 0.5-lb/cu. ft. (8-kg/cu. m) density; 2-inch- (51-mm-) wide, continuous, vapor-tight edge tabs; with a flame-spread index of 25 or less.

C. Unfaced Metal Building Insulation: ASTM C991, Type I, or NAIMA 202, glass-fiber-blanket insulation; 0.5-lb/cu. ft. (8-kg/cu. m) density; 2-inch- (51-mm-) wide, continuous, vapor-tight edge tabs; with a flame-spread index of 25 or less.

D. Mineral-Fiber-Blanket Insulation: ASTM C665, type indicated below; consisting of fibers manufactured from glass, slag wool, or rock wool.

1. Nonreflective Faced: Type II (blankets with nonreflective membrane covering), Category 1 (membrane is a vapor retarder), Class A (membrane-faced surface with a flame-spread index of 25 or less).
2. Reflective Faced: Type III (blankets with reflective membrane covering), Category 1 (membrane is a vapor retarder), Class A (membrane-faced surface with a flame-spread index of 25 or less).
3. Unfaced: Type I (blankets without membrane covering), passing ASTM E136 for combustion characteristics.

E. Faced, Polyisocyanurate Board Insulation: ASTM C1289, Type I (foil facing), Class 2, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, based on tests performed on unfaced core. Provide units tested for interior exposure without an approved thermal barrier.

F. Retainer Strips: For securing insulation between supports, 0.025-inch (0.64-mm) nominal-thickness, formed, metallic-coated steel or PVC retainer clips colored to match insulation facing.

G. Vapor-Retarder Facing: ASTM C1136, with permeance not greater than 0.02 perm (1.15 ng/Pa x s x sq. m) when tested according to ASTM E96/E96M, Desiccant Method.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Composition:

    a. White metallized-polypropylene film facing, fiberglass scrim reinforcement, and kraft-paper backing.

b. Aluminum foil facing, elastomeric barrier coating, fiberglass scrim reinforcement, and kraft-paper backing.
c. White [**polypropylene**] [**vinyl**] film facing, fiberglass scrim reinforcement, and metallized-polyester film backing.
d. White polypropylene film facing and fiberglass-polyester-blend fabric backing.

H. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.10 PERSONNEL DOORS AND FRAMES

A. Swinging Personnel Doors and Frames:

1. As specified in Section 081113 "Hollow Metal Doors and Frames."
2. Metal building system manufacturer's standard doors and frames; prepared and reinforced at strike and at hinges to receive factory- and field-applied hardware according to BHMA A156 Series.

a. Steel Doors: 1-3/4 inches (44.5 mm) thick; fabricated from metallic-coated steel face sheets, 0.036-inch (0.91-mm) nominal uncoated steel thickness, of [**seamed**] [**seamless**], hollow-metal construction; with 0.060-inch (1.52-mm) nominal uncoated steel thickness, inverted metallic-coated steel channels welded to face sheets at top and bottom of door.

1) Design: [**Flush panel**] [**As indicated on Drawings**] <**Insert design**>.
2) Core:

a) Kraft honeycomb with U-factor rating of at least 0.47 Btu/sq. ft. x h x deg F (2.67 W/sq. m x K).
b) Polystyrene foam with U-factor rating of at least 0.16 Btu/sq. ft. x h x deg F (0.91 W/sq. m x K).
c) Polyurethane foam with U-factor rating of at least 0.07 Btu/sq. ft. x h x deg F (0.40 W/sq. m x K).

3) Glazing Frames: Steel frames to receive field-installed glass.
4) Glazing: As specified in Section 088000 "Glazing."

b. Steel Frames: Fabricate 2-inch- (51-mm-) wide face frames from zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.060-inch (1.52-mm) nominal uncoated steel thickness.

1) Type: [**Knocked down for field assembly**] [**Factory welded**].

c. Fabricate concealed stiffeners, reinforcement, edge channels, and moldings from either cold- or hot-rolled steel sheet.
d. Hardware:

1) Provide hardware for each door leaf, as follows:

a) Hinges: BHMA A156.1. Three [**plain**] [**antifriction**]-bearing, standard-weight, full-mortise, stainless steel or bronze, template-type hinges; 4-1/2 by 4-1/2 inches (114 by 114 mm), with nonremovable pin.
b) Lockset: BHMA A156.2. [**Key-in-lever cylindrical**] [**Mortise, with lever handle**] type.
c) Exit Device: BHMA A156.3. Touch- or push-bar type.

d) Threshold: BHMA A156.21. Extruded aluminum.
e) Silencers: Pneumatic rubber; three silencers on strike jambs of single door frames and two silencers on heads of double door frames.
f) Closer: BHMA A156.4. Surface-applied, standard-duty hydraulic type.
g) Weather Stripping: Vinyl applied to head and jambs, with vinyl sweep at sill.

2) Provide each pair of double doors with the following hardware in addition to that specified for each leaf:

a) Astragal: Removable type.
b) Surface Bolts: Top and bottom of inactive door.

e. Anchors and Accessories: Manufacturer's standard units, galvanized according to ASTM A123/A123M.
f. Fabrication: Fabricate doors and frames to be rigid; neat in appearance; and free from defects, warp, or buckle. Provide continuous welds on exposed joints; grind, dress, and make welds smooth, flush, and invisible.

B. Materials:

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
2. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, CS, Type B; free of scale, pitting, or surface defects; pickled and oiled.
3. Metallic-Coated Steel Sheet: ASTM A653/A653M, CS, Type B; with G60 (Z180) zinc (galvanized) or A60 (ZF180) zinc-iron-alloy (galvannealed) coating designation.

C. Finishes for Personnel Doors and Frames:

1. Prime Finish: Factory-apply manufacturer's standard primer immediately after cleaning and pretreating.

a. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

2. Factory-Applied Paint Finish: Manufacturer's standard, complying with SDI A250.3 for performance and acceptance criteria.

a. Color and Gloss: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] <**Insert color and gloss**>.

2.11 HORIZONTAL SLIDING DOORS

A. Horizontal-Sliding Doors: Manufacturer's standard horizontal-sliding door assembly including structural frame, door panels, brackets, guides, tracks, hardware, and installation accessories.

1. Door Frames: Channels and zees; metallic-coated steel sheet or structural-steel shapes, 0.060-inch (1.52-mm) nominal uncoated steel thickness.
2. Door Panels: Same material and finish as metal wall panels.
3. Hardware: Manufacturer's standard metallic-coated steel track, bottom guides, lock angles for side closure, and brackets. Support each door leaf by two four-wheel trolleys. Provide metallic-

coated steel handle for each leaf, and slide bolt or padlock hasp. Flash top of track with metallic-coated steel sheet hood.

2.12 WINDOWS

A. Aluminum Windows:

1. As specified in Section 085113 "Aluminum Windows."
2. Metal building system manufacturer's standard, with self-flashing mounting fins, and as follows:

   a. Type, Performance Class, and Performance Grade: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 and as follows:

      1) Horizontal-Sliding Units: [**HS-LC25**] [**HS-CW30**] <**Insert designation**>.
      2) Single-Hung Units: [**H-LC25**] [**H-CW30**] <**Insert designation**>.
      3) Fixed Units: [**FW-LC25**] [**FW-CW30**] [**FW-AW40**] <**Insert designation**>.

   b. Aluminum Extrusions: ASTM B221 (ASTM B221M), alloy and temper recommended by manufacturer for strength, corrosion resistance, and application of required finish, but not less than 0.064-inch (1.63-mm) thickness at any location for main frame and sash members.

      1) Thermally Improved Construction: Fabricate window units with an integral, concealed, low-conductance thermal barrier; located between exterior materials and window members exposed on interior side; in a manner that eliminates direct metal-to-metal contact.

   c. Mullions: Between adjacent windows, fabricated of extruded aluminum matching finish of window units.
   d. Fasteners, Anchors, and Clips: Nonmagnetic stainless steel, aluminum, or other noncorrosive material, compatible with aluminum window members, trim, hardware, anchors, and other components of window units. Fasteners are not be exposed, except for attaching hardware.

      1) Reinforcement: Where fasteners screw-anchor into aluminum less than 0.128 inch (3.26 mm) thick, reinforce interior with aluminum or nonmagnetic stainless steel to receive screw threads, or provide standard, noncorrosive, pressed-in, spline grommet nuts.

   e. Hardware: Manufacturer's standard; of aluminum, stainless steel, die-cast steel, malleable iron, or bronze; including the following:

      1) Cam-action sweep sash lock and keeper at meeting rails.
      2) Spring-loaded, snap-type lock at jambs.
      3) Pole-operated, cam-action locking device on meeting rail where rail is more than 72 inches (1830 mm) above floor.
      4) Lift handles for single-hung units.
      5) Nylon sash rollers for horizontal-sliding units.
      6) Steel or bronze operating arms.

   f. Sliding-Type Weather Stripping: Woven-pile weather stripping of wool, polypropylene, or nylon pile and resin-impregnated backing fabric; complying with AAMA 701/702.
   g. Insect Screens: Provide removable insect screen on each operable exterior sash, with screen frame finished to match window unit, and as follows:

1) Aluminum Wire Fabric: 18-by-18 (1.1-by-1.1-mm), 18-by-16 (1.1-by-1.3-mm), or 18-by-14 (1.1-by-1.5-mm) mesh of 0.013-inch- (0.3-mm-) diameter, coated aluminum wire; complying with FS RR-W-365, Type VII.
2) Glass-Fiber Mesh Fabric: 18-by-16 (1.1-by-1.3-mm) or 18-by-14 (1.1-by-1.5-mm) mesh of PVC-coated, glass-fiber threads, woven and fused to form a fabric mesh; complying with ASTM D3656.
3) Fabric: Manufacturer's standard aluminum wire fabric or glass-fiber mesh fabric.

B. Glazing: Comply with requirements specified in Section 088000 "Glazing."

1. Float Glass: ASTM C1036, Type I, Quality-Q3, Class I (clear), 3 mm thick.
2. Heat-Treated Float Glass: ASTM C1048, Type I, Quality-Q3, Class I (clear), Condition A, 3 mm thick.
3. Tinted Float Glass: ASTM C1036, Type I, Quality-Q3, Class 2, 3 mm thick.

a. Tint Color: [**Blue**] [**Blue-green**] [**Bronze**] [**Green**] [**Gray**] [**Manufacturer's standard color**] <**Insert color**>.

4. Patterned Glass: ASTM C1036, Type II, Quality-Q6, Class 1 (clear), Form 3, Pattern P3 (random), 3 mm thick.
5. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of 2.5-mm-thick clear float glass separated by a dehydrated interspace, qualified according to ASTM E2190.
6. Safety Glass: Category II materials complying with testing requirements in 16 CFR 1201.

a. Provide safety glazing labeling.

7. Glazing Stops: Screw-applied or snap-on glazing stops coordinated with Section 088000 "Glazing" and with glazing system indicated. Match material and finish of window frames.
8. Factory-Glazed Fabrication: Glaze window units in the factory to greatest extent possible and practical for applications indicated. Comply with requirements in Section 088000 "Glazing."

C. Finish:

1. Mill finish.
2. Baked-Enamel Finish, Organic Coating: Thermosetting, modified-acrylic enamel primer/topcoat system complying with AAMA 2603 except with a minimum dry film thickness of 0.7 mil (0.02 mm), medium gloss.

a. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**] <**Insert color**>.

2.13 TRANSLUCENT PANELS

A. Uninsulated Translucent Panels: Glass-fiber-reinforced polyester, translucent plastic; complying with ASTM D3841, [**Type CC2 (general purpose)**] [**Type CC1 (limited flammability)**], Grade 1 (weather resistant); smooth finish on both sides. Match profile of adjacent metal panels.

1. Roof Panel Weight: Not less than 8 oz./sq. ft. (2441 g/sq. m).
2. Wall Panel Weight: Not less than 6 oz./sq. ft. (1831 g/sq. m).
3. Light Transmittance: Not less than [**55**] <**Insert number**> percent according to ASTM D1494.
4. Metal Edge: Fabricate full length of each side of panel with metal edge for seaming into standing-seam roof panel joint.
5. Color: [**White**] <**Insert color**>.

B. Insulated Translucent Panels: Fabricate insulating units of two sheets of glass-fiber-reinforced polyester, translucent plastic separated by an air space; complying with ASTM D3841, Type CC1 (limited flammability), Grade 1 (weather resistant); smooth finish on both sides. Match profile of adjacent metal panels.

1. Exterior Panel Weight: Not less than [**8 oz./sq. ft. (2441 g/sq. m)**] [**6 oz./sq. ft. (1831 g/sq. m)**].
2. Interior Panel Weight: Not less than [**8 oz./sq. ft. (2441 g/sq. m)**] [**6 oz./sq. ft. (1831 g/sq. m)**] [**4 oz./sq. ft. (1221 g/sq. m)**].
3. Light Transmittance: Not less than [**42**] <**Insert number**> percent according to ASTM D1494.
4. Metal Edge: Fabricate full length of each side of panel with metal edge for seaming into standing-seam roof panel joint.
5. Color: [**White**] <**Insert color**>.

C. Mastic for Translucent Panels: Nonstaining, saturated vinyl polymer as recommended by translucent panel manufacturer for sealing laps.

D. Performance:

1. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

   a. Flame-Spread Index: [**25**] <**Insert value**> or less.
   b. Smoke-Developed Index: [**450**] <**Insert value**> or less.

2.14 ACCESSORIES

A. General: Provide accessories as standard with metal building system manufacturer and as specified. Fabricate and finish accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes. Comply with indicated profiles and with dimensional and structural requirements.

1. Form exposed sheet metal accessories that are without excessive oil-canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

B. Roof Panel Accessories: Provide components required for a complete metal roof panel assembly including copings, fasciae, corner units, ridge closures, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same material as metal roof panels.
2. Clips: Manufacturer's standard, formed from [**steel**] [**stainless steel**] sheet, designed to withstand negative-load requirements.
3. Cleats: Manufacturer's standard, mechanically seamed cleats formed from [**steel**] [**stainless steel sheet or nylon-coated aluminum**] sheet.
4. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
5. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
6. Thermal Spacer Blocks: Where metal panels attach directly to purlins, provide thermal spacer blocks of thickness required to provide 1-inch (25-mm) standoff; fabricated from extruded polystyrene.

C. Wall Panel Accessories: Provide components required for a complete metal wall panel assembly including copings, fasciae, mullions, sills, corner units, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels unless otherwise indicated.

1. Closures: Provide closures at eaves and rakes, fabricated of same material as metal wall panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal wall panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

D. Flashing and Trim: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch (0.46-mm) nominal uncoated steel thickness, prepainted with coil coating; finished to match adjacent metal panels.

1. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers.
2. Opening Trim: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness, prepainted with coil coating. Trim head and jamb of door openings, and head, jamb, and sill of other openings.

E. Gutters: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch (0.46-mm) nominal uncoated steel thickness, prepainted with coil coating; finished to match roof fascia and rake trim. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- (2438-mm-) long sections, sized according to SMACNA's "Architectural Sheet Metal Manual."

1. Gutter Supports: Fabricated from same material and finish as gutters.
2. Strainers: Bronze, copper, or aluminum wire ball type at outlets.

F. Downspouts: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch (0.46-mm) nominal uncoated steel thickness, prepainted with coil coating; finished to match metal wall panels. Fabricate in minimum 10-foot- (3-m-) long sections, complete with formed elbows and offsets.

1. Mounting Straps: Fabricated from same material and finish as gutters.

G. Service Walkways: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.048-inch (1.21-mm) nominal uncoated steel thickness, steel plank grating; with slip-resistant pattern; [**18-inch (457-mm)**] [**24-inch (610-mm)**] [**36-inch (914-mm)**] overall width. Support walkways on framing system anchored to metal roof panels without penetrating panels; with predrilled holes and clamps or hooks for anchoring.

H. Roof Ventilators: Gravity type, complete with hardware, flashing, closures, and fittings.

1. Circular-Revolving Type: Minimum [**20-inch- (508-mm-)**] <**Insert dimension**> diameter throat opening; zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.024-inch (0.61-mm) nominal uncoated steel thickness, with coil coating; finished to match metal roof panels; with matching base and rain cap.

    a. Type: [**Directional**] [**Stationary**] revolving.
    b. Bird Screening: Galvanized steel, 1/2-inch- (13-mm-) square mesh, 0.041-inch (1.04-mm) wire; or aluminum, 1/2-inch- (13-mm-) square mesh, 0.063-inch (1.6-mm) wire.
    c. Dampers: Spring-loaded, butterfly type; pull-chain operation; with pull chain of length required to reach within 36 inches (914 mm) of floor.

d. Reinforce and brace units, with joints properly formed and edges beaded to be watertight under normal positive-pressure conditions.

e. Mount ventilators on square-to-round bases for ridge or on-slope mounting, designed to match roof pitch and roll formed to match metal roof panel profile.

2. Continuous or Sectional-Ridge Type: Factory-engineered and -fabricated, continuous unit; Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch (0.46-mm) nominal uncoated steel thickness, prepainted with coil coating; finished to match metal roof panels. Fabricated in minimum 10-foot- (3-m-) long sections. Provide throat size and total length indicated, complete with side baffles, ventilator assembly, end caps, splice plates, and reinforcing diaphragms.

a. Bird Screening: Galvanized steel, 1/2-inch- (13-mm-) square mesh, 0.041-inch (1.04-mm) wire; or aluminum, 1/2-inch- (13-mm-) square mesh, 0.063-inch (1.6-mm) wire.

b. Dampers: Manually operated, spring-loaded, vertically rising type; chain and worm gear operator; with pull chain of length required to reach within 36 inches (914 mm) of floor.

c. Throat Size: [**9 inches (229 mm)**] [**or**] [**12 inches (305 mm)**], [**as standard with manufacturer, and as required to comply with ventilation requirements**].

I. Louvers: Size and design indicated; self-framing and self-flashing. Fabricate welded frames from zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.048-inch (1.21-mm) nominal uncoated steel thickness; finished to match metal wall panels. Form blades from zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.036-inch (0.91-mm) nominal uncoated steel thickness; folded or beaded at edges, set at an angle that excludes driving rains, and secured to frames by riveting or welding. Fabricate louvers with equal blade spacing to produce uniform appearance.

1. Blades:

a. Fixed.

b. Adjustable type, with weather-stripped edges, and manually operated by hand crank or pull chain.

2. Free Area: Not less than [**7.0 sq. ft. (0.65 sq. m)**] <**Insert dimension**> for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.

3. Bird Screening: Galvanized steel, 1/2-inch- (13-mm-) square mesh, 0.041-inch (1.04-mm) wire; with rewirable frames, removable and secured with clips; fabricated of same kind and form of metal and with same finish as louvers.

a. Mounting: [**Interior**] [**Exterior**] face of louvers.

4. Vertical Mullions: Provide mullions at spacings recommended by manufacturer, or 72 inches (1830 mm) o.c., whichever is less.

J. Roof Curbs: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.048-inch (1.21-mm) nominal uncoated steel thickness prepainted with coil coating; finished to match metal roof panels; with welded top box and bottom skirt, and integral full-length cricket; capable of withstanding loads of size and height indicated.

1. Curb Subframing: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.060-inch (1.52-mm) nominal uncoated steel thickness, angle-, C-, or Z-shaped metallic-coated steel sheet.

2. Insulation: 1-inch- (25-mm-) thick, rigid type.

K. Pipe Flashing: Premolded, EPDM pipe collar with flexible aluminum ring bonded to base.

L. Materials:

1. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide fasteners with heads matching color of materials being fastened by means of plastic caps or factory-applied coating.
2. Fasteners for Metal Roof Panels:

   a. Self-drilling or self-tapping, zinc-plated, hex-head carbon-steel screws, with a stainless steel cap or zinc-aluminum-alloy head and EPDM sealing washer.
   b. Self-drilling, Type 410 stainless steel or self-tapping, Type 304 stainless steel or zinc-alloy-steel hex washer head, with EPDM washer under heads of fasteners bearing on weather side of metal panels.

3. Fasteners for Metal Wall Panels:

   a. Self-drilling or self-tapping, zinc-plated, hex-head carbon-steel screws[**, with EPDM sealing washers bearing on weather side of metal panels**].
   b. Self-drilling, Type 410 stainless steel or self-tapping, Type 304 stainless steel or zinc-alloy-steel hex washer head[**, with EPDM sealing washers bearing on weather side of metal panels**].

4. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.
5. Blind Fasteners: High-strength aluminum or stainless steel rivets.
6. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
7. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.
8. Metal Panel Sealants:

   a. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene-compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape of manufacturer's standard size.
   b. Joint Sealant: ASTM C920; one part elastomeric polyurethane or polysulfide; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended by metal building system manufacturer.

2.15 FABRICATION

A. General: Design components and field connections required for erection to permit easy assembly.

   1. Mark each piece and part of the assembly to correspond with previously prepared erection drawings, diagrams, and instruction manuals.
   2. Fabricate structural framing to produce clean, smooth cuts and bends. Punch holes of proper size, shape, and location. Members to be free of cracks, tears, and ruptures.

B. Tolerances: Comply with MBMA's "Metal Building Systems Manual" for fabrication and erection tolerances.

C. Primary Framing: Shop fabricate framing components to indicated size and section, with baseplates, bearing plates, stiffeners, and other items required for erection welded into place. Cut, form, punch, drill, and weld framing for bolted field assembly.

   1. Make shop connections by welding or by using high-strength bolts.
   2. Join flanges to webs of built-up members by a continuous, submerged arc-welding process.

3. Brace compression flange of primary framing with steel angles or cold-formed structural tubing between frame web and purlin web or girt web, so flange compressive strength is within allowable limits for any combination of loadings.
4. Weld clips to frames for attaching secondary framing if applicable, or punch for bolts.
5. Shop Priming: Prepare surfaces for shop priming according to SSPC-SP 2. Shop prime primary framing with specified primer after fabrication.

D. Secondary Framing: Shop fabricate framing components to indicated size and section by roll forming or break forming, with baseplates, bearing plates, stiffeners, and other plates required for erection welded into place. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.

1. Make shop connections by welding or by using non-high-strength bolts.
2. Shop Priming: Prepare uncoated surfaces for shop priming according to SSPC-SP 2. Shop prime uncoated secondary framing with specified primer after fabrication.

E. Metal Panels: Fabricate and finish metal panels at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.

1. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of metal panel.

2.16 SOURCE QUALITY CONTROL

A. Special Inspection: Owner will engage a qualified special inspector to perform source quality control inspections and to submit reports.

1. Accredited Manufacturers: Special inspections will not be required if fabrication is performed by an IAS AC472-accredited manufacturer approved by authorities having jurisdiction to perform such Work without special inspection.

a. After fabrication, submit copy of certificate of compliance to authorities having jurisdiction, certifying that Work was performed according to Contract requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with erector present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Before erection proceeds, survey elevations and locations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments to receive structural framing, with erector present, for compliance with requirements and metal building system manufacturer's tolerances.

1. Engage land surveyor to perform surveying.

C. Proceed with erection only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition.

B. Provide temporary shores, guys, braces, and other supports during erection to keep structural framing secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural framing, connections, and bracing are in place unless otherwise indicated.

3.3 ERECTION OF STRUCTURAL FRAMING

A. Erect metal building system according to manufacturer's written instructions and drawings.

B. Do not field cut, drill, or alter structural members without written approval from metal building system manufacturer's professional engineer.

C. Set structural framing accurately in locations and to elevations indicated, according to AISC specifications referenced in this Section. Maintain structural stability of frame during erection.

D. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
3. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

E. Align and adjust structural framing before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with framing. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure will be completed and in service.

F. Primary Framing and End Walls: Erect framing level, plumb, rigid, secure, and true to line. Level baseplates to a true even plane with full bearing to supporting structures, set with double-nutted anchor bolts. Use grout to obtain uniform bearing and to maintain a level base-line elevation. Moist-cure grout for not less than seven days after placement.

1. Make field connections using high-strength bolts installed according to RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt type and joint type specified.

   a. Joint Type: Snug tightened or pretensioned as required by manufacturer.

G. Secondary Framing: Erect framing level, plumb, rigid, secure, and true to line. Field bolt secondary framing to clips attached to primary framing.

1. Provide rake or gable purlins with tight-fitting closure channels and fasciae.
2. Locate and space wall girts to suit openings such as doors and windows.

3. Provide supplemental framing at entire perimeter of openings, including doors, windows, louvers, ventilators, and other penetrations of roof and walls.

H. Steel Joists[**and Joist Girders**]: Install joists[**, girders,**] and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Standard Specifications and Load Tables for Steel Joists and Joist Girders," joist manufacturer's written instructions, and requirements in this Section.

1. Before installation, splice joists delivered to Project site in more than one piece.
2. Space, adjust, and align joists accurately in location before permanently fastening.
3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
4. Joint Installation:

a. Bolt joists to supporting steel framework using carbon-steel bolts unless otherwise indicated.
b. Bolt joists to supporting steel framework using high-strength structural bolts unless otherwise indicated. Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for high-strength structural bolt installation and tightening requirements.
c. Weld joist seats to supporting steel framework.

5. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

I. Bracing: Install bracing in roof and sidewalls where indicated on erection drawings.

1. Tighten rod and cable bracing to avoid sag.
2. Locate interior end-bay bracing only where indicated.

J. Framing for Openings: Provide shapes of proper design and size to reinforce openings and to carry loads and vibrations imposed, including equipment furnished under mechanical and electrical work. Securely attach to structural framing.

K. Erection Tolerances: Maintain erection tolerances of structural framing within AISC 303.

3.4 METAL PANEL INSTALLATION, GENERAL

A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.

C. Examination: Examine primary and secondary framing to verify that structural-panel support members and anchorages have been installed within alignment tolerances required by manufacturer.

1. Examine roughing-in for components and systems penetrating metal panels, to verify actual locations of penetrations relative to seams before metal panel installation.

D. General: Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Field cut metal panels as required for doors, windows, and other openings. Cut openings as small as possible, neatly to size required, and without damage to adjacent metal panel finishes.

    a. Field cutting of metal panels by torch is not permitted unless approved in writing by manufacturer.

2. Install metal panels perpendicular to structural supports unless otherwise indicated.
3. Flash and seal metal panels with weather closures at perimeter of openings and similar elements. Fasten with self-tapping screws.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Locate metal panel splices over structural supports with end laps in alignment.
6. Lap metal flashing over metal panels to allow moisture to run over and off the material.

E. Lap-Seam Metal Panels: Install screw fasteners using power tools with controlled torque adjusted to compress EPDM washers tightly without damage to washers, screw threads, or metal panels. Install screws in predrilled holes.

1. Arrange and nest side-lap joints so prevailing winds blow over, not into, lapped joints. Lap ribbed or fluted sheets one full rib corrugation. Apply metal panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.

F. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.

G. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal panel assemblies. Provide types of gaskets, fillers, and sealants indicated; or, if not indicated, provide types recommended by metal panel manufacturer.

1. Seal metal panel end laps with double beads of tape or sealant the full width of panel. Seal side joints where recommended by metal panel manufacturer.
2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

3.5 METAL ROOF PANEL INSTALLATION

A. General: Provide metal roof panels of full length from eave to ridge unless otherwise indicated or restricted by shipping limitations.

1. Install ridge[**and hip**] caps as metal roof panel work proceeds.
2. Flash and seal metal roof panels with weather closures at eaves and rakes. Fasten with self-tapping screws.

B. Standing-Seam Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each standing-seam joint, at location and spacing and with fasteners recommended by manufacturer.

1. Install clips to supports with self-drilling or self-tapping fasteners.
2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
4. Seamed Joint: Crimp standing seams with manufacturer-approved motorized seamer tool so that clip, metal roof panel, and factory-applied sealant are completely engaged.
5. Rigidly fasten eave end of metal roof panels and allow ridge end free movement for thermal expansion and contraction. Predrill panels for fasteners.

6. Provide metal closures at [**peaks**] [**rake edges**] [**rake walls**] [**and**] each side of ridge[**and hip**] caps.

C. Lap-Seam Metal Roof Panels: Fasten metal roof panels to supports with exposed fasteners at each lapped joint, at location and spacing recommended by manufacturer.

1. Provide metal-backed sealing washers under heads of exposed fasteners bearing on weather side of metal roof panels.
2. Provide sealant tape at lapped joints of metal roof panels and between panels and protruding equipment, vents, and accessories.
3. Apply a continuous ribbon of sealant tape to weather-side surface of fastenings on end laps and on side laps of nesting-type metal panels, on side laps of ribbed or fluted metal panels, and elsewhere as needed to make metal panels weatherproof to driving rains.
4. At metal panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with butyl-rubber sealant and fastened together by interlocking clamping plates.

D. Metal Fascia Panels: Align bottom of metal panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws. Flash and seal metal panels with weather closures where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.

E. Metal Roof Panel Installation Tolerances: Shim and align metal roof panels within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.6 METAL WALL PANEL INSTALLATION

A. General: Install metal wall panels in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts, extending full height of building, unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Unless otherwise indicated, begin metal panel installation at corners with center of rib lined up with line of framing.
2. Shim or otherwise plumb substrates receiving metal wall panels.
3. When two rows of metal panels are required, lap panels 4 inches (102 mm) minimum.
4. When building height requires two rows of metal panels at gable ends, align lap of gable panels over metal wall panels at eave height.
5. Rigidly fasten base end of metal wall panels and allow eave end free movement for thermal expansion and contraction. Predrill panels.
6. Flash and seal metal wall panels with weather closures at eaves and rakes, and at perimeter of all openings. Fasten with self-tapping screws.
7. Install screw fasteners in predrilled holes.
8. Install flashing and trim as metal wall panel work proceeds.
9. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated on Drawings; if not indicated, as necessary for waterproofing.
10. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws.
11. Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.

B. Metal Wall Panels: Install metal wall panels on exterior side of girts. Attach metal wall panels to supports with fasteners as recommended by manufacturer.

C. Insulated Metal Wall Panels: Install insulated metal wall panels on exterior side of girts. Attach panels to supports at each panel joint using concealed clip and fasteners at maximum 42 inches (1067 mm) o.c., spaced not more than manufacturer's recommendation. Fully engage tongue and groove of adjacent insulated metal wall panels.

1. Install clips to supports with self-tapping fasteners.
2. Apply continuous ribbon of sealant to panel joint on concealed side of insulated metal wall panels as vapor seal; apply sealant to panel joint on exposed side of panels as weather seal.

D. Installation Tolerances: Shim and align metal wall panels within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m), noncumulative; level, plumb, and on location lines; and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.7 TRANSLUCENT PANEL INSTALLATION

A. Translucent Panels: Attach translucent panels to structural framing with fasteners according to manufacturer's written instructions. Install panels perpendicular to supports unless otherwise indicated. Anchor translucent panels securely in place, with provisions for thermal and structural movement.

1. Provide end laps of not less than 6 inches (152 mm) and side laps of not less than 1-1/2-inch (38-mm) corrugations for metal roof panels.
2. Provide end laps of not less than 4 inches (102 mm) and side laps of not less than 1-1/2-inch (38-mm) corrugations for metal wall panels.
3. Align horizontal laps with adjacent metal panels.
4. Seal intermediate end laps and side laps of translucent panels with translucent mastic.

3.8 METAL SOFFIT PANEL INSTALLATION

A. Provide metal soffit panels the full width of soffits. Install panels perpendicular to support framing.

B. Flash and seal metal soffit panels with weather closures where panels meet walls and at perimeter of all openings.

3.9 THERMAL INSULATION INSTALLATION

A. General: Install insulation concurrently with metal panel installation, in thickness indicated to cover entire surface, according to manufacturer's written instructions.

1. Set vapor-retarder-faced units with vapor retarder toward warm side of construction unless otherwise indicated. Do not obstruct ventilation spaces except for firestopping.
2. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to the surrounding construction to ensure airtight installation.
3. Install factory-laminated, vapor-retarder-faced blankets straight and true in one-piece lengths, with both sets of facing tabs sealed, to provide a complete vapor retarder.
4. Install blankets straight and true in one-piece lengths. Install vapor retarder over insulation, with both sets of facing tabs sealed, to provide a complete vapor retarder.

B. Blanket Roof Insulation: Comply with the following installation method:

1. Over-Framing Installation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing. Hold in place by metal roof panels fastened to secondary framing.
2. Between-Purlin Installation: Extend insulation and vapor retarder between purlins. Carry vapor-retarder-facing tabs up and over purlin, overlapping adjoining facing of next insulation course and maintaining continuity of retarder. Hold in place with bands and crossbands below insulation.

3. Over-Purlin-with-Spacer-Block Installation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing. Install layer of filler insulation over first layer to fill space formed by metal roof panel standoffs. Hold in place by panels fastened to standoffs.

    a. Thermal Spacer Blocks: Where metal roof panels attach directly to purlins, install thermal spacer blocks.

4. Two-Layers-between-Purlin-with-Spacer-Block Installation: Extend insulation and vapor retarder between purlins. Carry vapor-retarder-facing tabs up and over purlin, overlapping adjoining facing of next insulation course and maintaining continuity of retarder. Install layer of filler insulation over first layer to fill space between purlins formed by thermal spacer blocks. Hold in place with bands and crossbands below insulation.

    a. Thermal Spacer Blocks: Where metal roof panels attach directly to purlins, install thermal spacer blocks.

5. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.

C. Blanket Wall Insulation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing. Hold in place by metal wall panels fastened to secondary framing.

1. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.
2. Sound-Absorption Insulation: Where sound-absorption requirement is indicated for metal liner panels, cover insulation with polyethylene film and provide inserts of wire mesh to form acoustical spacer grid.

D. Board Wall Insulation: Extend board insulation in thickness indicated to cover entire wall. Hold in place by metal wall panels fastened to secondary framing. Comply with manufacturers' written instructions.

1. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.

3.10 DOOR AND FRAME INSTALLATION

A. General: Install doors and frames plumb, rigid, properly aligned, and securely fastened in place according to manufacturers' written instructions. Coordinate installation with wall flashings and other components. Seal perimeter of each door frame with elastomeric sealant used for metal wall panels.

B. Personnel Doors and Frames: Install doors and frames according to NAAMM-HMMA 840. Fit non-fire-rated doors accurately in their respective frames, with the following clearances:

1. Between Doors and Frames at Jambs and Head: 1/8 inch (3 mm).
2. Between Edges of Pairs of Doors: 1/8 inch (3 mm).
3. At Door Sills with Threshold: 3/8 inch (9.5 mm).
4. At Door Sills without Threshold: 3/4 inch (19.1 mm).
5. At fire-rated openings, install frames according to, and doors with clearances specified in, NFPA 80.

C. Sliding Service Doors: Bolt support angles to opening head members through factory-punched holes. Bolt door tracks to support angles at maximum 24 inches (610 mm) o.c. Set doors and operating equipment with necessary hardware, jamb and head mold stops, continuous hood flashing, anchors, inserts, hangers, and equipment supports.

D. Field Glazing: Comply with installation requirements in Section 088000 "Glazing."

E. Door Hardware:

1. Install surface-mounted items after finishes have been completed at heights indicated in DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
2. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
3. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
4. Set thresholds for exterior doors in full bed of sealant complying with requirements for concealed mastics specified in Section 079200 "Joint Sealants."

3.11 WINDOW INSTALLATION

A. General: Install windows plumb, rigid, properly aligned, without warp or rack of frames or sash, and securely fasten in place according to manufacturer's written instructions. Coordinate installation with wall flashings and other components. Seal perimeter of each window frame with elastomeric sealant used for metal wall panels.

1. Separate dissimilar materials from sources of corrosion or electrolytic action at points of contact with other materials by complying with requirements specified in AAMA/WDMA/CSA 101/I.S.2/A440.

B. Set sill members in bed of sealant or with gaskets, for weathertight construction.

C. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.

D. Mount screens directly to frames with tapped screw clips.

3.12 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal roof panel assembly, including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
2. Install components for a complete metal wall panel assembly, including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
3. Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by manufacturer.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil-canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.

2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

C. Gutters: Join sections with riveted-and-soldered or lapped-and-sealed joints. Attach gutters to eave with gutter hangers spaced as required for gutter size, but not more than 36 inches (914 mm) o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

D. Downspouts: Join sections with 1-1/2-inch (38-mm) telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1524 mm) o.c. in between.

1. Provide elbows at base of downspouts to direct water away from building.
2. Tie downspouts to underground drainage system indicated.

E. Circular Roof Ventilators: Set ventilators complete with necessary hardware, anchors, dampers, weather guards, rain caps, and equipment supports. Mount ventilators on flat level base. Install preformed filler strips at base to seal ventilator to metal roof panels.

F. Continuous Roof Ventilators: Set ventilators complete with necessary hardware, anchors, dampers, weather guards, rain caps, and equipment supports. Join sections with splice plates and end-cap skirt assemblies where required to achieve indicated length. Install preformed filler strips at base to seal ventilator to metal roof panels.

G. Louvers: Locate and place louver units level, plumb, and at indicated alignment with adjacent work.

1. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
2. Provide perimeter reveals and openings of uniform width for sealants and joint fillers.
3. Protect galvanized- and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of corrosion-resistant paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
4. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 079200 "Joint Sealants" for sealants applied during louver installation.

H. Roof Curbs: Install curbs at locations indicated on Drawings. Install flashing around bases where they meet metal roof panels.

I. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to panel as recommended by manufacturer.

3.13 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform field quality control special inspections and to submit reports.

B. Product will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.14 ADJUSTING

A. Doors: After completing installation, test and adjust doors to operate easily, free of warp, twist, or distortion.

B. Door Hardware: Adjust and check each operating item of door hardware and each door to ensure proper operation and function of every unit. Replace units that cannot be adjusted to operate as intended.

C. Windows: Adjust operating sashes and ventilators, screens, hardware, and accessories for a tight fit at contact points and at weather stripping to ensure smooth operation and weathertight closure. Lubricate hardware and moving parts.

D. [**Roof Ventilators**] [**and**] [**Adjustable Louvers**]: After completing installation, including work by other trades, lubricate, test, and adjust units to operate easily, free of warp, twist, or distortion as needed to provide fully functioning units.

1. Adjust louver blades to be weathertight when in closed position.

3.15 CLEANING AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

C. Touchup Painting:

1. After erection, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted structural framing[**, bearing plates,**] and accessories.

a. Clean and prepare surfaces by SSPC-SP 2, "Hand Tool Cleaning," or by SSPC-SP 3, "Power Tool Cleaning."
b. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

2. Cleaning and touchup painting are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

D. Metal Panels: Remove temporary protective coverings and strippable films, if any, as metal panels are installed. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

1. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

E. Doors and Frames: Immediately after installation, sand rusted or damaged areas of prime coat until smooth and apply touchup of compatible air-drying primer.

1. Immediately before final inspection, remove protective wrappings from doors and frames.

F. Windows: Clean metal surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances. Clean factory-glazed glass immediately after installing windows.

G. Louvers: Clean exposed surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning.

1. Restore louvers damaged during installation and construction period so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

a. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 13 34 19 00

Task	Specification	Specification Description
13 34 19 00	01 22 16 00	No Specification Required
13 34 23 13	13 34 19 00	Metal Building Systems
13 34 23 16	11 12 16 00	Parking Control Equipment
13 34 23 16	11 12 16 00a	Prefabricated Control Booths
13 34 23 31	13 34 19 00	Metal Building Systems

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SECTION 13 42 63 16 - SECURITY CEILING SYSTEMS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of material for security ceiling systems. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Downward-locking-panel security ceiling systems.
      b. Security-plank security ceiling systems.

C. Performance Requirements
   1. General Performance: Security ceiling systems shall withstand normal thermal movement and structural loads without failure, including permanent deformation of security ceiling system components including pans and suspension system; noise or metal fatigue caused by vibration, deflection, and displacement of security ceiling units; and permanent damage to fasteners and anchors.
   2. Acoustical Performance: Provide security ceiling systems with acoustical ratings indicated, as determined according to ASTM E 1264 and the following:
      a. Noise Reduction Coefficient: ASTM C 423 and ASTM E 795 in Type E-400 mounting.
      b. Ceiling Attenuation Class: ASTM E 1414.
   3. Structural Performance: Security ceiling systems shall withstand the effects of gravity loads and loads and stresses within limits and under conditions indicated:

D. Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittals:
      a. Product Data for Credit MR 4.1 and MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
         1) Include statement indicating costs for each product having recycled content.
      b. Product Data for Credit EQ 4.1: For sealants, including printed statement of VOC content.
   3. Coordination Drawings: Reflected ceiling plans.
   4. Welding certificates.
   5. Product test reports.
   6. Research/evaluation reports.
   7. Field quality-control reports documenting inspections of installed products.
   8. Field quality-control certification signed by Contractor and Detention Specialist.

E. Quality Assurance
   1. Installer Qualifications: An employer of workers trained and approved by manufacturer.
   2. Source Limitations: Obtain each security ceiling system from single source from single manufacturer.
   3. Welding Qualifications: Qualify procedures and personnel according to the following:
      a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
      b. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
      c. AWS D1.3, "Structural Welding Code - Sheet Steel."
      d. AWS D1.6, "Structural Welding Code - Stainless Steel."
   4. Seismic Standard: Provide ceilings designed and installed to withstand the effects of earthquake motions according to the following:

a. Standard for Ceiling Suspension Systems Requiring Seismic Restraint: Comply with ASTM E 580.
b. CISCA's Recommendations for Acoustical Ceilings: Comply with CISCA's "Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings - Seismic Zones 0-2."
c. CISCA's Guidelines for Systems Requiring Seismic Restraint: Comply with CISCA's "Guidelines for Seismic Restraint of Direct-Hung Suspended Ceiling Assemblies - Seismic Zones 3 & 4."
d. IBC Standard for Metal Suspension Systems for Acoustical Tile and for Lay-in Panel Ceilings.
e. SEI/ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

5. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Deliver acoustical metal panels, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
2. Handle acoustical metal panels, suspension system components, and accessories carefully to avoid damaging units and finishes in any way.

1.2 PRODUCTS

A. Materials
1. Recycled Content: Provide products made from steel with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
2. Steel Sheet: Uncoated or electrolytic zinc-coated, ASTM A 591/A 591M with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.
3. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, CS (Commercial Steel), Type B; with G60 (Z180) zinc (galvanized) or A60 (ZF180) zinc-iron-alloy (galvannealed) coating designation.
4. Steel Tubing: ASTM A 513, Type B.
5. Stainless-Steel Sheet: ASTM A 666, Type 302 or 304.
6. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, as standard with manufacturer.
7. Concealed Bolts: ASTM A 307, Grade A, unless otherwise indicated.
8. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
9. Attachment Devices: Size for 5 times the design load indicated in ASTM C 635, Table 1, Direct Hung, unless otherwise indicated.
   a. Cast-in-Place and Postinstalled Expansion Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 5 times the load imposed by security ceiling construction, as determined by testing per ASTM E 488, conducted by a qualified testing agency.
      1) Type: Cast-in-place **OR** Postinstalled expansion **OR** Chemical, **as directed**, anchors.
      2) Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC service condition (mild).
      3) Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Alloy Group 1 or 4) for bolts and nuts; ASTM A 666 or ASTM A 276, Type 304 or 316, for anchors.

4) Corrosion Protection: Components fabricated from nickel-copper-alloy rods complying with ASTM B 164 for UNS No. N04400 alloy.

b. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times the load imposed by security ceiling construction, as determined by testing per ASTM E 1190, conducted by a qualified testing and inspecting agency.

B. Downward-Locking-Panel Security Ceiling System

1. Provide a complete, integrated system, including security ceiling panels, exposed suspension system, perimeter supports, and accessories.
2. Panels: Fabricated from a single sheet of metal, with formed upturned edges on all four sides designed to continuously engage with and lock under rectangular bulb of suspension system.
   a. Steel Panels: Cold-rolled **OR** Electrolytic zinc-coated **OR** Metallic-coated, **as directed**, steel with minimum uncoated sheet thickness of 0.043 inch (1.09 mm) **OR** 0.033 inch (0.84 mm) **OR** 0.021 inch (0.53 mm), **as directed**.
      1) Finish: Factory-applied, baked enamel **OR** powder coating, **as directed**.
   b. Aluminum Panels: Nominal sheet thickness of 0.040 inch (1.0 mm).
      1) Finish: Factory-applied, baked enamel **OR** powder coating, **as directed**.
   c. Stainless-Steel Panels: Nominal sheet thickness of 0.050 inch (1.27 mm) **OR** 0.025 inch (0.65 mm), **as directed**.
      1) Finish: No. 2b **OR** 4, **as directed**.
   d. Panel Size: 12 by 24 inches (305 by 610 mm) **OR** 12 by 48 inches (305 by 1220 mm) **OR** 24 by 24 inches (610 by 610 mm) **OR** 24 by 48 inches (610 by 1220 mm), **as directed**.
   e. Perforation Pattern: Perforated **OR** Unperforated, **as directed**.
   f. Noise Reduction Coefficient (NRC): NRC 0.70 **OR** NRC 0.80 **OR** NRC 0.85 **OR** NRC 0.90 **OR** NRC 0.95 **OR** NRC 1.00, **as directed**.
3. Sound-Absorptive Pads: Provide sound-absorptive pads for placement over ceiling panels.
   a. Spacer Grids: Metallic-coated-steel **OR** Aluminum, **as directed**, grid units that provide an air cushion between security ceiling panels and sound-absorptive pads and that act to improve sound absorption.
   b. Support Clips: Metal clips designed to hold sound-absorptive pads above bottom face sheet.
4. Backer Plates: Unperforated units formed from metallic-coated steel **OR** aluminum, **as directed**, sheet that reduces travel of sound through panel and that makes panel assembly comply with the following performance:
   a. Ceiling Attenuation Class (CAC): CAC 40 **OR** CAC 45, **as directed**.
   b. Sound-Absorptive Pads: Provide secondary sound-absorptive pads, same as specified for primary pads, for placement over backer plates to reduce plenum sound.
5. Access Panels: Material, perforation pattern, and finish same as security ceiling panels; designed to be accessible by high-security locks with keyways coordinated to building master key system **OR** removal of security fasteners, **as directed**.
   a. Size: 24 by 24 inches (610 by 610 mm) **OR** 24 by 48 inches (610 by 1220 mm) **OR** As indicated, **as directed**.
6. Suspension System: ASTM C 635, heavy-duty exposed system consisting of snap-in main runners supported by hangers attached to building structure.
   a. Provide system complete with main runners, splice plates, connector and alignment clips, hangers, trim, seismic- and wind-load clips and struts, and other suspension components required to support security ceiling units and other security ceiling-supported construction.
   b. Main Runners and Cross Tees: Formed from metal sheet, 1-1/2 inches (38 mm) high, with 15/16-inch (23.8-mm) flange width and with oversized rectangular bulb for engaging panels.
      1) Material: Galvanized steel, G90 (Z275) zinc coating **OR** Electrolytic zinc-coated steel, 40Z (12G) zinc coating **OR** Aluminum **OR** Stainless steel, **as directed**.

c. Wire Hangers, Braces, and Ties: Zinc-coated carbon-steel wire, ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
   1) Size: Select wire diameter so its stress at 3 times the hanger design load (ASTM C 635, Table 1, Direct Hung) will be less than yield stress of wire, but provide not less than 0.106-inch- (2.69-mm-) diameter wire.

d. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.

e. Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.

f. Angle Hangers: Angles with legs not less than 7/8 inch (22 mm) wide, formed with 0.04-inch- (1.0-mm-) thick, galvanized-steel sheet, G90 (Z275) zinc coating, with bolted connections and 5/16-inch- (8-mm-) diameter bolts.

g. Compression Struts: Fabricated from 3/4-inch- (19-mm-) diameter steel tubing, designed to fit over rectangular bulb of suspension system.

h. Security Clips: Steel wire, designed to slip over suspension system and through holes in flanges of panel to prevent panel removal.

7. Perimeter Supports: Wall-mounted channel moldings and wall angles; fabricated from 0.042-inch- (1.06-mm-) thick galvanized steel **OR** 0.016-inch- (0.4-mm-) thick galvanized steel **OR** 0.040-inch- (1.0-mm-) thick aluminum, **as directed**; finished to match suspension system.

8. Exposed Edge Moldings and Trim: Provide exposed members as indicated or required for edges of security ceiling, fixture trim, beams, fasciae at changes in security ceiling height, and other conditions; of metal and finish matching security ceiling panels.

C. Security-Plank Security Ceiling System

1. Single-Configuration Panels: Fabricated from a single sheet of metal, with a self-locking male/female lap joint for joining panels.

a. Steel Panels: Cold-rolled **OR** Electrolytic zinc-coated **OR** Metallic-coated, **as directed**, steel with minimum uncoated sheet thickness of 0.097 inch (2.45 mm) **OR** 0.068 inch (1.72 mm) **OR** 0.053 inch (1.34 mm) **OR** 0.043 inch (1.09 mm) **OR** 0.033 inch (0.84 mm), **as directed**.
   1) Finish: Factory-applied, baked enamel **OR** powder coating, **as directed**.

b. Aluminum Panels: Nominal sheet thickness of 0.125 inch (3.2 mm) **OR** 0.100 inch (2.5 mm) **OR** 0.080 inch (2.0 mm) **OR** 0.063 inch (1.6 mm) **OR** 0.050 inch (1.2 mm) **OR** 0.040 inch (1.0 mm), **as directed**.
   1) Finish: Factory-applied, baked enamel **OR** powder coating, **as directed**.

c. Stainless-Steel Panels: Nominal sheet thickness of 0.109 inch (2.78 mm) **OR** 0.078 inch (1.98 mm) **OR** 0.062 inch (1.59 mm) **OR** 0.050 inch (1.27 mm), **as directed**.
   1) Finish: No. 2b **OR** 4, **as directed**.

d. Panel Width: 12 inches (305 mm) **OR** 18 inches (457 mm) **OR** 24 inches (610 mm), **as directed**.

e. Panel Length: Minimum 8 feet (2.4 m) **OR** Minimum 10 feet (3.0 m) **OR** Minimum 12 feet (3.7 m) **OR** Custom lengths to fit areas indicated, **as directed**.

f. Perforation Pattern: Perforated **OR** Unperforated, **as directed**.

g. Noise Reduction Coefficient (NRC): NRC 0.70 **OR** NRC 0.80 **OR** NRC 0.85 **OR** NRC 0.90 **OR** NRC 0.95 **OR** NRC 1.00, **as directed**.

2. Double-Configuration Panels: Factory-assembled units with cold-rolled steel top face sheet and metallic-coated steel bottom face sheet, welded to a truss core. Fabricate panels with a self-locking male/female lap joint for joining panels.

a. Panel Width: 12 inches (305 mm) **OR** 18 inches (457 mm) **OR** 24 inches (610 mm), **as directed**, wide by length indicated.

b. Overall Panel Thickness: As required by indicated spans **OR** indicated on Drawings, **as directed**.

c. Minimum Uncoated Top Face Sheet Thickness: 0.068 inch (1.72 mm) **OR** 0.053 inch (1.34 mm) **OR** 0.043 inch (1.09 mm) **OR** 0.033 inch (0.84 mm), **as directed**.

d. Minimum Uncoated Bottom Face Sheet Thickness: 0.068 inch (1.72 mm) **OR** 0.053 inch (1.34 mm) **OR** 0.043 inch (1.09 mm) **OR** 0.033 inch (0.84 mm), **as directed**.

e. Truss Core: Fabricated from 0.015-inch- (0.38-mm-) thick, cold-rolled steel sheet bent into corrugated shape; welded to top and bottom face sheets at even spacings across and along length of panel.
f. Perforation Pattern for Bottom Face Sheet: Perforated **OR** Unperforated, **as directed**.
g. Noise Reduction Coefficient (NRC): NRC 0.65 **OR** NRC 0.90 **OR** NRC 1.00, **as directed**.
h. Finish of Bottom Face: Factory-applied prime paint.

3. Sound-Absorptive Pads: Provide sound-absorptive pads for placement over ceiling planks.
   a. Spacer Grids: Metallic-coated-steel **OR** Aluminum, **as directed**, grid units that provide an air cushion between security ceiling panels and sound-absorptive pads and that act to improve sound absorption.
   b. Support Clips: Metal clips designed to hold sound-absorptive pads above bottom face sheet.
4. Backer Plates: Unperforated units formed from metallic-coated steel **OR** aluminum, **as directed**, sheet that reduces travel of sound through panel and that makes panel assembly comply with the following performance:
   a. Ceiling Attenuation Class (CAC): CAC 40 **OR** CAC 45, **as directed**.
   b. Sound-Absorptive Pads: Provide secondary sound-absorptive pads, same as specified for primary pads, for placement over backer plates to reduce plenum sound.
5. Access Panels: Material, perforation pattern, and finish same as security ceiling panels; designed to be held in place by high-security locks with keyways coordinated to building master key system **OR** security fasteners screwed through suspension system, **as directed**.
   a. Size: 24 by 24 inches (610 by 610 mm) **OR** 24 by 48 inches (610 by 1220 mm) **OR** As indicated, **as directed**.
6. Closures: Fabricated from minimum 0.053-inch- (1.34-mm-) thick steel sheet, finished to match security ceiling panels. Fasten with security fasteners or by welding.
7. Suspension System: Heavy-duty exposed system consisting of intermediate carriers supported by secondary support system attached to building structure.
   a. Intermediate Carriers: Formed from tees with a nominal 4-inch- (102-mm-) wide exposed face or built up from back-to-back angles or channels each with a nominal 2-inch- (51-mm-) wide exposed face; fabricated from 0.068-inch- (1.72-mm-) **OR** 0.053-inch- (1.34-mm-), **as directed**, thick, cold-rolled steel sheet.
      1) Finish: Match security ceiling panels.
   b. Secondary Support System:
      1) Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.
      2) Angle Hangers: 1-1/2-by-1-1/2-inch (38-by-38-mm) galvanized-steel angles, G90 (Z275) zinc coating, bolted to intermediate carriers and building structure.
8. Perimeter Supports: Wall-mounted angles, tees, and bearing plates; fabricated from minimum 0.068-inch- (1.72-mm-) thick, cold-rolled steel sheet; finished to match security ceiling panels.
9. Exposed Edge Moldings and Trim: Provide exposed members as indicated or required for edges of security ceiling, fixture trim, beams, fasciae at changes in security ceiling height, and other conditions, of metal and finish matching security ceiling panels.

D. Sound-Absorptive Pads
1. Plastic-Sheet-Wrapped, Mineral-Fiber Insulation: Pads consisting of nonrigid, vinyl chloride plastic sheet encapsulating unfaced mineral-fiber insulation.
   a. Plastic Sheet: Not less than 0.003 inch (0.076 mm) thick; flat black.
   b. Mineral Fiber: Glass fiber or fiber made from slag (mineral wool), complying with ASTM C 553, Type I, II, or III.
      1) Thickness: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (51 mm) **OR** 4 inches (102 mm) **OR** As required to meet NRC rating, **as directed**.
   c. Mineral-Fiber Density: 1.0 lb/cu. ft. (16 kg/cu. m) **OR** 1.5 lb/cu. ft. (24 kg/cu. m) **OR** As required to meet NRC rating, **as directed**.
   d. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
      1) Flame-Spread Index: 25 or less.

2) Smoke-Developed Index: 50 **OR** 450, **as directed**, or less..

E. Sealants
1. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex sealant, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction, as demonstrated by testing representative assemblies according to ASTM E 90.
2. Acoustical Sealant for Concealed Joints: Manufacturer's standard nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), recommended for sealing interior concealed joints to reduce airborne sound transmission.
3. Security Sealant: Manufacturer's standard, high-modulus, nonsag, two-part, pick-proof, epoxy sealant, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), recommended for sealing nonmoving interior joints in security applications.

F. Security Fasteners
1. Security Fasteners: Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator.
2. Drive-System Type, Head Style, Material, and Protective Coating: Provide as required for assembly, installation, and strength, and as follows:
   a. Drive-System Types: Pinned Torx-Plus **OR** Pinned Torx, **as directed**.
   b. Fastener Strength: Grade 8 (Class 10.9).
   c. Socket Button Head Fasteners:
      1) Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
      2) Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.
   d. Socket Flat Countersunk Head Fasteners:
      1) Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
      2) Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.
   e. Socket Head Cap Fasteners:
      1) Heat-treated alloy steel, ASTM A 574 (ASTM A 574M).
      2) Stainless steel, ASTM F 837 (ASTM F 837M), Group 1 CW.
   f. Protective Coatings for Heat-Treated Alloy Steel:
      1) Zinc and clear trivalent chromium, for exterior applications and interior applications where indicated.
      2) Zinc phosphate with oil, ASTM F 1137, Grade I, or black oxide unless otherwise indicated.

G. Fabrication
1. Panels: Form metal panels from sheet metals selected for their surface flatness, smoothness, and freedom from surface blemishes where exposed to view in finished unit. Do not use materials whose exposed surfaces exhibit pitting, seam marks, roller marks, or variations in flatness exceeding those permitted by referenced standards for stretcher-leveled metal sheet.
   a. Factory fabricate double-configuration security planks and join top and bottom face sheets by welding.

H. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Appearance of Finished Work: Noticeable variations in the same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

I. Aluminum Finishes
1. Color-Coated Finish: Manufacturer's standard powder-coat, **as directed**, baked paint complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.

J. Steel Sheet Finishes
1. Color-Coated Finish: Manufacturer's standard powder-coat, **as directed**, baked paint complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.

K. Stainless-Steel Finishes
1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
a. Run grain of directional finishes with long dimension of each piece.
b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

1.3 EXECUTION

A. Preparation
1. Coordination: Furnish layouts for cast-in-place anchors, clips, and other security ceiling anchors whose installation is specified in other Sections.
a. Furnish cast-in-place anchors and similar devices to other trades for installation well in advance of time needed for coordinating other work.
2. Measure each security ceiling area and establish layout of security ceiling panels to balance border widths at opposite edges of each security ceiling. Avoid using less-than-half-width panels at borders and comply with layout shown on reflected ceiling plans and Coordination Drawings.

B. General Installation
1. Comply with CISCA's "Ceiling Systems Handbook" for installation of security ceiling systems.
2. Install perimeter supports around perimeter of security ceiling area.
a. Apply acoustical **OR** security, **as directed**, sealant in a continuous ribbon concealed on back of vertical legs of supports before they are installed.
b. Attach supports with anchor bolts or expansion anchors spaced not more than 12 inches (305 mm) o.c. and not more than 3 inches (76 mm) from ends. Miter corners accurately.
1) Level perimeter supports with suspension system to a tolerance of 1/8 inch in 12 feet (3 mm in 3.7 m).
c. Do not use exposed fasteners, including pop rivets, on moldings and trim. If exposed fasteners are unavoidable, obtain approval from the Owner for their use and use security fasteners.
3. Install accessories where indicated and as required to comply with performance requirements.
a. Sound-Absorptive Pads: For security ceiling panels indicated, provide sound-absorptive pads of width and length to completely fill inside of each security ceiling panel.
1) Install sound-absorptive pads over metal spacer grids **OR** with support clips, **as directed**.
b. Backer Plates: Install plates in areas indicated on reflected ceiling plans or in room finish schedules. Lay backer plates directly on security ceiling system in manner indicated and close major openings to form complete coverage in required areas. Lay second sound-absorptive pad on backer plate, **as directed**.

C. Downward-Locking-Panel Security Ceiling System Installation
1. Comply with ASTM C 636 **OR** IBC Standard, **as directed**, and seismic requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
2. Ceiling Hangers: Suspend from building's structural members and as follows:

a. Install hangers plumb and free from contact with insulation or other objects within security ceiling plenum that are not part of supporting structure or of security ceiling suspension system.

b. Splay hangers only where required to avoid obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

c. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.

d. Secure wire hangers to security ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
OR
Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.

e. Do not support security ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.

f. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.

g. Do not attach hangers to steel deck tabs.

h. Do not attach hangers to steel roof deck. Attach hangers to structural members.

i. Space hangers not more than 48 inches (1220 mm) o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.

j. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

k. Install compression struts extending from main runners to structure above and spaced at 48 inches (1220 mm) o.c.

3. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

4. Panel Installation: Install panels to continuously engage with and lock under rectangular bulb of suspension system. Attach panels to perimeter supports with security fasteners not more than 3 inches (76 mm) from edges of panel. Fasten through exposed face of supports into panel.

a. Align joints in adjacent courses to form uniform, straight joints parallel to room axis in both directions unless otherwise indicated.

b. Fit adjoining units to form flush, tight joints. Scribe and cut units for accurate fit at borders and around construction penetrating security ceiling.

c. Install directionally patterned panels in directions indicated.

d. Scribe and cut security ceiling panels for accurate fit at borders and at interruptions and penetrations by other work through security ceilings. Stiffen edges of cut panels as required to eliminate evidence of buckling or variations in flatness.

5. Install each access panel within one security ceiling panel and attach with security fasteners **OR** by continuously welding access panel frame to security ceiling panel, **as directed**.

D. Security-Plank Security Ceiling System Installation

1. Install security planks with long edges continuously interlocked. Adjust security planks to final position before permanently fastening. Provide minimum 1-1/2-inch (38-mm) end bearing.

a. Attach adjacent security planks to each other with security fasteners spaced not more than 12 inches (305 mm) o.c. and not more than 6 inches (152 mm) from ends.

b. Continuously weld ends of security planks to perimeter supports. Remove exposed projecting burrs, edges, and rough spots resulting from welding operations by grinding smooth.
OR
Attach ends of security planks to perimeter supports with security fasteners not more than 3 inches (76 mm) from edges of security plank. Fasten through exposed face of supports into security planks.

c. Provide intermediate carriers for ends of security planks that are not supported by perimeter supports. To attach security planks to intermediate carriers, use same method as that used for attaching security planks to perimeter supports.
   1) Support intermediate carriers from structure above by secondary support system spaced at 48 inches (1220 mm) o.c. and bolted to carriers.

2. Install each access panels within one security plank and attach with security fasteners **OR** by continuously welding access panel frame to security plank, **as directed**.
3. Provide steel angle reinforcement on each side of openings that exceed 12 inches (305 mm) in any direction.

E. Field Quality Control
1. Detention Specialist shall inspect **OR** Inspect, **as directed**, installed products to verify compliance with requirements. Prepare inspection reports and indicate compliance with and deviations from the Contract Documents.
2. Remove and replace security ceiling systems where inspections indicate that work does not comply with specified requirements.
3. Perform additional inspections to determine compliance of replaced or additional work. Prepare inspection reports.
4. Prepare field quality-control certification that states installed products and their installation comply with requirements in the Contract Documents.
5. Field Quality-Control Testing: Engage a qualified independent testing agency to perform field quality-control testing.
6. Extent and Testing Frequency: Testing will take place in successive stages in areas described below. Proceed with installation of security ceiling systems only after test results for previously installed hangers comply with requirements.
   a. Extent of Each Test Area: When installation of security ceiling suspension systems on each floor has reached 20 percent completion but no security panel units have been installed.
   b. Within each test area, testing agency will select 1 of every 10 powder-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 200 lbf (890 N) of tension; it will also select 1 of every 2 postinstalled anchors used to attach bracing wires to concrete and will test them for 440 lbf (1957 N) of tension.
   c. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those fasteners and anchors not previously tested until 20 consecutively pass and then will resume initial testing frequency.
7. Fasteners and anchors will be considered defective if they do not pass tests and inspections.
8. Prepare test and inspection reports.
9. Additional Testing: Where fasteners and anchors are removed and replaced, additional testing will be performed to determine compliance with specified requirements.

F. Cleaning
1. Remove and replace work that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage, including dented and bent units.
2. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as that used for shop painting; comply with SSPC-PA 1 for touching up shop-painted surfaces.
   a. Apply by brush or spray to provide a minimum dry film thickness of 2 mils (0.05 mm).
3. Metallic-Coated Steel Surfaces: Clean field welds, bolted connections, and abraded areas and repair zinc or zinc-iron coating to comply with ASTM A 780.

END OF SECTION 13 42 63 16

Task	Specification	Specification Description
13 42 63 16	11 98 12 00	Detention Enclosures
13 42 63 16	10 86 00 00	Detention Furniture

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SECTION 13 46 13 00 - LIGHTNING PROTECTION

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for lightning protection. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes lightning protection for structures, structure elements and building site components.

C. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: For air terminals and mounting accessories.
   a. Layout of the lightning protection system, along with details of the components to be used in the installation.
   b. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.
3. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.
4. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.
5. Field quality-control reports.
6. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.
7. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:
   a. Ground rods.
   b. Ground loop conductor.

D. Quality Assurance
1. Installer Qualifications: Certified by UL or LPI as a Master Installer/Designer, trained and approved for installation of units required for this Project.
2. System Certificate:
   a. UL Master Label.
   OR
   LPI System Certificate.
   OR
   UL Master Label Recertification.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

E. Coordination
1. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.
2. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.
3. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

1.2 PRODUCTS

A. Lightning Protection System Components

1. Comply with UL 96 and NFPA 780, **as directed**.
2. Roof-Mounted Air Terminals: NFPA 780, Class I **OR** Class II, **as directed**, aluminum **OR** copper, **as directed**, unless otherwise indicated.
   a. Air Terminals More than 24 Inches (600 mm) Long: With brace attached to the terminal at not less than half the height of the terminal.
   b. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for single-membrane roof system materials. Comply with requirements in Division 07.
3. Main and Bonding Conductors: Copper **OR** Aluminum, **as directed**.
4. Ground Loop Conductor: The same size and type as the main conductor except tinned.
5. Ground Rods: Copper-clad **OR** Zinc-coated **OR** Stainless, **as directed**, steel, sectional type, **as directed**; 3/4 inch (19 mm) in diameter by 10 feet (3 m) **OR** 5/8 inch (16 mm) in diameter by 96 inches (2400 mm), **as directed**, long.
6. Heavy-Duty, Stack-Mounted, Lightning Protection Components: Stainless steel **OR** Solid copper **OR** Monel metal **OR** Lead sheathed, **as directed**.

1.3 EXECUTION

A. Installation

1. Install lightning protection components and systems according to UL 96A and NFPA 780.
2. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.
3. Conceal the following conductors:
   a. System conductors.
   b. Down conductors.
   c. Interior conductors.
   d. Conductors within normal view of exterior locations at grade within 200 feet (60 m) of building.
4. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.
   OR
   Cable Connections: Use exothermic-welded connections for all conductor splices and connections between conductors and other components.
   a. Exception: In single-ply membrane roofing, exothermic-welded connections may be used only below the roof level.
5. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.
6. Bond extremities of vertical metal bodies exceeding 60 feet (18 m) in length to lightning protection components.
7. Ground Loop: Install ground-level, potential equalization conductor and extend around the perimeter of structure **OR** area or item indicated, **as directed**.
   a. Bury ground ring not less than 24 inches (600 mm) from building foundation.
   b. Bond ground terminals to the ground loop.
   c. Bond grounded building systems to the ground loop conductor within 12 feet (3.6 m) of grade level.
8. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot (18-m) intervals.

B. Corrosion Protection

1. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

2. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

C. Field Quality Control
1. Notify the Owner at least 48 hours in advance of inspection before concealing lightning protection components.
2. UL Inspection: Meet requirements to obtain a UL Master Label for system.
OR
LPI System Inspection: Meet requirements to obtain an LPI System Certificate.

END OF SECTION 13 46 13 00

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SECTION 13 47 13 13 - CATHODIC PROTECTION

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for cathodic protection. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section includes passive cathodic protection systems that use magnesium or zinc anodes to protect iron and steel piping and tanks.

C. Performance Requirements
   1. Delegated Design: Design, supervise, test, and inspect the installation of cathodic protection systems, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
      a. Design cathodic protection for pipelines according to NACE RP0169.
      b. Design cathodic protection for metal underground storage tanks according to NACE RP0285.
   2. Survey site and determine soil or water corrosivity (resistivity), current requirements, potential surveys, stray currents, and water chemistry/corrosivity (pH).
   3. Select anodes and accessories relevant to level of protection. Design anodes for an estimated life of 15 **OR** 30, **as directed**, years before replacement.
   4. Cathodic protection systems shall provide protective potential that complies with referenced NACE standards. Insulators are required if needed to insulate protected metals from other structures.

D. Submittals
   1. Product Data: For each type of product indicated.
   2. Shop Drawings: For cathodic protection. Include plans, evaluations, sections, details, and attachments to other work.
      a. Detail locations of cathodic protection equipment, devices, and outlets, with characteristics and cross-references to products.
      b. Include calculations and details of anode designs.
      c. Include labeling and identifying scheme for wires, cables, and test boxes.
   3. Delegated-Design Submittal: For cathodic protection system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified corrosion engineer responsible for their preparation.
      a. Conduct site tests necessary for design, including soil resistivity, close-interval potential surveys, testing during construction, interference testing, and training of the Owner's personnel.
      b. Provide system design calculations, stating the maximum recommended anode current output density, and the rate of gaseous production, if any, at that current density.
   4. Coordination Drawings: Plans, drawn to scale, and coordinating connections to piping and tanks.
   5. Qualification Data: For qualified professional engineer. Submit evidence of current license, corporate authorization (if applicable) of the engineering business, and NACE certifications.
   6. Field quality-control reports.
   7. Operation and Maintenance Data: Include the following:
      a. Basic system operation, outlining the step-by-step procedures required for system startup, operation, adjustment of current flow, and shutdown.
      b. Instructions for pipe-to-reference cell and tank-to-reference cell potential measurements and frequency of monitoring.

c. Instructions for dielectric connections, interference and sacrificial-anode bonds; and precautions to ensure safe conditions during repair of pipe, tank or other metallic systems. Instructions shall be neatly bound.
d. Locations of all anodes, test stations, and insulating joints.
e. Structure-to-reference cell potentials as measured during the tests required by "Field Quality Control" Article.
f. Recommendations for maintenance testing, including instructions for pipe-to-reference cell potential measurements and frequency of testing.
g. Precautions to ensure safe conditions during repair of pipe system.

8. Warranty: Sample of special warranty.

E. Quality Assurance
1. Corrosion Engineer Qualifications: A qualified professional engineer who has education and experience in cathodic protection of buried and submerged metal structures and has NACE accreditation or certification as a Corrosion Specialist or Cathodic Protection Specialist.

F. Delivery, Storage, And Handling
1. Protect anodes from exposure to rain and direct sunlight.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace permanent reference electrodes that fail in materials or workmanship within specified warranty period.
a. Warranty Period: 15 **OR** 30, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Magnesium Anodes, Type II
1. Comply with ASTM B 843.
2. Chemical composition as percent of weight shall be as follows:
a. Aluminum: 0.010 maximum.
b. Manganese: 0.50 to 1.3.
c. Zinc: 0.05 maximum.
d. Silicon: 0.50 maximum.
e. Copper: 0.02 maximum.
f. Nickel: 0.001 maximum.
g. Iron: 0.03 maximum.
h. Other Impurities: 0.05 each; 0.3 maximum total.
i. Magnesium: Remainder.
3. Anode Core: Galvanized steel with anode wire silver-soldered to the core. Connection shall be recessed and epoxy insulated for 600-V rating. Connection shall be covered with heat-shrinkable tubing, and insulation shall be extended over connection.
4. Anode Wires: Factory-installed cables, with copper conductors, suitable for direct burial; not less than No. 10 AWG with Type THWN insulation according to ASTM D 1248 and NEMA WC 70/ICEA S-95-658; long enough to extend to accompanying junction box without splicing.
5. Anode Backfill: Backfill materials packaged in water-permeable fabric sack or cardboard container. Anodes shall be factory installed in packaged backfill using methods that result in dense packing of fill with factory-installed anode spacers to ensure centering of anode in packaged anode backfill. Backfill material shall have the following chemical composition by weight:
a. Hydrated Gypsum: 75 percent.
b. Bentonite Clay: 20 percent.
c. Anhydrous Sodium Sulfate: 5 percent.

B. Magnesium/Manganese Alloy Anodes
  1. Chemical composition as percent of weight shall be as follows:
    a. Aluminum: 0.01 maximum.
    b. Manganese: 0.50 to 1.3.
    c. Copper: 0.02 maximum.
    d. Nickel: 0.001 maximum.
    e. Iron: 0.03 maximum.
    f. Other Impurities: 0.05 each; 0.3 maximum total.
    g. Magnesium: Remainder.
  2. Bare Anode Weight: 40 lb (18 kg), not including core, and a nominal length of 60 inches (1520 mm).
  3. Anode Wires: Factory-installed cables, with copper conductors, suitable for direct burial; not less than No. 10 AWG with Type THWN insulation according to ASTM D 1248 and NEMA WC 70/ICEA S-95-658; long enough to extend to accompanying junction box without splicing.
  4. Anode Backfill: Backfill materials packaged in water-permeable fabric sack or cardboard container. Anodes shall be factory installed in packaged backfill using methods that result in dense packing of fill with factory-installed anode spacers to ensure centering of anode in packaged anode backfill. Backfill material shall have the following chemical composition by weight:
    a. Hydrated Gypsum: 75 percent.
    b. Bentonite Clay: 20 percent.
    c. Anhydrous Sodium Sulfate: 5 percent.

C. Zinc Anodes For Buried Service, Type Z-1
  1. Comply with ASTM B 418, Type II.
  2. Chemical composition as percent of weight shall be as follows:
    a. Aluminum: 0.005 maximum.
    b. Cadmium: 0.003 maximum.
    c. Iron: 0.0014 maximum.
    d. Zinc: Remainder.
  3. Bare Anode Ingot Weight: 30 lb (13.6 kg), 2 inches (50 mm) square and 30 inches (760 mm) long. Packaged weight of anode bag shall be 70 lb (32 kg).
  4. Anode Wires: Factory-installed cables, with copper conductors, suitable for direct burial; not less than No. 10 AWG with Type THWN insulation according to ASTM D 1248 and NEMA WC 70/ICEA S-95-658; long enough to extend to accompanying junction box without splicing.
  5. Anode Backfill: Backfill materials packaged in water-permeable fabric sack or cardboard container. Anodes shall be factory installed in packaged backfill using methods that result in dense packing of fill with factory-installed anode spacers to ensure centering of anode in packaged anode backfill. Backfill material shall have the following chemical composition by weight:
    a. Hydrated Gypsum: 75 percent.
    b. Bentonite Clay: 20 percent.
    c. Anhydrous Sodium Sulfate: 5 percent.

D. Permanent Reference Electrodes
  1. Copper/copper sulfate (Cu/CuSO4), suitable for direct burial. Electrode shall be guaranteed by supplier for 15 **OR** 30, **as directed**, years' service in the installed environment.

E. Wire And Cable
  1. Anode Header Cable: Single-conductor, Type HMWPE, insulated cable specifically designed for direct-buried dc service in cathodic protection installations.
    a. Conductor: Stranded, annealed, uncoated copper, not less than No. 8 AWG, complying with ASTM B 3 and ASTM B 8.

b. Insulation: High-molecular-weight polyethylene, complying with NEMA WC 70/ICEA S-95-658.
c. Minimum Average Thickness of Insulation: 110 mils (2.8 mm) for Nos. 8 through 2 AWG, and 125 mils (3.2 mm) for Nos. 1 through 4/0 AWG; rated at 600 V.
d. Connectors: Copper-compression type or exothermic welds.

2. Conductors and Cables: Comply with requirements in Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
   a. Bonding Conductors for Joint and Continuity Bonds: Not less than No. 8 AWG, stranded, Type THWN copper conductors.
   b. Flexible Pipe Coupling Bonds: Flexible copper straps with electrical resistance equal to No. 1/0 AWG stranded copper wire and with five holes for five exothermic welds to pipe.
   c. Test Wires: No. 12 AWG, Type THWN copper conductors.
   d. Resistance Wires: No. 16 or No. 22 AWG nickel-chromium wire.
   e. Cables for Installation in Conduit: Type THWN copper conductors.

F. Test Stations
1. Plastic Test Stations: Flush-mounted type, manufactured of high-impact-resistant PVC or polycarbonate with watertight conduit connections and cover and removable terminal board having at least five terminals.
2. Test Station Mounting Enclosures:
   a. Non-Traffic-Area Boxes: Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems".
   b. Traffic-Area Boxes: Comply with requirements in Division 26 Section "Underground Ducts And Raceways For Electrical Systems". Boxes shall have cast-iron covers with a welded bead legend "CP TEST."

G. Sealing, Potting, And Dielectric Compounds
1. Sealing and Dielectric Insulating Compound: Comply with NACE RP0188. Black, rubber based, soft, permanently pliable, tacky, moldable, and unbacked; 0.125 inch (3 mm) **OR** 0.5 inch (13 mm), **as directed**, thick.
2. Potting Compound: Comply with NACE RP0188. Cast-epoxy, two-package type; fabricated for this purpose and covered with heat-shrinkable tape.
3. Pressure-Sensitive, Vinyl-Plastic Electrical Tape: Comply with UL 510.

H. Exothermic Welding Materials
1. Exothermic Weld Kits: Specifically designed by manufacturer for welding materials and shapes required.
2. Exothermic Weld Caps: Dome of high-density polyethylene, 10-mil (0.254-mm) minimum thickness, filled with mastic and containing a tunnel portion to separate lead wire from exothermic weld.

I. Coating Repair Materials
1. Touchup Coating Materials: Comply with requirements in Division 09 Section "High-performance Coatings" for coating systems for touchup of factory-applied coatings.
2. Adhesive-Applied Coating Materials: Coating materials shall be compatible with factory-applied coating system.
   a. Nominal thickness of coating materials shall be not less than 8 mils (0.2 mm) **OR** 16 mils (0.4 mm) **OR** 24 mils (0.6 mm) **OR** 40 mils (1.0 mm) **OR** 60 mils (1.5 mm), **as directed**, plus or minus 5 percent.
   b. Coating materials shall be one of the following supplied by factory-applied coating system manufacturer:
      1) Polyvinyl-chloride, pressure-sensitive, adhesive tape.
      2) High-density polyethylene/bituminous rubber compound tape.
      3) Butyl rubber tape.
      4) Coal-tar epoxy.

1.3 EXECUTION

A. General Installation Requirements
   1. Comply with ANSI/IEEE C2 and NFPA 70.
   2. Make connections to ferrous pipe and metal tanks using exothermic welding.
   3. Coat welds with the coating repair material and apply an exothermic weld cap.

B. Magnesium Anode Installation
   1. Install magnesium anodes at locations that clear obstructions. Install at least 36 inches (900 mm) and no more than 10 feet (3 m) from pipe or tank to be protected. Install in augered holes with top of anode 24 inches (600 mm) below pipe invert elevation **OR** a minimum of 36 inches (900 mm) below finished grade. In soils that will collapse into augered holes, use casing of galvanized sheet steel.
   2. Install anodes in a dry condition after plastic or waterproof protective covering has been completely removed from water-permeable permanent container that houses anode metal. Do not use anode-connecting wire for lowering anode into hole. Backfill annular space around anode with fine earth in 6-inch (150-mm) layers; compact each layer using hand tools. Do not strike anode or connecting wire during backfilling and compacting. After backfilling and compacting to within 6 inches (150 mm) of finished grade, pour approximately 5 gal. (20 L) of water into each filled hole. After water has been absorbed by earth, complete backfilling to finished level.
   3. If rock strata are encountered before achieving specified augured hole depth, install anodes horizontally at depth at least as deep as bottom of pipe to be protected.
   4. Install anodes spaced as indicated, directly connected **OR** connected through a test station, **as directed**, to the pipeline, allowing slack in connecting wire to compensate for movement during backfill operation.
   5. For tank protection, connect groups of anodes to collector cable. Make contact, through a test station, with tank to be protected.
   6. Do not use resistance wires to reduce current output of individual or group anodes.

C. Zinc Anode Installation
   1. Install zinc anode horizontally in a hole at least 3 inches (76 mm) larger than anode. Install anode under new copper water tubing, including service lines, blowoffs, and air releases. Separate piping and anode by at least 24 inches (600 mm), but not more than 60 inches (1520 mm).
   2. Install anode midway between both ends of piping. Install anode wire in piping trench and connect to piping at an accessible location. Install anode wire in PVC conduit where rising out of the ground to the aboveground connection.

D. Installation Of Reference Electrodes
   1. Install directly beneath the buried metallic component being protected.

E. Cable And Wire Installation
   1. Install conductors, except anode wires, in PVC conduit with waterproof PVC junction boxes. Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems" for conduit and its installation.
   2. Anode Wire Installation: Cover trench bottom for the anode wire with 3-inch (76-mm) layer of sand or stone-free earth. Center wire on backfill layer and do not stretch or kink the conductor. Place backfill over wire in layers not exceeding 6 inches (150 mm) deep, and compact each layer. Use clean fill, free from roots, vegetable matter, and refuse. Place cable underground-line warning tape within 18 inches (460 mm) of finished grade, above cable and conduit.
   3. Bonding Conductors: Install conductors on metallic pipe and tanks, to and across buried flexible couplings, mechanical joints, and flanged joints except at places where insulating joints are specified. Welded and threaded joints are considered electrically continuous and do not require bonding.
      a. Install at least two bonds between parts requiring bonding.

b. Bonding conductors must contain sufficient slack for anticipated movement between structures. Bonding conductors across pipe joints shall have not less than a 4-inch (100-mm) slack for pipe expansion, contraction, and soil stress.
c. Connect bonding conductors to pipe, coupling follower rings and coupling middle ring or sleeve. Connect bonding conductors with exothermic welds.
4. For wire splicing, use compression connectors or exothermic welds.

F. Test Stations
1. Install test stations as follows:
a. At 1000-foot (300-m) intervals.
b. At insulating joints.
c. At both ends of casings when casing material is included in the cathodic protection system.
d. Where pipe crosses other metal pipes.
e. Where pipe connects to existing piping system.
f. Where pipe connects to dissimilar metal pipe.
g. At each tank component.
2. Install test stations on backfill complying with requirements for trench bottom fill for anode wires unless otherwise indicated.
3. Terminate test conductors on terminal boards and install a spare set of test leads at each testing location.

G. Pipe Joints
1. Insulating Flange Sets: Cover flanges with sealing and dielectric compound.
2. Insulating Unions: Install electrical isolation at each building entrance and at other locations indicated on approved Delegated-Design Drawings. Cover unions with sealing and dielectric compound.

H. Insulating Pipe Sleeves
1. Install insulating sleeves between metallic piping and metal buildings, hangers, supports, and other metal structures. Completely surround the metallic pipe for the full length of the steel contact and effectively prevent contact between the cathodically protected metallic pipe and other metallic structures. Support insulating sleeve to prevent damage to coating and to accommodate relative movement, vibrations, and temperature differentials.

I. Dissimilar Metals
1. Underground Dissimilar Piping: Coat insulating joint and pipe at joints of dissimilar piping material with sealing and dielectric compound for a minimum distance of 10 pipe diameters on both sides of joint.
2. Underground Dissimilar Valves: Coat dissimilar ferrous valves and pipe with sealing and dielectric compound for a minimum distance of 10 pipe diameters on both sides of valve.
3. Aboveground Dissimilar Pipe and Valves: If dissimilar metal pipe joints and valves are not buried and are exposed only to atmosphere, coat connection or valve, including pipe, with sealing and dielectric compound for a minimum distance of three pipe diameters on both sides of junction.

J. Coatings
1. Field Joints: Apply adhesive-applied coating system in a thickness to achieve corrosion protection equal to adjacent factory-applied coating.

K. Identification
1. Comply with requirements in Division 26 Section "Identification For Electrical Systems".
a. Identify anode wires and anode header cables with marker tape.
b. Identify underground wires and cables with underground-line warning tape.
c. Identify text boxes with engraved, laminated acrylic or melamine label, permanently attached to text box.

L. Field Quality Control
1. Comply with NACE RP0169 and NACE RP0285.
2. Perform tests and inspections.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
3. Tests and Inspections:
   a. Static Pull Test: Choose, at random, one completed anode of each type for this destructive test. Demonstrate that anode wire connections have enough strength to withstand a minimum tensile load of 300 lb (136 kg). If test fails, replace all anodes and repeat test at another randomly selected anode.
   b. Insulation Testing: Before anode system is connected to pipe and tank, test insulation at each insulating joint and fitting. Demonstrate that no metallic contact, or short circuit, exists between the two insulated sections of pipe and tank. Replace defective joints or fittings.
   c. Bonding Tests: Test for electrical continuity across all bonded joints. Repair or add additional bonds until electrical continuity is achieved.
   d. Baseline Potentials: After backfilling of pipe, tank, and anodes is completed, but before anodes are connected to pipe and tank, measure the static potential of pipe and tank to soil. Record initial measurements.
   e. Anode Output: Measure electrical current as anodes or groups of anodes are connected to pipe and tank. Use a low-resistance ammeter. Record current, date, time, and location of each measurement.
   f. Pipe- and- Tank-to-Reference Electrode Potential Measurements: On completion of installation of entire cathodic protection system, make electrode potential measurements according to NACE RP0169, using a copper/copper-sulfate reference electrode and a potentiometer-voltmeter, or a dc voltmeter with an internal resistance (sensitivity) of not less than 100,000 ohms per volt and a full scale of 1 or 2 V. Make measurements at same locations as those used for baseline potentials. Record voltage, date, time, and location of each measurement, using one of the following two methods:
      1) 0.85 V Negative Voltage: With cathodic system in operation, measure a negative voltage of at least minus 0.85 V between pipe or tank and a saturated copper/copper-sulfate reference electrode contacting the earth directly over pipe or tank.
      2) 100-mV Polarization Voltage: Determine polarization voltage shift by interrupting protective current and measuring polarization decay. An immediate voltage shift will occur if protective current is interrupted. Use voltage reading, after immediate shift, as base reading from which to measure polarization decay. Measure at least a minimum polarization voltage shift of 100 mV between pipe or tank and a saturated copper/copper-sulfate reference electrode contacting the earth directly over pipe or tank.
4. Location of Measurements for Piping: For coated piping or conduit, measure from reference electrode in contact with the earth directly over pipe. Measure at intervals not exceeding 400 feet (120 m). Make additional measurements at each distribution service riser, with reference electrode placed directly over service line.
5. Location of Measurements for Tanks: For underground tanks, measure from reference electrode located as follows:
   a. Directly over center of tank.
   b. At a point directly over tank and midway between each pair of anodes.
   c. At each end of tank.
6. Interference Testing: Test interference with cathodic protection from any foreign pipes and tanks in cooperation with the Owner of foreign pipes and tanks. Report results and recommendations.
7. Stray Current Measurements: Perform at each test station. Mitigate stray currents due to lightning or overhead ac power transmission lines as provided for in NACE standards.
8. Inspect coatings; comply with NACE RP0188. Repair imperfections of factory-applied coatings as specified in "Coatings" Article.

a. Use electronic holiday detectors to detect coating imperfections.
b. All damage to the protective coating during transit and handling shall be repaired before installation.
c. Repair factory-applied coatings to have equal or better corrosion resistance than the factory-applied coating system. Field-repair material shall be of the type approved by, and shall be applied as recommended by, manufacturer of the coating material.

M. Adjusting
1. Adjust cathodic current using resistors as recommended by corrosion engineer who prepared the Delegated-Design Submittal in Part 1.1.
2. During the first year after Final Completion, test, inspect, and adjust cathodic protection system every three months to ensure its continued compliance with specified requirements.

N. Demonstration
1. Train the Owner's maintenance personnel to adjust, operate, and maintain cathodic protection system.

END OF SECTION 13 47 13 13

Task	Specification	Specification Description
13 48 63 00	01 22 16 00	No Specification Required

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SECTION 14 01 30 71 - ELECTRIC TRACTION ELEVATORS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for electric traction elevators. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes electric traction passenger and service elevators.

C. Definitions

1. Definitions in ASME A17.1 apply to work of this Section.
2. Defective Elevator Work: Operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.
3. Service Elevator: A passenger elevator that is also used to carry freight.

D. Submittals

1. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include product data for the following:
    a. Car enclosures and hoistway entrances.
    b. Operation, control, and signal systems.
2. Shop Drawings: Show plans, elevations, sections, and large-scale details indicating service at each landing, machine room layout, coordination with building structure, relationships with other construction, and locations of equipment and signals. Include large-scale layout of car control station and standby power operation control panel, **as directed**. Indicate variations from specified requirements, maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.
3. Samples: For exposed finishes of cars, hoistway doors and frames, and signal equipment; 3-inch- (75-mm-) square Samples of sheet materials; and 4-inch (100-mm) lengths of running trim members.
4. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway, pit, and machine room layout and dimensions, as shown on Drawings, and electrical service, as shown and specified, are adequate for elevator system being provided.
5. Qualification Data: For Installer.
6. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.
7. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.
8. Warranty: Special warranty specified in this Section.

E. Quality Assurance

1. Installer Qualifications: Elevator manufacturer or manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Source Limitations: Obtain elevators, including hydraulic passenger elevators specified in another Division 14 Section, through one source from a single manufacturer.
    a. Provide major elevator components, including driving machines, controllers, signal fixtures, door operators, car frames, cabs, and entrances, manufactured by a single manufacturer.
3. Legal Requirements: Comply with ASME A17.1 and elevator design requirements for earthquake loads in ASCE 7.

a. Effective peak velocity acceleration (Av) for Project's location is less than 0.10 (seismic risk zones 0 and 1) **OR** greater than or equal to 0.10, but less than 0.20 (seismic risk zone 2) **OR** greater than or equal to 0.20 (seismic risk zones 3 and 4), **as directed**.
b. Provide earthquake equipment required by ASME A17.1.
c. Design earthquake spectral response acceleration, short period (Sds) for Project is determined by Project's location and site classification.
d. Project's seismic design category is A **OR** B **OR** C **OR** D, **as directed**.
e. Elevator importance factor is 1.5 **OR** 1.0, **as directed**.
f. Accessibility Requirements: Americans with Disabilities Act (including the ADA Standards issued by the U.S. Department of Justice and the U.S. Department of Transportation and the United States Access Board's Guide to the ADA Standards, specifically Chapter 4.

4. Fire-Rated Hoistway Entrance Assemblies: Door and frame assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to NFPA 252 **OR** IBC Standard 3002.4 **OR** UL 10B, **as directed**.

F. Delivery, Storage, And Handling
1. Deliver, store, and handle materials, components, and equipment in manufacturer's protective packaging.
2. Store materials, components, and equipment off of ground, under cover, and in a dry location. Handle according to manufacturer's written recommendations to prevent damage, deterioration, or soiling.

G. Coordination
1. Coordinate installation of sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.
2. Coordinate sequence of elevator installation with other work to avoid delaying the Work.
3. Coordinate locations and dimensions of other work relating to electric traction elevators including pit ladders, sumps, and floor drains in pits; entrance subsills; machine beams, **as directed**; and electrical service, electrical outlets, lights, and switches in pits and machine rooms **OR** hoistways, **as directed**.

H. Warranty
1. Special Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to repair, restore, or replace defective elevator work within specified warranty period.
a. Warranty Period: One year from date of Final Completion.

1.2 PRODUCTS

A. Systems And Components
1. General: Provide manufacturer's standard elevator systems. Where components are not otherwise indicated, provide standard components published by manufacturer as included in standard preengineered elevator systems and as required for complete system.
2. Elevator Machines: Provide variable-voltage, variable-frequency, ac-type hoisting machines **OR** At manufacturer's option, provide either variable-voltage, variable-frequency, ac-type or variable-voltage, dc-type hoisting machines, **as directed**. Provide solid-state power converters.
a. Provide regenerative **OR** nonregenerative, **as directed**, system.
b. Limit total harmonic distortion of regenerated power to 5 percent per IEEE 519.
c. Provide means for absorbing regenerated power when elevator system is operating on standby power.
d. Provide line filters or chokes to prevent electrical peaks or spikes from feeding back into building power system.

3. Fluid for Oil Buffers: If oil buffers are used, use only fire-resistant hydraulic fluid containing antioxidant, anticorrosive, antifoaming, and metal-passivating additives.
4. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work where installation of devices is specified in another Section.
5. Machine Beams: Provide framing to support elevator hoisting machine and deflector sheaves from the building structure. Comply with Division 5 Section "Metal Fabrications" for materials and fabrication.
6. Car Frame and Platform: Welded steel units.
7. Guides: Provide roller guides **OR** polymer-coated, nonlubricated sliding guides, **as directed**, at top and bottom of car and counterweight frames.

B. Operation Systems
1. General: Provide manufacturer's standard microprocessor operation system for each elevator **OR** for each group of elevators, **as directed**, as required to provide type of operation system indicated.
2. Group Automatic Operation with Demand-Based Dispatching: Provide reprogrammable, **as directed**, group automatic system that assigns cars to hall calls based on a dispatching program designed to minimize passenger waiting time. System automatically adjusts to changes in demand for different traffic conditions including heavy incoming, heavy two-way, heavy outgoing, and light off-hours as variations of normal two-way traffic.
3. Destination-Based Group Automatic Operation: Provide reprogrammable group automatic system that assigns elevators leaving the main lobby in the up direction to a selected group of floors and directs passengers to an elevator serving their destination floor. System dispatches cars in a regulated sequence for optimum system efficiency; dispatch is based on origin and destination of calls. System automatically adjusts to changes in demand for different traffic conditions including heavy incoming, heavy two-way, heavy outgoing, and light off-hours as variations of normal two-way traffic.
4. Auxiliary **OR** Single-Car Auxiliary, **as directed**, Operations: In addition to primary operation system features, provide the following operational features for elevators where indicated:
   a. Standby Power Operation: On activation of standby power, car is returned to a designated floor and parked with doors open. Car can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel located at main lobby **OR** fire command station, **as directed**. Manual operation causes automatic operation to cease.
   b. Standby Powered Lowering: On activation of standby power, if car is at a floor, it remains at that floor, opens its doors, and shuts down. If car is between floors, it is lowered to the next floor below, opens its doors, and shuts down.
   c. Battery-Powered Lowering: If power fails and car is at a floor, it remains at that floor, opens its doors, and shuts down. If car is between floors, it is lowered to the next floor below, opens its doors, and shuts down. System includes rechargeable battery and automatic recharging system.
   d. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors will begin closing.
   e. Nuisance Call Cancel: When car calls exceed a preset number while car load is less than a predetermined weight, all car calls are canceled. Preset number of calls and predetermined weight, **as directed**, can be adjusted.
5. Group Auxiliary Operations: In addition to primary operation system features, provide the following operational features for elevators and elevator groups where indicated:
   a. Standby Power Operation: On activation of standby power, cars are returned to a designated floor and parked with doors open. One car is returned at a time, with priority given to loaded cars. If a car cannot be returned after two attempts, it is removed from the system. When all cars have been returned or removed from the system, one car is automatically placed in service. If car selected for service cannot operate within 60 seconds, the system removes car from service and places another car in service. Cars can be manually put in service on standby power, either for return operation or for regular

operation, by switches in control panel located at main lobby **OR** fire command station, **as directed**. Manual operation causes automatic operation to cease.

b. Standby Power Operation: On activation of standby power, cars are returned, one at a time, to a designated floor and parked with doors open. If a car cannot be returned, it is removed from the system. When all cars have been returned or removed from the system, one car can be put in service on standby power by a selector switch in control panel located at main lobby **OR** fire command station, **as directed**.

c. Battery-Powered Lowering: If power fails, cars that are at a floor remain at that floor, open their doors, and shut down. Cars that are between floors are lowered one at a time to the next floor below, open their doors, and shut down. System includes rechargeable battery and automatic recharging system.

d. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors will begin closing.

e. Nuisance Call Cancel: When car calls exceed a preset number while the car load is less than a predetermined weight, all car calls are canceled. Preset number of calls and predetermined weight, **as directed**, can be adjusted.

f. Emergency Hospital **OR** Priority, **as directed**, Service: Service is initiated by a keyswitch **OR** card reader **OR** remote switch, **as directed**, at designated floors. One elevator is removed from group operation and directed to the floor where service was initiated. On arriving at the floor, elevator opens its doors and parks and a lighted sign directs passengers to exit elevator, **as directed**. Car is placed in operation by selecting a floor and pressing door close button or by operating keyswitch to put car in independent service. After responding to floor selected or being removed from independent service, car is returned to group operation. If car is not placed in operation within a preset time after being called, it is returned to group operation.

g. Independent Service: Keyswitch in car control station removes car from group operation and allows it to respond only to car calls. Key cannot be removed from keyswitch when car is in independent service. When in independent service, doors close only in response to door close button.

h. Loaded-Car Bypass: When car load exceeds 80 percent of rated capacity, car will respond only to car calls, not to hall calls.

i. Distributed Parking: When cars are not required for response to calls, they are parked with doors closed, distributed in predetermined zones throughout the building. One zone shall include the main floor and adjacent floors; remaining floors shall be divided into approximately equal zones.

6. Security Features: Provide the following security features, where indicated. Security features shall not affect emergency firefighters' service.

a. Card-Reader Operation: System uses card readers at car control stations **OR** hall push-button stations, **as directed**, to authorize calls. Security system determines which landings and at what times calls require authorization by card reader. Provide required conductors in traveling cable and panel in machine room for interconnecting card readers, other security access system equipment, and elevator controllers. Allow space as indicated for card reader in car **OR** Provide stripe-swipe card reader integral with each car control station, **as directed**.

1) Security access system equipment is specified in Division 28 Section "Access Control".

OR

Security access system equipment is not in the Contract.

b. Keyswitch Operation: Push buttons are activated and deactivated by security keyswitches at car control stations **OR** hall push-button stations, **as directed**. Key is removable only in deactivated position **OR** in either position, **as directed**.

c. Keypad Operation: Allows each landing to be restricted or unrestricted. When a restricted landing button is pressed, a "Restricted Floor" lamp lights and remains lit until landing access code has been entered into a keypad or predetermined time period has elapsed.

Car calls for restricted landings do not register until landing access code is entered into keypad within predetermined time period after landing button is pressed.

1) Access codes are programmed at each car operating panel using a security keyswitch. Keypad operation can be activated and deactivated by security keyswitch at main landing.

d. Car-to-Lobby Feature: Feature, activated by keyswitch at main lobby, that causes car **OR** all cars in a group, **as directed**, to return immediately to lobby and open doors for inspection. On deactivation by keyswitch, calls registered before keyswitch activation are completed and normal operation is resumed.

C. Door Reopening Devices

1. Infrared Array: Provide door reopening devices with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more of the light beams shall cause doors to stop and reopen.
2. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, through activating door reopening device, a loud buzzer shall sound and doors shall begin to close at reduced kinetic energy.

D. Finish Materials

1. General: Provide the following materials for exposed parts of elevator car enclosures, car doors, hoistway entrance doors and frames, and signal equipment as indicated.
2. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, commercial steel, Type B, exposed, matte finish.
3. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, commercial steel, Type B, pickled.
4. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.
   a. Textured Stainless-Steel Sheet: Product with coined **OR** embossed, **as directed**, texture rolled into exposed surface.
      1) Metal surface is satin polished **OR** satin relieved **OR** titanium nitride colored **OR** oxide colored **OR** satin polished and titanium nitride colored **OR** satin relieved and titanium nitride colored **OR** satin polished and oxide colored **OR** satin relieved and oxide colored **OR** color coated and satin relieved **OR** color coated and bright relieved, **as directed**, after rolling.
5. Stainless-Steel Bars: ASTM A 276, Type 304.
6. Stainless-Steel Tubing: ASTM A 554, Grade MT 304.
7. Bronze Plate and Sheet: ASTM B 36/B 36M, Alloy UNS No. C28000 (muntz metal).
8. Bronze Extrusions: ASTM B 455, Alloy UNS No. C38500 (architectural bronze).
9. Bronze Tubing: ASTM B 135 (ASTM B 135M), Alloy UNS No. C23000 (red brass, 85 percent copper).
10. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063.
11. Nickel Silver Extrusions: ASTM B 151/B 151M, Alloy UNS No. C74500 or No. C77600.
12. Plastic Laminate: High-pressure type complying with NEMA LD 3, Type HGS for flat applications **OR** Type HGL for flat applications, **as directed**, Type HGP for postformed applications and Type BKV for panel backing.

E. Car Enclosures

1. General: Provide enameled-steel car enclosures to receive removable **OR** steel-framed car enclosures with nonremovable, **as directed**, wall panels, with car **OR** removable car, **as directed**, roof, access doors, power door operators, and ventilation.
   a. Provide standard railings complying with ASME A17.1 on car tops where required by ASME A17.1.
   b. Provide finished car including materials and finishes specified below.
2. Materials and Finishes: Provide manufacturer's standards, but not less than the following:
   a. Subfloor: Underlayment grade, exterior plywood, 5/8-inch (16-mm) nominal thickness.
   b. Floor Finish: Specified in a Division 9 Section **OR** Elevator manufacturer's standard level-loop nylon carpet; color as selected from manufacturer's full range, **as directed**.

c. Enameled-Steel Wall Panels: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel finish; colors as selected from manufacturer's full range.
d. Stainless-Steel Wall Panels: Flush, hollow-metal construction; fabricated from stainless-steel sheet.
e. Bronze Wall Panels: Flush, hollow-metal construction; fabricated from bronze sheet.
f. Plastic-Laminate Wall Panels: Plastic laminate adhesively applied to 1/2-inch (13-mm) fire-retardant-treated particleboard **OR** manufacturer's standard honeycomb core, **as directed**, with plastic-laminate panel backing and, **as directed**, manufacturer's standard protective edge trim. Panels have a flame-spread index of 25 **OR** 75, **as directed**, or less, when tested according to ASTM E 84. Plastic-laminate color, texture, and pattern as selected from plastic-laminate **OR** elevator, **as directed**, manufacturer's full range.
g. Fabricate car with recesses and cutouts for signal equipment.
h. Fabricate car door frame integrally with front wall of car.
i. Enameled-Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel finish; colors as selected from manufacturer's full range.
j. Stainless-Steel Doors: Flush, hollow-metal construction; fabricated from stainless-steel sheet **OR** by laminating stainless-steel sheet to exposed faces and edges of enameled cold-rolled steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning, **as directed**.
k. Bronze Doors: Flush, hollow-metal construction; fabricated by laminating bronze sheet to exposed faces and edges of enameled cold-rolled steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
l. Plastic-Laminate Doors: Flush, hollow-metal construction; fabricated by laminating plastic laminate to exposed faces of enameled cold-rolled steel doors and covering edges with protective edge trim matching return panels, **as directed**. Plastic-laminate color, texture, and pattern as selected from plastic-laminate **OR** elevator, **as directed**, manufacturer's full range.
m. Sight Guards: Provide sight guards on car doors.
n. Sills: Extruded metal, with grooved surface, 1/4 inch (6.4 mm) thick.
o. Luminous Ceiling: Fluorescent light fixtures and ceiling panels of translucent acrylic or other permanent rigid plastic.
p. Metal **OR** Metallic-Finish, Plastic-Laminate, **as directed**, Ceiling: Flush panels, with incandescent downlights in the center of **OR** four low-voltage downlights in, **as directed**, each panel. Align ceiling panel joints with joints between wall panels, **as directed**.
q. Handrails: Manufacturer's standard handrails, of shape, metal, and finish indicated.

F. Hoistway Entrances
1. General: Provide manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Provide frame size and profile to coordinate with hoistway wall construction.
a. Where gypsum board wall construction is indicated, provide self-supporting frames with reinforced head sections.
2. Materials and Fabrication: Provide manufacturer's standards, but not less than the following:
a. Enameled-Steel Frames: Formed from cold-rolled or hot-rolled steel sheet. Provide with factory-applied enamel finish; colors as selected from manufacturer's full range.
b. Steel Subframes: Formed from cold-rolled or hot-rolled steel sheet with factory-applied enamel finish or corrosion-inhibiting primer. Fabricate to receive applied finish as indicated.
c. Stainless-Steel Frames: Formed from stainless-steel sheet.
d. Bronze Frames: Formed from cold-rolled or hot-rolled steel sheet, with enamel finish, and with formed-bronze sheet laminated to steel frames using adhesive that fully bonds metal to metal without telegraphing or oil-canning.

e. Enameled-Steel Doors and Transoms: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel finish; colors as selected from manufacturer's full range.

f. Stainless-Steel Doors and Transoms: Flush, hollow-metal construction; fabricated from stainless-steel sheet **OR** by laminating stainless-steel sheet to exposed faces and edges of enameled cold-rolled steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning, **as directed**.

g. Bronze Doors and Transoms: Flush, hollow-metal construction; fabricated by laminating bronze sheet to exposed faces and edges of enameled cold-rolled steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.

h. Plastic-Laminate Doors and Transoms: Flush, hollow-metal construction; fabricated by laminating plastic laminate to exposed faces of enameled cold-rolled steel doors and covering edges with protective edge trim matching door frames, **as directed**. Plastic-laminate color, texture, and pattern as selected from plastic-laminate **OR** elevator, **as directed**, manufacturer's full range.

i. Sight Guards: Provide sight guards on doors matching door edges.

j. Sills: Extruded metal, with grooved surface, 1/4 inch (6.4 mm) thick.

k. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107.

G. Signal Equipment

1. General: Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Fabricate lighted elements with long-life incandescent lamps and acrylic or other permanent, nonyellowing translucent plastic diffusers **OR** LEDs, **as directed**.

   OR

   General: Provide signal equipment designed for destination-based system. Fabricate lighted elements with long-life incandescent lamps and acrylic or other permanent, nonyellowing translucent plastic diffusers **OR** LEDs, **as directed**.

2. Car Control Stations: Provide manufacturer's standard recessed **OR** semirecessed, **as directed**, car control stations. Mount in return panel adjacent to car door, unless otherwise indicated.

   OR

   Swing-Return Car Control Stations: Provide car control stations mounted on rear of hinged return panel adjacent to car door and with buttons, switches, controls, and indicator lights projecting through return panel but substantially flush with face of return panel.

   a. Mark buttons and switches with standard identification for required use or function that complies with ASME A17.1. Use both tactile symbols and Braille.

   b. Provide "No Smoking" sign matching car control station, either integral with car control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.

3. Emergency Communication System: Provide system that complies with ASME A17.1 and the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)." On activation, system dials preprogrammed number of monitoring station and identifies elevator location to monitoring station. System provides two-way voice communication without using a handset and provides visible signals that indicate when system has been activated and when monitoring station has responded. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.

4. Firefighters' Two-Way Telephone Communication Service: Provide flush-mounted cabinet **OR** telephone jack, **as directed**, in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified in Division 28 Section(s) "Digital, Addressable Fire-alarm System" OR "Zoned (dc Loop) Fire-alarm System".

5. Car Position Indicator: Provide illuminated, **as directed**, digital-type car position indicator, located above car door or above car control station. Also provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served.

   a. Include travel direction arrows if not provided in car control station.

6. Hall Push-Button Stations: Provide one hall push-button station at each landing for each single elevator or group of elevators, but not less than one station for each four elevators in a group, **as directed**.
   OR
   Hall Push-Button Stations: Provide hall push-button stations at each landing as indicated.
   a. Provide manufacturer's standard wall-mounted units.
      OR
      Provide units with flat faceplate for mounting with body of unit recessed in wall.
   b. Equip units with buttons for calling elevator and for indicating desired direction of travel.
      OR
      Equip units with buttons **OR** touch screen, **as directed**, for calling elevator and for indicating direction of travel or destination as required by system. Provide a signaling system to verify floor selection, where destination registration is required, and to direct passengers to appropriate car.
      1) Provide a means for passengers to indicate that they have disabilities so control system can allow extra room in assigned car.
      2) Provide for connecting units that require destination registration to building security access system so a card reader can be used to register calls.
   c. Provide telephone jack in each unit for firefighters' two-way telephone communication service specified in Division 28 Section(s) "Digital, Addressable Fire-alarm System" OR "Zoned (dc Loop) Fire-alarm System".
7. Hall Lanterns: Units with illuminated arrows; but provide single arrow at terminal landings. Provide one of the following:
   a. Manufacturer's standard wall-mounted units, for mounting above entrance frames.
   b. Units with flat faceplate for mounting with body of unit recessed in wall and with illuminated elements projecting from faceplate for ease of angular viewing.
   c. Units mounted in both jambs of entrance frame for each elevator, **as directed**.
   d. Units mounted in both car door jambs; may be used only for single elevators or for two-car groups, **as directed**.
8. Hall Annunciator: With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.
   a. At manufacturer's option, audible signals may be placed on car **OR** each car, **as directed**.
9. Hall Position Indicators: Provide illuminated, **as directed**, digital-display-type position indicators, located above each, **as directed**, hoistway entrance at ground floor. Provide units with flat faceplate for mounting with body of unit recessed in wall.
   a. Integrate ground-floor hall lanterns with hall position indicators.
10. Standby Power Elevator Selector Switches: Provide switches, as required by ASME A17.1, where indicated. Adjacent to switches, provide illuminated signal that indicates when normal power supply has failed. For each elevator, provide illuminated signals that indicate when they are operational and when they are at the designated emergency return level with doors open.
    OR
    Fire Command Center Annunciator Panel: Provide panel containing illuminated position indicators for each elevator, clearly labeled with elevator designation; include illuminated signal that indicates when elevator is operational and when it is at the designated emergency return level with doors open. Provide standby power elevator selector switch(es), as required by ASME A17.1, adjacent to position indicators. Provide illuminated signal that indicates when normal power supply has failed.
11. Corridor Call Station Pictograph Signs: Provide signs matching hall push-button stations, with text and graphics as required by authorities having jurisdiction, indicating that in case of fire elevators are out of service and exits should be used instead. Provide one sign at each hall push-button station, unless otherwise indicated.

H. Elevators
   1. Elevator Description:

a. Group Number: <**Insert a different number for each group of elevators that share a group operation system.**>
b. Elevator Number(s): <**Insert elevator number(s) as shown on Drawings.**>
c. Service Elevator Number(s): <**Insert elevator number(s) as shown on Drawings.**>
d. Type: Geared **OR** Gearless, **as directed**, traction.
e. Machine Location: Machine room above hoistway **OR** Hoistway; no machine room is provided, **as directed**.
f. Rated Load: 2000 lb (908 kg) **OR** 2100 lb (953 kg) **OR** 2500 lb (1135 kg) **OR** 3000 lb (1362 kg) **OR** 3500 lb (1589 kg) **OR** 4000 lb (1816 kg) **OR** 4500 lb (2043 kg) **OR** 5000 lb (2270 kg), **as directed**.
g. Freight Loading Class for Service Elevator(s): Class A.
h. Rated Speed: 200 fpm (1.0 m/s) **OR** 350 fpm (1.8 m/s) **OR** 400 fpm (2.0 m/s) **OR** 450 fpm (2.3 m/s) **OR** 500 fpm (2.5 m/s) **OR** 700 fpm (3.6 m/s) **OR** 800 fpm (4.1 m/s) **OR** 1000 fpm (5.1 m/s) **OR** 1200 fpm (6.1 m/s) **OR** 1400 fpm (7.1 m/s), **as directed**.
i. Operation System: Selective collective automatic operation **OR** Group automatic operation **OR** Group automatic operation with demand-based dispatching **OR** Destination-based group automatic operation, **as directed**.
j. Auxiliary Operations:
    1) Standby power operation.
    2) Standby powered lowering.
    3) Battery-powered lowering.
    4) Earthquake Emergency Operation: Comply with requirements in ASME A17.1.
    5) Automatic dispatching of loaded car.
    6) Nuisance call cancel.
    7) Emergency hospital **OR** Priority, **as directed**, service at designated floors **OR** all floors, **as directed**.
    8) Independent service for service elevator **OR** all cars in group, **as directed**.
    9) Loaded-car bypass.
    10) Distributed parking.
k. Security Features: Card-reader operation **OR** Keyswitch operation **OR** Keypad operation **OR** Car-to-lobby feature, **as directed**.
l. Dual Car Control Stations: Provide two car control stations in each elevator, **aas directed**; equip only one with required keyswitches if any.
m. Car Enclosures:
    1) Inside Width: 64 inches (1626 mm) **OR** 68 inches (1727 mm) **OR** 80 inches (2032 mm) **OR** 92 inches (2337 mm), **as directed**, from side wall to side wall.
    2) Inside Depth: 51 inches (1295 mm) **OR** 53 inches (1346 mm) **OR** 57 inches (1448 mm) **OR** 65 inches (1651 mm) **OR** 87-1/2 inches (2222 mm) **OR** 90 inches (2286 mm) **OR** 93 inches (2362 mm) **OR** 93-1/2 inches (2375 mm) **OR** 96 inches (2438 mm) **OR** 101 inches (2565 mm) **OR** 102 inches (2591 mm), **as directed**, from back wall to front wall (return panels).
    3) Inside Height: 88 inches (2235 mm) **OR** 92 inches (2337 mm) **OR** 94 inches (2388 mm) **OR** 100 inches (2540 mm) **OR** 104 inches (2642 mm) **OR** 108 inches (2743 mm) **OR** 112 inches (2845 mm), **as directed**, to underside of ceiling.
    4) Front Walls (Return Panels): Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered, **as directed**.
    5) Car Fixtures: Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered, **as directed**.
    6) Side and Rear Wall Panels: Enameled steel **OR** Plastic laminate **OR** Satin stainless steel, No. 4 finish **OR** Textured stainless steel, **as directed**.
    7) Reveals: Enameled steel **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered, **as directed**.

8) Door Faces (Interior): Enameled steel **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Textured stainless steel **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered **OR** Plastic laminate, **as directed**.
9) Door Sills: Aluminum, mill finish **OR** Bronze, polished **OR** Nickel silver, polished, **as directed**.
10) Ceiling: Luminous ceiling **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Reflective metallic-finish, plastic-laminate, stainless steel **OR** Reflective metallic-finish, plastic-laminate, bronze, **as directed**.
11) Handrails: 1-1/2 inches (38 mm) round **OR** 1/2 by 2 inches (13 by 50 mm) rectangular, **as directed**, mirror-polished stainless steel, No. 8 finish **OR** satin stainless steel, No. 4 finish **OR** mirror-polished bronze, lacquered **OR** satin bronze, lacquered, **as directed**, at sides **OR** rear **OR** sides and rear, **as directed**, of car.
12) Floor: Manufacturer's standard carpet.
    OR
    Floor prepared to receive carpet (specified in Division 09 Section "Sheet Carpeting").
    OR
    Floor prepared to receive resilient tile (specified in Division 09 Section "Resilient Tile Flooring").
    OR
    Floor prepared to receive sheet vinyl (specified in Division 09 Section "Resilient Sheet Flooring").
    OR
    Floor recessed and prepared to receive dimension stone tile (specified in Division 09 Section "Stone Tiling") **OR** ceramic tile (specified in Division 09 Section "Tiling"), **as directed**.
13) Floor Thickness, Including Setting Materials: <**Insert thickness**> above plywood subfloor.

n. Hoistway Entrances: As follows:
1) Width: 36 inches (914 mm) **OR** 42 inches (1067 mm) **OR** 48 inches (1219 mm) **OR** 54 inches (1372 mm), **as directed**.
2) Height: 84 inches (2134 mm) **OR** 96 inches (2438 mm), **as directed**.
3) Type: Single-speed side sliding **OR** Two-speed side sliding **OR** Single-speed center opening **OR** Two-speed center opening, **as directed**.
4) Fire-Protection Rating: 1 hour **OR** 1-1/2 hours, **as directed**, with 30-minute temperature rise of 450 deg F (250 deg C), **as directed**.
5) Frames at First Floor **OR** at Basement Floors, **as directed**: Enameled steel **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered, **as directed**.
6) Frames at Other Floors: Enameled steel **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered, **as directed**.
7) Doors and Transoms at First Floor **OR** at Basement Floors, **as directed**: Enameled steel **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Textured stainless steel **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered **OR** Plastic laminate, **as directed**.
8) Doors and Transoms at Other Floors: Enameled steel **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Textured stainless steel **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered **OR** Plastic laminate, **as directed**.
9) Sills at First Floor **OR** at Basement Floors, **as directed**: Aluminum, mill finish **OR** Bronze, polished **OR** Nickel silver, polished, **as directed**.
10) Sills at Other Floors: Aluminum, mill finish **OR** Bronze, polished **OR** Nickel silver, polished, **as directed**.

o. Hall Fixtures at First Floor **OR** at Basement Floors, **as directed**: Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered **OR** Recessed type with no exposed-metal surfaces, **as directed**.

p. Hall Fixtures at Other Floors: Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered **OR** Recessed type with no exposed-metal surfaces, **as directed**.

q. Additional Requirements:

1) Provide inspection certificate in each car, mounted under acrylic cover with frame made from polished stainless steel, No. 8 finish **OR** satin stainless steel, No. 4 finish **OR** polished bronze, lacquered **OR** satin bronze, lacquered, **as directed**.

2) Provide blanket hooks in all cars, **as directed**, and one **OR** two, **as directed**, complete set(s) of full-height protective blankets.

1.3 EXECUTION

A. Examination

1. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Examine hoistways, hoistway openings, pits, and machine rooms as constructed; verify critical dimensions; and examine supporting structure and other conditions under which elevator work is to be installed.

a. For the record, prepare a written report, endorsed by Installer, listing dimensional discrepancies and conditions detrimental to performance or indicating that dimensions and conditions were found to be satisfactory.

b. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation

1. Comply with manufacturer's written instructions.

2. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS standards for workmanship and for qualifications of welding operators.

3. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts designed to minimize transmission of vibrations to structure and thereby minimize structure-borne noise from elevator system.

4. Lubricate operating parts of systems, including ropes, as recommended by manufacturers.

5. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay final adjustment of sills and doors until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.

6. Leveling Tolerance: 1/8 inch (3 mm), up or down, regardless of load and direction of travel.

7. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.

8. Locate hall signal equipment for elevators as follows, unless otherwise indicated:

a. For groups of elevators, locate hall push-button stations between two elevators at center of group or at location most convenient for approaching passengers.

b. Place hall lanterns either above or beside each hoistway entrance.

c. Mount hall lanterns at a minimum of 72 inches (1829 mm) above finished floor.

C. Field Quality Control

1. Acceptance Testing: On completion of elevator installation and before permitting use (either temporary or permanent) of elevators, perform acceptance tests as required and recommended by ASME A17.1 and by governing regulations and agencies.

2. Operating Test: Load elevator **OR** each elevator **OR** one elevator of each type, capacity, speed, and travel distance, **as directed**, to rated capacity and operate continuously for 30 minutes over full travel distance, stopping at each level and proceeding immediately to the next. Record

temperature rise of elevator machine during 30-minute test period. Record failure to perform as required.
3. Advise Owner and authorities having jurisdiction in advance of dates and times tests are to be performed on elevators.

D. Protection
1. Temporary Use: Limit temporary use for construction purposes to one elevator **as directed**. Comply with the following requirements for each, **as directed**, elevator used for construction purposes:
a. Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.
b. Provide strippable protective film on entrance and car doors and frames.
c. Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
d. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
e. Do not load elevators beyond their rated weight capacity.
f. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
g. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

E. Demonstration
1. Train Owner's maintenance personnel to operate, adjust, and maintain elevator(s).
2. Check operation of each elevator with Owner's personnel present and before date of Final Completion. Determine that operation systems and devices are functioning properly.
3. Check operation of each elevator with Owner's personnel present not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

END OF SECTION 14 01 30 71

SECTION 14 01 30 71a - HYDRAULIC ELEVATORS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for hydraulic elevators. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes hydraulic passenger and service elevators.

C. Definitions

1. Definitions in ASME A17.1 apply to work of this Section.
2. Defective Elevator Work: Operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.
3. Service Elevator: A passenger elevator that is also used to carry freight.

D. Submittals

1. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include product data for the following:
   a. Car enclosures and hoistway entrances.
   b. Operation, control, and signal systems.
2. Shop Drawings: Show plans, elevations, sections, and large-scale details indicating service at each landing, machine room layout, coordination with building structure, relationships with other construction, and locations of equipment and signals. Include large-scale layout of car control station and standby power operation control panel, **as directed**. Indicate variations from specified requirements, maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.
3. Samples: For exposed finishes of cars, hoistway doors and frames, and signal equipment; 3-inch- (75-mm-) square Samples of sheet materials; and 4-inch (100-mm) lengths of running trim members.
4. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway, pit, and machine room layout and dimensions, as shown on Drawings, and electrical service, as shown and specified, are adequate for elevator system being provided.
5. Qualification Data: For Installer.
6. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.
7. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.
8. Warranty: Special warranty specified in this Section.

E. Quality Assurance

1. Installer Qualifications: Elevator manufacturer or manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Source Limitations: Obtain elevators, including electric traction passenger elevators specified in another Division 14 Section, through one source from a single manufacturer.
   a. Provide major elevator components, including pump-and-tank units, plunger-cylinder assemblies, controllers, signal fixtures, door operators, car frames, cabs, and entrances, manufactured by a single manufacturer.

3. Legal Requirements: Comply with ASME A17.1 and elevator design requirements for earthquake loads in ASCE 7.
   a. Effective peak velocity acceleration (Av) for Project's location is less than 0.10 (seismic risk zones 0 and 1) **OR** greater than or equal to 0.10, but less than 0.20 (seismic risk zone 2) **OR** greater than or equal to 0.20 (seismic risk zones 3 and 4), **as directed**.
   b. Design earthquake spectral response acceleration, short period (Sds) for Project is determined by Project's location and site classification.
   c. Project's seismic design category is A **OR** B **OR** C **OR** D, **as directed**.
   d. Elevator importance factor is 1.5 **OR** 1.0, **as directed**.
   e. Accessibility Requirements: Comply with to U.S. Department of Justice ADA, U.S Department of Transportation ADA, U.S. Access Board's Guides ADA Standards Chapter 4.
4. Fire-Rated Hoistway Entrance Assemblies: Door and frame assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to NFPA 252 **OR** IBC Standard 3002 **OR** UL 10B, **as directed**.

F. Delivery, Storage, And Handling
1. Deliver, store, and handle materials, components and equipment in manufacturer's protective packaging.
2. Store materials, components, and equipment off of ground, under cover, and in a dry location. Handle according to manufacturer's written recommendations to prevent damage, deterioration, or soiling.

G. Coordination
1. Coordinate installation of sleeves, block outs, and items that are embedded in concrete or masonry for elevator equipment. Furnish templates and installation instructions and deliver to Project site in time for installation.
2. Furnish well casing and coordinate delivery with related excavation work.
3. Coordinate sequence of elevator installation with other work to avoid delaying the Work.
4. Coordinate locations and dimensions of other work relating to hydraulic elevators including pit ladders, sumps, and floor drains in pits; entrance subsills; and electrical service, electrical outlets, lights, and switches in pits and machine rooms.

H. Warranty
1. Special Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to repair, restore, or replace defective elevator work within specified warranty period.
   a. Warranty Period: One year from date of Final Completion.

1.2 PRODUCTS

A. Systems And Components
1. General: Provide manufacturer's standard elevator systems. Where components are not otherwise indicated, provide standard components published by manufacturer as included in standard preengineered elevator systems and as required for complete system.
2. Pump Units: Positive-displacement type with a maximum of 10 percent variation between no load and full load and with minimum pulsations. Provide the following, **as directed**:
   a. Pump, with fan-cooled squirrel-cage induction motor, mounted on oil tank with vibration isolation mounts. Enclose pump in prime-painted steel enclosure lined with 1-inch- (25-mm-) thick, glass-fiber insulation board.
   b. Submersible pump, with submersible squirrel-cage induction motor, suspended inside oil tank from vibration isolation mounts.
   c. Provide motor with wye-delta **OR** solid-state, **as directed**, starting.
   d. Provide variable-voltage variable-frequency motor control.

3. Hydraulic Silencers: Provide hydraulic silencer containing pulsation-absorbing material in a blowout-proof housing at pump unit.
4. Piping: Provide size, type, and weight piping recommended by manufacturer, and provide flexible connectors to minimize sound and vibration transmissions from power unit.
    a. Provide dielectric couplings at cylinder units.
    b. Casing for Underground Piping: PVC pipe complying with ASTM D 1785, joined with PVC fittings complying with ASTM D 2466 and solvent cement complying with ASTM D 2564.
5. Hydraulic Fluid: Elevator manufacturer's standard fire-resistant, **as directed**, fluid with additives as needed to prevent oxidation of fluid, corrosion of cylinder and other components, and other adverse effects.
   OR
   Hydraulic Fluid: Nontoxic, readily biodegradable, fire-resistant, **as directed**, fluid made from vegetable oil with antioxidant, anticorrosive, antifoaming, and metal-passivating additives. Hydraulic fluid is approved by elevator manufacturer for use with elevator equipment.
6. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work where installation of devices is specified in another Section.
7. Protective Cylinder Casing: PVC or HDPE pipe casing complying with ASME A17.1, of sufficient size to provide not less than 1-inch (25-mm) clearance from cylinder and extending above pit floor. Provide means to monitor casing effectiveness to comply with ASME A17.1.
8. Corrosion Protective Filler: A nontoxic, petroleum-based gel formulated for filling the space between hydraulic cylinder and protective casing. Filler is electrically nonconductive, displaces or absorbs water, and gels or solidifies at temperatures below 60 deg F (16 deg C).
9. Car Frame and Platform: Welded steel units.
10. Guides: Provide either roller guides or sliding guides at top and bottom of car and counterweight frames. If sliding guides are used, provide guide-rail lubricators or polymer-coated, nonlubricated guides.

B. Operation Systems
1. General: Provide manufacturer's standard microprocessor operation system for each elevator **OR** for each group of elevators, **as directed**, as required to provide type of operation system indicated.
2. Auxiliary **OR** Single-Car Auxiliary, **as directed**, Operations: In addition to primary operation system features, provide the following operational features for elevators where indicated:
    a. Standby Power Operation: On activation of standby power, car is returned to a designated floor and parked with doors open. Car can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel located at main lobby **OR** fire command station, **as directed**. Manual operation causes automatic operation to cease.
       OR
       Standby-Powered Lowering: On activation of standby power, if car is at a floor it remains at that floor, opens its doors, and shuts down. If car is between floors, it is lowered to a preselected floor, opens its doors, and shuts down. If car is below the preselected floor, it is lowered to the next lower floor, opens its doors, and shuts down.
       OR
       Standby-Powered Lowering: On activation of standby power, car is lowered to the lowest floor, opens its doors, and shuts down.
       OR
       Battery-Powered Lowering: If power fails and car is at a floor, it remains at that floor, opens its doors, and shuts down. If car is between floors, it is lowered to a preselected floor, opens its doors, and shuts down. If car is below the preselected floor, it is lowered to the next lower floor, opens its doors, and shuts down. System includes rechargeable battery and automatic recharging system.
       OR

Battery-Powered Lowering: When power fails, car is lowered to the lowest floor, opens its doors, and shuts down. System includes rechargeable battery and automatic recharging system.

b. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors will begin closing.

c. Nuisance Call Cancel: When car calls exceed a preset number while car load is less than a predetermined weight, all car calls are canceled. Preset number of calls and predetermined weight, **as directed**, can be adjusted.

3. Group Auxiliary Operations: In addition to primary operation system features, provide the following operational features for elevators and elevator groups where indicated:

a. Standby Power Operation: On activation of standby power, cars are returned to a designated floor and parked with doors open. Only one car is moved upward at a time, with priority given to loaded cars. If a car cannot be returned after two attempts, it is removed from the system. When all cars have been returned or removed from the system, one car is automatically placed in service. If car selected for service cannot operate within 60 seconds, the system removes car from service and places another car in service. Cars can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel located at main lobby **OR** fire command station, **as directed**. Manual operation causes automatic operation to cease.

OR

Standby Power Operation: On activation of standby power, cars are returned to lowest floor and parked with doors open. If a car cannot be returned, it is removed from the system. One car is selected for service on standby power by a switch located at main lobby **OR** fire command station, **as directed**.

OR

Standby-Powered Lowering: On activation of standby power, cars that are at a floor remain at that floor, open their doors, and shut down. Cars that are between floors are lowered to a preselected floor, open their doors, and shut down. Cars that are below the preselected floor are lowered to the next lower floor, open their doors, and shut down.

OR

Standby-Powered Lowering: On activation of standby power, cars are lowered to the lowest floor, open their doors, and shut down.

OR

Battery-Powered Lowering: If power fails, cars that are at a floor remain at that floor, open their doors, and shut down. Cars that are between floors are lowered to a preselected floor, open their doors, and shut down. Cars that are below the preselected floor are lowered to the next lower floor, open their doors, and shut down. System includes rechargeable battery and automatic recharging system.

OR

Battery-Powered Lowering: When power fails, cars are lowered to the lowest floor, open their doors, and shut down. System includes rechargeable battery and automatic recharging system.

b. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors will begin closing.

c. Nuisance Call Cancel: When car calls exceed a preset number while car load is less than a predetermined weight, all car calls are canceled. Preset number of calls and predetermined weight, **as directed**, can be adjusted.

d. Emergency Hospital **OR** Priority, **as directed**, Service: Service is initiated by a keyswitch **OR** card reader **OR** remote switch, **as directed**, at designated floors. One elevator is removed from group operation and directed to the floor where service was initiated. On arriving at the floor, elevator opens its doors and parks and a lighted sign directs passengers to exit elevator, **as directed**. Car is placed in operation by selecting a floor and pressing door close button or by operating keyswitch to put car in independent service. After responding to floor selected or being removed from independent service, car is returned to group operation. If car is not placed in operation within a preset time after being called, it is returned to group operation.

e. Independent Service: Keyswitch in car control station removes car from group operation and allows it to respond only to car calls. Key cannot be removed from keyswitch when car is in independent service. When in independent service, doors close only in response to door close button.

f. Loaded-Car Bypass: When car load exceeds 80 percent of rated capacity, car will respond only to car calls, not to hall calls.

4. Security Features: Provide the following security features, where indicated. Security features shall not affect emergency firefighters' service.

a. Card-Reader Operation: System uses card readers at car control stations **OR** hall push-button stations, **as directed**, to authorize calls. Security system determines which landings and at what times calls require authorization by card reader. Provide required conductors in traveling cable and panel in machine room for interconnecting card readers, other security access system equipment, and elevator controllers. Allow space as indicated for card reader in car **OR** Provide stripe-swipe card reader integral with each car control station, **as directed**.

1) Security access system equipment is specified in Division 28 Section "Access Control".
OR
Security access system equipment is not in the Contract.

b. Keyswitch Operation: Push buttons are activated and deactivated by security keyswitches at car control stations **OR** hall push-button stations, **as directed**. Key is removable only in deactivated position **OR** in either position, **as directed**.

c. Keypad Operation: Allows each landing to be restricted or unrestricted. When a restricted landing button is pressed, a "Restricted Floor" lamp lights and remains lit until landing access code has been entered into a keypad or predetermined time period has elapsed. Car calls for restricted landings do not register until landing access code is entered into keypad within predetermined time period after landing button is pressed.

1) Access codes are programmed at each car operating panel using a security keyswitch. Keypad operation can be activated and deactivated by security keyswitch at main landing.

d. Car-to-Lobby Feature: Feature, activated by keyswitch at main lobby, that causes car **OR** all cars in a group, **as directed**, to return immediately to lobby and open doors for inspection. On deactivation by keyswitch, calls registered before keyswitch activation are completed and normal operation is resumed.

C. Door Reopening Devices

1. Infrared Array: Provide door reopening devices with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more of the light beams shall cause doors to stop and reopen.

2. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, through activating door reopening device, a loud buzzer shall sound and doors shall begin to close at reduced kinetic energy.

D. Finish Materials

1. General: Provide the following materials for exposed parts of elevator car enclosures, car doors, hoistway entrance doors and frames, and signal equipment as indicated.

2. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, commercial steel, Type B, exposed, matte finish.

3. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, commercial steel, Type B, pickled.

4. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.

a. Textured Stainless-Steel Sheet: Product with coined **OR** embossed, **as directed**, texture rolled into exposed surface.

1) Metal surface is satin polished **OR** satin relieved **OR** titanium nitride colored **OR** oxide colored **OR** satin polished and titanium nitride colored **OR** satin relieved and

titanium nitride colored **OR** satin polished and oxide colored **OR** satin relieved and oxide colored **OR** color coated and satin relieved **OR** color coated and bright relieved, **as directed**, after rolling.

5. Stainless-Steel Bars: ASTM A 276, Type 304.
6. Stainless-Steel Tubing: ASTM A 554, Grade MT 304.
7. Bronze Plate and Sheet: ASTM B 36/B 36M, Alloy UNS No. C28000 (muntz metal).
8. Bronze Extrusions: ASTM B 455, Alloy UNS No. C38500 (architectural bronze).
9. Bronze Tubing: ASTM B 135 (ASTM B 135M), Alloy UNS No. C23000 (red brass, 85 percent copper).
10. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063.
11. Nickel Silver Extrusions: ASTM B 151/B 151M, Alloy UNS No. C74500 or No. C77600.
12. Plastic Laminate: High-pressure type complying with NEMA LD 3, Type HGS for flat applications **OR** Type HGL for flat applications, **as directed**, Type HGP for postformed applications and Type BKV for panel backing.

E. Car Enclosures

1. General: Provide enameled-steel car enclosures to receive removable **OR** steel-framed car enclosures with nonremovable, **as directed**, wall panels, with car **OR** removable car, **as directed**, roof, access doors, power door operators, and ventilation.
   a. Provide standard railings complying with ASME A17.1 on car tops where required by ASME A17.1.
   b. Provide finished car including materials and finishes specified below.
2. Materials and Finishes: Provide manufacturer's standards, but not less than the following:
   a. Subfloor: Underlayment grade, exterior plywood, 5/8-inch (16-mm) nominal thickness.
   b. Floor Finish: Specified in a Division 07 **OR** Elevator manufacturer's standard level-loop nylon carpet; color as selected from manufacturer's full range, **as directed**.
   c. Enameled-Steel Wall Panels: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel finish; colors as selected from manufacturer's full range.
   d. Stainless-Steel Wall Panels: Flush, hollow-metal construction; fabricated from stainless-steel sheet.
   e. Bronze Wall Panels: Flush, hollow-metal construction; fabricated from bronze sheet.
   f. Plastic-Laminate Wall Panels: Plastic laminate adhesively applied to 1/2-inch (13-mm) fire-retardant-treated particleboard **OR** manufacturer's standard honeycomb core, **as directed**, with plastic-laminate panel backing and, **as directed**, manufacturer's standard protective edge trim. Panels have a flame-spread index of 25 **OR** 75, **as directed**, or less, when tested according to ASTM E 84. Plastic-laminate color, texture, and pattern as selected from plastic-laminate **OR** elevator, **as directed**, manufacturer's full range.
   g. Fabricate car with recesses and cutouts for signal equipment.
   h. Fabricate car door frame integrally with front wall of car.
   i. Enameled-Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel finish; colors as selected from manufacturer's full range.
   j. Stainless-Steel Doors: Flush, hollow-metal construction; fabricated from stainless-steel sheet **OR** by laminating stainless-steel sheet to exposed faces and edges of enameled cold-rolled steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning, **as directed**.
   k. Bronze Doors: Flush, hollow-metal construction; fabricated by laminating bronze sheet to exposed faces and edges of enameled cold-rolled steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
   l. Plastic-Laminate Doors: Flush, hollow-metal construction; fabricated by laminating plastic laminate to exposed faces of enameled cold-rolled steel doors and covering edges with protective edge trim matching return panels, **as directed**. Plastic-laminate color, texture, and pattern as selected from plastic-laminate **OR** elevator, **as directed**, manufacturer's full range.

m. Sight Guards: Provide sight guards on car doors.
n. Sills: Extruded metal, with grooved surface, 1/4 inch (6.4 mm) thick.
o. Luminous Ceiling: Fluorescent light fixtures and ceiling panels of translucent acrylic or other permanent rigid plastic.
p. Metal **OR** Metallic-Finish, Plastic-Laminate, **as directed**, Ceiling: Flush panels, with incandescent downlights in the center of **OR** four low-voltage downlights in, **as directed**, each panel. Align ceiling panel joints with joints between wall panels, **as directed**.
q. Handrails: Manufacturer's standard handrails, of shape, metal, and finish indicated.

F. Hoistway Entrances
1. General: Provide manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Provide frame size and profile to coordinate with hoistway wall construction.
   a. Where gypsum board wall construction is indicated, provide self-supporting frames with reinforced head sections.
2. Materials and Fabrication: Provide manufacturer's standards, but not less than the following:
   a. Enameled-Steel Frames: Formed from cold-rolled or hot-rolled steel sheet. Provide with factory-applied enamel finish; colors as selected from manufacturer's full range.
   b. Steel Subframes: Formed from cold-rolled or hot-rolled steel sheet with factory-applied enamel finish or corrosion-inhibiting primer. Fabricate to receive applied finish as indicated.
   c. Stainless-Steel Frames: Formed from stainless-steel sheet.
   d. Bronze Frames: Formed from cold-rolled or hot-rolled steel sheet, with enamel finish, and with formed-bronze sheet laminated to steel frames using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
   e. Enameled-Steel Doors and Transoms: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel finish; colors as selected from manufacturer's full range.
   f. Stainless-Steel Doors and Transoms: Flush, hollow-metal construction; fabricated from stainless-steel sheet **OR** by laminating stainless-steel sheet to exposed faces and edges of enameled cold-rolled steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning, **as directed**.
   g. Bronze Doors and Transoms: Flush, hollow-metal construction; fabricated by laminating bronze sheet to exposed faces and edges of enameled cold-rolled steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
   h. Plastic-Laminate Doors and Transoms: Flush, hollow-metal construction; fabricated by laminating plastic laminate to exposed faces of enameled cold-rolled steel doors and covering edges with protective edge trim matching door frames, **as directed**. Plastic-laminate color, texture, and pattern as selected from plastic-laminate **OR** elevator, **as directed**, manufacturer's full range.
   i. Sight Guards: Provide sight guards on doors matching door edges.
   j. Sills: Extruded metal, with grooved surface, 1/4 inch (6.4 mm) thick.
   k. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107.

G. Signal Equipment
1. General: Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Fabricate lighted elements with long-life incandescent lamps and acrylic or other permanent, nonyellowing translucent plastic diffusers **OR** LEDs, **as directed**.
2. Car Control Stations: Provide manufacturer's standard recessed **OR** semirecessed, **as directed**, car control stations. Mount in return panel adjacent to car door, unless otherwise indicated.
   OR
   Swing-Return Car Control Stations: Provide car control stations mounted on rear of hinged return panel adjacent to car door and with buttons, switches, controls, and indicator lights projecting through return panel but substantially flush with face of return panel.

a. Mark buttons and switches with standard identification for required use or function that complies with ASME A17.1. Use both tactile symbols and Braille.
b. Provide "No Smoking" sign matching car control station, either integral with car control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.

3. Emergency Communication System: Provide system that complies with ASME A17.1 and the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)." On activation, system dials preprogrammed number of monitoring station and identifies elevator location to monitoring station. System provides two-way voice communication without using a handset and provides visible signals that indicate when system has been activated and when monitoring station has responded. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.
4. Firefighters' Two-Way Telephone Communication Service: Provide flush-mounted cabinet **OR** telephone jack, **as directed**, in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified in Division 28 Section(s) "Digital, Addressable Fire-alarm System" OR "Zoned (dc Loop) Fire-alarm System"
5. Car Position Indicator: Provide illuminated, **as directed**, digital-type car position indicator, located above car door or above car control station. Also provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served.
   a. Include travel direction arrows if not provided in car control station.
6. Hall Push-Button Stations: Provide one hall push-button station at each landing for each single elevator or group of elevators, but not less than one station for each four elevators in a group, **as directed**.
   OR
   Hall Push-Button Stations: Provide hall push-button stations at each landing as indicated.
   a. Provide manufacturer's standard wall-mounted units.
   b. Provide units with flat faceplate for mounting with body of unit recessed in wall.
   c. Equip units with buttons for calling elevator and for indicating desired direction of travel.
   d. Provide telephone jack in each unit for firefighters' two-way telephone communication service specified in Division 28 Section(s) "Digital, Addressable Fire-alarm System" OR "Zoned (dc Loop) Fire-alarm System".
7. Hall Lanterns: Units with illuminated arrows; but provide single arrow at terminal landings. Provide one of the following, **as directed**:
   a. Manufacturer's standard wall-mounted units, for mounting above entrance frames.
   b. Units with flat faceplate for mounting with body of unit recessed in wall and with illuminated elements projecting from faceplate for ease of angular viewing.
   c. Units mounted in both jambs of entrance frame for each elevator, **as directed**.
   d. Units mounted in both car door jambs; may be used only for single elevators or for two-car groups, **as directed**.
8. Hall Annunciator: With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.
   a. At manufacturer's option, audible signals may be placed on car **OR** each car, **as directed**.
9. Hall Position Indicators: Provide illuminated, **as directed**, digital-display-type position indicators, located above each, **as directed**, hoistway entrance at ground floor. Provide units with flat faceplate for mounting and with body of unit recessed in wall.
   a. Integrate ground-floor hall lanterns with hall position indicators.
10. Standby Power Elevator Selector Switches: Provide switches, as required by ASME A17.1, where indicated. Adjacent to switches, provide illuminated signal that indicates when normal power supply has failed. For each elevator, provide illuminated signals that indicate when they are operational and when they are at the designated emergency return level with doors open, **as directed**.
    OR
    Fire Command Center Annunciator Panel: Provide panel containing illuminated position indicators for each elevator, clearly labeled with elevator designation; include illuminated signal

that indicates when elevator is operational and when it is at the designated emergency return level with doors open. Provide standby power elevator selector switch(es), as required by ASME A17.1, adjacent to position indicators. Provide illuminated signal that indicates when normal power supply has failed.

11. Corridor Call Station Pictograph Signs: Provide signs matching hall push-button stations, with text and graphics as required by authorities having jurisdiction, indicating that in case of fire elevators are out of service and exits should be used instead. Provide one sign at each hall push-button station, unless otherwise indicated.

H. Elevators

1. Elevator Description:
   a. Group Number: Insert a different number for each group of elevators that share a group operation system, as directed by the Owner.
   b. Elevator Number(s): Insert elevator number(s) as shown on Drawings, as directed by the Owner.
   c. Service Elevator Number(s): Insert elevator number(s) as shown on Drawings, as directed by the Owner.
   d. Type: Under-the-car single cylinder.
      OR
      Type: Holeless, beside-the-car, single-acting, single **OR** dual, **as directed**, cylinder.
      OR
      Type: Holeless, beside-the-car, telescoping, single **OR** dual, **as directed**, cylinder.
      OR
      Type: Holeless, beside-the-car, roped hydraulic, single **OR** dual, **as directed**, cylinder.
   e. Rated Load: 2000 lb (908 kg) **OR** 2100 lb (953 kg) **OR** 2500 lb (1135 kg) **OR** 3000 lb (1362 kg) **OR** 3500 lb (1589 kg) **OR** 4000 lb (1816 kg) **OR** 4500 lb (2043 kg) **OR** 5000 lb (2270 kg), **as directed**.
   f. Freight Loading Class for Service Elevators: Class A.
   g. Rated Speed: 75 or 80 fpm (0.38 or 0.41 m/s) **OR** 100 fpm (0.51 m/s) **OR** 125 fpm (0.64 m/s) **OR** 150 fpm (0.76 m/s) **OR** 175 fpm (0.89 m/s) **OR** 200 fpm (1.0 m/s), **as directed**.
   h. Operation System: Single automatic **OR** Selective collective automatic **OR** Group automatic, **as directed**, operation.
   i. Auxiliary Operations:
      1) Standby power operation.
      2) Standby-powered lowering.
      3) Battery-powered lowering.
      4) Automatic dispatching of loaded car.
      5) Nuisance call cancel.
      6) Emergency hospital **OR** Priority, **as directed**, service at designated floors **OR** all floors, **as directed**.
      7) Independent service for service elevator **OR** all cars in group, **as directed**.
      8) Loaded-car bypass.
   j. Security Features: Card-reader operation **OR** Keyswitch operation **OR** Keypad operation **OR** Car-to-lobby feature, **as directed**.
   k. Dual Car Control Stations: Provide two car control stations in each elevator, **as directed**; equip only one with required keyswitches, if any.
   l. Car Enclosures:
      1) Inside Width: 64 inches (1626 mm) **OR** 68 inches (1727 mm) **OR** 80 inches (2032 mm) **OR** 92 inches (2337 mm), **as directed**, from side wall to side wall.
      2) Inside Depth: 51 inches (1295 mm) **OR** 53 inches (1346 mm) **OR** 57 inches (1448 mm) **OR** 65 inches (1651 mm) **OR** 87-1/2 inches (2222 mm) **OR** 90 inches (2286 mm) **OR** 93 inches (2362 mm) **OR** 93-1/2 inches (2375 mm) **OR** 96 inches (2438 mm) **OR** 101 inches (2565 mm) **OR** 102 inches (2591 mm), **as directed**, from back wall to front wall (return panels).

3) Inside Height: 88 inches (2235 mm) **OR** 92 inches (2337 mm) **OR** 94 inches (2388 mm) **OR** 100 inches (2540 mm) **OR** 104 inches (2642 mm) **OR** 108 inches (2743 mm) **OR** 112 inches (2845 mm), **as directed**, to underside of ceiling.
4) Front Walls (Return Panels): Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered, **as directed**, with integral car door frames.
5) Car Fixtures: Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered, **as directed**.
6) Side and Rear Wall Panels: Enameled steel **OR** Plastic laminate **OR** Satin stainless steel, No. 4 finish **OR** Textured stainless steel, **as directed**.
7) Reveals: Enameled steel **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered, **as directed**.
8) Door Faces (Interior): Enameled steel **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Textured stainless steel **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered **OR** Plastic laminate, **as directed**.
9) Door Sills: Aluminum, mill finish **OR** Bronze, polished **OR** Nickel silver, polished, **as directed**.
10) Ceiling: Luminous ceiling **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Reflective metallic-finish, plastic-laminate, stainless steel **OR** Reflective metallic-finish, plastic-laminate, bronze, **as directed**.
11) Handrails: 1-1/2 inches (38 mm) round **OR** 1/2 by 2 inches (13 by 50 mm) rectangular, **as directed**, mirror-polished stainless steel, No. 8 finish **OR** satin stainless steel, No. 4 finish **OR** mirror-polished bronze, lacquered **OR** satin bronze, lacquered, **as directed**, at sides **OR** sides and rear, **as directed**, of car.
12) Floor: Manufacturer's standard carpet.

OR

Floor prepared to receive carpet (specified in Division 09 Section "Sheet Carpeting").

OR

Floor prepared to receive resilient tile (specified in Division 09 Section "Resilient Tile Flooring").

OR

Floor prepared to receive sheet vinyl (specified in Division 09 Section "Resilient Sheet Flooring").

OR

Floor recessed and prepared to receive dimension stone tile (specified in Division 09 Section "Stone Tiling") **OR** ceramic tile (specified in Division 09 Section "Tiling"), **as directed**.

OR

Floor Thickness, Including Setting Materials: Thickness above plywood subfloor, shall be as directed by the Owner.

m. Hoistway Entrances:

1) Width: 36 inches (914 mm) **OR** 42 inches (1067 mm) **OR** 48 inches (1219 mm) **OR** 54 inches (1372 mm), **as directed**.
2) Height: 84 inches (2134 mm) **OR** 96 inches (2438 mm), **as directed**.
3) Type: Single-speed side sliding **OR** Two-speed side sliding **OR** Single-speed center opening **OR** Two-speed center opening, **as directed**.
4) Fire-Protection Rating: 1 hour **OR** 1-1/2 hours, **as directed**, with 30-minute temperature rise of 450 deg F (250 deg C), **as directeed**.
5) Frames at First Floor **OR** at Basement Floors, **as directed**: Enameled steel **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered, **as directed**.

6) Frames at Other Floors: Enameled steel **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered, **as directed**.
7) Doors and Transoms at First Floor **OR** at Basement Floors, **as directed**: Enameled steel **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Textured stainless steel **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered **OR** Plastic laminate, **as directed**.
8) Doors and Transoms at Other Floors: Enameled steel **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Textured stainless steel **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered **OR** Plastic laminate, **as directed**.
9) Sills at First Floor **OR** at Basement Floors, **as directed**: Aluminum, mill finish **OR** Bronze, polished **OR** Nickel silver, polished, **as directed**.
10) Sills at Other Floors: Aluminum, mill finish **OR** Bronze, polished **OR** Nickel silver, polished, **as directed**.

n. Hall Fixtures at First Floor **OR** at Basement Floors, **as directed**: Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered **OR** Recessed type with no exposed-metal surfaces, **as directed**.
o. Hall Fixtures at Other Floors: Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered **OR** Recessed type with no exposed-metal surfaces, **as directed**.
p. Additional Requirements:
1) Provide inspection certificate in each car, mounted under acrylic cover with frame made from polished stainless steel, No. 8 finish **OR** satin stainless steel, No. 4 finish **OR** polished bronze, lacquered **OR** satin bronze, lacquered, **as directed**.
2) Provide blanket hooks in all cars, **as directed**, and one **OR** two, **as directed**, complete set(s) of full-height protective blankets.

1.3 EXECUTION

A. Examination
1. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Verify critical dimensions and examine supporting structure and other conditions under which elevator work is to be installed.
a. For the record, prepare a written report, endorsed by Installer, listing dimensional discrepancies and conditions detrimental to performance or indicating that dimensions and conditions were found to be satisfactory.
b. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation
1. Excavation for Cylinder: Drill well hole in each, **as directed**, elevator pit to accommodate installation of cylinder; comply with applicable requirements in Division 31 Section "Earth Moving".
2. Provide waterproof well casing as necessary to retain walls of well hole.
3. Install cylinder in protective casing within well hole. Before installing protective casing, remove water and debris from well hole and provide permanent waterproof seal at bottom of well casing, **as directed**.
a. Fill void space between protective casing and cylinder with corrosion protective filler.
b. Align cylinders and fill space around protective casing with fine sand.
4. Install cylinder plumb and accurately centered for elevator car position and travel. Anchor securely in place, supported at pit floor. Seal between well **OR** protective, **as directed**, casing and pit floor with 4 inches (100 mm) of nonshrink, nonmetallic grout.
5. Install cylinder plumb and accurately centered for elevator car position and travel. Anchor securely in place, supported at pit floor and braced at intervals as needed to maintain alignment. Anchor cylinder guides at spacing needed to maintain alignment and avoid overstressing guides.

6. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS standards for workmanship and for qualifications of welding operators.
7. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts designed to effectively prevent transmission of vibrations to structure and thereby eliminate sources of structure-borne noise from elevator system.
8. Install piping above the floor, where possible. Where not possible, install underground piping in Schedule 40 PVC pipe casing assembled with solvent-cemented fittings.
   OR
   Install piping above the floor, where possible. Where not possible, cover underground piping with permanent protective wrapping before backfilling.
9. Lubricate operating parts of systems as recommended by manufacturers.
10. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay installation of sills and frames until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.
11. Leveling Tolerance: 1/4 inch (6 mm), up or down, regardless of load and direction of travel.
12. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.
13. Locate hall signal equipment for elevators as follows, unless otherwise indicated:
    a. For groups of elevators, locate hall push-button stations between two elevators at center of group or at location most convenient for approaching passengers.
    b. Place hall lanterns either above or beside each hoistway entrance.
    c. Mount hall lanterns at a minimum of 72 inches (1829 mm) above finished floor.

C. Field Quality Control
1. Acceptance Testing: On completion of elevator installation and before permitting use (either temporary or permanent) of elevators, perform acceptance tests as required and recommended by ASME A17.1 and by governing regulations and agencies.
2. Advise Owner and authorities having jurisdiction in advance of dates and times tests are to be performed on elevators.

D. Protection
1. Temporary Use: Limit temporary use for construction purposes to one elevator, **as directed**. Comply with the following requirements for each, **as directed**, elevator used for construction purposes:
   a. Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.
   b. Provide strippable protective film on entrance and car doors and frames.
   c. Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
   d. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
   e. Do not load elevators beyond their rated weight capacity.
   f. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
   g. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

E. Demonstration
1. Train Owner's maintenance personnel to operate, adjust, and maintain elevator(s).

2. Check operation of each, **as directed**, elevator with Owner's personnel present and before date of Final Completion. Determine that operation systems and devices are functioning properly.
3. Check operation of each, **as directed**, elevator with Owner's personnel present not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

END OF SECTION 14 01 30 71a

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Task	Specification	Specification Description
14 01 30 71	14 31 00 00	Escalators
14 24 13 00	14 01 30 71a	Hydraulic Elevators

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SECTION 14 31 00 00 - ESCALATORS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for escalators. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes high-traffic, interior and exterior escalators.

C. Definitions

1. High-Traffic Escalators: Escalators designed specifically for use where high-traffic volumes produce dense occupancy resulting in structural, machinery, and brake loads much higher than normal.
2. Defective Escalator Work: Operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; the need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.

D. Performance Requirements

1. Rated Speed: 90 fpm (0.46 m/s) or 100 fpm (0.5 m/s).
2. Braking Performance: Provide brakes that stop escalator in up-running mode at a rate no greater than 3 ft./s^2 (0.91 m/s^2).
   OR
   Braking Performance: Provide brakes that produce a stopping force on escalator in up-running mode that is one-third that used in down-running mode.
3. Step/Skirt Performance Index: Not more than 0.15.
4. Structural and Mechanical Performance for High-Traffic Escalators: For the purpose of structural design, driving machine and power transmission calculations, and brake calculations, design high-traffic escalators for loads not less than 2 times the design loads required by ASME A17.1.
5. Structural Performance of Balustrades, Deck Barricades, and Handrails: Provide components and assemblies capable of withstanding the effects of loads indicated in ASCE 7 for handrail assemblies and guardrail systems.

E. Submittals

1. Product Data: Include capacities, sizes, performances, safety features, finishes, and similar information.
2. Shop Drawings: Show plans, elevations, sections, and details indicating coordination with building structure and relationships with other construction. Indicate variations from specified requirements, maximum loads imposed on building structure at points of support, and power requirements. Indicate access and ventilation for escalator machine space.
3. Samples: For exposed finishes, 3-inch- (75-mm-) square Samples of sheet materials, and 4-inch (100-mm) lengths of running trim members.
4. Manufacturer Certificates: Signed by manufacturer certifying that escalator layout and dimensions, as shown on Drawings, and electrical service, as shown and specified, are adequate for escalator system being provided.
5. Qualification Data: For Installer.
6. Operation and Maintenance Data: For escalators to include in emergency, operation, and maintenance manuals.
7. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted escalator use.

8. Warranty: Special warranty specified in this Section.

F. Quality Assurance
1. Installer Qualifications: Escalator manufacturer or manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Source Limitations: Obtain escalators and moving walks, specified in another Division 14 Section, through one source from a single manufacturer.
3. Regulatory Requirements: Comply with ASME A17.1.

G. Delivery, Storage, And Handling
1. Deliver, store, and handle materials, components, and equipment in manufacturer's protective packaging.
2. Store materials, components, and equipment off of ground, under cover, and in a dry location. Handle according to manufacturer's recommendations to prevent damage, deterioration, or soiling.

H. Coordination
1. Coordinate installation of sleeves, block outs, escalator equipment with integral anchors, and other items that are embedded in concrete or masonry for escalator equipment. Furnish templates, sleeves, escalator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.
2. Coordinate sequence of escalator installation with other work to avoid delaying the Work.
3. Coordinate locations and dimensions of other work relating to escalators including sumps and floor drains in pits, electrical service, and electrical outlets, lights, and switches in pits.

I. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair, restore, or replace defective escalator work within specified warranty period.
   a. Warranty Period: One year from date of Final Completion.

1.2 PRODUCTS

A. Materials
1. Stainless Steel: ASTM A 240/A 240M, Type 304 **OR** 316 **OR** 304, except use Type 316 for exterior escalators, **as directed**.
   a. Satin Finish: No. 4 directional satin.
   b. Polished Finish: No. 8 mirror polish.
   c. Gold-Colored Satin Finish: No. 4 directional satin with gold-colored oxide or titanium nitride finish.
   d. Gold-Colored Mirror Finish: No. 8 mirror polish with gold-colored oxide or titanium nitride finish.
2. Satin Bronze Sheet: ASTM B 36/B 36M, Alloy UNS No. C28000 (muntz metal), fine satin finish, lacquered.
3. Satin Bronze Extrusions: ASTM B 455, Alloy UNS No. C38500 (architectural bronze), fine satin finish, lacquered.
4. Steel Sheet: Cold-rolled steel sheet, ASTM A 1008/A 1008M, commercial steel, Type B, exposed, matte finish.
5. Clear Tempered Glass: ASTM C 1048, Condition A (uncoated surfaces), Type 1 (transparent glass, flat), Class 1 (clear), Quality q3 (glazing, select), Kind FT (fully tempered), [**10.0**] [**12.0**] mm thick.
6. Tinted Tempered Glass: ASTM C 1048, Condition A (uncoated surfaces), Type 1 (transparent glass, flat), Class 2 (tinted), Quality q3 (glazing, select), Kind FT (fully tempered), [**10.0**] [**12.0**] mm thick.
   a. Color: Bronze **OR** Gray **OR** Green, **as directed**.

B. Components

1. General: Provide preengineered escalators complying with requirements. Unless otherwise indicated, provide standard components as indicated in manufacturers' publications and as required for a complete escalator.
2. General: Provide high-traffic escalators complying with requirements. Unless otherwise indicated, provide heavy-duty components as indicated in manufacturers' publications and as required for a complete escalator.
   a. Provide escalators with two **OR** three **OR** four, **as directed**, flat steps at top and bottom landings.
   b. Fabricate exposed metalwork, including deck covers, balustrade panels, and trim to provide surface flatness equivalent to stretcher-leveled standard of flatness and sufficient strength for indicated use; increase metal thickness or reinforce with concealed stiffeners, backing materials, or both, as necessary. Support joints with concealed stiffeners as needed to hold exposed faces of adjoining sheets in flush alignment.
3. Opaque Balustrades: Manufacturer's standard profile or arrangement of moving handrails on fully paneled guide rail with interior balustrade panels, deck covers, skirts, trim, and accessories. Prepare for exterior finish below the deck covers, specified in another Section.
4. Transparent Balustrades: Manufacturer's standard profile or arrangement of moving handrails on guide rail that is supported by tempered glass panels, with deck covers, skirts, trim, and accessories. Prepare for exterior finish below the deck covers, specified in another Section.
5. Guards at Ceiling Intersection: Clear plastic.
6. Handrails: Smooth, jointless, reinforced neoprene.
   a. Color: Black **OR** As selected from manufacturer's full range, **as directed**.
7. Deck Covers and Trim: Satin stainless steel **OR** Polished stainless steel **OR** Gold-colored satin stainless steel **OR** Gold-colored polished stainless steel **OR** Satin bronze, **as directed**.
8. Antislide Devices: Satin stainless steel **OR** Polished stainless steel **OR** Gold-colored satin stainless steel **OR** Gold-colored polished stainless steel **OR** Satin bronze, **as directed**.
9. Balustrade Interior Panels: Satin stainless steel **OR** Polished stainless steel **OR** Gold-colored satin stainless steel **OR** Gold-colored polished stainless steel **OR** Satin bronze, **as directed**.
10. Balustrade Exterior Panels and Escalator Soffits: Satin stainless steel **OR** Polished stainless steel **OR** Gold-colored satin stainless steel **OR** Gold-colored polished stainless steel **OR** Satin bronze, **as directed**.
11. Skirt Panels, if Applicable: Satin stainless steel **OR** Polished stainless steel **OR** Satin stainless steel with exposed surface coated with clear PTFE **OR** Steel panels with exposed surface coated with PTFE **OR** Manufacturer's standard low-friction material, **as directed**.
12. Steps: One-piece, die-cast aluminum with demarcation grooves at front and rear of tread surface.
   a. Finish: Powder-coated, gray **OR** black, **as directed**.
   b. Step Demarcation: Yellow inserts at sides and back of step treads.
   c. Nosing Demarcation: 2-inch- (50-mm-) wide yellow stripe at nosings of step treads.
13. Combs: Integrally colored structural plastic **OR** Cast aluminum **OR** Cast aluminum with powder-coated finish, **as directed**.
   a. Comb Color: Yellow.
14. Floor Plates: Cast or extruded aluminum with grooved or patterned surface and mill finish.
15. Abrasive-Surface Floor Plates: Cast or extruded aluminum **OR** Stainless steel, **as directed**, with grooved or patterned surface and with abrasive material embedded in or metallically bonded to floor-plate surface and having a coefficient of friction of 0.6 or higher when tested according to ASTM C 1028.
16. Operational Control: Provide escalators designed and equipped to run equally in either direction. Provide key-operated switches for directional control and key-operated starter switches located on exterior deck above newel base at both upper and lower landings of escalators.

C. Features

1. Fault Indicator: Provide escalators with a microprocessor unit that monitors safety devices, motor temperature, and escalator speed and records in nonvolatile memory date, time, and device identification if a safety device is activated or escalator malfunctions.

a. Provide built-in or plug-in unit to display recorded information.
2. Reduced-Current Starting: Provide escalator motors with wye-delta or solid-state starting.
3. Energy-Saving Feature: Provide escalator motors and controls designed for motors to run on partial windings (at reduced power) when not under full load.
4. Provide motors complying with NEMA MG 1, Insulation Class B.
5. Brake-Saving Feature: Provide stopping mechanism that allows escalator to coast to a stop before applying brakes, unless stopping is initiated by a safety device.
6. Equip step drive mechanism with automatic step-chain lubricators.
7. Oil Drip Pan: Provide metal pan under full width and length of escalator to collect and hold oil and grease drippings from lubricated components. Design and fabricate drip pan to sustain a load of 250 lbf (1.1 kN) on a 1.0-sq. ft. (0.9-sq. m) area at any location without permanent deflection.
8. Direction Indicator Lights: Provide red and green indicator lights at least 2 inches (50 mm) in diameter in right-hand **OR** both, **as directed**, balustrade newels at both upper and lower landings. Green light indicates entrance end, and red light indicates exit end. When escalator is stopped, red lights are illuminated at both ends.
9. Combplate Lights: Provide recessed light fixtures with flush lenses mounted in skirt panels at each side of combplates designed to illuminate steps at combplate.
10. Overspeed Governor: Provide units with overspeed governor that is activated if speed of steps exceeds rated speed by more than 20 percent.
11. Upper-Landing, Step Upthrust Device: Activated if a step is displaced against upthrust track at upper curve in passenger-carrying line of track system.
12. Comb-Step Impact Device: Activated if a horizontal force in direction of travel is applied exceeding 112 lbf (500 N) at either side or exceeding 225 lbf (1000 N) at center of front edge of combplate, or a resultant force in upward direction is applied exceeding 150 lbf (688 N) at center of front edge of combplate.

D. Exterior Escalators
1. Fabricate exposed components from stainless steel **OR** bronze, **as directed**, unless otherwise indicated.
2. Hot-dip galvanize escalator trusses and other structural components to comply with ASTM A 123/A 123M. Use only stainless-steel or zinc-plated fasteners for assembly of escalator components.
3. Fabricate oil drip pan from galvanized steel sheet. Provide drain and oil/water separator in oil drip pan.
4. Provide drains, weeps, and drips to prevent water accumulation on horizontal surfaces and to direct water away from electrical equipment and moving parts.
5. Provide enclosures complying with NEMA 250, Type 4 for electrical connections, switches, and equipment.
6. Provide totally enclosed motors complying with NEMA MG 1, Insulation Class B.
7. Equip step drive mechanism with automatic step-chain lubricators.
8. Provide electric heaters with integral thermostats in escalator truss space to maintain temperature above 40 deg F (4.4 deg C).
9. Equip combplates with 400-W electric heaters to prevent ice and snow accumulation.

1.3 EXECUTION

A. Examination
1. Examine escalator areas, with Installer present, for compliance with requirements, installation tolerances, and other conditions affecting performance. Examine supporting structure, machine spaces, and pits; verify critical dimensions; and examine conditions under which escalators are to be installed.
a. Proceed with installation only after unsatisfactory conditions have been corrected.

b. For the record, prepare written report, endorsed by Installer, listing dimensional discrepancies and conditions detrimental to performance or indicating that dimensions and conditions were found to be satisfactory.

B. Installation
1. Comply with manufacturer's written instructions.
2. Set escalators true to line and level, properly supported, and anchored to building structure. Use established benchmarks, lines, and levels to ensure dimensional coordination of the Work.
3. Adjust installed components for smooth, efficient operation, complying with required tolerances and free of hazardous conditions. Lubricate operating parts, including bearings, tracks, chains, guides, and hardware. Test operating devices, equipment, signals, controls, and safety devices. Install oil drip pans and verify that no oil drips outside of pans.
4. Repair damaged finishes so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

C. Field Quality Control
1. Acceptance Testing: On completion of escalator installation and before permitting use of escalators, perform acceptance tests as required and recommended by ASME A17.1 and by authorities having jurisdiction.
   a. For escalators specified to comply with requirements more stringent than those of ASME A17.1, perform tests for compliance with specified requirements. Test optional safety devices.
2. Advise the Owner and authorities having jurisdiction in advance of dates and times tests are to be performed.

D. Demonstration
1. Train the Owner's maintenance personnel to operate, adjust, and maintain escalators.
2. Check operation of escalators with the Owner's personnel present and before date of Final Completion. Determine that operation systems and devices are functioning properly.
3. Check operation of escalators with the Owner's personnel present not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

END OF SECTION 14 31 00 00

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SECTION 14 32 00 00 - MOVING WALKS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for moving walks. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes interior and exterior moving walks.

C. Definition
1. Defective Moving Walk Work: Operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; the need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.

D. Performance Requirements
1. Rated Speed: 90 fpm (0.45 m/s) **OR** 100 fpm (0.5 m/s) **OR** 120 fpm (0.6 m/s) **OR** 130 fpm (0.66 m/s) **OR** 150 fpm (0.76 m/s), **as directed**.
2. Structural Performance of Balustrades, Deck Barricades, and Handrails: Provide components and assemblies capable of withstanding the effects of loads indicated in ASCE 7 for handrail assemblies and guardrail systems.

E. Submittals
1. Product Data: Include capacities, sizes, performances, safety features, finishes, and similar information.
2. Shop Drawings: Show plans, elevations, sections, and details indicating coordination with building structure and relationships with other construction. Indicate variations from specified requirements, maximum loads imposed on building structure at points of support, and power requirements. Indicate access and ventilation for moving walk machine space.
3. Samples: For exposed finishes, 3-inch- (75-mm-) square Samples of sheet materials, and 4-inch (100-mm) lengths of running trim members.
4. Manufacturer Certificates: Signed by manufacturer certifying that moving walk layout and dimensions, as shown on Drawings, and electrical service, as shown and specified, are adequate for moving walks being provided.
5. Operation and Maintenance Data: For moving walks to include in emergency, operation, and maintenance manuals.
6. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted use of moving walks.

F. Quality Assurance
1. Regulatory Requirements: Comply with ASME A17.1.

G. Delivery, Storage, And Handling
1. Deliver, store, and handle materials, components, and equipment in manufacturer's protective packaging.
2. Store materials, components, and equipment off of ground, under cover, and in a dry location. Handle according to manufacturer's recommendations to prevent damage, deterioration, or soiling.

H. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair, restore, or replace defective moving walk work within one year from date of Final Completion.

I. Maintenance Service
1. Initial Maintenance Service: Beginning at Final Completion, provide one years' full maintenance service by skilled employees of moving walk Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper moving walk operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

1.2 PRODUCTS

A. General
1. Provide preengineered pallet- or belt-type moving walks complying with requirements.

B. Materials
1. Stainless Steel: ASTM A 240/A 240M, Type 304 **OR** 316 **OR** 304, except use Type 316 for exterior moving walks, **as directed**.
   a. Satin Finish: No. 4 directional satin.
   b. Polished Finish: No. 8 mirror polish.
   c. Gold-Colored Satin Finish: No. 4 directional satin with gold-colored oxide or titanium nitride finish.
   d. Gold-Colored Mirror Finish: No. 8 mirror polish with gold-colored oxide or titanium nitride finish.
2. Satin Bronze Sheet: ASTM B 36/B 36M, Alloy UNS No. C28000 (muntz metal), fine satin finish, lacquered.
3. Satin Bronze Extrusions: ASTM B 455, Alloy UNS No. C38500 (architectural bronze), fine satin finish, lacquered.
4. Steel Sheet: Cold-rolled steel sheet, ASTM A 1008/A 1008M, commercial steel, Type B, exposed, matte finish.
5. Clear Tempered Glass: ASTM C 1048, Condition A (uncoated surfaces), Type 1 (transparent glass, flat), Class 1 (clear), Quality q3 (glazing, select), Kind FT (fully tempered), 10.0 **OR** 12.0, **as directed**, mm thick.
6. Tinted Tempered Glass: ASTM C 1048, Condition A (uncoated surfaces), Type 1 (transparent glass, flat), Class 2 (tinted), Quality q3 (glazing, select), Kind FT (fully tempered), 10.0 **OR** 12.0, **as directed**, mm thick.
   a. Color: Bronze **OR** Gray **OR** Green, **as directed**.

C. Components
1. General: Unless otherwise indicated, provide standard components as indicated in manufacturers' publications and as required for a complete moving walk.
   a. Fabricate exposed metalwork, including deck covers, balustrade panels, and trim to provide surface flatness equivalent to stretcher-leveled standard of flatness and sufficient strength for indicated use; increase metal thickness or reinforce with concealed stiffeners, backing materials, or both, as necessary. Support joints with concealed stiffeners as needed to hold exposed faces of adjoining sheets in flush alignment.
2. Opaque Balustrades: Manufacturer's standard profile or arrangement of moving handrails on fully paneled guide rail with interior balustrade panels, deck covers, skirts, trim, and accessories. Prepare for exterior finish below the deck covers, specified in another Section.
3. Transparent Balustrades: Manufacturer's standard profile or arrangement of moving handrails on guide rail that is supported by clear **OR** tinted, **as directed**, tempered glass panels, with deck covers, skirts, trim, and accessories. Prepare for exterior finish below the deck covers, specified in another Section.
4. Handrails: Smooth, jointless, reinforced neoprene.

a. Color: Black **OR** As selected from manufacturer's full range, **as directed**.
5. Deck Covers and Trim: Satin stainless steel **OR** Polished stainless steel **OR** Gold-colored satin stainless steel **OR** Gold-colored polished stainless steel **OR** Satin bronze, **as directed**.
6. Balustrade Interior Panels: Satin stainless steel **OR** Polished stainless steel **OR** Gold-colored satin stainless steel **OR** Gold-colored polished stainless steel **OR** Satin bronze, **as directed**.
7. Balustrade Exterior Panels: Satin stainless steel **OR** Polished stainless steel **OR** Gold-colored satin stainless steel **OR** Gold-colored polished stainless steel **OR** Satin bronze, **as directed**.
8. Skirt Panels, if Applicable: Polished stainless steel **OR** Satin stainless steel with exposed surface coated with clear PTFE **OR** Steel panels with exposed surface coated with PTFE, **as directed**.
   a. Clearance between skirt panels or overhanging balustrade panels and treadway shall not exceed 1/16 inch (1.6 mm).
9. Combs: Integrally colored structural plastic **OR** Cast aluminum **OR** Cast aluminum with powder-coated finish, **as directed**.
   a. Comb Color: Yellow **OR** Black **OR** Gray **OR** Red, **as directed**.
10. Floor Plates: Cast or extruded aluminum **OR** Stainless steel, **as directed**, with grooved or patterned surface and mill finish.
11. Abrasive-Surface Floor Plates: Cast or extruded aluminum **OR** Stainless steel, **as directed**, with grooved or patterned surface and with abrasive material embedded in or metallically bonded to floor-plate surface and having a coefficient of friction of 0.6 or higher when tested according to ASTM C 1028.
12. Operational Control: Provide moving walks designed and equipped to run equally in either direction. Provide key-operated switches for directional control and key-operated starter switches located on exterior deck above newel base at both ends of moving walks.

D. Features
1. Fault Indicator: Provide moving walks with a microprocessor unit that monitors safety devices, motor temperature, and moving walk speed and records in nonvolatile memory date, time, and device identification if a safety device is activated or moving walk malfunctions.
   a. Provide built-in or plug-in unit to display recorded information.
2. Reduced-Current Starting: Provide moving walk motors with wye-delta or solid-state starting.
3. Energy-Saving Feature: Provide moving walk motors and controls designed for motors to run on partial windings (at reduced power) when not under full load.
4. Brake-Saving Feature: Provide stopping mechanism that allows moving walks to coast to a stop before applying brakes, unless stopping is initiated by a safety device.
5. Equip pallet drive mechanism with automatic pallet drive-chain lubricators.
6. Oil Drip Pan: Provide metal pan under full width and length of moving walks to collect and hold oil and grease drippings from lubricated components. Design and fabricate drip pan to sustain a load of 250 lbf (1.1 kN) on a 1.0-sq. ft. (0.09-sq. m) area at any location without permanent deflection.
7. Direction Indicator Lights: Provide red and green indicator lights at least 2 inches (50 mm) in diameter in right-hand **OR** both, **as directed**, balustrade newels at both landings. Green light indicates entrance end, and red light indicates exit end. When moving walk is stopped, red lights are illuminated at both ends.
8. Combplate Lights: Provide recessed light fixtures with flush lenses mounted in interior balustrade panels at each side of combplates designed to illuminate treadway at combplate.
9. Comb-Step Impact Device: Activated if a horizontal force in direction of travel is applied exceeding 112 lbf (500 N) at either side or exceeding 225 lbf (1000 N) at center of front edge of combplate, or a resultant force in upward direction is applied exceeding 150 lbf (688 N) at center of front edge of combplate.

E. Exterior Moving Walks
1. Fabricate exposed components from stainless steel **OR** bronze, **as directed**, unless otherwise indicated.
2. Hot-dip galvanize moving walk trusses and other structural components to comply with ASTM A 123/A 123M. Use only stainless-steel or zinc-plated fasteners for assembly of moving walk components.

3. Fabricate oil drip pan from galvanized steel sheet. Provide drain and oil/water separator in oil drip pan.
4. Provide drains, weeps, and drips to prevent water accumulation on horizontal surfaces and to direct water away from electrical equipment and moving parts.
5. Provide enclosures complying with NEMA 250, Type 4 for electrical connections, switches, and equipment.
6. Provide totally enclosed fan-cooled motors complying with NEMA MG 1, Insulation Class B.
7. Equip pallet drive mechanism with automatic pallet drive-chain lubricators.
8. Provide electric heaters with integral thermostats in moving walk truss space to maintain temperature above 40 deg F (4.4 deg C).
9. Equip combplates with 400-W electric heaters to prevent ice and snow accumulation.

1.3 EXECUTION

A. Installation
1. Comply with manufacturer's written instructions.
2. Set moving walks true to line and level, or to indicated slope, properly supported, and anchored to building structure. Use established benchmarks, lines, and levels to ensure dimensional coordination of the Work.
3. Adjust installed components for smooth, efficient operation, complying with required tolerances and free of hazardous conditions. Lubricate operating parts, including bearings, tracks, chains, guides, and hardware. Test operating devices, equipment, signals, controls, and safety devices. Install oil drip pans and verify that no oil drips outside of pans.
4. Repair damaged finishes so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

B. Field Quality Control
1. Acceptance Testing: On completion of moving walk installation and before permitting use of moving walks, perform acceptance tests as required and recommended by ASME A17.1 and by authorities having jurisdiction.
2. Advise the Owner, Architect, and authorities having jurisdiction in advance of dates and times tests are to be performed.

C. Demonstration
1. Engage a factory-authorized service representative to train the Owner's maintenance personnel to operate, adjust, and maintain moving walks.

END OF SECTION 14 32 00 00

SECTION 14 42 13 00 - WHEELCHAIR LIFTS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for wheelchair lifts. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
    a. Vertical and Private-residence, vertical platform lifts.
    b. Inclined and Private-residence, inclined platform lifts.
    c. Inclined and Private-residence, inclined stairway chairlifts.

C. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings: For each lift. Include plans, elevations, sections, details, and attachments to other work.
    a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
    b. Wiring Diagrams: For power, signal, and control wiring.
3. Samples: For each type of exposed finish required.
4. Manufacturer Certificates: Signed by lift manufacturer certifying that runway, ramp or pit, and dimensions as shown on Drawings and that electrical service as shown and specified are adequate for lift being provided.
5. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted use of lifts.
6. Operation and Maintenance Data: For each type of lift to include in operation and maintenance manuals.
7. Warranty: Sample of special warranty.
8. Continuing maintenance proposal.

D. Quality Assurance

1. Legal Requirements: In addition to requirements of authorities having jurisdiction, comply with Americans with Disabilities Act (including the ADA Standards issued by the U.S. Department of Justice and the U.S. Department of Transportation and the United States Access Board's Guide to the ADA Standards, specifically Chapter 4. "Elevators and Platform Lifts" (available on-line at https://www.access-board.gov), **as directed.**
2. Fire-Rated, Runway-Enclosure Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to NFPA 252 **OR** IBC Standard **OR** UL 10B, **as directed**.
    a. Temperature-Rise Limit: Provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.

E. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lifts that fail in materials or workmanship within two **OR** Four **OR** Five, **as directed**, years from date of Final Completion.

F. Maintenance Service

1. Initial Maintenance Service: Beginning at Final Completion, provide 12 months' full maintenance by skilled employees of lift Installer. Include quarterly preventive maintenance and repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper lift operation at rated speed and capacity. Provide parts and supplies the same as those used in the manufacture and installation of original equipment.
2. Continuing Maintenance Proposal: From Installer to the Owner, in the form of a standard yearly **OR** two-year **OR** five-year, **as directed**, maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.2 PRODUCTS

A. Materials
1. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
2. Steel Tubing: ASTM A 500.
3. Steel Pipe: ASTM A 53/A 53M; standard weight (Schedule 40) unless otherwise indicated or required by structural loads.
4. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, commercial steel (CS), Type B, exposed, matte finish.
5. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, commercial steel (CS), Type B, pickled.
6. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 (Z275) zinc coating,
7. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:
   a. ASTM A 123/A 123M, for galvanizing steel and iron products.
   b. ASTM A 153/A 153M, for galvanizing steel and iron hardware.
8. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required:
   a. Extruded Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6063-T6.
   b. Aluminum Sheet: ASTM B 209 (ASTM B 209M), Alloy 5005-H15.
9. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.
10. Stainless-Steel Tubing: ASTM A 554, Grade MT-304.
11. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 304.
12. Stainless-Steel Floor Plate: ASTM A 793.
13. Wood and Wood Panel Products: Comply with requirements in Division 06 Section "Interior Architectural Woodwork".
14. Wood and Wood Panel Products:
   a. Wood: Clear, vertical-grain, straight, kiln-dried wood, AWPA C20-02, Interior Type A, fire-retardant treated, **as directed**; of manufacturer's standard species.
   b. Wood Panels: Provide wood panels consisting of wood veneer and wood panel as follows:
      1) Wood Veneer: Laminated to core with moisture-resistant adhesive.
      2) Plywood: DOC PS 1.
      3) Particleboard: ANSI A208.1, made with binder containing no urea formaldehyde, **as directed**.
      4) Medium-Density Fiberboard: ANSI A208.2, made with binder containing no urea formaldehyde, **as directed**.
   c. Fire-Retardant-Treated Wood Panels: Provide wood panels consisting of wood veneer and AWPA C27-02 fire-retardant-treated wood panels. Panels shall have flame-spread index of 75 **OR** 25, **as directed**, or less and smoke-developed index of 450 or less per ASTM E 84.
      1) Wood Veneer: Laminated to core with moisture-resistant adhesive.
      2) Plywood: DOC PS 1.
      3) Particleboard: ANSI A208.1, made with binder containing no urea formaldehyde, **as directed**.

4) Medium-Density Fiberboard: ANSI A208.2, made with binder containing no urea formaldehyde, **as directed**.

15. Fiberglass: Multiple laminations of glass-fiber-reinforced polyester resin with UV-light-stable, colorfast, nonfading, weather- and stain-resistant, colored polyester gel coat, and manufacturer's standard finish.
16. Glass:
    a. Comply with requirements in Division 08 Section "Glazing".
    OR
    As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**, and complying with ASME A18.1.
        1) Safety Glazing Products: Comply with testing requirements in 16 CFR 1201, Category II.
        2) Safety Glass Marking: Glass permanently marked with certification label of SGCC or another certification agency or manufacturer acceptable to authorities having jurisdiction.
17. Acrylic Glazing: ASTM D 4802, Category A-1 (cell-cast) or Category A-2 (continuous cast), Finish 1 (smooth or polished), clear or tinted as indicated.
18. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing structural members, guide rails, machines, and other lift components where installation of devices is specified in another Section.
19. Expansion Anchors: Anchor-bolt-and-sleeve assembly of material indicated below with capability to sustain a load equal to 10 times the load imposed as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
    a. Material:
        1) Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
        OR
        Group 1, Alloy 304 or Alloy 316, stainless-steel bolts and nuts complying with ASTM F 593 (ASTM F 738M) and ASTM F 594 (ASTM F 836M).
20. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107.

B. Vertical Platform Lifts

1. Private-Residence, **as directed**, Vertical Platform Lifts: Manufacturer's standard preengineered lift systems as indicated.
2. Platform Size: 34 by 54 inches (864 by 1372 mm) **OR** 35 by 48 inches (889 by 1220 mm) **OR** 35 by 51 inches (889 by 1295 mm) **OR** 36 by 56 inches (914 by 1422 mm) **OR** 36 by 60 inches (914 by 1524 mm), **as directed**.
3. Door Operation and Clear Opening Width: Low-energy, power-operated doors that remain open for 20 seconds minimum; end door with minimum 32-inch (815-mm) and side door with minimum 42-inch (1065-mm) clear opening width.
4. Rated Speed: 8 fpm (0.04 m/s)\ **OR** 10 fpm (0.05 m/s) **OR** 12 fpm (0.06 m/s) **OR** 15 fpm (0.08 m/s) **OR** 20 fpm (0.10 m/s) **OR** 22 fpm (0.11 m/s) **OR** 30 fpm (0.15 m/s), **as directed**.
5. Power Supply: 208 V, 60 Hz, 3 phase **OR** 240 V, 60 Hz, 1 phase **OR** 120 V, 60 Hz, 1 phase, **as directed**.
6. Emergency Operation: Provide emergency manual operation and emergency battery power system **OR** connection to indicated standby (emergency) power, **as directed**, to raise or lower units in case of malfunction or power loss.
7. Attendant Operation: Provide attendant operation at location shown.
8. Self-Supporting Units: Support vertical loads of units only at base, with lateral support only at landing levels.
9. Partial, **as directed**, Runway Enclosure: Manufacturer's standard weather-resistant, **as directed**, enclosure assembly.
    a. Runway Enclosure: One of the following, **as directed.**
        1) Rectangular steel-tube frame with flush steel-sheet panels.
        2) Rectangular hot-dip-galvanized steel-tube frame with flush galvanized-steel-sheet panels.

3) Extruded-aluminum frame with flush galvanized-steel-sheet panels.
4) Extruded-aluminum frame with flush aluminum-sheet panels; with hot-dip-galvanized steel-tube frame for structural framing that cannot be aluminum.
5) Rectangular steel-tube frame with wood panels and trim.
6) Rectangular wood frame with wood panels and trim.
7) Rectangular steel-tube frame with fiberglass panels.

b. Glazed Runway Enclosure: Rectangular structure of glazed extruded-aluminum framing with a tinted, acrylic dome roof.
1) Glazing:
a) Bronze-tinted acrylic glazing, 6.0 mm thick.
OR
Bronze-tinted, float glass **OR** tempered safety **OR** laminated safety, **as directed**, glass, 6.0 mm thick, where indicated.

c. Runway-Enclosure Doors: One of the following, **as directed**:
1) Rectangular steel-tube frames with flush steel-sheet panels.
2) Rectangular steel-tube frames glazed with 6.0-mm-thick, clear acrylic glazing and with 12-inch- (300-mm-) high, steel kick panels.
3) Wide-stile aluminum entrance doors glazed with bronze-tinted tempered safety glass, 6.0 mm thick.
4) Enclosure doors matching appearance of adjacent glass-supported railings, complying with Division 05 Section "Decorative Metal Railings".

d. Fire-Rated Runway-Enclosure Door: Provide fire-rated runway-enclosure door where shown **OR** at upper landing **OR** at lower landing, **as directed**.
1) Fire-Protection Rating: 1-1/2 hours.
2) Equip door with wired glass vision panel, delay-action door closer, dead latch, dummy trim door handle, and electric strike.

10. Platform: One of the following, **as directed:**
a. Galvanized-steel sheet with black rubber flooring.
b. Stainless-steel floor plate with checkered texture.
c. Aluminum floor plate with nonskid surface texture.

11. Platform Low-Profile Carriage: Fabricate platform floor assembly to total thickness not exceeding 1-1/2 inches (38 mm).

12. Platform Enclosure and Door: One of the following, **as directed:**
a. Rectangular steel-tube frame with flush steel-sheet panels.
b. Rectangular hot-dip-galvanized steel-tube frame with flush galvanized-steel-sheet panels.
c. Extruded-aluminum frame with flush galvanized-steel-sheet panels.
d. Extruded-aluminum frame with flush aluminum-sheet panels; with hot-dip-galvanized steel-tube frame for structural framing that cannot be aluminum.
e. Rectangular steel-tube frame with wood panels and trim.
f. Rectangular steel-tube frame with fiberglass panels.
g. Enclosure walls and doors matching appearance of adjacent glass-supported railings, complying with Division 05 Section "Decorative Metal Railings".

13. Platform Top: Provide a non-load-bearing top, matching construction of enclosure walls. Permanently mark top to indicate that it cannot sustain a load.

14. Fixed Ramp: Provide fixed ramp matching platform to provide transition from floor to lift platform at bottom landing.

15. Retractable Ramp: Provide ramp matching platform to provide transition from lower floor to lift platform. Ramp lowers to floor automatically when lifts reach lower landing and door opens. Ramp rises automatically when lift control is activated for lift to leave lower landing.
a. Ramp Size: End ramps a minimum of 32 inches (815 mm) and side ramps a minimum of 42 inches (1065 mm) wide; length as required for slope.
b. Ramp Slope: As indicated **OR** Maximum 1:12, **as directed**.
c. Ramp Finish: Finish ramps to match lift platform **OR** Ramp finish is specified elsewhere as indicated, **as directed**.

16. Accessories: Provide units with the following accessories:

a. Fold-down seat with armrests and safety belt.
b. Forced Ventilation System: Minimum 1 air change per minute, continuously operating **OR** thermostatically controlled to activate at 90 deg F (32.22 deg C) , **as directed**, and with auxiliary power source to operate ventilation for 1 hour in case of power failure.
c. Lighting system within lift enclosures as indicated on Drawings **OR** selected from manufacturer's available products, **as directed**.

C. Inclined Platform Lifts
1. Private-Residence, **as directed**, Inclined Platform Lifts: Manufacturer's standard preengineered lift systems as indicated.
2. Platform Size: 29 by 33 inches (737 by 838 mm) **OR** 28 by 35 inches (711 by 889 mm) **OR** 30 by 35 inches (760 by 889 mm) **OR** 30 by 36 inches (760 by 914 mm) **OR** 31 by 39 inches (787 by 991 mm) **OR** 30 by 41 inches (760 by 1041 mm) **OR** 30 by 42 inches (760 by 1067 mm) **OR** 31 by 43 inches (787 by 1092 mm) **OR** 30 by 48 inches (760 by 1220 mm), **as directed**.
3. Door Operation and Clear Opening Width: Low-energy, power-operated doors that remain open for 20 seconds minimum; end door with minimum 32-inch (815-mm) and side door with minimum 42-inch (1065-mm) clear opening width.
4. Rated Speed: 20 fpm (0.10 m/s) **OR** 22 fpm (0.11 m/s) **OR** 25 fpm (0.13 m/s) **OR** 30 fpm (0.15 m/s), **as directed**.
5. Minimum Headroom Clearance during Travel: Minimum of 80 inches (2032 mm) above any point on platform floor.
6. Power Supply: 208 V, 60 Hz, 3 phase **OR** 240 V, 60 Hz, 1 phase **OR** 120 V, 60 Hz, 1 phase, **as directed**.
7. Emergency Operation: Provide emergency manual operation and emergency battery power system **OR** connection to indicated standby (emergency) power, **as directed**, to raise or lower units in case of malfunction or power loss.
8. Attendant Operation: Provide attendant operation at location shown.
9. Platform: One of the following, **as directed:**
   a. Galvanized-steel sheet with black rubber flooring.
   b. Stainless-steel floor plate with checkered texture.
   c. Aluminum floor plate with nonskid surface texture.
10. Automatic Folding Platforms: When not in use, platforms automatically fold up against wall to minimize projection into stairway.
11. Manual Folding Platforms: When not in use, platforms can be folded up against wall to minimize projection into stairway.
12. Platform Guarding: Guard platform with passenger restraining arms **OR** enclosure, **as directed**.
    a. Passenger Restraining Arms: Steel **OR** Galvanized-steel **OR** Stainless-steel, **as directed**, tubing, manually **OR** power, **as directed**, operated.
    b. Platform Enclosure (Side Walls and Self-Closing Door): One of the following, **as directed**:
       1) Rectangular steel-tube frame with flush steel-sheet panels.
       2) Enclosure walls and doors matching appearance of adjacent glass-supported railings, complying with Division 05 Section "Decorative Metal Railings".
13. Platform Guarding: Guard platform with automatically **OR** manually, **as directed**, actuated, retractable metal guard on lower access end of platform.
14. Fixed Ramp: Provide fixed ramp matching platform to provide transition from floor to lift platform at bottom landing.
15. Retractable Ramp: Provide ramp matching platform to provide transition from floor to lift platform. Ramp lowers to floor automatically when lifts reach landing and enclosure door opens. Ramp rises automatically when lift control is activated for lift to leave landing.
    a. Ramp Size: End ramps a minimum of 32 inches (815 mm) and side ramps a minimum of 42 inches (1065 mm) wide; length as required for slope.
    b. Ramp Slope: As indicated **OR** Maximum 1:12, **as directed**.
    c. Ramp Finish: Finish ramps to match lift platform **OR** Ramp finish is specified elsewhere as indicated, **as directed**.

16. Supporting Structure: Provide framing to support vertical loads from floor or stair treads and only lateral loads from walls. Fabricate framing from steel **OR** stainless-steel, **as directed**, rectangular tubing, plates, shapes, and bars.
17. Guide Rails: Fabricate from steel **OR** stainless-steel, **as directed**, tubing.
18. Accessories: Provide units with the following accessories:
    a. Fold-down seat with armrests and safety belt.
    b. Caution sign as required by ASME A18.1.

D. Inclined Stairway Chairlifts
1. Private-Residence, **as directed**, Inclined Stairway Chairlifts: Manufacturer's standard preengineered lift systems as indicated.
2. Systems and Machinery: Manufacturer's standard preengineered lift systems as indicated in published product literature and as follows:
    a. Rated Capacity: Minimum 250 lb (113 kg) **OR** 400 lb (181 kg), **as directed**.
    b. Rated Speed: 18 fpm (0.09 m/s) **OR** 20 fpm (0.10 m/s) **OR** 22 fpm (0.11 m/s) **OR** 25 fpm (0.13 m/s), **as directed**.
3. Power Supply: 120 V, 60 Hz, 1 phase.
4. Battery Operation: Provide battery-operated drive with automatic charging system.
5. Manual Lowering: Provide means to manually lower units in case of malfunction or power loss.
6. Folding Units: Provide units that can be folded up against wall when not in use, to minimize projection into stairway.
7. Supporting Structure: Provide brackets to support vertical loads from floor or stair treads and to support lateral loads from walls. Fabricate brackets from steel plates, shapes, or bars.
8. Accessories: Provide units with the following accessories:
    a. Tubular-steel, manually operated safety arms designed to restrain and provide grab bar for occupant.
    b. Retractable seat belt.
    c. Seat with back and two handgrips or arms.

E. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

F. Finishes
1. Steel and Galvanized-Steel Factory Finish:
    a. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard 2-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat.
    b. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard, thermosetting polyester or acrylic urethane powder coating with a cured film thickness not less than 1.5 mils (0.04 mm).
    c. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
2. Stainless-Steel Finishes:
    a. Floor Plate Finish: Mill **OR** Abrasive blasted, **as directed**.
    b. Grab Rail Finish: As selected from manufacturer's full range **OR** Directional satin finish No. 4, **as directed**.
3. Aluminum Finishes:
    a. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.

b. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
   1) Color: As selected from full range of industry colors and color densities.
c. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard, thermosetting polyester or acrylic urethane powder coating with a cured film thickness not less than 1.5 mils (0.04 mm).
   1) Color and Gloss: As selected from manufacturer's full range.

4. Wood Finish:
   a. As specified in Division 09 Section "Staining And Transparent Finishing".
      OR
      As selected from manufacturer's full range, as follows:
      1) Type: Transparent finish **OR** Transparent finish over stain, **as directed**, over wood variety indicated.
5. Fiberglass Color and Gloss: As selected from manufacturer's full range.

1.3 EXECUTION

A. Installation
1. Wiring Method: Conceal conductors and cables within housings of units or building construction. Do not install conduit exposed to view in finished spaces. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
2. Coordinate runway doors with platform travel and positioning, for accurate alignment and minimum clearance between platforms, runway doors, sills, and door frames.
3. Position sills accurately and fill space under sills solidly with nonshrink, nonmetallic grout.
4. Coordinate platform doors with platform travel and positioning.
5. Adjust stops for accurate stopping and leveling at each landing, within required tolerances.
   a. Leveling Tolerance: 1/4 inch (6 mm) up or down, regardless of load and direction of travel.
6. Adjust retractable ramps to meet maximum allowable slope and change-in-elevation requirements, and to lie fully against landing surfaces.
7. Lubricate operating parts of lift, including drive mechanism, guide rails, hinges, safety devices, and hardware.
8. Test safety devices and verify smoothness of required protective enclosures and fascias

B. Field Quality Control
1. Acceptance Testing: On completion of lift installation and before permitting use of lifts, perform acceptance tests as required and recommended by ASME A18.1 and authorities having jurisdiction.
2. Operating Test: In addition to above testing, load lifts to rated capacity and operate continuously for 30 minutes between lowest and highest landings served. Readjust stops, signal equipment, and other devices for accurate stopping and operation of system.
3. Advise the Owner, Architect, and authorities having jurisdiction in advance of dates and times tests are to be performed on lifts.

C. Demonstration
1. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain lifts. Include a review of emergency systems and emergency procedures to be followed at time of operational failure and other building emergencies.

END OF SECTION 14 42 13 00

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Task	Specification	Specification Description
14 42 16 00	14 42 13 00	Wheelchair Lifts

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SECTION 14 91 82 00 - CHUTES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for chutes. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes waste and laundry chutes.

C. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
3. Operation and maintenance data.

D. Quality Assurance
1. NFPA Compliance: Provide chutes complying with NFPA 82.
2. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated.
   a. Test Pressure: Test at atmospheric (neutral) pressure according to NFPA 252 or UL 10B.
   b. Intake Door: Class B labeled; 1-hour **OR** 1-1/2-hour, **as directed**, fire rated with 30-minute temperature rise of 250 deg F (140 deg C), **as directed**.
   c. Discharge Door: Class B labeled; 1-hour fire rated with 30-minute temperature rise of 250 deg F (140 deg C), **as directed**.
   d. Access Door: Class B labeled; 1-hour **OR** 1-1/2-hour, **as directed**, fire rated with 30-minute temperature rise of 250 deg F (140 deg C), **as directed**.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.2 PRODUCTS

A. Chutes
1. Chute Metal: Aluminum-coated, cold-rolled, commercial steel sheet; ASTM A 463/A 463M, Type 1 with not less than T1-40 (T1M-120) coating **OR** Type 430 stainless steel, ASTM A 240/A 240M **OR** Type 304 stainless steel, ASTM A 240/A 240M, **as directed.**
   a. Thickness: 0.060 inch (1.6 mm) **OR** 0.080 inch (2.0 mm), **as directed**.
2. Size: 20-inch (508-mm) diameter **OR** 24-inch (610-mm) diameter **OR** As indicated on Drawings, **as directed**.

B. Doors
1. Intake Door Assemblies: ASTM A 240/A 240M, Type 304 stainless-steel, self-closing units with positive latch and latch handle; as required to provide fire-protection and temperature-rise, **as directed**, ratings indicated; and with frame suitable for enclosing chase construction.
   a. Door Type: Hopper **OR** Hopper, limited access **OR** Side hinged, limited access, 180-degree swing, square **OR** Type as indicated on Drawings, **as directed**.
   b. Size: Manufacturer's standard size for door type, chute type, and diameter indicated.
   c. Finish: Manufacturer's standard satin or No. 3 directional polish.

d. Locks: Cylinder locks with keys that are removable only when cylinder is locked. For each chute, key locks alike **OR** to master key system, **as directed**. For each door, furnish four, **as directed**, keys.
e. Foot Operators: Hopper-type door operators that unlatch and open door when foot pedal is depressed.
f. Mechanical Interlocks: Interlock system operated from discharge door to automatically lock intake doors.
g. Electrical Interlocks: Interlock system that is energized by opening one intake door; remaining doors automatically lock when system is energized.

2. Discharge-Door Assemblies: Aluminum-coated-steel doors as required to provide fire-protection and temperature-rise, **as directed**, ratings indicated; equipped with fusible links that cause doors to close in the event of fire.
   a. Direct Vertical Discharge: Provide inclined, horizontally rolling, shutter-type unit.
   b. Horizontal Discharge: Provide top-hinged, self-closing, hopper door with self-latching hardware; floor-mounted leg brace designed to absorb impact of material dropping against chute; and minimum NPS 2 (DN 50) drain pipe connection.
3. Heat- **OR** Heat- and Smoke-, **as directed**, Detector System: Interlock system with temperature-rise elements that locks chute doors when temperature in chute reaches a predetermined, adjustable temperature.
   a. Locate smoke detector outside discharge door with solenoid to close discharge door.
4. Access Door Assemblies: Manufacturer's standard ASTM A 240/A 240M, Type 302/304 stainless-steel doors; as required to provide fire-protection and temperature-rise, **as directed**, ratings indicated; with frame suitable for enclosing chase construction; and in satin or No. 3 directional polish finish.
5. Manual Control System: Control system with manual switches that lock doors of chute during shutdown hours and service operations.

C. Accessories
1. Fire Sprinklers: NPS 1/2 (DN 13) fire sprinklers ready for piping connections.
2. Flushing Spray Unit: NPS 3/4 (DN 19) spray head unit located in chute above highest intake door, ready for hot-water piping connection, and with access for head and piping maintenance.
3. Sanitizing Unit: NPS 3/4 (DN 19) disinfecting and sanitizing spray head unit located in chute above highest intake door, including 1-gal. (3.8-L) tank and adjustable proportioning valve with bypass for manual control of sanitizing and flushing operation, ready for hot-water piping connection, and with access for head and piping maintenance.
4. Intake Door Baffles: Rubber baffles, 1/8 inch (3 mm) thick.
5. Sound Dampening: Manufacturer's standard exterior mastic coating on chute.
   a. Sound and vibration isolator pads at floor supporting frames.

D. Fabrication
1. General: Factory-assemble chutes to greatest extent practical with continuously welded or lock-seamed joints without bolts, rivets, or clips projecting on chute interior. Include intake-door assemblies and metal supporting framing at each floor, and chute expansion joints between each support point.
2. Roof Vent: Fabricate vent unit to extend 36 inches (910 mm) **OR** 48 inches (1200 mm), **as directed**, above roof with full-diameter, screened vent and metal safety cap or glass explosion-release cap. Fabricate with roof-deck flange, counterflashing, and clamping ring of nonferrous metal compatible with chute metal.
3. Fire Sprinklers: Comply with NFPA 13. Locate fire sprinklers at or above the top service opening of chutes, within the chute at alternate floor levels in buildings more than two stories tall, and at the lowest service level.
4. Equipment Access: Fabricate chutes with access for maintaining equipment located within the chute, such as flushing and sanitizing units, fire sprinklers, and plumbing and electrical connections.

1.3 EXECUTION

A. Installation
1. General: Comply with NFPA 82 requirements and with chute manufacturer's written instructions. Assemble components with tight, nonleaking joints. Anchor securely to supporting structure to withstand impact and stresses on vent units. Install chute and components to maintain fire-resistive construction of chute and enclosing chase.
2. Install chutes plumb, without offsets or obstructions that might prevent materials from free falling within chutes.
3. Anchor roof flanges of chute vents before installing roofing and flashing. Install chute-vent counterflashing after roofing and roof-penetration flashing are installed.
4. Intake and Discharge Doors: Interface door units with throat sections of chutes for safe, snag-resistant, sanitary depositing of materials in chutes by users.
   a. Coordinate installation of foot-pedal door operator with installation of door and chase.
   b. Interconnect sanitizer control with door interlock system.
5. Electrical Interlock System: Comply with applicable NECA 1 recommendations.
6. Test chute components after installation. Operate doors, locks, and interlock systems to demonstrate that hardware is adjusted and electrical wiring is connected correctly. Complete test operations before installing chase enclosures.
7. Test fire sprinklers and heat- and smoke-sensing devices for proper operation.
8. Operate sanitizing unit through one complete cycle of chute use and cleanup, and replenish chemicals or cleaning fluids in unit containers.

B. Cleaning
1. After completing chase enclosure, clean exposed surfaces of chute system's components. Do not remove labels of independent testing and inspecting agencies.

END OF SECTION 14 91 82 00

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SECTION 21 05 13 00 - COMMON MOTOR REQUIREMENTS FOR FIRE SUPPRESSION EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

C. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 ft. (1000 m) above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors, Multiple Winding: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: [**Class F**] <**Insert class**>.

J. Code Letter Designation:

1. Motors [**15**] <**Insert number**> HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller Than [**15**] <**Insert number**> HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes [**324T**] <**Insert number**> and larger; rolled steel for motor frame sizes smaller than [**324T**] <**Insert number**>.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable-Frequency Controllers:[**Ratings, characteristics, and features coordinated with and approved by controller manufacturer.**]

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp must be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device will automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 21 05 13 00

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SECTION 21 05 19 00 - METERS AND GAGES FOR PLUMBING PIPING

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for meters and gages for plumbing piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Bimetallic-actuated thermometers.
      b. Filled-system thermometers.
      c. Liquid-in-glass thermometers.
      d. Light-activated thermometers.
      e. Thermowells.
      f. Dial-type pressure gages.
      g. Gage attachments.
      h. Test plugs.
      i. Test-plug kits.
      j. Sight flow indicators.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. Product Certificates: For each type of meter and gage, from manufacturer.
   3. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

1.2 PRODUCTS

A. Bimetallic-Actuated Thermometers
   1. Standard: ASME B40.200.
   2. Case: Liquid-filled and sealed type(s); stainless steel with 3-inch (76-mm) **OR** 5-inch (127-mm), **as directed**, nominal diameter.
   3. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F (deg C) **OR** deg F and deg C, **as directed**.
   4. Connector Type(s): Union joint, adjustable angle **OR** rigid, back **OR** rigid, bottom, **as directed**, with unified-inch screw threads.
   5. Connector Size: 1/2 inch (13 mm), with ASME B1.1 screw threads.
   6. Stem: 0.25 or 0.375 inch (6.4 or 9.4 mm) in diameter; stainless steel.
   7. Window: Plain glass or plastic.
   8. Ring: Stainless steel.
   9. Element: Bimetal coil.
   10. Pointer: Dark-colored metal.
   11. Accuracy: Plus or minus 1 **OR** 1.5, **as directed**, percent of scale range.

B. Filled-System Thermometers
   1. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:
      a. Standard: ASME B40.200.
      b. Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch (114-mm) **OR** 5-inch (127-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter.
      c. Element: Bourdon tube or other type of pressure element.

d. Movement: Mechanical, dampening type, **as directed**, with link to pressure element and connection to pointer.
e. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
f. Pointer: Dark-colored metal.
g. Window: Glass or plastic.
h. Ring: Metal **OR** Stainless steel, **as directed**.
i. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device **OR** rigid, back **OR** rigid, bottom, **as directed**; with ASME B1.1 screw threads.
j. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
   1) Design for Thermowell Installation: Bare stem.
k. Accuracy: Plus or minus 1 percent of scale range.

2. Direct-Mounted, Plastic-Case, Vapor-Actuated Thermometers:
   a. Standard: ASME B40.200.
   b. Case: Sealed type, plastic; 4-1/2-inch (114-mm) **OR** 5-inch (127-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter.
   c. Element: Bourdon tube or other type of pressure element.
   d. Movement: Mechanical, with link to pressure element and connection to pointer.
   e. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
   f. Pointer: Dark-colored metal.
   g. Window: Glass or plastic.
   h. Ring: Metal or plastic.
   i. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device **OR** rigid, back **OR** rigid, bottom, **as directed**; with ASME B1.1 screw threads.
   j. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
      1) Design for Thermowell Installation: Bare stem.
   k. Accuracy: Plus or minus 1 percent of scale range.

3. Remote-Mounted, Metal-Case, Vapor-Actuated Thermometers:
   a. Standard: ASME B40.200.
   b. Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter with back **OR** front, **as directed**, flange and holes for panel mounting.
   c. Element: Bourdon tube or other type of pressure element.
   d. Movement: Mechanical, with link to pressure element and connection to pointer.
   e. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
   f. Pointer: Dark-colored metal.
   g. Window: Glass or plastic.
   h. Ring: Metal **OR** Stainless steel, **as directed**.
   i. Connector Type(s): Union joint, back **OR** bottom, **as directed**; with ASME B1.1 screw threads.
   j. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
      1) Design for Thermowell Installation: Bare stem.
   k. Accuracy: Plus or minus 1 percent of scale range.

4. Remote-Mounted, Plastic-Case, Vapor-Actuated Thermometers:
   a. Standard: ASME B40.200.
   b. Case: Sealed type, plastic; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter with back **OR** front, **as directed**, flange and holes for panel mounting.
   c. Element: Bourdon tube or other type of pressure element.

d. Movement: Mechanical, with link to pressure element and connection to pointer.
e. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
f. Pointer: Dark-colored metal.
g. Window: Glass or plastic.
h. Ring: Metal or plastic.
i. Connector Type(s): Union joint, threaded, back **OR** bottom, **as directed**; with ASME B1.1 screw threads.
j. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
   1) Design for Thermowell Installation: Bare stem.
k. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

C. Liquid-In-Glass Thermometers
1. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:
   a. Standard: ASME B40.200.
   b. Case: Cast aluminum; 6-inch (152-mm) nominal size.
   c. Case Form: Back angle **OR** Straight, **as directed**, unless otherwise indicated.
   d. Tube: Glass with magnifying lens and blue or red organic liquid.
   e. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
   f. Window: Glass or plastic.
   g. Stem: Aluminum or brass and of length to suit installation.
      1) Design for Thermowell Installation: Bare stem.
   h. Connector: 3/4 inch (19 mm), with ASME B1.1 screw threads.
   i. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
2. Plastic-Case, Compact-Style, Liquid-in-Glass Thermometers:
   a. Standard: ASME B40.200.
   b. Case: Plastic; 6-inch (152-mm) nominal size.
   c. Case Form: Back angle **OR** Straight, **as directed**, unless otherwise indicated.
   d. Tube: Glass with magnifying lens and blue or red organic liquid.
   e. Tube Background: Nonreflective with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
   f. Window: Glass or plastic.
   g. Stem: Aluminum or brass and of length to suit installation.
      1) Design for Thermowell Installation: Bare stem.
   h. Connector: 3/4 inch (19 mm), with ASME B1.1 screw threads.
   i. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
3. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
   a. Standard: ASME B40.200.
   b. Case: Cast aluminum; 7-inch (178-mm) **OR** 9-inch (229-mm), **as directed**, nominal size unless otherwise indicated.
   c. Case Form: Adjustable angle **OR** Back angle **OR** Straight, **as directed**, unless otherwise indicated.
   d. Tube: Glass with magnifying lens and blue or red organic liquid.
   e. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
   f. Window: Glass or plastic.
   g. Stem: Aluminum and of length to suit installation.
      1) Design for Thermowell Installation: Bare stem.
   h. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
   i. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

4. Plastic-Case, Industrial-Style, Liquid-in-Glass Thermometers:
    a. Standard: ASME B40.200.
    b. Case: Plastic; 7-inch (178-mm) **OR** 9-inch (229-mm), **as directed**, nominal size unless otherwise indicated.
    c. Case Form: Adjustable angle **OR** Back angle **OR** Straight, **as directed**, unless otherwise indicated.
    d. Tube: Glass with magnifying lens and blue or red organic liquid.
    e. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
    f. Window: Glass or plastic.
    g. Stem: Aluminum **OR** Brass **OR** Stainless steel **OR** Aluminum, brass, or stainless steel, **as directed**, and of length to suit installation.
        1) Design for Thermowell Installation: Bare stem.
    h. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
    i. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

D. Light-Activated Thermometers
1. Direct-Mounted, Light-Activated Thermometers:
    a. Case: Plastic **OR** Metal, **as directed**; 7-inch (178-mm) **OR** 9-inch (229-mm), **as directed**, nominal size unless otherwise indicated.
    b. Scale(s): Deg F (Deg C) **OR** Deg F and deg C, **as directed**.
    c. Case Form: Adjustable angle.
    d. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
    e. Stem: Aluminum and of length to suit installation.
        1) Design for Thermowell Installation: Bare stem.
    f. Display: Digital.
    g. Accuracy: Plus or minus 2 deg F (1 deg C).
2. Remote-Mounted, Light-Activated Thermometers:
    a. Case: Plastic, for wall mounting.
    b. Scale(s): Deg F (Deg C) **OR** Deg F and deg C, **as directed**.
    c. Sensor: Bulb and thermister wire.
        1) Design for Thermowell Installation: Bare stem.
    d. Display: Digital.
    e. Accuracy: Plus or minus 2 deg F (1 deg C).

E. Thermowells
1. Thermowells:
    a. Standard: ASME B40.200.
    b. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
    c. Material for Use with Copper Tubing: CNR or CUNI.
    d. Material for Use with Steel Piping: CRES **OR** CSA, **as directed**.
    e. Type: Stepped shank unless straight or tapered shank is indicated.
    f. External Threads: NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.
    g. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
    h. Bore: Diameter required to match thermometer bulb or stem.
    i. Insertion Length: Length required to match thermometer bulb or stem.
    j. Lagging Extension: Include on thermowells for insulated piping and tubing.
    k. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
2. Heat-Transfer Medium: Mixture of graphite and glycerin.

F. Pressure Gages

1. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
   a. Standard: ASME B40.100.
   b. Case: Liquid-filled **OR** Sealed **OR** Open-front, pressure relief **OR** Solid-front, pressure relief, **as directed**, type(s); cast aluminum or drawn steel; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter.
   c. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
   d. Pressure Connection: Brass, with NPS 1/4 (DN 8) **OR** NPS 1/4 or NPS 1/2 (DN 8 or DN 15) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
   e. Movement: Mechanical, with link to pressure element and connection to pointer.
   f. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa) **OR** psi and kPa, **as directed**.
   g. Pointer: Dark-colored metal.
   h. Window: Glass or plastic.
   i. Ring: Metal **OR** Brass **OR** Stainless steel, **as directed**.
   j. Accuracy: Grade A, plus or minus 1 percent of middle half of **OR** Grade B, plus or minus 2 percent of middle half of **OR** Grade C, plus or minus 3 percent of middle half of **OR** Grade D, plus or minus 5 percent of whole, **as directed**, scale range.
2. Direct-Mounted, Plastic-Case, Dial-Type Pressure Gages:
   a. Standard: ASME B40.100.
   b. Case: Sealed type; plastic; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter.
   c. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
   d. Pressure Connection: Brass, with NPS 1/4 (DN 8) **OR** NPS 1/4 or NPS 1/2 (DN 8 or DN 15) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
   e. Movement: Mechanical, with link to pressure element and connection to pointer.
   f. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa) **OR** psi and kPa, **as directed**.
   g. Pointer: Dark-colored metal.
   h. Window: Glass or plastic.
   i. Accuracy: Grade A, plus or minus 1 percent of middle half of **OR** Grade B, plus or minus 2 percent of middle half of **OR** Grade C, plus or minus 3 percent of middle half of **OR** Grade D, plus or minus 5 percent of whole, **as directed**, scale range.
3. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:
   a. Standard: ASME B40.100.
   b. Case: Liquid-filled **OR** Sealed, **as directed**, type; cast aluminum or drawn steel **OR** metal, **as directed**; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter with back **OR** front, **as directed**, flange and holes for panel mounting.
   c. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
   d. Pressure Connection: Brass, with NPS 1/4 (DN 8) **OR** NPS 1/4 or NPS 1/2 (DN 8 or DN 15) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
   e. Movement: Mechanical, with link to pressure element and connection to pointer.
   f. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa) **OR** psi and kPa, **as directed**.
   g. Pointer: Dark-colored metal.
   h. Window: Glass or plastic.
   i. Ring: Metal **OR** Stainless steel, **as directed**.
   j. Accuracy: Grade A, plus or minus 1 percent of middle half of **OR** Grade B, plus or minus 2 percent of middle half of **OR** Grade C, plus or minus 3 percent of middle half of **OR** Grade D, plus or minus 5 percent of whole, **as directed**, scale range.
4. Remote-Mounted, Plastic-Case, Dial-Type Pressure Gages:
   a. Standard: ASME B40.100.
   b. Case: Sealed type; plastic; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter with back **OR** front, **as directed**, flange and holes for panel mounting.

c. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.

d. Pressure Connection: Brass, with NPS 1/4 (DN 8) **OR** NPS 1/4 or NPS 1/2 (DN 8 or DN 15) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.

e. Movement: Mechanical, with link to pressure element and connection to pointer.

f. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa) **OR** psi and kPa, **as directed**.

g. Pointer: Dark-colored metal.

h. Window: Glass or plastic.

i. Accuracy: Grade A, plus or minus 1 percent of middle half of **OR** Grade B, plus or minus 2 percent of middle half of **OR** Grade C, plus or minus 3 percent of middle half of **OR** Grade D, plus or minus 5 percent of whole, **as directed**, scale range.

G. Gage Attachments

1. Snubbers: ASME B40.100, brass; with NPS 1/4 (DN 8) **OR** NPS 1/4 or NPS 1/2 (DN 8 or DN 15) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads and piston **OR** porous-metal, **as directed**,-type surge-dampening device. Include extension for use on insulated piping.
2. Valves: Brass ball **OR** Brass or stainless-steel needle, **as directed**, with NPS 1/4 (DN 8) **OR** NPS 1/4 or NPS 1/2 (DN 8 or DN 15) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads.

H. Test Plugs

1. Description: Test-station fitting made for insertion into piping tee fitting.
2. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
3. Thread Size: NPS 1/4 (DN 8) or NPS 1/2 (DN 15), ASME B1.20.1 pipe thread.
4. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).
5. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

I. Test-Plug Kits

1. Furnish one test-plug kit(s) containing one **OR** two, **as directed**, thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
2. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F (minus 4 to plus 52 deg C).
3. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F (minus 18 to plus 104 deg C).
4. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- (51- to 76-mm-) diameter dial and probe. Dial range shall be at least 0 to 200 psig (0 to 1380 kPa).
5. Carrying Case: Metal or plastic, with formed instrument padding.

J. Sight Flow Indicators

1. Description: Piping inline-installation device for visual verification of flow.
2. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.
3. Minimum Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1034 kPa), **as directed**.
4. Minimum Temperature Rating: 200 deg F (93 deg C).
5. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
6. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

1.3 EXECUTION

A. Installation
1. Install thermowells with socket extending a minimum of 2 inches (51 mm) into fluid **OR** one-third of pipe diameter **OR** to center of pipe, **as directed**, and in vertical position in piping tees.
2. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
3. Install thermowells with extension on insulated piping.
4. Fill thermowells with heat-transfer medium.
5. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
6. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
7. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
8. Install remote-mounted pressure gages on panel.
9. Install valve and snubber in piping for each pressure gage for fluids.
10. Install test plugs in piping tees.
11. Install thermometers in the following locations:
    a. Inlet and outlet of each water heater.
    b. Inlets and outlets of each domestic water heat exchanger.
    c. Inlet and outlet of each domestic hot-water storage tank.
    d. Inlet and outlet of each remote domestic water chiller.
12. Install pressure gages in the following locations:
    a. Building water service entrance into building.
    b. Inlet and outlet of each pressure-reducing valve.
    c. Suction and discharge of each domestic water pump.

B. Connections
1. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

C. Adjusting
1. Adjust faces of meters and gages to proper angle for best visibility.

D. Thermometer Schedule
1. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:
    a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
    b. Direct **OR** Remote, **as directed**,-mounted, metal **OR** plastic, **as directed**,-case, vapor-actuated type.
    c. Compact **OR** Industrial, **as directed**,-style, liquid-in-glass type.
    d. Direct **OR** Remote, **as directed**,-mounted, light-activated type.
    e. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
2. Thermometers at inlets and outlets of each domestic water heat exchanger shall be one of the following:
    a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
    b. Direct **OR** Remote, **as directed**,-mounted, metal **OR** plastic, **as directed**,-case, vapor-actuated type.
    c. Compact **OR** Industrial, **as directed**,-style, liquid-in-glass type.
    d. Direct **OR** Remote, **as directed**,-mounted, light-activated type.
    e. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
3. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be one of the following:
    a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.

b. Direct **OR** Remote, **as directed**,-mounted, metal **OR** plastic, **as directed**,-case, vapor-actuated type.
c. Compact **OR** Industrial, **as directed**,-style, liquid-in-glass type.
d. Direct **OR** Remote, **as directed**,-mounted, light-activated type.
e. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.

4. Thermometers at inlet and outlet of each remote domestic water chiller shall be one of the following:
   a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
   b. Direct **OR** Remote, **as directed**,-mounted, metal **OR** plastic, **as directed**,-case, vapor-actuated type.
   c. Compact **OR** Industrial, **as directed**,-style, liquid-in-glass type.
   d. Direct **OR** Remote, **as directed**,-mounted, light-activated type.
   e. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
5. Thermometer stems shall be of length to match thermowell insertion length.

E. Thermometer Scale-Range Schedule
1. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F (Minus 20 to plus 50 deg C) **OR** 0 to 100 deg F and minus 20 to plus 50 deg C, **as directed**.
2. Scale Range for Domestic Cold-Water Piping: 0 to 150 deg F (Minus 20 to plus 70 deg C) **OR** 0 to 150 deg F and minus 20 to plus 70 deg C, **as directed**.
3. Scale Range for Domestic Cold-Water Piping: 30 to 240 deg F (0 to plus 115 deg C) **OR** 30 to 240 deg F and 0 to plus 115 deg C, **as directed**.
4. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F (0 to 150 deg C) **OR** 0 to 250 deg F and 0 to 150 deg C, **as directed**.
5. Scale Range for Domestic Hot-Water Piping: 20 to 240 deg F (0 to 150 deg C) **OR** 20 to 240 deg F and 0 to 150 deg C, **as directed**.
6. Scale Range for Domestic Hot-Water Piping: 30 to 240 deg F (0 to plus 115 deg C) **OR** 30 to 240 deg F and 0 to plus 115 deg C, **as directed**.
7. Scale Range for Domestic Cooled-Water Piping: 0 to 100 deg F (Minus 20 to plus 50 deg C) **OR** 0 to 100 deg F and minus 20 to plus 50 deg C, **as directed**.
8. Scale Range for Domestic Cooled-Water Piping: 0 to 150 deg F (Minus 20 to plus 70 deg C) **OR** 0 to 150 deg F and minus 20 to plus 70 deg C, **as directed**.

F. Pressure-Gage Schedule
1. Pressure gages at discharge of each water service into building shall be one of the following:
   a. Liquid-filled **OR** Sealed **OR** Open-front, pressure-relief **OR** Solid-front, pressure-relief, **as directed**, direct **OR** remote, **as directed**,-mounted, metal case.
   b. Sealed, direct **OR** remote, **as directed**,-mounted, plastic case.
   c. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
2. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:
   a. Liquid-filled **OR** Sealed **OR** Open-front, pressure-relief **OR** Solid-front, pressure-relief, **as directed**, direct **OR** remote, **as directed**,-mounted, metal case.
   b. Sealed, direct **OR** remote, **as directed**,-mounted, plastic case.
   c. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
3. Pressure gages at suction and discharge of each domestic water pump shall be one of the following:
   a. Liquid-filled **OR** Sealed **OR** Open-front, pressure-relief **OR** Solid-front, pressure-relief, **as directed**, direct **OR** remote, **as directed**,-mounted, metal case.
   b. Sealed, direct **OR** remote, **as directed**,-mounted, plastic case.

c. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.

G. Pressure-Gage Scale-Range Schedule
1. Scale Range for Water Service Piping: 0 to 100 psi (0 to 600 kPa) **OR** 0 to 100 psi and 0 to 600 kPa, **as directed**.
2. Scale Range for Water Service Piping: 0 to 160 psi (0 to 1100 kPa) **OR** 0 to 160 psi and 0 to 1100 kPa, **as directed**.
3. Scale Range for Water Service Piping: 0 to 200 psi (0 to 1400 kPa) **OR** 0 to 200 psi and 0 to 1400 kPa, **as directed**.
4. Scale Range for Domestic Water Piping: 0 to 100 psi (0 to 600 kPa) **OR** 0 to 100 psi and 0 to 600 kPa, **as directed**.
5. Scale Range for Domestic Water Piping: 0 to 160 psi (0 to 1100 kPa) **OR** 0 to 160 psi and 0 to 1100 kPa, **as directed**.
6. Scale Range for Domestic Water Piping: 0 to 200 psi (0 to 1400 kPa) **OR** 0 to 200 psi and 0 to 1400 kPa, **as directed**.
7. Scale Range for Domestic Water Piping: 0 to 300 psi (0 to 2500 kPa) **OR** 0 to 300 psi and 0 to 2500 kPa, **as directed**.

END OF SECTION 21 05 19 00

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SECTION 21 05 19 00a - METERS AND GAGES FOR HVAC PIPING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for meters and gages for HVAC piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Bimetallic-actuated thermometers.
b. Filled-system thermometers.
c. Liquid-in-glass thermometers.
d. Light-activated thermometers.
e. Thermowells.
f. Dial-type pressure gages.
g. Gage attachments.
h. Test plugs.
i. Test-plug kits.
j. Sight flow indicators.
k. Orifice flowmeters.
l. Pitot-tube flowmeters.
m. Turbine flowmeters.
n. Venturi flowmeters.
o. Vortex-shedding flowmeters.
p. Impeller-turbine, thermal-energy meters.
q. Ultrasonic, thermal-energy meters.

C. Submittals
1. Product Data: For each type of product indicated.
2. Wiring Diagrams: For power, signal, and control wiring.
3. Product Certificates: For each type of meter and gage, from manufacturer.
4. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

1.2 PRODUCTS

A. Bimetallic-Actuated Thermometers
1. Standard: ASME B40.200.
2. Case: Liquid-filled and sealed type(s); stainless steel with 3-inch (76-mm) **OR** 5-inch (127-mm), **as directed**, nominal diameter.
3. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F (deg C) **OR** deg F and deg C, **as directed**.
4. Connector Type(s): Union joint, adjustable angle **OR** rigid, back **OR** rigid, bottom, **as directed**, with unified-inch screw threads.
5. Connector Size: 1/2 inch (13 mm), with ASME B1.1 screw threads.
6. Stem: 0.25 or 0.375 inch (6.4 or 9.4 mm) in diameter; stainless steel.
7. Window: Plain glass or plastic.
8. Ring: Stainless steel.
9. Element: Bimetal coil.
10. Pointer: Dark-colored metal.

11. Accuracy: Plus or minus 1 **OR** 1.5, **as directed**, percent of scale range.

B. Filled-System Thermometers
1. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:
   a. Standard: ASME B40.200.
   b. Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch (114-mm) **OR** 5-inch (127-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter.
   c. Element: Bourdon tube or other type of pressure element.
   d. Movement: Mechanical, dampening type, **as directed**, with link to pressure element and connection to pointer.
   e. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
   f. Pointer: Dark-colored metal.
   g. Window: Glass or plastic.
   h. Ring: Metal **OR** Stainless steel.
   i. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device **OR** rigid, back **OR** rigid, bottom, **as directed**; with ASME B1.1 screw threads.
   j. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
      1) Design for Air-Duct Installation: With ventilated shroud.
      2) Design for Thermowell Installation: Bare stem.
   k. Accuracy: Plus or minus 1 percent of scale range.
2. Direct-Mounted, Plastic-Case, Vapor-Actuated Thermometers:
   a. Standard: ASME B40.200.
   b. Case: Sealed type, plastic; 4-1/2-inch (114-mm) **OR** 5-inch (127-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter.
   c. Element: Bourdon tube or other type of pressure element.
   d. Movement: Mechanical, with link to pressure element and connection to pointer.
   e. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
   f. Pointer: Dark-colored metal.
   g. Window: Glass or plastic.
   h. Ring: Metal or plastic.
   i. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device **OR** rigid, back **OR** rigid, bottom, **as directed**; with ASME B1.1 screw threads.
   j. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
      1) Design for Air-Duct Installation: With ventilated shroud.
      2) Design for Thermowell Installation: Bare stem.
   k. Accuracy: Plus or minus 1 percent of scale range.
3. Remote-Mounted, Metal-Case, Vapor-Actuated Thermometers:
   a. Standard: ASME B40.200.
   b. Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter with back **OR** front, **as directed**, flange and holes for panel mounting.
   c. Element: Bourdon tube or other type of pressure element.
   d. Movement: Mechanical, with link to pressure element and connection to pointer.
   e. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
   f. Pointer: Dark-colored metal.
   g. Window: Glass or plastic.
   h. Ring: Metal **OR** Stainless steel, **as directed**.

i. Connector Type(s): Union joint, back **OR** bottom, **as directed**; with ASME B1.1 screw threads.
j. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
   1) Design for Air-Duct Installation: With ventilated shroud.
   2) Design for Thermowell Installation: Bare stem.
k. Accuracy: Plus or minus 1 percent of scale range.

4. Remote-Mounted, Plastic-Case, Vapor-Actuated Thermometers:
   a. Standard: ASME B40.200.
   b. Case: Sealed type, plastic; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter with back **OR** front, **as directed**, flange and holes for panel mounting.
   c. Element: Bourdon tube or other type of pressure element.
   d. Movement: Mechanical, with link to pressure element and connection to pointer.
   e. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
   f. Pointer: Dark-colored metal.
   g. Window: Glass or plastic.
   h. Ring: Metal or plastic.
   i. Connector Type(s): Union joint, threaded, back **OR** bottom, **as directed**; with ASME B1.1 screw threads.
   j. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
      1) Design for Air-Duct Installation: With ventilated shroud.
      2) Design for Thermowell Installation: Bare stem.
   k. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

C. Liquid-In-Glass Thermometers
1. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:
   a. Standard: ASME B40.200.
   b. Case: Cast aluminum; 6-inch (152-mm) nominal size.
   c. Case Form: Back angle **OR** Straight, **as directed**, unless otherwise indicated.
   d. Tube: Glass with magnifying lens and blue or red, **as directed**, organic liquid.
   e. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
   f. Window: Glass or plastic.
   g. Stem: Aluminum or brass and of length to suit installation.
      1) Design for Air-Duct Installation: With ventilated shroud.
      2) Design for Thermowell Installation: Bare stem.
   h. Connector: 3/4 inch (19 mm), with ASME B1.1 screw threads.
   i. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
2. Plastic-Case, Compact-Style, Liquid-in-Glass Thermometers:
   a. Standard: ASME B40.200.
   b. Case: Plastic; 6-inch (152-mm) nominal size.
   c. Case Form: Back angle **OR** Straight, **as directed**, unless otherwise indicated.
   d. Tube: Glass with magnifying lens and blue or red, **as directed**, organic liquid.
   e. Tube Background: Nonreflective with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
   f. Window: Glass or plastic.
   g. Stem: Aluminum or brass and of length to suit installation.
      1) Design for Air-Duct Installation: With ventilated shroud.
      2) Design for Thermowell Installation: Bare stem.
   h. Connector: 3/4 inch (19 mm), with ASME B1.1 screw threads.
   i. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

3. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
   a. Standard: ASME B40.200.
   b. Case: Cast aluminum; 7-inch (178-mm) **OR** 9-inch (229-mm), **as directed**, nominal size unless otherwise indicated.
   c. Case Form: Adjustable angle **OR** Back angle **OR** Straight, **as directed**, unless otherwise indicated.
   d. Tube: Glass with magnifying lens and blue or red, **as directed**, organic liquid.
   e. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
   f. Window: Glass or plastic.
   g. Stem: Aluminum and of length to suit installation.
      1) Design for Air-Duct Installation: With ventilated shroud.
      2) Design for Thermowell Installation: Bare stem.
   h. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
   i. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
4. Plastic-Case, Industrial-Style, Liquid-in-Glass Thermometers:
   a. Standard: ASME B40.200.
   b. Case: Plastic; 7-inch (178-mm) **OR** 9-inch (229-mm), **as directed**, nominal size unless otherwise indicated.
   c. Case Form: Adjustable angle **OR** Back angle **OR** Straight, **as directed**, unless otherwise indicated.
   d. Tube: Glass with magnifying lens and blue or red, **as directed**, organic liquid.
   e. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
   f. Window: Glass or plastic.
   g. Stem: Aluminum **OR** Brass **OR** Stainless steel, **as directed**, and of length to suit installation.
      1) Design for Air-Duct Installation: With ventilated shroud.
      2) Design for Thermowell Installation: Bare stem.
   h. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
   i. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

D. Light-Activated Thermometers
1. Direct-Mounted, Light-Activated Thermometers:
   a. Case: Plastic **OR** Metal, **as directed**; 7-inch (178-mm) **OR** 9-inch (229-mm), **as directed**, nominal size unless otherwise indicated.
   b. Scale(s): Deg F (Deg C) **OR** Deg F and deg C, **as directed**.
   c. Case Form: Adjustable angle.
   d. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
   e. Stem: Aluminum and of length to suit installation.
      1) Design for Air-Duct Installation: With ventilated shroud.
      2) Design for Thermowell Installation: Bare stem.
   f. Display: Digital.
   g. Accuracy: Plus or minus 2 deg F (1 deg C).
2. Remote-Mounted, Light-Activated Thermometers:
   a. Case: Plastic, for wall mounting.
   b. Scale(s): Deg F (Deg C) **OR** Deg F and deg C, **as directed**.
   c. Sensor: Bulb and thermister wire.
      1) Design for Air-Duct Installation: With ventilated shroud.
      2) Design for Thermowell Installation: Bare stem.
   d. Display: Digital.
   e. Accuracy: Plus or minus 2 deg F (1 deg C).

E. Duct-Thermometer Mounting Brackets
   1. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

F. Thermowells
   1. Thermowells:
      a. Standard: ASME B40.200.
      b. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
      c. Material for Use with Copper Tubing: CNR **OR** CUNI, **as directed**.
      d. Material for Use with Steel Piping: CRES **OR** CSA, **as directed**.
      e. Type: Stepped shank unless straight or tapered shank is indicated.
      f. External Threads: NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.
      g. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
      h. Bore: Diameter required to match thermometer bulb or stem.
      i. Insertion Length: Length required to match thermometer bulb or stem.
      j. Lagging Extension: Include on thermowells for insulated piping and tubing.
      k. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
   2. Heat-Transfer Medium: Mixture of graphite and glycerin.

G. Pressure Gages
   1. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
      1) Standard: ASME B40.100.
      2) Case: Liquid-filled **OR** Sealed **OR** Open-front, pressure relief **OR** Solid-front, pressure relief, **as directed**, type(s); cast aluminum or drawn steel; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter.
      3) Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
      4) Pressure Connection: Brass, with NPS 1/4 (DN 8) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
      5) Movement: Mechanical, with link to pressure element and connection to pointer.
      6) Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa) **OR** psi and kPa, **as directed**.
      7) Pointer: Dark-colored metal.
      8) Window: Glass or plastic.
      9) Ring: Metal **OR** Brass **OR** Stainless steel, **as directed**.
      10) Accuracy: Grade A, plus or minus 1 percent of middle half of **OR** Grade B, plus or minus 2 percent of middle half of **OR** Grade C, plus or minus 3 percent of middle half of **OR** Grade D, plus or minus 5 percent of whole, **as directed**, scale range.
   2. Direct-Mounted, Plastic-Case, Dial-Type Pressure Gages:
      a. Standard: ASME B40.100.
      b. Case: Sealed type; plastic; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter.
      c. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
      d. Pressure Connection: Brass, with NPS 1/4 (DN 8) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
      e. Movement: Mechanical, with link to pressure element and connection to pointer.
      f. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa) **OR** psi and kPa, **as directed**.
      g. Pointer: Dark-colored metal.
      h. Window: Glass or plastic.
      i. Accuracy: Grade A, plus or minus 1 percent of middle half of **OR** Grade B, plus or minus 2 percent of middle half of **OR** Grade C, plus or minus 3 percent of middle half of **OR** Grade D, plus or minus 5 percent of whole, **as directed**, scale range.

3. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:
   a. Standard: ASME B40.100.
   b. Case: Liquid-filled **OR** Sealed, **as directed**, type; cast aluminum or drawn steel **OR** metal, **as directed**; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter with back **OR** front, **as directed**, flange and holes for panel mounting.
   c. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
   d. Pressure Connection: Brass, with NPS 1/4 (DN 8) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
   e. Movement: Mechanical, with link to pressure element and connection to pointer.
   f. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa) **OR** psi and kPa, **as directed**.
   g. Pointer: Dark-colored metal.
   h. Window: Glass or plastic.
   i. Ring: Metal **OR** Stainless steel, **as directed**.
   j. Accuracy: Grade A, plus or minus 1 percent of middle half of **OR** Grade B, plus or minus 2 percent of middle half of **OR** Grade C, plus or minus 3 percent of middle half of **OR** Grade D, plus or minus 5 percent of whole, **as directed**, scale range.
4. Remote-Mounted, Plastic-Case, Dial-Type Pressure Gages:
   a. Standard: ASME B40.100.
   b. Case: Sealed type; plastic; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter with back **OR** front, **as directed**, flange and holes for panel mounting.
   c. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
   d. Pressure Connection: Brass, with NPS 1/4 (DN 8) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
   e. Movement: Mechanical, with link to pressure element and connection to pointer.
   f. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa) **OR** psi and kPa, **as directed**.
   g. Pointer: Dark-colored metal.
   h. Window: Glass or plastic.
   i. Accuracy: Grade A, plus or minus 1 percent of middle half of **OR** Grade B, plus or minus 2 percent of middle half of **OR** Grade C, plus or minus 3 percent of middle half of **OR** Grade D, plus or minus 5 percent of whole, **as directed**, scale range.

H. Gage Attachments
1. Snubbers: ASME B40.100, brass; with NPS 1/4 (DN 8) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads and piston-type **OR** porous-metal-type, **as directed**, surge-dampening device. Include extension for use on insulated piping.
2. Siphons: Loop-shaped section of brass **OR** stainless-steel **OR** steel, **as directed**, pipe with NPS 1/4 (DN 8) **OR** NPS 1/2 (DN 15), **as directed**, pipe threads.
3. Valves: Brass ball **OR** Brass or stainless-steel needle, **as directed**, with NPS 1/4 (DN 8) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads.

I. Test Plugs
1. Description: Test-station fitting made for insertion into piping tee fitting.
2. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
3. Thread Size: NPS 1/4 (DN 8) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe thread.
4. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).
5. Core Inserts: Chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber.

J. Test-Plug Kits
1. Furnish one test-plug kit(s) containing one **OR** two, **as directed**, thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

2. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F (minus 4 to plus 52 deg C).
3. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F (minus 18 to plus 104 deg C).
4. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- (51- to 76-mm-) diameter dial and probe. Dial range shall be at least 0 to 200 psig (0 to 1380 kPa).
5. Carrying Case: Metal or plastic, with formed instrument padding.

K. Sight Flow Indicators
1. Description: Piping inline-installation device for visual verification of flow.
2. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.
3. Minimum Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1034 kPa), **as directed**.
4. Minimum Temperature Rating: 200 deg F (93 deg C).
5. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
6. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

L. Flowmeters
1. Orifice Flowmeters:
   a. Description: Flowmeter with sensor, hoses or tubing, fittings, valves, indicator, and conversion chart.
   b. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
   c. Sensor: Wafer-orifice-type, calibrated, flow-measuring element; for installation between pipe flanges.
      1) Design: Differential-pressure-type measurement for gas **OR** oil **OR** steam **OR** water, **as directed**.
      2) Construction: Cast-iron body, brass valves with integral check valves and caps, and calibrated nameplate.
      3) Minimum Pressure Rating: 300 psig (2070 kPa).
      4) Minimum Temperature Rating: 250 deg F (121 deg C).
   d. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected sensor and having 6-inch- (152-mm-) diameter, or equivalent, dial with fittings and copper tubing for connecting to sensor.
      1) Scale: Gallons per minute (Liters per second).
      2) Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range.
   e. Portable Indicators: Hand-held, differential-pressure type, calibrated for connected sensor and having two 12-foot (3.7-m) hoses, with carrying case.
      1) Scale: Gallons per minute (Liters per second).
      2) Accuracy: Plus or minus 2 percent between 20 and 80 percent of scale range.
   f. Display: Shows rate of flow, with register to indicate total volume in gallons (liters).
   g. Conversion Chart: Flow rate data compatible with sensor and indicator.
   h. Operating Instructions: Include complete instructions with each flowmeter.
2. Pitot-Tube Flowmeters:
   a. Description: Flowmeter with sensor and indicator.
   b. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
   c. Sensor: Insertion type; for inserting probe into piping and measuring flow directly in gallons per minute (liters per second).
      1) Design: Differential-pressure-type measurement for oil **OR** water, **as directed**.
      2) Construction: Stainless-steel probe of length to span inside of pipe, with integral transmitter and direct-reading scale.
      3) Minimum Pressure Rating: 150 psig (1035 kPa).
      4) Minimum Temperature Rating: 250 deg F (121 deg C).

d. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
e. Integral Transformer: For low-voltage power connection.
f. Accuracy: Plus or minus 3 percent.
g. Display: Shows rate of flow, with register to indicate total volume in gallons (liters).
h. Operating Instructions: Include complete instructions with each flowmeter.

3. Turbine Flowmeters:
   a. Description: Flowmeter with sensor and indicator.
   b. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
   c. Sensor: Impeller turbine; for inserting into pipe fitting or for installing in piping and measuring flow directly in gallons per minute (liters per second).
      1) Design: Device or pipe fitting with inline turbine and integral direct-reading scale for gas **OR** oil **OR** steam **OR** water, **as directed**.
      2) Construction: Bronze or stainless-steel body, with plastic turbine or impeller.
      3) Minimum Pressure Rating: 150 psig (1035 kPa).
      4) Minimum Temperature Rating: 180 deg F (82 deg C).
   d. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
   e. Accuracy: Plus or minus 1-1/2 percent.
   f. Display: Shows rate of flow, with register to indicate total volume in gallons (liters).
   g. Operating Instructions: Include complete instructions with each flowmeter.
4. Venturi Flowmeters:
   a. Description: Flowmeter with calibrated flow-measuring element, hoses or tubing, fittings, valves, indicator, and conversion chart.
   b. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
   c. Sensor: Venturi-type, calibrated, flow-measuring element; for installation in piping.
      1) Design: Differential-pressure-type measurement for gas **OR** oil **OR** steam **OR** water, **as directed**.
      2) Construction: Bronze, brass, or factory-primed steel, with brass fittings and attached tag with flow conversion data.
      3) Minimum Pressure Rating: 250 psig (1725 kPa).
      4) Minimum Temperature Rating: 250 deg F (121 deg C).
      5) End Connections for NPS 2 (DN 50) and Smaller: Threaded.
      6) End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged or welded.
      7) Flow Range: Flow-measuring element and flowmeter shall cover operating range of equipment or system served.
   d. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having 6-inch- (152-mm-) diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element.
      1) Scale: Gallons per minute (Liters per second).
      2) Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range.
   e. Portable Indicators: Hand-held, differential-pressure type, calibrated for connected flowmeter element and having two 12-foot (3.7-m) hoses, with carrying case.
      1) Scale: Gallons per minute (Liters per second).
      2) Accuracy: Plus or minus 2 percent between 20 and 80 percent of scale range.
   f. Display: Shows rate of flow, with register to indicate total volume in gallons (liters).
   g. Conversion Chart: Flow rate data compatible with sensor.
   h. Operating Instructions: Include complete instructions with each flowmeter.
5. Vortex-Shedding Flowmeters:
   a. Description: Flowmeter with sensor and indicator.
   b. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
   c. Sensor: Inline type; for installing between pipe flanges and measuring flow directly in gallons per minute (liters per second).

1) Design: Flow obstruction device, vortex-measurement type for gas **OR** steam **OR** liquids, **as directed**.
2) Construction: Stainless-steel body, with integral transmitter and direct-reading scale.
3) Minimum Pressure Rating: 1000 psig (6900 kPa).
4) Minimum Temperature Rating: 500 deg F (260 deg C).
5) Integral Transformer: For low-voltage power operation.

d. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
e. Accuracy: Plus or minus 0.25 percent for liquids and 0.75 percent for gases.
f. Display: Shows rate of flow, with register to indicate total volume in gallons (liters).
g. Operating Instructions: Include complete instructions with each flowmeter.

M. Thermal-Energy Meters

1. Impeller-Turbine, Thermal-Energy Meters:
   a. Description: System with strainer, **as directed**, flow sensor, temperature sensors, transmitter, indicator, and connecting wiring.
   b. Flow Sensor: Impeller turbine with corrosion-resistant-metal body and transmitter; for installing in piping.
      1) Design: Total thermal-energy measurement.
      2) Minimum Pressure Rating: 150 psig (1035 kPa).
      3) Minimum Temperature Range: 40 to 250 deg F (5 to 121 deg C).
   c. Temperature Sensors: Insertion-type transducer.
   d. Indicator: Solid-state, integrating-type meter with integral battery pack, **as directed**; for wall mounting.
      1) Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units (joules).
      2) Battery Pack: Five-year lithium battery.
   e. Accuracy: Plus or minus 1 percent.
   f. Display: Visually indicates total fluid volume in gallons (liters) and thermal-energy flow in kilowatts per hour or British thermal units (joules).
   g. Strainer: Full size of main line piping.
   h. Operating Instructions: Include complete instructions with each thermal-energy meter system.
2. Ultrasonic, Thermal-Energy Meters:
   a. Description: Meter with flow sensor, temperature sensors, transmitter, indicator, and connecting wiring.
   b. Flow Sensor: Transit-time ultrasonic type with transmitter.
   c. Temperature Sensors: Insertion-type or strap-on transducer.
   d. Indicator: Solid-state, integrating-type meter with integral battery pack, **as directed**.
      1) Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units (joules).
      2) Battery Pack: Five-year lithium battery.
   e. Accuracy: Plus or minus 1 percent.
   f. Display: Visually indicates total fluid volume in gallons (liters) and thermal-energy flow in kilowatts per hour or British thermal units (joules).
   g. Operating Instructions: Include complete instructions with each thermal-energy meter system.

1.3 EXECUTION

A. Installation

1. Install thermowells with socket extending a minimum of 2 inches (51 mm) into fluid **OR** one-third of pipe diameter **OR** to center of pipe, **as directed**, and in vertical position in piping tees.
2. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

3. Install thermowells with extension on insulated piping.
4. Fill thermowells with heat-transfer medium.
5. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
6. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
7. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.
8. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
9. Install remote-mounted pressure gages on panel.
10. Install valve and snubber in piping for each pressure gage for fluids (except steam).
11. Install valve and syphon fitting in piping for each pressure gage for steam.
12. Install test plugs in piping tees.
13. Install flow indicators in piping systems in accessible positions for easy viewing.
14. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
15. Install flowmeter elements in accessible positions in piping systems.
16. Install wafer-orifice flowmeter elements between pipe flanges.
17. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
18. Install permanent indicators on walls or brackets in accessible and readable positions.
19. Install connection fittings in accessible locations for attachment to portable indicators.
20. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.
21. Install thermometers in the following locations:
    a. Inlet and outlet of each hydronic zone.
    b. Inlet and outlet of each hydronic boiler.
    c. Two inlets and two outlets of each chiller.
    d. Inlet and outlet of each hydronic coil in air-handling units.
    e. Two inlets and two outlets of each hydronic heat exchanger.
    f. Inlet and outlet of each thermal-storage tank.
    g. Outside-, return-, supply-, and mixed-air ducts.
22. Install pressure gages in the following locations:
    a. Discharge of each pressure-reducing valve.
    b. Inlet and outlet of each chiller chilled-water and condenser-water connection.
    c. Suction and discharge of each pump.

B. Connections
1. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
2. Connect flowmeter-system elements to meters.
3. Connect flowmeter transmitters to meters.
4. Connect thermal-energy meter transmitters to meters.

C. Adjusting
1. After installation, calibrate meters according to manufacturer's written instructions.
2. Adjust faces of meters and gages to proper angle for best visibility.

D. Thermometer Schedule
1. Thermometers at inlet and outlet of each hydronic zone shall be one of the following:
    a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
    b. Direct-mounted **OR** Remote-mounted, **as directed**, metal-case **OR** plastic-case, **as directed**, vapor-actuated type.
    c. Compact-style **OR** Industrial-style, **as directed**, liquid-in-glass type.
    d. Direct-mounted **OR** Remote-mounted, **as directed**, light-activated type.
    e. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.

2. Thermometers at inlet and outlet of each hydronic boiler shall be one of the following:
   a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
   b. Direct-mounted **OR** Remote-mounted, **as directed**, metal-case **OR** plastic-case, **as directed**, vapor-actuated type.
   c. Compact-style **OR** Industrial-style, **as directed**, liquid-in-glass type.
   d. Direct-mounted **OR** Remote-mounted, **as directed**, light-activated type.
   e. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
3. Thermometers at inlets and outlets of each chiller shall be one of the following:
   a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
   b. Direct-mounted **OR** Remote-mounted, **as directed**, metal-case **OR** plastic-case, **as directed**, vapor-actuated type.
   c. Compact-style **OR** Industrial-style, **as directed**, liquid-in-glass type.
   d. Direct-mounted **OR** Remote-mounted, **as directed**, light-activated type.
   e. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
4. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be one of the following:
   a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
   b. Direct-mounted **OR** Remote-mounted, **as directed**, metal-case **OR** plastic-case, **as directed**, vapor-actuated type.
   c. Compact-style **OR** Industrial-style, **as directed**, liquid-in-glass type.
   d. Direct-mounted **OR** Remote-mounted, **as directed**, light-activated type.
   e. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
5. Thermometers at inlets and outlets of each hydronic heat exchanger shall be one of the following:
   a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
   b. Direct-mounted **OR** Remote-mounted, **as directed**, metal-case **OR** plastic-case, **as directed**, vapor-actuated type.
   c. Compact-style **OR** Industrial-style, **as directed**, liquid-in-glass type.
   d. Direct-mounted **OR** Remote-mounted, **as directed**, light-activated type.
   e. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
6. Thermometers at inlet and outlet of each hydronic heat-recovery unit shall be one of the following:
   a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
   b. Direct-mounted **OR** Remote-mounted, **as directed**, metal-case **OR** plastic-case, **as directed**, vapor-actuated type.
   c. Compact-style **OR** Industrial-style, **as directed**, liquid-in-glass type.
   d. Direct-mounted **OR** Remote-mounted, **as directed**, light-activated type.
   e. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
7. Thermometers at inlet and outlet of each thermal-storage tank shall be one of the following:
   a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
   b. Direct-mounted **OR** Remote-mounted, **as directed**, metal-case **OR** plastic-case, **as directed**, vapor-actuated type.
   c. Compact-style **OR** Industrial-style, **as directed**, liquid-in-glass type.
   d. Direct-mounted **OR** Remote-mounted, **as directed**, light-activated type.
   e. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
8. Thermometers at outside-, return-, supply-, and mixed-air ducts shall be one of the following:
   a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
   b. Direct-mounted **OR** Remote-mounted, **as directed**, metal-case **OR** plastic-case, **as directed**, vapor-actuated type.
   c. Compact-style **OR** Industrial-style, **as directed**, liquid-in-glass type.
   d. Direct-mounted **OR** Remote-mounted, **as directed**, light-activated type.
9. Thermometer stems shall be of length to match thermowell insertion length.

E. Thermometer Scale-Range Schedule
1. Scale Range for Chilled-Water Piping: Minus 40 to plus 160 deg F (Minus 40 to plus 100 deg C) **OR** Minus 40 to plus 160 deg F and minus 40 to plus 100 deg C, **as directed**.
2. Scale Range for Chilled-Water Piping: 0 to 100 deg F (Minus 20 to plus 50 deg C) **OR** 0 to 100 deg F and minus 20 to plus 50 deg C, **as directed**.
3. Scale Range for Chilled-Water Piping: 0 to 150 deg F (Minus 20 to plus 70 deg C) **OR** 0 to 150 deg F and minus 20 to plus 70 deg C, **as directed**.
4. Scale Range for Chilled-Water Piping: 0 to 250 deg F (0 to 150 deg C) **OR** 0 to 250 deg F and 0 to 150 deg C, **as directed**.
5. Scale Range for Condenser-Water Piping: 0 to 100 deg F (Minus 20 to plus 50 deg C) **OR** 0 to 100 deg F and minus 20 to plus 50 deg C, **as directed**.
6. Scale Range for Condenser-Water Piping: 0 to 150 deg F (Minus 20 to plus 70 deg C) **OR** 0 to 150 deg F and minus 20 to plus 70 deg C, **as directed**.
7. Scale Range for Condenser-Water Piping: 0 to 250 deg F (0 to 150 deg C) **OR** 0 to 250 deg F and 0 to 150 deg C, **as directed**.
8. Scale Range for Condenser-Water Piping: 20 to 240 deg F (0 to 150 deg C) **OR** 20 to 240 deg F and 0 to 150 deg C, **as directed**.
9. Scale Range for Condenser-Water Piping: 30 to 240 deg F (0 to plus 115 deg C) **OR** 30 to 240 deg F and 0 to plus 115 deg C, **as directed**.
10. Scale Range for Heating, Hot-Water Piping: 0 to 250 deg F (0 to 150 deg C) **OR** 0 to 250 deg F and 0 to 150 deg C, **as directed**.
11. Scale Range for Heating, Hot-Water Piping: 20 to 240 deg F (0 to 150 deg C) **OR** 20 to 240 deg F and 0 to 150 deg C, **as directed**.
12. Scale Range for Heating, Hot-Water Piping: 30 to 240 deg F (0 to plus 115 deg C) **OR** 30 to 240 deg F and 0 to plus 115 deg C, **as directed**.
13. Scale Range for Heating, Hot-Water Piping: 50 to 400 deg F (0 to 200 deg C) **OR** 50 to 400 deg F and 0 to 200 deg C, **as directed**.
14. Scale Range for Heating, Hot-Water Piping: 50 to 550 deg F (10 to 300 deg C) **OR** 50 to 550 deg F and 10 to 300 deg C, **as directed**.
15. Scale Range for Steam and Steam-Condensate Piping: 0 to 250 deg F (0 to 150 deg C) **OR** 0 to 250 deg F and 0 to 150 deg C, **as directed**.
16. Scale Range for Steam and Steam-Condensate Piping: 20 to 240 deg F (0 to 150 deg C) **OR** 20 to 240 deg F and 0 to 150 deg C, **as directed**.
17. Scale Range for Steam and Steam-Condensate Piping: 30 to 240 deg F (0 to plus 115 deg C) **OR** 30 to 240 deg F and 0 to plus 115 deg C, **as directed**.
18. Scale Range for Steam and Steam-Condensate Piping: 50 to 400 deg F (0 to 200 deg C) **OR** 50 to 400 deg F and 0 to 200 deg C, **as directed**.
19. Scale Range for Air Ducts: Minus 40 to plus 110 deg F (Minus 40 to plus 45 deg C) **OR** Minus 40 to plus 110 deg F and minus 40 to plus 45 deg C, **as directed**.
20. Scale Range for Air Ducts: Minus 40 to plus 160 deg F (Minus 40 to plus 100 deg C) **OR** Minus 40 to plus 160 deg F and minus 40 to plus 100 deg C, **as directed**.
21. Scale Range for Air Ducts: 0 to 100 deg F (Minus 20 to plus 50 deg C) **OR** 0 to 100 deg F and minus 20 to plus 50 deg C, **as directed**.
22. Scale Range for Air Ducts: 0 to 150 deg F (Minus 20 to plus 70 deg C) **OR** 0 to 150 deg F and minus 20 to plus 70 deg C, **as directed**.
23. Scale Range for Air Ducts: 0 to 250 deg F (0 to 150 deg C) **OR** 0 to 250 deg F and 0 to 150 deg C, **as directed**.
24. Scale Range for Air Ducts: 20 to 240 deg F (0 to 150 deg C) **OR** 20 to 240 deg F and 0 to 150 deg C, **as directed**.
25. Scale Range for Air Ducts: 30 to 240 deg F (0 to plus 115 deg C) **OR** 30 to 240 deg F and 0 to plus 115 deg C, **as directed.**
26. Scale Range for Air Ducts: 50 to 400 deg F (0 to 200 deg C) **OR** 50 to 400 deg F and 0 to 200 deg C, **as directed**.

F. Pressure-Gage Schedule

1. Pressure gages at discharge of each pressure-reducing valve shall be one of the following:
    a. Liquid-filled **OR** Sealed **OR** Open-front, pressure-relief **OR** Solid-front, pressure-relief, **as directed**, direct-mounted **OR** remote-mounted, **as directed**, metal case.
    b. Sealed, direct-mounted **OR** remote-mounted, **as directed**, plastic case.
    c. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
2. Pressure gages at inlet and outlet of each chiller chilled-water and condenser-water connection shall be one of the following:
    a. Liquid-filled **OR** Sealed **OR** Open-front, pressure-relief **OR** Solid-front, pressure-relief, **as directed**, direct-mounted **OR** remote-mounted, **as directed**, metal case.
    b. Sealed, direct-mounted **OR** remote-mounted, **as directed**, plastic case.
    c. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
3. Pressure gages at suction and discharge of each pump shall be one of the following:
    a. Liquid-filled **OR** Sealed **OR** Open-front, pressure-relief **OR** Solid-front, pressure-relief, **as directed**, direct-mounted **OR** remote-mounted, **as directed**, metal case.
    b. Sealed, direct-mounted **OR** remote-mounted, **as directed**, plastic case.
    c. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.

G. Pressure-Gage Scale-Range Schedule
1. Scale Range for Chilled-Water Piping: 30 in. Hg to 15 psi (minus 100 to 0 kPa) **OR** 30 in. Hg to 15 psi and minus 100 to 0 kP, **as directed**.
2. Scale Range for Chilled-Water Piping: 0 to 30 psi (0 to 240 kPa) **OR** 0 to 30 psi and 0 to 240 kP, **as directed**.
3. Scale Range for Chilled-Water Piping: 0 to 100 psi (0 to 600 kPa) **OR** 0 to 100 psi and 0 to 600 kP, **as directed**.
4. Scale Range for Chilled-Water Piping: 0 to 160 psi (0 to 1100 kPa) **OR** 0 to 160 psi and 0 to 1100 kP, **as directed**.
5. Scale Range for Chilled-Water Piping: 0 to 200 psi (0 to 1400 kPa) **OR** 0 to 200 psi and 0 to 1400 kPa, **as directed**.
6. Scale Range for Chilled-Water Piping: 0 to 300 psi (0 to 2500 kPa) **OR** 0 to 300 psi and 0 to 2500 kPa, **as directed**.
7. Scale Range for Chilled-Water Piping: 0 to 600 psi (0 to 4000 kPa) **OR** 0 to 600 psi and 0 to 4000 kPa, **as directed**.
8. Scale Range for Condenser-Water Piping: 30 in. Hg to 15 psi (minus 100 to 0 kPa) **OR** 30 in. Hg to 15 psi and minus 100 to 0 kPa, **as directed**.
9. Scale Range for Condenser-Water Piping: 0 to 30 psi (0 to 240 kPa) **OR** 0 to 30 psi and 0 to 240 kPa, **as directed**.
10. Scale Range for Condenser-Water Piping: 0 to 100 psi (0 to 600 kPa) **OR** 0 to 100 psi and 0 to 600 kPa, **as directed**.
11. Scale Range for Condenser-Water Piping: 0 to 160 psi (0 to 1100 kPa) **OR** 0 to 160 psi and 0 to 1100 kPa, **as directed**.
12. Scale Range for Condenser-Water Piping: 0 to 200 psi (0 to 1400 kPa) **OR** 0 to 200 psi and 0 to 1400 kPa, **as directed**.
13. Scale Range for Condenser-Water Piping: 0 to 300 psi (0 to 2500 kPa) **OR** 0 to 300 psi and 0 to 2500 kPa, **as directed**.
14. Scale Range for Condenser-Water Piping: 0 to 600 psi (0 to 4000 kPa) **OR** 0 to 600 psi and 0 to 4000 kPa, **as directed**.
15. Scale Range for Heating, Hot-Water Piping: 30 in. Hg to 15 psi (minus 100 to 0 kPa) **OR** 30 in. Hg to 15 psi and minus 100 to 0 kPa, **as directed**.
16. Scale Range for Heating, Hot-Water Piping: 0 to 30 psi (0 to 240 kPa) **OR** 0 to 30 psi and 0 to 240 kPa, **as directed**.
17. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi (0 to 600 kPa) **OR** 0 to 100 psi and 0 to 600 kPa, **as directed**.

18. Scale Range for Heating, Hot-Water Piping: 0 to 160 psi (0 to 1100 kPa) **OR** 0 to 160 psi and 0 to 1100 kPa, **as directed**.
19. Scale Range for Heating, Hot-Water Piping: 0 to 200 psi (0 to 1400 kPa) **OR** 0 to 200 psi and 0 to 1400 kPa, **as directed**.
20. Scale Range for Heating, Hot-Water Piping: 0 to 300 psi (0 to 2500 kPa) **OR** 0 to 300 psi and 0 to 2500 kPa, **as directed**.
21. Scale Range for Heating, Hot-Water Piping: 0 to 600 psi (0 to 4000 kPa) **OR** 0 to 600 psi and 0 to 4000 kPa, **as directed**.
22. Scale Range for Steam Piping: 30 in. Hg to 15 psi (minus 100 to 0 kPa) **OR** 30 in. Hg to 15 psi and minus 100 to 0 kPa, **as directed**.
23. Scale Range for Steam Piping: 0 to 30 psi (0 to 240 kPa) **OR** 0 to 30 psi and 0 to 240 kPa, **as directed**.
24. Scale Range for Steam Piping: 0 to 100 psi (0 to 600 kPa) **OR** 0 to 100 psi and 0 to 600 kPa, **as directed**.
25. Scale Range for Steam Piping: 0 to 160 psi (0 to 1100 kPa) **OR** 0 to 160 psi and 0 to 1100 kPa, **as directed**.
26. Scale Range for Steam Piping: 0 to 200 psi (0 to 1400 kPa) **OR** 0 to 200 psi and 0 to 1400 kPa, **as directed**.
27. Scale Range for Steam Piping: 0 to 300 psi (0 to 2500 kPa) **OR** 0 to 300 psi and 0 to 2500 kPa, **as directed**.
28. Scale Range for Steam Piping: 0 to 600 psi (0 to 4000 kPa) **OR** 0 to 600 psi and 0 to 4000 kPa, **as directed**.

H. Flowmeter Schedule
1. Flowmeters for Chilled-Water Piping: Orifice **OR** Pitot-tube **OR** Turbine **OR** Venturi **OR** Vortex-shedding, **as directed,** type.
2. Flowmeters for Condenser-Water Piping: Orifice **OR** Pitot-tube **OR** Turbine **OR** Venturi **OR** Vortex-shedding, **as directed,** type.
3. Flowmeters for Heating, Hot-Water Piping: Orifice **OR** Pitot-tube **OR** Turbine **OR** Venturi **OR** Vortex-shedding, **as directed,** type.
4. Flowmeters for Steam and Steam-Condensate Piping: Orifice **OR** Turbine **OR** Venturi **OR** Vortex-shedding, **as directed,** type.

I. Thermal-Energy Meter Schedule
1. Thermal-Energy Meters for Chilled-Water Piping: Impeller-turbine **OR** Ultrasonic, **as directed,** type.
2. Thermal-Energy Meters for Condenser-Water Piping: Impeller-turbine **OR** Ultrasonic, **as directed,** type.
3. Thermal-Energy Meters for Heating, Hot-Water Piping: Impeller-turbine **OR** Ultrasonic, **as directed,** type.
4. Thermal-Energy Meters for Steam and Steam-Condensate Piping: Impeller-turbine **OR** Ultrasonic, **as directed,** type.

END OF SECTION 21 05 19 00a

Task	Specification	Specification Description
21 05 19 00	01 22 16 00	No Specification Required
21 05 19 00	13 12 13 00	Water Distribution

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SECTION 21 05 23 00 - PIPED UTILITIES BASIC MATERIALS AND METHODS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for piped utilities - basic materials and methods. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes the following:
   a. Piping joining materials.
   b. Transition fittings.
   c. Dielectric fittings.
   d. Sleeves.
   e. Identification devices.
   f. Grout.
   g. Flowable fill.
   h. Piped utility demolition.
   i. Piping system common requirements.
   j. Equipment installation common requirements.
   k. Painting.
   l. Concrete bases.
   m. Metal supports and anchorages.

C. Definitions

1. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.
2. Concealed Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
3. ABS: Acrylonitrile-butadiene-styrene plastic.
4. CPVC: Chlorinated polyvinyl chloride plastic.
5. PE: Polyethylene plastic.
6. PVC: Polyvinyl chloride plastic.

D. Submittals

1. Product Data: For the following:
   a. Dielectric fittings.
   b. Identification devices.
2. Welding certificates.

E. Quality Assurance

1. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. Steel Piping Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   a. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   b. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
3. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

F. Delivery, Storage, And Handling
1. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
2. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.2 PRODUCTS

A. Piping Joining Materials
1. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   a. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness, unless otherwise indicated.
      1) Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      2) Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   b. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
3. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
4. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
5. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
6. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
7. Solvent Cements for Joining Plastic Piping:
   a. ABS Piping: ASTM D 2235.
   b. CPVC Piping: ASTM F 493.
   c. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
   d. PVC to ABS Piping Transition: ASTM D 3138.
8. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

B. Transition Fittings
1. Transition Fittings, General: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
2. Transition Couplings NPS 1-1/2 (DN 40) and Smaller:
   a. Underground Piping: Manufactured piping coupling or specified piping system fitting.
   b. Aboveground Piping: Specified piping system fitting.
3. AWWA Transition Couplings NPS 2 (DN 50) and Larger:
   a. Description: AWWA C219, metal sleeve-type coupling for underground pressure piping.
4. Plastic-to-Metal Transition Fittings:
   a. Description: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint or threaded end.
5. Plastic-to-Metal Transition Unions:
   a. Description: MSS SP-107, CPVC and PVC four-part union. Include brass or stainless-steel threaded end, solvent-cement-joint or threaded plastic end, rubber O-ring, and union nut.
6. Flexible Transition Couplings for Underground Nonpressure Drainage Piping:
   a. Description: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

C. Dielectric Fittings
1. Dielectric Fittings, General: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.
2. Dielectric Unions:
a. Description: Factory fabricated, union, NPS 2 (DN 50) and smaller.
1) Pressure Rating: 150 psig (1035 kPa) minimum **OR** 250 psig (1725 kPa), **as directed**, at 180 deg F (82 deg C).
2) End Connections: Solder-joint copper alloy and threaded ferrous; threaded ferrous.
3. Dielectric Flanges:
a. Description: Factory-fabricated, bolted, companion-flange assembly, NPS 2-1/2 to NPS 4 (DN 65 to DN 100) and larger.
1) Pressure Rating: 150 psig (1035 kPa) minimum **OR** 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
2) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
4. Dielectric-Flange Kits:
a. Description: Nonconducting materials for field assembly of companion flanges, NPS 2-1/2 (DN 65) and larger.
1) Pressure Rating: 150 psig (1035 kPa) minimum.
2) Gasket: Neoprene or phenolic.
3) Bolt Sleeves: Phenolic or polyethylene.
4) Washers: Phenolic with steel backing washers.
5. Dielectric Couplings:
a. Description: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining, NPS 3 (DN 80) and smaller.
1) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
2) End Connections: Threaded.
6. Dielectric Nipples:
a. Description: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining.
1) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
2) End Connections: Threaded or grooved.

D. Sleeves
1. Mechanical sleeve seals for pipe penetrations are specified in Division 22 Section "Common Work Results For Plumbing".
2. Galvanized-Steel Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
3. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized, plain ends.
4. Cast-Iron Sleeves: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
5. Molded PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.
6. PVC Pipe Sleeves: ASTM D 1785, Schedule 40.
7. Molded PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

E. Identification Devices
1. Equipment Nameplates: Metal permanently fastened to equipment with data engraved or stamped.
a. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.
b. Location: Accessible and visible.
2. Stencils: Standard stencils prepared with letter sizes complying with recommendations in ASME A13.1. Minimum letter height is 1-1/4 inches (30 mm) for ducts, and 3/4 inch (20 mm) for access door signs and similar operational instructions.
a. Material: Fiberboard **OR** Brass, **as directed**.

b. Stencil Paint: Exterior, oil-based, alkyd-gloss black enamel, unless otherwise indicated. Paint may be in pressurized spray-can form.
c. Identification Paint: Exterior, oil-based, alkyd enamel in colors according to ASME A13.1, unless otherwise indicated.

3. Snap-on Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid, snap-on type. Include color-coding according to ASME A13.1, unless otherwise indicated.
4. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, color-coded, pressure-sensitive-vinyl type with permanent adhesive.
5. Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): Full-band pipe markers, extending 360 degrees around pipe at each location.
6. Pipes with OD, Including Insulation, 6 Inches (150 mm) and Larger: Either full-band or strip-type pipe markers, at least three times letter height and of length required for label.
7. Lettering: Manufacturer's standard preprinted captions as selected by the Owner.
8. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
   a. Arrows: Either integrally with piping system service lettering to accommodate both directions of flow, or as separate unit on each pipe marker to indicate direction of flow.
9. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive vinyl tape, at least 3 mils (0.08 mm) thick.
   a. Width: 1-1/2 inches (40 mm) on pipes with OD, including insulation, less than 6 inches (150 mm); 2-1/2 inches (65 mm) for larger pipes.
   b. Color: Comply with ASME A13.1, unless otherwise indicated.
10. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) sequenced numbers. Include 5/32-inch (4-mm) hole for fastener.
   a. Material: 0.032-inch- (0.8-mm-) thick, polished brass **OR** aluminum, **as directed**.
   b. Material: 0.0375-inch- (1-mm-) thick stainless steel.
   c. Material: 3/32-inch- (2.4-mm-) thick plastic laminate with 2 black surfaces and a white inner layer.
   d. Material: Valve manufacturer's standard solid plastic.
   e. Size: 1-1/2 inches (40 mm) in diameter, unless otherwise indicated.
   f. Shape: As indicated for each piping system.
11. Valve Tag Fasteners: Brass, wire-link or beaded chain; or brass S-hooks.
12. Engraved Plastic-Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
   a. Engraving: Engraver's standard letter style, of sizes and with terms to match equipment identification.
   b. Thickness: 1/16 inch (1.6 mm), for units up to 20 sq. in. (130 sq. cm) or 8 inches (200 mm) in length, and 1/8 inch (3 mm) for larger units.
   c. Fasteners: Self-tapping, stainless-steel screws or contact-type permanent adhesive.
13. Plastic Equipment Markers: Manufacturer's standard laminated plastic, in the following color codes:
   a. Green: Cooling equipment and components.
   b. Yellow: Heating equipment and components.
   c. Brown: Energy reclamation equipment and components.
   d. Blue: Equipment and components that do not meet criteria above.
   e. Hazardous Equipment: Use colors and designs recommended by ASME A13.1.
   f. Terminology: Match schedules as closely as possible. Include the following:
      1) Name and plan number.
      2) Equipment service.
      3) Design capacity.
      4) Other design parameters such as pressure drop, entering and leaving conditions, and speed.

g. Size: 2-1/2 by 4 inches (65 by 100 mm) for control devices, dampers, and valves; 4-1/2 by 6 inches (115 by 150 mm) for equipment.

14. Plasticized Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with mat finish suitable for writing.
    a. Size: 3-1/4 by 5-5/8 inches (83 by 143 mm).
    b. Fasteners: Brass grommets and wire.
    c. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
15. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in piped utility identification with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of piped utility systems and equipment.
    a. Multiple Systems: Identify individual system number and service if multiple systems of same name are indicated.

F. Grout
1. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
    a. Characteristics: Post hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
    b. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
    c. Packaging: Premixed and factory packaged.

G. Flowable Fill
1. Description: Low-strength-concrete, flowable-slurry mix.
    a. Cement: ASTM C 150, Type I, portland.
    b. Density: 115- to 145-lb/cu. ft. (1840- to 2325-kg/cu. m).
    c. Aggregates: ASTM C 33, natural sand, fine and crushed gravel or stone, coarse
    OR
    Aggregates: ASTM C 33, natural sand, fine with admixture, ASTM C 618, fly-ash mineral.
    d. Water: Comply with ASTM C 94/C 94M.
    e. Strength: 100 to 200 psig (690 to 1380 kPa) at 28 days.

1.3 EXECUTION

A. Piped Utility Demolition
1. Refer to Division 01 Section(s) "Cutting And Patching" AND Division 02 Section(s) "Selective Structure Demolition" for general demolition requirements and procedures.
2. Disconnect, demolish, and remove piped utility systems, equipment, and components indicated to be removed.
    a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
    b. Piping to Be Abandoned in Place: Drain piping. Fill abandoned piping with flowable fill, and cap or plug piping with same or compatible piping material.
    c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
    d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make operational.
    e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to the Owner.
3. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

B. Dielectric Fitting Applications
1. Dry Piping Systems: Connect piping of dissimilar metals with the following:
    a. NPS 2 (DN 50) and Smaller: Dielectric unions.
    b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Dielectric flanges or dielectric flange kits.

2. Wet Piping Systems: Connect piping of dissimilar metals with the following:
   a. NPS 2 (DN 50) and Smaller: Dielectric couplings **OR** dielectric nipples, **as directed**.
   b. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Dielectric nipples.
   c. NPS 2-1/2 to NPS 8 (DN 65 to DN 200): Dielectric nipples or dielectric flange kits.
   d. NPS 10 and NPS 12 (DN 250 and DN 300): Dielectric flange kits.

C. Piping Installation
1. Install piping according to the following requirements and Division 33 specifying piping systems.
2. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on the Coordination Drawings.
3. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
4. Install piping to permit valve servicing.
5. Install piping at indicated slopes.
6. Install piping free of sags and bends.
7. Install fittings for changes in direction and branch connections.
8. Select system components with pressure rating equal to or greater than system operating pressure.
9. Sleeves are not required for core-drilled holes, unless directed otherwise.
10. Permanent sleeves are not required for holes formed by removable PE sleeves, unless directed otherwise.
11. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
    a. Cut sleeves to length for mounting flush with both surfaces.
       1) Exception: Extend sleeves installed in floors of equipment areas or other wet areas 2 inches (50 mm) above finished floor level.
    b. Install sleeves in new walls and slabs as new walls and slabs are constructed.
       1) PVC **OR** Steel, **as directed**, Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
       2) Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
12. Verify final equipment locations for roughing-in.
13. Refer to equipment specifications in other Sections for roughing-in requirements.

D. Piping Joint Construction
1. Join pipe and fittings according to the following requirements and Division 33 specifying piping systems.
2. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
3. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
4. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
5. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1.1 "Quality Assurance" Article.
6. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
7. Grooved Joints: Assemble joints with grooved-end pipe coupling with coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

8. Soldered Joints: Apply ASTM B 813 water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B 32.
9. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
10. Pressure-Sealed Joints: Assemble joints for plain-end copper tube and mechanical pressure seal fitting with proprietary crimping tool to according to fitting manufacturer's written instructions.
11. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
    a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
    b. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 appendixes.
    c. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
    d. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
    e. PVC Nonpressure Piping: Join according to ASTM D 2855.
    f. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
12. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
13. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
14. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
    a. Plain-End PE Pipe and Fittings: Use butt fusion.
    b. Plain-End PE Pipe and Socket Fittings: Use socket fusion.
15. Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

E. Piping Connections
1. Make connections according to the following, unless otherwise indicated:
    a. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
    b. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
    c. Install dielectric fittings at connections of dissimilar metal pipes.

F. Equipment Installation
1. Install equipment level and plumb, unless otherwise indicated.
2. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference with other installations. Extend grease fittings to an accessible location.
3. Install equipment to allow right of way to piping systems installed at required slope.

G. Painting
1. Painting of piped utility systems, equipment, and components is specified in Division 09.
2. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

H. Identification
1. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.
    a. Stenciled Markers: According to ASME A13.1.
    b. Plastic markers, with application systems. Install on insulation segment if required for hot noninsulated piping.
    c. Locate pipe markers on exposed piping according to the following:
        1) Near each valve and control device.

2) Near each branch, excluding short takeoffs for equipment and terminal units. Mark each pipe at branch if flow pattern is not obvious.
3) Near locations where pipes pass through walls or floors or enter inaccessible enclosures.
4) At manholes and similar access points that permit view of concealed piping.
5) Near major equipment items and other points of origination and termination.

2. Equipment: Install engraved plastic-laminate sign or equipment marker on or near each major item of equipment.
   a. Lettering Size: Minimum 1/4 inch (6.4 mm) high for name of unit if viewing distance is less than 24 inches (610 mm), 1/2 inch (13 mm) high for distances up to 72 inches (1800 mm), and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.
   b. Text of Signs: Provide name of identified unit. Include text to distinguish among multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
3. Adjusting: Relocate identifying devices that become visually blocked by work of this or other Divisions.

I. Concrete Bases
1. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
   a. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
   b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of base.
   c. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   d. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   e. Install anchor bolts to elevations required for proper attachment to supported equipment.
   f. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   g. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-place Concrete".

J. Erection Of Metal Supports And Anchorages
1. Refer to Division 05 Section "Metal Fabrications" for structural steel.
2. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor piped utility materials and equipment.
3. Field Welding: Comply with AWS D1.1/D1.1M.

K. Grouting
1. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors.
2. Clean surfaces that will come into contact with grout.
3. Provide forms as required for placement of grout.
4. Avoid air entrapment during placement of grout.
5. Place grout, completely filling equipment bases.
6. Place grout on concrete bases and provide smooth bearing surface for equipment.
7. Place grout around anchors.
8. Cure placed grout.

END OF SECTION 21 05 23 00

SECTION 21 05 23 00a - GENERAL-DUTY VALVES FOR PLUMBING PIPING

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of general-duty valves for plumbing piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Bronze angle valves.
      b. Brass ball valves.
      c. Bronze ball valves.
      d. Iron ball valves.
      e. Iron, single-flange butterfly valves.
      f. Iron, grooved-end butterfly valves.
      g. Bronze lift check valves.
      h. Bronze swing check valves.
      i. Iron swing check valves.
      j. Iron swing check valves with closure control.
      k. Iron, grooved-end swing check valves.
      l. Iron, center-guided check valves.
      m. Iron, plate-type check valves.
      n. Bronze gate valves.
      o. Iron gate valves.
      p. Bronze globe valves.
      q. Iron globe valves.
      r. Lubricated plug valves.
      s. Chainwheels.

C. Definitions
   1. CWP: Cold working pressure.
   2. EPDM: Ethylene propylene copolymer rubber.
   3. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
   4. NRS: Nonrising stem.
   5. OS&Y: Outside screw and yoke.
   6. RS: Rising stem.
   7. SWP: Steam working pressure.

D. Submittals
   1. Product Data: For each type of valve indicated.

E. Quality Assurance
   1. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
   2. ASME Compliance:
      a. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
      b. ASME B31.1 for power piping valves.
      c. ASME B31.9 for building services piping valves.
   3. NSF Compliance: NSF 61 for valve materials for potable-water service.

F. Delivery, Storage, And Handling

1. Prepare valves for shipping as follows:
   a. Protect internal parts against rust and corrosion.
   b. Protect threads, flange faces, grooves, and weld ends.
   c. Set angle, gate, and globe valves closed to prevent rattling.
   d. Set ball and plug valves open to minimize exposure of functional surfaces.
   e. Set butterfly valves closed or slightly open.
   f. Block check valves in either closed or open position.
2. Use the following precautions during storage:
   a. Maintain valve end protection.
   b. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
3. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

1.2 PRODUCTS

A. General Requirements For Valves
   1. Refer to valve schedule articles for applications of valves.
   2. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
   3. Valve Sizes: Same as upstream piping unless otherwise indicated.
   4. Valve Actuator Types:
      a. Gear Actuator: For quarter-turn valves NPS 8 (DN 200) and larger.
      b. Handwheel: For valves other than quarter-turn types.
      c. Handlever: For quarter-turn valves NPS 6 (DN 150) and smaller except plug valves, **as directed**.
      d. Wrench: For plug valves with square heads. Furnish the Owner with 1 wrench for every 5 **OR** 10, **as directed**, plug valves, for each size square plug-valve head.
      e. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
   5. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
      a. Gate Valves: With rising stem.
      b. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
      c. Butterfly Valves: With extended neck.
   6. Valve-End Connections:
      a. Flanged: With flanges according to ASME B16.1 for iron valves.
      b. Grooved: With grooves according to AWWA C606.
      c. Solder Joint: With sockets according to ASME B16.18.
      d. Threaded: With threads according to ASME B1.20.1.
   7. Valve Bypass and Drain Connections: MSS SP-45.

B. Bronze Angle Valves
   1. Class 125, Bronze Angle Valves with Bronze Disc:
      a. Description:
         1) Standard: MSS SP-80, Type 1.
         2) CWP Rating: 200 psig (1380 kPa).
         3) Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
         4) Ends: Threaded.
         5) Stem and Disc: Bronze.
         6) Packing: Asbestos free.
         7) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
   2. Class 125, Bronze Angle Valves with Nonmetallic Disc:

a. Description:
   1) Standard: MSS SP-80, Type 2.
   2) CWP Rating: 200 psig (1380 kPa).
   3) Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
   4) Ends: Threaded.
   5) Stem: Bronze.
   6) Disc: PTFE or TFE.
   7) Packing: Asbestos free.
   8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.

3. Class 150, Bronze Angle Valves with Bronze Disc:
   a. Description:
      1) Standard: MSS SP-80, Type 1.
      2) CWP Rating: 300 psig (2070 kPa).
      3) Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
      4) Ends: Threaded.
      5) Stem and Disc: Bronze.
      6) Packing: Asbestos free.
      7) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
4. Class 150, Bronze Angle Valves with Nonmetallic Disc:
   a. Description:
      1) Standard: MSS SP-80, Type 2.
      2) CWP Rating: 300 psig (2070 kPa).
      3) Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
      4) Ends: Threaded.
      5) Stem: Bronze.
      6) Disc: PTFE or TFE.
      7) Packing: Asbestos free.
      8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.

C. Brass Ball Valves
1. One-Piece, Reduced-Port, Brass Ball Valves with Brass Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) CWP Rating: 400 psig (2760 kPa).
      3) Body Design: One piece.
      4) Body Material: Forged brass.
      5) Ends: Threaded.
      6) Seats: PTFE or TFE.
      7) Stem: Brass.
      8) Ball: Chrome-plated brass.
      9) Port: Reduced.
2. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Two piece.
      5) Body Material: Forged brass.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Brass.
      9) Ball: Chrome-plated brass.
      10) Port: Full.
3. Two-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:
   a. Description:
      1) Standard: MSS SP-110.

2) SWP Rating: 150 psig (1035 kPa).
3) CWP Rating: 600 psig (4140 kPa).
4) Body Design: Two piece.
5) Body Material: Forged brass.
6) Ends: Threaded.
7) Seats: PTFE or TFE.
8) Stem: Stainless steel.
9) Ball: Stainless steel, vented.
10) Port: Full.

4. Two-Piece, Regular-Port, Brass Ball Valves with Brass Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Two piece.
      5) Body Material: Forged brass.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Brass.
      9) Ball: Chrome-plated brass.
      10) Port: Regular.
5. Two-Piece, Regular-Port, Brass Ball Valves with Stainless-Steel Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Two piece.
      5) Body Material: Brass or bronze.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Stainless steel.
      9) Ball: Stainless steel, vented.
      10) Port: Regular.
6. Three-Piece, Full-Port, Brass Ball Valves with Brass Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Three piece.
      5) Body Material: Forged brass.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Brass.
      9) Ball: Chrome-plated brass.
      10) Port: Full.
7. Three-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Three piece.
      5) Body Material: Forged brass.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Stainless steel.

9) Ball: Stainless steel, vented.
10) Port: Full.

D. Bronze Ball Valves
1. One-Piece, Reduced-Port, Bronze Ball Valves with Bronze Trim:
a. Description:
1) Standard: MSS SP-110.
2) CWP Rating: 400 psig (2760 kPa).
3) Body Design: One piece.
4) Body Material: Bronze.
5) Ends: Threaded.
6) Seats: PTFE or TFE.
7) Stem: Bronze.
8) Ball: Chrome-plated brass.
9) Port: Reduced.
2. One-Piece, Reduced-Port, Bronze Ball Valves with Stainless-Steel Trim:
a. Description:
1) Standard: MSS SP-110.
2) CWP Rating: 600 psig (4140 kPa).
3) Body Design: One piece.
4) Body Material: Bronze.
5) Ends: Threaded.
6) Seats: PTFE or TFE.
7) Stem: Stainless steel.
8) Ball: Stainless steel, vented.
9) Port: Reduced.
3. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
a. Description:
1) Standard: MSS SP-110.
2) SWP Rating: 150 psig (1035 kPa).
3) CWP Rating: 600 psig (4140 kPa).
4) Body Design: Two piece.
5) Body Material: Bronze.
6) Ends: Threaded.
7) Seats: PTFE or TFE.
8) Stem: Bronze.
9) Ball: Chrome-plated brass.
10) Port: Full.
4. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
a. Description:
1) Standard: MSS SP-110.
2) SWP Rating: 150 psig (1035 kPa).
3) CWP Rating: 600 psig (4140 kPa).
4) Body Design: Two piece.
5) Body Material: Bronze.
6) Ends: Threaded.
7) Seats: PTFE or TFE.
8) Stem: Stainless steel.
9) Ball: Stainless steel, vented.
10) Port: Full.
5. Two-Piece, Regular-Port, Bronze Ball Valves with Bronze Trim:
a. Description:
1) Standard: MSS SP-110.
2) SWP Rating: 150 psig (1035 kPa).
3) CWP Rating: 600 psig (4140 kPa).
4) Body Design: Two piece.

5) Body Material: Bronze.
6) Ends: Threaded.
7) Seats: PTFE or TFE.
8) Stem: Bronze.
9) Ball: Chrome-plated brass.
10) Port: Regular.

6. Two-Piece, Regular-Port, Bronze Ball Valves with Stainless-Steel Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Two piece.
      5) Body Material: Bronze.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Stainless steel.
      9) Ball: Stainless steel, vented.
      10) Port: Regular.
7. Three-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Three piece.
      5) Body Material: Bronze.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Bronze.
      9) Ball: Chrome-plated brass.
      10) Port: Full.
8. Three-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Three piece.
      5) Body Material: Bronze.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Stainless steel.
      9) Ball: Stainless steel, vented.
      10) Port: Full.

E. Iron Ball Valves
   1. Class 125, Iron Ball Valves:
      a. Description:
         1) Standard: MSS SP-72.
         2) CWP Rating: 200 psig (1380 kPa).
         3) Body Design: Split body.
         4) Body Material: ASTM A 126, gray iron.
         5) Ends: Flanged.
         6) Seats: PTFE or TFE.
         7) Stem: Stainless steel.
         8) Ball: Stainless steel.
         9) Port: Full.

F. Iron, Single-Flange Butterfly Valves
1. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      5) Seat: EPDM.
      6) Stem: One- or two-piece stainless steel.
      7) Disc: Aluminum bronze.
2. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      5) Seat: NBR.
      6) Stem: One- or two-piece stainless steel.
      7) Disc: Aluminum bronze.
3. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      5) Seat: EPDM.
      6) Stem: One- or two-piece stainless steel.
      7) Disc: Nickel-plated or -coated, **as directed**, ductile iron.
4. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Ductile-Iron Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      5) Seat: NBR.
      6) Stem: One- or two-piece stainless steel.
      7) Disc: Nickel-plated or -coated, **as directed**, ductile iron.
5. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      5) Seat: EPDM.
      6) Stem: One- or two-piece stainless steel.
      7) Disc: Stainless steel.
6. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Stainless-Steel Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.
      2) CWP Rating: 200 psig (1380 kPa).

3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
5) Seat: NBR.
6) Stem: One- or two-piece stainless steel.
7) Disc: Stainless steel.

G. Iron, Grooved-End Butterfly Valves
1. 175 CWP, Iron, Grooved-End Butterfly Valves:
a. Description:
1) Standard: MSS SP-67, Type I.
2) CWP Rating: 175 psig (1200 kPa).
3) Body Material: Coated, ductile iron.
4) Stem: Two-piece stainless steel.
5) Disc: Coated, ductile iron.
6) Seal: EPDM.
2. 300 CWP, Iron, Grooved-End Butterfly Valves:
a. Description:
1) Standard: MSS SP-67, Type I.
2) NPS 8 (DN 200) and Smaller CWP Rating: 300 psig (2070 kPa).
3) NPS 10 (DN 250) and Larger CWP Rating: 200 psig (1380 kPa).
4) Body Material: Coated, ductile iron.
5) Stem: Two-piece stainless steel.
6) Disc: Coated, ductile iron.
7) Seal: EPDM.

H. Bronze Lift Check Valves
1. Class 125, Lift Check Valves with Bronze Disc:
a. Description:
1) Standard: MSS SP-80, Type 1.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Design: Vertical flow.
4) Body Material: ASTM B 61 or ASTM B 62, bronze.
5) Ends: Threaded.
6) Disc: Bronze.
2. Class 125, Lift Check Valves with Nonmetallic Disc:
a. Description:
1) Standard: MSS SP-80, Type 2.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Design: Vertical flow.
4) Body Material: ASTM B 61 or ASTM B 62, bronze.
5) Ends: Threaded.
6) Disc: NBR, PTFE, or TFE.

I. Bronze Swing Check Valves
1. Class 125, Bronze Swing Check Valves with Bronze Disc:
a. Description:
1) Standard: MSS SP-80, Type 3.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Design: Horizontal flow.
4) Body Material: ASTM B 62, bronze.
5) Ends: Threaded.
6) Disc: Bronze.
2. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:
a. Description:

1) Standard: MSS SP-80, Type 4.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Design: Horizontal flow.
4) Body Material: ASTM B 62, bronze.
5) Ends: Threaded.
6) Disc: PTFE or TFE.

3. Class 150, Bronze Swing Check Valves with Bronze Disc:
   a. Description:
      1) Standard: MSS SP-80, Type 3.
      2) CWP Rating: 300 psig (2070 kPa).
      3) Body Design: Horizontal flow.
      4) Body Material: ASTM B 62, bronze.
      5) Ends: Threaded.
      6) Disc: Bronze.
4. Class 150, Bronze Swing Check Valves with Nonmetallic Disc:
   a. Description:
      1) Standard: MSS SP-80, Type 4.
      2) CWP Rating: 300 psig (2070 kPa).
      3) Body Design: Horizontal flow.
      4) Body Material: ASTM B 62, bronze.
      5) Ends: Threaded.
      6) Disc: PTFE or TFE.

J. Iron Swing Check Valves
1. Class 125, Iron Swing Check Valves with Metal Seats:
   a. Description:
      1) Standard: MSS SP-71, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Clear or full waterway.
      4) Body Material: ASTM A 126, gray iron with bolted bonnet.
      5) Ends: Flanged.
      6) Trim: Bronze.
      7) Gasket: Asbestos free.
2. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:
   a. Description:
      1) Standard: MSS SP-71, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Clear or full waterway.
      4) Body Material: ASTM A 126, gray iron with bolted bonnet.
      5) Ends: Flanged.
      6) Trim: Composition.
      7) Seat Ring: Bronze.
      8) Disc Holder: Bronze.
      9) Disc: PTFE or TFE.
      10) Gasket: Asbestos free.
3. Class 250, Iron Swing Check Valves with Metal Seats:
   a. Description:
      1) Standard: MSS SP-71, Type I.
      2) CWP Rating: 500 psig (3450 kPa).
      3) Body Design: Clear or full waterway.
      4) Body Material: ASTM A 126, gray iron with bolted bonnet.
      5) Ends: Flanged.
      6) Trim: Bronze.
      7) Gasket: Asbestos free.

K. Iron Swing Check Valves With Closure Control

1. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:
   a. Description:
      1) Standard: MSS SP-71, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Clear or full waterway.
      4) Body Material: ASTM A 126, gray iron with bolted bonnet.
      5) Ends: Flanged.
      6) Trim: Bronze.
      7) Gasket: Asbestos free.
      8) Closure Control: Factory-installed, exterior lever and spring.
2. Class 125, Iron Swing Check Valves with Lever- and Weight-Closure Control:
   a. Description:
      1) Standard: MSS SP-71, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Clear or full waterway.
      4) Body Material: ASTM A 126, gray iron with bolted bonnet.
      5) Ends: Flanged.
      6) Trim: Bronze.
      7) Gasket: Asbestos free.
      8) Closure Control: Factory-installed, exterior lever and weight.

L. Iron, Grooved-End Swing Check Valves
1. 300 CWP, Iron, Grooved-End Swing Check Valves:
   a. Description:
      1) CWP Rating: 300 psig (2070 kPa).
      2) Body Material: ASTM A 536, ductile iron.
      3) Seal: EPDM.
      4) Disc: Spring-operated, ductile iron or stainless steel.

M. Iron, Center-Guided Check Valves
1. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Material: ASTM A 126, gray iron.
      4) Style: Compact wafer.
      5) Seat: Bronze.
2. Class 125, Iron, Globe, Center-Guided Check Valves with Metal Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Material: ASTM A 126, gray iron.
      4) Style: Globe, spring loaded.
      5) Ends: Flanged.
      6) Seat: Bronze.
3. Class 150, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) CWP Rating: 300 psig (2070 kPa).
      3) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
      4) Style: Compact wafer.
      5) Seat: Bronze.
4. Class 150, Iron, Globe, Center-Guided Check Valves with Metal Seat:
   a. Description:
      1) Standard: MSS SP-125.

2) CWP Rating: 300 psig (2070 kPa).
3) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
4) Style: Globe, spring loaded.
5) Ends: Flanged.
6) Seat: Bronze.

5. Class 250, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) CWP Rating: 400 psig (2760 kPa).
      3) Body Material: ASTM A 126, gray iron.
      4) Style: Compact wafer, spring loaded.
      5) Seat: Bronze.
6. Class 250, Iron, Globe, Center-Guided Check Valves with Metal Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) CWP Rating: 400 psig (2760 kPa).
      3) Body Material: ASTM A 126, gray iron.
      4) Style: Globe, spring loaded.
      5) Ends: Flanged.
      6) Seat: Bronze.
7. Class 300, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) CWP Rating: 500 psig (3450 kPa).
      3) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
      4) Style: Compact wafer, spring loaded.
      5) Seat: Bronze.
8. Class 300, Iron, Globe, Center-Guided Check Valves with Metal Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) CWP Rating: 500 psig (3450 kPa).
      3) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
      4) Style: Globe, spring loaded.
      5) Ends: Flanged.
      6) Seat: Bronze.
9. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Material: ASTM A 126, gray iron.
      4) Style: Compact wafer.
      5) Seat: EPDM **OR** NBR, **as directed**.
10. Class 125, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Material: ASTM A 126, gray iron.
      4) Style: Globe, spring loaded.
      5) Ends: Flanged.
      6) Seat: EPDM **OR** NBR, **as directed**.
11. Class 150, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) CWP Rating: 300 psig (2070 kPa).
      3) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
      4) Style: Compact wafer.

5) Seat: EPDM **OR** NBR, **as directed**.

12. Class 150, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
    a. Description:
        1) Standard: MSS SP-125.
        2) CWP Rating: 300 psig (2070 kPa).
        3) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
        4) Style: Globe, spring loaded.
        5) Ends: Flanged.
        6) Seat: EPDM **OR** NBR, **as directed**.
13. Class 250, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
    a. Description:
        1) Standard: MSS SP-125.
        2) CWP Rating: 400 psig (2760 kPa).
        3) Body Material: ASTM A 126, gray iron.
        4) Style: Compact wafer, spring loaded.
        5) Seat: EPDM **OR** NBR, **as directed**.
14. Class 250, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
    a. Description:
        1) Standard: MSS SP-125.
        2) CWP Rating: 400 psig (2760 kPa).
        3) Body Material: ASTM A 126, gray iron.
        4) Style: Globe, spring loaded.
        5) Ends: Flanged.
        6) Seat: EPDM **OR** NBR, **as directed**.
15. Class 300, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
    a. Description:
        1) Standard: MSS SP-125.
        2) CWP Rating: 500 psig (3450 kPa).
        3) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
        4) Style: Compact wafer, spring loaded.
        5) Seat: EPDM **OR** NBR, **as directed**.
16. Class 300, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
    a. Description:
        1) Standard: MSS SP-125.
        2) CWP Rating: 500 psig (3450 kPa).
        3) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
        4) Style: Globe, spring loaded.
        5) Ends: Flanged.
        6) Seat: EPDM **OR** NBR, **as directed**.

N. Iron, Plate-Type Check Valves

1. Class 125, Iron, Dual-Plate Check Valves with Metal Seat:
    a. Description:
        1) Standard: API 594.
        2) CWP Rating: 200 psig (1380 kPa).
        3) Body Design: Wafer, spring-loaded plates.
        4) Body Material: ASTM A 126, gray iron.
        5) Seat: Bronze.
2. Class 150, Iron, Dual-Plate Check Valves with Metal Seat:
    a. Description:
        1) Standard: API 594.
        2) CWP Rating: 300 psig (2070 kPa).
        3) Body Design: Wafer, spring-loaded plates.
        4) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
        5) Seat: Bronze.

3. Class 250, Iron, Dual-Plate Check Valves with Metal Seat:
   a. Description:
      1) Standard: API 594.
      2) CWP Rating: 400 psig (2760 kPa).
      3) Body Design: Wafer, spring-loaded plates.
      4) Body Material: ASTM A 126, gray iron.
      5) Seat: Bronze.
4. Class 300, Iron, Dual-Plate Check Valves with Metal Seat:
   a. Description:
      1) Standard: API 594.
      2) CWP Rating: 500 psig (3450 kPa).
      3) Body Design: Wafer, spring-loaded plates.
      4) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
      5) Seat: Bronze.
5. Class 125, Iron, Single-Plate Check Valves with Resilient Seat:
   a. Description:
      1) Standard: API 594.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Wafer, spring-loaded plate.
      4) Body Material: ASTM A 126, gray iron.
      5) Seat: EPDM **OR** NBR, **as directed**.
6. Class 125, Iron, Dual-Plate Check Valves with Resilient Seat:
   a. Description:
      1) Standard: API 594.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Wafer, spring-loaded plates.
      4) Body Material: ASTM A 126, gray iron.
      5) Seat: EPDM **OR** NBR, **as directed**.
7. Class 150, Iron, Dual-Plate Check Valves with Resilient Seat:
   a. Description:
      1) Standard: API 594.
      2) CWP Rating: 300 psig (2070 kPa).
      3) Body Design: Wafer, spring-loaded plates.
      4) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
      5) Seat: EPDM **OR** NBR, **as directed**.
8. Class 250, Iron, Wafer, Single-Plate Check Valves with Resilient Seat:
   a. Description:
      1) Standard: API 594.
      2) CWP Rating: 400 psig (2760 kPa).
      3) Body Design: Wafer, spring-loaded plate.
      4) Body Material: ASTM A 126, gray iron.
      5) Seat: EPDM **OR** NBR, **as directed**.
9. Class 250, Iron, Dual-Plate Check Valves with Resilient Seat:
   a. Description:
      1) Standard: API 594.
      2) CWP Rating: 400 psig (2760 kPa).
      3) Body Design: Wafer, spring-loaded plates.
      4) Body Material: ASTM A 126, gray iron.
      5) Seat: EPDM **OR** NBR, **as directed**.
10. Class 300, Iron, Dual-Plate Check Valves with Resilient Seat:
   a. Description:
      1) Standard: API 594.
      2) CWP Rating: 500 psig (3450 kPa).
      3) Body Design: Wafer, spring-loaded plates.
      4) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
      5) Seat: EPDM **OR** NBR, **as directed**.

O. Bronze Gate Valves
1. Class 125, NRS Bronze Gate Valves:
   a. Description:
      1) Standard: MSS SP-80, Type 1.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
      4) Ends: Threaded or solder joint, **as directed**.
      5) Stem: Bronze.
      6) Disc: Solid wedge; bronze.
      7) Packing: Asbestos free.
      8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
2. Class 125, RS Bronze Gate Valves:
   a. Description:
      1) Standard: MSS SP-80, Type 2.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
      4) Ends: Threaded or solder joint, **as directed**.
      5) Stem: Bronze.
      6) Disc: Solid wedge; bronze.
      7) Packing: Asbestos free.
      8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
3. Class 150, NRS Bronze Gate Valves:
   a. Description:
      1) Standard: MSS SP-80, Type 1.
      2) CWP Rating: 300 psig (2070 kPa).
      3) Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
      4) Ends: Threaded.
      5) Stem: Bronze.
      6) Disc: Solid wedge; bronze.
      7) Packing: Asbestos free.
      8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
4. Class 150, RS Bronze Gate Valves:
   a. Description:
      1) Standard: MSS SP-80, Type 2.
      2) CWP Rating: 300 psig (2070 kPa).
      3) Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
      4) Ends: Threaded.
      5) Stem: Bronze.
      6) Disc: Solid wedge; bronze.
      7) Packing: Asbestos free.
      8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.

P. Iron Gate Valves
1. Class 125, NRS, Iron Gate Valves:
   a. Description:
      1) Standard: MSS SP-70, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Material: ASTM A 126, gray iron with bolted bonnet.
      4) Ends: Flanged.
      5) Trim: Bronze.
      6) Disc: Solid wedge.
      7) Packing and Gasket: Asbestos free.
2. Class 125, OS&Y, Iron Gate Valves:
   a. Description:
      1) Standard: MSS SP-70, Type I.

2) CWP Rating: 200 psig (1380 kPa).
3) Body Material: ASTM A 126, gray iron with bolted bonnet.
4) Ends: Flanged.
5) Trim: Bronze.
6) Disc: Solid wedge.
7) Packing and Gasket: Asbestos free.

3. Class 250, NRS, Iron Gate Valves:
   a. Description:
      1) Standard: MSS SP-70, Type I.
      2) CWP Rating: 500 psig (3450 kPa).
      3) Body Material: ASTM A 126, gray iron with bolted bonnet.
      4) Ends: Flanged.
      5) Trim: Bronze.
      6) Disc: Solid wedge.
      7) Packing and Gasket: Asbestos free.
4. Class 250, OS&Y, Iron Gate Valves:
   a. Description:
      1) Standard: MSS SP-70, Type I.
      2) CWP Rating: 500 psig (3450 kPa).
      3) Body Material: ASTM A 126, gray iron with bolted bonnet.
      4) Ends: Flanged.
      5) Trim: Bronze.
      6) Disc: Solid wedge.
      7) Packing and Gasket: Asbestos free.

Q. Bronze Globe Valves
1. Class 125, Bronze Globe Valves with Bronze Disc:
   a. Description:
      1) Standard: MSS SP-80, Type 1.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
      4) Ends: Threaded or solder joint, **as directed**.
      5) Stem and Disc: Bronze.
      6) Packing: Asbestos free.
      7) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
2. Class 125, Bronze Globe Valves with Nonmetallic Disc:
   a. Description:
      1) Standard: MSS SP-80, Type 2.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
      4) Ends: Threaded or solder joint, **as directed**.
      5) Stem: Bronze.
      6) Disc: PTFE or TFE.
      7) Packing: Asbestos free.
      8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
3. Class 150, Bronze Globe Valves with Nonmetallic Disc:
   a. Description:
      1) Standard: MSS SP-80, Type 2.
      2) CWP Rating: 300 psig (2070 kPa).
      3) Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
      4) Ends: Threaded.
      5) Stem: Bronze.
      6) Disc: PTFE or TFE.
      7) Packing: Asbestos free.
      8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.

R. Iron Globe Valves
1. Class 125, Iron Globe Valves:
a. Description:
1) Standard: MSS SP-85, Type I.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Material: ASTM A 126, gray iron with bolted bonnet.
4) Ends: Flanged.
5) Trim: Bronze.
6) Packing and Gasket: Asbestos free.
2. Class 250, Iron Globe Valves:
a. Description:
1) Standard: MSS SP-85, Type I.
2) CWP Rating: 500 psig (3450 kPa).
3) Body Material: ASTM A 126, gray iron with bolted bonnet.
4) Ends: Flanged.
5) Trim: Bronze.
6) Packing and Gasket: Asbestos free.

S. Lubricated Plug Valves
1. Class 125, Regular-Gland, Lubricated Plug Valves with Threaded Ends:
a. Description:
1) Standard: MSS SP-78, Type II.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
4) Pattern: Regular or short **OR** Venturi, **as directed**.
5) Plug: Cast iron or bronze with sealant groove.
2. Class 125, Regular-Gland, Lubricated Plug Valves with Flanged Ends:
a. Description:
1) Standard: MSS SP-78, Type II.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
4) Pattern: Regular or short **OR** Venturi, **as directed**.
5) Plug: Cast iron or bronze with sealant groove.
3. Class 125, Cylindrical, Lubricated Plug Valves with Threaded Ends:
a. Description:
1) Standard: MSS SP-78, Type IV.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
4) Pattern: Regular or short **OR** Venturi, **as directed**.
5) Plug: Cast iron or bronze with sealant groove.
4. Class 125, Cylindrical, Lubricated Plug Valves with Flanged Ends:
a. Description:
1) Standard: MSS SP-78, Type IV.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
4) Pattern: Regular or short **OR** Venturi, **as directed**.
5) Plug: Cast iron or bronze with sealant groove.
5. Class 250, Regular-Gland, Lubricated Plug Valves with Threaded Ends:
a. Description:
1) Standard: MSS SP-78, Type II.
2) CWP Rating: 400 psig (2760 kPa).

3) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
4) Pattern: Regular or short **OR** Venturi, **as directed**.
5) Plug: Cast iron or bronze with sealant groove.

6. Class 250, Regular-Gland, Lubricated Plug Valves with Flanged Ends:
   a. Description:
      1) Standard: MSS SP-78, Type II.
      2) CWP Rating: 400 psig (2760 kPa).
      3) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
      4) Pattern: Regular or short **OR** Venturi, **as directed**.
      5) Plug: Cast iron or bronze with sealant groove.
7. Class 250, Cylindrical, Lubricated Plug Valves with Threaded Ends:
   a. Description:
      1) Standard: MSS SP-78, Type IV.
      2) CWP Rating: 400 psig (2760 kPa).
      3) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
      4) Pattern: Regular or short **OR** Venturi, **as directed**.
      5) Plug: Cast iron or bronze with sealant groove.
8. Class 250, Cylindrical, Lubricated Plug Valves with Flanged Ends:
   a. Description:
      1) Standard: MSS SP-78, Type IV.
      2) CWP Rating: 400 psig (2760 kPa).
      3) Body Material: ASTM A 48/A 48M or ASTM A 126, Grade 40 cast iron with lubrication-sealing system.
      4) Pattern: Regular or short **OR** Venturi, **as directed**.
      5) Plug: Cast iron or bronze with sealant groove.

T. Chainwheels
1. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
   a. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
   b. Attachment: For connection to ball **OR** butterfly **OR** plug, **as directed**, valve stems.
   c. Sprocket Rim with Chain Guides: Ductile iron **OR** Cast iron **OR** Aluminum **OR** Bronze, **as directed**, of type and size required for valve. Include zinc coating, **as directed**.
   d. Chain: Hot-dip, galvanized steel **OR** Brass **OR** Stainless steel, **as directed**, of size required to fit sprocket rim.

1.3 EXECUTION

A. Valve Installation
1. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
2. Locate valves for easy access and provide separate support where necessary.
3. Install valves in horizontal piping with stem at or above center of pipe.
4. Install valves in position to allow full stem movement.
5. Install chainwheels on operators for ball **OR** butterfly **OR** gate **OR** globe **OR** plug, **as directed**, valves NPS 4 (DN 100) and larger and more than 96 inches (2400 mm) above floor. Extend chains to 60 inches (1520 mm) above finished floor.
6. Install check valves for proper direction of flow and as follows:
   a. Swing Check Valves: In horizontal position with hinge pin level.
   b. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
   c. Lift Check Valves: With stem upright and plumb.

B. Adjusting
1. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

C. General Requirements For Valve Applications
1. If valve applications are not indicated, use the following:
a. Shutoff Service: Ball **OR** butterfly **OR** gate **OR** plug, **as directed**, valves.
b. Butterfly Valve Dead-End Service: Single-flange (lug) type.
c. Throttling Service: Globe **OR** angle **OR** ball **OR** butterfly, **as directed**, valves.
d. Pump-Discharge Check Valves:
1) NPS 2 (DN 50) and Smaller: Bronze swing check valves with bronze **OR** nonmetallic, **as directed**, disc.
2) NPS 2-1/2 (DN 65) and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal **OR** resilient, **as directed**,-seat check valves.
3) NPS 2-1/2 (DN 65) and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.
2. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
3. Select valves, except wafer types, with the following end connections:
a. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
b. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
c. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
d. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
e. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
f. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.
g. For Grooved-End Copper Tubing and Steel Piping: Valve ends may be grooved.

D. Low-Pressure, Compressed-Air Valve Schedule (150 psig (1035 kPa) Or Less)
1. Pipe NPS 2 (DN 50) and Smaller:
a. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
b. Ball Valves: One **OR** Two **OR** Three, **as directed**, piece, full **OR** regular **OR** reduced, **as directed**, port, brass **OR** bronze, **as directed**, with brass **OR** bronze **OR** stainless-steel, **as directed**, trim.
c. Bronze Lift Check Valves: Class 125, bronze **OR** nonmetallic, **as directed**, disc.
d. Bronze Swing Check Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
e. Bronze Gate Valves: Class 125 **OR** Class 150, **as directed**, NRS **OR** RS, **as directed**.
2. Pipe NPS 2-1/2 (DN 65) and Larger:
a. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
b. Iron, Single-Flange Butterfly Valves: 200 CWP, NBR seat, aluminum-bronze **OR** ductile-iron **OR** stainless-steel, **as directed**, disc.
c. Iron, Grooved-End Butterfly Valves: 175 **OR** 300, **as directed**, CWP.
d. Iron Swing Check Valves: Class 125 **OR** Class 250, **as directed**, metal **OR** nonmetallic-to-metal, **as directed**, seats.
e. Iron, Grooved-End Swing Check Valves: 300 CWP.
f. Iron, Center-Guided Check Valves: Class 125 **OR** Class 150 **OR** Class 250 **OR** Class 300, **as directed**, compact-wafer **OR** globe, **as directed**, metal **OR** resilient, **as directed**, seat.
g. Iron, Plate-Type Check Valves: Class 125 **OR** Class 150 **OR** Class 250 **OR** Class 300, **as directed**; single **OR** dual, **as directed**, plate; metal **OR** resilient, **as directed**, seat.

h. Iron Gate Valves: Class 125 **OR** Class 250, **as directed**, NRS **OR** OS&Y, **as directed**,.

E. High-Pressure, Compressed-Air Valve Schedule (150 to 200 psig (1035 to 1380 kPa))
1. Pipe NPS 2 (DN 50) and Smaller:
a. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
b. Ball Valves: One **OR** Two **OR** Three, **as directed**, piece, full **OR** regular **OR** reduced, **as directed**, port, brass **OR** bronze, **as directed**, with brass **OR** bronze **OR** stainless-steel, **as directed**, trim.
c. Bronze Lift Check Valves: Class 125, bronze **OR** nonmetallic, **as directed**, disc.
d. Bronze Swing Check Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
e. Bronze Gate Valves: Class 125 **OR** Class 150, **as directed**, NRS **OR** RS, **as directed**.
2. Pipe NPS 2-1/2 (DN 65) and Larger:
a. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
b. Iron, Single-Flange Butterfly Valves: 200 CWP, NBR seat, aluminum-bronze **OR** ductile-iron **OR** stainless-steel, **as directed**, disc.
c. Iron, Grooved-End Butterfly Valves: 175 **OR** 300, **as directed**, CWP.
d. Iron Swing Check Valves: Class 125 **OR** Class 250, **as directed**, metal **OR** nonmetallic-to-metal, **as directed**, seats.
e. Iron, Grooved-End Swing Check Valves: 300 CWP.
f. Iron, Center-Guided Check Valves: Class 125 **OR** Class 150 **OR** Class 250 **OR** Class 300, **as directed**, compact-wafer **OR** globe, **as directed**, metal **OR** resilient, **as directed**, seat.
g. Iron, Plate-Type Check Valves: Class 125 **OR** Class 150 **OR** Class 250 **OR** Class 300, **as directed**; single **OR** dual, **as directed**, plate; metal **OR** resilient, **as directed**, seat.
h. Iron Gate Valves: Class 125 **OR** Class 250, **as directed**, NRS **OR** OS&Y, **as directed**.

F. Domestic, Hot- And Cold-Water Valve Schedule
1. Pipe NPS 2 (DN 50) and Smaller:
a. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
b. Bronze Angle Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
c. Ball Valves: One **OR** Two **OR** Three, **as directed**, piece, full **OR** regular **OR** reduced, **as directed**, port, brass **OR** bronze, **as directed**, with brass **OR** bronze **OR** stainless-steel, **as directed**, trim.
d. Bronze Swing Check Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
e. Bronze Gate Valves: Class 125 **OR** Class 150, **as directed**, NRS **OR** RS, **as directed**,.
f. Bronze Globe Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
2. Pipe NPS 2-1/2 (DN 65) and Larger:
a. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
b. Iron Ball Valves: Class 150.
c. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM **OR** NBR, **as directed**, seat, aluminum-bronze **OR** ductile-iron **OR** stainless-steel, **as directed**, disc.
d. Iron, Grooved-End Butterfly Valves: 175 **OR** 300, **as directed**, CWP.
e. Iron Swing Check Valves: Class 125 **OR** Class 250, **as directed**, metal **OR** nonmetallic-to-metal, **as directed**, seats.
f. Iron Swing Check Valves with Closure Control: Class 125, lever and spring **OR** weight, **as directed**.
g. Iron, Grooved-End Swing Check Valves: 300 CWP.
h. Iron, Center-Guided Check Valves: Class 125 **OR** Class 150 **OR** Class 250 **OR** Class 300, **as directed**, compact-wafer **OR** globe, **as directed**, metal **OR** resilient, **as directed**, seat.

i. Iron, Plate-Type Check Valves: Class 125 **OR** Class 150 **OR** Class 250 **OR** Class 300, **as directed**; single **OR** dual, **as directed**, plate; metal **OR** resilient, **as directed**, seat.
j. Iron Gate Valves: Class 125 **OR** Class 250, **as directed**, NRS **OR** OS&Y, **as directed**.
k. Iron Globe Valves: Class 125 **OR** Class 250, **as directed**.

G. Sanitary-Waste And Storm-Drainage Valve Schedule
1. Pipe NPS 2 (DN 50) and Smaller:
a. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
b. Bronze Angle Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic **OR** stainless-steel, **as directed**, disc.
c. Ball Valves: One **OR** Two **OR** Three, **as directed**, piece, full **OR** regular **OR** reduced, **as directed**, port, brass **OR** bronze, **as directed**, with brass **OR** bronze **OR** stainless-steel, **as directed**, trim.
d. Bronze Swing Check Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
e. Bronze Gate Valves: Class 125 **OR** Class 150, **as directed**, NRS **OR** RS, **as directed**.
f. Bronze Globe Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
2. Pipe NPS 2-1/2 (DN 65) and Larger:
a. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
b. Iron Ball Valves: Class 150.
c. Iron Swing Check Valves: Class 125 **OR** Class 250, **as directed**, metal **OR** nonmetallic-to-metal, **as directed**, seats.
d. Iron Swing Check Valves with Closure Control: Class 125, lever and spring **OR** weight, **as directed**.
e. Iron, Grooved-End Swing Check Valves: 300 CWP.
f. Iron Gate Valves: Class 125 **OR** Class 250, **as directed**, NRS **OR** OS&Y, **as directed**.
g. Iron Globe Valves: Class 125 **OR** Class 250, **as directed**.
h. Lubricated Plug Valves: Class 125 **OR** Class 250, **as directed**, regular gland **OR** cylindrical, **as directed**, threaded **OR** flanged, **as directed**.

END OF SECTION 21 05 23 00a

SECTION 21 05 23 00b - GENERAL-DUTY VALVES FOR HVAC PIPING

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of general-duty valves for HVAC piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Bronze angle valves.
      b. Brass ball valves.
      c. Bronze ball valves.
      d. Iron ball valves.
      e. Iron, single-flange butterfly valves.
      f. Iron, grooved-end butterfly valves.
      g. High-performance butterfly valves.
      h. Bronze lift check valves.
      i. Bronze swing check valves.
      j. Iron swing check valves.
      k. Iron swing check valves with closure control.
      l. Iron, grooved-end swing-check valves.
      m. Iron, center-guided check valves.
      n. Iron, plate-type check valves.
      o. Bronze gate valves.
      p. Iron gate valves.
      q. Bronze globe valves.
      r. Iron globe valves.
      s. Lubricated plug valves.
      t. Eccentric plug valves.
      u. Chainwheels.

C. Definitions
   1. CWP: Cold working pressure.
   2. EPDM: Ethylene propylene copolymer rubber.
   3. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
   4. NRS: Nonrising stem.
   5. OS&Y: Outside screw and yoke.
   6. RS: Rising stem.
   7. SWP: Steam working pressure.

D. Submittals
   1. Product Data: For each type of valve indicated.

E. Quality Assurance
   1. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
   2. ASME Compliance:
      a. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
      b. ASME B31.1 for power piping valves.
      c. ASME B31.9 for building services piping valves.

F. Delivery, Storage, And Handling
1. Prepare valves for shipping as follows:
   a. Protect internal parts against rust and corrosion.
   b. Protect threads, flange faces, grooves, and weld ends.
   c. Set angle, gate, and globe valves closed to prevent rattling.
   d. Set ball and plug valves open to minimize exposure of functional surfaces.
   e. Set butterfly valves closed or slightly open.
   f. Block check valves in either closed or open position.
2. Use the following precautions during storage:
   a. Maintain valve end protection.
   b. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
3. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

1.2 PRODUCTS

A. General Requirements For Valves
1. Refer to HVAC valve schedule articles for applications of valves.
2. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
3. Valve Sizes: Same as upstream piping unless otherwise indicated.
4. Valve Actuator Types:
   a. Gear Actuator: For quarter-turn valves NPS 8 (DN 200) and larger.
   b. Handwheel: For valves other than quarter-turn types.
   c. Handlever: For quarter-turn valves NPS 6 (DN 150) and smaller except plug valves, **as directed**.
   d. Wrench: For plug valves with square heads. Furnish the Owner with 1 wrench for every 5 **OR** 10, **as directed**, plug valves, for each size square plug-valve head.
   e. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
5. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
   a. Gate Valves: With rising stem.
   b. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
   c. Butterfly Valves: With extended neck.
6. Valve-End Connections:
   a. Flanged: With flanges according to ASME B16.1 for iron valves.
   b. Grooved: With grooves according to AWWA C606.
   c. Solder Joint: With sockets according to ASME B16.18.
   d. Threaded: With threads according to ASME B1.20.1.
7. Valve Bypass and Drain Connections: MSS SP-45.

B. Bronze Angle Valves
1. Class 125, Bronze Angle Valves with Bronze Disc:
   a. Description:
      1) Standard: MSS SP-80, Type 1.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
      4) Ends: Threaded.
      5) Stem and Disc: Bronze.
      6) Packing: Asbestos free.
      7) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.

2. Class 125, Bronze Angle Valves with Nonmetallic Disc:
    a. Description:
        1) Standard: MSS SP-80, Type 2.
        2) CWP Rating: 200 psig (1380 kPa).
        3) Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
        4) Ends: Threaded.
        5) Stem: Bronze.
        6) Disc: PTFE or TFE.
        7) Packing: Asbestos free.
        8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
3. Class 150, Bronze Angle Valves with Bronze Disc:
    a. Description:
        1) Standard: MSS SP-80, Type 1.
        2) CWP Rating: 300 psig (2070 kPa).
        3) Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
        4) Ends: Threaded.
        5) Stem and Disc: Bronze.
        6) Packing: Asbestos free.
        7) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
4. Class 150, Bronze Angle Valves with Nonmetallic Disc:
    a. Description:
        1) Standard: MSS SP-80, Type 2.
        2) CWP Rating: 300 psig (2070 kPa).
        3) Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
        4) Ends: Threaded.
        5) Stem: Bronze.
        6) Disc: PTFE or TFE.
        7) Packing: Asbestos free.
        8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.

C. Brass Ball Valves
1. One-Piece, Reduced-Port, Brass Ball Valves with Brass Trim:
    a. Description:
        1) Standard: MSS SP-110.
        2) CWP Rating: 400 psig (2760 kPa).
        3) Body Design: One piece.
        4) Body Material: Forged brass.
        5) Ends: Threaded.
        6) Seats: PTFE or TFE.
        7) Stem: Brass.
        8) Ball: Chrome-plated brass.
        9) Port: Reduced.
2. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:
    a. Description:
        1) Standard: MSS SP-110.
        2) SWP Rating: 150 psig (1035 kPa).
        3) CWP Rating: 600 psig (4140 kPa).
        4) Body Design: Two piece.
        5) Body Material: Forged brass.
        6) Ends: Threaded.
        7) Seats: PTFE or TFE.
        8) Stem: Brass.
        9) Ball: Chrome-plated brass.
        10) Port: Full.
3. Two-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:
    a. Description:

1) Standard: MSS SP-110.
2) SWP Rating: 150 psig (1035 kPa).
3) CWP Rating: 600 psig (4140 kPa).
4) Body Design: Two piece.
5) Body Material: Forged brass.
6) Ends: Threaded.
7) Seats: PTFE or TFE.
8) Stem: Stainless steel.
9) Ball: Stainless steel, vented.
10) Port: Full.

4. Two-Piece, Regular-Port, Brass Ball Valves with Brass Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Two piece.
      5) Body Material: Forged brass.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Brass.
      9) Ball: Chrome-plated brass.
      10) Port: Regular.
5. Two-Piece, Regular-Port, Brass Ball Valves with Stainless-Steel Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Two piece.
      5) Body Material: Brass or bronze.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Stainless steel.
      9) Ball: Stainless steel, vented.
      10) Port: Regular.
6. Three-Piece, Full-Port, Brass Ball Valves with Brass Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Three piece.
      5) Body Material: Forged brass.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Brass.
      9) Ball: Chrome-plated brass.
      10) Port: Full.
7. Three-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Three piece.
      5) Body Material: Forged brass.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.

8) Stem: Stainless steel.
9) Ball: Stainless steel, vented.
10) Port: Full.

D. Bronze Ball Valves
1. One-Piece, Reduced-Port, Bronze Ball Valves with Bronze Trim:
a. Description:
1) Standard: MSS SP-110.
2) CWP Rating: 400 psig (2760 kPa).
3) Body Design: One piece.
4) Body Material: Bronze.
5) Ends: Threaded.
6) Seats: PTFE or TFE.
7) Stem: Bronze.
8) Ball: Chrome-plated brass.
9) Port: Reduced.
2. One-Piece, Reduced-Port, Bronze Ball Valves with Stainless-Steel Trim:
a. Description:
1) Standard: MSS SP-110.
2) CWP Rating: 600 psig (4140 kPa).
3) Body Design: One piece.
4) Body Material: Bronze.
5) Ends: Threaded.
6) Seats: PTFE or TFE.
7) Stem: Stainless steel.
8) Ball: Stainless steel, vented.
9) Port: Reduced.
3. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
a. Description:
1) Standard: MSS SP-110.
2) SWP Rating: 150 psig (1035 kPa).
3) CWP Rating: 600 psig (4140 kPa).
4) Body Design: Two piece.
5) Body Material: Bronze.
6) Ends: Threaded.
7) Seats: PTFE or TFE.
8) Stem: Bronze.
9) Ball: Chrome-plated brass.
10) Port: Full.
4. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
a. Description:
1) Standard: MSS SP-110.
2) SWP Rating: 150 psig (1035 kPa).
3) CWP Rating: 600 psig (4140 kPa).
4) Body Design: Two piece.
5) Body Material: Bronze.
6) Ends: Threaded.
7) Seats: PTFE or TFE.
8) Stem: Stainless steel.
9) Ball: Stainless steel, vented.
10) Port: Full.
5. Two-Piece, Regular-Port, Bronze Ball Valves with Bronze Trim:
a. Description:
1) Standard: MSS SP-110.
2) SWP Rating: 150 psig (1035 kPa).
3) CWP Rating: 600 psig (4140 kPa).

4) Body Design: Two piece.
5) Body Material: Bronze.
6) Ends: Threaded.
7) Seats: PTFE or TFE.
8) Stem: Bronze.
9) Ball: Chrome-plated brass.
10) Port: Regular.

6. Two-Piece, Regular-Port, Bronze Ball Valves with Stainless-Steel Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Two piece.
      5) Body Material: Bronze.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Stainless steel.
      9) Ball: Stainless steel, vented.
      10) Port: Regular.
7. Three-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Three piece.
      5) Body Material: Bronze.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Bronze.
      9) Ball: Chrome-plated brass.
      10) Port: Full.
8. Three-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Three piece.
      5) Body Material: Bronze.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Stainless steel.
      9) Ball: Stainless steel, vented.
      10) Port: Full.

E. Iron Ball Valves
   1. Class 125, Iron Ball Valves:
      a. Description:
         1) Standard: MSS SP-72.
         2) CWP Rating: 200 psig (1380 kPa).
         3) Body Design: Split body.
         4) Body Material: ASTM A 126, gray iron.
         5) Ends: Flanged.
         6) Seats: PTFE or TFE.
         7) Stem: Stainless steel.
         8) Ball: Stainless steel.

9) Port: Full.

F. Iron, Single-Flange Butterfly Valves
1. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
a. Description:
1) Standard: MSS SP-67, Type I.
2) CWP Rating: 150 psig (1035 kPa).
3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
5) Seat: EPDM.
6) Stem: One- or two-piece stainless steel.
7) Disc: Aluminum bronze.
2. 150 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze Disc:
a. Description:
1) Standard: MSS SP-67, Type I.
2) CWP Rating: 150 psig (1035 kPa).
3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
5) Seat: NBR.
6) Stem: One- or two-piece stainless steel.
7) Disc: Aluminum bronze.
3. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:
a. Description:
1) Standard: MSS SP-67, Type I.
2) CWP Rating: 150 psig (1035 kPa).
3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
5) Seat: EPDM.
6) Stem: One- or two-piece stainless steel.
7) Disc: Nickel-plated or -coated, **as directed**, ductile iron.
4. 150 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Ductile-Iron Disc:
a. Description:
1) Standard: MSS SP-67, Type I.
2) CWP Rating: 150 psig (1035 kPa).
3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
5) Seat: NBR.
6) Stem: One- or two-piece stainless steel.
7) Disc: Nickel-plated or -coated, **as directed**, ductile iron.
5. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:
a. Description:
1) Standard: MSS SP-67, Type I.
2) CWP Rating: 150 psig (1035 kPa).
3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
5) Seat: EPDM.
6) Stem: One- or two-piece stainless steel.
7) Disc: Stainless steel.
6. 150 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Stainless-Steel Disc:
a. Description:
1) Standard: MSS SP-67, Type I.

2) CWP Rating: 150 psig (1035 kPa).
3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
5) Seat: NBR.
6) Stem: One- or two-piece stainless steel.
7) Disc: Stainless steel.

7. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      5) Seat: EPDM.
      6) Stem: One- or two-piece stainless steel.
      7) Disc: Aluminum bronze.
8. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      5) Seat: NBR.
      6) Stem: One- or two-piece stainless steel.
      7) Disc: Aluminum bronze.
9. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      5) Seat: EPDM.
      6) Stem: One- or two-piece stainless steel.
      7) Disc: Nickel-plated or -coated, **as directed**, ductile iron.
10. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Ductile-Iron Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      5) Seat: NBR.
      6) Stem: One- or two-piece stainless steel.
      7) Disc: Nickel-plated or -coated, **as directed**, ductile iron.
11. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      5) Seat: EPDM.

6) Stem: One- or two-piece stainless steel.
7) Disc: Stainless steel.

12. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Stainless-Steel Disc:
    a. Description:
        1) Standard: MSS SP-67, Type I.
        2) CWP Rating: 200 psig (1380 kPa).
        3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
        4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
        5) Seat: NBR.
        6) Stem: One- or two-piece stainless steel.
        7) Disc: Stainless steel.

G. Iron, Grooved-End Butterfly Valves
1. 175 CWP, Iron, Grooved-End Butterfly Valves:
    a. Description:
        1) Standard: MSS SP-67, Type I.
        2) CWP Rating: 175 psig (1200 kPa).
        3) Body Material: Coated, ductile iron.
        4) Stem: Two-piece stainless steel.
        5) Disc: Coated, ductile iron.
        6) Seal: EPDM.
2. 300 CWP, Iron, Grooved-End Butterfly Valves:
    a. Description:
        1) Standard: MSS SP-67, Type I.
        2) NPS 8 (DN 50) and Smaller CWP Rating: 300 psig (2070 kPa).
        3) NPS 10 (DN 250) and Larger CWP Rating: 200 psig (1380 kPa).
        4) Body Material: Coated, ductile iron.
        5) Stem: Two-piece stainless steel.
        6) Disc: Coated, ductile iron.
        7) Seal: EPDM.

H. High-Performance Butterfly Valves
1. Class 150, Single-Flange, High-Performance Butterfly Valves:
    a. Description:
        1) Standard: MSS SP-68.
        2) CWP Rating: 285 psig (1965 kPa) at 100 deg F (38 deg C).
        3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
        4) Body Material: Carbon steel, cast iron, ductile iron, or stainless steel.
        5) Seat: Reinforced PTFE or metal.
        6) Stem: Stainless steel; offset from seat plane.
        7) Disc: Carbon steel.
        8) Service: Bidirectional.
2. Class 300, Single-Flange, High-Performance Butterfly Valves:
    a. Description:
        1) Standard: MSS SP-68.
        2) CWP Rating: 720 psig (4965 kPa) at 100 deg F (38 deg C).
        3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
        4) Body Material: Carbon steel, cast iron, or ductile iron.
        5) Seat: Reinforced PTFE or metal.
        6) Stem: Stainless steel; offset from seat plane.
        7) Disc: Carbon steel.
        8) Service: Bidirectional.

I. Bronze Lift Check Valves
1. Class 125, Lift Check Valves with Bronze Disc:
a. Description:
1) Standard: MSS SP-80, Type 1.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Design: Vertical flow.
4) Body Material: ASTM B 61 or ASTM B 62, bronze.
5) Ends: Threaded.
6) Disc: Bronze.
2. Class 125, Lift Check Valves with Nonmetallic Disc:
a. Description:
1) Standard: MSS SP-80, Type 2.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Design: Vertical flow.
4) Body Material: ASTM B 61 or ASTM B 62, bronze.
5) Ends: Threaded.
6) Disc: NBR, PTFE, or TFE.

J. Bronze Swing Check Valves
1. Class 125, Bronze Swing Check Valves with Bronze Disc:
a. Description:
1) Standard: MSS SP-80, Type 3.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Design: Horizontal flow.
4) Body Material: ASTM B 62, bronze.
5) Ends: Threaded.
6) Disc: Bronze.
2. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:
a. Description:
1) Standard: MSS SP-80, Type 4.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Design: Horizontal flow.
4) Body Material: ASTM B 62, bronze.
5) Ends: Threaded.
6) Disc: PTFE or TFE.
3. Class 150, Bronze Swing Check Valves with Bronze Disc:
a. Description:
1) Standard: MSS SP-80, Type 3.
2) CWP Rating: 300 psig (2070 kPa).
3) Body Design: Horizontal flow.
4) Body Material: ASTM B 62, bronze.
5) Ends: Threaded.
6) Disc: Bronze.
4. Class 150, Bronze Swing Check Valves with Nonmetallic Disc:
a. Description:
1) Standard: MSS SP-80, Type 4.
2) CWP Rating: 300 psig (2070 kPa).
3) Body Design: Horizontal flow.
4) Body Material: ASTM B 62, bronze.
5) Ends: Threaded.
6) Disc: PTFE or TFE.

K. Iron Swing Check Valves
1. Class 125, Iron Swing Check Valves with Metal Seats:
a. Description:

1) Standard: MSS SP-71, Type I.
2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
4) Body Design: Clear or full waterway.
5) Body Material: ASTM A 126, gray iron with bolted bonnet.
6) Ends: Flanged.
7) Trim: Bronze.
8) Gasket: Asbestos free.

2. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:
   a. Description:
      1) Standard: MSS SP-71, Type I.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
      4) Body Design: Clear or full waterway.
      5) Body Material: ASTM A 126, gray iron with bolted bonnet.
      6) Ends: Flanged.
      7) Trim: Composition.
      8) Seat Ring: Bronze.
      9) Disc Holder: Bronze.
      10) Disc: PTFE or TFE.
      11) Gasket: Asbestos free.
3. Class 250, Iron Swing Check Valves with Metal Seats:
   a. Description:
      1) Standard: MSS SP-71, Type I.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
      4) Body Design: Clear or full waterway.
      5) Body Material: ASTM A 126, gray iron with bolted bonnet.
      6) Ends: Flanged.
      7) Trim: Bronze.
      8) Gasket: Asbestos free.

L. Iron Swing Check Valves With Closure Control
1. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:
   a. Description:
      1) Standard: MSS SP-71, Type I.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
      4) Body Design: Clear or full waterway.
      5) Body Material: ASTM A 126, gray iron with bolted bonnet.
      6) Ends: Flanged.
      7) Trim: Bronze.
      8) Gasket: Asbestos free.
      9) Closure Control: Factory-installed, exterior lever and spring.
2. Class 125, Iron Swing Check Valves with Lever and Weight-Closure Control:
   a. Description:
      1) Standard: MSS SP-71, Type I.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
      4) Body Design: Clear or full waterway.
      5) Body Material: ASTM A 126, gray iron with bolted bonnet.
      6) Ends: Flanged.
      7) Trim: Bronze.
      8) Gasket: Asbestos free.
      9) Closure Control: Factory-installed, exterior lever and weight.

M. Iron, Grooved-End Swing Check Valves
1. 300 CWP, Iron, Grooved-End Swing Check Valves:
a. Description:
1) CWP Rating: 300 psig (2070 kPa).
2) Body Material: ASTM A 536, ductile iron.
3) Seal: EPDM.
4) Disc: Spring operated, ductile iron or stainless steel.

N. Iron, Center-Guided Check Valves
1. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
a. Description:
1) Standard: MSS SP-125.
2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
4) Body Material: ASTM A 126, gray iron.
5) Style: Compact wafer.
6) Seat: Bronze.
2. Class 125, Iron, Globe, Center-Guided Check Valves with Metal Seat:
a. Description:
1) Standard: MSS SP-125.
2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
4) Body Material: ASTM A 126, gray iron.
5) Style: Globe, spring loaded.
6) Ends: Flanged.
7) Seat: Bronze.
3. Class 150, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
a. Description:
1) Standard: MSS SP-125.
2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 300 psig (2070 kPa).
3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 250 psig (1725 kPa).
4) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
5) Style: Compact wafer.
6) Seat: Bronze.
4. Class 150, Iron, Globe, Center-Guided Check Valves with Metal Seat:
a. Description:
1) Standard: MSS SP-125.
2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 300 psig (2070 kPa).
3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 250 psig (1725 kPa).
4) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
5) Style: Globe, spring loaded.
6) Ends: Flanged.
7) Seat: Bronze.
5. Class 250, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
a. Description:
1) Standard: MSS SP-125.
2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
4) Body Material: ASTM A 126, gray iron.
5) Style: Compact wafer, spring loaded.
6) Seat: Bronze.
6. Class 250, Iron, Globe, Center-Guided Check Valves with Metal Seat:
a. Description:
1) Standard: MSS SP-125.
2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).

3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
4) Body Material: ASTM A 126, gray iron.
5) Style: Globe, spring loaded.
6) Ends: Flanged.
7) Seat: Bronze.

7. Class 300, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 400 psig (2760 kPa).
      4) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
      5) Style: Compact wafer, spring loaded.
      6) Seat: Bronze.
8. Class 300, Iron, Globe, Center-Guided Check Valves with Metal Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 400 psig (2760 kPa).
      4) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
      5) Style: Globe, spring loaded.
      6) Ends: Flanged.
      7) Seat: Bronze.
9. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
      4) Body Material: ASTM A 126, gray iron.
      5) Style: Compact wafer.
      6) Seat: EPDM **OR** BR, **as directed**.
10. Class 125, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
      4) Body Material: ASTM A 126, gray iron.
      5) Style: Globe, spring loaded.
      6) Ends: Flanged.
      7) Seat: EPDM **OR** NBR, **as directed**.
11. Class 150, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 300 psig (2070 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 250 psig (1725 kPa).
      4) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
      5) Style: Compact wafer.
      6) Seat: EPDM **OR** NBR, **as directed**.
12. Class 150, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 300 psig (2070 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 250 psig (1725 kPa).
      4) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
      5) Style: Globe, spring loaded.
      6) Ends: Flanged.
      7) Seat: EPDM **OR** NBR, **as directed**.

13. Class 250, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
    a. Description:
        1) Standard: MSS SP-125.
        2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
        3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
        4) Body Material: ASTM A 126, gray iron.
        5) Style: Compact wafer, spring loaded.
        6) Seat: EPDM **OR** NBR, **as directed**.
14. Class 250, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
    a. Description:
        1) Standard: MSS SP-125.
        2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
        3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
        4) Body Material: ASTM A 126, gray iron.
        5) Style: Globe, spring loaded.
        6) Ends: Flanged.
        7) Seat: EPDM **OR** NBR, **as directed**.
15. Class 300, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
    a. Description:
        1) Standard: MSS SP-125.
        2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
        3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 400 psig (2760 kPa).
        4) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
        5) Style: Compact wafer, spring loaded.
        6) Seat: EPDM **OR** NBR, **as directed**.
16. Class 300, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
    a. Description:
        1) Standard: MSS SP-125.
        2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
        3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 400 psig (2760 kPa).
        4) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
        5) Style: Globe, spring loaded.
        6) Ends: Flanged.
        7) Seat: EPDM **OR** NBR, **as directed**.

O. Iron, Plate-Type Check Valves
1. Class 125, Iron, Dual-Plate Check Valves with Metal Seat:
    a. Description:
        1) Standard: API 594.
        2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
        3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
        4) Body Design: Wafer, spring-loaded plates.
        5) Body Material: ASTM A 126, gray iron.
        6) Seat: Bronze.
2. Class 150, Iron, Dual-Plate Check Valves with Metal Seat:
    a. Description:
        1) Standard: API 594.
        2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 300 psig (2070 kPa).
        3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 250 psig (1725 kPa).
        4) Body Design: Wafer, spring-loaded plates.
        5) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
        6) Seat: Bronze.
3. Class 250, Iron, Dual-Plate Check Valves with Metal Seat:
    a. Description:
        1) Standard: API 594.

2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
4) Body Design: Wafer, spring-loaded plates.
5) Body Material: ASTM A 126, gray iron.
6) Seat: Bronze.

4. Class 300, Iron, Dual-Plate Check Valves with Metal Seat:
   a. Description:
      1) Standard: API 594.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 400 psig (2760 kPa).
      4) Body Design: Wafer, spring-loaded plates.
      5) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
      6) Seat: Bronze.
5. Class 125, Iron, Single-Plate Check Valves with Resilient Seat:
   a. Description:
      1) Standard: API 594.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
      4) Body Design: Wafer, spring-loaded plate.
      5) Body Material: ASTM A 126, gray iron.
      6) Seat: EPDM **OR** NBR, **as directed**.
6. Class 125, Iron, Dual-Plate Check Valves with Resilient Seat:
   a. Description:
      1) Standard: API 594.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
      4) Body Design: Wafer, spring-loaded plates.
      5) Body Material: ASTM A 126, gray iron.
      6) Seat: EPDM **OR** NBR, **as directed**.
7. Class 150, Iron, Dual-Plate Check Valves with Resilient Seat:
   a. Description:
      1) Standard: API 594.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 300 psig (2070 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 250 psig (1725 kPa).
      4) Body Design: Wafer, spring-loaded plates.
      5) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
      6) Seat: EPDM **OR** NBR, **as directed**.
8. Class 250, Iron, Wafer, Single-Plate Check Valves with Resilient Seat:
   a. Description:
      1) Standard: API 594.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
      4) Body Design: Wafer, spring-loaded plate.
      5) Body Material: ASTM A 126, gray iron.
      6) Seat: EPDM **OR** NBR, **as directed**.
9. Class 250, Iron, Dual-Plate Check Valves with Resilient Seat:
   a. Description:
      1) Standard: API 594.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
      4) Body Design: Wafer, spring-loaded plates.
      5) Body Material: ASTM A 126, gray iron.
      6) Seat: EPDM **OR** NBR, **as directed**.
10. Class 300, Iron, Dual-Plate Check Valves with Resilient Seat:
    a. Description:
       1) Standard: API 594.

2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 400 psig (2760 kPa).
4) Body Design: Wafer, spring-loaded plates.
5) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
6) Seat: EPDM **OR** NBR, **as directed**.

P. Bronze Gate Valves
1. Class 125, NRS Bronze Gate Valves:
a. Description:
1) Standard: MSS SP-80, Type 1.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
4) Ends: Threaded or solder joint, **as directed**.
5) Stem: Bronze.
6) Disc: Solid wedge; bronze.
7) Packing: Asbestos free.
8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
2. Class 125, RS Bronze Gate Valves:
a. Description:
1) Standard: MSS SP-80, Type 2.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
4) Ends: Threaded or solder joint, **as directed**.
5) Stem: Bronze.
6) Disc: Solid wedge; bronze.
7) Packing: Asbestos free.
8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
3. Class 150, NRS Bronze Gate Valves:
a. Description:
1) Standard: MSS SP-80, Type 1.
2) CWP Rating: 300 psig (2070 kPa).
3) Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
4) Ends: Threaded.
5) Stem: Bronze.
6) Disc: Solid wedge; bronze.
7) Packing: Asbestos free.
8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
4. Class 150, RS Bronze Gate Valves:
a. Description:
1) Standard: MSS SP-80, Type 2.
2) CWP Rating: 300 psig (2070 kPa).
3) Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
4) Ends: Threaded.
5) Stem: Bronze.
6) Disc: Solid wedge; bronze.
7) Packing: Asbestos free.
8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.

Q. Iron Gate Valves
1. Class 125, NRS, Iron Gate Valves:
a. Description:
1) Standard: MSS SP-70, Type I.
2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
4) Body Material: ASTM A 126, gray iron with bolted bonnet.

5) Ends: Flanged.
6) Trim: Bronze.
7) Disc: Solid wedge.
8) Packing and Gasket: Asbestos free.

2. Class 125, OS&Y, Iron Gate Valves:
   a. Description:
      1) Standard: MSS SP-70, Type I.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
      4) Body Material: ASTM A 126, gray iron with bolted bonnet.
      5) Ends: Flanged.
      6) Trim: Bronze.
      7) Disc: Solid wedge.
      8) Packing and Gasket: Asbestos free.
3. Class 250, NRS, Iron Gate Valves:
   a. Description:
      1) Standard: MSS SP-70, Type I.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
      4) Body Material: ASTM A 126, gray iron with bolted bonnet.
      5) Ends: Flanged.
      6) Trim: Bronze.
      7) Disc: Solid wedge.
      8) Packing and Gasket: Asbestos free.
4. Class 250, OS&Y, Iron Gate Valves:
   a. Description:
      1) Standard: MSS SP-70, Type I.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
      4) Body Material: ASTM A 126, gray iron with bolted bonnet.
      5) Ends: Flanged.
      6) Trim: Bronze.
      7) Disc: Solid wedge.
      8) Packing and Gasket: Asbestos free.

R. Bronze Globe Valves
1. Class 125, Bronze Globe Valves with Bronze Disc:
   a. Description:
      1) Standard: MSS SP-80, Type 1.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
      4) Ends: Threaded or solder joint, **as directed**.
      5) Stem and Disc: Bronze.
      6) Packing: Asbestos free.
      7) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
2. Class 125, Bronze Globe Valves with Nonmetallic Disc:
   a. Description:
      1) Standard: MSS SP-80, Type 2.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
      4) Ends: Threaded or solder joint, **as directed**.
      5) Stem: Bronze.
      6) Disc: PTFE or TFE.
      7) Packing: Asbestos free.
      8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
3. Class 150, Bronze Globe Valves with Nonmetallic Disc:

a. Description:
1) Standard: MSS SP-80, Type 2.
2) CWP Rating: 300 psig (2070 kPa).
3) Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
4) Ends: Threaded.
5) Stem: Bronze.
6) Disc: PTFE or TFE.
7) Packing: Asbestos free.
8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.

S. Iron Globe Valves
1. Class 125, Iron Globe Valves:
a. Description:
1) Standard: MSS SP-85, Type I.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Material: ASTM A 126, gray iron with bolted bonnet.
4) Ends: Flanged.
5) Trim: Bronze.
6) Packing and Gasket: Asbestos free.
2. Class 250, Iron Globe Valves:
a. Description:
1) Standard: MSS SP-85, Type I.
2) CWP Rating: 500 psig (3450 kPa).
3) Body Material: ASTM A 126, gray iron with bolted bonnet.
4) Ends: Flanged.
5) Trim: Bronze.
6) Packing and Gasket: Asbestos free.

T. Lubricated Plug Valves
1. Class 125, Regular-Gland, Lubricated Plug Valves with Threaded Ends:
a. Description:
1) Standard: MSS SP-78, Type II.
2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
4) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
5) Pattern: Regular or short **OR** Venturi, **as directed**.
6) Plug: Cast iron or bronze with sealant groove.
2. Class 125, Regular-Gland, Lubricated Plug Valves with Flanged Ends:
a. Description:
1) Standard: MSS SP-78, Type II.
2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
4) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
5) Pattern: Regular or short **OR** Venturi, **as directed**.
6) Plug: Cast iron or bronze with sealant groove.
3. Class 125, Cylindrical, Lubricated Plug Valves with Threaded Ends:
a. Description:
1) Standard: MSS SP-78, Type IV.
2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
4) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
5) Pattern: Regular or short **OR** Venturi, **as directed**.

6) Plug: Cast iron or bronze with sealant groove.

4. Class 125, Cylindrical, Lubricated Plug Valves with Flanged Ends:
   a. Description:
      1) Standard: MSS SP-78, Type IV.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
      4) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
      5) Pattern: Regular or short **OR** Venturi, **as directed**.
      6) Plug: Cast iron or bronze with sealant groove.
5. Class 250, Regular-Gland, Lubricated Plug Valves with Threaded Ends:
   a. Description:
      1) Standard: MSS SP-78, Type II.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
      4) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
      5) Pattern: Regular or short **OR** Venturi, **as directed**.
      6) Plug: Cast iron or bronze with sealant groove.
6. Class 250, Regular-Gland, Lubricated Plug Valves with Flanged Ends:
   a. Description:
      1) Standard: MSS SP-78, Type II.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
      4) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
      5) Pattern: Regular or short **OR** Venturi, **as directed**.
      6) Plug: Cast iron or bronze with sealant groove.
7. Class 250, Cylindrical, Lubricated Plug Valves with Threaded Ends:
   a. Description:
      1) Standard: MSS SP-78, Type IV.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
      4) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
      5) Pattern: Regular or short **OR** Venturi, **as directed**.
      6) Plug: Cast iron or bronze with sealant groove.
8. Class 250, Cylindrical, Lubricated Plug Valves with Flanged Ends:
   a. Description:
      1) Standard: MSS SP-78, Type IV.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
      4) Body Material: ASTM A 48/A 48M or ASTM A 126, Grade 40 cast iron with lubrication-sealing system.
      5) Pattern: Regular or short **OR** Venturi, **as directed**.
      6) Plug: Cast iron or bronze with sealant groove.

U. Eccentric Plug Valves

1. 175 CWP, Eccentric Plug Valves with Resilient Seating.
   a. Description:
      1) Standard: MSS SP-108.
      2) CWP Rating: 175 psig (1200 kPa) minimum.
      3) Body and Plug: ASTM A 48/A 48M, gray iron; ASTM A 126, gray iron; or ASTM A 536, ductile iron.
      4) Bearings: Oil-impregnated bronze or stainless steel.
      5) Ends: Flanged.

6) Stem-Seal Packing: Asbestos free.
7) Plug, Resilient-Seating Material: Suitable for potable-water service unless otherwise indicated.

V. Chainwheels
1. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
   a. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
   b. Attachment: For connection to ball **OR** butterfly **OR** plug, **as directed**, valve stems.
   c. Sprocket Rim with Chain Guides: Ductile iron **OR** Cast iron **OR** Aluminum **OR** Bronze, **as directed**, of type and size required for valve. Include zinc coating, **as directed**.
   d. Chain: Hot-dip, galvanized steel **OR** Brass **OR** Stainless steel, **as directed**, of size required to fit sprocket rim.

1.3 EXECUTION

A. Valve Installation
1. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
2. Locate valves for easy access and provide separate support where necessary.
3. Install valves in horizontal piping with stem at or above center of pipe.
4. Install valves in position to allow full stem movement.
5. Install chainwheels on operators for ball **OR** butterfly **OR** gate **OR** globe **OR** plug, **as directed**, valves NPS 4 (DN 100) and larger and more than 96 inches (2400 mm) above floor. Extend chains to 60 inches (1520 mm) above finished floor.
6. Install check valves for proper direction of flow and as follows:
   a. Swing Check Valves: In horizontal position with hinge pin level.
   b. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
   c. Lift Check Valves: With stem upright and plumb.

B. Adjusting
1. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

C. General Requirements For Valve Applications
1. If valve applications are not indicated, use the following:
   a. Shutoff Service: Ball, butterfly **OR** gate **OR** plug, **as directed**, valves.
   b. Butterfly Valve Dead-End Service: Single-flange (lug) type.
   c. Throttling Service except Steam: Globe **OR** angle **OR** ball **OR** butterfly, **as directed**, valves.
   d. Throttling Service, Steam: Globe **OR** angle **OR** butterfly, **as directed**, valves.
   e. Pump-Discharge Check Valves:
      1) NPS 2 (DN 50) and Smaller: Bronze swing check valves with bronze **OR** nonmetallic, **as directed**, disc.
      2) NPS 2-1/2 (DN 65) and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal **OR** resilient, **as directed**,-seat check valves.
2. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
3. Select valves, except wafer types, with the following end connections:
   a. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
   b. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.

c. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
d. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
e. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
f. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.
g. For Grooved-End Copper Tubing and Steel Piping except Steam and Steam Condensate Piping: Valve ends may be grooved.

D. Chilled-Water Valve Schedule
1. Pipe NPS 2 (DN 50) and Smaller:
a. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
b. Bronze Angle Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
c. Ball Valves: One **OR** Two **OR** Three, **as directed**, piece, full **OR** regular **OR** reduced, **as directed**, port, brass **OR** bronze, **as directed**, with brass **OR** bronze **OR** stainless-steel, **as directed**, trim.
d. Bronze Swing Check Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
e. Bronze Gate Valves: Class 125 **OR** Class 150, **as directed**, NRS **OR** RS, **as directed**, bronze.
f. Bronze Globe Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
2. Pipe NPS 2-1/2 (DN 65) and Larger:
a. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
b. Iron Ball Valves, NPS 2-1/2 to NPS 10 (DN 65 to DN 250): Class 150.
c. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 200 CWP, EPDM **OR** NBR, **as directed**, seat, aluminum-bronze **OR** ductile-iron **OR** stainless-steel, **as directed**, disc.
d. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24 (DN 350 to DN 600): 150 CWP, EPDM **OR** NBR, **as directed**, seat, aluminum-bronze **OR** ductile-iron **OR** stainless-steel, **as directed**, disc.
e. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 175 **OR** 300, **as directed**, CWP.
f. High-Performance Butterfly Valves: Class 150 **OR** Class 300, **as directed**, single flange.
g. Iron Swing Check Valves: Class 125 **OR** Class 250, **as directed**, metal **OR** nonmetallic-to-metal, **as directed**, seats.
h. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125, lever and spring **OR** weight, **as directed**.
i. Iron, Grooved-End Check Valves, NPS 3 to NPS 12 (DN 80 to DN 300): 300 CWP.
j. Iron, Center-Guided Check Valves: Class 125 **OR** Class 150 **OR** Class 250 **OR** Class 300, **as directed**, compact-wafer **OR** globe, **as directed**, metal **OR** resilient, **as directed**, seat.
k. Iron, Plate-Type Check Valves: Class 125 **OR** Class 150 **OR** Class 250 **OR** Class 300, **as directed**; single **OR** dual, **as directed**, plate; metal **OR** resilient, **as directed**, seat.
l. Iron Gate Valves: Class 125 **OR** Class 250, **as directed**, NRS **OR** OS&Y, **as directed**.
m. Iron Globe Valves: Class 125 **OR** Class 250, **as directed**.
n. Lubricated Plug Valves: Class 125 **OR** Class 250, **as directed**, regular gland **OR** cylindrical, **as directed**, threaded **OR** flanged, **as directed**.
o. Eccentric Plug Valves: 175 CWP, resilient seating.

E. Condenser-Water Valve Schedule
1. Pipe NPS 2 (DN 50) and Smaller:
a. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.

b. Bronze Angle Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
c. Ball Valves: One **OR** Two **OR** Three, **as directed**, piece, full **OR** regular **OR** reduced, **as directed**, port, brass **OR** bronze, **as directed**, with brass **OR** bronze **OR** stainless-steel, **as directed**, trim.
d. Bronze Swing Check Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
e. Bronze Gate Valves: Class 125 **OR** Class 150, **as directed**, NRS **OR** RS, **as directed**.
f. Bronze Globe Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.

2. Pipe NPS 2-1/2 (DN 65) and Larger:
a. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
b. Iron Ball Valves, NPS 2-1/2 to NPS 10 (DN 65 to DN 250): Class 150.
c. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 200 CWP, EPDM **OR** NBR, **as directed**, seat, aluminum-bronze **OR** ductile-iron **OR** stainless-steel, **as directed**, disc.
d. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24 (DN 350 to DN 600): 150 CWP, EPDM **OR** NBR, **as directed**, seat, aluminum-bronze **OR** ductile-iron **OR** stainless-steel, **as directed**, disc.
e. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 175 **OR** 300, **as directed**, CWP.
f. High-Performance Butterfly Valves: Class 150 **OR** Class 300, **as directed**, single flange.
g. Iron Swing Check Valves: Class 125 **OR** Class 250, **as directed**, metal **OR** nonmetallic-to-metal, **as directed**, seats.
h. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125, lever and spring **OR** weight, **as directed**.
i. Iron, Grooved-End Check Valves, NPS 3 to NPS 12 (DN 80 to DN 300): 300 CWP.
j. Iron, Center-Guided Check Valves, NPS 2-1/2 to NPS 24 (DN 65 to DN 600): Class 125 **OR** Class 150 **OR** Class 250 **OR** Class 300, **as directed**, metal **OR** resilient, **as directed**, seat.
k. Iron, Plate-Type Check Valves: Class 125 **OR** Class 150 **OR** Class 250 **OR** Class 300, **as directed**; single **OR** dual, **as directed**, plate; metal **OR** resilient, **as directed**, seat.
l. Iron Gate Valves: Class 125 **OR** Class 250, **as directed**, NRS **OR** OS&Y, **as directed**.
m. Iron Globe Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125 **OR** Class 250, **as directed**.
n. Lubricated Plug Valves: Class 125 **OR** Class 250, **as directed**, regular gland **OR** cylindrical, **as directed**, threaded **OR** flanged, **as directed**.

F. Heating-Water Valve Schedule
1. Pipe NPS 2 (DN 50) and Smaller:
a. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
b. Bronze Angle Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
c. Ball Valves: One **OR** Two **OR** Three, **as directed**, piece, full **OR** regular **OR** reduced, **as directed**, port, brass **OR** bronze, **as directed**, with brass **OR** bronze **OR** stainless-steel, **as directed**, trim.
d. Bronze Swing Check Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
e. Bronze Gate Valves: Class 125 **OR** Class 150, **as directed**, NRS **OR** RS, **as directed**.
f. Bronze Globe Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
2. Pipe NPS 2-1/2 (DN 65) and Larger:

a. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
b. Iron Ball Valves, NPS 2-1/2 to NPS 10 (DN 65 to DN 250): Class 150.
c. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 200 CWP, EPDM **OR** NBR, **as directed**, seat, aluminum-bronze **OR** ductile-iron **OR** stainless-steel, **as directed**, disc.
d. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24 (DN 350 to DN 600): 150 CWP, EPDM **OR** NBR, **as directed**, seat, aluminum-bronze **OR** ductile-iron **OR** stainless-steel, **as directed**, disc.
e. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 175 **OR** 300, **as directed**, CWP.
f. High-Performance Butterfly Valves: Class 150 **OR** Class 300, **as directed**, single flange.
g. Iron Swing Check Valves: Class 125 **OR** Class 250, **as directed**, metal **OR** nonmetallic-to-metal, **as directed**, seats.
h. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125, lever and spring **OR** weight, **as directed**.
i. Iron, Grooved-End Check Valves, NPS 3 to NPS 12 (DN 80 to DN 300): 300 CWP.
j. Iron, Center-Guided Check Valves: Class 125 **OR** Class 150 **OR** Class 250 **OR** Class 300, **as directed**, compact-wafer **OR** globe, **as directed**, metal **OR** resilient, **as directed**, seat.
k. Iron, Plate-Type Check Valves: Class 125 **OR** Class 150 **OR** Class 250 **OR** Class 300, **as directed**; single **OR** dual, **as directed**, plate; metal **OR** resilient, **as directed**, seat.
l. Iron Gate Valves: Class 125 **OR** Class 250, **as directed**, NRS **OR** OS&Y, **as directed**.
m. Iron Globe Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125 **OR** Class 250, **as directed**.

G. Low-Pressure Steam Valve Schedule (15 psig (104 kPa) Or Less)
1. Pipe NPS 2 (DN 50) and Smaller:
a. Bronze Angle Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
b. Ball Valves: One **OR** Two **OR** Three, **as directed**, piece, full **OR** regular **OR** reduced, **as directed**, port, brass **OR** bronze, **as directed**, with brass **OR** bronze **OR** stainless-steel, **as directed**, trim.
c. Bronze Swing Check Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
d. Bronze Gate Valves: Class 125 **OR** Class 150, **as directed**, NRS **OR** RS, **as directed**.
e. Bronze Globe Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
2. Pipe NPS 2-1/2 (DN 65) and Larger:
a. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
b. Iron Ball Valves, NPS 2-1/2 to NPS 10 (DN 65 to DN 250): Class 150.
c. High-Performance Butterfly Valves: Class 150 **OR** Class 300, **as directed**, single flange.
d. Iron Swing Check Valves: Class 125 **OR** Class 250, **as directed**, metal **OR** nonmetallic-to-metal, **as directed**, seats.
e. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125, lever and spring **OR** weight, **as directed**.
f. Iron Gate Valves: Class 125 **OR** Class 250, **as directed**, NRS **OR** OS&Y, **as directed**.
g. Iron Globe Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125 **OR** Class 250, **as directed**.

H. High-Pressure Steam Valve Schedule (More Than 15 psig (104 kPa))
1. Pipe NPS 2 (DN 50) and Smaller:
a. Bronze Angle Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.

b. Ball Valves: One **OR** Two **OR** Three, **as directed**, piece, full **OR** regular **OR** reduced, **as directed**, port, brass **OR** bronze, **as directed**, with brass **OR** bronze **OR** stainless-steel, **as directed**, trim.
c. Bronze Swing Check Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
d. Bronze Gate Valves: Class 125 **OR** Class 150, **as directed**, NRS **OR** RS, **as directed**, bronze.
e. Globe Valves: Class 125 **OR** 150, **as directed**, bronze, bronze **OR** nonmetallic, **as directed**, disc.

2. Pipe Sizes NPS 2-1/2 (DN 65) and Larger:
a. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
b. Ball Valves, NPS 2-1/2 to NPS 10 (DN 65 to DN 250): Class 150, iron.
c. High-Performance Butterfly Valves: Class 150 **OR** Class 300, **as directed**, single flange.
d. Iron Swing Check Valves: Class 125 **OR** Class 250, **as directed**, metal **OR** nonmetallic-to-metal, **as directed**, seats.
e. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125, lever and spring **OR** weight, **as directed**.
f. Iron Gate Valves: Class 125 **OR** Class 250, **as directed**, NRS **OR** OS&Y, **as directed**.
g. Iron Globe Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125 **OR** Class 250, **as directed**.

I. Steam-Condensate Valve Schedule

1. Pipe NPS 2 (DN 50) and Smaller:
a. Bronze Angle Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
b. Ball Valves: One **OR** Two **OR** Three, **as directed**, piece, full **OR** regular **OR** reduced, **as directed**, port, brass **OR** bronze, **as directed**, with brass **OR** bronze **OR** stainless-steel, **as directed**, trim.
c. Bronze Swing Check Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
d. Bronze Gate Valves: Class 125 **OR** Class 150, **as directed**, NRS **OR** RS, **as directed**.
e. Bronze Globe Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.

2. Pipe NPS 2-1/2 (DN 65) and Larger:
a. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
b. Iron Ball Valves, NPS 2-1/2 to NPS 10 (DN 65 to DN 250): Class 150.
c. High-Performance Butterfly Valves: Class 150 **OR** Class 300, **as directed**, single flange.
d. Iron Swing Check Valves: Class 125 **OR** Class 250, **as directed**, metal **OR** nonmetallic-to-metal, **as directed**, seats.
e. Iron Swing Check Valves with Closure Control: Class 125, lever and spring **OR** weight, **as directed**.
f. Iron Gate Valves: Class 125 **OR** Class 250, **as directed**, NRS **OR** OS&Y, **as directed**.
g. Iron Globe Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125 **OR** Class 250, **as directed**.
h. Lubricated Plug Valves: Class 125 **OR** Class 250, **as directed**, regular gland **OR** cylindrical, **as directed**, threaded **OR** flanged, **as directed**.

END OF SECTION 21 05 23 00b

Task	Specification	Specification Description
21 05 23 00	07 63 00 00	Common Work Results for Fire Suppression
21 05 23 00	07 63 00 00a	Common Work Results for Plumbing
21 05 23 00	07 63 00 00b	Common Work Results for HVAC

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SECTION 21 05 48 13 - VIBRATION AND SEISMIC CONTROLS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Elastomeric hangers.
5. Snubbers.
6. Restraints - rigid type.
7. Restraints - cable type.
8. Restraint accessories.
9. Post-installed concrete anchors.
10. Concrete inserts.

B. Related Requirements:

1. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for devices for plumbing equipment and systems.
2. Section 230548 "Vibration and Seismic Controls for HVAC" for devices for HVAC equipment and systems.

1.2 DEFINITIONS

A. Designated Seismic System: A fire-suppression component that requires design in accordance with ASCE/SEI 7, Ch. 13 and for which the Component Importance Factor is greater than 1.0.

B. IBC: International Building Code.

C. OSHPD: Office of Statewide Health Planning and Development (for the State of California).

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Include load rating for each wind-load-restraint fitting and assembly.
3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-[**and wind-load-**]restraint component.
4. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by [**ICC-ES product listing**] [**UL product listing**] [**FM Approvals**] [**an evaluation service member of ICC-ES**] [**OSHPD**] [**an agency acceptable to authorities having jurisdiction**].
5. Annotate to indicate application of each product submitted and compliance with requirements.

6. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated Design Submittal:

1. For each seismic-restraint [**and**] [**wind-load protection**] device, including [**seismic-restrained mounting,**] [**pipe-riser resilient support,**] [**snubber,**] [**seismic restraint,**] [**seismic-restraint accessory,**] [**and**] [**concrete anchor and insert**] that is required by this Section or is indicated on Drawings, submit the following:

   a. Seismic-[**and Wind-Load-**]Restraint Selection: Select seismic [**and wind-load**]restraints complying with performance requirements, design criteria, and analysis data.
   b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and seismic loads. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.
   c. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated seismic[**and wind**] loads. Include certification that device is approved by an NRTL for seismic reinforcement use.
   d. Seismic Design Calculations: Submit all input data and loading calculations prepared under "Seismic Design Calculations" Paragraph in "Performance Requirements" Article.
   e. Wind-Load Design Calculations: Submit all static and dynamic loading calculations prepared under "Wind-Load Design Calculations" in "Performance Requirements" Article.
   f. Qualified Professional Engineer: All designated-design submittals for seismic [**and wind-load-restraint**]calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.

2. Seismic-[**and Wind-Load-**]Restraint Detail Drawing:

   a. Design Analysis: To support selection and arrangement of seismic[**and wind**] restraints. Include calculations of combined tensile and shear loads.
   b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
   c. Coordinate seismic restraint details with wind-load restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.

3. Product Listing, Preapproval, and Evaluation Documentation: By [**an evaluation service member of ICC-ES**] [**UL**] [**FM Approvals**] [**OSHPD**] [**an agency acceptable to authorities having jurisdiction**], showing maximum ratings of restraint items and the basis for approval (tests or calculations).
4. All delegated design submittals for seismic-[**and wind-load-**]restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.

D. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of seismic bracing for fire-suppression piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For [**professional engineer**] [**and**] [**testing agency**].

C. Welding certificates.

D. Field quality-control reports.

E. Seismic Qualification Data: Provide special certification for designated seismic systems as indicated in [**ASCE/SEI 7-05,**] [**ASCE/SEI 7-10,**] [**ASCE/SEI 7-16,**] Paragraph 13.2.2, "Special Certification Requirements for Designated Seismic Systems" for all Designated Seismic Systems identified as such on Drawings or in the Specifications.

1. Provide equipment manufacturer's written certification for each designated active fire-suppression system seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI 7 and AHRI 1270 (AHRI 1271), including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction [**or**] [**experience data as permitted by**] [**ASCE/SEI 7-05**] [**ASCE/SEI 7-10**] [**ASCE/SEI 7-16**].
2. Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in [**ASCE/SEI 7-05**] [**ASCE/SEI 7-10**] [**ASCE/SEI 7-16**].
3. Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by a licensed professional engineer.
4. The following fire-suppression systems and components are Designated Seismic Systems and require written special certification of seismic qualification by manufacturer:

    a. <**Insert list**>.

F. Wind-Load Performance Certification: Provide special certification for fire-suppression system components subject to high-wind exposure and impact damage and designated on Drawings or in the Specifications to require wind-load performance certification.

1. Provide equipment manufacturer's written certification for each designated fire-suppression system device, stating that it will remain in place and operable following the design wind event and comply with all requirements of authorities having jurisdiction.
2. Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.
3. The following fire-suppression system systems and components require special certification for high wind performance. Written special certification of resistance to the effects of high wind load and impact damage must be provided by manufacturer.

    a. <**Insert list**>.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Seismic-[**and Wind-Load-**]Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: [**ICC-ES product listing**] [**UL product listing**] [**FM Approvals**] [**an evaluation service member of ICC-ES**] [**an agency acceptable to authorities having jurisdiction**].

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic[**and wind-load**] control system.

1. Seismic Performance: Equipment must be designed and secured to withstand the effects of earthquake motions determined in accordance with NFPA 13 and [**ASCE/SEI 7-05**] [**ASCE/SEI 7-10**] [**ASCE/SEI 7-16**] <**Insert requirement**>.
2. Wind-Load Performance: Equipment must be designed and secured to withstand the effects of high wind events determined in accordance with [**ASCE/SEI 7-05**] [**ASCE/SEI 7-10**] [**ASCE/SEI 7-16**] <**Insert requirement**>.

B. Seismic Design Calculations:

1. Perform calculations to obtain force information necessary to properly select seismic-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in [**NFPA 13**] [**and**] [**ASCE/SEI 7-05**] [**ASCE/SEI 7-10 including supplement No. 1**] [**ASCE/SEI 7-16**] <**Insert ASCE/SEI 7 edition or other seismic calculation method required by authorities having jurisdiction**>. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is the edition intended as reference throughout the Section Text.

   a. Data indicated below to be determined by Delegated Design Contractor must be obtained by Contractor and must be included in individual component submittal packages.
   b. Coordinate seismic design calculations with wind-load calculations for equipment mounted outdoors. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.
   c. Building Occupancy Category: [**I**] [**II**] [**III**] [**IV**].
   d. Building Risk Category: [**I**] [**II**] [**III**] [**IV**].
   e. Building Site Classification: [**A**] [**B**] [**C**] [**D**] [**E**] [**F**].

2. Calculation Factors, ASCE/SEI 7-16, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-16 unless otherwise noted.

   a. Horizontal Seismic Design Force F_p: Value is to be calculated by Delegated Design Contractor using Equation 13.3-1. Factors below must be obtained for this calculation:

      1) S_{DS} = Spectral Acceleration: <**Insert value**>. Value applies to all components on Project.
      2) a_p = Component Amplification Factor: See Drawing Schedule for each component.
      3) I_p = Component Importance Factor: See Drawing Schedule for each component.
      4) W_p = Component Operating Weight: For each component. Obtain by Delegated Design Contractor from each component submittal.
      5) R_p = Component Response Modification Factor: See Drawing Schedule for each component.
      6) z = Height in Structure of Point of Attachment of Component for Base: Determine from Project Drawings for each component by Delegated Design Contractor. For items at or below the base, "z" is to be taken as zero.
      7) h = Average Roof Height of Structure for Base: Determine from Project Drawings by Delegated Design Contractor.

   b. Vertical Seismic Design Force: Calculated by Delegated Design Contractor using method explained in ASCE/SEI 7-16, Paragraph 13.3.1.2.
   c. Seismic Relative Displacement D_{pI}: Calculated by Delegated Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.2. Factors below must be obtained for this calculation:

      1) D_p = Relative Seismic Displacement that Each Component Must Be Designed to Accommodate: Calculated by Delegated Design Contractor in accordance with ASCE/SEI 7-16, Paragraph 13.3.2.
      2) I_e = Structure Importance Factor: <**Insert value**>. Value applies to all components on Project.
      3) δ_{xA} = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.
      4) δ_{yA} = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.
      5) δ_{yB} = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.
      6) h_x = Height of Level x to which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
      7) h_y = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
      8) Δ_{aA} = Allowable Story Drift for Structure A: See Drawing Schedules for each component.
      9) Δ_{aB} = Allowable Story Drift for Structure B: See Drawing Schedules for each component.
      10) h_{sx} = Story Height Used in the Definition of the Allowable Drift Δ_a: See Drawings Schedules for each component.

   d. Component Fundamental Period T_p: Calculated by Delegated Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.3. Factors below must be obtained for this calculation:

1) W_p = Component Operating Weight: Determined by contractor from Project Drawings and manufacturer's data.
2) g = Gravitational Acceleration: [**32.17 fps^2 (9.81 m/s^2)**] <**Insert option**>.
3) K_p = Combined Stiffness of Component, Supports, and Attachments: Determined by delegated design seismic engineer. <**Insert value**>.

3. Calculation Factors, ASCE/SEI 7-10, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-10 unless otherwise noted.

a. Horizontal Seismic Design Force F_p: Calculated by Delegated Design Contractor by ASCE/SEI 7-10, Equation 13.3-1. Factors below must be obtained for this calculation:

1) S_{DS} = Spectral Acceleration: <**Insert value**>. Value applies to all components on Project.
2) a_p = Component Amplification Factor: See Drawing Schedule for each component.
3) I_p = Component Importance Factor: See Drawing Schedule for each component.
4) W_p = Component Operating Weight: For each component. Obtain by Delegated Design Contractor from equipment submittal.
5) R_p = Component Response Modification Factor: See Drawing Schedule for each component.
6) z = Height in Structure of Point of Attachment of Component for Base: Determined from Project Drawings for each component by Contractor. For items at or below the base, "z" is to be taken as zero.
7) h = Average Roof Height of Structure for Base: Determine from Project Drawings by Delegated Design Contractor.

b. Vertical Seismic Design Force: Calculate by Delegated Design Contractor using method explained in ASCE/SEI 7-10, Paragraph 13.3.1.
c. Seismic Relative Displacement D_{pl}: Calculate by Delegated Design Contractor using methods explained in ASCE/SEI 7-10, Paragraph 13.3.2. Factors below must be obtained for this calculation:

1) D_p = Relative Seismic Displacement that Each Component Must Be Designed to Accommodate: Calculate by Delegated Design Contractor in accordance with ASCE/SEI 7-10, Paragraph 13.3.2.
2) I_e = Structure Importance Factor: <**Insert value**>. Value applies to all components on Project.
3) δ_{xA} = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.
4) δ_{yA} = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.
5) δ_{yB} = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.
6) h_x = Height of Level x to which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
7) h_y = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
8) Δ_{aA} = Allowable Story Drift for Structure A: See Drawing Schedule for each component.

9) Δ_{aB} = Allowable Story Drift for Structure B: See Drawing Schedule for each component.
10) h_{sx} = Story Height Used in the Definition of the Allowable Drift Δ_a: See Drawing Schedule for each component.

4. Calculation Factors, ASCE/SEI 7-05, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-05 unless otherwise noted.

a. Horizontal Seismic Design Force F_p: Calculated by Delegated Design Contractor by ASCE/SEI 7-05, Equation 13.3-1. Factors below must be obtained for this calculation:

1) S_{DS} = Spectral Acceleration: <**Insert value**>. Value applies to all components on Project.
2) a_p = Component Amplification Factor: See Drawing Schedule for each component.
3) I_p = Component Importance Factor: See Drawing Schedule for each component.
4) W_p = Component Operating Weight: Obtain by Delegated Design Contractor for each component from component submittal.
5) R_p = Component Response Modification Factor: See Drawing Schedule for each component.
6) z = Height in Structure of Point of Attachment of Component for Base: Determine by Delegated Design Contractor for each component from Project Drawings. For items at or below the base, "z" is to be taken as zero.
7) h = Average Roof Height of Structure for Base: Determine by Delegated Design Contractor from Project Drawings.

b. Vertical Seismic Design Force: Calculated by Delegated Design Contractor using method explained in ASCE/SEI 7-05, Paragraph 13.3.1.

c. Seismic Relative Displacement D_p: Calculated by Delegated Design Contractor using methods explained in ASCE/SEI 7-05, Paragraph 13.3.2. Factors below must be obtained for this calculation:

1) δ_{xA} = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.
2) δ_{yA} = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.
3) δ_{yB} = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.
4) h_x = Height of Level x to which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
5) h_y = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
6) Δ_{aA} = Allowable Story Drift for Structure A: See Drawing Schedule for each component.
7) Δ_{aB} = Allowable Story Drift for Structure B: See Drawing Schedule for each component.
8) h_{sx} = Story Height Used in the Definition of the Allowable Drift Δ_a: See Drawing Schedule for each component.

C. Wind-Load Design Calculations:

1. Perform calculations to obtain force information necessary to properly select wind-load-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in [**ASCE/SEI 7-05**] [**ASCE/SEI 7-10**] [**ASCE/SEI 7-16**] <**Insert ASCE/SEI 7 edition or other wind-load calculation method required by authorities having jurisdiction**>. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is intended as referenced throughout the Section Text unless otherwise noted.

    a. Factors indicated below that are specific to individual pieces of equipment must be obtained by Contractor and must be included in individual component submittal packages.
    b. Coordinate design wind-load calculations with seismic load calculations for equipment requiring both seismic and wind-load reinforcement. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.

2. Design wind pressure "p" for external sidewall-mounted equipment is to be calculated by Delegated Design Contractor using methods in ASCE/SEI 7-16, Ch. 30. Perform calculations in accordance with one of the following, as appropriate:

    a. PART 1: Low-Rise Buildings.
    b. PART 2: Low-Rise Buildings (Simplified).
    c. PART 3: Buildings with "h" less than 60 feet (18.3 m).
    d. PART 4: Buildings with "h" greater than 60 feet (18.3 m) and less than 160 feet (48.8 m).
    e. PART 5: Open Buildings.

3. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated Design Contractor using methods in ASCE/SEI 7-16, Ch 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.

    a. Risk Category: [**I**] [**II**] [**III**] [**IV**] [**V**].
    b. h = Mean Roof Height: <**Insert value**>.
    c. V = Basic Wind Speed: <**Insert value**>.
    d. K_d = Wind Directionality Factor: <**Insert factor**>.
    e. Exposure Category: [**B**] [**C**] [**D**].
    f. K_{zt} = Topographic Factor: <**Insert factor**>.
    g. K_e = Ground Elevation Factor: <**Insert factor**>.
    h. K_z = Velocity Pressure Exposure Coefficient (Evaluated at Height z): <**Insert coefficient**>.
    i. K_h = Velocity Pressure Exposure Coefficient (Evaluated at Height h): <**Insert coefficient**>.
    j. q_z = Velocity Pressure: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-16 Section 26.10.1 or other source approved by authorities having jurisdiction.
    k. q_h = Velocity Pressure: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-16 Section 26.10.1 or other source approved by authorities having jurisdiction.
    l. G = Gust-Effect Factor: [**0.85**] <**Insert factor**>.
    m. Enclosure Classification: <**Insert classification**>.
    n. GC_{pi} = Internal Pressure Coefficient: <**Insert coefficient**>.

4. Design wind pressure "p" for external sidewall-mounted equipment is to be calculated by Delegated Design Contractor using methods in ASCE/SEI 7-10, Ch. 30. Perform calculations in accordance with the following, as appropriate:

    a. PART 1: Low-Rise Buildings.
    b. PART 2: Low-Rise Buildings (Simplified).
    c. PART 3: Buildings with "h" greater than 60 feet (18.3 m).

d. PART 4: Buildings with "h" less than 160 feet (48.8 m).
e. PART 5: Open Buildings.

5. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated Design Contractor using methods in ASCE/SEI 7-10, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.

a. Risk Category: [**I**] [**II**] [**III**] [**IV**] [**V**].
b. h = Mean Roof Height: <**Insert value**>.
c. V = Basic Wind Speed: <**Insert value**>.
d. K_d = Wind Directionality Factor: <**Insert factor**>.
e. Exposure Category: [**B**] [**C**] [**D**].
f. K_{zt} = Topographic Factor: <**Insert factor**>.
g. K_z = Velocity Pressure Exposure Coefficient (Evaluated at Height z): <**Insert coefficient**>.
h. K_h = Velocity Pressure Exposure Coefficient (Evaluated at Height h): <**Insert coefficient**>.
i. q_z = Velocity Pressure at Height z: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-10 Section 26.10.1 or other source approved by authorities having jurisdiction.
j. q_h = Velocity Pressure at Height h: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-10 Section 26.10.1 or other source approved by authorities having jurisdiction.
k. G = Gust-Effect Factor: [**0.85**] <**Insert factor**>.
l. Enclosure Classification: <**Insert classification**>.
m. GC_{pi} = Internal Pressure Coefficient: <**Insert coefficient**>.

6. Design wind force "F" for rooftop equipment and external sidewall-mounted equipment such as louvers is to be calculated by Delegated Design Contractor using methods in ASCE/SEI 7-05, Ch. 6.

a. I = Importance Factor: <**Insert factor**>.
b. h = Mean Roof Height: <**Insert value**>.
c. V = Basic Wind Speed: <**Insert value**>.
d. K_d = Wind Directionality Factor: <**Insert factor**>.
e. Exposure Category: [**B**] [**C**] [**D**].
f. K_{zt} = Topographic Factor: <**Insert factor**>.
g. K_z = Velocity Pressure Exposure Coefficient (Evaluated at Height z): <**Insert coefficient**>.
h. K_h = Velocity Pressure Exposure Coefficient (Evaluated at Height h): <**Insert coefficient**>.
i. q_z = Velocity Pressure at Height z: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-05 Section 6.5.10 or other source approved by authorities having jurisdiction.
j. q_h = Velocity Pressure at Roof Height h: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-05 Section 6.5.10 or other source approved by authorities having jurisdiction.
k. G = Gust-Effect Factor: [**0.85**] <**Insert factor**>.
l. GC_{pi}= Internal Pressure Coefficient: <**Insert coefficient**>.
m. GC_p = External Pressure Coefficient: <**Insert coefficient**>.
n. C_f = Force Coefficient: Value determined by delegated wind-load design Contractor from ASCE/SEI 7-05, Figures 6-21 through 6-23 or other source approved by authorities having jurisdiction.
o. A_f = Projected Area Normal to the Wind: Except where C_f is specified for the actual surface area, value determined by delegated wind-load design Contractor from equipment submittal or manufacturer.

D. Consequential Damage: Provide additional seismic and wind-load restraints for suspended fire-suppression system components or anchorage of floor-, roof-, or wall-mounted fire-suppression system components as indicated in [**ASCE/SEI 7-05**] [**ASCE/SEI 7-10**] [**ASCE/SEI 7-16**] so that failure of a non-essential or essential fire-suppression system component will not cause the failure of any other essential architectural, mechanical, or electrical building component.

E. Fire/Smoke Resistance: Seismic-[**and wind-load-**]restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.

F. Component Supports:

1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.
2. All component support attachments must comply with force and displacement resistance requirements of [**ASCE/SEI 7-05 Section 13.6**] [**ASCE/SEI 7-10 Section 13.6**] [**ASCE/SEI 7-16 Section 13.6**].

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
5. Surface Pattern: Smooth, ribbed, or waffle pattern.
6. Infused nonwoven cotton or synthetic fibers.
7. Load-bearing metal plates adhered to pads.
8. Sandwich-Core Material: [**Resilient**] [**and**] [**elastomeric**] <**Insert compound**>.

   a. Surface Pattern: Smooth, ribbed, or waffle pattern.
   b. Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Mounting Plates:

   a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded[**with threaded studs or bolts**].
   b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

3. Elastomeric Material: Molded, oil- and water-resistant neoprene rubber, silicone rubber, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

   a. Housing: Cast-ductile iron or welded steel.
   b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.5 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
3. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel-to-steel contact.

2.6 SNUBBERS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be seismically prequalified in accordance with ACI 355.2 testing and designated in accordance with [**ACI 318-08 Appendix D for 2009 IBC**] [**ACI 318-11 Appendix D for 2012 IBC**] [**ACI 318-14 Ch. 17 for 2015 or 2018 IBC**].
2. Preset Concrete Inserts: Seismically prequalified in accordance with ICC-ES AC446 testing.
3. Anchors in Masonry: Design in accordance with TMS 402.
4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
5. Resilient Cushion: Maximum 1/4-inch (6-mm) air gap, and minimum 1/4 inch (6 mm) thick.

2.7 RESTRAINTS - RIGID TYPE

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.8 RESTRAINTS - CABLE TYPE

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Seismic-Restraint Cables: [**ASTM A1023/A12023M galvanized or ASTM A603 galvanized-steel**] [**ASTM A492 stainless steel**] cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.

C. Restraint cable assembly with cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.9 RESTRAINT ACCESSORIES

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Hanger-Rod Stiffener: [**Steel tube or steel slotted-support-system sleeve with internally bolted connections**] [**Reinforcing steel angle clamped**] to hanger rod. Non-metallic stiffeners are unacceptable.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to [**rigid restraints**] [**and**] [**restraint cables**].

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.10 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

B. Adhesive Anchor Bolts:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
a.

2. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware

with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

C. Provide post-installed concrete anchors that have been prequalified for use in seismic applications. Post-installed concrete anchors must comply with all requirements of [**ASCE/SEI 7-05, Ch. 13**] [**ASCE/SEI 7-10, Ch. 13**] [**ASCE/SEI 7-16, Ch. 13**].

1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

D. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp (7.46 kW) that is not vibration isolated.

1. Undercut expansion anchors are permitted.

2.11 CONCRETE INSERTS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC466 testing.

C. Comply with ANSI/MSS SP-58.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation[**, wind control,**] and seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by [**an evaluation service member of ICC-ES**] [**OSHPD**] [**an agency acceptable to authorities having jurisdiction**].

B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry calculated static[**, wind load,**] and seismic loads within specified loading limits.

3.3 INSTALLATION OF VIBRATION CONTROL[**, WIND-LOAD-RESTRAINT,**] AND SEISMIC-RESTRAINT DEVICES

A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Fire-Suppression Vibration Isolation, Seismic, and Wind-Load-Restraint Schedule, where indicated on Drawings, or where the Specifications indicate they are to be installed on specific equipment and systems.

B. Provide seismic-restraint [**and wind-load-restraint**]devices for systems and equipment where indicated in Equipment Schedules or Vibration Isolation, Seismic, and Wind-Load-Restraint Schedules, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

D. Installation of vibration isolators[**, wind-load restraints,**] and seismic restraints must not cause any stresses, misalignment, or change of position of equipment or piping.

E. Comply with installation requirements of NFPA 13 for installation of all seismic-restraint devices.

F. Comply with requirements in Section 077200 "Roof Accessories" for installation of equipment supports and roof penetrations.

G. Equipment Restraints:

1. Install snubbers on fire-suppression equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
3. Install seismic-restraint devices using methods approved by [**an evaluation service member of ICC-ES**] [**OSHPD**] [**an agency acceptable to authorities having jurisdiction**] that provides required submittals for component.

H. Piping Restraints:

1. Comply with all requirements in NFPA 13.
2. Design piping sway bracing in accordance with NFPA 13.
    a. Maximum spacing of all sway bracing to be no greater than indicated in NFPA 13.
    b. Design loading of all sway bracing not to exceed values indicated in NFPA 13.

I. Install seismic-[**and wind-load-**]restraint devices using methods approved by [**an evaluation service member of ICC-ES**] [**OSHPD**] [**an agency acceptable to authorities having jurisdiction**] that provides required submittals for component.

J. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

K. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

L. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

M. Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors to be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross structural seismic joints and other points where differential movement may occur, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 211200 "Fire-Suppression Standpipes," Section 211313 "Wet-Pipe Sprinkler Systems," and Section 211316 "Dry-Pipe Sprinkler Systems" for piping flexible connections.

3.5 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at no fewer than [**four**] <**Insert number**> of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.

D. Remove and replace malfunctioning units and retest as specified above.

E. Units will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 21 05 48 13

SECTION 21 07 00 00 - FIRE-SUPPRESSION SYSTEMS INSULATION

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for fire-suppression systems insulation. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Insulation Materials:
         1) Calcium silicate.
         2) Cellular glass.
         3) Flexible elastomeric.
         4) Mineral fiber.
         5) Phenolic.
         6) Polyisocyanurate.
         7) Polyolefin.
         8) Polystyrene.
      b. Insulating cements.
      c. Adhesives.
      d. Mastics.
      e. Lagging adhesives.
      f. Sealants.
      g. Factory-applied jackets.
      h. Field-applied fabric-reinforcing mesh.
      i. Field-applied cloths.
      j. Field-applied jackets.
      k. Tapes.
      l. Securements.
      m. Corner angles.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittal:
      a. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
   3. Shop Drawings:
      a. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
      b. Detail attachment and covering of heat tracing inside insulation.
      c. Detail insulation application at pipe expansion joints for each type of insulation.
      d. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
      e. Detail removable insulation at piping specialties and equipment connections.
      f. Detail application of field-applied jackets.
      g. Detail application at linkages of control devices.
      h. Detail field application for fire-suppression water storage tanks.
   4. Field quality-control reports.

D. Quality Assurance

1. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
   a. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   b. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

E. Delivery, Storage, And Handling
   1. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.2 PRODUCTS

A. Insulation Materials
   1. Comply with requirements in Part 1.3 schedule articles for where insulating materials shall be applied.
   2. Products shall not contain asbestos, lead, mercury, or mercury compounds.
   3. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
   4. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
   5. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
   6. Calcium Silicate:
      a. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
      b. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.
   7. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
      a. Block Insulation: ASTM C 552, Type I.
      b. Special-Shaped Insulation: ASTM C 552, Type III.
      c. Board Insulation: ASTM C 552, Type IV.
      d. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
      e. Preformed Pipe Insulation with Factory-Applied ASJ **OR** ASJ-SSL, **as directed**: Comply with ASTM C 552, Type II, Class 2.
      f. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
   8. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
   9. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   10. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For equipment applications, provide insulation without factory-applied jacket **OR** with factory-applied ASJ **OR** with factory-applied FSK jacket, **as directed**. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   11. Mineral-Fiber, Preformed Pipe Insulation:
      a. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, without factory-applied

jacket **OR** with factory-applied ASJ **OR** with factory-applied ASJ-SSL, **as directed**. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
b. Type II, 1200 deg F (649 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, without factory-applied jacket **OR** with factory-applied ASJ **OR** with factory-applied ASJ-SSL, **as directed**. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

12. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ **OR** FSK jacket, **as directed**, complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
13. Phenolic:
    a. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
    b. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
    c. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
    d. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
        1) Preformed Pipe Insulation: None **OR** ASJ, **as directed**.
        2) Board for Equipment Applications: None **OR** ASJ, **as directed**.
14. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.
    a. Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F (0.027 W/m x K) at 75 deg F (24 deg C) after 180 days of aging.
    b. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less for thickness up to 1-1/2 inches (38 mm) as tested by ASTM E 84.
    c. Fabricate shapes according to ASTM C 450 and ASTM C 585.
    d. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
        1) Pipe Applications: None **OR** ASJ **OR** ASJ-SSL **OR** PVDC **OR** PVDC-SSL, **as directed**.
        2) Equipment Applications: None **OR** ASJ **OR** ASJ-SSL **OR** PVDC **OR** PVDC-SSL, **as directed**.
15. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.
16. Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C 578, Type IV or Type XIII, except thermal conductivity (k-value) shall not exceed 0.26 Btu x in./h x sq. ft. x deg F (0.038 W/m x K) after 180 days of aging. Fabricate shapes according to ASTM C 450 and ASTM C 585.

B. Insulating Cements
1. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
2. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
3. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

C. Adhesives
1. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
2. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F (10 to 427 deg C).
    a. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Cellular-Glass, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F (minus 59 to plus 149 deg C).
   a. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
4. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   a. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
5. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   a. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140 deg F (29 to plus 60 deg C).
7. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.
   a. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
8. PVC Jacket Adhesive: Compatible with PVC jacket.
   a. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Mastics
1. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
   a. For indoor applications, use mastics that have a VOC content of <**Insert value**> g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
   a. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
   b. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
   c. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
   d. Color: White.
3. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
   a. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30-mil (0.8-mm) dry film thickness.
   b. Service Temperature Range: Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).
   c. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
   d. Color: White.
4. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
   a. Water-Vapor Permeance: ASTM F 1249, 3 perms (2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
   b. Service Temperature Range: Minus 20 to plus 200 deg F (Minus 29 to plus 93 deg C).
   c. Solids Content: 63 percent by volume and 73 percent by weight.
   d. Color: White.

E. Lagging Adhesives
1. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
   a. For indoor applications, use lagging adhesives that have a VOC content of <**Insert value**> g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment and pipe insulation.
   c. Service Temperature Range: Minus 50 to plus 180 deg F (Minus 46 to plus 82 deg C).
   d. Color: White.

F. Sealants
1. Joint Sealants:
a. Materials shall be compatible with insulation materials, jackets, and substrates.
b. Permanently flexible, elastomeric sealant.
c. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
d. Color: White or gray.
e. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. FSK and Metal Jacket Flashing Sealants:
a. Materials shall be compatible with insulation materials, jackets, and substrates.
b. Fire- and water-resistant, flexible, elastomeric sealant.
c. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
d. Color: Aluminum.
e. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
a. Materials shall be compatible with insulation materials, jackets, and substrates.
b. Fire- and water-resistant, flexible, elastomeric sealant.
c. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
d. Color: White.
e. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

G. Factory-Applied Jackets
1. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
c. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
d. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms (0.013 metric perms) when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
e. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms (0.007 metric perms) when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
f. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

H. Field-Applied Fabric-Reinforcing Mesh
1. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. (68 g/sq. m) with a thread count of 10 strands by 10 strands/sq. inch (4 strands by 4 strands/sq. mm) for covering pipe and pipe fittings.
2. Woven Glass-Fiber Fabric for Equipment Insulation: Approximately 6 oz./sq. yd. (203 g/sq. m) with a thread count of 5 strands by 5 strands/sq. inch (2 strands by 2 strands/sq. mm) for covering equipment.
3. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. inch (4 strands by 4 strands/sq. mm), in a Leno weave.

I. Field-Applied Cloths
1. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. (271 g/sq. m).

J. Field-Applied Jackets
1. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
2. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   a. Adhesive: As recommended by jacket material manufacturer.
   b. Color: White **OR** Color-code jackets based on system. Color as selected by the Owner, **as directed**.
   c. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
      1) Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
   d. Factory-fabricated tank heads and tank side panels.
3. Metal Jacket:
   a. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005, Temper H-14.
      1) Sheet and roll stock ready for shop or field sizing **OR** Factory cut and rolled to size, **as directed**.
      2) Finish and thickness are indicated in field-applied jacket schedules.
      3) Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 2.5-mil- (0.063-mm-) thick Polysurlyn, **as directed**.
      4) Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 2.5-mil- (0.063-mm-) thick Polysurlyn, **as directed**.
      5) Factory-Fabricated Fitting Covers:
         a) Same material, finish, and thickness as jacket.
         b) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
         c) Tee covers.
         d) Flange and union covers.
         e) End caps.
         f) Beveled collars.
         g) Valve covers.
         h) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
   b. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
      1) Sheet and roll stock ready for shop or field sizing **OR** Factory cut and rolled to size, **as directed**.
      2) Material, finish, and thickness are indicated in field-applied jacket schedules.
      3) Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 2.5-mil- (0.063-mm-) thick Polysurlyn, **as directed**.
      4) Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 2.5-mil- (0.063-mm-) thick Polysurlyn, **as directed**.
      5) Factory-Fabricated Fitting Covers:
         a) Same material, finish, and thickness as jacket.
         b) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
         c) Tee covers.
         d) Flange and union covers.
         e) End caps.
         f) Beveled collars.
         g) Valve covers.
         h) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

K. Tapes

1. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   a. Width: 3 inches (75 mm).
   b. Thickness: 11.5 mils (0.29 mm).
   c. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   d. Elongation: 2 percent.
   e. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   f. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
2. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   a. Width: 3 inches (75 mm).
   b. Thickness: 6.5 mils (0.16 mm).
   c. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   d. Elongation: 2 percent.
   e. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   f. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
3. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
   a. Width: 2 inches (50 mm).
   b. Thickness: 6 mils (0.15 mm).
   c. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
   d. Elongation: 500 percent.
   e. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.
4. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
   a. Width: 2 inches (50 mm).
   b. Thickness: 3.7 mils (0.093 mm).
   c. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
   d. Elongation: 5 percent.
   e. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.
5. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
   a. Width: 3 inches (75 mm).
   b. Film Thickness: 4 mils (0.10 mm).
   c. Adhesive Thickness: 1.5 mils (0.04 mm).
   d. Elongation at Break: 145 percent.
   e. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.
6. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
   a. Width: 3 inches (75 mm).
   b. Film Thickness: 6 mils (0.15 mm).
   c. Adhesive Thickness: 1.5 mils (0.04 mm).
   d. Elongation at Break: 145 percent.
   e. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.

L. Securements
1. Bands:
   a. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 **OR** Type 316, **as directed**; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, wide with wing seal **OR** closed seal, **as directed**.
   b. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, wide with wing seal **OR** closed seal, **as directed**.
   c. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
2. Insulation Pins and Hangers:
   a. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in

position indicated when self-locking washer is in place. Comply with the following requirements:

1) Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
2) Spindle: Copper- or zinc-coated, low carbon steel **OR** Aluminum **OR** Stainless steel, **as directed**, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
3) Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

b. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

1) Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
2) Spindle: Copper- or zinc-coated, low carbon steel **OR** Aluminum **OR** Stainless steel, **as directed**, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
3) Adhesive-backed base with a peel-off protective cover.

c. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, galvanized-steel **OR** aluminum **OR** stainless-steel, **as directed**, sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

1) Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

3. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.
4. Wire: 0.080-inch (2.0-mm) nickel-copper alloy **OR** 0.062-inch (1.6-mm) soft-annealed, stainless steel **OR** 0.062-inch (1.6-mm) soft-annealed, galvanized steel, **as directed**.

1.3 EXECUTION

A. Preparation

1. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
   OR
   Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
   a. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range between 140 and 300 deg F (60 and 149 deg C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
   b. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
3. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

B. General Installation Requirements

1. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.

2. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
3. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
4. Install insulation with longitudinal seams at top and bottom of horizontal runs.
5. Install multiple layers of insulation with longitudinal and end seams staggered.
6. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
7. Keep insulation materials dry during application and finishing.
8. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
9. Install insulation with least number of joints practical.
10. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
    a. Install insulation continuously through hangers and around anchor attachments.
    b. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
    c. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
    d. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
11. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
12. Install insulation with factory-applied jackets as follows:
    a. Draw jacket tight and smooth.
    b. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
    c. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) **OR** 4 inches (100 mm), **as directed**, o.c.
        1) For below ambient services, apply vapor-barrier mastic over staples.
    d. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
    e. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
13. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
14. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
15. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
16. For above ambient services, do not install insulation to the following:
    a. Vibration-control devices.
    b. Testing agency labels and stamps.
    c. Nameplates and data plates.
    d. Manholes.
    e. Handholes.
    f. Cleanouts.

C. Penetrations

1. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   a. Seal penetrations with flashing sealant.
   b. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   c. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
   d. Seal jacket to roof flashing with flashing sealant.
2. Insulation Installation at Below-Grade Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
3. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   a. Seal penetrations with flashing sealant.
   b. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   c. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
   d. Seal jacket to wall flashing with flashing sealant.
4. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
5. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   a. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
6. Insulation Installation at Floor Penetrations:
   a. Pipe: Install insulation continuously through floor penetrations.
   b. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping".

D. Equipment, Tank, And Vessel Insulation Installation
   1. Secure insulation with adhesive and anchor pins and speed washers.
      a. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 **OR** 50, **as directed**, percent coverage of tank and vessel surfaces.
      b. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
      c. Protect exposed corners with secured corner angles.
      d. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
         1) Do not weld anchor pins to ASME-labeled pressure vessels.
         2) Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
         3) On tanks and vessels, maximum anchor-pin spacing is 3 inches (75 mm) from insulation end joints, and 16 inches (400 mm) o.c. in both directions.
         4) Do not overcompress insulation during installation.
         5) Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
         6) Impale insulation over anchor pins and attach speed washers.
         7) Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

e. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
f. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches (150 mm) from each end. Install wire or cable between two circumferential girdles 12 inches (300 mm) o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches (1200 mm) o.c. Use this network for securing insulation with tie wire or bands.
g. Stagger joints between insulation layers at least 3 inches (75 mm).
h. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
i. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
j. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

2. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
a. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
b. Seal longitudinal seams and end joints.

E. General Pipe Insulation Installation
1. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
2. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
a. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
b. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
c. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
d. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
e. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
f. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
g. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for

above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

h. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

i. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

3. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

4. Install removable insulation covers at locations indicated. Installation shall conform to the following:

a. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

b. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

c. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.

d. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

e. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

F. Calcium Silicate Insulation Installation

1. Insulation Installation on Straight Pipes and Tubes:

a. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation materials.

b. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.

c. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

2. Insulation Installation on Pipe Flanges:

a. Install preformed pipe insulation to outer diameter of pipe flange.

b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.

d. Finish flange insulation same as pipe insulation.

3. Insulation Installation on Pipe Fittings and Elbows:

a. Install preformed sections of same material as straight segments of pipe insulation when available.

b. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
c. Finish fittings insulation same as pipe insulation.

4. Insulation Installation on Valves and Pipe Specialties:
   a. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   b. Install insulation to flanges as specified for flange insulation application.
   c. Finish valve and specialty insulation same as pipe insulation.

G. Cellular-Glass Insulation Installation
1. Insulation Installation on Straight Pipes and Tubes:
   a. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and applicable insulation joint sealant.
   c. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
   d. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
2. Insulation Installation on Pipe Flanges:
   a. Install preformed pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
   d. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.
3. Insulation Installation on Pipe Fittings and Elbows:
   a. Install preformed sections of same material as straight segments of pipe insulation when available.
   b. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.
4. Insulation Installation on Valves and Pipe Specialties:
   a. Install preformed sections of cellular-glass insulation to valve body.
   b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   c. Install insulation to flanges as specified for flange insulation application.

H. Flexible Elastomeric Insulation Installation
1. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
2. Insulation Installation on Pipe Flanges:
   a. Install pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
   d. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
3. Insulation Installation on Pipe Fittings and Elbows:
   a. Install mitered sections of pipe insulation.
   b. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

4. Insulation Installation on Valves and Pipe Specialties:
    a. Install preformed valve covers manufactured of same material as pipe insulation when available.
    b. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
    c. Install insulation to flanges as specified for flange insulation application.
    d. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

I. Mineral-Fiber Insulation Installation
1. Insulation Installation on Straight Pipes and Tubes:
    a. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
    b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and applicable insulation joint sealant.
    c. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
    d. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
2. Insulation Installation on Pipe Flanges:
    a. Install preformed pipe insulation to outer diameter of pipe flange.
    b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
    c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
    d. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.
3. Insulation Installation on Pipe Fittings and Elbows:
    a. Install preformed sections of same material as straight segments of pipe insulation when available.
    b. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
4. Insulation Installation on Valves and Pipe Specialties:
    a. Install preformed sections of same material as straight segments of pipe insulation when available.
    b. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
    c. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
    d. Install insulation to flanges as specified for flange insulation application.

J. Phenolic Insulation Installation
1. General Installation Requirements:
    a. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation materials.
    b. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with 0.062-inch (1.6-mm) wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.
2. Insulation Installation on Straight Pipes and Tubes:
    a. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and applicable insulation joint sealant.
c. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
d. For insulation with factory-applied jackets with vapor retarders on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
3. Insulation Installation on Pipe Flanges:
a. Install preformed pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
4. Insulation Installation on Pipe Fittings and Elbows:
a. Install preformed insulation sections of same material as straight segments of pipe insulation.
5. Insulation Installation on Valves and Pipe Specialties:
a. Install preformed insulation sections of same material as straight segments of pipe insulation.
b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
c. Install insulation to flanges as specified for flange insulation application.

K. Polyisocyanurate Insulation Installation
1. Insulation Installation on Straight Pipes and Tubes:
a. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
b. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
c. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.
2. Insulation Installation on Pipe Flanges:
a. Install preformed pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch (38-mm) thickness.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation.
3. Insulation Installation on Fittings and Elbows:
a. Install preformed sections of same material as straight segments of pipe insulation.
4. Insulation Installation on Valves and Pipe Specialties:
a. Install preformed sections of polyisocyanurate insulation to valve body.
b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
c. Install insulation to flanges as specified for flange insulation application.

L. Polyolefin Insulation Installation
1. Insulation Installation on Straight Pipes and Tubes:
a. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
2. Insulation Installation on Pipe Flanges:
a. Install pipe insulation to outer diameter of pipe flange.

b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
d. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3. Insulation Installation on Pipe Fittings and Elbows:
a. Install mitered sections of polyolefin pipe insulation.
b. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

4. Insulation Installation on Valves and Pipe Specialties:
a. Install cut sections of polyolefin pipe and sheet insulation to valve body.
b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
c. Install insulation to flanges as specified for flange insulation application.
d. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

M. Polystyrene Insulation Installation

1. Insulation Installation on Straight Pipes and Tubes:
a. Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
b. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
c. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

2. Insulation Installation on Pipe Flanges:
a. Install preformed pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch (38-mm) thickness.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polystyrene block insulation of same thickness as pipe insulation.

3. Insulation Installation on Pipe Fittings and Elbows:
a. Install preformed insulation sections of same material as straight segments of pipe insulation.

4. Insulation Installation on Valves and Pipe Specialties:
a. Install preformed section of polystyrene insulation to valve body.
b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
c. Install insulation to flanges as specified for flange insulation application.

N. Field-Applied Jacket Installation

1. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
a. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
b. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
c. Completely encapsulate insulation with coating, leaving no exposed insulation.

2. Where FSK jackets are indicated, install as follows:
a. Draw jacket material smooth and tight.
b. Install lap or joint strips with same material as jacket.

c. Secure jacket to insulation with manufacturer's recommended adhesive.
d. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
e. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

3. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
   a. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
4. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.
5. Where PVDC jackets are indicated, install as follows:
   a. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
   b. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches (50 mm) over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
   c. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
   d. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches (850 mm) or less. The 33-1/2-inch- (850-mm-) circumference limit allows for 2-inch- (50-mm-) overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
   e. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

O. Finishes
1. Equipment and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 07.
   a. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
      1) Finish Coat Material: Interior, flat, latex-emulsion size.
2. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
3. Color: Final color as selected by the Owner. Vary first and second coats to allow visual inspection of the completed Work.
4. Do not field paint aluminum or stainless-steel jackets.

P. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
   a. Inspect field-insulated equipment, randomly selected by the Owner, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
   b. Inspect pipe, fittings, strainers, and valves, randomly selected by the Owner, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of

inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

3. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

Q. Equipment Insulation Schedule

1. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
2. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.
3. Fire-suppression water storage tank insulation shall be one of the following:
   a. Cellular Glass: 2 inches (50 mm) thick.
   b. Flexible Elastomeric: 1 inch (25 mm) thick.
   c. Mineral-Fiber Board: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   d. Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
   e. Phenolic: 1 inch (25 mm) thick.
   f. Polyisocyanurate: 1 inch (25 mm) thick.
   g. Polyolefin: 1 inch (25 mm) thick.

R. Piping Insulation Schedule, General

1. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
2. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   a. Indoor fire-suppression piping.
   b. Underground piping.

S. Indoor Piping Insulation Schedule

1. Indoor Engine Coolant Piping for Remote Radiator of Engine-Driven Fire Pump:
   a. All Pipe Sizes: Insulation shall be one of the following:
      1) Calcium Silicate: 2 inches (50 mm) thick.
      2) Cellular Glass: 2 inches (50 mm) thick.
      3) Mineral-Fiber, Preformed Pipe, Type I or II: 2 inches (50 mm) thick.
2. Indoor Engine Exhaust Piping and Silencer, All Pipe Sizes: Calcium silicate, 4 inches (100 mm) thick.

T. Outdoor, Aboveground Piping Insulation Schedule

1. Outdoor Engine Coolant Piping for Remote Radiator of Engine-Driven Fire Pump:
   a. All Pipe Sizes: Insulation shall be one of the following:
      1) Calcium Silicate: 2 inches (50 mm) thick.
      2) Cellular Glass: 2 inches (50 mm) thick.
      3) Mineral-Fiber, Preformed Pipe, Type I or II: 2 inches (50 mm) thick.
2. Outdoor Engine Exhaust Piping and Silencer, All Pipe Sizes: Calcium silicate, 4 inches (100 mm) thick.
3. Outdoor Fire-Suppression Piping Filled with Water:
   a. All Pipe Sizes: Insulation shall be one of the following:
      1) Cellular Glass: 2 inches (50 mm) thick.
      2) Flexible Elastomeric: 2 inches (50 mm) thick.
      3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.
      4) Phenolic: 2 inches (50 mm) thick.
      5) Polyisocyanurate: 2 inches (50 mm) thick.
      6) Polyolefin: 2 inches (50 mm) thick.
      7) Polystyrene: 2 inches (50 mm) thick.

U. Indoor, Field-Applied Jacket Schedule
1. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
2. If more than one material is listed, selection from materials listed is Contractor's option.
3. Piping, Concealed:
   a. None.
   b. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
   c. Painted Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
   d. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.
4. Piping, Exposed:
   a. None.
   b. PVC **OR** PVC, Color-Coded by System, **as directed**: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm), **as directed**, thick.
   c. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
   d. Painted Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
   e. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.

V. Outdoor, Field-Applied Jacket Schedule
1. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
2. If more than one material is listed, selection from materials listed is Contractor's option.
3. Equipment, Concealed:
   a. None.
   b. PVC **OR** PVC, Color-Coded by System, **as directed**: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm), **as directed**, thick.
   c. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
   d. Painted Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
   e. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.
4. Equipment, Exposed, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces up to 72 Inches (1800 mm):
   a. Aluminum **OR** Painted Aluminum, **as directed**, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**, with Z-Shaped Locking Seam, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
   b. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**, with Z-Shaped Locking Seam, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.

5. Equipment, Exposed, Larger Than 48 Inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 Inches (1800 mm):
   a. Aluminum **OR** Painted Aluminum, **as directed**, Smooth **OR** Stucco Embossed, **as directed**, with 1-1/4-Inch- (32-mm-) Deep Corrugations **OR** 2-1/2-Inch- (65-mm-) Deep Corrugations **OR** 4-by-1-Inch (100-by-25-mm) Box Ribs, **as directed**: 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
   b. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth **OR** Stucco Embossed, **as directed**, with 1-1/4-Inch- (32-mm-) Deep Corrugations **OR** 2-1/2-Inch- (65-mm-) Deep Corrugations **OR** 4-by-1-Inch (100-by-25-mm) Box Ribs, **as directed**: 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.
6. Outdoor Exposed Piping:
   a. PVC: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm) **OR** 40 mils (1.0 mm), **as directed**, thick.
   b. Aluminum **OR** Painted Aluminum, **as directed**, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**, with Z-Shaped Locking Seam, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
   c. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, ,**as directed** with Z-Shaped Locking Seam, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.

END OF SECTION 21 07 00 00

SECTION 21 11 19 00 - FIRE-SUPPRESSION STANDPIPES

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for fire-suppression standpipes. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
    a. Pipes, fittings, and specialties.
    b. Fire-protection valves.
    c. Hose connections.
    d. Hose stations.
    e. Monitors.
    f. Fire-department connections.
    g. Alarm devices.
    h. Manual control stations.
    i. Control panels.
    j. Pressure gages.

C. Definitions

1. High-Pressure Standpipe Piping: Fire-suppression standpipe piping designed to operate at working pressure higher than standard 175 psig (1200 kPa), but not higher than 250 psig (1725 kPa) **OR** 300 psig (2070 kPa), **as directed**.
2. Standard-Pressure Standpipe Piping: Fire-suppression standpipe piping designed to operate at working pressure 175 psig (1200 kPa) maximum.

D. System Descriptions

1. Automatic Wet-Type, Class I Standpipe System: Includes NPS 2-1/2 (DN 65) hose connections. Has open water-supply valve with pressure maintained and is capable of supplying water demand.
2. Automatic Wet-Type, Class II Standpipe System: Includes NPS 1-1/2 (DN 40) hose stations. Has open water-supply valve with pressure maintained and is capable of supplying water demand.
3. Automatic Wet-Type, Class III Standpipe System: Includes NPS 1-1/2 (DN 40) hose stations and NPS 2-1/2 (DN 65) hose connections. Has open water-supply valve with pressure maintained and is capable of supplying water demand.
4. Automatic Dry-Type, Class I Standpipe System: Includes NPS 2-1/2 (DN 65) hose connections. Has open water-supply valve and dry-pipe valve with standpipes containing compressed air. Opening fire-hose valve releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into standpipes.
5. Automatic Dry-Type, Class II Standpipe System: Includes NPS 1-1/2 (DN 40) hose stations. Has open water-supply valve and dry-pipe valve with standpipes containing compressed air. Opening fire-hose valve releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into standpipes.
6. Automatic Dry-Type, Class III Standpipe System: Includes NPS 1-1/2 (DN 40) hose stations and NPS 2-1/2 (DN 65) hose connections. Has open water-supply valve and dry-pipe valve with standpipes containing compressed air. Opening fire-hose valve releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into standpipes.
7. Semiautomatic Dry-Type, Class I Standpipe System: Includes NPS 2-1/2 (DN 65) hose connections. Has open water-supply valve and deluge valve with standpipes containing air.

Actuation of detection device permits water pressure to open deluge valve. Water then flows into standpipes.

8. Semiautomatic Dry-Type, Class II Standpipe System: Includes NPS 1-1/2 (DN 40) hose stations. Has open water-supply valve and deluge valve with standpipes containing air. Actuation of detection device permits water pressure to open deluge valve. Water then flows into standpipes.
9. Semiautomatic Dry-Type, Class III Standpipe System: Includes NPS 1-1/2 (DN 40) hose stations and NPS 2-1/2 (DN 65) hose connections. Has open water-supply valve and deluge valve with standpipes containing air. Actuation of detection device permits water pressure to open deluge valve. Water then flows into standpipes.
10. Manual Wet-Type, Class I Standpipe System: Includes NPS 2-1/2 (DN 65) hose connections. Has small water supply to maintain water in standpipes. Piping is wet, but water must be pumped into standpipes to satisfy demand.
11. Manual Dry-Type, Class I Standpipe System: Includes NPS 2-1/2 (DN 65) hose connections. Does not have permanent water supply. Piping is dry. Water must be pumped into standpipes to satisfy demand.

E. Performance Requirements
1. Standard-Pressure, Fire-Suppression Standpipe System Component: Listed for 175-psig (1200-kPa) minimum working pressure.
2. High-Pressure, Fire-Suppression Standpipe System Component: Listed for 250-psig (1725-kPa) minimum **OR** 300-psig (2070-kPa), **as directed**, working pressure.
3. Delegated Design: Design fire-suppression standpipes, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
4. Fire-suppression standpipe design shall be approved by authorities having jurisdiction.
    a. Minimum residual pressure at each hose-connection outlet is as follows:
        1) NPS 1-1/2 (DN 40) Hose Connections: 65 psig (450 kPa).
        2) NPS 2-1/2 (DN 65) Hose Connections: 100 psig (690 kPa).
    b. Maximum residual pressure at required flow at each hose-connection outlet is as follows unless otherwise indicated:
        1) NPS 1-1/2 (DN 40) Hose Connections: 100 psig (690 kPa).
        2) NPS 2-1/2 (DN 65) Hose Connections: 175 psig (1200 kPa).
5. Seismic Performance: Fire-suppression standpipes shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

F. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: For fire-suppression standpipes. Include plans, elevations, sections, details, and attachments to other work.
    a. Wiring Diagrams: For power, signal, and control wiring.
3. Delegated-Design Submittal: For standpipe systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
4. Qualification Data: For qualified Installer and professional engineer.
5. Approved Standpipe Drawings: Working plans, prepared according to NFPA 14, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
6. Welding certificates.
7. Fire-hydrant flow test report.
8. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 14. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."
9. Field quality-control reports.
10. Operation and Maintenance Data: For fire-suppression standpipes specialties to include in emergency, operation, and maintenance manuals.

G. Quality Assurance
1. Installer Qualifications:
a. Installer's responsibilities include designing, fabricating, and installing fire-suppression standpipes and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
1) Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
2. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. NFPA Standards: Fire-suppression standpipe equipment, specialties, accessories, installation, and testing shall comply with NFPA 14, "Installation of Standpipe and Hose Systems."

H. Project Conditions
1. Interruption of Existing Fire-Suppression Standpipe Service: Do not interrupt fire-suppression standpipe service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fire-suppression standpipe service according to requirements indicated:
a. Notify the Owner no fewer than two days in advance of proposed interruption of fire-suppression standpipe service.
b. Do not proceed with interruption of fire-suppression standpipe service without the Owner's written permission.

1.2 PRODUCTS

A. Piping Materials
1. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

B. Steel Pipe And Fittings
1. Standard Weight, Galvanized- and Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.
2. Schedule 30, Galvanized- and Black-Steel Pipe: ASTM A 135; ASTM A 795/A 795M, Type E; or ASME B36.10M, wrought steel; with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.
3. Thinwall Galvanized- and Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.
4. Schedule 10, Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, Schedule 10 in NPS 5 (DN 125) and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10 (DN 150 to DN 250), plain end.
5. Nonstandard OD, Thinwall Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, thinwall, with plain ends and wall thickness less than Schedule 10.
6. Hybrid Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, lightwall, with wall thickness less than Schedule 10 and greater than Schedule 5.
7. Standard-Weight, Galvanized- and Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, seamless steel pipe with threaded ends.
8. Galvanized and Uncoated, Steel Couplings: ASTM A 865, threaded.
9. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
10. Malleable- or Ductile-Iron Unions: UL 860.
11. Cast-Iron Flanges: ASME B16.1, Class 125.
12. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
13. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

14. Grooved-Joint, Steel-Pipe Appurtenances:
    a. Pressure Rating: 175 psig (1200 kPa) **OR** 250 psig (1725 kPa) **OR** 300 psig (2070 kPa), **as directed**, minimum.
    b. Galvanized and Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
    c. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

C. Copper Tube And Fittings
1. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) and ASTM B 88, Type M (ASTM B 88M, Type C) water tube, drawn temper.
2. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
3. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.
4. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
5. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
6. Grooved-Joint, Copper-Tube Appurtenances:
    a. Grooved-End, Copper Fittings: ASTM B 75 (ASTM B 75M), copper tube or ASTM B 584, bronze castings.
    b. Grooved-End-Tube Couplings: To fit copper tube dimensions, with design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gasket suitable for hot and cold water, and bolts and nuts.

D. Piping Joining Materials
1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free.
    a. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
    b. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
2. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
3. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
4. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

E. Listed Fire-Protection Valves
1. General Requirements:
    a. Valves shall be UL listed or FM approved.
    b. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig (1200 kPa).
    c. Minimum Pressure Rating for High-Pressure Piping: 250 psig (1725 kPa) **OR** 300 psig (2070 kPa), **as directed**.
2. Ball Valves:
    a. Standard: UL 1091 except with ball instead of disc.
    b. Valves NPS 1-1/2 (DN 40) and Smaller: Bronze body with threaded ends.
    c. Valves NPS 2 and NPS 2-1/2 (DN 50 and DN 65): Bronze body with threaded ends or ductile-iron body with grooved ends.
    d. Valves NPS 3 (DN 80): Ductile-iron body with grooved ends.
3. Bronze Butterfly Valves:
    a. Standard: UL 1091.
    b. Pressure Rating: 175 psig (1200 kPa).
    c. Body Material: Bronze.
    d. End Connections: Threaded.

4. Iron Butterfly Valves:
   a. Standard: UL 1091.
   b. Pressure Rating: 175 psig (1200 kPa).
   c. Body Material: Cast or ductile iron.
   d. Style: Lug or wafer.
      OR
      End Connections: Grooved.
5. Check Valves:
   a. Standard: UL 312.
   b. Pressure Rating: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
   c. Type: Swing check.
   d. Body Material: Cast iron.
   e. End Connections: Flanged or grooved.
6. Bronze OS&Y Gate Valves:
   a. Standard: UL 262.
   b. Pressure Rating: 175 psig (1200 kPa).
   c. Body Material: Bronze.
   d. End Connections: Threaded.
7. Iron OS&Y Gate Valves:
   a. Standard: UL 262.
   b. Pressure Rating: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
   c. Body Material: Cast or ductile iron.
   d. End Connections: Flanged or grooved.
8. Indicating-Type Butterfly Valves:
   a. Standard: UL 1091.
   b. Pressure Rating: 175 psig (1200 kPa) minimum.
   c. Valves NPS 2 (DN 50) and Smaller:
      1) Valve Type: Ball or butterfly.
      2) Body Material: Bronze.
      3) End Connections: Threaded.
   d. Valves NPS 2-1/2 (DN 65) and Larger:
      1) Valve Type: Butterfly.
      2) Body Material: Cast or ductile iron.
      3) End Connections: Flanged, grooved, or wafer.
   e. Valve Operation: Integral electrical, 115-V ac, prewired, single-circuit, supervisory switch **OR** electrical, 115-V ac, prewired, two-circuit, supervisory switch **OR** visual, **as directed**, indicating device.
9. NRS Gate Valves:
   a. Standard: UL 262.
   b. Pressure Rating: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
   c. Body Material: Cast iron with indicator post flange.
   d. Stem: Nonrising.
   e. End Connections: Flanged or grooved.
10. Indicator Posts:
   a. Standard: UL 789.
   b. Type: Horizontal for wall mounting.
   c. Body Material: Cast iron with extension rod and locking device.
   d. Operation: Wrench **OR** Hand wheel, **as directed**.

F. Trim And Drain Valves
1. General Requirements:
   a. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
   b. Pressure Rating: 175 psig (1200 kPa) minimum.
2. Angle Valves.
3. Ball Valves.

4. Globe Valves.
5. Plug Valves.

G. Specialty Valves
1. General Requirements:
    a. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
    b. Pressure Rating:
        1) Standard-Pressure Piping Specialty Valves: 175 psig (1200 kPa) minimum.
        2) High-Pressure Piping Specialty Valves: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
    c. Body Material: Cast or ductile iron.
    d. Size: Same as connected piping.
    e. End Connections: Flanged or grooved.
2. Alarm Valves:
    a. Standard: UL 193.
    b. Design: For horizontal or vertical installation.
    c. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, **as directed**, and fill-line attachment with strainer.
    d. Drip Cup Assembly (if retarding chamber is required): Pipe drain without valves and separate from main drain piping.
    e. Drip Cup Assembly (if retarding chamber is not required): Pipe drain with check valve to main drain piping.
3. Dry-Pipe Valves:
    a. Standard: UL 260.
    b. Design: Differential-pressure type.
    c. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
    d. Air-Pressure Maintenance Device:
        1) Standard: UL 260.
        2) Type: Automatic device to maintain minimum air pressure in piping.
        3) Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig (95- to 410-kPa) adjustable range, and 175-psig (1200-kPa) **OR** 300-psig (2070-kPa), **as directed**, outlet pressure.
    e. Air Compressor:
        1) Standard: UL's "Fire Protection Equipment Directory" listing.
        2) Motor Horsepower: Fractional.
        3) Power: 120-V ac, 60 Hz, single phase.
4. Deluge Valves:
    a. Standard: UL 260.
    b. Design: Hydraulically operated, differential-pressure type.
    c. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, drip cup assembly piped without valves and separate from main drain line, fill-line attachment with strainer, and push-rod chamber supply connection.
    d. Wet, Pilot-Line Trim Set: Include gage to read push-rod chamber pressure, globe valve for manual operation of deluge valve, and connection for actuation device.
    e. Dry, Pilot-Line Trim Set: Include dry, pilot-line actuator; air- and water-pressure gages; low-air-pressure warning switch; air relief valve; and actuation device. Dry, pilot-line actuator includes cast-iron, operated, diaphragm-type valve with resilient facing plate, resilient diaphragm, and replaceable bronze seat. Valve includes threaded water and air inlets and water outlet. Loss of air pressure on dry, pilot-line side allows pilot-line actuator to open and causes deluge valve to open immediately.
    f. Air-Pressure Maintenance Device:

1) Standard: UL 260.
2) Type: Automatic device to maintain minimum air pressure in piping.
3) Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator, or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig (95- to 410-kPa) adjustable range, and 175-psig (1200-kPa) **OR** 300-psig (2070-kPa), **as directed**, outlet pressure.

g. Air Compressor:
1) Standard: UL's "Fire Protection Equipment Directory" listing.
2) Motor Horsepower: Fractional.
3) Power: 120-V ac, 60 Hz, single phase.

5. Pressure-Reducing Valves:
a. UL 668 hose valve, with integral UL 1468 reducing device.
b. Pressure Rating: 300 psig (2070 kPa) minimum.
c. Material: Brass or bronze.
d. Inlet: Female pipe threads.
e. Outlet: Threaded with or without adapter having male hose threads.
f. Pattern: Angle or gate.
g. Finish: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.

6. Automatic (Ball Drip) Drain Valves:
a. Standard: UL 1726.
b. Pressure Rating: 175 psig (1200 kPa) minimum.
c. Type: Automatic draining, ball check.
d. Size: NPS 3/4 (DN 20).
e. End Connections: Threaded.

H. Hose Connections
1. Adjustable-Valve Hose Connections:
a. Standard: UL 668 hose valve, with integral UL 1468 reducing or restricting pressure-control device, for connecting fire hose.
b. Pressure Rating: 300 psig (2070 kPa) minimum.
c. Material: Brass or bronze.
d. Size: NPS 1-1/2 or NPS 2-1/2 (DN 40 or DN 65), as indicated.
e. Inlet: Female pipe threads.
f. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads according to NFPA 1963 and matching local fire-department threads.
g. Pattern: Angle or gate.
h. Pressure-Control Device Type: Pressure reducing **OR** restricting, **as directed**.
i. Design Outlet Pressure Setting: as directed by the Owner.
j. Finish: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.

2. Nonadjustable-Valve Hose Connections:
a. Standard: UL 668 hose valve for connecting fire hose.
b. Pressure Rating: 300 psig (2070 kPa) minimum.
c. Material: Brass or bronze.
d. Size: NPS 1-1/2 or NPS 2-1/2 (DN 40 or DN 65), as indicated.
e. Inlet: Female pipe threads.
f. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads according to NFPA 1963 and matching local fire-department threads.
g. Pattern: Angle or gate.
h. Finish: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.

I. NPS 1-1/2 (DN 40) Rack-Type Hose Stations
1. Hose Rack:
a. Standard: UL 47.

b. Material: Brass or bronze with polished chrome-plated **OR** Steel with red-enamel, **as directed**, finish.
c. Type: Hose-rack assembly. Include hose valve, hose rack, water-retention device, hose pins, and hose.
d. Operation: Semiautomatic.
e. Sized to hold fire hose.

2. Hose Valve:
   a. Standard: UL 668 NPS 1-1/2 (DN 40), for connecting fire hose.
   b. Type: Adjustable **OR** Nonadjustable, **as directed**.
   c. Pressure-Control Device: Not required **OR** Pressure reducing **OR** Pressure restricting, **as directed**.
   d. Design Outlet Pressure Setting: Not applicable **OR as directed**.
   e. Hose Valve and Trim Finish: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.
   f. Pressure Rating: 300 psig (2070 kPa) minimum.
   g. Pattern: Angle.
   h. Material: Brass or bronze.
   i. Pressure-Control Device: UL 1468 integral or for field installation if indicated.
   j. Size: NPS 1-1/2 (DN 40).
   k. Inlet: Female pipe threads.
   l. Outlet: Male hose threads according to NFPA 1963 and matching local fire-department threads.
3. Hose:
   a. Standards: NFPA 1961 and UL 219 lined fire hose with swivel inlet, coupling, gaskets, and nozzle.
   b. Size: NPS 1-1/2 (DN 40).
   c. Length: 50 feet (15 m) **OR** 75 feet (23 m) **OR** 100 feet (30 m), **as directed**.
   d. Jacket: Combination of natural and synthetic threads **OR** Natural thread **OR** Synthetic thread, **as directed**.
   e. Lining: Combination of rubber and plastic compounds **OR** Rubber compound **OR** Plastic compound, **as directed**.
   f. Cover: Rubber, plastic, or combination of rubber and plastic compounds.
   g. Nozzle: UL 401.
      1) Material: Brass **OR** Polished brass **OR** Rough chrome-plated brass **OR** Polished chrome-plated brass **OR** Polycarbonate plastic, **as directed**.
      2) Type: Plain, for nonadjustable water stream **OR** Spray, adjustable from shutoff to fog spray or straight stream **OR** Spray, adjustable from shutoff to full fog; for use on electrical fires, **as directed**.

J. NPS 1-1/2 BY NPS 2-1/2 (DN 40 BY DN 65) Rack-Type Hose Stations
1. Hose Rack:
   a. Standard: UL 47.
   b. Material: Brass or bronze with polished chrome-plated **OR** Steel with red-enamel, **as directed**, finish.
   c. Type: Hose-rack assembly. Include hose valve, reducer adapter, hose rack, water-retention device, hose pins, and hose.
   d. Operation: Semiautomatic.
   e. Sized to hold fire hose.
2. Hose Valve:
   a. Standard: UL 668, NPS 2-1/2 (DN 65), for connecting fire hose.
   b. Type: Adjustable **OR** Nonadjustable, **as directed**.
   c. Pressure-Control Device: Not required **OR** Pressure reducing **OR** Pressure restricting, **as directed**.
   d. Design Outlet Pressure Setting: Not applicable **OR as directed**.

e. Hose Valve and Trim Finish: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.
f. Pressure Rating: 300 psig (2070 kPa) minimum.
g. Pattern: Angle.
h. Material: Brass or bronze.
i. Pressure-Control Device: UL 1468, integral or for field installation if indicated.
j. Size: NPS 2-1/2 (DN 65).
k. Inlet: Female pipe threads.
l. Outlet: Male hose threads according to NFPA 1963 and matching local fire-department threads.
m. Reducer Adapter: NPS 2-1/2 by NPS 1-1/2 (DN 65 by DN 40).

3. Hose:
   a. Standards: NFPA 1961 and UL 219, lined fire hose with swivel inlet, coupling, gaskets, and nozzle.
   b. Size: NPS 1-1/2 (DN 40).
   c. Length: 50 feet (15 m) **OR** 75 feet (23 m) **OR** 100 feet (30 m), **as directed**.
   d. Jacket: Combination of natural and synthetic threads **OR** Natural thread **OR** Synthetic thread, **as directed**.
   e. Lining: Combination of rubber and plastic compounds **OR** Rubber compound **OR** Plastic compound, **as directed**.
   f. Cover: Rubber, plastic, or combination of rubber and plastic compounds.
   g. Nozzle: UL 401 spray nozzle unless plain nozzle is indicated.
      1) Material: Brass **OR** Polished brass **OR** Rough chrome-plated brass **OR** Polished chrome-plated brass **OR** Polycarbonate plastic, **as directed**.
      2) Type: Plain, for nonadjustable water stream **OR** Spray, adjustable from shutoff to fog spray or straight stream **OR** Spray, adjustable from shutoff to full fog; for use on electrical fires, **as directed**.

K. NPS 1-1/2 (DN 40) Reel-Type Hose Stations

1. Hose Reel:
   a. Standard: UL 47.
   b. Hose Reel and Bracket Material: Steel.
   c. Type: Hose-reel assembly. Include hose valve, wall bracket, hose reel, water-retention device, hose pins, and hose.
   d. Operation: Semiautomatic.
   e. Sized to hold fire hose.
   f. Finish: Red enamel.
2. Hose Valve:
   a. Standard: UL 668, NPS 1-1/2 (DN 40), for connecting fire hose.
   b. Type: Adjustable **OR** Nonadjustable, **as directed**.
   c. Pressure-Control Device: Not required **OR** Pressure reducing **OR** Pressure restricting, **as directed**.
   d. Design Outlet Pressure Setting: Not applicable **OR as directed**.
   e. Hose Valve and Trim Finish: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.
   f. Pressure Rating: 300 psig (2070 kPa) minimum.
   g. Pattern: Angle.
   h. Material: Brass or bronze.
   i. Pressure-Control Device: UL 1468, integral or for field installation if indicated.
   j. Size: NPS 1-1/2 (DN 40).
   k. Inlet: Female pipe threads.
   l. Outlet: Male hose threads according to NFPA 1963 and matching local fire-department threads.
3. Hose:
   a. Standards: NFPA 1961 and UL 219 lined fire hose with swivel inlet, coupling, gaskets, and nozzle.

b. Size: NPS 1-1/2 (DN 40).
c. Length: 50 feet (15 m) **OR** 75 feet (23 m) **OR** 100 feet (30 m), **as directed**.
d. Jacket: Combination of natural and synthetic threads **OR** Natural thread **OR** Synthetic thread, **as directed**.
e. Lining: Combination of rubber and plastic compounds **OR** Rubber compound **OR** Plastic compound, **as directed**.
f. Cover: Rubber, plastic, or combination of rubber and plastic compounds.
g. Nozzle: UL 401.
   1) Material: Brass **OR** Polished brass **OR** Rough chrome-plated brass **OR** Polished chrome-plated brass **OR** Polycarbonate plastic, **as directed**.
   2) Type: Spray, adjustable from shutoff to fog spray or straight stream **OR** full fog; for use on electrical fires, **as directed**.

L. Monitors
1. Type: Stationary.
2. Nozzle: UL 401, NPS 2-1/2 (DN 65), brass, adjustable from fog spray to straight stream to shutoff.
3. Horizontal Rotation: 360 degrees with locking device.
4. Vertical Rotation: 80-degree elevation and 60-degree depression with locking device.
5. Waterway: Double **OR** Single, **as directed**, brass or stainless-steel tube.
6. Waterway Size: NPS 2-1/2 (DN 65) minimum.
7. Water Stream Flow: 500 gpm (31.5 L/s) **OR** 750 gpm (47.3 L/s) **OR** 1000 gpm (63 L/s), **as directed**.
8. Operation: Lever **OR** Wheel, **as directed**.
9. Base Inlet Size: NPS 2-1/2 (DN 65) **OR** NPS 3 (DN 80) **OR** NPS 4 (DN 100), **as directed**.
10. Finish: Red-painted body with brass trim.

M. Fire-Department Connections
1. Exposed-Type, Fire-Department Connection:
   a. Standard: UL 405.
   b. Type: Exposed, projecting, for wall mounting.
   c. Pressure Rating: 175 psig (1200 kPa) minimum.
   d. Body Material: Corrosion-resistant metal.
   e. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
   f. Caps: Brass, lugged type, with gasket and chain.
   g. Escutcheon Plate: Round, brass, wall type.
   h. Outlet: Back, with pipe threads.
   i. Number of Inlets: Two **OR** Three, **as directed**.
   j. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE" **OR** "STANDPIPE", **as directed**.
   k. Finish: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.
   l. Outlet Size: NPS 4 (DN 100) **OR** NPS 5 (DN 125) **OR** NPS 6 (DN 150), **as directed**.
2. Flush-Type, Fire-Department Connection:
   a. Standard: UL 405.
   b. Type: Flush, for wall mounting.
   c. Pressure Rating: 175 psig (1200 kPa) minimum.
   d. Body Material: Corrosion-resistant metal.
   e. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
   f. Caps: Brass, lugged type, with gasket and chain.
   g. Escutcheon Plate: Rectangular, brass, wall type.

h. Outlet: With pipe threads.
i. Body Style: Horizontal **OR** Square **OR** Vertical, **as directed**.
j. Number of Inlets: Two **OR** Three **OR** Four **OR** Six, **as directed**.
k. Outlet Location: Back **OR** Bottom **OR** Left side **OR** Right side **OR** Top, **as directed**.
l. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE" **OR** "STANDPIPE", **as directed**.
m. Finish: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.
n. Outlet Size: NPS 4 (DN 100) **OR** NPS 5 (DN 125) **OR** NPS 6 (DN 150) **OR** NPS 8 (DN 200), **as directed**.

3. Yard-Type, Fire-Department Connection:
a. Standard: UL 405.
b. Type: Exposed, freestanding.
c. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
d. Body Material: Corrosion-resistant metal.
e. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
f. Caps: Brass, lugged type, with gasket and chain.
g. Escutcheon Plate: Round, brass, floor type.
h. Outlet: Bottom, with pipe threads.
i. Number of Inlets: Two **OR** Three **OR** Four, **as directed**.
j. Sleeve: Brass **OR** Not required, **as directed**.
k. Sleeve Height: 18 inches (460 mm).
l. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE" **OR** "STANDPIPE", **as directed**.
m. Finish, Including Sleeve: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.
n. Outlet Size: NPS 4 (DN 100) **OR** NPS 5 (DN 125) **OR** NPS 6 (DN 150), **as directed**.

N. Alarm Devices
1. Alarm-device types shall match piping and equipment connections.
2. Water-Motor-Operated Alarm:
a. Standard: UL 753.
b. Type: Mechanically operated, with Pelton wheel.
c. Alarm Gong: Cast aluminum with red-enamel factory finish.
d. Size: 10-inch (250-mm) diameter.
e. Components: Shaft length, bearings, and sleeve to suit wall construction.
f. Inlet: NPS 3/4 (DN 20).
g. Outlet: NPS 1 (DN 25) drain connection.
3. Electrically Operated Alarm Bell:
a. Standard: UL 464.
b. Type: Vibrating, metal alarm bell.
c. Size: 6-inch (150-mm) minimum **OR** 8-inch (200-mm) minimum **OR** 10-inch (250-mm), **as directed**, diameter.
d. Finish: Red-enamel factory finish, suitable for outdoor use.
4. Water-Flow Indicators:
a. Standard: UL 346.
b. Water-Flow Detector: Electrically supervised.
c. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
d. Type: Paddle operated.
e. Pressure Rating: 250 psig (1725 kPa).
f. Design Installation: Horizontal or vertical.

5. Pressure Switches:
   a. Standard: UL 346.
   b. Type: Electrically supervised water-flow switch with retard feature.
   c. Components: Single-pole, double-throw switch with normally closed contacts.
   d. Design Operation: Rising pressure signals water flow.
6. Valve Supervisory Switches:
   a. Standard: UL 346.
   b. Type: Electrically supervised.
   c. Components: Single-pole, double-throw switch with normally closed contacts.
   d. Design: Signals that controlled valve is in other than fully open position.
7. Indicator-Post Supervisory Switches:
   a. Standard: UL 346.
   b. Type: Electrically supervised.
   c. Components: Single-pole, double-throw switch with normally closed contacts.
   d. Design: Signals that controlled indicator-post valve is in other than fully open position.

O. Manual Control Stations
   1. Description: UL listed or FM approved, hydraulic operation, with union, NPS 1/2 (DN 15) pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

P. Control Panels
   1. Description: Single-area, two-area, or single-area cross-zoned control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves. Panels contain power supply; battery charger; standby batteries; field-wiring terminal strip; electrically supervised solenoid valves and polarized fire-alarm bell; lamp test facility; single-pole, double-throw auxiliary alarm contacts; and rectifier.
      a. Panels: UL listed and FM approved when used with thermal detectors and Class A detector circuit wiring. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
      b. Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.
         OR
         Manual Control Stations: Hydraulic operation, with union, NPS 1/2 (DN 15) pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

Q. Pressure Gages
   1. Standard: UL 393.
   2. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.
   3. Pressure Gage Range: 0 to 250 psig (0 to 1725 kPa) minimum **OR** 0 to 300 psig (0 to 2070 kPa), **as directed**.
   4. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.
   5. Air System Piping Gage: Include retard feature, **as directed**, and "AIR" or "AIR/WATER" label on dial face.

R. Escutcheons
   1. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
   2. One-Piece, Cast-Brass Escutcheons: Polished chrome-plated or rough-brass finish with set-screws.
   3. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with chrome-plated finish.

4. One-Piece, Stamped-Steel Escutcheons: Chrome-plated finish with set-screw or spring clips.
5. Split-Casting, Cast-Brass Escutcheons: Polished chrome-plated or rough-brass finish with concealed hinge and set-screw.
6. Split-Plate, Stamped-Steel Escutcheons: Chrome-plated finish with concealed **OR** exposed-rivet, **as directed**, hinge, set-screw or spring clips.
7. One-Piece Floor Plates: Cast-iron flange with holes for fasteners, **as directed**.
8. Split-Casting Floor Plates: Cast brass with concealed hinge.

S. Sleeves
1. Cast-Iron Wall-Pipe Sleeves: Cast or fabricated of cast iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
2. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
3. Molded-PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
4. Molded-PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.
5. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
6. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, standard weight, zinc coated, plain ends.
7. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   a. Underdeck Clamp: Clamping ring with set-screws.

T. Sleeve Seals
1. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   a. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   b. Pressure Plates: Carbon steel **OR** Plastic **OR** Stainless steel, **as directed**.
   c. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating **OR** Stainless steel, **as directed**, of length required to secure pressure plates to sealing elements.

U. Grout
1. Standard: ASTM C 1107, Grade B, posthardening and volume adjusting, dry, hydraulic-cement grout.
2. Characteristics: Nonshrink, and recommended for interior and exterior applications.
3. Design Mix: 5000-psi (34-MPa), 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

1.3 EXECUTION

A. Preparation
1. Perform fire-hydrant flow test according to NFPA 14 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
2. Report test results promptly and in writing.

B. Service-Entrance Piping
1. Connect fire-suppression standpipe piping to water-service piping at service entrance into building. Comply with requirements for exterior piping in Division 21 Section "Facility Fire-suppression Water-service Piping".
2. Install shutoff valve, backflow preventer, **as directed**, pressure gage, drain, and other accessories at connection to fire-suppression water-service piping. Comply with requirements for backflow preventers in Division 21 Section "Facility Fire-suppression Water-service Piping", **as directed**.
3. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

C. Water-Supply Connections
1. Connect fire-suppression standpipe piping to building's interior water-distribution piping. Comply with requirements for interior piping in Division 22 Section "Domestic Water Piping".
2. Install shutoff valve, backflow preventer, **as directed**, pressure gage, drain, and other accessories at connection to water-distribution piping. Comply with requirements for backflow preventers in Division 22 Section "Domestic Water Piping Specialties", **as directed**.
OR
Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

D. Piping Installation
1. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
   a. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with the Owner before deviating from approved working plans.
2. Piping Standard: Comply with requirements in NFPA 14 for installation of fire-suppression standpipe piping.
3. Install seismic restraints on piping. Comply with requirements in NFPA 13 for seismic-restraint device materials and installation.
4. Install listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
5. Install drain valves on standpipes. Extend drain piping to outside of building.
6. Install automatic (ball drip) drain valves to drain piping between fire-department connections and check valves. Drain to floor drain or outside building.
7. Install alarm devices in piping systems.
8. Install hangers and supports for standpipe system piping according to NFPA 14. Comply with requirements in NFPA 13 for hanger materials.
9. Install pressure gages on riser or feed main and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 (DN 8) and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
10. Drain dry-type standpipe system piping.
11. Pressurize and check dry-type standpipe system piping and air-pressure maintenance devices **OR** air compressors, **as directed**.
12. Fill wet-type standpipe system piping with water.
13. Install electric heating cables and pipe insulation on wet-type, fire-suppression standpipe piping in areas subject to freezing. Comply with requirements for heating cables in Division 21 Section "Heat Tracing For Fire-suppression Piping" and for piping insulation in Division 21 Section "Fire-suppression Systems Insulation".
14. Connect compressed-air supply to dry-pipe sprinkler piping.
OR
Connect air compressor to the following piping and wiring:
   a. Pressure gages and controls.
   b. Electrical power system.
   c. Fire-alarm devices, including low-pressure alarm.

E. Joint Construction
1. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
2. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
3. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
4. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

5. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
6. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
7. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   a. Apply appropriate tape or thread compound to external pipe threads.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
8. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
9. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
10. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
    a. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
11. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.
12. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
13. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

F. Valve And Specialties Installation
1. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 14 and authorities having jurisdiction.
2. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
3. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
4. Specialty Valves:
   a. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
   b. Alarm Valves: Install bypass check valve and retarding chamber drain-line connection.
   c. Dry-Pipe and Deluge Valves: Install trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
      1) Install air compressor and compressed-air supply piping.
         OR
         Air-Pressure Maintenance Device: Install shutoff valves to permit servicing without shutting down sprinkler system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with 14- to 60-psig (95- to 410-kPa) adjustable range; and 175-psig (1200-kPa) maximum inlet pressure.
      2) Install compressed-air supply piping from building's compressed-air piping system.

G. Hose-Connection Installation
1. Install hose connections adjacent to standpipes.
2. Install freestanding hose connections for access and minimum passage restriction.
3. Install NPS 1-1/2 (DN 40) hose-connection valves with flow-restricting device.

4. Install NPS 2-1/2 (DN 65) hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 (DN 65 by DN 40) reducer adapter and flow-restricting device.
5. Install wall-mounted-type hose connections in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose. Comply with requirements for cabinets in Division 10 Section "Fire Extinguisher Cabinets".

H. Hose-Station Installation
1. Install freestanding hose stations for access and minimum passage restriction.
2. Install NPS 1-1/2 (DN 40) hose-station valves with flow-restricting device unless otherwise indicated.
3. Install NPS 2-1/2 (DN 65) hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 (DN 65 by DN 40) reducer adapter and flow-restricting device unless otherwise indicated.
4. Install freestanding hose stations with support or bracket attached to standpipe.
5. Install wall-mounted, rack hose stations in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose. Comply with requirements for cabinets in Division 10 Section "Fire Extinguisher Cabinets".
6. Install hose-reel hose stations on wall with bracket.

I. Monitor Installation
1. Install monitors on standpipe piping.

J. Fire-Department Connection Installation
1. Install wall-type, fire-department connections.
2. Install yard-type, fire-department connections in concrete slab support. Comply with requirements for concrete in Division 03 Section "Cast-in-place Concrete".
   a. Install two **OR** three, **as directed**, protective pipe bollards around **OR** on sides of, **as directed**, each fire-department connection. Comply with requirements for bollards in Division 05 Section "Metal Fabrications".
3. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

K. Escutcheon Installation
1. Install escutcheons for penetrations of walls, ceilings, and floors.
2. Escutcheons for New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
   b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** stamped steel with set-screw **OR** stamped steel with set-screw or spring clips **OR** stamped steel with spring clips, **as directed**.
   c. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** One piece or split casting, cast brass with polished chrome-plated finish **OR** Split casting, cast brass with polished chrome-plated finish **OR** One piece, stamped steel with set-screw **OR** One piece or split plate, stamped steel with set-screw **OR** Split plate, stamped steel with set-screw, **as directed**.
   d. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish **OR** cast brass with rough-brass finish **OR** stamped steel with set-screw **OR** stamped steel with spring clips **OR** stamped steel with set-screw or spring clips, **as directed**.
   e. Bare Piping in Equipment Rooms: One piece, cast brass **OR** stamped steel with set-screw **OR** stamped steel with spring clips **OR** stamped steel with set-screw or spring clips, **as directe**.
   f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.
3. Escutcheons for Existing Piping:
   a. Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.

b. Insulated Piping: Split plate, stamped steel with concealed or exposed-rivet hinge and spring clips.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and spring clips, **as directed**.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and set-screw, **as directed**.
e. Bare Piping in Unfinished Service Spaces: Split casting, cast brass with polished chrome-plated finish **OR** casting, cast brass with rough-brass finish **OR** plate, stamped steel with concealed hinge and set-screw or spring clips **OR** plate, stamped steel with concealed or exposed-rivet hinge and set-screw or spring clips **OR** plate, stamped steel with exposed-rivet hinge and set-screw or spring clips, **as directed**.
f. Bare Piping in Equipment Rooms: Split casting, cast brass **OR** plate, stamped steel with set-screw or spring clips, **as directed**.
g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

L. Sleeve Installation
1. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
2. Sleeves are not required for core-drilled holes.
3. Permanent sleeves are not required for holes formed by removable PE sleeves.
4. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
5. Install sleeves in new partitions, slabs, and walls as they are built.
6. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants".
7. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants".
8. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals.
9. Seal space outside of sleeves in concrete slabs and walls with grout.
10. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.
11. Install sleeve materials according to the following applications:
a. Sleeves for Piping Passing through Concrete Floor Slabs: Molded PE **OR** Molded PVC **OR** Galvanized-steel pipe, **as directed**.
b. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Galvanized-steel pipe **OR** Stack sleeve fittings, **as directed**.
1) Extend sleeves 2 inches (50 mm) above finished floor level.
2) For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Comply with requirements for flashing in Division 07 Section "Sheet Metal Flashing And Trim".
c. Sleeves for Piping Passing through Gypsum-Board Partitions:
1) PVC-pipe **OR** Galvanized-steel-pipe, **as directed**, sleeves for pipes smaller than NPS 6 (DN 150).
2) Galvanized-steel-sheet sleeves for pipes NPS 6 (DN 150) and larger.
3) Exception: Sleeves are not required for water-supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.
d. Sleeves for Piping Passing through Concrete Roof Slabs: Molded PE **OR** Molded PVC **OR** Galvanized-steel pipe, **as directed**.
e. Sleeves for Piping Passing through Exterior Concrete Walls:
1) Galvanized-steel-pipe sleeves for pipes smaller than NPS 6 (DN 150).

2) Cast-iron wall pipe sleeves for pipes NPS 6 (DN 150) and larger.
3) Install sleeves that are large enough to provide 1-inch (25-mm) annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.

f. Sleeves for Piping Passing through Interior Concrete Walls:
1) PVC-pipe **OR** Galvanized-steel-pipe, **as directed**, sleeves for pipes smaller than NPS 6 (DN 150).
2) Galvanized-steel-sheet sleeves for pipes NPS 6 (DN 150) and larger.

12. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestop materials and installations in Division 07 Section "Penetration Firestopping".

M. Sleeve Seal Installation
1. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.
2. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

N. Identification
1. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 14.
2. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".

O. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
a. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
c. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter.
d. Energize circuits to electrical equipment and devices.
e. Start and run air compressors.
f. Coordinate with fire-alarm tests. Operate as required.
g. Coordinate with fire-pump tests. Operate as required.
h. Verify that equipment hose threads are same as local fire-department equipment.
3. Fire-suppression standpipe system will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

P. Demonstration
1. Train the Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

Q. Piping Schedule
1. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends; cast-iron threaded fittings; and threaded **OR** grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved, **as directed**, joints.
2. Standard-pressure, wet-type, fire-suppression standpipe piping, NPS 4 (DN 100) and smaller, shall be one of the following:
a. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
b. Standard-weight **OR** Schedule 30 or thinwall, **as directed**, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.

c. Standard-weight or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
d. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
e. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
f. Thinwall **OR** Schedule 10, **as directed**, **OR** nonstandard OD, thinwall or hybrid, **as directed**, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
g. Thinwall **OR** Schedule 10, **as directed**, **OR** nonstandard OD, thinwall or hybrid, **as directed**, black-steel pipe with plain ends; welding fittings; and welded joints.
h. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; cast- or wrought-copper solder-joint fittings; and brazed joints.
i. Type L (Type B) **OR** Type M (Type B), **as directed**, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

3. Standard-pressure, wet-type, fire-suppression standpipe piping, NPS 5 to NPS 8 (DN 125 to DN 200), shall be one of the following:
a. Standard-weight **OR** Schedule 30, **as directed**, or thinwall, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
b. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
c. Standard-weight or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
d. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
e. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
f. Thinwall **OR** Schedule 10, **as directed**, or hybrid black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
g. Thinwall **OR** Schedule 10, **as directed**, or hybrid black-steel pipe with plain ends; welding fittings; and welded joints.
h. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; cast- or wrought-copper solder-joint fittings; and brazed joints.
i. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

4. Standard-pressure, wet-type, fire-suppression standpipe piping, NPS 10 and NPS 12 (DN 250 and DN 300), shall be one of the following:
a. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
b. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
c. Standard-weight or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
d. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
e. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
f. Thinwall **OR** Schedule 10, **as directed**, **OR** nonstandard OD, thinwall or hybrid, **as directed**, black-steel pipe with plain ends; welding fittings; and welded joints.

5. High-pressure, wet-type, fire-suppression standpipe piping, NPS 4 (DN 100) and smaller, shall be one of the following:
   a. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   b. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   c. Standard-weight or Schedule 30, black-steel pipe with cut-grooved **OR** roll-grooved, **as directed**, ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   d. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   e. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
   f. Thinwall **OR** Schedule 10, **as directed**, **OR** nonstandard OD, thinwall or hybrid, **as directed**, black-steel pipe with plain ends; welding fittings; and welded joints.
6. High-pressure, wet-type, fire-suppression standpipe piping, NPS 5 (DN 125) and larger, shall be one of the following:
   a. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   b. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   c. Standard-weight or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   d. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   e. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
   f. Thinwall **OR** Schedule 10, **as directed**, **OR** nonstandard OD, thinwall or hybrid, **as directed**, black-steel pipe with plain ends; welding fittings; and welded joints.
7. Standard-pressure, dry-type, fire-suppression standpipe piping, NPS 4 (DN 100) and smaller, shall be one of the following:
   a. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   b. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   c. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; cast- or wrought-copper solder-joint fittings; and brazed joints.
   d. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.
8. Standard-pressure, dry-type, fire-suppression standpipe piping, NPS 5 and NPS 6 (DN 125 and DN 150), shall be one of the following:
   a. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   b. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   c. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; cast- or wrought-copper solder-joint fittings; and brazed joints.
   d. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

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Task	Specification	Specification Description
21 12 13 00	21 11 19 00	Fire-Suppression Standpipes
21 12 23 00	21 11 19 00	Fire-Suppression Standpipes
21 12 29 00	01 22 16 00	No Specification Required
21 12 29 00	21 11 19 00	Fire-Suppression Standpipes

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SECTION 21 13 13 00 - WET-PIPE FIRE-SUPPRESSION SPRINKLERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for wet-pipe fire-suppression sprinklers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Pipes, fittings, and specialties.
b. Fire-protection valves.
c. Fire-department connections.
d. Sprinklers.
e. Excess-pressure pumps.
f. Alarm devices.
g. Manual control stations.
h. Control panels.
i. Pressure gages.

C. Definitions
1. High-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure higher than standard 175 psig (1200 kPa), but not higher than 250 psig (1725 kPa) **OR** 300 psig (2070 kPa), **as directed**.
2. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig (1200 kPa) maximum.

D. System Descriptions
1. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.
2. Deluge Sprinkler System: Open sprinklers are attached to piping connected to water supply through deluge valve. Fire-detection system, in same area as sprinklers, opens valve. Water flows into piping system and discharges from attached sprinklers when valve opens.

E. Performance Requirements
1. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) minimum working pressure.
2. High-Pressure Piping System Component: Listed for 250-psig (1725-kPa) minimum **OR** 300-psig (2070-kPa), **as directed**, working pressure.
3. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
4. Sprinkler system design shall be approved by authorities having jurisdiction.
a. Margin of Safety for Available Water Flow and Pressure: 10 **OR** 20, **as directed**, percent, including losses through water-service piping, valves, and backflow preventers.
b. Sprinkler Occupancy Hazard Classifications:
1) Automobile Parking Areas: Ordinary Hazard, Group 1.
2) Building Service Areas: Ordinary Hazard, Group 1.
3) Churches: Light Hazard.
4) Electrical Equipment Rooms: Ordinary Hazard, Group 1.
5) Dry Cleaners: Ordinary Hazard, Group 2.

6) General Storage Areas: Ordinary Hazard, Group 1.
7) Laundries: Ordinary Hazard, Group 1.
8) Libraries except Stack Areas: Light Hazard.
9) Library Stack Areas: Ordinary Hazard, Group 2.
10) Machine Shops: Ordinary Hazard, Group 2.
11) Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
12) Office and Public Areas: Light Hazard.
13) Plastics Processing Areas: Extra Hazard, Group 2.
14) Printing Plants: Extra Hazard, Group 1.
15) Repair Garages: Ordinary Hazard, Group 2.
16) Residential Living Areas: Light Hazard.
17) Restaurant Service Areas: Ordinary Hazard, Group 1.
18) Solvent Cleaning Areas: Extra Hazard, Group 2.
19) Upholstering Plants: Extra Hazard, Group 1.

c. Minimum Density for Automatic-Sprinkler Piping Design:
1) Residential (Dwelling) Occupancy: 0.05 gpm over 400-sq. ft. (2.04 mm/min. over 37.2-sq. m) area.
2) Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. (4.1 mm/min. over 139-sq. m) area.
3) Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. (6.1 mm/min. over 139-sq. m) area.
4) Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. (8.1 mm/min. over 139-sq. m) area.
5) Extra-Hazard, Group 1 Occupancy: 0.30 gpm over 2500-sq. ft. (12.2 mm/min. over 232-sq. m) area.
6) Extra-Hazard, Group 2 Occupancy: 0.40 gpm over 2500-sq. ft. (16.3 mm/min. over 232-sq. m) area.
7) Special Occupancy Hazard: As determined by authorities having jurisdiction.

d. Minimum Density for Deluge-Sprinkler Piping Design:
1) Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm (6.1 mm/min.) over entire area.
2) Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm (8.1 mm/min.) over entire area.
3) Extra-Hazard, Group 1 Occupancy: 0.30 gpm (12.2 mm/min.) over entire area.
4) Extra-Hazard, Group 2 Occupancy: 0.40 gpm (16.3 mm/min.) over entire area.
5) Special Occupancy Hazard: As determined by authorities having jurisdiction.

e. Maximum Protection Area per Sprinkler: Per UL listing.
OR
Maximum Protection Area per Sprinkler:
1) Residential Areas: 400 sq. ft. (37 sq. m).
2) Office Spaces: 120 sq. ft. (11.1 sq. m) **OR** 225 sq. ft. (20.9 sq. m), **as directed**.
3) Storage Areas: 130 sq. ft. (12.1 sq. m).
4) Mechanical Equipment Rooms: 130 sq. ft. (12.1 sq. m).
5) Electrical Equipment Rooms: 130 sq. ft. (12.1 sq. m).
6) Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

f. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:
1) Light-Hazard Occupancies: 100 gpm (6.3 L/s) for 30 minutes.
2) Ordinary-Hazard Occupancies: 250 gpm (15.75 L/s) for 60 to 90 minutes.
3) Extra-Hazard Occupancies: 500 gpm (31.5 L/s) for 90 to 120 minutes.

5. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

F. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:

a. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content and chemical components.

3. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
   a. Wiring Diagrams: For power, signal, and control wiring.
4. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
5. Qualification Data: For qualified Installer and professional engineer, **as directed**.
6. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
7. Welding certificates.
8. Fire-hydrant flow test report.
9. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
10. Field quality-control reports.
11. Operation and maintenance data.

G. Quality Assurance
1. Installer Qualifications:
   a. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
      1) Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
2. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
   a. NFPA 13, "Installation of Sprinkler Systems."
   b. NFPA 13R, "Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height."
   c. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

H. Project Conditions
1. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:
   a. Notify the Owner no fewer than two days in advance of proposed interruption of sprinkler service.
   b. Do not proceed with interruption of sprinkler service without the Owner's written permission.

1.2 PRODUCTS

A. Piping Materials
1. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

B. Steel Pipe And Fittings
1. Standard Weight, Galvanized- and Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

2. Schedule 30, Galvanized- and Black-Steel Pipe: ASTM A 135; ASTM A 795/A 795M, Type E; or ASME B36.10M, wrought steel; with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.
3. Thinwall Galvanized- and Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.
4. Schedule 10, Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, Schedule 10 in NPS 5 (DN 125) and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10 (DN 150 to DN 250), plain end.
5. Nonstandard OD, Thinwall Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, thinwall, with plain ends and wall thickness less than Schedule 10.
6. Hybrid Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, lightwall, with wall thickness less than Schedule 10 and greater than Schedule 5.
7. Schedule 5 Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, lightwall, with plain ends.
8. Galvanized- and Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
9. Galvanized and Uncoated, Steel Couplings: ASTM A 865, threaded.
10. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
11. Malleable- or Ductile-Iron Unions: UL 860.
12. Cast-Iron Flanges: ASME 16.1, Class 125.
13. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
14. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
15. Grooved-Joint, Steel-Pipe Appurtenances:
    a. Pressure Rating: 175 psig (1200 kPa) **OR** 250 psig (1725 kPa) **OR** 300 psig (2070 kPa), **as directed**, minimum.
    b. Galvanized and Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
    c. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.
16. Steel Pressure-Seal Fittings: UL 213, FM-approved, 175-psig (1200-kPa) pressure rating with steel housing, rubber O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.

C. Copper Tube And Fittings
1. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) and ASTM B 88, Type M (ASTM B 88M, Type C) water tube, drawn temper.
2. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
3. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.
4. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
5. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
6. Copper Pressure-Seal Fittings:
    a. Standard: UL 213.
    b. NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
    c. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Cast-bronze fitting with EPDM-rubber O-ring seal in each end.
7. Grooved-Joint, Copper-Tube Appurtenances:
    a. Grooved-End, Copper Fittings: ASTM B 75 (ASTM B 75M), copper tube or ASTM B 584, bronze castings.

b. Grooved-End-Tube Couplings: To fit copper-tube dimensions, with design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gasket suitable for hot and cold water, and bolts and nuts.

8. Copper-Tube, Extruded-Tee Connections:
   a. Description: Tee formed in copper tube according to ASTM F 2014.

D. CPVC Pipe And Fittings
1. CPVC Pipe: ASTM F 442/F 442M and UL 1821, SDR 13.5, for 175-psig (1200-kPa) rated pressure at 150 deg F (62 deg C), with plain ends. Include "LISTED" and "CPVC SPRINKLER PIPE" markings.
2. CPVC Fittings: UL listed or FM approved, for 175-psig (1200-kPa) rated pressure at 150 deg F (62 deg C), socket type. Include "LISTED" and "CPVC SPRINKLER FITTING" markings.
   a. NPS 3/4 to NPS 1-1/2 (DN 20 to DN 40): ASTM F 438 and UL 1821, Schedule 40, socket type.
   b. NPS 2 to NPS 3 (DN 50 to DN 80): ASTM F 439 and UL 1821, Schedule 80, socket type.
   c. CPVC-to-Metal Transition Fittings: CPVC, one piece, with dimensions equivalent to pipe; one end with threaded brass insert, and one socket end.
   d. CPVC-to-Metal Transition Unions: CPVC, with dimensions equivalent to pipe; one end with threaded brass insert, and one socket end.
   e. Flanges: CPVC, one or two pieces.

E. Piping Joining Materials
1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free.
   a. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
   b. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
2. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
3. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
4. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
5. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493, solvent cement recommended by pipe and fitting manufacturer, and made for joining CPVC sprinkler pipe and fittings. Include cleaner or primer recommended by pipe and fitting manufacturer.
   a. Use solvent cement that has a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. Use adhesive primer that has a VOC content of 650 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Plastic, Pipe-Flange Gasket, and Bolts and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

F. Cover System For Sprinkler Piping
1. Description: System of support brackets and covers made to protect sprinkler piping.
2. Brackets: Glass-reinforced nylon.
3. Covers: Extruded PVC sections of length, shape, and size required for size and routing of CPVC piping.

G. Listed Fire-Protection Valves
1. General Requirements:
   a. Valves shall be UL listed or FM approved.
   b. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig (1200 kPa).
   c. Minimum Pressure Rating for High-Pressure Piping: 250 psig (1725 kPa) **OR** 300 psig (2070 kPa), **as directed**.
2. Ball Valves:

a. Standard: UL 1091 except with ball instead of disc.
b. Valves NPS 1-1/2 (DN 40) and Smaller: Bronze body with threaded ends.
c. Valves NPS 2 and NPS 2-1/2 (DN 50 and DN 65): Bronze body with threaded ends or ductile-iron body with grooved ends.
d. Valves NPS 3 (DN 80): Ductile-iron body with grooved ends.

3. Bronze Butterfly Valves:
   a. Standard: UL 1091.
   b. Pressure Rating: 175 psig (1200 kPa).
   c. Body Material: Bronze.
   d. End Connections: Threaded.
4. Iron Butterfly Valves:
   a. Standard: UL 1091.
   b. Pressure Rating: 175 psig (1200 kPa).
   c. Body Material: Cast or ductile iron.
   d. Style: Lug or wafer.
      OR
      End Connections: Grooved.
5. Check Valves:
   a. Standard: UL 312.
   b. Pressure Rating: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
   c. Type: Swing check.
   d. Body Material: Cast iron.
   e. End Connections: Flanged or grooved.
6. Bronze OS&Y Gate Valves:
   a. Standard: UL 262.
   b. Pressure Rating: 175 psig (1200 kPa).
   c. Body Material: Bronze.
   d. End Connections: Threaded.
7. Iron OS&Y Gate Valves:
   a. Standard: UL 262.
   b. Pressure Rating: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
   c. Body Material: Cast or ductile iron.
   d. End Connections: Flanged or grooved.
8. Indicating-Type Butterfly Valves:
   a. Standard: UL 1091.
   b. Pressure Rating: 175 psig (1200 kPa) minimum.
   c. Valves NPS 2 (DN 50) and Smaller:
      1) Valve Type: Ball or butterfly.
      2) Body Material: Bronze.
      3) End Connections: Threaded.
   d. Valves NPS 2-1/2 (DN 65) and Larger:
      1) Valve Type: Butterfly.
      2) Body Material: Cast or ductile iron.
      3) End Connections: Flanged, grooved, or wafer.
   e. Valve Operation: Integral electrical, 115-V ac, prewired, single-circuit, supervisory switch **OR** electrical, 115-V ac, prewired, two-circuit, supervisory switch **OR** visual, **as directed**, indicating device.
9. NRS Gate Valves:
   a. Standard: UL 262.
   b. Pressure Rating: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
   c. Body Material: Cast iron with indicator post flange.
   d. Stem: Nonrising.
   e. End Connections: Flanged or grooved.
10. Indicator Posts:
    a. Standard: UL 789.

b. Type: Horizontal for wall mounting.
c. Body Material: Cast iron with extension rod and locking device.
d. Operation: Wrench **OR** Hand wheel, **as directed**.

H. Trim And Drain Valves
1. General Requirements:
a. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
b. Pressure Rating: 175 psig (1200 kPa) minimum.
2. Angle Valves.
3. Ball Valves.
4. Globe Valves.
5. Plug Valves.

I. Specialty Valves
1. General Requirements:
a. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
b. Pressure Rating:
1) Standard-Pressure Piping Specialty Valves: 175 psig (1200 kPa) minimum.
2) High-Pressure Piping Specialty Valves: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
c. Body Material: Cast or ductile iron.
d. Size: Same as connected piping.
e. End Connections: Flanged or grooved.
2. Alarm Valves:
a. Standard: UL 193.
b. Design: For horizontal or vertical installation.
c. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, **as directed**, and fill-line attachment with strainer.
d. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
OR
Drip Cup Assembly: Pipe drain with check valve to main drain piping.
3. Deluge Valves:
a. Standard: UL 260.
b. Design: Hydraulically operated, differential-pressure type.
c. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, drip cup assembly piped without valves and separate from main drain line, fill-line attachment with strainer, and push-rod chamber supply connection.
d. Wet, Pilot-Line Trim Set: Include gage to read push-rod chamber pressure, globe valve for manual operation of deluge valve, and connection for actuation device.
4. Automatic (Ball Drip) Drain Valves:
a. Standard: UL 1726.
b. Pressure Rating: 175 psig (1200 kPa) minimum.
c. Type: Automatic draining, ball check.
d. Size: NPS 3/4 (DN 20).
e. End Connections: Threaded.

J. Fire-Department Connections
1. Exposed-Type, Fire-Department Connection:
a. Standard: UL 405.
b. Type: Exposed, projecting, for wall mounting.
c. Pressure Rating: 175 psig (1200 kPa) minimum.
d. Body Material: Corrosion-resistant metal.

e. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
f. Caps: Brass, lugged type, with gasket and chain.
g. Escutcheon Plate: Round, brass, wall type.
h. Outlet: Back, with pipe threads.
i. Number of Inlets: Two **OR** Three, **as directed**.
j. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE" **OR** "AUTO SPKR", **as directed**.
k. Finish: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.
l. Outlet Size: NPS 4 (DN 100) **OR** NPS 5 (DN 125) **OR** NPS 6 (DN 150), **as directed**.

2. Flush-Type, Fire-Department Connection:
a. Standard: UL 405.
b. Type: Flush, for wall mounting.
c. Pressure Rating: 175 psig (1200 kPa) minimum.
d. Body Material: Corrosion-resistant metal.
e. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
f. Caps: Brass, lugged type, with gasket and chain.
g. Escutcheon Plate: Rectangular, brass, wall type.
h. Outlet: With pipe threads.
i. Body Style: Horizontal **OR** Square **OR** Vertical, **as directed**.
j. Number of Inlets: Two **OR** Three **OR** Four **OR** Six, **as directed**.
k. Outlet Location: Back **OR** Bottom **OR** Left side **OR** Right side **OR** Top, **as directed**.
l. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE" **OR** "AUTO SPKR", **as directed**.
m. Finish: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.
n. Outlet Size: NPS 4 (DN 100) **OR** NPS 5 (DN 125) **OR** NPS 6 (DN 150) **OR** NPS 8 (DN 200), **as directed**.

3. Yard-Type, Fire-Department Connection:
a. Standard: UL 405.
b. Type: Exposed, freestanding.
c. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
d. Body Material: Corrosion-resistant metal.
e. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
f. Caps: Brass, lugged type, with gasket and chain.
g. Escutcheon Plate: Round, brass, floor type.
h. Outlet: Bottom, with pipe threads.
i. Number of Inlets: Two **OR** Three **OR** Four, **as directed**.
j. Sleeve: Brass **OR** Not required, **as directed**.
k. Sleeve Height: 18 inches (460 mm).
l. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE" **OR** "AUTO SPKR", **as directed**.
m. Finish, Including Sleeve: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.
n. Outlet Size: NPS 4 (DN 100) **OR** NPS 5 (DN 125) **OR** NPS 6 (DN 150), **as directed**.

K. Sprinkler Specialty Pipe Fittings
1. Branch Outlet Fittings:
a. Standard: UL 213.

b. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
c. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
d. Type: Mechanical-T and -cross fittings.
e. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
f. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
g. Branch Outlets: Grooved, plain-end pipe, or threaded.

2. Flow Detection and Test Assemblies:
   a. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
   b. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
   c. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
   d. Size: Same as connected piping.
   e. Inlet and Outlet: Threaded.
3. Branch Line Testers:
   a. Standard: UL 199.
   b. Pressure Rating: 175 psig (1200 kPa).
   c. Body Material: Brass.
   d. Size: Same as connected piping.
   e. Inlet: Threaded.
   f. Drain Outlet: Threaded and capped.
   g. Branch Outlet: Threaded, for sprinkler.
4. Sprinkler Inspector's Test Fittings:
   a. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
   b. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
   c. Body Material: Cast- or ductile-iron housing with sight glass.
   d. Size: Same as connected piping.
   e. Inlet and Outlet: Threaded.
5. Adjustable Drop Nipples:
   a. Standard: UL 1474.
   b. Pressure Rating: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
   c. Body Material: Steel pipe with EPDM-rubber O-ring seals.
   d. Size: Same as connected piping.
   e. Length: Adjustable.
   f. Inlet and Outlet: Threaded.
6. Flexible, Sprinkler Hose Fittings:
   a. Standard: UL 1474.
   b. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
   c. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
   d. Size: Same as connected piping, for sprinkler.

L. Sprinklers
1. General Requirements:
   a. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
   b. Pressure Rating for Residential Sprinklers: 175 psig (1200 kPa) maximum.
   c. Pressure Rating for Automatic Sprinklers: 175 psig (1200 kPa) minimum.
   d. Pressure Rating for High-Pressure Automatic Sprinklers: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
2. Automatic Sprinklers with Heat-Responsive Element:
   a. Early-Suppression, Fast-Response Applications: UL 1767.
   b. Nonresidential Applications: UL 199.
   c. Residential Applications: UL 1626.

d. Characteristics: Nominal 1/2-inch (12.7-mm) orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
3. Open Sprinklers with Heat-Responsive Element Removed: UL 199.
   a. Characteristics:
      1) Nominal 1/2-inch (12.7-mm) Orifice: With Discharge Coefficient K between 5.3 and 5.8.
      2) Nominal 17/32-inch (13.5-mm) Orifice: With Discharge Coefficient K between 7.4 and 8.2.
4. Sprinkler Finishes:
   a. Chrome plated.
   b. Bronze.
   c. Painted.
5. Special Coatings:
   a. Wax.
   b. Lead.
   c. Corrosion-resistant paint.
6. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
   a. Ceiling Mounting: Chrome-plated steel, one piece, flat **OR** Chrome-plated steel, two piece, with 1-inch (25-mm) vertical adjustment **OR** Plastic, white finish, one piece, flat, **as directed**.
   b. Sidewall Mounting: Chrome-plated steel **OR** Plastic, white finish, **as directed**, one piece, flat.
7. Sprinkler Guards:
   a. Standard: UL 199.
   b. Type: Wire cage with fastening device for attaching to sprinkler.

M. Excess-Pressure Pumps
1. Pump: Factory-fabricated, positive-displacement, gear type.
   a. Pump and Motor: Directly connected.
   b. Motor: Comply with requirements in Division 21 Section "Common Work Results For Fire Suppression".
2. Miscellaneous Components: Wet-pipe kit of switches, fittings, valves, mounting brackets, and connections for power, hydraulic piping, and wiring from alarm devices.
3. Motor Control: Differential-pressure switch.
4. Lights: To indicate sprinkler system's operating condition.
   a. White Light: Pressure is normal.
   b. Red Light: Pressure is low.
5. Capacity: 2.0 gpm at 75-psig (0.13 L/s at 520-kPa) differential pressure and 1/3 hp **OR** 1.85 gpm at 100-psig (0.12 L/s at 690-kPa) differential pressure and 1/2 hp **OR** 3.5 gpm at 100-psig (0.22 L/s at 690-kPa) differential pressure and 1/2 hp, **as directed**.

N. Alarm Devices
1. Alarm-device types shall match piping and equipment connections.
2. Water-Motor-Operated Alarm:
   a. Standard: UL 753.
   b. Type: Mechanically operated, with Pelton wheel.
   c. Alarm Gong: Cast aluminum with red-enamel factory finish.
   d. Size: 10-inch (250-mm) diameter.
   e. Components: Shaft length, bearings, and sleeve to suit wall construction.
   f. Inlet: NPS 3/4 (DN 20).
   g. Outlet: NPS 1 (DN 25) drain connection.
3. Electrically Operated Alarm Bell:

a. Standard: UL 464.
b. Type: Vibrating, metal alarm bell.
c. Size: 6-inch (150-mm) minimum-diameter **OR** 8-inch (200-mm) minimum-diameter **OR** 10-inch (250-mm) diameter, **as directed**.
d. Finish: Red-enamel factory finish, suitable for outdoor use.

4. Water-Flow Indicators:
   a. Standard: UL 346.
   b. Water-Flow Detector: Electrically supervised.
   c. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
   d. Type: Paddle operated.
   e. Pressure Rating: 250 psig (1725 kPa).
   f. Design Installation: Horizontal or vertical.
5. Pressure Switches:
   a. Standard: UL 346.
   b. Type: Electrically supervised water-flow switch with retard feature.
   c. Components: Single-pole, double-throw switch with normally closed contacts.
   d. Design Operation: Rising pressure signals water flow.
6. Valve Supervisory Switches:
   a. Standard: UL 346.
   b. Type: Electrically supervised.
   c. Components: Single-pole, double-throw switch with normally closed contacts.
   d. Design: Signals that controlled valve is in other than fully open position.
7. Indicator-Post Supervisory Switches:
   a. Standard: UL 346.
   b. Type: Electrically supervised.
   c. Components: Single-pole, double-throw switch with normally closed contacts.
   d. Design: Signals that controlled indicator-post valve is in other than fully open position.

O. Manual Control Stations
   1. Description: UL listed or FM approved, hydraulic operation, with union, NPS 1/2 (DN 15) pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

P. Control Panels
   1. Description: Single-area, two-area, or single-area cross-zoned control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves. Panels contain power supply; battery charger; standby batteries; field-wiring terminal strip; electrically supervised solenoid valves and polarized fire-alarm bell; lamp test facility; single-pole, double-throw auxiliary alarm contacts; and rectifier.
      a. Panels: UL listed and FM approved when used with thermal detectors and Class A detector circuit wiring. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
      b. Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.
      OR
      Manual Control Stations: Hydraulic operation, with union, NPS 1/2 (DN 15) pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

Q. Pressure Gages

1. Standard: UL 393.
2. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.
3. Pressure Gage Range: 0 to 250 psig (0 to 1725 kPa) minimum **OR** 0 to 300 psig (0 to 2070 kPa), **as directed**.
4. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.
5. Air System Piping Gage: Include retard feature, **directed**, and "AIR" or "AIR/WATER" label on dial face.

R. Escutcheons
1. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
2. One-Piece, Cast-Brass Escutcheons: Polished chrome-plated **OR** rough-brass, **as directed**, finish with set-screws.
3. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with chrome-plated finish.
4. One-Piece, Stamped-Steel Escutcheons: Chrome-plated finish with set-screw **OR** spring clips, **as directed**.
5. Split-Casting, Cast-Brass Escutcheons: Polished chrome-plated **OR** rough-brass, **as directed**, finish with concealed hinge and set-screw.
6. Split-Plate, Stamped-Steel Escutcheons: Chrome-plated finish with concealed **OR** exposed-rivet, **as directed**, hinge, set-screw **OR** spring clips, **as directed**.
7. One-Piece Floor Plates: Cast-iron flange with holes for fasteners, **as directed**.
8. Split-Casting Floor Plates: Cast brass with concealed hinge.

S. Sleeves
1. Cast-Iron Wall Pipe Sleeves: Cast or fabricated of cast iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
2. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
3. Molded-PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
4. Molded-PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.
5. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
6. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, standard weight, zinc coated, plain ends.
7. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   a. Underdeck Clamp: Clamping ring with set-screws.

T. Sleeve Seals
1. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   a. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   b. Pressure Plates: Carbon steel **OR** Plastic **OR** Stainless steel, **as directed**.
   c. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating **OR** Stainless steel, **as directed**, of length required to secure pressure plates to sealing elements.

U. Grout
1. Standard: ASTM C 1107, Grade B, posthardening and volume adjusting, dry, hydraulic-cement grout.
2. Characteristics: Nonshrink, and recommended for interior and exterior applications.
3. Design Mix: 5000-psi (34-MPa), 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

1.3 EXECUTION

A. Preparation
1. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
2. Report test results promptly and in writing.

B. Service-Entrance Piping
1. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in Division 21 Section "Facility Fire-suppression Water-service Piping".
2. Install shutoff valve, backflow preventer, **as directed**, pressure gage, drain, and other accessories indicated at connection to water-service piping. Comply with requirements for backflow preventers in Division 21 Section "Facility Fire-suppression Water-service Piping", **as directed**.
OR
Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

C. Water-Supply Connections
1. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Division 22 Section "Domestic Water Piping".
2. Install shutoff valve, backflow preventer, **as directed**, pressure gage, drain, and other accessories indicated at connection to water-distribution piping. Comply with requirements for backflow preventers in Division 22 Section "Domestic Water Piping Specialties", **as directed**.
OR
Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

D. Piping Installation
1. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
   a. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with the Owner before deviating from approved working plans.
2. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
3. Install seismic restraints on piping. Comply with requirements for seismic-restraint device materials and installation in NFPA 13.
4. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
5. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
6. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
7. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
8. Install sprinkler piping with drains for complete system drainage.
9. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
10. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
11. Install alarm devices in piping systems.
12. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
13. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 (DN 8) and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

14. Pressurize and check preaction sprinkler system piping and air-pressure maintenance devices **OR** air compressors, **as directed**.
15. Fill sprinkler system piping with water.
16. Install electric heating cables and pipe insulation on sprinkler piping in areas subject to freezing. Comply with requirements for heating cables in Division 21 Section "Heat Tracing For Fire-suppression Piping" and for piping insulation in Division 21 Section "Fire-suppression Systems Insulation".

E. Joint Construction
1. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
2. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
3. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
4. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
5. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
6. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
7. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   a. Apply appropriate tape or thread compound to external pipe threads.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
8. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
9. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
10. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
    a. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
11. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
12. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
13. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
14. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.
15. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
16. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and copper pressure-seal fittings with tools recommended by fitting manufacturer.
17. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
18. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

19. Plastic-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
    a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
    b. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

F. Installation Of Cover System For Sprinkler Piping
1. Install cover system, brackets, and cover components for sprinkler piping according to manufacturer's "Installation Manual" and with NFPA 13 or NFPA 13R for supports.

G. Valve And Specialties Installation
1. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
2. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
3. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
4. Specialty Valves:
    a. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
    b. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.
    c. Deluge Valves: Install in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

H. Excess-Pressure Pump Installation
1. Assemble components and mount on wood backing. Comply with requirements in Division 06 Section "Rough Carpentry" for wood backing material and installation.
2. Install excess-pressure pumps, controls, devices, and supports for sprinkler piping application.
    a. Mounting: Install on wall, where indicated **OR** attached to water-supply pipe, **as directed**.

I. Sprinkler Installation
1. Install sprinklers in suspended ceilings in center of narrow dimension of, **as directed**, acoustical ceiling panels.
2. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
3. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

J. Fire-Department Connection Installation
1. Install wall-type, fire-department connections.
2. Install yard-type, fire-department connections in concrete slab support. Comply with requirements for concrete in Division 03 Section "Cast-in-place Concrete".
    a. Install two **OR** three, **as directed**, protective pipe bollards around **OR** on sides of, **as directed**, each fire-department connection. Comply with requirements for bollards in Division 05 Section "Metal Fabrications".
3. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

K. Escutcheon Installation
1. Install escutcheons for penetrations of walls, ceilings, and floors.
2. Escutcheons for New Piping:
    a. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
    b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** stamped steel with set-screw **OR** stamped steel with set-screw or spring clips **OR** stamped steel with spring clips, **as directed**.

c. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** One piece or split casting, cast brass with polished chrome-plated finish **OR** Split casting, cast brass with polished chrome-plated finish **OR** One piece, stamped steel with set-screw **OR** One piece or split plate, stamped steel with set-screw **OR** Split plate, stamped steel with set-screw, **as directed**.
d. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish **OR** cast brass with rough-brass finish **OR** stamped steel with set-screw **OR** stamped steel with spring clips **OR** stamped steel with set-screw or spring clips, **as directed**.
e. Bare Piping in Equipment Rooms: One piece, cast brass **OR** stamped steel with set-screw **OR** stamped steel with spring clips **OR** stamped steel with set-screw or spring clips, **as directed**.
f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3. Escutcheons for Existing Piping:
   a. Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
   b. Insulated Piping: Split plate, stamped steel with concealed or exposed-rivet hinge and spring clips.
   c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and spring clips, **as directed**.
   d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and set-screw, **as directed**.
   e. Bare Piping in Unfinished Service Spaces: Split casting, cast brass with polished chrome-plated finish **OR** casting, cast brass with rough-brass finish **OR** plate, stamped steel with concealed hinge and set-screw or spring clips **OR** plate, stamped steel with concealed or exposed-rivet hinge and set-screw or spring clips **OR** plate, stamped steel with exposed-rivet hinge and set-screw or spring clips, **as directed**.
   f. Bare Piping in Equipment Rooms: Split casting, cast brass **OR** plate, stamped steel with set-screw or spring clips, **as directed**.
   g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

L. Sleeve Installation
1. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
2. Sleeves are not required for core-drilled holes.
3. Permanent sleeves are not required for holes formed by removable PE sleeves.
4. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
5. Install sleeves in new partitions, slabs, and walls as they are built.
6. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants".
7. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants".
8. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals.
9. Seal space outside of sleeves in concrete slabs and walls with grout.
10. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.
11. Install sleeve materials according to the following applications:
    a. Sleeves for Piping Passing through Concrete Floor Slabs: Molded PE **OR** Molded PVC **OR** Galvanized-steel pipe, **as directed**.
    b. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Galvanized-steel pipe **OR** Stack sleeve fittings, **as directed**.

1) Extend sleeves 2 inches (50 mm) above finished floor level.
2) For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Comply with requirements for flashing in Division 07 Section "Sheet Metal Flashing And Trim".

c. Sleeves for Piping Passing through Gypsum-Board Partitions:
1) PVC-pipe **OR** Galvanized-steel-pipe, **as directed**, sleeves for pipes smaller than NPS 6 (DN 150).
2) Galvanized-steel-sheet sleeves for pipes NPS 6 (DN 150) and larger.
3) Exception: Sleeves are not required for water-supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.

d. Sleeves for Piping Passing through Concrete Roof Slabs: Molded PE **OR** Molded PVC **OR** Galvanized-steel pipe, **as directed**.

e. Sleeves for Piping Passing through Exterior Concrete Walls:
1) Galvanized-steel-pipe sleeves for pipes smaller than NPS 6 (DN 150).
2) Cast-iron wall-pipe sleeves for pipes NPS 6 (DN 150) and larger.
3) Install sleeves that are large enough to provide 1-inch (25-mm) annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.

f. Sleeves for Piping Passing through Interior Concrete Walls:
1) PVC-pipe **OR** Galvanized-steel-pipe, **as directed**, sleeves for pipes smaller than NPS 6 (DN 150).
2) Galvanized-steel-sheet sleeves for pipes NPS 6 (DN 150) and larger.

12. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestop materials and installations in Division 07 Section "Penetration Firestopping".

M. Sleeve Seal Installation
1. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.
2. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

N. Identification
1. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
2. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".

O. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
a. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
c. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
d. Energize circuits to electrical equipment and devices.
e. Start and run excess-pressure pumps.
f. Coordinate with fire-alarm tests. Operate as required.
g. Coordinate with fire-pump tests. Operate as required.
h. Verify that equipment hose threads are same as local fire-department equipment.
3. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

P. Cleaning
1. Clean dirt and debris from sprinklers.
2. Remove and replace sprinklers with paint other than factory finish.

Q. Piping Schedule
1. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends; cast-iron threaded fittings; and threaded **OR** grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved, **as directed**, joints.
2. Sprinkler specialty fittings may be used, downstream of control vales, instead of specified fittings.
3. Copper-tube, extruded-tee connections may be used for tee branches in copper tubing instead of specified copper fittings. Branch-connection joints must be brazed.
4. CPVC pipe; Schedule 40 **OR** Schedule 80, **as directed**, CPVC fittings; and solvent-cemented joints may be used for light-hazard and residential occupancies.
5. Standard-pressure, wet-pipe sprinkler system, NPS 2 (DN 50) and smaller, shall be one of the following:
   a. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   b. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   c. Standard-weight or Schedule 30, black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
   d. Standard-weight or Schedule 30, galvanized-steel pipe with plain ends; galvanized, plain-end-pipe fittings; and twist-locked joints.
   e. Standard-weight or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   f. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   g. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
   h. Thinwall **OR** Schedule 10, **as directed**, nonstandard OD, thinwall or hybrid black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   i. Thinwall **OR** Schedule 10, **as directed**, or hybrid black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
   j. Thinwall **OR** Schedule 10, **as directed**, nonstandard OD, thinwall or hybrid black-steel pipe with plain ends; welding fittings; and welded joints.
   k. Schedule 5 steel pipe; steel pressure-seal fittings; and pressure-sealed joints.
   l. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; cast- or wrought-copper solder-joint fittings; and brazed joints.
   m. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; copper pressure-seal fittings; and pressure-sealed joints.
   n. NPS 2 (DN 50), Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.
6. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:
   a. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   b. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   c. Standard-weight or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

d. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
e. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
f. Thinwall **OR** Schedule 10, **as directed**, nonstandard OD, thinwall or hybrid black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
g. Thinwall **OR** Schedule 10, **as directed**, nonstandard OD, thinwall or hybrid black-steel pipe with plain ends; welding fittings; and welded joints.
h. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; cast- or wrought-copper solder-joint fittings; and brazed joints.
i. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; copper pressure-seal fittings; and pressure-sealed joints.
j. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

7. Standard-pressure, wet-pipe sprinkler system, NPS 5 (DN 125) and larger, shall be one of the following:
a. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
b. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
c. Standard-weight or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
d. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
e. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
f. Thinwall **OR** Schedule 10, **as directed**, or hybrid black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
g. Thinwall **OR** Schedule 10, **as directed**, or hybrid black-steel pipe with plain ends; welding fittings; and welded joints.
h. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; cast- or wrought-copper solder-joint fittings; and brazed joints.
i. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

8. High-pressure, wet-pipe sprinkler system, NPS 4 (DN 100) and smaller, shall be one of the following:
a. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
b. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
c. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
d. Thinwall **OR** Schedule 10, **as directed**, or hybrid black-steel pipe with plain ends; welding fittings; and welded joints.

9. High-pressure, wet-pipe sprinkler system, NPS 5 (DN 125) and larger, shall be one of the following:
a. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.

b. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
c. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
d. Thinwall **OR** Schedule 10, **as directed**, or hybrid black-steel pipe with plain ends; welding fittings; and welded joints.

R. Sprinkler Schedule
1. Use sprinkler types in subparagraphs below for the following applications:
   a. Rooms without Ceilings: Upright sprinklers.
   b. Rooms with Suspended Ceilings: Pendent sprinklers **OR** Recessed sprinklers **OR** Flush sprinklers **OR** Concealed sprinklers, **as directed**.
   c. Wall Mounting: Sidewall sprinklers.
   d. Spaces Subject to Freezing: Upright sprinklers **OR** Pendent, dry sprinklers **OR** Sidewall, dry sprinklers, **as directed**.
   e. Deluge-Sprinkler Systems: Upright and pendent, open sprinklers.
   f. Special Applications: Extended-coverage, flow-control, and quick-response sprinklers where indicated.
2. Provide sprinkler types in subparagraphs below with finishes indicated.
   a. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
   b. Flush Sprinklers: Bright chrome, with painted white escutcheon.
   c. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
   d. Residential Sprinklers: Dull chrome.
   e. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 21 13 13 00

SECTION 21 13 16 00 - DRY-PIPE FIRE-SUPPRESSION SPRINKLERS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for dry-pipe fire-suppression sprinklers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Pipes, fittings, and specialties.
      b. Fire-protection valves.
      c. Fire-department connections.
      d. Sprinkler specialty pipe fittings.
      e. Sprinklers.
      f. Alarm devices.
      g. Manual control stations.
      h. Control panels.
      i. Pressure gages.

C. Definitions
   1. Standard-Pressure Sprinkler Piping: Dry-pipe sprinkler system piping designed to operate at working pressure 175 psig (1200 kPa) maximum.

D. System Descriptions
   1. Dry-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing compressed air. Opening of sprinklers releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into piping and discharges from sprinklers that are open.
   2. Combined Dry-Pipe and Preaction Sprinkler System: Automatic sprinklers are attached to piping containing compressed air. Fire-detection system in same area as sprinklers actuates tripping devices that open dry-pipe valve without loss of air pressure and actuates fire alarm. Water discharges from sprinklers that have opened.
   3. Single-Interlock Preaction Sprinkler System: Automatic sprinklers are attached to piping containing low-pressure air. Actuation of fire-detection system in same area as sprinklers opens deluge valve, permitting water to flow into piping and to discharge from sprinklers that have opened.
   4. Double-Interlock Preaction Sprinkler System: Automatic sprinklers are attached to piping containing low-pressure air. Actuation of a fire-detection system in the same area as sprinklers opens the deluge valve permitting water to flow into the sprinkler piping; a closed solenoid valve in the sprinkler piping is opened by another fire-detection device; then water will discharge from sprinklers that have opened.

E. Performance Requirements
   1. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) minimum working pressure.
   2. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
   3. Sprinkler system design shall be approved by authorities having jurisdiction.
      a. Margin of Safety for Available Water Flow and Pressure: 10 **OR** 20, **as directed**, percent, including losses through water-service piping, valves, and backflow preventers.
      b. Sprinkler Occupancy Hazard Classifications:
         1) Automobile Parking Areas: Ordinary Hazard, Group 1.

2) Building Service Areas: Ordinary Hazard, Group 1.
3) Churches: Light Hazard.
4) Electrical Equipment Rooms: Ordinary Hazard, Group 1.
5) Dry Cleaners: Ordinary Hazard, Group 2.
6) General Storage Areas: Ordinary Hazard, Group 1.
7) Laundries: Ordinary Hazard, Group 1.
8) Libraries Except Stack Areas: Light Hazard.
9) Library Stack Areas: Ordinary Hazard, Group 2.
10) Machine Shops: Ordinary Hazard, Group 2.
11) Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
12) Office and Public Areas: Light Hazard.
13) Plastics Processing Areas: Extra Hazard, Group 2.
14) Printing Plants: Extra Hazard, Group 1.
15) Repair Garages: Ordinary Hazard, Group 2.
16) Restaurant Service Areas: Ordinary Hazard, Group 1.
17) Solvent Cleaning Areas: Extra Hazard, Group 2.
18) Upholstering Plants: Extra Hazard, Group 1.

c. Minimum Density for Automatic-Sprinkler Piping Design:
1) Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. (4.1 mm/min. over 139-sq. m) area.
2) Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. (6.1 mm/min. over 139-sq. m) area.
3) Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. (8.1 mm/min. over 139-sq. m) area.
4) Extra-Hazard, Group 1 Occupancy: 0.30 gpm over 2500-sq. ft. (12.2 mm/min. over 232-sq. m) area.
5) Extra-Hazard, Group 2 Occupancy: 0.40 gpm over 2500-sq. ft. (16.3 mm/min. over 232-sq. m) area.
6) Special Occupancy Hazard: As determined by authorities having jurisdiction.

d. Maximum Protection Area per Sprinkler: Per UL listing.
OR
Maximum Protection Area per Sprinkler:
1) Office Spaces: 120 sq. ft. (11.1 sq. m) **OR** 225 sq. ft. (20.9 sq. m), **as directed**.
2) Storage Areas: 130 sq. ft. (12.1 sq. m).
3) Mechanical Equipment Rooms: 130 sq. ft. (12.1 sq. m).
4) Electrical Equipment Rooms: 130 sq. ft. (12.1 sq. m).
5) Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

e. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:
1) Light-Hazard Occupancies: 100 gpm (6.3 L/s) for 30 minutes.
2) Ordinary-Hazard Occupancies: 250 gpm (15.75 L/s) for 60 to 90 minutes.
3) Extra-Hazard Occupancies: 500 gpm (31.5 L/s) for 90 to 120 minutes.

4. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

F. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: For dry-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
a. Wiring Diagrams: For power, signal, and control wiring.
3. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
4. Qualification Data: For qualified Installer and professional engineer, **as directed**.

5. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
6. Fire-hydrant flow test report.
7. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
8. Field quality-control reports.
9. Operation and maintenance data.

G. Quality Assurance
1. Installer Qualifications:
   a. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
      1) Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
   a. NFPA 13, "Installation of Sprinkler Systems."
   b. NFPA 13R, "Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height."
   c. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

H. Project Conditions
1. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:
   a. Notify the Owner no fewer than two days in advance of proposed interruption of sprinkler service.
   b. Do not proceed with interruption of sprinkler service without the Owner's written permission.

1.2 PRODUCTS

A. Piping Materials
1. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Steel Pipe And Fittings
1. Standard Weight, Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.
2. Schedule 30, Galvanized-Steel Pipe: ASTM A 135; ASTM A 795/A 795M, Type E; or ASME B36.10M, wrought steel; with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.
3. Thinwall Galvanized-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.
4. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
5. Galvanized, Steel Couplings: ASTM A 865, threaded.
6. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
7. Malleable- or Ductile-Iron Unions: UL 860.
8. Cast-Iron Flanges: ASME B16.1, Class 125.

9. Plain-End-Pipe Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn or screwed retainer pin to secure pipe in fitting.
10. Grooved-Joint, Steel-Pipe Appurtenances:
    a. Pressure Rating: 175 psig (1200 kPa) **OR** 250 psig (1725 kPa) **OR** 300 psig (2070 kPa), **as directed**, minimum.
    b. Galvanized, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
    c. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

C. Copper Tube And Fittings
1. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) and ASTM B 88, Type M (ASTM B 88M, Type C) water tube, drawn temper.
2. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
3. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.
4. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
5. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
6. Copper Pressure-Seal Fittings:
    a. Standard: UL 213.
    b. NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
    c. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Cast-bronze fitting with EPDM-rubber O-ring seal in each end.
7. Grooved-Joint, Copper-Tube Appurtenances:
    a. Grooved-End, Copper Fittings: ASTM B 75 (ASTM B 75M), copper tube or ASTM B 584, bronze castings.
    b. Grooved-End-Tube Couplings: To fit copper tube, with dimensions and design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gasket suitable for hot and cold water, and bolts and nuts.
8. Copper-Tube, Extruded-Tee Connections:
    a. Description: Tee formed in copper tube according to ASTM F 2014.

D. Piping Joining Materials
1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free.
    a. Class 125, Cast-Iron and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
    b. Class 250, Cast-Iron and Class 300, Raised-Face Flanges: Ring-type gaskets.
2. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
3. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

E. Listed Fire-Protection Valves
1. General Requirements:
    a. Valves shall be UL listed or FM approved.
    b. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig (1200 kPa).
2. Ball Valves:
    a. Standard: UL 1091 except with ball instead of disc.
    b. Valves NPS 1-1/2 (DN 40) and Smaller: Bronze body with threaded ends.
    c. Valves NPS 2 and NPS 2-1/2 (DN 50 and DN 65): Bronze body with threaded ends or ductile-iron body with grooved ends.
    d. Valves NPS 3 (DN 80): Ductile-iron body with grooved ends.

F. Bronze Butterfly Valves:

a. Standard: UL 1091.
b. Pressure Rating: 175 psig (1200 kPa).
c. Body Material: Bronze.
d. End Connections: Threaded.

G. Iron Butterfly Valves:
a. Standard: UL 1091.
b. Pressure Rating: 175 psig (1200 kPa).
c. Body Material: Cast or ductile iron.
d. Style: Lug or wafer.
OR
End Connections: Grooved.

H. Check Valves:
a. Standard: UL 312
b. Pressure Rating: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
c. Type: Swing check.
d. Body Material: Cast iron.
e. End Connections: Flanged or grooved.
2. Bronze OS&Y Gate Valves:
a. Standard: UL 262.
b. Pressure Rating: 175 psig (1200 kPa).
c. Body Material: Bronze.
d. End Connections: Threaded.
3. Iron OS&Y Gate Valves:
a. Standard: UL 262.
b. Pressure Rating: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
c. Body Material: Cast or ductile iron.
d. End Connections: Flanged or grooved.
4. Indicating-Type Butterfly Valves:
a. Standard: UL 1091.
b. Pressure Rating: 175 psig (1200 kPa) minimum.
c. Valves NPS 2 (DN 50) and Smaller:
1) Valve Type: Ball or butterfly.
2) Body Material: Bronze.
3) End Connections: Threaded.
d. Valves NPS 2-1/2 (DN 65) and Larger:
1) Valve Type: Butterfly.
2) Body Material: Cast or ductile iron.
3) End Connections: Flanged, grooved, or wafer.
e. Valve Operation: Integral electrical, 115-V ac, prewired, single-circuit, supervisory switch **OR** electrical, 115-V ac, prewired, two-circuit, supervisory switch **OR** visual, **as directed**, indicating device.
5. NRS Gate Valves:
a. Standard: UL 262.
b. Pressure Rating: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
c. Body Material: Cast iron with indicator post flange.
d. Stem: Nonrising.
e. End Connections: Flanged or grooved.
6. Indicator Posts:
a. Standard: UL 789.
b. Type: Horizontal for wall mounting.
c. Body Material: Cast iron with extension rod and locking device.
d. Operation: Wrench **OR** Hand wheel, **as directed**.

I. Trim And Drain Valves

1. General Requirements:
   a. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
   b. Pressure Rating: 175 psig (1200 kPa) minimum.
2. Angle Valves.
3. Ball Valves.
4. Globe Valves.
5. Plug Valves.

J. Specialty Valves
1. General Requirements:
   a. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
   b. Pressure Rating:
      1) Standard-Pressure Piping Specialty Valves: 175 psig (1200 kPa) minimum.
      2) High-Pressure Piping Specialty Valves: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
   c. Body Material: Cast or ductile iron.
   d. Size: Same as connected piping.
   e. End Connections: Flanged or grooved.
2. Dry-Pipe Valves:
   a. Standard: UL 260
   b. Design: Differential-pressure type.
   c. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
   d. Air-Pressure Maintenance Device:
      1) Standard: UL 260.
      2) Type: Automatic device to maintain minimum air pressure in piping.
      3) Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig (95- to 410-kPa) adjustable range, and 175-psig (1200-kPa) **OR** 300-psig (2070-kPa), **as directed**, outlet pressure.
   e. Air Compressor:
      1) Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
      2) Motor Horsepower: Fractional.
      3) Power: 120-V ac, 60 Hz, single phase.
3. Deluge Valves:
   a. Standard: UL 260.
   b. Design: Hydraulically operated, differential-pressure type.
   c. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, drip cup assembly piped without valves and separate from main drain line, fill-line attachment with strainer, and push-rod chamber supply connection.
   d. Dry, Pilot-Line Trim Set: Include dry, pilot-line actuator; air- and water-pressure gages; low-air-pressure warning switch; air relief valve; and actuation device. Dry, pilot-line actuator includes cast-iron, operated, diaphragm-type valve with resilient facing plate, resilient diaphragm, and replaceable bronze seat. Valve includes threaded water and air inlets and water outlet. Loss of air pressure on dry, pilot-line side allows pilot-line actuator to open and causes deluge valve to open immediately.
   e. Air-Pressure Maintenance Device:
      1) Standard: UL 260.
      2) Type: Automatic device to maintain minimum air pressure in piping.
      3) Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure,

strainer, pressure ratings with 14- to 60-psig (95- to 410-kPa) adjustable range, and 175-psig (1200-kPa) **OR** 300-psig (2070-kPa), **as directed**, outlet pressure.

f. Air Compressor:
   1) Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
   2) Motor Horsepower: Fractional.
   3) Power: 120-V ac, 60 Hz, single phase.

4. Automatic (Ball Drip) Drain Valves:
   a. Standard: UL 1726.
   b. Pressure Rating: 175 psig (1200 kPa) minimum.
   c. Type: Automatic draining, ball check.
   d. Size: NPS 3/4 (DN 20).
   e. End Connections: Threaded.

K. Fire-Department Connections
1. Exposed-Type, Fire-Department Connection:
   a. Standard: UL 405.
   b. Type: Exposed, projecting, for wall mounting.
   c. Pressure Rating: 175 psig (1200 kPa) minimum.
   d. Body Material: Corrosion-resistant metal.
   e. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
   f. Caps: Brass, lugged type, with gasket and chain.
   g. Escutcheon Plate: Round, brass, wall type.
   h. Outlet: Back, with pipe threads.
   i. Number of Inlets: Two **OR** Three, **as directed**.
   j. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE" **OR** "AUTO SPKR", **as directed**.
   k. Finish: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.
   l. Outlet Size: NPS 4 (DN 100) **OR** NPS 5 (DN 125) **OR** NPS 6 (DN 150), **as directed**.
2. Flush-Type, Fire-Department Connection:
   a. Standard: UL 405.
   b. Type: Flush, for wall mounting.
   c. Pressure Rating: 175 psig (1200 kPa) minimum.
   d. Body Material: Corrosion-resistant metal.
   e. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
   f. Caps: Brass, lugged type, with gasket and chain.
   g. Escutcheon Plate: Rectangular, brass, wall type.
   h. Outlet: With pipe threads.
   i. Body Style: Horizontal **OR** Square **OR** Vertical, **as directed**.
   j. Number of Inlets: Two **OR** Three **OR** Four **OR** Six, **as directed**.
   k. Outlet Location: Back **OR** Bottom **OR** Left side **OR** Right side **OR** Top, **as directed**.
   l. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE" **OR** "AUTO SPKR", **as directed**.
   m. Finish: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.
   n. Outlet Size: NPS 4 (DN 100) **OR** NPS 5 (DN 125) **OR** NPS 6 (DN 150) **OR** NPS 8 (DN 200), **as directed**.
3. Yard-Type, Fire-Department Connection:
   a. Standard: UL 405.
   b. Type: Exposed, freestanding.
   c. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.

d. Body Material: Corrosion-resistant metal.
e. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
f. Caps: Brass, lugged type, with gasket and chain.
g. Escutcheon Plate: Round, brass, floor type.
h. Outlet: Bottom, with pipe threads.
i. Number of Inlets: Two **OR** Three **OR** Four, **as directed**.
j. Sleeve: Brass **OR** Not required, **as directed**.
k. Sleeve Height: 18 inches (460 mm).
l. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE" **OR** "AUTO SPKR", **as directed**.
m. Finish, Including Sleeve: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.
n. Outlet Size: NPS 4 (DN 100) **OR** NPS 5 (DN 125) **OR** NPS 6 (DN 150), **as directed**.

L. Sprinkler Specialty Pipe Fittings
1. General Requirements for Dry-Pipe-System Fittings: UL listed for dry-pipe service.
2. Branch Outlet Fittings:
a. Standard: UL 213.
b. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
c. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
d. Type: Mechanical-T and -cross fittings.
e. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
f. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
g. Branch Outlets: Grooved, plain-end pipe, or threaded.
3. Flow Detection and Test Assemblies:
a. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
b. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
c. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
d. Size: Same as connected piping.
e. Inlet and Outlet: Threaded.
4. Branch Line Testers:
a. Standard: UL 199.
b. Pressure Rating: 175 psig (1200 kPa) minimum.
c. Body Material: Brass.
d. Size: Same as connected piping.
e. Inlet: Threaded.
f. Drain Outlet: Threaded and capped.
g. Branch Outlet: Threaded, for sprinkler.
5. Sprinkler Inspector's Test Fittings:
a. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
b. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
c. Body Material: Cast- or ductile-iron housing with sight glass.
d. Size: Same as connected piping.
e. Inlet and Outlet: Threaded.
6. Adjustable Drop Nipples:
a. Standard: UL 1474.
b. Pressure Rating: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
c. Body Material: Steel pipe with EPDM O-ring seals.
d. Size: Same as connected piping.
e. Length: Adjustable.

f. Inlet and Outlet: Threaded.

7. Flexible, Sprinkler Hose Fittings:
   a. Standard: UL 1474.
   b. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
   c. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
   d. Size: Same as connected piping, for sprinkler.

M. Sprinklers
1. General Requirements:
   a. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
   b. Pressure Rating for Residential Sprinklers: 175 psig (1200 kPa) maximum.
   c. Pressure Rating for Automatic Sprinklers: 175 psig (1200 kPa) minimum.
   d. Pressure Rating for High-Pressure Automatic Sprinklers: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
2. Automatic Sprinklers with Heat-Responsive Element:
   a. Nonresidential Applications: UL 199.
   b. Residential Applications: UL 1626.
   c. Characteristics: Nominal 1/2-inch (12.7-mm) orifice with discharge coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
3. Sprinkler Finishes:
   a. Chrome plated.
   b. Bronze.
   c. Painted.
4. Special Coatings:
   a. Wax.
   b. Lead.
   c. Corrosion-resistant paint.
5. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
   a. Ceiling Mounting: Chrome-plated steel, one piece, flat **OR** Chrome-plated steel, two piece, with 1-inch (25-mm) vertical adjustment **OR** Plastic, white finish, one piece, flat, **as directed**.
   b. Sidewall Mounting: Chrome-plated steel **OR** Plastic, white finish, **as directed**, one piece, flat.
6. Sprinkler Guards:
   a. Standard: UL 199.
   b. Type: Wire cage with fastening device for attaching to sprinkler.

N. Alarm Devices
1. Alarm-device types shall match piping and equipment connections.
2. Water-Motor-Operated Alarm:
   a. Standard: UL 753.
   b. Type: Mechanically operated, with Pelton wheel.
   c. Alarm Gong: Cast aluminum with red-enamel factory finish.
   d. Size: 10-inch (250-mm) diameter.
   e. Components: Shaft length, bearings, and sleeve to suit wall construction.
   f. Inlet: NPS 3/4 (DN 20).
   g. Outlet: NPS 1 (DN 25) drain connection.
3. Electrically Operated Alarm Bell:
   a. Standard: UL 464.
   b. Type: Vibrating, metal alarm bell.

c. Size: 6-inch (150-mm) minimum **OR** 8-inch (200-mm) minimum **OR** 10-inch (250-mm), **as directed**, diameter.
d. Finish: Red-enamel factory finish, suitable for outdoor use.

4. Pressure Switches:
   a. Standard: UL 346.
   b. Type: Electrically supervised water-flow switch with retard feature.
   c. Components: Single-pole, double-throw switch with normally closed contacts.
   d. Design Operation: Rising pressure signals water flow.
5. Valve Supervisory Switches:
   a. Standard: UL 346.
   b. Type: Electrically supervised.
   c. Components: Single-pole, double-throw switch with normally closed contacts.
   d. Design: Signals that controlled valve is in other than fully open position.
6. Indicator-Post Supervisory Switches:
   a. Standard: UL 346.
   b. Type: Electrically supervised.
   c. Components: Single-pole, double-throw switch with normally closed contacts.
   d. Design: Signals that controlled indicator-post valve is in other than fully open position.

O. Manual Control Stations
   1. Description: UL listed or FM Global approved, hydraulic operation, with union, NPS 1/2 (DN 15) pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

P. Control Panels
   1. Description: Single-area, two-area, or single-area cross-zoned type control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves. Panels contain power supply; battery charger; standby batteries; field-wiring terminal strip; electrically supervised solenoid valves and polarized fire-alarm bell; lamp test facility; single-pole, double-throw auxiliary alarm contacts; and rectifier.

   2. Panels: UL listed and FM Global approved when used with thermal detectors and Class A detector circuit wiring. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
      a. Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.
         OR
         Manual Control Stations: Hydraulic operation, with union, NPS 1/2 (DN 15) pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

Q. Pressure Gages
   1. Standard: UL 393.
   2. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.
   3. Pressure Gage Range: 0 to 250 psig (0 to 1725 kPa) minimum **OR** 0 to 300 psig (0 to 2070 kPa), **as directed**.
   4. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.
   5. Air System Piping Gage: Include retard feature, **as directed**, and "AIR" or "AIR/WATER" label on dial face.

R. Escutcheons
   1. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.

2. One-Piece, Cast-Brass Escutcheons: Polished chrome-plated or rough-brass finish with set-screws.
3. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with chrome-plated finish.
4. One-Piece, Stamped-Steel Escutcheons: Chrome-plated finish with set-screw or spring clips.
5. Split-Casting, Cast-Brass Escutcheons: Polished chrome-plated or rough-brass finish with concealed hinge and set-screw.
6. Split-Plate, Stamped-Steel Escutcheons: Chrome-plated finish with concealed **OR** exposed-rivet, **as directed**, hinge, set-screw or spring clips.
7. One-Piece Floor Plates: Cast-iron flange with holes for fasteners, **as directed**.
8. Split-Casting Floor Plates: Cast brass with concealed hinge.

S. Sleeves
1. Cast-Iron Wall Pipe Sleeves: Cast or fabricated of cast iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
2. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
3. Molded-PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
4. Molded-PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.
5. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
6. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, standard weight, zinc coated, plain ends.
7. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   a. Underdeck Clamp: Clamping ring with set-screws.

T. Sleeve Seals
1. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   a. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   b. Pressure Plates: Carbon steel **OR** Plastic **OR** Stainless steel, **as directed**.
   c. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating **OR** Stainless steel, **as directed**, of length required to secure pressure plates to sealing elements.

U. Grout
1. Standard: ASTM C 1107, Grade B, posthardening and volume adjusting, dry, hydraulic-cement grout.
2. Characteristics: Nonshrink, and recommended for interior and exterior applications.
3. Design Mix: 5000-psi (34-MPa), 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

1.3 EXECUTION

A. Preparation
1. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
2. Report test results promptly and in writing.

B. Service-Entrance Piping
1. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements in Division 21 Section "Facility Fire-suppression Water-service Piping" for exterior piping.

2. Install shutoff valve, backflow preventer, **as directed**, pressure gage, drain, and other accessories indicated at connection to water-service piping. Comply with requirements in Division 21 Section "Facility Fire-suppression Water-service Piping" for backflow preventers, **as directed**.
3. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

C. Water-Supply Connections
1. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements in Division 22 Section "Domestic Water Piping" for interior piping.
2. Install shutoff valve, backflow preventer, **as directed**, pressure gage, drain, and other accessories indicated at connection to water-distribution piping. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for backflow preventers, **as directed**.
3. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

D. Piping Installation
1. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
   a. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with the Owner before deviating from approved working plans.
2. Piping Standard: Comply with requirements in NFPA 13 for installation of sprinkler piping.
3. Install seismic restraints on piping. Comply with requirements in NFPA 13 for seismic-restraint device materials and installation.
4. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
5. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
6. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
7. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
8. Install sprinkler piping with drains for complete system drainage.
9. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
10. Install automatic (ball drip) drain valves to drain piping between fire-department connections and check valves. Drain to floor drain or to outside building.
11. Connect compressed-air supply to dry-pipe sprinkler piping.
    OR
    Connect air compressor to the following piping and wiring:
    a. Pressure gages and controls.
    b. Electrical power system.
    c. Fire-alarm devices, including low-pressure alarm.
12. Install alarm devices in piping systems.
13. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements in NFPA 13 for hanger materials.
14. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 (DN 8) and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
15. Drain dry-pipe sprinkler piping.
16. Pressurize and check dry-pipe sprinkler system piping and air-pressure maintenance devices **OR** air compressors, **as directed**.

E. Joint Construction

1. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
2. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
3. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
4. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
5. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
6. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
7. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   a. Apply appropriate tape or thread compound to external pipe threads.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
8. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
9. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
10. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.
11. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
12. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and copper pressure-seal fittings with tools recommended by fitting manufacturer.
13. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
14. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

F. Valve And Specialties Installation
1. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
2. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
3. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
4. Specialty Valves:
   a. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
   b. Dry-Pipe and Deluge Valves: Install trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
      1) Install air compressor and compressed-air supply piping.
      2) Air-Pressure Maintenance Device: Install shutoff valves to permit servicing without shutting down sprinkler system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with 14- to 60-psig (95- to 410-kPa) adjustable range; and 175-psig (1200-kPa) maximum inlet pressure.
      3) Install compressed-air supply piping from building's compressed-air piping system.

G. Sprinkler Installation
1. Install sprinklers in suspended ceilings in center of narrow dimension of, **as directed**, acoustical ceiling panels.
2. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
3. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

H. Fire-Department Connection Installation
1. Install wall-type, fire-department connections.
2. Install yard-type, fire-department connections in concrete slab support. Comply with requirements for concrete in Division 03 Section "Cast-in-place Concrete".
   a. Install two **OR** three, **as directed**, protective pipe bollards around **OR** on sides of, **as directed**, each fire-department connection. Comply with requirements for bollards in Division 05 Section "Metal Fabrications".
3. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

I. Escutcheon Installation
1. Install escutcheons for penetrations of walls, ceilings, and floors.
2. Escutcheons for New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
   b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** stamped steel with set-screw **OR** stamped steel with set-screw or spring clips **OR** stamped steel with spring clips, **as directed**.
   c. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** One piece or split casting, cast brass with polished chrome-plated finish **OR** Split casting, cast brass with polished chrome-plated finish **OR** One piece, stamped steel with set-screw **OR** One piece or split plate, stamped steel with set-screw **OR** Split plate, stamped steel with set-screw, **as directed**.
   d. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish **OR** cast brass with rough-brass finish **OR** stamped steel with set-screw **OR** stamped steel with spring clips **OR** stamped steel with set-screw or spring clips, **as directed**.
   e. Bare Piping in Equipment Rooms: One piece, cast brass **OR** stamped steel with set-screw **OR** stamped steel with spring clips **OR** stamped steel with set-screw or spring clips, **as directed**.
   f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.
3. Escutcheons for Existing Piping:
   a. Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
   b. Insulated Piping: Split plate, stamped steel with concealed or exposed-rivet hinge and spring clips.
   c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and spring clips, **as directed**.
   d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and set-screw, **as directed**.
   e. Bare Piping in Unfinished Service Spaces: Split casting, cast brass with polished chrome-plated finish **OR** casting, cast brass with rough-brass finish **OR** plate, stamped steel with concealed hinge and set-screw or spring clips **OR** plate, stamped steel with concealed or exposed-rivet hinge and set-screw or spring clips **OR** plate, stamped steel with exposed-rivet hinge and set-screw or spring clips, **as directed**.
   f. Bare Piping in Equipment Rooms: Split casting, cast brass **OR** plate, stamped steel with set-screw or spring clips, **as directed**.
   g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

J. Sleeve Installation
1. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
2. Sleeves are not required for core-drilled holes.
3. Permanent sleeves are not required for holes formed by removable PE sleeves.
4. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
5. Install sleeves in new partitions, slabs, and walls as they are built.
6. For interior wall penetrations, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants".
7. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants".
8. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals.
9. Seal space outside of sleeves in concrete slabs and walls with grout.
10. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe unless otherwise indicated.
11. Install sleeve materials according to the following applications:
    a. Sleeves for Piping Passing through Concrete Floor Slabs: Molded PE **OR** Molded PVC **OR** Galvanized-steel pipe, **as directed**.
    b. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Galvanized-steel pipe **OR** Stack sleeve fittings, **as directed**.
        1) Extend sleeves 2 inches (50 mm) above finished floor level.
        2) For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Comply with requirements for flashing in Division 07 Section "Sheet Metal Flashing And Trim".
    c. Sleeves for Piping Passing through Gypsum-Board Partitions:
        1) PVC-pipe **OR** Galvanized-steel-pipe, **as directed**, sleeves for pipes smaller than NPS 6 (DN 150).
        2) Galvanized-steel-sheet sleeves for pipes NPS 6 (DN 150) and larger.
        3) Exception: Sleeves are not required for water-supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.
    d. Sleeves for Piping Passing through Concrete Roof Slabs: Molded PE **OR** Molded PVC **OR** Galvanized-steel pipe, **as directed**.
    e. Sleeves for Piping Passing through Exterior Concrete Walls:
        1) Galvanized-steel-pipe sleeves for pipes smaller than NPS 6 (DN 150).
        2) Cast-iron wall pipe sleeves for pipes NPS 6 (DN 150) and larger.
        3) Install sleeves that are large enough to provide 1-inch (25-mm) annular clear space between sleeve and pipe when sleeve seals are used.
    f. Sleeves for Piping Passing through Interior Concrete Walls:
        1) PVC-pipe **OR** Galvanized-steel pipe, **as directed**, sleeves for pipes smaller than NPS 6 (DN 150).
        2) Galvanized-steel-sheet sleeves for pipes NPS 6 (DN 150) and larger.
12. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestop materials and installations.

K. Sleeve Seal Installation
1. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.
2. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe

and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

L. Identification
1. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
2. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".

M. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
   a. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
   b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   c. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
   d. Energize circuits to electrical equipment and devices.
   e. Start and run air compressors.
   f. Coordinate with fire-alarm tests. Operate as required.
   g. Coordinate with fire-pump tests. Operate as required.
   h. Verify that equipment hose threads are same as local fire-department equipment.
3. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

N. Cleaning
1. Clean dirt and debris from sprinklers.
2. Remove and replace sprinklers with paint other than factory finish.

O. Demonstration
1. Train the Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

P. Piping Schedule
1. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends; cast-iron threaded fittings; and threaded **OR** grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved, **as directed**, joints.
2. Sprinkler specialty fittings may be used, downstream of control vales, instead of specified fittings.
3. Copper-tube, extruded-tee connections may be used for tee branches in copper tubing instead of specified copper fittings. Branch-connection joints must be brazed.
4. Standard-pressure, dry-pipe sprinkler system, NPS 2 (DN 50) and smaller, shall be one of the following:
   a. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   b. Standard-weight **OR** Schedule 30 **OR** thinwall, **as directed**, galvanized-steel pipe with plain ends; plain-end-pipe fittings; and twist-locked joints.
   c. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   d. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; cast- or wrought-copper solder-joint fittings; and brazed joints.
   e. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; copper pressure-seal fittings; and pressure-sealed joints.
   f. NPS 2 (DN 50), Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

5. Standard-pressure, dry-pipe sprinkler system, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:
    a. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
    b. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
    c. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; cast- or wrought-copper solder-joint fittings; and brazed joints.
    d. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; copper pressure-seal fittings; and pressure-sealed joints.
    e. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.
6. Standard-pressure, dry-pipe sprinkler system, NPS 5 and NPS 6 (DN 125 and DN 150), shall be one of the following:
    a. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
    b. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
    c. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; cast- or wrought-copper solder-joint fittings; and brazed joints.
    d. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

Q. Sprinkler Schedule
1. Use sprinkler types in subparagraphs below for the following applications:
    a. Rooms without Ceilings: Upright sprinklers.
    b. Rooms with Suspended Ceilings: Dry pendent sprinklers **OR** Dry recessed sprinklers **OR** Dry flush sprinklers **OR** Dry concealed sprinklers, **as directed**.
    c. Wall Mounting: Dry sidewall sprinklers.
    d. Spaces Subject to Freezing: Upright sprinklers **OR** Dry pendent sprinklers **OR** Dry sidewall sprinklers**, as directed**.
    e. Special Applications: Extended-coverage and quick-response sprinklers where indicated.
2. Provide sprinkler types in subparagraphs below with finishes indicated.
    a. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
    b. Flush Sprinklers: Bright chrome, with painted white escutcheon.
    c. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
    d. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

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SECTION 21 13 39 00 - FOAM FIRE EXTINGUISHING

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for foam fire extinguishing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes fixed, low-expansion, AFFF fire-extinguishing systems and the following:
      a. Concentrate piping and piping specialties.
      b. Proportioning tanks and proportioning devices.
      c. Foam concentrate.
      d. Discharge devices.
      e. Monitoring and alarm devices.

C. Definitions
   1. AFFF: Aqueous film-forming foam.
   2. AR-AFFF: Alcohol-resistant aqueous film-forming foam.
   3. ATS: Acceptance Testing Specifications.

D. System Description
   1. Description: Engineered, fixed, wet-pipe **OR** dry-pipe, **OR** preaction, **OR** deluge, **as directed**, automatically actuated, low-expansion, AFFF **OR** AR-AFFF, **as directed**, fire-extinguishing system for flammable-liquid fires. System includes diaphragm proportioning tanks and devices as described in NFPA 16.

E. Performance Requirements
   1. Standard Piping System Component Working Pressure: Listed for at least 175 psig (1200 kPa).
   2. Minimum design parameters to be used with the approval of authorities having jurisdiction are as follows:
      a. Solution: 3 percent foam-water solution.
      b. Sprinkler Spacing: Maximum of 100 sq. ft. (9.5 sq. m) per sprinkler, and maximum 12-foot (3.7-m) spacing.
      c. Design Density: Minimum 0.16 gpm/sq. ft. (0.108 L/s per sq. m).
      d. Foam Supply: Minimum 10-minute discharge time.
      e. Water Supply: Minimum 60 minutes.
      f. Remote Area: Minimum 5000-sq. ft. (476-sq. m) design area for closed-sprinkler systems. Open-sprinkler systems shall discharge over the entire system area.
      g. Sprinkler Temperature Rating: Maximum 250 to 300 deg F (121 to 149 deg C) at a roof or ceiling, and 135 to 170 deg F (57 to 77 deg C) for intermediate sprinklers.
   3. Seismic Performance: Fire-suppression piping shall be capable of withstanding the effects of earthquake motions determined according to NFPA 13.

F. Submittals
   1. Product Data: For the following:
      a. Piping and equipment seismic restraints.
      b. Valves.
      c. Proportioning tanks and proportioning devices.
      d. Foam concentrate.
      e. Discharge devices. Include flow characteristics.
      f. Monitoring and alarm devices. Include electrical data.

2. Shop Drawings: Signed and sealed by a qualified professional engineer. Include the following for each hazard area, drawn to scale:
   a. Include plans, elevations, sections, details, and attachments to other work. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   b. Wiring Diagrams: Power, signal, and control wiring.
   c. Design Calculations: For amount of foam concentrate required for each hazard area.
   d. Plans: Show the following:
      1) Foam-solution proportioning tanks and devices, piping, discharge devices, monitoring and alarm devices, and accessories.
      2) Method of attaching hangers to building structure.
      3) Fire alarm panel.
      4) Equipment and furnishings.
3. Permit-Approved Drawings: Working plans, prepared according to NFPA 16, that have been approved by authorities having jurisdiction. Include design calculations.
4. Welding certificates.
5. Field quality-control test reports.
6. Operation and Maintenance Data: For foam fire extinguishing to include in emergency, operation, and maintenance manuals.

G. Quality Assurance
1. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
3. FMG Compliance: Provide components that are FMG approved and that are listed in FMG's "Fire Protection Approval Guide."
4. UL Compliance: Provide equipment listed in UL's "Fire Protection Equipment Directory."

1.2 PRODUCTS

A. Pipe And Fittings
1. Steel Pipe: ASTM A 53/A 53M, ASTM A 135, ASTM A 106, or ASTM A 795, Type E or S, Grade A or B, Schedule 40, with factory- or field-formed threaded ends.
   a. Cast-Iron Threaded Flanges: ASME B16.1.
   b. Malleable-Iron Threaded Fittings: ASME B16.3.
   c. Gray-Iron Threaded Fittings: ASME B16.4.
   d. Butt-Weld Fittings: ASTM A 234/A 234M, Grade WPB, Schedule 40, carbon-steel butt-weld fittings.
   e. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.
   f. Steel Threaded Couplings: ASTM A 865.
2. Stainless Steel: ASTM A 312/A 312M, Schedule 40, with factory-formed threaded or beveled ends; ASTM A 376/A 376M for seamless pipe; or ASTM A 213/A 213M, ASTM A 249/A 249M, and ASTM A 269 for seamless and welded tubing.
   a. Class 150 Threaded Fittings: ASME B16.3 and MSS SP 114.
   b. Butt-Weld Fittings: ASTM A 403/A 403M.
   c. Flanges, Forged Fittings and Flanges, and Socket-Weld Fittings: ASTM A 182/A 182M.
   d. Bar Stock and Compression Fittings: ASTM A 276 and ASTM A 479/A 479M.
3. Red Brass Pipe: ASTM B 43, Schedule 40, with factory- or field-formed threaded ends.
   a. Threaded Flanges and Fittings: ASTM B 584.
4. Refer to Division 21 Section "Common Work Results For Fire Suppression" for basic joining materials.

B. Valves
   1. Ball Valves: Bronze body with threaded or flanged ends. Comply with UL 1091, except with stainless-steel ball instead of disc.

C. Specialties
   1. Concentrate Storage Tank: Buna-N, bladder-type proportioning tank complying with UL 162 and ASME Boiler and Pressure Vessel Code: Section VIII. Include bladder, internal piping, fill and drain, pipe assembly, glass sight gage, piping, and valves. Concentrate to be contained in the bladder.
      a. Orientation: Horizontal design with saddle **OR** Vertical design with skirt, **as directed**, support.
   2. Proportioning Controller: Venturi type complying with UL 162 and of capacity to match design at minimum and maximum flow.
   3. Concentrate Control Valve: Water-operated ball or deluge valve designed to open with flow through the proportioning controller.
   4. Concentrate Strainers: Bronze body and stainless-steel mesh strainer with minimum 0.125-inch (3.2-mm) perforations to remove solids that would block system components.
   5. Provide devices that comply with NFPA 16, are compatible with the foam concentrate, and are designed to be drained and cleaned.

D. Foam Concentrate
   1. Description: AFFF **OR** AR-AFFF, **as directed**, liquid concentrate, complying with NFPA 11 and UL 162, for making foam-water fire-extinguishing foam solution.

E. Pressure Gages
   1. Description: Comply with UL 393, with 3-1/2-inch- (90-mm-) minimum diameter dial, 0- to 300-psig (0- to 2070-kPa) dial range, and caption "WATER" or "CONCENTRATE" on dial face.

F. Discharge Devices
   1. General: Discharge devices shall be listed and approved by UL and FMG.
   2. Sprinklers: Closed **OR** Open, **as directed**, air-aspirating **OR** non-air-aspirating, **as directed**, type complying with UL 162 and suitable for discharging foam.
   3. Spray Nozzles: Foam-water spray nozzles including foam generator and distributing deflector complying with UL 162 and designed to distribute foam or water in the absence of foam solution in a special pattern peculiar to a particular head.

G. Monitoring Devices
   1. Valve Supervisory Switches: UL 753, electrical, single pole, double throw, with normally closed contacts. Include design that signals controlled valve is in other than fully open position.

H. Alarm Devices
   1. Description: UL listed or FMG approved, low voltage, and surface mounting. Alarm and monitoring devices are specified in Division 28 Section(s) "Digital, Addressable Fire-alarm System" OR "Zoned (dc Loop) Fire-alarm System".

1.3 EXECUTION

A. Concentrate Storage Tank Installation
   1. Install proportioning tanks on concrete bases. Concrete bases are specified in Division 21 Section "Common Work Results For Fire Suppression".
   2. Install tanks level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
   3. Install seismic restraints for tanks. Anchor tanks to substrate.

B. Piping Applications
1. Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.
2. AFFF-Concentrate Piping: Steel pipe, malleable- or cast-iron threaded fittings, and threaded joints.
3. AFFF-Concentrate Piping: Steel pipe with welded fittings and joints.
4. AR-AFFF-Concentrate Piping: Brass **OR** Stainless-steel, **as directed**, pipe, threaded fittings, and joints.
5. AR-AFFF-Concentrate Piping: Stainless-steel pipe with welded fittings and joints.
6. Foam-solution piping is specified in Division 21 Section "Wet-pipe Sprinkler Systems".

C. Piping Installation
1. Install piping and other components level and plumb.
2. Refer to Division 21 Section "Common Work Results For Fire Suppression" for basic pipe installation and joint construction.
3. Install proportioning tanks anchored to substrate.
4. Install pipe and fittings, valves, and discharge devices according to requirements listed in NFPA 16, "Installation of Deluge Foam-Water Sprinkler and Foam-Water Spray Systems."
    a. Support piping using supports and methods according to NFPA 13.
    b. Install seismic restraints for proportioning tanks and piping systems.
    c. Install monitoring and alarm devices according to NFPA 16 and NFPA 72.

D. Connections
1. Piping installation requirements are specified in Division 21 Section "Wet-pipe Sprinkler Systems". Drawings indicate general arrangement of piping, fittings, and specialties.
2. Provide concentrate control, maintenance service, and drain valves with piping to permit maintenance of the foam concentrate with continuous sprinkler system service.
3. Install proportioning controller in fire-suppression piping to provide coverage to area indicated on Drawings.
4. Install piping adjacent to equipment to allow service and maintenance.
5. Connect electrical devices to building's fire alarm system. Electrical power, wiring, and devices are specified in Division 28 Section(s) "Digital, Addressable Fire-alarm System" OR "Zoned (dc Loop) Fire-alarm System".

E. Labeling
1. Install labeling on piping, equipment, and panels according to Division 22 Section "Identification For Plumbing Piping And Equipment".

F. Charging System
1. Fill proportioning tanks with foam concentrate after field quality-control testing is complete and satisfactory results have been achieved.

G. Field Quality Control
1. Inspection: Engage the services of a qualified professional engineer to inspect installed fire-extinguishing systems, prepare installation report, and certify that installation complies with the Contract Documents, calculations, and requirements of authorities having jurisdiction.
2. Comply with operating instructions and procedures in NFPA 16, "Acceptance Tests" Chapter. Include the following tests and inspections to demonstrate compliance with requirements:
    a. Check mechanical items.
    b. Inspect equipment and fire-extinguishing foam concentrate, and check mountings for adequate anchoring to substrate.
    c. Check electrical systems.
    d. Flush piping.
    e. Perform acceptance test.
    f. Perform pressure test.

g. Perform operating test.
h. Perform discharge test.
i. Correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment that cannot be satisfactorily corrected or does not perform as specified and indicated, then retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.
   1) Report test results promptly and in writing and authorities having jurisdiction.

3. Perform the following field tests and inspections and prepare test reports:
   a. After installing foam fire-extinguishing piping system and after electrical circuitry has been energized, test for compliance with requirements.
   b. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, "Inspection and Test Procedures" and "System Function Tests." Certify compliance with test parameters.
   c. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   d. Operational Test: After electrical circuitry has been energized, start systems to confirm proper unit operation.
   e. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 21 13 39 00

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SECTION 21 22 16 00 - CLEAN-AGENT EXTINGUISHING SYSTEMS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for clean-agent extinguishing systems. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes clean-agent extinguishing systems and the following:
   a. Piping and piping specialties.
   b. Extinguishing-agent containers.
   c. Extinguishing agent.
   d. Detection and alarm devices.
   e. Control and alarm panels.
   f. Accessories.
   g. Connection devices for and wiring between system components.
   h. Connection devices for power and integration into building's fire alarm system.

C. Definitions
1. ATS: Acceptance Testing Specifications.
2. EPO: Emergency Power Off.

D. System Description
1. Clean-agent fire-extinguishing system shall be an engineered system for total flooding of the hazard area including the room cavity below the ceiling and below the raised floor. Provide separate zones above and below the raised floor. If smoke is detected below the raised floor, agent shall be discharged in the underfloor zone only. If smoke is detected above the raised floor, agent shall be discharged in zones above and below the floor.

E. Performance Requirements
1. Design clean-agent extinguishing system and obtain approval from authorities having jurisdiction. Design system for Class A, B, or C fires as appropriate for areas being protected and include safety factor. Use clean agent indicated and in concentration suitable for normally occupied areas.
2. Performance Requirements: Discharge HFC 227ea within 10 seconds and maintain 7.1 percent concentration by volume at 70 deg F (21 deg C) for 10-minute holding time in hazard areas.
   a. HFC 227ea concentration in hazard areas greater than 9.0 percent immediately after discharge or less than 5.8 percent throughout holding time will not be accepted without written authorization from the Owner and authorities having jurisdiction.
   b. System Capabilities: Minimum 620-psig (4278-kPa) calculated working pressure and 360-psig (2484-kPa) initial charging pressure.
3. Performance Requirements: Discharge IG-541 within 60 seconds and maintain 38 percent concentration by volume at 70 deg F (21 deg C) for 10-minute holding time in hazard areas.
   a. IG-541 concentration in hazard areas greater than 40 percent immediately after discharge or less than 32 percent throughout holding time will not be accepted without written authorization from the Owner and authorities having jurisdiction.
   b. System Capabilities: Minimum 2175-psig (15-MPa) calculated working pressure upstream from orifice union, minimum 1000-psig (6895-kPa) calculated working pressure downstream from orifice union, and 2175-psig (15-MPa) initial charging pressure.

4. Cross-Zoned Detection: Devices located in two separate zones. Sound alarm on activating single-detection device, and discharge extinguishing agent on actuating single-detection device in other zone.
   OR
   Verified Detection: Devices located in single zone. Sound alarm on activating single-detection device, and discharge extinguishing agent on actuating second-detection device.
5. System Operating Sequence: As follows:
   a. Actuating First Detector: Visual indication on annunciator panel, energize audible alarm and visual alarms (slow pulse), shut down air-conditioning and ventilating systems serving protected area, close doors in protected area, and send signal to fire alarm system.
   b. Actuating Second Detector: Visual indication on annunciator panel, energize audible and visual alarms (fast pulse), shut down power to protected equipment, start time delay for extinguishing-agent discharge for 30 seconds, and discharge extinguishing agent. On agent discharge, release preaction valve to allow water to fill sprinkler system.
   c. Extinguishing-agent discharge will operate audible alarms and strobe lights inside and outside the protected area.
6. System Operating Sequence: System shall be cross-zoned, air-sampling detectors and photoelectric detectors reporting to a fully programmable microprocessor-based control panel programmed to operate as follows:
   a. If one photoelectric detector and air-sampling detector reaches the third detection level (Fire 1), agent discharge will be initiated as described for the third detection level (Fire 1) below.
   b. Air-Sampling System:
      1) First Detection Level (Alert): Mild audible and visual indication on annunciator panel. Strobe lights flash slowly in the protected area.
      2) Second Detection Level (Action): Strong audible and visual indication on annunciator panel. Strobe lights flash rapidly in the protected area.
      3) Third Detection Level (Fire 1): Strong audible and visual indication on annunciator panel. Energize horn(s), bell(s), and strobe light(s) in the protected area and outside entry doors. Shut down air-conditioning and ventilating systems serving the protected area, and close doors in the protected area. Send signal to fire alarm system, initiate 30-second time delay for extinguishing-agent discharge, and discharge extinguishing agent. At agent discharge, terminate power to equipment in the protected area, and release preaction valve to allow water flow to sprinkler system.
      4) Fourth Detection Level (Fire 2): Same as Fire 1.
7. Manual stations shall immediately discharge extinguishing agent when activated.
8. Operating abort switches will delay extinguishing-agent discharge while being activated, and switches must be reset to prevent agent discharge. Release of hand pressure on the switch will cause agent discharge if the time delay has expired.
9. EPO: Will terminate power to protected equipment immediately on actuation.
10. Low-Agent Pressure Switch: Initiate trouble alarm if sensing less than set pressure.
11. Power Transfer Switch: Transfer from normal to stand-by power source.
12. Seismic Performance: Fire-suppression piping and containers shall be capable of withstanding the effects of earthquake motions determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

F. Submittals
   1. Product Data: For each product indicated.
   2. LEED Submittal:
      a. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that clean agents comply.
   3. Shop Drawings: Signed and sealed by a qualified professional engineer. Include design calculations.

4. Permit Approved Drawings: Working plans, prepared according to NFPA 2001, that have been approved by authorities having jurisdiction. Include design calculations.
5. Field quality-control test reports.
6. Maintenance Data: For components to include in maintenance manuals.

G. Quality Assurance
1. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of clean-agent extinguishing systems that are similar to those indicated for this Project in material, design, and extent.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.2 PRODUCTS

A. Piping Materials
1. Refer to Part 1.3 piping applications Article retained for applications of pipe, tube, fitting, and joining materials.
2. Piping, Valves, and Discharge Nozzles: Comply with types and standards listed in NFPA 2001, Section "Distribution," for charging pressure of system.

B. Pipe And Fittings
1. Steel Pipe: ASTM A 53/A 53M, Type S, Grade B or ASTM A 106, Grade B; Schedule 40, or Schedule 80, seamless steel pipe.
   a. Threaded Fittings:
      1) Malleable-Iron Fittings: ASME B16.3, Class 300.
      2) Flanges and Flanged Fittings: ASME B16.5, Class 300, unless Class 600 is indicated.
   b. Forged-Steel Welding Fittings: ASME B16.11, Class 3000, socket pattern.
   c. Grooved-End Fittings: FMG approved and NRTL listed, ASTM A 47/A 47M malleable iron or ASTM A 536 ductile iron, with dimensions matching steel pipe and ends factory grooved according to AWWA C606.

   Plain-End, Hard Copper Tube: ASTM B 88, Type K **OR** L, **as directed**, (ASTM B 88M, Type A **OR** B, **as directed**,), water tube, drawn temper.
   d. Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper alloy, pressure.
   e. Bronze Flanges and Flanged Fittings: ASME B16.24, Class 300.
2. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   a. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness, unless thickness or specific material is indicated.
3. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.
4. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing.
5. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
6. Steel, Keyed Couplings: UL 213, AWWA C606, approved or listed for clean-agent service, and matching steel-pipe dimensions. Include ASTM A 536, ductile-iron housing, rubber gasket, and steel bolts and nuts.

C. Valves
1. General: Brass; suitable for intended operation.
2. Container Valves: With rupture disc or solenoid and manual-release lever, capable of immediate and total agent discharge and suitable for intended flow capacity.

3. Valves in Sections of Closed Piping and Manifolds: Fabricate to prevent entrapment of liquid, or install valve and separate pressure relief device.
4. Valves in Manifolds: Check valve; installed to prevent loss of extinguishing agent when container is removed from manifold.

D. Extinguishing-Agent Containers
1. Description: Steel tanks complying with ASME Boiler and Pressure Vessel Code: Section VIII, for unfired pressure vessels. Include minimum working-pressure rating that matches system charging pressure, valve, pressure switch, and pressure gage.
   a. Finish: Red **OR** Manufacturer's standard color, **as directed**, enamel or epoxy paint.
   b. Manifold: Fabricate with valves, pressure switches, and connections for multiple storage containers, as indicated.
   OR
   Manifold: Fabricate with valves, pressure switches, selector switch, and connections for main- and reserve-supply banks of multiple storage containers.
   c. Storage-Tank Brackets: Factory- or field-fabricated retaining brackets consisting of steel straps and channels; suitable for container support, maintenance, and tank refilling or replacement.

E. Fire-Extinguishing Clean Agent
1. Clean Agent: HFC 227ea, heptafluoropropane.
OR
Clean Agent: IG-541, mixture of nitrogen, argon, and carbon dioxide inert gases.

F. Discharge Nozzles
1. Equipment manufacturer's standard one-piece brass or aluminum alloy of type, discharge pattern, and capacity required for application.

G. Manifold And Orifice Unions
1. Description: NRTL-listed device with minimum 2175-psig (15-MPa) pressure rating, to control flow and reduce pressure of IG-541 gas in piping.
   a. NPS 2 (DN 50) and Smaller: Piping assembly with orifice, sized for system design requirements.
   b. NPS 2-1/2 (DN 65) and Larger: Piping assembly with nipple, sized for system design requirements.

H. Control Panels
1. Description: FMG approved or NRTL listed, including equipment and features required for testing, supervising, and operating fire-extinguishing system.
2. Power Requirements: 120/240-V ac; with electrical contacts for connection to system components and fire alarm system, and transformer or rectifier as needed to produce power at voltage required for accessories and alarm devices.
3. Enclosure: NEMA ICS 6, Type 1, enameled-steel cabinet.
   a. Mounting: Recessed flush with surface **OR** Surface, **as directed**.
4. Supervised Circuits: Separate circuits for each independent hazard area.
   a. Detection circuits equal to the required number of zones, or addressable devices assigned to the required number of zones.
   b. Manual pull-station circuit.
   c. Alarm circuit.
   d. Release circuit.
   e. Abort circuit.
   f. EPO circuit.
5. Provide the following control-panel features:
   a. Electrical contacts for shutting down fans, activating dampers, and operating system electrical devices.

b. Automatic switchover to standby power at loss of primary power.
c. Storage container, low-pressure indicator.
d. Service disconnect to interrupt system operation for maintenance with visual status indication on the annunciator panel.

6. Annunciator Panel: Graphic type showing protected, hazard-area plans and locations of detectors, abort, EPO, and manual stations. Include lamps to indicate device-initiating alarm, electrical contacts for connection to control panel, and stainless-steel or aluminum enclosure.
7. Standby Power: Lead-acid or nickel-cadmium batteries with capacity to operate system for 72 hours and alarm for minimum of 15 minutes. Include automatic battery charger, with varying charging rate between trickle and high depending on battery voltage, that is capable of maintaining batteries fully charged. Include manual voltage control, dc voltmeter, dc ammeter, electrical contacts for connection to control panel, and suitable enclosure.

I. Detection Devices
1. Description: Comply with NFPA 2001 and NFPA 72, and include the following types:
a. Ionization Detectors: Comply with UL 268, dual-chamber type, having sampling and referencing chambers, with smoke-sensing element.
b. Photoelectric Detectors: Comply with UL 268, consisting of LED light source and silicon photodiode receiving element.
c. Remote Air-Sampling Detector System: Includes air-sampling pipe network, a laser-based photoelectric detector, a sample transport fan, and a control unit.
1) Comply with UL 268 and NRTL listed, operating at 24-V dc, nominal.
2) Pipe Network: CPVC tubing connects control unit with calibrated sampling holes.
3) Smoke Detector: Particle-counting type with continuous laser beam. Sensitivity adjustable to a minimum of four preset values.
4) Sample Transport Fan: Centrifugal type, creating a minimum static pressure of 0.05-inch wg (12.5 Pa) at all sampling ports.
5) Control Unit: Multizone unit as indicated on Drawings. Provides same system power supply, supervision, and alarm features as specified for the control panel plus separate trouble indication for airflow and detector problems.
6) Signals to the Central Fire Alarm Control Panel: Any type of local system trouble is reported to the central fire alarm control panel as a composite "trouble" signal. Alarms on each system zone are individually reported to the central fire alarm control panel as separately identified zones.

J. Manual Stations
1. General Description: Surface **OR** Semirecessed, **as directed**, FMG approved or NRTL listed, with clear plastic hinged cover, 120-V ac or low voltage compatible with controls. Include contacts for connection to control panel.
2. Manual Release: "MANUAL RELEASE" caption, and red finish. Unit can manually discharge extinguishing agent with operating device that remains engaged until unlocked.
3. Abort Switch: "ABORT" caption, momentary contact, with green finish.
4. EPO Switch: "EPO" caption, with yellow finish.

K. Switches
1. Description: FMG approved or NRTL listed, where available, 120-V ac or low voltage compatible with controls. Include contacts for connection to control panel.
a. Low-Agent Pressure Switches: Pneumatic operation.
b. Power Transfer Switches: Key-operation selector, for transfer of release circuit signal from main supply to reserve supply.
c. Door Closers: Magnetic retaining and release device or electrical interlock to cause the door operator to drive the door closed.

L. Alarm Devices
1. Description: FMG approved or NRTL listed, low voltage, and surface mounting, unless otherwise indicated.

2. Bells: Minimum 6-inch (150-mm) diameter.
3. Horns: 90 to 94 dBA.
4. Strobe Lights: Translucent lens, with "FIRE" or similar caption.

M. Electrical Power And Wiring
1. Electrical power, wiring, and devices are specified in Division 22.

1.3 EXECUTION

A. Piping Applications
1. Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.
2. Fittings Working Pressure: 620 psig (4278 kPa) minimum.
3. Flanged Joints: Class 300 minimum.
4. NPS 2 (DN 50) and Smaller: ASTM B 88, Type K **OR** L, **as directed**, (ASTM B 88M, Type A **OR** B, **as directed**,) copper tube; copper, solder-joint fittings; and brazed joints.
OR
NPS 2 (DN 50) and Smaller: Schedule 40, steel pipe; malleable-iron threaded fittings; and threaded joints.
5. NPS 2-1/2 and NPS 3 (DN 65 and DN 80): ASTM B 88, Type K **OR** L, **as directed**, (ASTM B 88M, Type A **OR** B, **as directed**,) copper tube; copper, solder-joint fittings; and brazed joints.
OR
NPS 2-1/2 and NPS 3 (DN 65 and DN 80): Schedule 40, steel pipe; forged-steel welding fittings; and welded joints.
OR
NPS 2-1/2 and NPS 3 (DN 65 and DN 80): Schedule 40, steel pipe; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.
6. NPS 4 (DN 100) and Larger: Schedule 40, steel pipe; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.
OR
NPS 4 (DN 100) and Larger: Schedule 40, steel pipe; forged-steel welding fittings; and welded joints.

B. Piping Applications
1. Piping between Storage Containers and Orifice Union:
a. Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.
b. Fittings Working Pressure: 2175 psig (15 MPa) minimum.
c. Flanged Joints: Class 600 minimum.
d. All Sizes: Schedule 80, steel pipe; forged-steel welding fittings; and welded joints.
2. Piping Downstream from Orifice Union:
a. Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.
b. Fittings Working Pressure: 1000 psig (6900 kPa) minimum.
c. Flanged Joints: Class 300 minimum.
d. All Sizes: Schedule 40 **OR** 80, **as directed**, steel pipe; forged-steel welding fittings; and welded joints.

C. Clean-Agent Extinguishing Piping Installation
1. Install clean-agent extinguishing piping and other components level and plumb and according to manufacturers' written instructions.
2. Refer to Division 21 Section "Common Work Results For Fire Suppression" for basic pipe installation and joint construction.

3. Grooved Piping Joints: Groove pipe ends according to AWWA C606 dimensions. Assemble grooved-end steel pipe and steel, grooved-end fittings with steel, keyed couplings and lubricant according to manufacturer's written instructions.
4. Install extinguishing-agent containers anchored to substrate.
5. Install pipe and fittings, valves, and discharge nozzles according to requirements listed in NFPA 2001, Section "Distribution," and in ASME B31.1.
    a. Install valves designed to prevent entrapment of liquid or install pressure relief devices in valved sections of piping systems.
    b. Support piping using supports and methods according to NFPA 13.
    c. Install seismic restraints for extinguishing-agent containers and piping systems.
    d. Install control panels, detection system components, alarms, and accessories, complying with requirements of NFPA 2001, Section "Detection, Actuation, and Control Systems," as required for supervised system application.

D. Connections
1. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to extinguishing-agent containers to allow service and maintenance.
3. Connect electrical devices to control panel and to building's fire alarm system. Electrical power, wiring, and devices are specified in Division 28 Section(s) "Digital, Addressable Fire-alarm System" OR "Zoned (dc Loop) Fire-alarm System".

E. Labeling
1. Install labeling on piping, extinguishing-agent containers, other equipment, and panels according to NFPA 2001.
2. Install signs at entry doors for protected areas to warn occupants that they are entering a room protected with a clean-agent fire extinguishing system.
3. Install signs at entry doors to advise persons outside the room the meaning of the horn(s), bell(s), and strobe light(s) outside the protected space.

F. Field Quality Control
1. Comply with operating instructions and procedures of NFPA 2001, Section "Approval of Installations." Include the following tests and inspections to demonstrate compliance with requirements:
    a. Check mechanical items.
    b. Inspect extinguishing-agent containers and extinguishing agent, and check mountings for adequate anchoring to substrate.
    c. Check electrical systems.
    d. Check enclosure integrity. Comply with NFPA 2001, Section "Enclosure Inspection," and Appendix C, "Enclosure Integrity Procedure."
    e. Perform functional pre-discharge test.
    f. Perform system functional operational test including, EPO, abort, and manual release.
    g. Check remote monitoring operations.
    h. Check control-panel primary power source.
    i. Perform "puff" test on piping system, using nitrogen.
2. Perform field-acceptance tests of each clean-agent extinguishing system when installation is complete. Perform system testing only after hazard-area enclosure construction has been completed and openings sealed. Comply with operating instructions and procedures of NFPA 2001, Section "Approval of Installations." Include the following to demonstrate compliance with requirements:
    a. Perform functional predischarge test.
    b. Perform system functional operational test.
    c. Check remote monitoring operations.
    d. Check control-panel primary power source.
    e. Perform "puff" test on piping system, using nitrogen.

3. Correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment that cannot be corrected or does not perform as specified and indicated, then retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.
    a. Report test results promptly and in writing to the Owner and authorities having jurisdiction.
4. Perform the following field tests and inspections and prepare test reports:
    a. After installing clean-agent extinguishing piping system and after electrical circuitry has been energized, test for compliance with requirements.
    b. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections "Inspection and Test Procedures" and "System Function Tests." Certify compliance with test parameters.
    c. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
    d. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
    e. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Remove and replace malfunctioning units and retest as specified above.

G. Cleaning
1. Each pipe section shall be cleaned internally after preparation and before assembly by means of swabbing, using a suitable nonflammable cleaner. Pipe network shall be free of particulate matter and oil residue before installing nozzles or discharge devices.

H. System Filling
1. Preparation:
    a. Verify that piping system installation is completed and cleaned.
    b. Check for complete enclosure integrity.
    c. Check operation of ventilation and exhaust systems.
2. Filling Procedures:
    a. Fill extinguishing-agent containers with extinguishing agent and pressurize to indicated charging pressure.
    b. Install filled extinguishing-agent containers.
    c. Energize circuits.
    d. Adjust operating controls.

I. Demonstration
1. Train the Owner's maintenance personnel to adjust, operate, and maintain clean-agent extinguishing systems.

END OF SECTION 21 22 16 00

Task	Specification	Specification Description
21 22 16 00	01 22 16 00	No Specification Required

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SECTION 21 24 00 00 - FIBERGLASS REINFORCED POLYESTER (FRP) FLUSH DOORS

1.1 GENERAL

A. Description of Work
1. This specification covers the furnishing and installation of materials for fiberglass reinforced polyester (FRP) flush doors and aluminum frames. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Performance Requirements
1. General: Provide door assemblies that have been designed and fabricated to comply with specified performance requirements, as demonstrated by testing manufacturer's corresponding standard systems.
2. Air Infiltration: For a single door 3'-0" x 7'-0", test specimen shall be tested in accordance with ASTM E 283 at pressure differential of 6.24 psf. Door shall not exceed 0.90 cfm per linear foot of perimeter crack.
3. Water Resistance: For a single door 3'-0" x 7'-0", test specimen shall be tested in accordance with ASTM E 331 at pressure differential of 7.50 psf. Door shall not have water leakage.
4. Hurricane Test Standards, Single Door with Single-Point Latching:
    a. Uniform Static Load, ASTM E 330: Plus or minus 75 pounds per square foot.
    b. Forced Entry Test, 300 Pound Load Applied, SFBC 3603.2 (b)(5): Passed.
    c. Cyclic Load Test, SFBC PA 203: Plus or minus 53 pounds per square foot.
    d. Large Missile Impact Test, SFBC PA 201: Passed.
5. Swinging Door Cycle Test, Doors and Frames, ANSI A250.4: Minimum of 20,000,000 cycles.
6. Swinging Security Door Assembly, Doors and Frames, ASTM F 476: Grade 40.
7. Salt Spray, Exterior Doors and Frames, ASTM B 117: Minimum of 500 hours.
8. Sound Transmission, Exterior Doors, STC, ASTM E 90: Minimum of 25.
9. Thermal Transmission, Exterior Doors, U-Value, AAMA 1503-98: Maximum of 0.29 BTU/hr x sf x degrees F. Minimum of 55 CRF value.
10. Surface Burning Characteristics, FRP Doors and Panels, ASTM E 84:
    a. Flame Spread: Maximum of 200, Class C.
    b. Smoke Developed: Maximum of 450, Class C.
11. Surface Burning Characteristics, Class A Option On Interior Faces of FRP Exterior Panels and Both Faces of FRP Interior Panels, ASTM E 84:
    a. Flame Spread: Maximum of 25.
    b. Smoke Developed: Maximum of 450.
12. Impact Strength, FRP Doors and Panels, Nominal Value, ASTM D 256: 15.0 foot-pounds per inch of notch.
13. Tensile Strength, FRP Doors and Panels, Nominal Value, ASTM D 638: 14,000 psi.
14. Flexural Strength, FRP Doors and Panels, Nominal Value, ASTM D 790: 21,000 psi.
15. Water Absorption, FRP Doors and Panels, Nominal Value, ASTM D 570: 0.20 percent after 24 hours.
16. Indentation Hardness, FRP Doors and Panels, Nominal Value, ASTM D 2583: 55.
17. Abrasion Resistance, Face Sheet, Taber Abrasion Test, 25 Cycles at 1,000 Gram Weight with CS-17 Wheel: Maximum of 0.029 average weight loss percentage.
18. Stain Resistance, ASTM D 1308: Face sheet unaffected after exposure to red cabbage, tea, and tomato acid. Stain removed easily with mild abrasive or FRP cleaner when exposed to Sharpie ink pen and white spray paint.
19. Chemical Resistance, ASTM D 543. Excellent rating.
    a. Acetic acid, 5 percent solution.
    b. Chlorine bleach, 10 percent solution.
    c. Sodium hypochlorite, 4 to 6 percent solution.
    d. Citric acid, 10 percent solution.
    e. Sodium carbonate, 20 percent solution.

f. Turpentine.
20. Compressive Strength, Foam Core, Nominal Value, ASTM D 1621: 84.2 psi.
21. Compressive Modulus, Foam Core, Nominal Value, ASTM D 1621: 448 psi.
22. Tensile Adhesion, Foam Core, Nominal Value, ASTM D 1623: 48 psi.
23. Thermal and Humid Aging, Nominal Value, 158 Degrees F and 100 Percent Humidity for 14 Days, ASTM D 2126: Minus 4.89 percent volume change.

C. Submittals
1. Product Data: Submit manufacturer's product data, including description of materials, components, fabrication, finishes, and installation.
2. Shop Drawings: Submit manufacturer's shop drawings, including elevations, sections, and details, indicating dimensions, tolerances, materials, fabrication, doors, panels, framing, hardware schedule, and finish.
3. Samples:
   a. Door: Submit manufacturer's sample of door showing face sheets, core, framing, and finish.
   b. Color: Submit manufacturer's samples of standard colors of doors and frames.
4. Test Reports: Submit certified test reports from qualified independent testing agency indicating doors comply with specified performance requirements.
5. Manufacturer's Project References: Submit list of successfully completed projects including project name and location, name of architect, and type and quantity of doors manufactured.
6. Maintenance Manual: Submit manufacturer's maintenance and cleaning instructions for doors, including maintenance and operating instructions for hardware.
7. Warranty: Submit manufacturer's standard warranty.

D. Quality Assurance
1. Manufacturer's Qualifications:
   a. Continuously engaged in manufacturing of doors of similar type to that specified, with a minimum of 25 years successful experience.
   b. Door and frame components from same manufacturer.
   c. Evidence of a compliant documented quality management system.

E. Delivery, Storage, And Handling
1. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying opening door mark and manufacturer.
2. Storage: Store materials in clean, dry area indoors in accordance with manufacturer's instructions.
3. Handling: Protect materials and finish from damage during handling and installation.

F. Warranty
1. Warrant doors, frames, and factory hardware against failure in materials and workmanship, including excessive deflection, faulty operation, defects in hardware installation, and deterioration of finish or construction in excess of normal weathering.
2. Warranty Period: Ten years starting on date of shipment.

1.2 PRODUCTS

A. Manufacturer: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Special-Lite, Inc., PO Box 6, Decatur, Michigan 49045. Toll Free (800) 821-6531. Phone (269) 423-7068. Fax (800) 423-7610. Web Site www.special-lite.com. E-Mail info@special-lite.com.

B. FRP Flush Doors
1. Model: SL-17 Flush Doors with SpecLite3 fiberglass reinforced polyester (FRP) face sheets.
2. Door Opening Size: As indicated on the Drawings **OR as directed**.

3. Construction:
    a. Door Thickness: 1-3/4 inches.
    b. Stiles and Rails: Aluminum Alloy 6063-T5, minimum of 2-5/16-inch depth.
    c. Corners: Mitered.
    d. Provide joinery of 3/8-inch diameter full-width tie rods through extruded splines top and bottom as standard tubular shaped stiles and rails reinforced to accept hardware as specified.
    e. Securing Internal Door Extrusions: 3/16-inch angle blocks and locking hex nuts for joinery. Welds, glue, or other methods are not acceptable.
    f. Furnish extruded stiles and rails with integral reglets to accept face sheets. Lock face sheets into place to permit flush appearance.
    g. Rail caps or other face sheet capture methods are not acceptable.
    h. Extrude top and bottom rail legs for interlocking continuous weather bar.
    i. Meeting Stiles: Pile brush weatherseals. Extrude meeting stile to include integral pocket to accept pile brush weatherseals.
    j. Bottom of Door: Install bottom weather bar with nylon brush weatherstripping into extruded interlocking edge of bottom rail.
4. Face Sheet:
    a. Material: SpecLite3 FRP, 0.120-inch thickness, finish color throughout. Abuse-resistant engineered surface.
    b. Texture: Pebble.
    c. Color: **As directed**.
5. Core:
    a. Material: Poured-in-place polyurethane foam.
    b. Density: Minimum of 5 pounds per cubic foot.
    c. R-Value: Minimum of 9.
6. Cutouts:
    a. Manufacture doors with cutouts for required vision lites, louvers, and panels.
    b. Factory install vision lites, louvers, and panels.
7. Hardware:
    a. Premachine doors in accordance with templates from specified hardware manufacturers and hardware schedule.
    b. Factory install hardware.

C. Materials
1. Aluminum Members:
    a. Extrusions: ASTM B 221.
    b. Sheet and Plate: ASTM B 209.
    c. Alloy and Temper: As required by manufacturer for strength, corrosion resistance, application of required finish, and control of color.
2. Components: Door and frame components from same manufacturer.
3. Fasteners:
    a. Material: Aluminum, 18-8 stainless steel, or other noncorrosive metal.
    b. Compatibility: Compatible with items to be fastened.
    c. Exposed Fasteners: Screws with finish matching items to be fastened.

D. Fabrication
1. Sizes and Profiles: Required sizes for door and frame units, and profile requirements shall be as indicated on the Drawings.
2. Coordination of Fabrication: Field measure before fabrication and show recorded measurements on shop drawings.
3. Assembly:
    a. Complete cutting, fitting, forming, drilling, and grinding of metal before assembly.
    b. Remove burrs from cut edges.
4. Welding: Welding of doors or frames is not acceptable.
5. Fit:

a. Maintain continuity of line and accurate relation of planes and angles.
b. Secure attachments and support at mechanical joints with hairline fit at contacting members.

E. Architectural Panels
1. FRP Panels:
a. Model: SL-37 Architectural Panels with SpecLite3 FRP face sheets.
b. Size: As indicated on the Drawings **OR as directed**.
c. Thickness: 1/4 inch **OR** 1 inch **OR** As indicated on the Drawings **OR as directed**.
2. Face Sheets:
a. Material: SpecLite3 FRP, 0.120-inch thickness, finish color throughout. Abuse-resistant engineered surface.
b. Texture: Pebble.
c. Color: **As directed**.
3. Insulated Speclite3 FRP Panels:
a. Insulated Panels: Two 0.120-inch minimum thickness sheets.
b. Core: Foamed polyurethane core of a minimum of 5 pounds per cubic foot density.
c. Form components to function as single unit.
d. U-Value: Minimum of 0.23 for 1-inch panels.
4. Class A Flame Spread and Smoke Developed Rating, **as directed**:
a. Class A flame spread and smoke developed rating on interior faces of exterior panels and both faces of interior panels.
b. Flame Spread, ASTM E 84: Maximum of 25.
c. Smoke Developed, ASTM E 84: Maximum of 450.

F. Aluminum Door Framing Systems
1. Tubular Framing:
a. Size and Type: As indicated on the Drawings.
b. Materials: Aluminum Alloy 6063-T5, 1/8-inch minimum wall thickness.
c. Applied Door Stops: 0.625-inch high, with screws and weatherstripping. Door stop shall incorporate pressure gasketing for weathering seal. Counterpunch fastener holes in door stop to preserve full metal thickness under fastener head.
d. Frame Members: Box type with 4 enclosed sides. Open-back framing is not acceptable.
e. Caulking: Caulk joints before assembling frame members.
f. Joints:
1) Secure joints with fasteners.
2) Provide hairline butt joint appearance.
g. Field Fabrication: Field fabrication of framing using stick material is not acceptable.
h. Applied Stops: For side, transom, and borrowed lites and panels. Applied stops shall incorporate pressure gasketing for weathering seal. Reinforce with solid bar stock fill for frame hardware attachments.
i. Hardware:
1) Premachine and reinforce frame members for hardware in accordance with manufacturer's standards and hardware schedule.
2) Factory install hardware.
j. Anchors:
1) Anchors appropriate for wall conditions to anchor framing to wall materials.
2) Door Jamb and Header Mounting Holes: Maximum of 24-inch centers.
3) Secure head and sill members of transom, side lites, and similar conditions.
k. Side Lites:
1) Factory preassemble side lites to greatest extent possible.
2) Mark frame assemblies according to location.
2. Insert Framing System:
a. Model: SL-1030 Series, SL-1031 **OR** SL-1032 **OR** SL-1034, **as directed**.
b. Insert frame as indicated on the Drawings, using integral stop fitted with weatherstripping.

c. Corner joints of miter design, secure with furnished aluminum clips, and screw into place.
d. Hardware:
1) Premachine and reinforce insert frame members for hardware in accordance with manufacturer's standards and hardware schedule.
2) Factory install hardware.
e. Anchors:
1) Anchors of suitable type to fasten insert framing to existing frame materials.
2) Minimum of 5 anchors on jambs up to 7'-4" height, 3 anchors on headers, and 1 additional anchor for each additional foot of frame.
3. Frame Capping:
a. Model: SL-70.
b. Capping: With insert frame as indicated on the Drawings, **OR as directed**.
c. Finish: Match framing.

G. Hardware
1. Premachine doors in accordance with templates from specified hardware manufacturers and hardware schedule.
2. Factory install hardware.
3. Hardware Schedule: As specified in Division 08 Section "Door Hardware" **OR** As indicated on the Drawings, **OR as directed**.
a. Hinges shall be continuous type.
4. Finish: As specified in Division 08 Section "Door Hardware" **OR** As indicated on the Drawings, **OR as directed**.

H. Vision Lites
1. Factory Glazing: 1/4-inch glass **OR** 1-inch glass insulating units, **as directed**.
2. Lites in Exterior Doors: Allow for thermal expansion.
3. Rectangular Lites:
a. Size: 12 inches by 12 inches **OR** Half lite **OR** Full lite **OR** Narrow lite **OR** Double lite **OR** As indicated on the Drawings **OR as directed**.
b. Factory glazed with screw-applied aluminum stops anodized to match perimeter door rails.
4. Security Grate: SL-SG349.
a. Frame Perimeter: 1-inch by 1-inch by 1/8-inch steel angle.
b. Expanded Metal: 1/4-inch diameter, round hole perforated, 14-gauge steel sheet.
c. Finish: Factory painted to match door finish.
5. Vandal Screen: SL-SG350.
a. Frame Perimeter: Aluminum. Finish to match vision lite.
b. Expanded Metal: 1/4-inch diameter, round hole perforated, 16-gauge stainless steel sheet. Powder coat black finish.

I. Louvers
1. Type: Aluminum, inverted Y-type, fixed blade, 12 inches minimum from bottom of door.
2. Size: As indicated on the Drawings OR as directed.
3. Installation: Factory installed into standard vision lite kit. Exterior side of louver shall be free of fasteners.
4. Insect screen.

J. Aluminum Finishes
1. Anodized Finish: Class **I** finish, 0.7 mils thick.
a. Clear 215 R1, AA-M10C12C22A41, Class **I**, 0.7 mils thick.
b. Champagne, AA-M10C12C22A44, Class **I**, 0.7 mils thick.
c. Light Bronze, AA-M10C12C22A44, Class **I**, 0.7 mils thick.
d. Medium Bronze, AA-M10C12C22A44, Class **I**, 0.7 mils thick.
e. Dark Bronze, AA-M10C12C22A44, Class **I**, 0.7 mils thick.
f. Black, AA-M10C12C22A44, Class **I**, 0.7 mils thick.
2. Painted: as directed by the Owner.

1.3 EXECUTION

A. Preparation
1. Ensure openings to receive frames are plumb, level, square, and in tolerance.

B. Installation
1. Install doors in accordance with manufacturer's instructions.
2. Install doors plumb, level, square, true to line, and without warp or rack.
3. Anchor frames securely in place.
4. Separate aluminum from other metal surfaces with bituminous coatings or other means approved by the Owner.
5. Set thresholds in bed of mastic and backseal.
6. Install exterior doors to be weathertight in closed position.
7. Repair minor damages to finish in accordance with manufacturer's instructions and as approved by the Owner.
8. Remove and replace damaged components that cannot be successfully repaired as determined by the Owner.

C. Field Quality Control
1. Manufacturer's Field Services: Manufacturer's representative shall provide technical assistance and guidance for installation of doors.

D. Adjusting
1. Adjust doors, hinges, and locksets for smooth operation without binding.

E. Cleaning
1. Clean doors promptly after installation in accordance with manufacturer's instructions.
2. Do not use harsh cleaning materials or methods that would damage finish.

F. Protection
1. Protect installed doors to ensure that, except for normal weathering, doors will be without damage or deterioration at time of Final Completion.

END OF SECTION 21 24 00 00

Task	Specification	Specification Description
21 24 16 00	21 24 00 00	Fiberglass Reinforced Polyester (FRP) Flush Doors

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SECTION 21 30 00 00 - ELECTRIC-DRIVE, CENTRIFUGAL FIRE PUMPS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for electric-drive, centrifugal fire pumps. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. End-suction, In-line, and Split-case fire pumps.
   b. Fire-pump accessories and specialties.
   c. Flowmeter systems.

C. Performance Requirements
1. Seismic Performance: Fire pumps shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig (1200 kPa) minimum unless higher pressure rating is indicated.

D. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: For fire pumps, motor drivers, and fire-pump accessories and specialties. Include plans, elevations, sections, details, and attachments to other work.
   a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   b. Wiring Diagrams: For power, signal, and control wiring.
3. Seismic Qualification Certificates: For fire pumps, accessories, and components, from manufacturer.
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Product Certificates: For each fire pump, from manufacturer.
5. Source quality-control reports.
6. Field quality-control reports.
7. Operation and maintenance data.

E. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. NFPA Compliance: Comply with NFPA 20, "Installation of Stationary Pumps for Fire Protection."

1.2 PRODUCTS

A. General Requirements For Centrifugal Fire Pumps

1. Description: Factory-assembled and -tested fire-pump and driver unit.
2. Base: Fabricated and attached to fire-pump and driver unit with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.
3. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

B. End-Suction Fire Pumps
   1. Pump:
      a. Standard: UL 448, for end-suction pumps for fire service.
      b. Casing: Radially split case, cast iron with ASME B16.1 pipe-flange connections.
      c. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
      d. Wear Rings: Replaceable bronze.
      e. Shaft and Sleeve: Steel shaft with bronze sleeve.
         1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
         2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
      f. Mounting: Pump and driver shafts are horizontal, with pump and driver on same base.
   2. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
   3. Driver:
      a. Standard: UL 1004A.
      b. Type: Electric motor; NEMA MG 1, polyphase Design B.

C. In-Line Fire Pumps
   1. Pump:
      a. Standard: UL 448, for in-line pumps for fire service.
      b. Casing: Radially split case, cast iron with ASME B16.1 pipe-flange connections.
      c. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
      d. Wear Rings: Replaceable bronze.
      e. Shaft and Sleeve: Steel shaft with bronze sleeve.
         1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
         2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
      f. Mounting: Pump and driver shaft is vertical, with motor above pump and pump on base.
   2. Coupling: None or rigid.
   3. Driver:
      a. Standard: UL 1004A.
      b. Type: Electric motor; NEMA MG 1, polyphase Design B.

D. Horizontally Mounted, Single-Stage, Split-Case Fire Pumps
   1. Pump:
      a. Standard: UL 448, for split-case pumps for fire service.
      b. Casing: Axially split case, cast iron with ASME B16.1 pipe-flange connections.
      c. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
      d. Wear Rings: Replaceable bronze.
      e. Shaft and Sleeve: Steel shaft with bronze sleeve.
         1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
         2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
      f. Mounting: Pump and driver shafts are horizontal, with pump and driver on same base.
   2. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
   3. Driver:
      a. Standard: UL 1004A.
      b. Type: Electric motor; NEMA MG 1, polyphase Design B.

E. Horizontally Mounted, Multistage, Split-Case Fire Pumps
1. Pump:
a. Standard: UL 448, for split-case pumps for fire service.
b. Number of Stages: Two.
c. Casing: Axially split case, cast iron with ASME B16.1 pipe-flange connections.
d. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
e. Wear Rings: Replaceable bronze.
f. Shaft and Sleeve: Steel shaft with bronze sleeve.
1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
g. Mounting: Pump and driver shafts are horizontal, with pump and driver on same base.
2. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
3. Driver:
a. Standard: UL 1004A.
b. Type: Electric motor; NEMA MG 1, polyphase Design B.

F. Vertically Mounted, Single-Stage, Split-Case Fire Pumps
1. Pump:
a. Standard: UL 448, for split-case pumps for fire service.
b. Casing: Axially split case, cast iron with ASME B16.1 pipe-flange connections.
c. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
d. Wear Rings: Replaceable bronze.
e. Shaft and Sleeve: Steel shaft with bronze sleeve.
1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
f. Mounting: Pump and driver shafts are vertical, with motor above pump and pump on base.
2. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
3. Driver:
a. Standard: UL 1004A.
b. Type: Electric motor; NEMA MG 1, polyphase Design B.

G. Fire-Pump Accessories And Specialties
1. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump casing.
2. Circulation Relief Valves: UL 1478, brass, spring loaded; for installation in pump discharge piping.
3. Relief Valves:
a. Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.
4. Inlet Fitting: Eccentric tapered reducer at pump suction inlet.
5. Outlet Fitting: Concentric tapered reducer at pump discharge outlet.
6. Discharge Cone: Closed **OR** Open, **as directed**, type.
7. Hose Valve Manifold Assembly:
a. Standard: Comply with requirements in NFPA 20.
b. Header Pipe: ASTM A 53/A 53M, Schedule 40, galvanized steel with ends threaded according to ASME B1.20.1.
c. Header Pipe Fittings: ASME B16.4, galvanized cast-iron threaded fittings.
d. Automatic Drain Valve: UL 1726.
e. Manifold:
1) Test Connections: Comply with UL 405 except provide outlets without clappers instead of inlets.
2) Body: Flush type, brass or ductile iron, with number of outlets required by NFPA 20.

3) Nipples: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with ends threaded according to ASME B1.20.1.
4) Adapters and Caps with Chain: Brass or bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
5) Escutcheon Plate: Brass or bronze; rectangular.
6) Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
7) Exposed Parts Finish: Polished **OR** Rough, **as directed**, brass, chrome plated, **as directed**.
8) Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

OR

Manifold:

1) Test Connections: Comply with UL 405 except provide outlets without clappers instead of inlets.
2) Body: Exposed type, brass, with number of outlets required by NFPA 20.
3) Escutcheon Plate: Brass or bronze; round.
4) Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads. Include caps and chains.
5) Exposed Parts Finish: Polished **OR** Rough, **as directed**, brass, chrome plated, **as directed**.
6) Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

H. Flowmeter Systems
1. Description: UL-listed or FM-Approved, fire-pump flowmeter system with capability to indicate flow to not less than 175 percent of fire-pump rated capacity.
2. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 250 psig (1725 kPa), **as directed**.
3. Sensor: Annubar probe, orifice plate, or venturi unless otherwise indicated. Sensor size shall match pipe, tubing, flowmeter, and fittings.
4. Permanently Mounted Flowmeter: Compatible with flow sensor; with dial not less than 4-1/2 inches (115 mm) in diameter. Include bracket or device for wall mounting.
   a. Tubing Package: NPS 1/8 or NPS 1/4 (DN 6 or DN 10) soft copper **OR** plastic, **as directed**, tubing with copper or brass fittings and valves.

   OR

   Portable Flowmeter: Compatible with flow sensor; with dial not less than 4-1/2 inches (115 mm) in diameter and with two 12-foot- (3.7-m-) long hoses in carrying case.

I. Grout
1. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
2. Characteristics: Nonshrink and recommended for interior and exterior applications.
3. Design Mix: 5000-psi (34-MPa), 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

J. Source Quality Control
1. Testing: Test and inspect fire pumps according to UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."
   a. Verification of Performance: Rate fire pumps according to UL 448.
2. Fire pumps will be considered defective if they do not pass tests and inspections.
3. Prepare test and inspection reports.

1.3 EXECUTION

A. Installation

1. Fire-Pump Installation Standard: Comply with NFPA 20 for installation of fire pumps, relief valves, and related components.
2. Equipment Mounting: Install fire pumps on concrete bases. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-place Concrete".
   a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   d. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install fire-pump suction and discharge piping equal to or larger than sizes required by NFPA 20.
4. Support piping and pumps separately so weight of piping does not rest on pumps.
5. Install valves that are same size as connecting piping. Comply with requirements for fire-protection valves specified in Division 21 Section(s) "Fire-suppression Standpipes" OR "Wet-pipe Sprinkler Systems", **as directed**.
6. Install pressure gages on fire-pump suction and discharge flange pressure-gage tappings. Comply with requirements for pressure gages specified in Division 21 Section(s) "Fire-suppression Standpipes" OR "Wet-pipe Sprinkler Systems", **as directed**.
7. Install piping hangers and supports, anchors, valves, gages, and equipment supports according to NFPA 20.
8. Install flowmeters and sensors. Install flowmeter-system components and make connections according to NFPA 20 and manufacturer's written instructions.
9. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.
10. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

B. Alignment
1. Align end-suction and split-case pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.
2. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.
3. Align piping connections.
4. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.

C. Connections
1. Comply with requirements for piping and valves specified in Division 21 Section(s) "Fire-suppression Standpipes" OR "Wet-pipe Sprinkler Systems", **as directed**. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to pumps and equipment to allow service and maintenance.
3. Connect relief-valve discharge to drainage piping or point of discharge.
4. Connect flowmeter-system meters, sensors, and valves to tubing.
5. Connect fire pumps to their controllers.

D. Identification
1. Identify system components. Comply with requirements for fire-pump marking according to NFPA 20.

E. Field Quality Control
1. Test each fire pump with its controller as a unit. Comply with requirements for electric-motor-driver fire-pump controllers specified in Division 21 Section(s) "Electric-drive, Centrifugal Fire Pumps" OR "Diesel-drive, Centrifugal Fire Pumps" OR "Electric-drive, Vertical-turbine Fire Pumps" OR "Diesel-drive, Vertical-turbine Fire Pumps".

2. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
3. Perform tests and inspections.
    a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
4. Tests and Inspections:
    a. After installing components, assemblies, and equipment including controller, test for compliance with requirements.
    b. Test according to NFPA 20 for acceptance and performance testing.
    c. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
    d. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
    e. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.
6. Prepare test and inspection reports.
7. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to the Owner.

F. Demonstration
1. Train the Owner's maintenance personnel to adjust, operate, and maintain fire pumps.

END OF SECTION 21 30 00 00

SECTION 21 30 00 00a - DIESEL-DRIVE, CENTRIFUGAL FIRE PUMPS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for diesel-drive, centrifugal fire pumps. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. End-suction and Split-case fire pumps.
      b. Fire-pump accessories and specialties.
      c. Flowmeter systems.

C. Performance Requirements
   1. Seismic Performance: Fire pumps shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   2. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig (1200 kPa) minimum unless higher pressure rating is indicated.

D. Submittals
   1. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, performance curves, electrical characteristics, and furnished specialties and accessories.
   2. Shop Drawings: For fire pumps, engine drivers, and fire-pump accessories and specialties. Include plans, elevations, sections, details, and attachments to other work.
      a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      b. Wiring Diagrams: For power, signal, and control wiring.
   3. Seismic Qualification Certificates: For fire pumps, accessories, and components, from manufacturer.
      a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
      c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
   4. Product Certificates: For each fire pump, from manufacturer.
   5. Source quality-control reports.
   6. Field quality-control reports.
   7. Operation and maintenance data.

E. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. NFPA Compliance: Comply with NFPA 20, "Installation of Stationary Pumps for Fire Protection."

1.2 PRODUCTS

A. General Requirements For Centrifugal Fire Pumps
1. Description: Factory-assembled and -tested fire-pump and driver unit.
2. Base: Fabricated and attached to fire-pump and driver unit with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.
3. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

B. End-Suction Fire Pumps
1. Pump:
a. Standard: UL 448, for end-suction pumps for fire service.
b. Casing: Radially split case, cast iron with ASME B16.1 pipe-flange connections.
c. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
d. Wear Rings: Replaceable bronze.
e. Shaft and Sleeve: Steel shaft with bronze sleeve.
1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
f. Mounting: Pump and driver shafts are horizontal, with pump and driver on same base.
2. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
3. Driver:
a. Standard: UL 1247.
b. Type: Diesel engine.
c. Emergency Manual Operator: Factory wired for starting and operating standby engine in case of malfunction in main controller or wiring.
d. Engine Cooling System: Factory-installed radiator.
1) Coolant: Type recommended by driver manufacturer.
OR
Engine Cooling System: Factory-installed water piping, valves, strainer, pressure regulator, heat exchanger, coolant pump, bypass piping, and fittings.
1) Piping: ASTM B 88, Type L (ASTM B 88M, Type B), copper water tube; ASME B16.22, wrought-copper, solder-joint pressure fittings; AWS A5.8/A5.8M, BCuP Series brazing filler metal; and brazed joints.
e. Engine-Jacket Water Heater: Factory-installed electric elements.
f. Dual Batteries: Lead-acid-storage type with 100 percent standby reserve capacity.
g. Fuel System: Comply with NFPA 20.
1) Fuel Storage Tank: Size indicated but not less than required by NFPA 20. Include floor legs, direct-reading level gage, and secondary containment tank with capacity at least equal to fuel storage tank.
h. Exhaust System: ASTM A 53/A 53M, Type E or S, Schedule 40, black steel pipe; ASME B16.9, weld-type pipe fittings; ASME B16.5, steel flanges; and ASME B16.21, nonmetallic gaskets. Fabricate double-wall, ventilated thimble from steel pipe.
1) Exhaust Connector: Flexible type.
2) Exhaust Silencer: Industrial **OR** Residential, **as directed**, type.

C. Single-Stage, Split-Case Fire Pumps
1. Pump:
a. Standard: UL 448, for split-case pumps for fire service.
b. Casing: Axially split case, cast iron with ASME B16.1 pipe-flange connections.
c. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
d. Wear Rings: Replaceable bronze.
e. Shaft and Sleeve: Steel shaft with bronze sleeve.
1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
f. Mounting: Pump and driver shafts are horizontal, with pump and driver on same base.

2. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
3. Driver:
   a. Standard: UL 1247.
   b. Type: Diesel engine.
   c. Emergency Manual Operator: Factory wired for starting and operating standby engine in case of malfunction in main controller or wiring.
   d. Engine Cooling System: Factory-installed radiator.
      1) Coolant: Type recommended by driver manufacturer.

      OR

      Engine Cooling System: Factory-installed water piping, valves, strainer, pressure regulator, heat exchanger, coolant pump, bypass piping, and fittings.
      1) Piping: ASTM B 88, Type L (ASTM B 88M, Type B), copper water tube; ASME B16.22, wrought-copper, solder-joint pressure fittings; AWS A5.8/A5.8M, BCuP Series brazing filler metal; and brazed joints.
   e. Engine-Jacket Water Heater: Factory-installed electric elements.
   f. Dual Batteries: Lead-acid-storage type with 100 percent standby reserve capacity.
   g. Fuel System: Comply with NFPA 20.
      1) Fuel Storage Tank: Size indicated but not less than required by NFPA 20. Include floor legs, direct-reading level gage, and secondary containment tank with capacity at least equal to fuel storage tank.
   h. Exhaust System: ASTM A 53/A 53M, Type E or S, Schedule 40, black steel pipe; ASME B16.9, weld-type pipe fittings; ASME B16.5, steel flanges; and ASME B16.21, nonmetallic gaskets. Fabricate double-wall, ventilated thimble from steel pipe.
      1) Exhaust Connector: Flexible type.
      2) Exhaust Silencer: Industrial **OR** Residential, **as directed**, type.

D. Multistage, Split-Case Fire Pumps
1. Pump:
   a. Standard: UL 448, for split-case pumps for fire service.
   b. Number Stages: Two.
   c. Casing: Axially split case, cast iron with ASME B16.1 pipe-flange connections.
   d. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
   e. Wear Rings: Replaceable bronze.
   f. Shaft and Sleeve: Steel shaft with bronze sleeve.
      1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
      2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
   g. Mounting: Pump and driver shafts are horizontal, with pump and driver on same base.
2. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
3. Driver:
   a. Standard: UL 1247.
   b. Type: Diesel engine.
   c. Emergency Manual Operator: Factory wired for starting and operating standby engine in case of malfunction in main controller or wiring.
   d. Engine Cooling System: Factory-installed radiator.
      1) Coolant: Type recommended by driver manufacturer.

      OR

      Engine Cooling System: Factory-installed water piping, valves, strainer, pressure regulator, heat exchanger, coolant pump, bypass piping, and fittings.
      1) Piping: ASTM B 88, Type L (ASTM B 88M, Type B), copper water tube; ASME B16.22, wrought-copper, solder-joint pressure fittings; AWS A5.8/A5.8M, BCuP Series brazing filler metal; and brazed joints.
   e. Engine-Jacket Water Heater: Factory-installed electric elements.
   f. Dual Batteries: Lead-acid-storage type with 100 percent standby reserve capacity.

g. Fuel System: Comply with NFPA 20.
   1) Fuel Storage Tank: Size indicated but not less than required by NFPA 20. Include floor legs, direct-reading level gage, and secondary containment tank with capacity at least equal to fuel storage tank.

h. Exhaust System: ASTM A 53/A 53M, Type E or S, Schedule 40, black steel pipe; ASME B16.9, weld-type pipe fittings; ASME B16.5, steel flanges; and ASME B16.21, nonmetallic gaskets. Fabricate double-wall, ventilated thimble from steel pipe.
   1) Exhaust Connector: Flexible type.
   2) Exhaust Silencer: Industrial **OR** Residential, **as directed**, type.

E. Fire-Pump Accessories And Specialties
1. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump casing.
2. Circulation Relief Valves: UL 1478, brass, spring loaded; for installation in pump discharge piping.
3. Relief Valves:
   a. Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.
4. Inlet Fitting: Eccentric tapered reducer at pump suction inlet.
5. Outlet Fitting: Concentric tapered reducer at pump discharge outlet.
6. Discharge Cone: Closed **OR** Open, **as directed**, type.
7. Hose Valve Manifold Assembly:
   a. Standard: Comply with requirements in NFPA 20.
   b. Header Pipe: ASTM A 53/A 53M, Schedule 40, galvanized steel with ends threaded according to ASME B1.20.1.
   c. Header Pipe Fittings: ASME B16.4, galvanized cast-iron threaded fittings.
   d. Automatic Drain Valve: UL 1726.
   e. Manifold:
      1) Test Connections: Comply with UL 405 except provide outlets without clappers instead of inlets.
      2) Body: Flush type, brass or ductile iron, with number of outlets required by NFPA 20.
      3) Nipples: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with ends threaded according to ASME B1.20.1.
      4) Adapters and Caps with Chain: Brass or bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
      5) Escutcheon Plate: Brass or bronze; rectangular.
      6) Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
      7) Exposed Parts Finish: Polished **OR** Rough, **as directed**, brass, **as directed**, chrome plated, **as directed**.
      8) Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

      OR

      Manifold:
      1) Test Connections: Comply with UL 405 except provide outlets without clappers instead of inlets.
      2) Body: Exposed type, brass, with number of outlets required by NFPA 20.
      3) Escutcheon Plate: Brass or bronze; round.
      4) Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads. Include caps and chains.
      5) Exposed Parts Finish: Polished **OR** Rough, **as directed**, brass, **as directed**, chrome plated, **as directed**.
      6) Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

F. Flowmeter Systems
1. Description: UL-listed or FM-Approved, fire-pump flowmeter system with capability to indicate flow to not less than 175 percent of fire-pump rated capacity.

2. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 250 psig (1725 kPa), **as directed**.
3. Sensor: Annubar probe, orifice plate, or venturi unless otherwise indicated. Sensor size shall match pipe, tubing, flowmeter, and fittings.
4. Permanently Mounted Flowmeter: Compatible with flow sensor; with dial not less than 4-1/2 inches (115 mm) in diameter. Include bracket or device for wall mounting.
   a. Tubing Package: NPS 1/8 or NPS 1/4 (DN 6 or DN 10) soft copper **OR** plastic, **as directed**, tubing with copper or brass fittings and valves.

   OR

   Portable Flowmeter: Compatible with flow sensor; with dial not less than 4-1/2 inches (115 mm) in diameter and with two 12-foot- (3.7-m-) long hoses in carrying case.

G. Grout
1. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
2. Characteristics: Nonshrink and recommended for interior and exterior applications.
3. Design Mix: 5000-psi (34-MPa), 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

H. Source Quality Control
1. Testing: Test and inspect fire pumps according to UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."
   a. Verification of Performance: Rate fire pumps according to UL 448.
2. Fire pumps will be considered defective if they do not pass tests and inspections.
3. Prepare test and inspection reports.

1.3 EXECUTION

A. Installation
1. Fire-Pump Installation Standard: Comply with NFPA 20 for installation of fire pumps, relief valves, and related components.
2. Equipment Mounting: Install fire pumps on concrete bases. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-place Concrete".
   a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   d. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install fire-pump suction and discharge piping equal to or larger than sizes required by NFPA 20.
4. Support piping and pumps separately so weight of piping does not rest on pumps.
5. Install valves that are same size as connecting piping. Comply with requirements for fire-protection valves specified in Division 21 Section(s) "Fire-suppression Standpipes" OR "Wet-pipe Sprinkler Systems", **as directed**.
6. Install pressure gages on fire-pump suction and discharge flange pressure-gage tappings. Comply with requirements for pressure gages specified in Division 21 Section(s) "Fire-suppression Standpipes" OR "Wet-pipe Sprinkler Systems", **as directed**.
7. Install piping hangers and supports, anchors, valves, gages, and equipment supports according to NFPA 20.
8. Install fuel system according to NFPA 20.
9. Install water supply and drain piping for diesel-engine heat exchangers. Extend drain piping from heat exchangers to point of disposal.
10. Install exhaust-system piping for diesel engines. Extend to point of termination outside structure. Install pipe and fittings with welded joints; install components having flanged connections with gasketed joints.

11. Install condensate-drain piping for diesel-engine exhaust system. Extend drain piping from low points of exhaust system to condensate traps and to point of disposal.
12. Install flowmeters and sensors. Install flowmeter-system components and make connections according to NFPA 20 and manufacturer's written instructions.
13. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.
14. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

B. Alignment
1. Align end-suction and split-case pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.
2. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.
3. Align piping connections.
4. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.

C. Connections
1. Comply with requirements for piping and valves specified in Division 21 Section(s) "Fire-suppression Standpipes" OR "Wet-pipe Sprinkler Systems", **as directed**. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to pumps and equipment to allow service and maintenance.
3. Connect relief-valve discharge to drainage piping or point of discharge.
4. Connect flowmeter-system meters, sensors, and valves to tubing.
5. Connect fire pumps to their controllers.

D. Identification
1. Identify system components. Comply with requirements for fire-pump marking according to NFPA 20.

E. Field Quality Control
1. Test each fire pump with its controller as a unit. Comply with requirements for diesel-engine-driver fire-pump controllers specified in Division 21 Section(s) "Electric-drive, Centrifugal Fire Pumps" OR "Diesel-drive, Centrifugal Fire Pumps" OR "Electric-drive, Vertical-turbine Fire Pumps" OR "Diesel-drive, Vertical-turbine Fire Pumps".
2. Perform tests and inspections.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
3. Tests and Inspections:
   a. After installing components, assemblies, and equipment including controller, test for compliance with requirements.
   b. Test according to NFPA 20 for acceptance and performance testing.
   c. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   d. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   e. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.
5. Prepare test and inspection reports.

6. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to the Owner.

F. Startup Service
   1. Perform startup service.
      a. Complete installation and startup checks according to manufacturer's written instructions.

G. Demonstration
   1. Train the Owner's maintenance personnel to adjust, operate, and maintain fire pumps.

END OF SECTION 21 30 00 00a

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SECTION 21 31 13 00 - PRESSURE-MAINTENANCE PUMPS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for pressure-maintenance pumps. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Multistage, pressure-maintenance pumps.
      b. Regenerative-turbine, pressure-maintenance pumps.
      c. Submersible, pressure-maintenance pumps.
      d. Vertical-turbine, pressure-maintenance pumps.

C. Performance Requirements
   1. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig (1200 kPa) minimum unless higher pressure rating is indicated.

D. Submittals
   1. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, performance curves, electrical characteristics, and furnished specialties and accessories.
   2. Shop Drawings: For pumps, accessories, and specialties. Include plans, elevations, sections, details, and attachments to other work.
      a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      b. Wiring Diagrams: For power, signal, and control wiring.
   3. Field quality-control reports.
   4. Operation and maintenance data.

E. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.2 PRODUCTS

A. Multistage, Pressure-Maintenance Pumps
   1. Description: Factory-assembled and -tested, multistage, barrel-type vertical pump as defined in HI 2.1-2.2 and HI 2.3; designed for surface installation with pump and motor direct coupled and mounted vertically.
   2. Pump Construction:
      a. Barrel: Stainless steel.
      b. Suction and Discharge Chamber: Cast iron with flanged inlet and outlet.
      c. Pump Head/Motor Mount: Cast iron.
      d. Impellers: Stainless steel, balanced, and keyed to shaft.
      e. Pump Shaft: Stainless steel.
      f. Seal: Mechanical type with carbon rotating face and silicon-carbide stationary seat.
      g. Intermediate Chamber Bearings: Aluminum-oxide ceramic or bronze.
      h. Chamber-Base Bearing: Tungsten carbide.
      i. O-Rings: EPDM or NBR.

3. Motor: Single speed with permanently lubricated ball bearings and rigidly mounted to pump head. Comply with requirements in Division 15 Section "Common Motor Requirements for Fire Suppression Equipment."
   a. Power Cord: Factory-connected to motor for field connection to controller and at least 10 feet (3 m) long.
4. Nameplate: Permanently attached to pump and indicating capacity and characteristics.

B. Regenerative-Turbine, Pressure-Maintenance Pumps
1. Description: Factory-assembled and -tested, close-coupled, single-stage, regenerative-turbine centrifugal pump as defined in HI 1.1-1.2 and HI 1.3; with pump and motor mounted horizontally.
2. Pump Construction:
   a. Casing: Radially split, cast iron, with threaded inlet and outlet.
   b. Impeller: Bronze, balanced, and keyed to shaft.
   c. Pump Shaft: Stainless steel **OR** steel, **as directed**, with deflector.
   d. Shaft Sleeve: Bronze.
   e. Seal: Mechanical type with spring-loaded rotating head.
3. Motor: Single speed with permanently lubricated ball bearings. Comply with requirements in Division 15 Section "Common Motor Requirements for Fire Suppression Equipment."
   a. Power Cord: Factory-connected to motor for field connection to controller and at least 10 feet (3 m) long.
4. Nameplate: Permanently attached to pump and indicating capacity and characteristics.

C. Submersible, Pressure-Maintenance Pumps
1. Description: Factory-assembled and -tested, vertical, multistage, submersible pump as defined in HI 2.1-2.2 and HI 2.3; with pump motor mounted below pump.
2. Pump Construction:
   a. Pump Head or Elbow: Cast iron, for surface discharge, with flanged or threaded connections.
   b. Pump Shaft: Stainless steel.
   c. Bearings: Bronze.
   d. Bowl Section: Multiple cast-iron bowls with closed-type bronze or stainless-steel impellers.
   e. Column Pipe: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with threaded ends and cast-iron or steel fittings, in sections 10 feet (3 m) or less, with strainer of cast or fabricated bronze or stainless steel between pump and bowl section.
3. Motor: Single speed with permanently lubricated ball bearings and capable of continuous operation under water. Comply with requirements in Division 15 Section "Common Motor Requirements for Fire Suppression Equipment."
   a. Power Cord: Capable of continuous under-water operation, factory-connected to motor for field connection to controller, and at least 10 feet (3 m) long.
4. Base: Cast iron or steel with hole for electrical cable.
5. Nameplate: Permanently attached to pump and indicating capacity and characteristics.

D. Vertical-Turbine, Pressure-Maintenance Pumps
1. Description: Factory-assembled and -tested, vertical, multistage, open-line-shaft turbine pump as defined in HI 2.1-2.2 and HI 2.3; with pump motor mounted above pump head.
2. Pump Construction:
   a. Pump Head: Cast iron, for surface discharge, with flange except connections may be threaded in sizes in which flanges are not available.
   b. Pump Head Seal: Stuffing box and stuffing.
   c. For static water levels of 50 feet (15 m) or less and for water-lubricated bearings.
      1) Line Shaft: Stainless steel or steel, with corrosion-resistant shaft sleeves.
      2) Line Shaft Bearings: Rubber sleeve, water lubricated.
   d. For static water levels between 50 and 200 feet (15 and 61 m) and for oil-lubricated bearings.
      1) Line Shaft: Steel.

2) Line Shaft Bearings: Corrosion resistant, oil lubricated.
e. Impeller Shaft: Monel metal or stainless steel.
f. Bowl Section: Multiple cast-iron bowls with closed-type bronze or stainless-steel impellers.
g. Column Pipe: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with threaded ends and cast-iron or steel fittings, in sections 10 feet (3 m) or less, with strainer of cast or fabricated bronze or stainless steel at bottom.
3. Motor: Single speed with permanently lubricated ball bearings. Comply with requirements in Division 15 Section "Common Motor Requirements for Fire Suppression Equipment."
a. Power Cord: Factory-connected to motor for field connection to controller and at least 10 feet (3 m) long.
4. Base: Cast iron or steel with hole for electrical cable.
5. Nameplate: Permanently attached to pump and indicating capacity and characteristics.

E. Motors
1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 15 Section "Common Motor Requirements for Fire Suppression Equipment."
a. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
b. Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 16 Sections.

1.3 EXECUTION

A. Equipment Installation
1. NFPA Standard: Comply with NFPA 20 for installation of pressure-maintenance pumps.
2. Base-Mounted Pump Mounting: Install pumps on concrete bases. Comply with requirements for concrete bases specified in Division 3 Section "Cast-in-Place Concrete."
a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
d. Install anchor bolts to elevations required for proper attachment to supported equipment.
e. Attach pumps to equipment base using anchor bolts.
3. Install multistage and regenerative-turbine, pressure-maintenance pumps according to HI 1.4.
4. Install submersible and vertical-turbine, pressure-maintenance pumps according to HI 2.4.

B. Field Quality Control
1. Perform tests and inspections.
a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Tests and Inspections:
a. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Pressure-maintenance pumps will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

C. Adjusting
1. Lubricate pumps as recommended by manufacturer.

2. Set field-adjustable pressure-switch ranges as indicated.

END OF SECTION 21 31 13 00

SECTION 21 31 13 00a - CONTROLLERS FOR FIRE-PUMP DRIVERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for controllers for fire-pump drivers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Full-service, full-voltage **OR** reduced-voltage, **as directed**, controllers rated 600 V and less.
b. Limited-service controllers rated 600 V and less.
c. Controllers for diesel-drive fire pumps.
d. Remote alarm panels.
e. Low-suction-shutdown panels.

C. Definitions
1. ATS: Automatic transfer switch(es).
2. ECM: Electronic control module.
3. MCCB: Molded-case circuit breaker.
4. N.O.: Normally open.

D. Performance Requirements
1. Seismic Performance: Fire-pump controllers and alarm panels shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

E. Submittals
1. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Shop Drawings: For each type of product indicated. Include dimensioned plans, elevations, sections, details, and attachments to other work, including required clearances and service spaces around controller enclosures.
a. Show tabulations of the following:
1) Each installed unit's type and details.
2) Enclosure types and details for types other than NEMA 250, Type 2.
3) Factory-installed devices.
4) Nameplate legends.
5) Short-circuit current (withstand) rating of integrated unit.
6) Features, characteristics, ratings, and factory settings of individual overcurrent protective devices.
7) Specified modifications.
b. Detail equipment assemblies and indicate dimensions, weights, loads, method of field assembly, components, and location and size of each field connection.
c. Schematic and Connection Diagrams: For power, signal, alarm, and control wiring and for pressure-sensing tubing.
3. Qualification Data: For qualified testing agency.
4. Seismic Qualification Certificates: For each type of product indicated, from manufacturer.

a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
5. Product Certificates: For each type of product indicated, from manufacturer.
6. Manufacturer's factory test reports of fully assembled and tested equipment.
7. Source quality-control reports.
8. Field quality-control reports.
9. Operation and Maintenance Data: For each type of product indicated to include in emergency, operation, and maintenance manuals. Include the following:
   a. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
   b. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor-based logic controls.

F. Quality Assurance
1. Testing Agency Qualifications: Member company of an NRTL.
2. Source Limitations: Obtain fire-pump controllers and all associated equipment from single source or producer.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Comply with standards of authorities having jurisdiction pertaining to materials and installation.
5. Comply with NFPA 20 and NFPA 70.
6. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Division 16 Section "Vibration and Seismic Controls for Electrical Systems."

G. Delivery, Storage, And Handling
1. Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
2. If stored in areas subject to weather, protect controllers from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install temporary electric heating, with at least 250 W per controller **OR** connect factory-installed space heaters to temporary electrical service, **as directed**.

H. Project Conditions
1. Environmental Limitations:
   a. Ambient Temperature Rating: Not less than 40 deg F (5 deg C) and not exceeding 122 deg F (50 deg C) unless otherwise indicated.
   b. Altitude Rating: Not exceeding 6600 feet (2010 m) unless otherwise indicated.
2. Interruption of Existing Electric Service: Notify the Owner no fewer than seven days in advance of proposed interruption of electric service, and comply with NFPA 70E.

I. Coordination
1. Coordinate layout and installation of controllers with other construction including conduit, piping, fire-pump equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels. Ensure that controllers are within sight of fire-pump drivers.
2. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.2 PRODUCTS

A. Full-Service Controllers
1. General Requirements for Full-Service Controllers:
a. Comply with NFPA 20 and UL 218.
b. Listed by an NRTL for electric-motor driver for fire-pump service.
c. Combined automatic and nonautomatic **OR** Nonautomatic, **as directed**, operation.
d. Factory assembled, wired, and tested; continuous-duty rated.
e. Service Equipment Label: NRTL labeled for use as service equipment.
2. Method of Starting:
a. Pressure **OR** Nonpressure, **as directed**,-switch actuated.
1) Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
2) System pressure recorder, electric ac driven, with spring backup.
3) Programmable minimum-run-time relay to prevent short cycling.
4) Programmable timer for weekly tests.
b. Magnetic Controller: Across-the-line **OR** Autotransformer **OR** Part-winding **OR** Primary-resistor **OR** Wye-delta (open transition) **OR** Wye-delta (closed transition), **as directed**, type.
OR
Solid-State Controller: Reduced-voltage type.
c. Emergency Start: Mechanically operated start handle that closes and retains the motor RUN contactor independent of all electric or pressure actuators.
3. Method of Stopping: Automatic and nonautomatic shutdown after automatic starting **OR** Nonautomatic, **as directed**.
4. Capacity: Rated for fire-pump-driver horsepower and short-circuit-current (withstand) rating equal to or greater than short-circuit current available at controller location.
5. Method of Isolation and Overcurrent Protection: Interlocked isolating switch and nonthermal MCCB; with a common, externally mounted operating handle, and providing locked-rotor protection.
6. Door-Mounted Operator Interface and Controls:
a. Monitor, display, and control the devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
b. Method of Control and Indication:
1) Microprocessor-based logic controller, with multiline digital readout.
2) Membrane keypad.
3) LED alarm and status indicating lights.
c. Local and Remote, **as directed**, Alarm and Status Indications:
1) Controller power on.
2) Motor running condition.
3) Loss-of-line power.
4) Line-power phase reversal.
5) Line-power single-phase condition.
d. Audible alarm, with silence push button.
e. Nonautomatic START and STOP push buttons or switches.
7. Optional Features:
a. Extra Output Contacts:
1) One N.O. contact(s) for motor running condition.
2) One set(s) of contacts for loss-of-line power.
3) One each, Form C contacts for high and low reservoir level.
b. Local alarm bell.
c. Door-mounted thermal or impact printer for alarm and status logs.
d. Operator Interface Communications Ports: USB, Ethernet, and RS485.
8. ATS:
a. Complies with NFPA 20, UL 218, and UL 1008.

b. Integral with controller as a listed combination fire-pump controller and power transfer switch.
c. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.
d. Allows manual transfer from one source to the other.
e. Alternate-Source Isolating and Disconnecting Means: Integral molded-case switch, with an externally mounted operating handle.
OR
Alternate-Source Isolating and Disconnecting Means: Mechanically interlocked isolation switch and circuit breaker rated at a minimum of 115 percent of rated motor full-load current, with an externally mounted operating handle; circuit breaker shall be provided with nonthermal sensing, instantaneous-only short-circuit overcurrent protection to comply with available fault currents.
f. Local and Remote, **as directed**, Alarm and Status Indications:
1) Normal source available.
2) Alternate source available.
3) In normal position.
4) In alternate position.
5) Isolating means open.
g. Audible alarm, with silence push button.
h. Nonautomatic (manual, nonelectric) means of transfer.
i. Engine test push button.
j. Start generator output contacts.
k. Timer for weekly generator tests.

B. Limited-Service Controllers
1. General Requirements for Limited-Service Controllers:
a. Comply with NFPA 20 and UL 218.
b. Listed by an NRTL for electric-motor driver for fire-pump service.
c. Combined automatic and nonautomatic **OR** Nonautomatic, **as directed**, operation.
d. Factory assembled, wired, and tested; continuous-duty rated.
e. Service Equipment Label: NRTL labeled for use as service equipment.
2. Method of Starting:
a. Pressure **OR** Nonpressure, **as directed**,-switch actuated.
1) Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
2) System pressure recorder, electric ac driven, with spring backup.
3) Programmable minimum-run-time relay to prevent short cycling.
4) Programmable timer for weekly tests.
b. Across-the-line magnetic controller.
c. Emergency Start: Mechanically operated start handle that closes and retains the motor RUN contactor independent of all electric or pressure actuators.
3. Method of Stopping: Automatic and nonautomatic shutdown after automatic starting **OR** Nonautomatic, **as directed**.
4. Capacity: Rated for fire-pump-driver horsepower and short-circuit-current (withstand) rating equal to or greater than short-circuit current available at controller location.
5. Method of Isolation and Overcurrent Protection: Inverse-time, nonadjustable MCCB, with an externally mounted operating handle.
6. Door-Mounted Operator Interface and Controls:
a. Monitor, display, and control the devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
b. Method of Control and Indication:
1) Microprocessor-based logic controller, with multiline LCD digital readout.
2) Membrane keypad.

3) LED alarm and status indicating lights.

c. Local and Remote, **as directed** Alarm and Status Indications:

1) Controller power on.

2) Motor running condition.

3) Loss-of-line power.

4) Line-power phase reversal.

5) Line-power single-phase condition.

d. Audible alarm, with silence push button.

e. Nonautomatic START and STOP push buttons.

7. Optional Features:

a. Extra Output Contacts:

1) One N.O. contact(s) for motor running condition.

2) One set(s) of contacts for loss-of-line power.

3) One each, Form C contacts for high and low reservoir level.

b. Local alarm bell.

c. Door-mounted thermal or impact printer for alarm and status logs.

d. Operator Interface Communications Ports: USB, Ethernet, and RS485.

8. ATS:

a. Complies with NFPA 20, UL 218, and UL 1008.

b. Integral with controller as a listed combination fire-pump controller and power transfer switch.

c. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.

d. Allows manual transfer from one source to the other.

e. Alternate-Source Isolating and Disconnecting Means: Integral molded-case switch, with an externally mounted operating handle.

OR

Alternate-Source Isolating and Disconnecting Means: Mechanically interlocked isolation switch and circuit breaker rated at a minimum of 115 percent of rated motor full-load current, with an externally mounted operating handle; circuit breaker shall be provided with nonthermal sensing, instantaneous-only short-circuit overcurrent protection to comply with available fault currents.

f. Local and Remote, **as directed**, Alarm and Status Indications:

1) Normal source available.

2) Alternate source available.

3) In normal position.

4) In alternate position.

5) Isolating means open.

g. Audible alarm, with silence push button.

h. Nonautomatic (manual, nonelectric) means of transfer.

i. Engine test push button.

j. Start generator output contacts.

k. Timer for weekly generator tests.

C. Standalone ATS

1. General Requirements for Standalone ATS:

a. Complies with NFPA 20, UL 218, and UL 1008.

b. Listed by an NRTL for fire-pump service.

c. Automatic and nonautomatic operation.

d. Separate from controller and individually listed as a fire-pump-controller power transfer switch.

e. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.

f. Allows manual transfer from one source to the other; factory assembled, wired, and tested.

2. Capacity: Rated for fire-pump-driver horsepower and short-circuit-current (withstand) rating equal to or greater than short-circuit current available at ATS location.

3. Alternate-Source Isolating and Disconnecting Means: Integral molded-case switch, with an externally mounted operating handle.
4. Alternate-Source Isolating and Disconnecting Means:
   a. Mechanically interlocked isolation switch and circuit breaker rated at a minimum of 115 percent of rated motor full-load current.
   b. Externally mounted operating handle.
   c. Circuit breaker provided with nonthermal sensing, instantaneous-only, short-circuit overcurrent protection.
   d. Equipped with a voltage surge arrester.
5. Door-Mounted Operator Interface and Controls:
   a. Monitor, display, and control devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
   b. Method of Control and Indication:
      1) Microprocessor-based logic controller, with multiline LCD readout.
      2) Membrane keypad.
      3) LED alarm and status indicating lights.
   c. Local and Remote, **as directed**, Alarm and Status Indications:
      1) Normal source available.
      2) Alternate source available.
      3) In normal position.
      4) In alternate position.
      5) Isolating means open.
   d. Audible alarm, with silence push button.
   e. Nonautomatic (manual, nonelectric) means of transfer.
   f. Engine test push button.
   g. Start generator output contacts.
   h. Timer for weekly generator tests
6. Optional Features:
   a. Extra Output Contacts:
      1) One each, Form A; isolating means open.
      2) One each, Form C; in normal or alternate position
   b. Door-mounted thermal or impact printer for alarm and status logs.
   c. Operator Interface Communications Ports: USB, Ethernet, and RS485.

D. Controllers For Diesel-Drive Fire Pumps
1. General Requirements for Controllers:
   a. Comply with NFPA 20 and UL 218.
   b. Listed by an NRTL for diesel-engine driver for fire-pump service.
   c. Combined automatic and nonautomatic **OR** Nonautomatic, ,**as directed** operation.
   d. Factory assembled, wired, and tested.
2. Method of Starting:
   a. Pressure **OR** Nonpressure, **as directed**,-switch actuated.
      1) Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
      2) System pressure recorder, electric ac driven, with spring backup.
      3) Programmable minimum-run-time relay to prevent short cycling.
      4) Programmable timer for weekly tests.
   b. Dual, redundant dc-voltage battery units, with automatic changeover.
   c. Emergency Control: Bypasses all automatic control circuits during manual starting and running.
   d. Automatic engine start on loss of ac power to the controller.
3. Method of Stopping: Automatic and nonautomatic shutdown after automatic starting **OR** Nonautomatic, **as directed**.
4. Door-Mounted Operator Interface and Controls:

a. Monitor, display, and control devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
b. Method of Control and Indication:
   1) Microprocessor-based logic controller, with multiline LCD readout.
   2) Membrane keypad.
   3) LED alarm and status indicating lights.
c. Local and Remote, **as directed**, Alarm and Status Indications:
   1) Controller power on.
   2) Engine-lubrication-system critically low oil pressure.
   3) Engine-jacket coolant high temperature.
   4) Engine fail-to-start.
   5) Engine overspeed shutdown.
   6) Low fuel level.
   7) Missing or failed battery.
   8) Battery charger failure.
   9) System overpressure.
   10) ECM selector switch in alternate ECM position.
   11) Fuel injector malfunction.
d. Audible alarm.
e. Nonautomatic START and STOP push buttons or switches.

5. Optional Features:
   a. Extra Output Contacts:
      1) One Form C contacts for low pump-room temperature.
      2) One each, Form C contacts for high and low fuel levels.
      3) One each, Form C contacts for high and low reservoir levels.
   b. Door-mounted thermal or impact printer for alarm and status logs.
   c. Operator Interface Communications Ports: USB, Ethernet, and RS485.
   d. Powered louver contacts.
   e. Powered engine-oil heater contacts.
6. Battery Charger System:
   a. Built-in, independent, dual battery chargers with automatic changeover; 12-V dc **OR** 24-V dc, **as directed**, for lead-acid **OR** nickel-cadmium, **as directed**, batteries.
   b. Standard: UL 1236.

E. Remote Alarm Panels
1. General Requirements for Remote Alarm Panels: Comply with NFPA 20 and UL 218; listed by an NRTL for fire-pump service.
2. General Requirements for Remote Alarm Panels: Factory assembled, wired, and tested.
3. Supervisory and Normal Control Voltage: 120-V ac **OR** 240-V ac, **as directed**; single **OR** dual, **as directed**, source.
4. Audible and Visual Alarm and Status Indications:
   a. Driver running.
   b. Loss of phase.
   c. Phase reversal.
   d. Supervised power on.
   e. Common **OR** Separate, **as directed**, trouble on the controller.
   f. Controller connected to alternate power source.
5. Audible and Visual Alarm and Status Indications: Manufacturer's standard indicating lights; push-to-test **OR** non-push-to-test, with separate test push button, **as directed**.
   a. Engine running.
   b. Controller main switch turned to the off or manual position.
   c. Supervised power on.
   d. Common **OR** Separate, **as directed**, trouble on the controller or engine.
   e. Common pump room trouble.
   f. Controller connected to alternate power source.
6. Audible alarm, with silence push button.

7. Pump REMOTE START push button.

F. Low-Suction-Shutdown Panels
   1. General Requirements for Low-Suction-Shutdown Panels:
      a. Listed by an NRTL for fire-pump service.
      b. Factory assembled, wired, and tested.
      c. Prevents automatic start of fire pump, and shuts down automatically started fire pump, on low-suction pressure.
      d. Automatic **OR** Manual, **as directed**, reset.
   2. Operation: External contact input **OR** Integral pressure switch, **as directed**.
   3. Supervisory and Normal Control Voltage: 120-V ac **OR** 240-V ac, **as directed**; single **OR** dual, **as directed**, source.
   4. Include audible and visual alarms and status indications, with silence push button, for the following conditions:
      a. Control power available.
      b. Low-suction pressure.
      c. Normal-suction pressure.

G. Enclosures
   1. Fire-Pump Controllers, ATS, Remote Alarm Panels, and Low-Suction-Shutdown Panels: NEMA 250, to comply with environmental conditions at installed locations and NFPA 20.
      a. Indoor, Dry and Clean Locations: Type 1 (IEC IP10).
      b. Indoor Locations Subject to Dripping Noncorrosive Liquids: Type 2 (IEC IP11).
      c. Outdoor Locations: Type 3R (IEC IP14) **OR** Type 4 (IEC IP56) **OR** Type 4X (IEC IP56), **as directed**.
      d. Other Wet or Damp, Indoor Locations: Type 4 (IEC IP56) **OR** Type 4X (IEC IP56), **as directed**.
      e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12 (IEC IP12).
   2. Enclosure Color: Manufacturer's standard "fire-pump-controller red".
   3. Nameplates: Comply with NFPA 20; complete with capacity, characteristics, approvals, listings, and other pertinent data.
   4. Optional Features:
      a. Floor stands, 12 inches (305 mm) high, for floor-mounted controllers.
      b. Space heater, 120-V ac **OR** 240-V ac, **as directed**, with humidistat, **as directed**, with thermostat, **as directed**.
      c. Tropicalization.

H. Source Quality Control
   1. Testing: Test and inspect fire-pump controllers according to requirements in NFPA 20 and UL 218.
      a. Verification of Performance: Rate controllers according to operation of functions and features specified.
   2. Fire-pump controllers will be considered defective if they do not pass tests and inspections.
   3. Prepare test and inspection reports.

1.3 EXECUTION

A. Examination
   1. Examine areas and surfaces to receive equipment, with Installer present, for compliance with requirements and other conditions affecting performance.
   2. Examine equipment before installation. Reject equipment that is wet or damaged by moisture or mold.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Controller Installation
1. Install controllers within sight of their respective drivers.
2. Connect controllers to their dedicated pressure-sensing lines.
3. Wall-Mounting Controllers: Install controllers on walls with disconnect operating handles not higher than 79 inches (2006 mm) above finished floor, and bottom of enclosure not less than 12 inches (305 mm) above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Division 16 Section "Hangers and Supports for Electrical Systems."
4. Floor-Mounting Controllers: Install controllers on 4-inch (100-mm) nominal-thickness concrete bases, using floor stands high enough so that the bottom of enclosure cabinet is not less than 12 inches (305 mm) above finished floor. Comply with requirements for concrete bases specified in Division 3 Section "Cast-in-Place Concrete."
   a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
   c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   d. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Seismic Bracing: Comply with requirements specified in Division 16 Section "Vibration and Seismic Controls for Electrical Systems."
6. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
7. Comply with NEMA ICS 15.

C. Standalone ATS Installation
1. Wall-Mounting ATS: Install ATS on walls with disconnect operating handles not higher than 79 inches (2006 mm) above finished floor, and bottom of enclosure not less than 12 inches (305 mm) above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For ATS not on walls, provide freestanding racks complying with Division 16 Section "Hangers and Supports for Electrical Systems."
2. Floor-Mounting ATS: Install ATS on 4-inch (100-mm) nominal-thickness concrete bases, using floor stands high enough so that the bottom of enclosure cabinet is not less than 12 inches (305 mm) above finished floor. Comply with requirements for concrete bases specified in Division 3 Section "Cast-in-Place Concrete."
   a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
   c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   d. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Seismic Bracing: Comply with requirements specified in Division 16 Section "Vibration and Seismic Controls for Electrical Systems."
4. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Remote Alarm And Low-Suction-Shutdown, **as directed**, Panel Installation
1. Install panels on walls with tops not higher than 72 inches (1829 mm) above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For ATS not on walls, provide freestanding racks complying with Division 16 Section "Hangers and Supports for Electrical Systems."

E. Power Wiring Installation

1. Install power wiring between controllers and their services or sources, and between controllers and their drivers. Comply with requirements in NFPA 20, NFPA 70, and Division 16 Section "Conductors and Cables."
2. Comply with NECA 1.

F. Control And Alarm Wiring Installation
1. Install wiring between controllers and remote devices and facility's central monitoring system, **as directed**. Comply with requirements in NFPA 20, NFPA 70, and Division 16 Section "Control-Voltage Electrical Power Cables."
2. Install wiring between remote alarm and low-suction-shutdown, **as directed**, panels and controllers. Comply with requirements in NFPA 20, NFPA 70, and Division 16 Section "Control-Voltage Electrical Power Cables."
3. Install wiring between controllers and the building's fire-alarm system. Comply with requirements specified in Division 13 Section "Digital, Addressable Fire-Alarm System."
4. Bundle, train, and support wiring in enclosures.
5. Connect remote manual and automatic activation devices where applicable.

G. Identification
1. Comply with requirements in NFPA 20 for marking fire-pump controllers.
2. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification in NFPA 20 and as specified in Division 16 Section "Electrical Identification."

H. Field Quality Control
1. Perform tests and inspections.
2. Acceptance Testing Preparation:
   a. Inspect and Test Each Component:
      1) Inspect wiring, components, connections, and equipment installations. Test and adjust components and equipment.
      2) Test insulation resistance for each element, component, connecting supply, feeder, and control circuits.
      3) Test continuity of each circuit.
   b. Verify and Test Each Electric-Driver Controller:
      1) Verify that voltages at controller locations are within plus 10 or minus 1 percent of motor nameplate rated voltages, with motors off. If outside this range for any motor, notify the Owner before starting the motor(s).
      2) Test each motor for proper phase rotation.
   c. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
   d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Field Acceptance Tests:
   a. Do not begin field acceptance testing until suction piping has been flushed and hydrostatically tested and the certificate for flushing and testing has been submitted to the Owner and authorities having jurisdiction.
   b. Prior to starting, notify authorities having jurisdiction of the time and place of the acceptance testing.
   c. Engage manufacturer's factory-authorized service representative to be present during the testing.
   d. Perform field acceptance tests as outlined in NFPA 20.
4. Controllers will be considered defective if they do not pass tests and inspections.
5. Prepare test and inspection reports.

I. Startup Service
1. Perform startup service.
   a. Complete installation and startup checks according to manufacturer's written instructions.

J. Adjusting
1. Adjust controllers and battery charger systems, **as directed**, to function smoothly and as recommended by manufacturer.
2. Set field-adjustable switches, auxiliary relays, time-delay relays, and timers.
3. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Final Completion.
4. Set field-adjustable pressure switches.

K. Protection
1. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.
2. Replace controllers whose interiors have been exposed to water or other liquids prior to Final Completion.

L. Demonstration
1. Train the Owner's maintenance personnel to adjust, operate, and maintain controllers, remote alarm panels, **as directed**, low-suction-shutdown panels, **as directed**, and to use and reprogram microprocessor-based controls within this equipment, **as directed**.

END OF SECTION 21 31 13 00a

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Task	Specification	Specification Description
21 31 13 00	21 30 00 00	Electric-Drive, Centrifugal Fire Pumps
21 31 16 00	21 30 00 00a	Diesel-Drive, Centrifugal Fire Pumps
21 31 16 00	21 31 13 00	Pressure-Maintenance Pumps
21 31 16 00	21 31 13 00a	Controllers for Fire-Pump Drivers
21 34 13 00	21 31 13 00	Pressure-Maintenance Pumps
21 34 13 00	21 31 13 00a	Controllers for Fire-Pump Drivers

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SECTION 22 01 40 81 - EMERGENCY PLUMBING FIXTURES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for emergency plumbing fixtures. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work

B. Summary
1. This Section includes the following emergency plumbing fixtures:
   a. Emergency showers.
   b. Eyewash equipment.
   c. Self-contained eyewash equipment.
   d. Personal eyewash equipment.
   e. Eye/face wash equipment.
   f. Hand-held drench hoses.
   g. Combination units.
   h. Water-tempering equipment.

C. Definitions
1. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
2. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
3. Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.
4. Tepid: Moderately warm.

D. Submittals
1. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.
2. Shop Drawings: Diagram power, signal, and control wiring.
3. Operation and maintenance data.

E. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."
3. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
4. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

1.2 PRODUCTS

1.3 PERFORMANCE REQUIREMENTS

A. Comply with ANSI/ISEA Z358.1 for emergency plumbing fixtures including third-party certification of fixtures.

B. Comply with ASSE 1071 for temperature-actuated mixing valves for plumbed emergency fixtures.

C. Comply with ASME A112.18.1/CSA B125.1 for water-supply fittings.

D. Comply with ASME A112.18.2/CSA B125.2 for plumbing waste fittings.

E. Comply with NSF 61 and NSF 372 for fixture materials that will be in contact with potable water.

F. Comply with requirements in ICC A117.1 for plumbing fixtures for people with disabilities.

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Emergency Showers:
1. Description: Plumbed, single-shower-head horizontal, wall-mounting **OR** vertical, ceiling-mounting **OR** freestanding, **as directed,** emergency shower.
   a. Capacity: Deliver potable water at rate not less than 20 gpm (76 L/min.) for at least 15 minutes.
   b. Supply Piping: NPS 1 (DN 25) **OR** NPS 1-1/4 (DN 32) **OR** galvanized steel **OR** chrome-plated brass or stainless steel **OR** PVC, **as directed,** with flow regulator and stay-open control valve.
   c. Control-Valve Actuator: Pull rod **OR** chain, **as directed**.
   d. Shower Head: 8-inch (200-mm) minimum diameter, chrome-plated brass or stainless steel **OR** plastic, **as directed**.
2. Description: Plumbed, multiple-spray emergency shower with eight **OR** 12 **OR** 16, **as directed,** small shower heads or nozzles.
   a. Capacity: Deliver potable water at rate not less than 20 gpm (76 L/min.) for at least 15 minutes.
   b. Supply Piping: NPS 1-1/4 (DN 32) minimum galvanized **OR** chrome-plated brass or stainless, **as directed,** steel with flow regulator and stay-open control valve.
   c. Control-Valve Actuator: Paddle **OR** Treadle, **as directed**.
3. Description: Plumbed, freeze-protected, freestanding emergency shower.
   a. Capacity: Deliver potable water at rate not less than 20 gpm (76 L/min.) for at least 15 minutes.
   b. Supply Piping: NPS 1-1/4 (DN 32) galvanized steel with flow regulator and stay-open control valve.
   c. Control-Valve Actuator: Pull rod **OR** chain, **as directed**.
   d. Shower Head: 8-inch (200-mm) minimum diameter, chrome-plated brass or stainless steel **OR** plastic, **as directed**.
   e. Heating System: 120 **OR** 240, **as directed**,-V ac electric; and insulation with protective jacket.

I. Eyewash Equipment
1. Description: Plumbed, freestanding eyewash equipment.
   a. Capacity: Deliver potable water at rate not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
   b. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   c. Control-Valve Actuator: Paddle **OR** Push bar **OR** Treadle, **as directed**.
   d. Receptor: Chrome-plated brass or stainless-steel **OR** Plastic, **as directed,** bowl.
   e. Drain Piping: NPS 1-1/4 (DN 32) minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2 **OR** Omit drain piping **OR** Include galvanized-steel indirect connection to drainage system, **as directed**.
2. Description: Plumbed, accessible, **as directed**, wall-mounting eyewash equipment with receptor and wall bracket.

a. Capacity: Deliver potable water at rate not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
b. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
c. Control-Valve Actuator: Paddle.
d. Receptor: Chrome-plated brass or stainless-steel **OR** Plastic, **as directed**, bowl.
e. Drain Piping: NPS 1-1/4 (DN 32) minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2.

3. Description: Plumbed, accessible, **as directed**, wall-mounting eyewash equipment with wall bracket.
   a. Capacity: Deliver potable water at rate not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
   b. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   c. Control-Valve Actuator: Paddle **OR** Movement sensor, **as directed**.
4. Description: Plumbed, adjacent-to-sink, swivel, counter-mounting eyewash equipment.
   a. Capacity: Deliver potable water at rate not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
   b. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   c. Control-Valve Actuator: Paddle.

J. Self-Contained Eyewash Equipment:
1. Description: Portable, pressurized, self-contained eyewash equipment.
   a. Capacity: Deliver flushing fluid at rate not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
   b. Tank: 10 gal. (3.8 L), stainless steel, cylindrical, and suitable for on-floor installation.
   c. Flushing Fluid: Medically acceptable solution manufactured and labeled according to applicable regulations.
   d. Piping: Chrome-plated copper alloy or stainless steel with flow regulator and stay-open control valve.
   e. Control-Valve Actuator: Paddle.
   f. Spray Heads: Twin with covers.
2. Description: Static, nonpressurized, self-contained eyewash equipment.
   a. Capacity: Deliver flushing fluid at rate not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
   b. Tank: 14 gal. (53 L) minimum, plastic, and suitable for shelf mounting.
   c. Flushing Fluid: Medically acceptable solution manufactured and labeled according to applicable regulations.
   d. Actuator: Pull-down front panel.
   e. Spray Heads: Protected, twin.
3. Description: Freeze-protected, static, nonpressurized, self-contained eyewash equipment with heating system.
   a. Capacity: Deliver flushing fluid at rate not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
   b. Tank: 14 gal. (53 L) minimum **OR** 20 gal. (76 L) minimum, **as directed**, plastic, and suitable for shelf mounting.
   c. Flushing Fluid: Medically acceptable solution manufactured and labeled according to applicable regulations.
   d. Actuator: Pull-down front panel.
   e. Spray Heads: Protected, twin.
   f. Heating System: Electric, 120-V ac; and insulation with protective jacket.

K. Personal Eyewash Equipment:
1. Description: Portable, pressurized, personal eyewash equipment with spray heads.
   a. Capacity: Deliver flushing fluid at rate not less than 0.4 gpm (1.5 L/min.), **as directed**.

b. Tank: 5 gal. (19 L), stainless steel, cylindrical, and with base suitable for on-floor installation.
c. Flushing Fluid: Medically acceptable solution manufactured and labeled according to applicable regulations.
d. Piping: Chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
e. Control-Valve Actuator: Paddle.
f. Spray Heads: Twin with covers.

2. Description: Portable, pressurized, personal eyewash equipment with spray heads and drench hose.
   a. Capacity: Deliver flushing fluid at rate not less than 0.4 gpm (1.5 L/min.), **as directed**.
   b. Tank: 5 gal. (19 L), stainless steel, cylindrical, and with base suitable for on-floor installation.
   c. Flushing Fluid: Medically acceptable solution manufactured and labeled according to applicable regulations.
   d. Piping: Chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   e. Spray-Head, Control-Valve Actuator: Paddle.
   f. Spray Heads: Twin with covers.
   g. Drench Hose: Rubber or plastic.
      1) Control-Valve Actuator: Hand-held squeeze valve.
      2) Spray Head: Single with cover.

L. Eye/Face Wash Equipment:
1. Description: Plumbed, freestanding, pedestal eye/face wash equipment.
   a. Capacity: Deliver potable water at rate not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.
   b. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   c. Control-Valve Actuator: Paddle **OR** Push bar **OR** Treadle, **as directed**.
   d. Receptor: Chrome-plated brass or stainless-steel **OR** Plastic, **as directed,** bowl.
   e. Drain Piping: NPS 1-1/4 (DN 32) minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2. Include galvanized-steel indirect connection to drainage system.
2. Description: Plumbed, accessible, **as directed**, wall-mounting eye/face wash equipment with receptor and wall bracket.
   a. Capacity: Deliver potable water at rate not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.
   b. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   c. Control-Valve Actuator: Paddle.
   d. Receptor: Chrome-plated brass or stainless-steel **OR** Plastic, **as directed,** bowl.
   e. Drain Piping: NPS 1-1/4 (DN 32) minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2.
3. Description: Plumbed, accessible, **as directed**, wall-mounting eye/face wash equipment without receptor and with wall bracket.
   a. Capacity: Deliver potable water at rate not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.
   b. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   c. Control-Valve Actuator: Paddle.
4. Description: Plumbed, adjacent-to-sink, swivel, counter-mounting eye/face wash equipment.
   a. Capacity: Deliver potable water at rate not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.

b. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
c. Control-Valve Actuator: Paddle.

M. Hand-Held Drench Hoses:
1. Description: Plumbed, wall-mounting, hand-held drench hose with wall bracket.
a. Capacity: Deliver potable water at rate not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.
b. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
c. Control-Valve Actuator: Paddle.
d. Hose: Coiled **OR** Plain, **as directed**, rubber or plastic.
e. Spray Heads: Single **OR** Twin, **as directed**.
2. Description: Plumbed, counter-mounting, hand-held drench hose.
a. Capacity: Deliver potable water at rate not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.
b. Supply Fitting: NPS 1/2 (DN 15) brass with flow regulator.
c. Hose: Rubber or plastic.
d. Control-Valve Actuator: Hand-held squeeze valve.
e. Spray Heads: Single **OR** Twin, **as directed**.

N. Combination Units:
1. Description: Plumbed, accessible, **as directed,** freestanding, with emergency shower and eyewash **OR** eye/face wash **OR** drench hose, **as directed,** equipment.
a. Piping: Galvanized steel **OR** Chrome-plated brass or stainless steel **OR** PVC, **as directed**.
1) Unit Supply: NPS 1-1/4 (DN 32) minimum **OR** NPS 1-1/2 (DN 40), **as directed,** from top **OR** side, **as directed**.
2) Unit Drain: Outlet at side near bottom.
3) Shower Supply: NPS 1 (DN 25) with flow regulator and stay-open control valve.
4) Eyewash **OR** Eye/Face Wash **OR** Drench Hose, **as directed,** Supply: NPS 1/2 (DN 15) with flow regulator and stay-open control valve.
b. Shower Capacity: Deliver potable water at rate not less than 20 gpm (76 L/min.) for at least 15 minutes.
1) Control-Valve Actuator: Pull rod **OR** Pull chain **OR** Treadle, **as directed**.
2) Shower Head: 8-inch (200-mm) minimum diameter, chrome-plated brass or stainless steel **OR** plastic, **as directed**.
c. Eyewash Equipment: With capacity to deliver potable water at rate not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
1) Control-Valve Actuator: Paddle **OR** Push bar, **as directed**.
2) Receptor: Chrome-plated brass or stainless-steel **OR** Plastic, **as directed,** bowl.
d. Eye/Face Wash Equipment: With capacity to deliver potable water at rate not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.
1) Control-Valve Actuator: Paddle **OR** Push bar, **as directed**.
2) Receptor: Chrome-plated brass or stainless-steel **OR** Plastic, **as directed,** bowl.
e. Hand-Held Drench Hose: With capacity to deliver potable water at rate not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.
1) Hose: Rubber or plastic.
2) Control-Valve Actuator: Hand-held squeeze valve.
3) Spray Head(s): Single **OR** Twin, **as directed**.
2. Description: Plumbed, accessible, **as directed,** freeze-protected, freestanding, with emergency shower and eye/face wash equipment.
a. Piping: Galvanized steel.
1) Unit Supply: NPS 1-1/4 (DN 32) minimum **OR** NPS 1-1/2 (DN 40), **as directed,** from top **OR** side **OR** bottom, **as directed**.
2) Shower Supply: NPS 1 (DN 25) with flow regulator and stay-open control valve.

3) Eye/Face Wash Supply: NPS 1/2 (DN 15) with flow regulator and stay-open control valve.

b. Heating System: Electric, 120 **OR** 240, **as directed**,-V ac; and insulation with protective jacket.

c. Shower Capacity: Deliver potable water at rate not less than 20 gpm (76 L/min.) for at least 15 minutes.

1) Control-Valve Actuator: Pull rod **OR** Pull chain **OR** Treadle, **as directed**.

2) Shower Head: 8-inch (200-mm) minimum diameter, chrome-plated brass or stainless steel **OR** plastic, **as directed**.

d. Eye/Face Wash Equipment: With capacity to deliver potable water at rate not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.

1) Control-Valve Actuator: Paddle **OR** Push bar, **as directed**.

O. Water-Tempering Equipment:

1. Description: Factory-fabricated, hot- and cold-water-tempering equipment with thermostatic mixing valve.

a. Thermostatic Mixing Valve: Designed to provide 85 deg F (29 deg C) tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F (3 deg C) throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.

2. Description: Factory-fabricated, steam and cold-water, water-tempering equipment with thermostatic mixing valve.

a. Thermostatic Mixing Valve: Designed to provide 85 deg F (29 deg C) tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F (3 deg C) throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, steam controls, heat exchanger, high-temperature-limit and freeze-protection devices, metal piping, and corrosion-resistant enclosure.

3. Description: Factory-fabricated, water-tempering equipment with electric heating.

a. Heating System: Electric, designed to provide 85 deg F (29 deg C) tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F (3 deg C) throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, heating coils, high-temperature-limit device, metal piping, and corrosion-resistant enclosure.

1) Electrical Characteristics: 208-V ac, 38 **OR** 220-V ac, 40 **OR** 277-V ac, 32, **as directed,** A, single phase, 60 Hz.

1.4 EXECUTION

A. Installation

1. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
2. Install fixtures level and plumb.
3. Fasten fixtures to substrate.
4. Install shutoff valves in water-supply piping to fixtures. Use ball, gate, or globe valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Valves are specified in Division 22 Section "General-duty Valves For Plumbing Piping".

a. Exception: Omit shutoff valve on supply to group of plumbing fixtures that includes emergency plumbing fixture.

b. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.

5. Install shutoff valve and strainer in steam piping and shutoff valve in condensate return piping.

6. Install dielectric fitting in supply piping to fixture if piping and fixture connections are made of different metals. Dielectric fittings are specified in Division 22 Section "Common Work Results For Plumbing".
7. Install thermometers in supply and outlet piping connections to water-tempering equipment. Thermometers are specified in Division 22 Section "Meters And Gages For Plumbing Piping".
8. Install trap and waste to wall on drain outlet of fixture receptors that are indicated to be directly connected to drainage system.
9. Install indirect waste piping to wall on drain outlet of fixture receptors that are indicated to be indirectly connected to drainage system. Drainage piping is specified in Division 22 Section "Sanitary Waste And Vent Piping".
10. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Escutcheons are specified in Division 22 Section "Common Work Results For Plumbing".
11. Fill self-contained fixtures with flushing fluid.
12. Install equipment nameplates or equipment markers on fixtures and equipment signs on water-tempering equipment. Identification materials are specified in Division 22 Section "Identification For Plumbing Piping And Equipment".
13. Piping installation requirements are specified in other Division 14. Drawings indicate general arrangement of piping, fittings, and specialties.
14. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment.
15. Connect hot- and cold-water-supply piping to hot- and cold-water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures.
16. Connect cold-water and steam supply and condensate return piping to steam and cold-water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures.
17. Connect cold water and electrical power to electric heating water-tempering equipment.
18. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary drainage and vent piping.
19. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary or storm drainage piping.
20. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
21. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

B. Field Quality Control
1. Electrical-Component Testing: After electrical circuitry has been energized, test for compliance with requirements.
   a. Test and adjust controls and safeties.
2. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

C. Adjusting
1. Adjust or replace fixture flow regulators for proper flow.
2. Adjust equipment temperature settings.

END OF SECTION 22 01 40 81

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Task	Specification	Specification Description
22 01 40 81	10 28 19 16	Plumbing Fixtures

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SECTION 22 05 13 00 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for common motor requirements for plumbing equipment. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

C. Coordination
1. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
    a. Motor controllers.
    b. Torque, speed, and horsepower requirements of the load.
    c. Ratings and characteristics of supply circuit and required control sequence.
    d. Ambient and environmental conditions of installation location.

1.2 PRODUCTS

A. General Motor Requirements
1. Comply with requirements in this Section except when stricter requirements are specified in plumbing equipment schedules or Sections.
2. Comply with NEMA MG 1 unless otherwise indicated.
3. Comply with IEEE 841 for severe-duty motors.

B. Motor Characteristics
1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) above sea level.
2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

C. Polyphase Motors
1. Description: NEMA MG 1, Design B, medium induction motor.
2. Efficiency: Energy efficient, as defined in NEMA MG 1.
3. Service Factor: 1.15.
4. Multispeed Motors: Variable torque.
    a. For motors with 2:1 speed ratio, consequent pole, single winding.
    b. For motors with other than 2:1 speed ratio, separate winding for each speed.
5. Multispeed Motors: Separate winding for each speed.
6. Rotor: Random-wound, squirrel cage.
7. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
8. Temperature Rise: Match insulation rating.
9. Insulation: Class F.
10. Code Letter Designation:
    a. Motors 15 HP and Larger: NEMA starting Code F or Code G.

b. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

11. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

D. Polyphase Motors With Additional Requirements

1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
2. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   a. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   b. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   c. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   d. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
3. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

E. Single-Phase Motors

1. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
   a. Permanent-split capacitor.
   b. Split phase.
   c. Capacitor start, inductor run.
   d. Capacitor start, capacitor run.
2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 HP and Smaller: Shaded-pole type.
5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

1.3 EXECUTION (Not Applicable)

END OF SECTION 22 05 13 00

SECTION 22 05 16 00 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for expansion fittings and loops for plumbing piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Flexible-hose packless expansion joints.
      b. Metal-bellows packless expansion joints.
      c. Rubber packless expansion joints.
      d. Grooved-joint expansion joints.
      e. Pipe loops and swing connections.
      f. Alignment guides and anchors.

C. Performance Requirements
   1. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
   2. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

D. Submittals
   1. Product Data: For each type of product indicated.
   2. Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
      a. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
      b. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
      c. Alignment Guide Details: Detail field assembly and attachment to building structure.
      d. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.
   3. Welding certificates.
   4. Product Certificates: For each type of expansion joint, from manufacturer.
   5. Maintenance Data: For expansion joints to include in maintenance manuals.

E. Quality Assurance
   1. Welding Qualifications: Qualify procedures and personnel according to the following:
      a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
      b. ASME Boiler and Pressure Vessel Code: Section IX.

1.2 PRODUCTS

A. Packless Expansion Joints
   1. Flexible-Hose Packless Expansion Joints:
      a. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
      b. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.

c. Expansion Joints for Copper Tubing NPS 2 (DN 50) and Smaller: Copper-alloy fittings with solder-joint end connections.
   1) Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F (3100 kPa at 21 deg C) and 340 psig at 450 deg F (2340 kPa at 232 deg C) ratings.
   2) Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F (4830 kPa at 21 deg C) and 500 psig at 450 deg F (3450 kPa at 232 deg C) ratings.
d. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Copper-alloy fittings with threaded end connections.
   1) Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F (2070 kPa at 21 deg C) and 225 psig at 450 deg F (1550 kPa at 232 deg C) ratings.
   2) Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F (2890 kPa at 21 deg C) and 315 psig at 450 deg F (2170 kPa at 232 deg C) ratings.
e. Expansion Joints for Steel Piping NPS 2 (DN 50) and Smaller: Stainless-steel fittings with threaded end connections.
   1) Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F (3100 kPa at 21 deg C) and 325 psig at 600 deg F (2250 kPa at 315 deg C) ratings.
   2) Stainless-steel hoses and double-braid, stainless-steel sheaths with 700 psig at 70 deg F (4830 kPa at 21 deg C) and 515 psig at 600 deg F (3550 kPa at 315 deg C) ratings.
f. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Stainless-steel fittings with flanged end connections.
   1) Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F (1380 kPa at 21 deg C) and 145 psig at 600 deg F (1000 kPa at 315 deg C) ratings.
   2) Stainless-steel hoses and double-braid, stainless-steel sheaths with 275 psig at 70 deg F (1900 kPa at 21 deg C) and 200 psig at 600 deg F (1380 kPa at 315 deg C) ratings.
g. Expansion Joints for Steel Piping NPS 8 to NPS 12 (DN 200 to DN 300): Stainless-steel fittings with flanged end connections.
   1) Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg F (860 kPa at 21 deg C) and 90 psig at 600 deg F (625 kPa at 315 deg C) ratings.
   2) Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F (1130 kPa at 21 deg C) and 120 psig at 600 deg F (830 kPa at 315 deg C) ratings.

2. Metal-Bellows Packless Expansion Joints:
   a. Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
   b. Type: Circular, corrugated bellows with external tie rods.
   c. Minimum Pressure Rating: 150 psig (1035 kPa) **OR** 175 psig (1200 kPa), **as directed**, unless otherwise indicated.
   d. Configuration: Single joint **OR** Single joint with base and double joint with base, **as directed**, class(es) unless otherwise indicated.
   e. Expansion Joints for Copper Tubing: Single **OR** Multi, **as directed**,-ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.
      1) End Connections for Copper Tubing NPS 2 (DN 50) and Smaller: Solder joint or threaded.
      2) End Connections for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Solder joint or threaded.
      3) End Connections for Copper Tubing NPS 5 (DN 125) and Larger: Flanged.
3. Rubber Packless Expansion Joints:

a. Standards: ASTM F 1123 and FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."
b. Material: Fabric-reinforced rubber complying with FSA-NMEJ-703.
c. Arch Type: Single **OR** Multiple, **as directed**, arches with external control rods, **as directed**.
d. Spherical Type: Single **OR** Multiple, **as directed** spheres with external control rods, **as directed**.
e. Minimum Pressure Rating for NPS 1-1/2 to NPS 4 (DN 40 to DN 100): 150 psig (1035 kPa) at 220 deg F (104 deg C).
f. Minimum Pressure Rating for NPS 5 and NPS 6 (DN 125 and DN 150): 140 psig (966 kPa) at 200 deg F (93 deg C).
g. Minimum Pressure Rating for NPS 8 to NPS 12 (DN 200 to DN 300): 140 psig (966 kPa) at 180 deg F (82 deg C).
h. Material for Fluids Containing Acids, Alkalies, or Chemicals: BR **OR** CSM **OR** EPDM, **as directed**.
i. Material for Fluids Containing Gas, Hydrocarbons, or Oil: Buna-N **OR** CR, **as directed**.
j. Material for Water: BR **OR** Buna-N **OR** CR **OR** CSM **OR** EPDM **OR** NR, **as directed**.
k. End Connections: Full-faced, integral steel flanges with steel retaining rings.

B. Grooved-Joint Expansion Joints
1. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.
2. Standard: AWWA C606, for grooved joints.
3. Nipples: Galvanized, **as directed**, ASTM A 53/A 53M, Schedule 40, Type E or S, steel pipe with grooved ends.
4. Couplings: Five **OR** Seven **OR** 10 **OR** 12, **as directed**, flexible type for steel-pipe dimensions. Include ferrous housing sections, Buna-N gasket suitable for diluted acid, alkaline fluids, and cold and hot water **OR** EPDM gasket suitable for cold and hot water, **as directed**, and bolts and nuts.

C. Alignment Guides And Anchors
1. Alignment Guides:
a. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.
2. Anchor Materials:
a. Steel Shapes and Plates: ASTM A 36/A 36M.
b. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
c. Washers: ASTM F 844, steel, plain, flat washers.
d. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
1) Stud: Threaded, zinc-coated carbon steel.
2) Expansion Plug: Zinc-coated steel.
3) Washer and Nut: Zinc-coated steel.
e. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
1) Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
2) Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
3) Washer and Nut: Zinc-coated steel.

1.3 EXECUTION

A. Expansion-Joint Installation
1. Install expansion joints of sizes matching sizes of piping in which they are installed.
2. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
3. Install rubber packless expansion joints according to FSA-NMEJ-702.
4. Install grooved-joint expansion joints to grooved-end steel piping

B. Pipe Loop And Swing Connection Installation
1. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
2. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.
3. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.
4. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

C. Alignment-Guide And Anchor Installation
1. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
2. Install one **OR** two, **as directed**, guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
3. Attach guides to pipe and secure guides to building structure.
4. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
5. Anchor Attachments:
   a. Anchor Attachment to Black-Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   b. Anchor Attachment to Galvanized-Steel Pipe: Attach with pipe hangers. Use MSS SP-69, Type 42, riser clamp welded to anchor.
   c. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.
6. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
   a. Anchor Attachment to Steel Structural Members: Attach by welding.
   b. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
7. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 22 05 16 00

Task	Specification	Specification Description
22 05 19 00	21 05 19 00	Meters and Gages for Plumbing Piping

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SECTION 22 05 23 00 - ARCHITECTURALLY EXPOSED STRUCTURAL STEEL FRAMING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for architecturally exposed structural steel framing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes architecturally exposed structural-steel framing.

C. Definitions
1. Architecturally Exposed Structural Steel: Structural steel designated as "architecturally exposed structural steel" or "AESS" in the Contract Documents.
2. Category 1 AESS: AESS that is within 96 inches (2400 mm) vertically and 36 inches (900 mm) horizontally of a walking surface and is visible to a person standing on that walking surface or is designated as "Category 1 architecturally exposed structural steel" or "AESS-1" in the Contract Documents.
3. Category 2 AESS: AESS that is within 20 feet (6 m) vertically and horizontally of a walking surface and is visible to a person standing on that walking surface or is designated as "Category 2 architecturally exposed structural steel" or "AESS-2" in the Contract Documents.
4. Category 3 AESS: AESS that is not defined as Category 1 or Category 2 or that is designated as "Category 3 architecturally exposed structural steel" or "AESS-3" in the Contract Documents.

D. Submittals
1. Shop Drawings: Show fabrication of AESS components. Shop Drawings for structural steel may be used for AESS provided items of AESS are specifically identified and requirements below are met for AESS, **as directed**.
   a. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
   b. Include embedment drawings.
   c. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain. Indicate grinding, finish, and profile of welds, **as directed**.
   d. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections. Indicate orientation of bolt heads, **as directed**.
   e. Indicate exposed surfaces and edges and surface preparation being used.
   f. Indicate special tolerances and erection requirements.
2. Samples: Submit samples of AESS to set quality standards for exposed welds for Category 1 AESS, **as directed**.
   a. Two steel plates, 3/8 by 8 by 4 inches (9.5 by 200 by 100 mm), with long edges joined by a groove weld and with weld ground smooth, **as directed**.
   b. Steel plate, 3/8 by 8 by 8 inches (9.5 by 200 by 200 mm), with one end of a short length of rectangular steel tube, 4 by 6 by 3/8 inches (100 by 150 by 9.5 mm), welded to plate with a continuous fillet weld and with weld ground smooth and blended, **as directed**.
   c. Round steel tube or pipe, minimum 8 inches (200 mm) in diameter, with end of another round steel tube or pipe, approximately 4 inches (100 mm) in diameter, welded to its side at a 45-degree angle with a continuous fillet weld and with weld ground smooth and blended, **as directed**.
3. Qualification Data: For qualified Installer **OR** fabricator, **as directed**.

E. Quality Assurance
1. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category ACSE **OR** CSE, **as directed**.
2. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.
3. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P1 **OR** P2 **OR** P3, **as directed**, or SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."
4. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Use special care in handling to prevent twisting, warping, nicking, and other damage. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
   a. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

G. Project Conditions
1. Field Measurements: Where AESS is indicated to fit against other construction, verify actual dimensions by field measurements before fabrication.

H. Coordination
1. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.

1.2 PRODUCTS

A. Bolts, Connectors, And Anchors
1. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, round-head assemblies, consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
   a. Finish: Plain **OR** Mechanically deposited zinc coating, **as directed**.
2. Corrosion-Resisting (Weathering Steel), Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 3, round-head assemblies, consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.

B. Primer
1. Primer: Comply with Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
   OR
   Primer: SSPC-Paint 25, Type I **OR** Type II, **as directed**, zinc oxide, alkyd, linseed oil primer.
   OR
   Primer: SSPC-Paint 25 BCS, Type I **OR** Type II, **as directed**, zinc oxide, alkyd, linseed oil primer.
   OR
   Primer: SSPC-Paint 23, latex primer.
   OR
   Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.
2. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
3. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20 **OR** ASTM A 780, **as directed**.

4. Shop Primer for Galvanized Steel: Cementitious galvanized metal primer complying with MPI#26 **OR** Vinyl wash primer complying with MPI#80 **OR** Water-based galvanized metal primer complying with MPI#134, **as directed**.

C. Fabrication
1. Shop fabricate and assemble AESS to the maximum extent possible. Locate field joints at concealed locations if possible. Detail assemblies to minimize handling and to expedite erection.
2. In addition to special care used to handle and fabricate AESS, comply with the following:
   a. Fabricate with exposed surfaces smooth, square, and free of surface blemishes including pitting, rust, scale, and roughness.
   b. Grind sheared, punched, and flame-cut edges of Category 1 AESS to remove burrs and provide smooth surfaces and edges.
   c. Fabricate Category 1 AESS with exposed surfaces free of mill marks, including rolled trade names and stamped or raised identification.
   d. Fabricate Category 1 and Category 2 AESS with exposed surfaces free of seams to maximum extent possible.
   e. Remove blemishes by filling or grinding or by welding and grinding, before cleaning, treating, and shop priming.
   f. Fabricate with piece marks fully hidden in the completed structure or made with media that permits full removal after erection.
   g. Fabricate Category 1 AESS to the tolerances specified in AISC 303 for steel that is designated AESS.
   h. Fabricate Category 2 and Category 3 AESS to the tolerances specified in AISC 303 for steel that is not designated AESS.
   i. Seal-weld open ends of hollow structural sections with 3/8-inch (9.5-mm) closure plates for Category 1 AESS.
3. Curved Members: Fabricate indicated members to curved shape by rolling to final shape in fabrication shop.
   a. Distortion of webs, stems, outstanding flanges, and legs of angles shall not be visible from a distance of 20 feet (6 m) under any lighting conditions.
   b. Tolerances for walls of hollow steel sections after rolling shall be approximately 1/2 inch (13 mm).
4. Coping, Blocking, and Joint Gaps: Maintain uniform gaps of 1/8 inch (3.2 mm) with a tolerance of 1/32 inch (0.8 mm) for Category 1 AESS.
5. Bolt Holes: Cut, drill, mechanically thermal cut, **as directed**, or punch standard bolt holes perpendicular to metal surfaces.
6. Cleaning Corrosion-Resisting Structural Steel: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
7. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
   a. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning, **unless directed otherwise**.
   b. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
   c. Weld threaded nuts to framing and other specialty items indicated to receive other work.

D. Shop Connections
1. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
   a. Joint Type: Snug tightened **OR** Pretensioned **OR** Slip critical, **as directed**.
2. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M, **as directed**, for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work, and comply with the following:
   a. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding specified tolerances.

b. Use weld sizes, fabrication sequence, and equipment for AESS that limit distortions to allowable tolerances.
c. Provide continuous, sealed welds at angle to gusset-plate connections and similar locations where Category 1 AESS is exposed to weather.
d. Provide continuous welds of uniform size and profile where Category 1 AESS is welded.
e. Grind butt and groove welds flush to adjacent surfaces within tolerance of plus 1/16 inch, minus 0 inch (plus 1.5 mm, minus 0 mm) for Category 1 and Category 2 AESS.
OR
Make butt and groove welds flush to adjacent surfaces within tolerance of plus 1/16 inch, minus 0 inch (plus 1.5 mm, minus 0 mm) for Category 1 and Category 2 AESS. Do not grind unless required for clearances or for fitting other components, or unless directed to correct unacceptable work.
f. Remove backing bars or runoff tabs; back-gouge and grind steel smooth for Category 1 and Category 2 AESS.
g. At locations where welding on the far side of an exposed connection of Category 1 and Category 2 AESS occurs, grind distortions and marking of the steel to a smooth profile aligned with adjacent material.
h. Make fillet welds for Category 1 and Category2 AESS oversize and grind to uniform profile with smooth face and transition.
OR
Make fillet welds for Category 1 and Category 2 AESS of uniform size and profile with exposed face smooth and slightly concave. Do not grind unless directed to correct unacceptable work.

E. Galvanizing
1. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.
a. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
b. Fill vent and drain holes that will be exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
c. Galvanize lintels and shelf angles attached to structural-steel frame and located in exterior walls.

F. Shop Priming
1. Shop prime steel surfaces except the following:
a. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
b. Surfaces to be field welded.
c. Surfaces to be high-strength bolted with slip-critical connections.
d. Surfaces to receive sprayed fire-resistive materials.
e. Galvanized surfaces.
2. Surface Preparation for Nongalvanized Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
a. SSPC-SP 2, "Hand Tool Cleaning."
b. SSPC-SP 3, "Power Tool Cleaning."
c. SSPC-SP 7/NACE No. 4, "Brush-Off Blast Cleaning."
d. SSPC-SP 14/NACE No. 8, "Industrial Blast Cleaning."
e. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."
f. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
g. SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning."
h. SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning."
i. SSPC-SP 8, "Pickling."

3. Preparing Galvanized Steel for Shop Priming: After galvanizing, thoroughly clean steel of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.
4. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
   a. Stripe paint corners, crevices, bolts, welds, and sharp edges.
   b. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

1.3 EXECUTION

A. Examination
1. Verify, with steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
   a. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.
2. Examine AESS for twists, kinks, warping, gouges, and other imperfections before erecting.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Provide temporary shores, guys, braces, and other supports during erection to keep AESS secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.
   a. If possible, locate welded tabs for attaching temporary bracing and safety cabling where they will be concealed from view in the completed Work.
   b. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

C. Erection
1. Set AESS accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
   a. Erect Category 1 AESS to the tolerances specified in AISC 303 for steel that is designated AESS.
   b. Erect Category 2 and Category 3 AESS to the tolerances specified in AISC 303 for steel that is not designated AESS.
2. Do not use thermal cutting during erection unless approved by the Owner. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.

D. Field Connections
1. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
   a. Joint Type: Snug tightened **OR** Pretensioned **OR** Slip critical, **as directed**.
   b. Orient bolt heads as indicated on Drawings **OR** in same direction for each connection and to maximum extent possible in same direction for similar connections, **as directed**.
2. Weld Connections: Comply with requirements in "Weld Connections" Paragraph in "Shop Connections" Article.
   a. Remove backing bars or runoff tabs; back-gouge and grind steel smooth for Category 1 and Category 2 AESS.
   b. Remove erection bolts in Category 1 and Category 2 AESS, fill holes, and grind smooth.
   c. Fill weld access holes in Category 1 and Category 2 AESS and grind smooth.

E. Field Quality Control

1. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect AESS as specified in Division 5 Section "Structural Steel." The testing agency will not be responsible for enforcing requirements relating to aesthetic effect.
2. the Owner will observe AESS in place to determine acceptability relating to aesthetic effect.

F. Repairs And Protection
1. Remove welded tabs that were used for attaching temporary bracing and safety cabling and that are exposed to view in the completed Work. Grind steel smooth.
2. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.
3. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

   OR

   Touchup Painting: Cleaning and touchup painting are specified in Division 9 painting Sections.

END OF SECTION 22 05 23 00

Task	Specification	Specification Description
22 05 23 00	21 05 23 00	Piped Utilities Basic Materials And Methods
22 05 23 00	13 12 13 00	Water Distribution
22 05 23 00	21 05 23 00a	General-Duty Valves for Plumbing Piping
22 05 23 00	21 05 23 00b	General-Duty Valves for HVAC Piping

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SECTION 22 05 29 00 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for hangers and supports for plumbing piping and equipment. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Metal pipe hangers and supports.
   b. Trapeze pipe hangers.
   c. Fiberglass pipe hangers.
   d. Metal framing systems.
   e. Fiberglass strut systems.
   f. Thermal-hanger shield inserts.
   g. Fastener systems.
   h. Pipe stands.
   i. Pipe positioning systems.
   j. Equipment supports.

C. Definitions

1. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

D. Performance Requirements

1. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   a. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
   b. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
   c. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

E. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
   a. Trapeze pipe hangers.
   b. Metal framing systems.
   c. Fiberglass strut systems.
   d. Pipe stands.
   e. Equipment supports.
3. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   a. Detail fabrication and assembly of trapeze hangers.

b. Design Calculations: Calculate requirements for designing trapeze hangers.
4. Welding certificates.

F. Quality Assurance
1. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.2 PRODUCTS

A. Metal Pipe Hangers And Supports
1. Carbon-Steel Pipe Hangers and Supports:
a. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
b. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
c. Nonmetallic Coatings: Plastic coating, jacket, or liner.
d. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
e. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel **OR** stainless steel, **as directed**.
2. Stainless-Steel Pipe Hangers and Supports:
a. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
b. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
c. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
3. Copper Pipe Hangers:
a. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
b. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel **OR** stainless steel, **as directed**.

B. Trapeze Pipe Hangers
1. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

C. Fiberglass Pipe Hangers
1. Clevis-Type, Fiberglass Pipe Hangers:
a. Description: Similar to MSS SP-58, Type 1, steel pipe hanger except hanger is made of fiberglass or fiberglass-reinforced resin.
b. Hanger Rods: Continuous-thread rod, washer, and nuts made of fiberglass, polyurethane or stainless steel.
2. Strap-Type, Fiberglass Pipe Hangers:
a. Description: Similar to MSS SP-58, Type 9 or Type 10, steel pipe hanger except hanger is made of fiberglass-reinforced resin.
b. Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of stainless steel.

D. Metal Framing Systems
1. MFMA Manufacturer Metal Framing Systems:
a. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
b. Standard: MFMA-4.

c. Channels: Continuous slotted steel channel with inturned lips.
d. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
e. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel **OR** stainless steel, **as directed**.
f. Metallic Coating: Electroplated zinc **OR** Hot-dipped galvanized **OR** Mill galvanized **OR** In-line, hot galvanized **OR** Mechanically-deposited zinc, **as directed**.
OR
Paint Coating: Vinyl **OR** Vinyl alkyd **OR** Epoxy **OR** Polyester **OR** Acrylic **OR** Amine **OR** Alkyd, **as directed**.
OR
Plastic Coating: PVC **OR** Polyurethane **OR** Epoxy **OR** Polyester, **as directed**.
OR
Combination Coating: <**Insert coating materials in order of application**>.

2. Non-MFMA Manufacturer Metal Framing Systems:
a. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
b. Standard: Comply with MFMA-4.
c. Channels: Continuous slotted steel channel with inturned lips.
d. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
e. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel **OR** stainless steel, **as directed**.
f. Coating: Zinc **OR** Paint **OR** PVC, **as directed**.

E. Fiberglass Strut Systems
1. Description: Shop- or field-fabricated pipe-support assembly similar to MFMA-4 for supporting multiple parallel pipes.
a. Channels: Continuous slotted fiberglass or other plastic channel with inturned lips.
b. Channel Nuts: Fiberglass nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
c. Hanger Rods: Continuous-thread rod, nuts, and washer made of fiberglass **OR** stainless steel, **as directed**.

F. Thermal-Hanger Shield Inserts
1. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.
2. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig (688-kPa), ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength.
3. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
4. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
5. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

G. Fastener Systems
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated **OR** stainless-, **as directed**, steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

H. Pipe Stands

1. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
2. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
3. Low-Type, Single-Pipe Stand: One-piece plastic **OR** stainless-steel, **as directed**, base unit with plastic roller, for roof installation without membrane penetration.
4. High-Type, Single-Pipe Stand:
   a. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
   b. Base: Plastic **OR** Stainless steel, **as directed**.
   c. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
   d. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
5. High-Type, Multiple-Pipe Stand:
   a. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
   b. Bases: One or more; plastic.
   c. Vertical Members: Two or more protective-coated-steel channels.
   d. Horizontal Member: Protective-coated-steel channel.
   e. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
6. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

I. Pipe Positioning Systems
   1. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

J. Equipment Supports
   1. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

K. Miscellaneous Materials
   1. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
   2. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
      a. Properties: Nonstaining, noncorrosive, and nongaseous.
      b. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

1.3 EXECUTION

A. Hanger And Support Installation
   1. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
   2. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
      a. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.

b. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

3. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.
4. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
5. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled fiberglass struts.
6. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
7. Fastener System Installation:
   a. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   b. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
8. Pipe Stand Installation:
   a. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
   b. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 7 Section "Roof Accessories" for curbs.
9. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. See Division 15 plumbing fixture Sections for requirements for pipe positioning systems for plumbing fixtures.
10. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
11. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
12. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
13. Install lateral bracing with pipe hangers and supports to prevent swaying.
14. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
15. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
16. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
17. Insulated Piping:
   a. Attach clamps and spacers to piping.
      1) Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      2) Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      3) Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
   b. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      1) Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
   c. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

1) Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

d. Shield Dimensions for Pipe: Not less than the following:
   1) NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
   2) NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
   3) NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
   4) NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
   5) NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.

e. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

f. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

B. Equipment Supports
1. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
2. Grouting: Place grout under supports for equipment and make bearing surface smooth.
3. Provide lateral bracing, to prevent swaying, for equipment supports.

C. Metal Fabrications
1. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
2. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
3. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   b. Obtain fusion without undercut or overlap.
   c. Remove welding flux immediately.
   d. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

D. Adjusting
1. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
2. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

E. Painting
1. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   a. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

   OR

   Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9 painting Sections **OR** Section "High-Performance Coatings", **as directed**.
2. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

F. Hanger And Support Schedule
1. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
2. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
3. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
4. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
5. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
6. Use stainless-steel pipe hangers and fiberglass pipe hangers and fiberglass strut systems and stainless-steel or corrosion-resistant attachments for hostile environment applications.
7. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
8. Use padded hangers for piping that is subject to scratching.
9. Use thermal-hanger shield inserts for insulated piping and tubing.
10. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
    a. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
    b. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
    c. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
    d. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
    e. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
    f. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).
    g. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
    h. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
    i. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
    j. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
    k. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
    l. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
    m. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
    n. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
    o. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
    p. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

q. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
r. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction might occur.
s. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
t. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 (DN 50 to DN 600) if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
u. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

11. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
    a. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
    b. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.
12. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
    a. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
    b. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
    c. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
    d. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
    e. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.
13. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
    a. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
    b. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
    c. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
    d. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
    e. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
    f. C-Clamps (MSS Type 23): For structural shapes.
    g. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
    h. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
    i. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
    j. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
    k. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
    l. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

1) Light (MSS Type 31): 750 lb (340 kg).
2) Medium (MSS Type 32): 1500 lb (680 kg).
3) Heavy (MSS Type 33): 3000 lb (1360 kg).

m. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
n. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
o. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

14. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
    a. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
    b. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
    c. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
15. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
    a. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
    b. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
    c. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
    d. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
    e. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
    f. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
    g. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
    h. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
        1) Horizontal (MSS Type 54): Mounted horizontally.
        2) Vertical (MSS Type 55): Mounted vertically.
        3) Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
16. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
17. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
18. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
19. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 22 05 29 00

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SECTION 22 05 48 13 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of vibration and seismic controls for plumbing piping and equipment. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Isolation pads.
b. Isolation mounts.
c. Restrained elastomeric isolation mounts.
d. Freestanding and Restrained spring isolators.
e. Housed spring mounts.
f. Elastomeric hangers.
g. Spring hangers.
h. Spring hangers with vertical-limit stops.
i. Pipe riser resilient supports.
j. Resilient pipe guides.
k. Seismic snubbers.
l. Restraining braces and cables.
m. Steel and Inertia, vibration isolation equipment bases.

C. Definitions
1. IBC: International Building Code.
2. ICC-ES: ICC-Evaluation Service.
3. OSHPD: Office of Statewide Health Planning and Development for the State of California.

D. Performance Requirements
1. Seismic-Restraint Loading:
a. Site Class as Defined in the IBC: A **OR** B **OR** C **OR** D **OR** E **OR** F, **as directed**.
b. Assigned Seismic Use Group or Building Category as Defined in the IBC: I **OR** II **OR** III, as directed.
1) Component Importance Factor: 1.0 **OR** 1.5, **as directed**.
2) Component Response Modification Factor: 1.5 **OR** 2.5 **OR** 3.5 **OR** 5.0, **as directed**.
3) Component Amplification Factor: 1.0 **OR** 2.5, **as directed**.
c. Design Spectral Response Acceleration at Short Periods (0.2 Second): Percentage as directed.
d. Design Spectral Response Acceleration at 1-Second Period: Percentage as directed.

E. Submittals
1. Product Data: For each product indicated.
2. Delegated-Design Submittal: For vibration isolation and seismic-restraint calculations and details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
3. Welding certificates.
4. Qualification Data: For professional engineer.
5. Field quality-control test reports.

F. Quality Assurance

1. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
2. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
3. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproved by ICC-ES, or preapproved by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

1.2 PRODUCTS

A. Vibration Isolators
1. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
    a. Resilient Material: Oil- and water-resistant neoprene **OR** rubber **OR** hermetically sealed compressed fiberglass, **as directed**.
2. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
    a. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
    b. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
3. Restrained Mounts: All-directional mountings with seismic restraint.
    a. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
    b. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
4. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
    a. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
    b. Minimum Additional Travel: 50 percent of the required deflection at rated load.
    c. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
    d. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
    e. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- (6-mm-) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig (3447 kPa).
    f. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
5. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
    a. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.

b. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
c. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
d. Minimum Additional Travel: 50 percent of the required deflection at rated load.
e. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
f. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.
   a. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
   b. Base: Factory drilled for bolting to structure.
   c. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch (6-mm) travel up or down before contacting a resilient collar.
7. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.
8. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
   a. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
   b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   f. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
   g. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
9. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
   a. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
   b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   f. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
   g. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
   h. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
10. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- (13-mm-) thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig (3.45 MPa) and for equal resistance in all directions.
11. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- (13-mm-) thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion

and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

B. Vibration Isolation Equipment Bases
1. Steel Base: Factory-fabricated, welded, structural-steel bases and rails.
a. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
1) Include supports for suction and discharge elbows for pumps.
b. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
c. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
2. Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
a. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
1) Include supports for suction and discharge elbows for pumps.
b. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
c. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
d. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

C. Seismic-Restraint Devices
1. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of ICC-ES **OR** OSHPD **OR** an agency acceptable to authorities having jurisdiction, **as directed**.
a. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
2. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
a. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
b. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
c. Maximum 1/4-inch (6-mm) air gap, and minimum 1/4-inch- (6-mm-) thick resilient cushion.
3. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
4. Restraint Cables: ASTM A 603 galvanized-steel **OR** ASTM A 492 stainless-steel, **as directed**, cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
5. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections **OR** Reinforcing steel angle clamped, **as directed**, to hanger rod.
6. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

7. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
8. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
9. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
10. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

D. Factory Finishes
1. Finish:
a. Manufacturer's standard prime-coat finish ready for field painting.
OR
Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
1) Powder coating on springs and housings.
2) All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3) Baked enamel or powder coat for metal components on isolators for interior use.
4) Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

1.3 EXECUTION

A. Applications
1. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES **OR** OSHPD **OR** an agency acceptable to authorities having jurisdiction, **as directed**.
2. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
3. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

B. Vibration-Control And Seismic-Restraint Device Installation
1. Equipment Restraints:
a. Install seismic snubbers on plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
b. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inches (3.2 mm).
c. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES **OR** OSHPD **OR** an agency acceptable to authorities having jurisdiction, **as directed**, providing required submittals for component.
2. Piping Restraints:
a. Comply with requirements in MSS SP-127.
b. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.

c. Brace a change of direction longer than 12 feet (3.7 m).
3. Install cables so they do not bend across edges of adjacent equipment or building structure.
4. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES **OR** OSHPD **OR** an agency acceptable to authorities having jurisdiction, **as directed**, providing required submittals for component.
5. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
6. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
7. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
8. Drilled-in Anchors:
   a. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
   b. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   c. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
   d. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
   e. Set anchors to manufacturer's recommended torque, using a torque wrench.
   f. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

C. Accommodation Of Differential Seismic Motion
1. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 22 Section "Domestic Water Piping" for piping flexible connections.

D. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
   a. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
   b. Schedule test with the Owner before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
   c. Obtain approval before transmitting test loads to structure. Provide temporary load-spreading members.
   d. Test at least four of each type and size of installed anchors and fasteners selected.
   e. Test to 90 percent of rated proof load of device.
   f. Measure isolator restraint clearance.
   g. Measure isolator deflection.
   h. Verify snubber minimum clearances.
   i. Air-Mounting System Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

j. Air-Mounting System Operational Test: Test the compressed-air leveling system.
k. Test and adjust air-mounting system controls and safeties.
l. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

3. Remove and replace malfunctioning units and retest as specified above.
4. Prepare test and inspection reports.

E. Adjusting
1. Adjust isolators after piping system is at operating weight.
2. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
3. Adjust active height of sprint isolators.
4. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 22 05 48 13

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SECTION 22 05 53 00 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for identification for plumbing piping and equipment. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Equipment labels.
      b. Warning signs and labels.
      c. Pipe labels.
      d. Stencils.
      e. Valve tags.
      f. Warning tags.

C. Submittals
   1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Equipment Labels
   1. Metal Labels for Equipment:
      a. Material and Thickness: Brass, 0.032-inch (0.8-mm) **OR** Stainless steel, 0.025-inch (0.64-mm) **OR** Aluminum, 0.032-inch (0.8-mm) **OR** anodized aluminum, 0.032-inch (0.8-mm), **as directed**, minimum thickness, and having predrilled or stamped holes for attachment hardware.
      b. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
      c. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
      d. Fasteners: Stainless-steel rivets **OR** self-tapping screws, **as directed**.
      e. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
   2. Plastic Labels for Equipment:
      a. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) **OR** 1/8 inch (3.2 mm), **as directed**, thick, and having predrilled holes for attachment hardware.
      b. Letter Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
      c. Background Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
      d. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
      e. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
      f. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
      g. Fasteners: Stainless-steel rivets **OR** self-tapping screws, **as directed**.
      h. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

3. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
4. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

B. Warning Signs And Labels
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) **OR** 1/8 inch (3.2 mm), **as directed**, thick, and having predrilled holes for attachment hardware.
2. Letter Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
3. Background Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets **OR** self-tapping screws, **as directed**.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
9. Label Content: Include caution and warning information, plus emergency notification instructions.

C. Pipe Labels
1. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
2. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover **OR** cover full, **as directed,** circumference of pipe and to attach to pipe without fasteners or adhesive.
3. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
4. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   a. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
   b. Lettering Size: At least 1-1/2 inches (38 mm) high.

D. Stencils
1. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch (19 mm) for access panel and door labels, equipment labels, and similar operational instructions.
   a. Stencil Material: Aluminum **OR** Brass **OR** Fiberboard, **as directed**.
   b. Stencil Paint: Exterior, gloss, alkyd enamel **OR** acrylic enamel, **as directed**, black unless otherwise indicated. Paint may be in pressurized spray-can form.
   c. Identification Paint: Exterior, alkyd enamel **OR** acrylic enamel, **as directed**, in colors according to ASME A13.1 unless otherwise indicated.

E. Valve Tags
1. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
   a. Tag Material: Brass, 0.032-inch (0.8-mm) **OR** Stainless steel, 0.025-inch (0.64-mm) **OR** Aluminum, 0.032-inch (0.8-mm) **OR** anodized aluminum, 0.032-inch (0.8-mm), **as directed**, minimum thickness, and having predrilled or stamped holes for attachment hardware.

b. Fasteners: Brass wire-link chain **OR** beaded chain **OR** S-hook, **as directed.**

2. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   a. Valve-tag schedule shall be included in operation and maintenance data.

F. Warning Tags
1. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
   a. Size: 3 by 5-1/4 inches (75 by 133 mm) minimum **OR** Approximately 4 by 7 inches (100 by 178 mm), **as directed**.
   b. Fasteners: Brass grommet and wire **OR** Reinforced grommet and wire or string, **as directed**.
   c. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
   d. Color: Yellow background with black lettering.

1.3 EXECUTION

A. Preparation
1. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

B. Equipment Label Installation
1. Install or permanently fasten labels on each major item of mechanical equipment.
2. Locate equipment labels where accessible and visible.

C. Pipe Label Installation
1. Piping Color-Coding: Painting of piping is specified in Division 09 Section(s) "Interior Painting" OR "High-performance Coatings", **as directed**.
2. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles **OR** complying with ASME A13.1, **as directed**, on each piping system.
   a. Identification Paint: Use for contrasting background.
   b. Stencil Paint: Use for pipe marking.
3. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   a. Near each valve and control device.
   b. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   c. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   d. At access doors, manholes, and similar access points that permit view of concealed piping.
   e. Near major equipment items and other points of origination and termination.
   f. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
   g. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
4. Pipe Label Color Schedule:
   a. Low-Pressure, Compressed-Air Piping:
      1) Background Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
      2) Letter Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
   b. Medium-Pressure, Compressed-Air Piping:
      1) Background Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.

   2) Letter Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
  c. Domestic Water Piping:
   1) Background Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
   2) Letter Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
  d. Sanitary Waste and Storm Drainage Piping:
   1) Background Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
   2) Letter Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.

D. Valve-Tag Installation
 1. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
 2. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
  a. Valve-Tag Size and Shape:
   1) Cold Water: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, round **OR** square, **as directed**.
   2) Hot Water: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, round **OR** square, **as directed**.
   3) Low-Pressure Compressed Air: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, round **OR** square, **as directed**.
   4) High-Pressure Compressed Air: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, round **OR** square, **as directed**.
  b. Valve-Tag Color:
   1) Cold Water: Natural **OR** Green, **as directed**.
   2) Hot Water: Natural **OR** Green, **as directed**.
   3) Low-Pressure Compressed Air: Natural **OR** Green, **as directed**.
   4) High-Pressure Compressed Air: Natural **OR** Green, **as directed**.
  c. Letter Color:
   1) Cold Water: Black **OR** White, **as directed**.
   2) Hot Water: Black **OR** White, **as directed**.
   3) Low-Pressure Compressed Air: Black **OR** White, **as directed**.
   4) High-Pressure Compressed Air: Black **OR** White, **as directed**.

E. Warning-Tag Installation
 1. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 22 05 53 00

SECTION 22 05 76 00 - SANITARY SEWERAGE

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for sanitary sewerage. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Pipe and fittings.
b. Nonpressure and pressure couplings.
c. Expansion joints and deflection fittings.
d. Backwater valves.
e. Cleanouts.
f. Encasement for piping.
g. Manholes.

C. Definitions
1. FRP: Fiberglass-reinforced plastic.

D. Submittals
1. Product Data: For the following:
a. Expansion joints and deflection fittings.
b. Backwater valves.
2. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.
3. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
4. Profile Drawings: Show system piping in elevation. Draw profiles to horizontal scale of not less than 1 inch equals 50 feet (1:500) and to vertical scale of not less than 1 inch equals 5 feet (1:50). Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.
5. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.
6. Field quality-control reports.

E. Delivery, Storage, And Handling
1. Do not store plastic manholes, pipe, and fittings in direct sunlight.
2. Protect pipe, pipe fittings, and seals from dirt and damage.
3. Handle manholes according to manufacturer's written rigging instructions.

F. Project Conditions
1. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
a. Notify the Owner no fewer than two days in advance of proposed interruption of service.
b. Do not proceed with interruption of service without the Owner written permission.

1.2 PRODUCTS

A. Hub-And-Spigot, Cast-Iron Soil Pipe And Fittings
1. Pipe and Fittings: ASTM A 74, Service class **OR** Service and Extra-Heavy classes **OR** Extra-Heavy class, **as directed**.
2. Gaskets: ASTM C 564, rubber.
3. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

B. Hubless Cast-Iron Soil Pipe And Fittings
1. Pipe and Fittings: ASTM A 888 or CISPI 301.
2. CISPI-Trademark, Shielded Couplings:
   a. Description: ASTM C 1277 and CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
3. Heavy-Duty, Shielded Couplings:
   a. Description: ASTM C 1277 and ASTM C 1540, with stainless-steel shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
4. Cast-Iron, Shielded Couplings:
   a. Description: ASTM C 1277 with ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.
5. Unshielded Couplings:
   a. Description: ASTM C 1277 and ASTM C 1461, rigid, sleeve-type, reducing- or transition-type mechanical coupling, with integral, center pipe stop, molded from ASTM C 1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

C. Ductile-Iron, Gravity Sewer Pipe And Fittings
1. Pipe: ASTM A 746, for push-on joints.
2. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.
3. Compact Fittings: AWWA C153, ductile iron, for push-on joints.
4. Gaskets: AWWA C111, rubber.

D. Ductile-Iron, Pressure Pipe And Fittings
1. Push-on-Joint Piping:
   a. Pipe: AWWA C151.
   b. Standard Fittings: AWWA C110, ductile or gray iron.
   c. Compact Fittings: AWWA C153.
   d. Gaskets: AWWA C111, rubber, of shape matching pipe and fittings.
2. Mechanical-Joint Piping:
   a. Pipe: AWWA C151, with bolt holes in bell.
   b. Standard Fittings: AWWA C110, ductile or gray iron, with bolt holes in bell.
   c. Compact Fittings: AWWA C153, with bolt holes in bells.
   d. Glands: Cast or ductile iron; with bolt holes and high-strength, cast-iron or high-strength, low-alloy steel bolts and nuts.
   e. Gaskets: AWWA C111, rubber, of shape matching pipe, fittings, and glands.

E. ABS Pipe And Fittings
1. ABS Sewer Pipe and Fittings: ASTM D 2751, with bell-and-spigot ends for gasketed joints.
   a. NPS 3 to NPS 6 (DN 80 to DN 150): SDR 35.
   b. NPS 8 to NPS 12 (DN 200 to DN 300): SDR 42.
2. Gaskets: ASTM F 477, elastomeric seals.

F. PVC Pipe And Fittings

1. PVC Cellular-Core Sewer Piping:
   a. Pipe: ASTM F 891, Sewer and Drain Series, PS 50 minimum stiffness, PVC cellular-core pipe with plain ends for solvent-cemented joints.
   b. Fittings: ASTM D 3034, SDR 35, PVC socket-type fittings.
2. PVC Corrugated Sewer Piping:
   a. Pipe: ASTM F 949, PVC corrugated pipe with bell-and-spigot ends for gasketed joints.
   b. Fittings: ASTM F 949, PVC molded or fabricated, socket type.
   c. Gaskets: ASTM F 477, elastomeric seals.
3. PVC Profile Sewer Piping:
   a. Pipe: ASTM F 794, PVC profile, gravity sewer pipe with bell-and-spigot ends for gasketed joints.
   b. Fittings: ASTM D 3034, PVC with bell ends.
   c. Gaskets: ASTM F 477, elastomeric seals.
4. PVC Type PSM Sewer Piping:
   a. Pipe: ASTM D 3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
   b. Fittings: ASTM D 3034, PVC with bell ends.
   c. Gaskets: ASTM F 477, elastomeric seals.
5. PVC Gravity Sewer Piping:
   a. Pipe and Fittings: ASTM F 679, T-1 **OR** T-2, **as directed**, wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.
6. PVC Pressure Piping:
   a. Pipe: AWWA C900, Class 100 **OR** Class 150 **OR** Class 200, **as directed**, PVC pipe with bell-and-spigot ends for gasketed joints.
   b. Fittings: AWWA C900, Class 100 **OR** Class 150 **OR** Class 200, **as directed**, PVC pipe with bell ends.
   c. Gaskets: ASTM F 477, elastomeric seals.
7. PVC Water-Service Piping:
   a. Pipe: ASTM D 1785, Schedule 40 **OR** Schedule 80, **as directed**, PVC, with plain ends for solvent-cemented joints.
   b. Fittings: ASTM D 2466, Schedule 40 **OR** ASTM D 2467, Schedule 80, **as directed**, PVC, socket type.

G. Fiberglass Pipe And Fittings
1. Fiberglass Sewer Pipe: ASTM D 3262, RTRP, for gasketed joints fabricated with Type 2, polyester **OR** Type 4, epoxy, **as directed**, resin.
   a. Liner: Reinforced thermoset **OR** Nonreinforced thermoset **OR** Thermoplastic **OR** No liner, **as directed**.
   b. Grade: Reinforced, surface layer matching pipe resin **OR** Nonreinforced, surface layer matching pipe resin **OR** No surface layer, **as directed**.
   c. Stiffness: 9 psig (62 kPa) **OR** 18 psig (124 kPa) **OR** 36 psig (248 kPa) **OR** 72 psig (496 kPa), **as directed**.
2. Fiberglass Nonpressure Fittings: ASTM D 3840, RTRF, for gasketed joints.
   a. Laminating Resin: Type 1, polyester **OR** Type 2, epoxy, **as directed**, resin.
   b. Reinforcement: Grade with finish compatible with resin.
3. Gaskets: ASTM F 477, elastomeric seals.

H. Concrete Pipe And Fittings
1. Nonreinforced-Concrete Sewer Pipe and Fittings: ASTM C 14 (ASTM C 14M), Class 1 **OR** Class 2 **OR** Class 3, **as directed**, with bell-and-spigot **OR** tongue-and-groove, **as directed**, ends for gasketed joints with ASTM C 443 (ASTM C 443M), rubber gaskets.
2. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76 (ASTM C 76M).
   a. Bell-and-spigot **OR** tongue-and-groove, **as directed**, ends for gasketed joints, with ASTM C 443 (ASTM C 443M), rubber gaskets.
   b. Class II, Wall A **OR** Wall B **OR** Wall C, **as directed**.

c. Class III, Wall A **OR** Wall B **OR** Wall C, **as directed**.
d. Class IV, Wall A **OR** Wall B **OR** Wall C, **as directed**.
e. Class V, Wall A **OR** Wall B, **as directed**.

I. Nonpressure-Type Transition Couplings
1. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.
2. Sleeve Materials:
a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
b. For Concrete Pipes: ASTM C 443 (ASTM C 443M), rubber.
c. For Fiberglass Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
d. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
e. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
3. Unshielded, Flexible Couplings:
a. Description: Elastomeric sleeve, with stainless-steel shear ring, **as directed**, and corrosion-resistant-metal tension band and tightening mechanism on each end.
4. Shielded, Flexible Couplings:
a. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
5. Ring-Type, Flexible Couplings:
a. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.
6. Nonpressure-Type, Rigid Couplings:
a. Description: ASTM C 1461, sleeve-type, reducing- or transition-type mechanical coupling, molded from ASTM C 1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

J. Pressure-Type Pipe Couplings
1. Tubular-Sleeve Couplings: AWWA C219, with center sleeve, gaskets, end rings, and bolt fasteners.
2. Metal, bolted, sleeve-type, reducing or transition coupling, for joining underground pressure piping. Include 150-psig (1035-kPa) **OR** 200-psig (1380-kPa), **as directed**, minimum pressure rating and ends of same sizes as piping to be joined.
3. Center-Sleeve Material: Manufacturer's standard **OR** Carbon steel **OR** Stainless steel **OR** Ductile iron **OR** Malleable iron, **as directed**.
4. Gasket Material: Natural or synthetic rubber.
5. Metal Component Finish: Corrosion-resistant coating or material.

K. Expansion Joints And Deflection Fittings
1. Ductile-Iron, Flexible Expansion Joints:
a. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig (1725-kPa) minimum working pressure and for offset and expansion indicated.
2. Ductile-Iron Expansion Joints:
a. Description: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Include rating for 250-psig (1725-kPa) minimum working pressure and for expansion indicated.
3. Ductile-Iron Deflection Fittings:

a. Description: Compound coupling fitting with ball joint, flexing section, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include rating for 250-psig (1725-kPa) minimum working pressure and for up to 15 degrees of deflection.

L. Backwater Valves
1. Cast-Iron Backwater Valves:
a. Description: ASME A112.14.1, gray-iron body and bolted cover, with bronze seat.
b. Horizontal type; with swing check valve and hub-and-spigot ends.
c. Combination horizontal and manual gate-valve type; with swing check valve, integral gate valve, and hub-and-spigot ends.
d. Terminal type; with bronze seat, swing check valve, and hub inlet.
2. PVC Backwater Valves:
a. Description: Horizontal type; with PVC body, PVC removable cover, and PVC swing check valve.

M. Cleanouts
1. Cast-Iron Cleanouts:
a. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
b. Top-Loading Classification(s): Light Duty **OR** Medium Duty **OR** Heavy Duty **OR** Extra-Heavy Duty, **as directed**.
c. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.
2. PVC Cleanouts:
a. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

N. Encasement For Piping
1. Standard: ASTM A 674 or AWWA C105.
2. Material: Linear low-density polyethylene film of 0.008-inch (0.20-mm) **OR** high-density, cross-laminated polyethylene film of 0.004-inch (0.10-mm), **as directed**, minimum thickness.
3. Form: Sheet **OR** Tube, **as directed**.
4. Color: Black **OR** Natural, **as directed**.

O. Manholes
1. Standard Precast Concrete Manholes:
a. Description: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
b. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
c. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
d. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (100-mm) minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
e. Riser Sections: 4-inch (100-mm) minimum thickness, of length to provide depth indicated.
f. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
g. Joint Sealant: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.
h. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
i. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, **as directed**; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor

steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).

j. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
OR
Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

2. Designed Precast Concrete Manholes:
   a. Description: ASTM C 913; designed according to ASTM C 890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
   b. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.
   c. Joint Sealant: ASTM C 990 (ASTM 990M), bitumen or butyl rubber.
   d. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
   e. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, **as directed**; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).
   f. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
   OR
   Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.
3. Fiberglass Manholes:
   a. Description: ASTM D 3753.
   b. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
   c. Ballast: Increase thickness of concrete base as required to prevent flotation.
   d. Base Section: Concrete, 6-inch (150-mm) minimum thickness.
   e. Resilient Pipe Connectors (if required): ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
   f. Steps: Individual FRP steps or FRP ladder, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).
   g. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
   OR
   Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.
4. Manhole Frames and Covers:

a. Description: Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser, with 4-inch- (100-mm-) minimum-width flange and 26-inch- (660-mm-) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
b. Material: ASTM A 536, Grade 60-40-18 ductile **OR** ASTM A 48/A 48M, Class 35 gray, **as directed**, iron unless otherwise indicated.

5. Manhole-Cover Inserts:
   a. Description: Manufactured, plastic form, of size to fit between manhole frame and cover and designed to prevent stormwater inflow. Include handle for removal and gasket for gastight sealing.
   b. Type: Solid **OR** Drainage with vent holes **OR** Valve, **as directed**.

P. Concrete
1. General: Cast-in-place concrete complying with ACI 318, ACI 350/350R (ACI 350M/350RM), and the following:
   a. Cement: ASTM C 150, Type II.
   b. Fine Aggregate: ASTM C 33, sand.
   c. Coarse Aggregate: ASTM C 33, crushed gravel.
   d. Water: Potable.
2. Portland Cement Design Mix: 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio.
   a. Reinforcing Fabric: ASTM A 1064/A 1064M, steel, welded wire fabric, plain.
   b. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.
3. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
   a. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
      1) Invert Slope: 1 **OR** 2, **as directed**, percent through manhole.
   b. Benches: Concrete, sloped to drain into channel.
      1) Slope: 4 **OR** 8, **as directed**, percent.
4. Ballast and Pipe Supports: Portland cement design mix, 3000 psi (20.7 MPa) minimum, with 0.58 maximum water/cementitious materials ratio.
   a. Reinforcing Fabric: ASTM A 1064/A 1064M, steel, welded wire fabric, plain.
   b. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

1.3 EXECUTION

A. Earthwork
1. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving".

B. Piping Installation
1. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
2. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
3. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
4. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

5. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
6. Install gravity-flow, nonpressure, drainage piping according to the following:
   a. Install piping pitched down in direction of flow, at minimum slope of 1 **OR** 2, **as directed**, percent unless otherwise indicated.
   b. Install piping NPS 6 (DN 150) and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
   c. Install piping with 36-inch (915-mm) **OR** 48-inch (1220-mm) **OR** 60-inch (1520-mm) **OR** 72-inch (1830-mm), **as directed**, minimum cover.
   d. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
   e. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
   f. Install ductile-iron, gravity sewer piping according to ASTM A 746.
   g. Install ABS sewer piping according to ASTM D 2321 and ASTM F 1668.
   h. Install PVC cellular-core sewer piping according to ASTM D 2321 and ASTM F 1668.
   i. Install PVC corrugated sewer piping according to ASTM D 2321 and ASTM F 1668.
   j. Install PVC profile sewer piping according to ASTM D 2321 and ASTM F 1668.
   k. Install PVC Type PSM sewer piping according to ASTM D 2321 and ASTM F 1668.
   l. Install PVC gravity sewer piping according to ASTM D 2321 and ASTM F 1668.
   m. Install fiberglass sewer piping according to ASTM D 3839 and ASTM F 1668.
   n. Install nonreinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
   o. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
7. Install force-main, pressure piping according to the following:
   a. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
   b. Install piping with 36-inch (915-mm) **OR** 48-inch (1220-mm) **OR** 60-inch (1520-mm) **OR** 72-inch (1830-mm), **as directed**, minimum cover.
   c. Install ductile-iron pressure piping according to AWWA C600 or AWWA M41.
   d. Install ductile-iron special fittings according to AWWA C600.
   e. Install PVC pressure piping according to AWWA M23 or to ASTM D 2774 and ASTM F 1668.
   f. Install PVC water-service piping according to ASTM D 2774 and ASTM F 1668.
8. If required to provide protection for metal piping, install corrosion-protection piping encasement over the following underground metal piping according to ASTM A 674 or AWWA C105:
   a. Hub-and-spigot, cast-iron soil pipe.
   b. Hubless cast-iron soil pipe and fittings.
   c. Ductile-iron pipe and fittings.
   d. Expansion joints and deflection fittings.
9. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

C. Pipe Joint Construction
1. Join gravity-flow, nonpressure, drainage piping according to the following:
   a. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
   b. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
   c. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

d. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
e. Join ABS sewer piping according to ASTM D 2321 and ASTM D 2751 for elastomeric-seal joints.
f. Join PVC cellular-core sewer piping according to ASTM D 2321 and ASTM F 891 for solvent-cemented joints.
g. Join PVC corrugated sewer piping according to ASTM D 2321.
h. Join PVC profile sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
i. Join PVC Type PSM sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
j. Join PVC gravity sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
k. Join fiberglass sewer piping according to ASTM D 4161 for elastomeric-seal joints.
l. Join nonreinforced-concrete sewer piping according to ASTM C 14 (ASTM C 14M) and ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
m. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
n. Join dissimilar pipe materials with nonpressure-type, flexible **OR** rigid, **as directed**, couplings.

2. Join force-main, pressure piping according to the following:
   a. Join ductile-iron pressure piping according to AWWA C600 or AWWA M41 for push-on joints.
   b. Join ductile-iron special fittings according to AWWA C600 or AWWA M41 for push-on joints.
   c. Join PVC pressure piping according to AWWA M23 for gasketed joints.
   d. Join PVC water-service piping according to ASTM D 2855.
   e. Join dissimilar pipe materials with pressure-type couplings.
3. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
   a. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
      1) Unshielded **OR** Shielded, **as directed**, flexible **OR** rigid, **as directed**, couplings for pipes of same or slightly different OD.
      2) Unshielded, increaser/reducer-pattern, flexible **OR** rigid, **as directed**, couplings for pipes with different OD.
      3) Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
   b. Use pressure pipe couplings for force-main joints.

D. Manhole Installation
1. General: Install manholes complete with appurtenances and accessories indicated.
2. Install precast concrete manhole sections with sealants according to ASTM C 891.
3. Install FRP manholes according to manufacturer's written instructions.
4. Form continuous concrete channels and benches between inlets and outlet.
5. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches (76 mm) above finished surface elsewhere unless otherwise indicated.
6. Install manhole-cover inserts in frame and immediately below cover.

E. Concrete Placement
1. Place cast-in-place concrete according to ACI 318.

F. Backwater Valve Installation
1. Install horizontal-type backwater valves in piping manholes or pits.
2. Install combination horizontal and manual gate valves in piping and in manholes.
3. Install terminal-type backwater valves on end of piping and in manholes. Secure units to sidewalls.

G. Cleanout Installation

1. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
   a. Use Light-Duty, top-loading classification cleanouts in earth **OR** unpaved foot-traffic, **as directed**, areas.
   b. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
   c. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
   d. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.
2. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches (450 by 450 by 300 mm) deep. Set with tops 1 inch (25 mm) above surrounding grade.
3. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

H. Connections

1. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 22 Section "Sanitary Waste And Vent Piping".
2. Connect force-main piping to building's sanitary force mains specified in Division 22 Section "Sanitary Waste And Vent Piping". Terminate piping where indicated.
3. Make connections to existing piping and underground manholes.
   a. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch (150-mm) overlap with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
   b. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500). Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
   c. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches (76 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches (150 mm) of concrete for minimum length of 12 inches (300 mm) to provide additional support of collar from connection to undisturbed ground.
      1) Use concrete that will attain a minimum 28-day compressive strength of 3000 psi (20.7 MPa) unless otherwise indicated.
      2) Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
   d. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
4. Connect to grease **OR** oil **OR** sand, **as directed**, interceptors specified in Division 22 Section "Sanitary Waste Interceptors".

I. Closing Abandoned Sanitary Sewer Systems

1. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
   a. Close open ends of piping with at least 8-inch- (203-mm-) thick, brick masonry bulkheads.
   b. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
2. Abandoned Manholes: Excavate around manhole as required and use either procedure below:
   a. Remove manhole and close open ends of remaining piping.

b. Remove top of manhole down to at least 36 inches (915 mm) below final grade. Fill to within 12 inches (300 mm) of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

3. Backfill to grade according to Division 31 Section "Earth Moving".

J. Identification

1. Materials and their installation are specified in Division 31 Section "Earth Moving". Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.
   a. Use warning tape **OR** detectable warning tape, **as directed**, over ferrous piping.
   b. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

K. Field Quality Control

1. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (600 mm) of backfill is in place, and again at completion of Project.
   a. Submit separate report for each system inspection.
   b. Defects requiring correction include the following:
      1) Alignment: Less than full diameter of inside of pipe is visible between structures.
      2) Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
      3) Damage: Crushed, broken, cracked, or otherwise damaged piping.
      4) Infiltration: Water leakage into piping.
      5) Exfiltration: Water leakage from or around piping.
   c. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
   d. Reinspect and repeat procedure until results are satisfactory.
2. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
   a. Do not enclose, cover, or put into service before inspection and approval.
   b. Test completed piping systems according to requirements of authorities having jurisdiction.
   c. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
   d. Submit separate report for each test.
   e. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
      1) Fill sewer piping with water. Test with pressure of at least 10-foot (3-m) head of water, and maintain such pressure without leakage for at least 15 minutes.
      2) Close openings in system and fill with water.
      3) Purge air and refill with water.
      4) Disconnect water supply.
      5) Test and inspect joints for leaks.

      OR

      Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
      6) Option: Test plastic gravity sewer piping according to ASTM F 1417.
      7) Option: Test concrete gravity sewer piping according to ASTM C 924 (ASTM C 924M).
   f. Force Main: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 150 psig (1035 kPa).
      1) Ductile-Iron Piping: Test according to AWWA C600, "Hydraulic Testing" Section.
      2) PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.
   g. Manholes: Perform hydraulic test according to ASTM C 969 (ASTM C 969M).
3. Leaks and loss in test pressure constitute defects that must be repaired.

4. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

L. Cleaning
   1. Clean dirt and superfluous material from interior of piping. Flush with potable water.

END OF SECTION 22 05 76 00

SECTION 22 05 76 00a - STORM DRAINAGE PIPING SPECIALTIES

1.1 GENERAL

A. Description Of Work
  1. This specification covers the furnishing and installation of materials for storm drainage piping specialties. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
  1. Section Includes:
    a. Roof drains.
    b. Miscellaneous storm drainage piping specialties.
    c. Cleanouts.
    d. Backwater valves.
    e. Trench drains.
    f. Channel drainage systems.
    g. Through-penetration firestop assemblies.
    h. Flashing materials.

C. Submittals
  1. Product Data: For each type of product indicated.

D. Quality Assurance
  1. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

1.2 PRODUCTS

A. Metal Roof Drains
  1. Cast-Iron, Large-Sump, General-Purpose Roof Drains:
    a. Standard: ASME A112.6.4, for general-purpose roof drains.
    b. Body Material: Cast iron.
    c. Dimension of Body: Nominal 14-inch (357-mm) diameter.
    d. Combination Flashing Ring and Gravel Stop: Not required **OR** Required, **as directed**.
    e. Flow-Control Weirs: Not required **OR** Required, **as directed**.
    f. Outlet: Bottom **OR** Side, **as directed**.
    g. Extension Collars: Not required **OR** Required, **as directed**.
    h. Underdeck Clamp: Not required **OR** Required, **as directed**.
    i. Expansion Joint: Not required **OR** Required, **as directed**.
    j. Sump Receiver Plate: Not required **OR** Required, **as directed**.
    k. Dome Material: Aluminum **OR** Cast iron **OR** PE **OR** Stainless steel, **as directed**.
    l. Perforated Gravel Guard: Stainless steel **OR** Not required, **as directed**.
    m. Vandal-Proof Dome: Not required **OR** Required, **as directed**.
    n. Water Dam: Not required **OR** 2 inches (51 mm) high, **as directed**.
  2. Cast-Iron, Medium-Sump, General-Purpose Roof Drains:
    a. Standard: ASME A112.6.4, for general-purpose roof drains.
    b. Body Material: Cast iron.
    c. Dimension of Body: 8- to 12-inch (203- to 305-mm) diameter.
    d. Combination Flashing Ring and Gravel Stop: Not required **OR** Required, **as directed**.
    e. Flow-Control Weirs: Not required **OR** Required, **as directed**.
    f. Outlet: Bottom **OR** Side, **as directed**.
    g. Extension Collars: Not required **OR** Required, **as directed**.

h. Underdeck Clamp: Not required **OR** Required, **as directed**.
i. Expansion Joint: Not required **OR** Required, **as directed**.
j. Sump Receiver Plate: Not required **OR** Required, **as directed**.
k. Dome Material: Aluminum **OR** Cast iron **OR** Copper **OR** PE **OR** Stainless steel, **as directed**.
l. Wire Mesh: Stainless steel or brass over dome **OR** Not required, **as directed**.
m. Perforated Gravel Guard: Stainless steel **OR** Not required, **as directed**.
n. Vandal-Proof Dome: Not required **OR** Required, **as directed**.
o. Water Dam: Not required **OR** 2 inches (51 mm) high, **as directed**.

3. Copper, Medium-Sump, General-Purpose Roof Drains:
a. Standard: ASME A112.6.4, for general-purpose roof drains.
b. Body Material: Copper.
c. Dimension of Body: 8- to 12-inch (203- to 305-mm) diameter.
d. Combination Flashing Ring and Gravel Stop: Not required **OR** Required, **as directed**.
e. Flow-Control Weirs: Not required **OR** Required, **as directed**.
f. Outlet: Bottom **OR** Side, **as directed**.
g. Extension Collars: Not required **OR** Required, **as directed**.
h. Underdeck Clamp: Not required **OR** Required, **as directed**.
i. Expansion Joint: Not required **OR** Required, **as directed**.
j. Sump Receiver Plate: Not required **OR** Required, **as directed**.
k. Dome Material: Aluminum **OR** Cast iron **OR** Copper **OR** PE **OR** Stainless steel, **as directed**.
l. Wire Mesh: Stainless steel or brass over dome **OR** Not required, **as directed**.
m. Perforated Gravel Guard: Stainless steel **OR** Not required, **as directed**.
n. Vandal-Proof Dome: Not required **OR** Required, **as directed**.
o. Water Dam: Not required **OR** 2 inches (51 mm) high, **as directed**.

4. Cast-Iron, Small-Sump, General-Purpose Roof Drains:
a. Standard: ASME A112.6.4, for general-purpose roof drains.
b. Body Material: Cast iron.
c. Dimension of Body: Nominal 8-inch (203-mm) diameter.
d. Combination Flashing Ring and Gravel Stop: Not required **OR** Required, **as directed**.
e. Outlet: Bottom **OR** Side, **as directed**.
f. Extension Collars: Not required **OR** Required, **as directed**.
g. Underdeck Clamp: Not required **OR** Required, **as directed**.
h. Expansion Joint: Not required **OR** Required, **as directed**.
i. Sump Receiver Plate: Not required **OR** Required, **as directed**.
j. Dome Material: Cast iron.
k. Wire Mesh: Stainless steel or brass over dome **OR** Not required, **as directed**.
l. Vandal-Proof Dome: Not required **OR** Required, **as directed**.

5. Copper, Small-Sump, General-Purpose Roof Drains:
a. Standard: ASME A112.6.4, for general-purpose roof drains.
b. Body Material: Copper.
c. Dimension of Body: Nominal 8-inch (203-mm) diameter.
d. Combination Flashing Ring and Gravel Stop: Not required **OR** Required, **as directed**.
e. Outlet: Bottom **OR** Side, **as directed**.
f. Extension Collars: Not required **OR** Required, **as directed**.
g. Underdeck Clamp: Not required **OR** Required, **as directed**.
h. Expansion Joint: Not required **OR** Required, **as directed**.
i. Sump Receiver Plate: Not required **OR** Required, **as directed**.
j. Dome Material: Cast iron.
k. Wire Mesh: Stainless steel or brass over dome **OR** Not required, **as directed**.
l. Vandal-Proof Dome: Not required **OR** Required, **as directed**.

6. Metal, Cornice and Gutter Roof Drains:
a. Standard: ASME A112.6.4, for cornice and gutter roof drains.
b. Body Material: Metal.

c. Dimension of Body: Nominal 6-inch (152-mm) diameter.
d. Outlet: Bottom **OR** Side **OR** 45-degree angle, **as directed**.
e. Dome Material: Bronze.
f. Vandal-Proof Dome: Not required **OR** Required, **as directed**.

7. Metal, Parapet Roof Drains:
   a. Standard: ASME A112.6.4, for parapet roof drains.
   b. Body Material: Cast iron.
   c. Outlet: Back **OR** Angle, **as directed**.
   d. Grate Material: Bronze **OR** Cast iron **OR** Nickel-bronze alloy, **as directd**.
   e. Vandal-Proof Grate: Not required **OR** Required, **as directed**.
8. Metal, Large-Sump, Promenade Roof Drains:
   a. Standard: ASME A112.6.4, for promenade roof drains.
   b. Body Material: Cast iron.
   c. Dimension of Body: Nominal 14-inch (357-mm) diameter.
   d. Dimension of Frame and Grate: Nominal 14 inches (357 mm) square.
   e. Outlet: Bottom.
   f. Grate Material: Bronze **OR** Cast iron **OR** Nickel-bronze alloy, **as directed**.
   g. Vandal-Proof Grate: Not required **OR** Required, **as directed**.
   h. Extension Collars: Not required **OR** Required, **as directed**.
   i. Underdeck Clamp: Not required **OR** Required, **as directed**.
   j. Expansion Joint: Not required **OR** Required, **as directed**.
   k. Sump Receiver Plate: Not required **OR** Required, **as directed**.
9. Metal, Medium-Sump, Promenade Roof Drains:
   a. Standard: ASME A112.6.4, for promenade roof drains.
   b. Body Material: Cast iron.
   c. Dimension of Body: 11- to 12-inch (280- to 305-mm) diameter.
   d. Dimension of Frame and Grate: Nominal 12 inches (305 mm) square.
   e. Outlet: Bottom.
   f. Grate Material: Bronze **OR** Cast iron **OR** Nickel-bronze alloy, **as directed**.
   g. Vandal-Proof Grate: Not required **OR** Required, **as directed**.
   h. Extension Collars: Not required **OR** Required, **as directed**.
   i. Underdeck Clamp: Not required **OR** Required, **as directed**.
   j. Expansion Joint: Not required **OR** Required, **as directed**.
   k. Sump Receiver Plate: Not required **OR** Required, **as directed**.
10. Metal, Small-Sump, Promenade Roof Drains:
    a. Standard: ASME A112.6.4, for promenade roof drains.
    b. Body Material: Cast iron.
    c. Dimension of Body: Nominal 8-inch (203-mm) diameter.
    d. Dimension of Frame and Grate: Nominal 8 inches (203 mm) square.
    e. Outlet: Bottom.
    f. Grate Material: Bronze **OR** Cast iron **OR** Nickel-bronze alloy, **as directed**.
    g. Vandal-Proof Grate: Not required **OR** Required, **as directed**.
    h. Extension Collars: Not required **OR** Required, **as directed**.
    i. Underdeck Clamp: Not required **OR** Required, **as directed**.
    j. Expansion Joint: Not required **OR** Required, **as directed**.
    k. Sump Receiver Plate: Not required **OR** Required, **as directed**.
11. Metal, Medium-Sump, Deck Roof Drains:
    a. Standard: ASME A112.6.4, for deck roof drains; ASME A112.6.3, for floor drains.
    b. Body Material: Metal.
    c. Flange: Anchor **OR** Anchor with weep holes **OR** Not required, **as directed**.
    d. Clamping Device: Not required **OR** Required, **as directed**.
    e. Integral Backwater Valve: Not required **OR** Required, **as directed**.
    f. Outlet: Bottom **OR** End **OR** Side, **as directed**.
    g. Grate Material: Cast iron.
    h. Grate Finish: Painted **OR** Not required, **as directed**.

i. Overall Dimension of Frame and Grate: Nominal 14 inches (357 mm) round **OR** square, **as directed**.
j. Top-Loading Classification: Extra-Heavy Duty **OR** Heavy Duty, **as directed**.
k. Vandal-Proof Frame and Grate: Not required **OR** Required, **as directed**.

12. Metal, Small-Sump, Deck Roof Drains:
    a. Standard: ASME A112.6.4, for deck roof drains; ASME A112.6.3, for floor drains.
    b. Body Material: Metal.
    c. Flange: Anchor **OR** Anchor with weep holes **OR** Not required, **as directed**.
    d. Clamping Device: Not required **OR** Required, **as directed**.
    e. Integral Backwater Valve: Not required **OR** Required, **as directed**.
    f. Outlet: Bottom **OR** End **OR** Side, **as directed**.
    g. Grate Material: Cast iron.
    h. Grate Finish: Painted **OR** Not required, **as directed**.
    i. Overall Dimension of Frame and Grate: Nominal 8 inches (203 mm) round **OR** square, **as directed**.
    j. Top-Loading Classification: Extra-Heavy Duty **OR** Heavy Duty **OR** Light Duty **OR** Medium Duty, **as directed**.
    k. Vandal-Proof Frame and Grate: Not required **OR** Required, **as directed**.

B. Plastic Roof Drains
1. Plastic Roof Drains:
    a. Standard: ASME A112.6.4, for plastic roof drains.
    b. Body Material: ABS or PVC.
    c. Sump Diameter: <**Insert nominal dimension**>.
    d. Combination Flashing Ring and Gravel Stop: Not required **OR** Required, **as directed**.
    e. Outlet: Bottom.
    f. Extension Collars: Not required **OR** Required, **as directed**.
    g. Underdeck Clamp: Not required **OR** Required, **as directed**.
    h. Expansion Joint: Not required **OR** Required, **as directed**.
    i. Sump Receiver Plate: Not required **OR** Required, **as directed**.
    j. Dome Material: Aluminum **OR** Cast iron **OR** PE **OR** Stainless steel, **as directed**.
    k. Vandal-Proof Dome: Not required **OR** Required, **as directed**.

C. Miscellaneous Storm Drainage Piping Specialties
1. Downspout Adaptors:
    a. Description: Manufactured, gray-iron casting, for attaching to horizontal-outlet, parapet roof drain and to exterior, sheet metal downspout.
    b. Size: Inlet size to match parapet drain outlet.
2. Downspout Boots:
    a. Description: Manufactured, ASTM A 48/A 48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 (DN 100) outlet; and shop-applied bituminous coating.
    b. Size: Inlet size to match downspout and NPS 4 (DN 100) outlet.
3. Conductor Nozzles:
    a. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
    b. Size: Same as connected conductor.

D. Cleanouts
1. Floor Cleanouts:
    a. Standard: ASME A112.36.2M, for adjustable housing **OR** cast-iron soil pipe with cast-iron ferrule **OR** heavy-duty, adjustable housing **OR** threaded, adjustable housing, **as directed**, cleanouts.
    b. Size: Same as connected branch.
    c. Type: Adjustable housing **OR** Cast-iron soil pipe with cast-iron ferrule **OR** Heavy-duty, adjustable housing **OR** Threaded, adjustable housing, **as directed**.
    d. Body or Ferrule Material: Cast iron **OR** Stainless steel, **as directed**.

e. Clamping Device: Not required **OR** Required, **as directed**.
f. Outlet Connection: Inside calk **OR** Spigot **OR** Threaded, **as directed**.
g. Closure: Brass plug with straight threads and gasket **OR** Brass plug with tapered threads **OR** Cast-iron plug **OR** Plastic plug, **as directed**.
h. Adjustable Housing Material: Cast iron **OR** Plastic, **as directed**, with threads **OR** set-screws or other device, **as directed**.
i. Frame and Cover Material and Finish: Nickel-bronze, copper alloy **OR** Painted cast iron **OR** Polished bronze **OR** Rough bronze **OR** Stainless steel, **as directed**.
j. Frame and Cover Shape: Round **OR** Square, **as directed**.
k. Top-Loading Classification: Extra-Heavy Duty **OR** Heavy Duty **OR** Light Duty **OR** Medium Duty, **as directed**.
l. Riser: ASTM A 74, Extra-Heavy **OR** Service, **as directed**, class, cast-iron drainage pipe fitting and riser to cleanout.

2. Test Tees:
a. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301, for cleanout test tees.
b. Size: Same as connected drainage piping.
c. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or hubless, cast-iron soil-pipe test tee as required to match connected piping.
d. Closure Plug: Countersunk or raised head, brass.
e. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

3. Wall Cleanouts:
a. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
b. Size: Same as connected drainage piping.
c. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch **OR** Hubless, cast-iron soil-pipe test tee, **as directed**, as required to match connected piping.
d. Closure: Countersunk **OR** Countersunk or raised-head **OR** Raised-head, **as directed**, drilled-and-threaded **OR** brass **OR** cast-iron, **as directed**, plug.
e. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
f. Wall Access: Round, deep, chrome-plated bronze **OR** flat, chrome-plated brass or stainless-steel, **as directed**, cover plate with screw.
g. Wall Access: Round **OR** Square, **as directed**, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

4. Plastic Floor Cleanouts:
a. Size: Same as connected branch.
b. Body Material: PVC.
c. Closure Plug: PVC.
d. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

E. Backwater Valves

1. Cast-Iron, Horizontal Backwater Valves:
a. Standard: ASME A112.14.1, for backwater valves.
b. Size: Same as connected piping.
c. Body Material: Cast iron.
d. Cover: Cast iron with bolted or threaded access check valve.
e. End Connections: Hub and spigot or hubless.
f. Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed **OR** open for airflow unless subject to backflow condition, **as directed**.
g. Extension: ASTM A 74, Service class; full-size, cast-iron soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

2. Cast-Iron, Drain-Outlet Backwater Valves:
a. Size: Same as floor drain outlet.
b. Body Material: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
c. Check Valve: Removable ball float.
d. Inlet: Threaded.

e. Outlet: Threaded or spigot.
3. Plastic, Horizontal Backwater Valves:
a. Standard: ASME A112.14.1, for backwater valves.
b. Size: Same as connected piping.
c. Body Material: ABS **OR** PVC, **as directed.**
d. Cover: Same material as body with threaded access to check valve.
e. Check Valve: Removable swing check.
f. End Connections: Socket type.

F. Trench Drains
1. Trench Drains:
a. Standard: ASME A112.6.3, for trench drains.
b. Body Material: Cast iron.
c. Flange: Anchor **OR** Anchor with weep holes **OR** Not required, **as directed.**
d. Clamping Device: Not required **OR** Required, **as directed.**
e. Outlet: Bottom **OR** End **OR** Side, **as directed.**
f. Grate Material: Ductile iron or gray iron **OR** stainless steel, **as directed.**
g. Grate Finish: Painted **OR** Not required, **as directed.**
h. Dimensions of Frame and Grate: <**Insert dimensions**>.
i. Top-Loading Classification: Extra-Heavy Duty **OR** Heavy Duty **OR** Light Duty **OR** Medium Duty, **as directed.**

G. Channel Drainage Systems
1. Narrow, Sloped-Invert, Polymer-Concrete, Channel Drainage Systems:
a. Type: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
1) Channel Sections: Narrow, interlocking-joint, sloped-invert, polymer-concrete modular units with end caps. Include rounded bottom, with built-in invert slope of 0.6 percent and with outlets in number, sizes, and locations indicated. Include extension sections necessary for required depth.
a) Dimensions: 4-inch (102-mm) inside width. Include number of units required to form total lengths indicated.
b) Frame: Galvanized steel or gray iron for grates **OR** Not required, **as directed.**
2) Grates: Manufacturer's designation "heavy duty" **OR** "medium duty", **as directed**, with slots or perforations, and of width and thickness that fit recesses in channel sections.
a) Material: Ductile iron **OR** Fiberglass **OR** Galvanized steel **OR** Gray iron **OR** Stainless steel, **as directed.**
b) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections **OR** Not required, **as directed.**
3) Covers: Solid ductile or gray iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.
4) Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
5) Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
2. Narrow, Level-Invert, Polymer-Concrete, Channel Drainage Systems:
a. Type: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
1) Channel Sections: Narrow, interlocking-joint, precast, polymer-concrete modular units with end caps. Include rounded bottom, with level invert and with NPS 4 (DN 100) outlets in number and locations indicated.
a) Dimensions: 5-inch (127-mm) inside width and 9-3/4-inch (248-mm) depth. Include number of units required to form total lengths indicated.

b) Frame: Galvanized steel or gray iron for grates **OR** Not required, **as directed**.

2) Grates: Manufacturer's designation "heavy duty" **OR** "medium duty", **as directed,** with slots or perforations, and of width and thickness that fit recesses in channel sections.

a) Material: Ductile iron **OR** Fiberglass **OR** Galvanized steel **OR** Gray iron **OR** Stainless steel, **as directed**.

b) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections **OR** Not required, **as directed**.

3) Covers: Solid ductile or gray iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.

4) Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.

5) Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

3. Wide, Level-Invert, Polymer-Concrete, Channel Drainage Systems:

a. Type: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.

1) Channel Sections: Wide, interlocking-joint, precast, polymer-concrete modular units with end caps. Include flat or rounded bottom, with level invert and with outlets in number, sizes, and locations indicated.

a) Dimensions: 8-inch (203-mm) inside width and 13-3/4-inch (350-mm) depth. Include number of units required to form total lengths indicated.

b) Frame: Galvanized steel or gray iron for grates **OR** Not required, **as directed**.

2) Grates: Manufacturer's designation "heavy duty" **OR** "medium duty", **as directed**, with slots or perforations, and of width and thickness that fit recesses in channel sections.

a) Material: Ductile iron **OR** Fiberglass **OR** Galvanized steel **OR** Gray iron **OR** Stainless steel, **as directed**.

b) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections **OR** Not required, **as directed**.

3) Covers: Solid ductile or gray iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.

4) Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.

5) Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

H. Through-Penetration Firestop Assemblies

1. Through-Penetration Firestop Assemblies:

a. Standard: ASTM E 814, for through-penetration firestop assemblies.

b. Certification and Listing: Intertek Testing Service NA for through-penetration firestop assemblies.

c. Size: Same as connected pipe.

d. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.

e. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.

f. Special Coating: Corrosion resistant on interior of fittings.

I. Flashing Materials

1. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft. (3.7 kg/sq. m or 0.41-mm thickness).

2. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch (1.01-mm) minimum thickness unless otherwise indicated. Include G90 (Z275) hot-dip galvanized, mill-phosphatized finish for painting if indicated.
3. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil (1.01-mm) minimum thickness.
4. Fasteners: Metal compatible with material and substrate being fastened.
5. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
6. Solder: ASTM B 32, lead-free alloy.

1.3 EXECUTION

A. Installation

1. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 7 Sections.
    a. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
    b. Install expansion joints, if indicated, in roof drain outlets.
    c. Position roof drains for easy access and maintenance.
2. Install downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.
3. Install downspout boots at grade with top 6 inches (152 mm) **OR** 12 inches (305 mm) **OR** 18 inches (457 mm), **as directed**, above grade. Secure to building wall.
4. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.
5. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
    a. Use cleanouts the same size as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
    b. Locate cleanouts at each change in direction of piping greater than 45 degrees.
    c. Locate cleanouts at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
    d. Locate cleanouts at base of each vertical soil and waste stack.
6. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
7. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
8. Install horizontal backwater valves in floor with cover flush with floor.
9. Install drain-outlet backwater valves in outlet of drains.
10. Install test tees in vertical conductors and near floor.
11. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.
12. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.
13. Assemble channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
14. Install through-penetration firestop assemblies in plastic conductors at concrete floor penetrations.
15. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

B. Connections

1. Comply with requirements for piping specified in Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

C. Flashing Installation

1. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
    a. Lead Sheets: Burn joints of 6.0-lb/sq. ft. (30-kg/sq. m) lead sheets, 0.0938-inch (2.4-mm) thickness or thicker. Solder joints of 4.0-lb/sq. ft. (20-kg/sq. m) lead sheets, 0.0625-inch (1.6-mm) thickness or thinner.
    b. Copper Sheets: Solder joints of copper sheets.
2. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
    a. Pipe Flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches (250 mm) and with skirt or flange extending at least 8 inches (200 mm) around pipe.
    b. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.
    c. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around specialty.
3. Set flashing on floors and roofs in solid coating of bituminous cement.
4. Secure flashing into sleeve and specialty clamping ring or device.
5. Fabricate and install flashing and pans, sumps, and other drainage shapes.

D. Protection
1. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
2. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 05 76 00a

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SECTION 22 07 19 00 - PLUMBING INSULATION

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for plumbing insulation. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Insulation Materials:
         1) Calcium silicate.
         2) Cellular glass.
         3) Flexible elastomeric.
         4) Mineral fiber.
         5) Phenolic.
         6) Polyisocyanurate.
         7) Polyolefin.
         8) Polystyrene.
      b. Insulating cements.
      c. Adhesives.
      d. Mastics.
      e. Lagging adhesives.
      f. Sealants.
      g. Factory-applied jackets.
      h. Field-applied fabric-reinforcing mesh.
      i. Field-applied cloths.
      j. Field-applied jackets.
      k. Tapes.
      l. Securements.
      m. Corner angles.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittal:
      a. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
   3. Shop Drawings:
      a. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
      b. Detail attachment and covering of heat tracing inside insulation.
      c. Detail insulation application at pipe expansion joints for each type of insulation.
      d. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
      e. Detail removable insulation at piping specialties, equipment connections, and access panels.
      f. Detail application of field-applied jackets.
      g. Detail application at linkages of control devices.
      h. Detail field application for each equipment type.
   4. Field quality-control reports.

D. Quality Assurance

1. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
   a. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   b. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

E. Delivery, Storage, And Handling
   1. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.2 PRODUCTS

A. Insulation Materials
   1. Comply with requirements in Part 1.3 schedule articles for where insulating materials shall be applied.
   2. Products shall not contain asbestos, lead, mercury, or mercury compounds.
   3. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
   4. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
   5. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
   6. Calcium Silicate:
      a. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
      b. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
      c. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.
   7. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
      a. Block Insulation: ASTM C 552, Type I.
      b. Special-Shaped Insulation: ASTM C 552, Type III.
      c. Board Insulation: ASTM C 552, Type IV.
      d. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
      e. Preformed Pipe Insulation with Factory-Applied ASJ **OR** ASJ-SSL, **as directed**: Comply with ASTM C 552, Type II, Class 2.
      f. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
   8. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
   9. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   10. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.
   11. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For equipment applications, provide insulation

without factory-applied jacket **OR** with factory-applied ASJ **OR** with factory-applied FSK jacket, **as directed**. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

12. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.
13. Mineral-Fiber, Preformed Pipe Insulation:
    a. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, without factory-applied jacket **OR** with factory-applied ASJ **OR** with factory-applied ASJ-SSL, **as directed**. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
14. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ **OR** FSK jacket, **as directed**, complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
15. Phenolic:
    a. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
    b. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
    c. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
    d. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
        1) Preformed Pipe Insulation: None **OR** ASJ, **as directed**.
        2) Board for Equipment Applications: None **OR** ASJ, **as directed**.
16. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.
    a. Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F (0.027 W/m x K) at 75 deg F (24 deg C) after 180 days of aging.
    b. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less for thickness up to 1-1/2 inches (38 mm) as tested by ASTM E 84.
    c. Fabricate shapes according to ASTM C 450 and ASTM C 585.
    d. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
        1) Pipe Applications: None **OR** ASJ **OR** ASJ-SSL **OR** PVDC **OR** PVDC-SSL, **as directed**.
        2) Equipment Applications: None **OR** ASJ **OR** ASJ-SSL **OR** PVDC **OR** PVDC-SSL, **as directed**.
17. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.
18. Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C 578, Type IV or Type XIII, except thermal conductivity (k-value) shall not exceed 0.26 Btu x in./h x sq. ft. x deg F (0.038 W/m x K) after 180 days of aging. Fabricate shapes according to ASTM C 450 and ASTM C 585.

B. Insulating Cements
1. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
2. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
3. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

C. Adhesives
1. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
2. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F (10 to 427 deg C).

a. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Cellular-Glass, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F (minus 59 to plus 149 deg C).
   a. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
4. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   a. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
5. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   a. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140 deg F (29 to plus 60 deg C).
7. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
   a. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
8. PVC Jacket Adhesive: Compatible with PVC jacket.
   a. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Mastics

1. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
   a. For indoor applications, use mastics that have a VOC content of <**Insert value**> g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
   a. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
   b. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
   c. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
   d. Color: White.
3. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
   a. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.03 metric perm) at 35-mil (0.9-mm) dry film thickness.
   b. Service Temperature Range: 0 to 180 deg F (Minus 18 to plus 82 deg C).
   c. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
   d. Color: White.
4. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
   a. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30-mil (0.8-mm) dry film thickness.
   b. Service Temperature Range: Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).
   c. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
   d. Color: White.
5. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
   a. Water-Vapor Permeance: ASTM F 1249, 3 perms (2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
   b. Service Temperature Range: Minus 20 to plus 200 deg F (Minus 29 to plus 93 deg C).
   c. Solids Content: 63 percent by volume and 73 percent by weight.
   d. Color: White.

E. Lagging Adhesives

1. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
    a. For indoor applications, use lagging adhesives that have a VOC content of <**Insert value**> g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    b. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment and pipe insulation.
    c. Service Temperature Range: Minus 50 to plus 180 deg F (Minus 46 to plus 82 deg C).
    d. Color: White.

F. Sealants
1. Joint Sealants:
    a. Materials shall be compatible with insulation materials, jackets, and substrates.
    b. Permanently flexible, elastomeric sealant.
    c. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
    d. Color: White or gray.
    e. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. FSK and Metal Jacket Flashing Sealants:
    a. Materials shall be compatible with insulation materials, jackets, and substrates.
    b. Fire- and water-resistant, flexible, elastomeric sealant.
    c. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
    d. Color: Aluminum.
    e. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
    a. Materials shall be compatible with insulation materials, jackets, and substrates.
    b. Fire- and water-resistant, flexible, elastomeric sealant.
    c. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
    d. Color: White.
    e. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

G. Factory-Applied Jackets
1. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
    a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
    b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
    c. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
    d. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms (0.013 metric perms) when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
    e. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms (0.007 metric perms) when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
    f. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

H. Field-Applied Fabric-Reinforcing Mesh
1. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. (68 g/sq. m) with a thread count of 10 strands by 10 strands/sq. inch (4 strands by 4 strands/sq. mm) for covering pipe and pipe fittings.

2. Woven Glass-Fiber Fabric for Equipment Insulation: Approximately 6 oz./sq. yd. (203 g/sq. m) with a thread count of 5 strands by 5 strands/sq. inch (2 strands by 2 strands/sq. mm) for covering equipment.
3. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. inch (4 strands by 4 strands/sq. mm), in a Leno weave, for equipment and pipe.

I. Field-Applied Cloths
1. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. (271 g/sq. m).

J. Field-Applied Jackets
1. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
2. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   a. Adhesive: As recommended by jacket material manufacturer.
   b. Color: White **OR** Color-code jackets based on system. Color as selected by the Owner, **as directed**.
   c. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
      1) Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
   d. Factory-fabricated tank heads and tank side panels.
3. Metal Jacket:
   a. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005, Temper H-14.
      1) Sheet and roll stock ready for shop or field sizing **OR** Factory cut and rolled to size, **as directed**.
      2) Finish and thickness are indicated in field-applied jacket schedules.
      3) Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 2.5-mil- (0.063-mm-) thick Polysurlyn, **as directed**.
      4) Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 2.5-mil- (0.063-mm-) thick Polysurlyn, **as directed**.
      5) Factory-Fabricated Fitting Covers:
         a) Same material, finish, and thickness as jacket.
         b) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
         c) Tee covers.
         d) Flange and union covers.
         e) End caps.
         f) Beveled collars.
         g) Valve covers.
         h) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
   b. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
      1) Sheet and roll stock ready for shop or field sizing **OR** Factory cut and rolled to size, **as directed**.
      2) Material, finish, and thickness are indicated in field-applied jacket schedules.
      3) Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 2.5-mil- (0.063-mm-) thick Polysurlyn, **as directed**.
      4) Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 2.5-mil- (0.063-mm-) thick Polysurlyn, **as directed**.
      5) Factory-Fabricated Fitting Covers:

a) Same material, finish, and thickness as jacket.
b) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
c) Tee covers.
d) Flange and union covers.
e) End caps.
f) Beveled collars.
g) Valve covers.
h) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

4. Underground Direct-Buried Jacket: 125-mil- (3.2-mm-) thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

K. Tapes

1. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   a. Width: 3 inches (75 mm).
   b. Thickness: 11.5 mils (0.29 mm).
   c. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   d. Elongation: 2 percent.
   e. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   f. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
2. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   a. Width: 3 inches (75 mm).
   b. Thickness: 6.5 mils (0.16 mm).
   c. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   d. Elongation: 2 percent.
   e. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   f. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
3. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
   a. Width: 2 inches (50 mm).
   b. Thickness: 6 mils (0.15 mm).
   c. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
   d. Elongation: 500 percent.
   e. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.
4. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
   a. Width: 2 inches (50 mm).
   b. Thickness: 3.7 mils (0.093 mm).
   c. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
   d. Elongation: 5 percent.
   e. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.
5. PVDC Tape: White vapor-retarder PVDC tape with acrylic adhesive.
   a. Width: 3 inches (75 mm).
   b. Film Thickness: 4 mils (0.10 mm) **OR** 6 mils (0.15 mm), **as directed**.
   c. Adhesive Thickness: 1.5 mils (0.04 mm).
   d. Elongation at Break: 145 percent.
   e. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.

L. Securements

1. Bands:
   a. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 **OR** Type 316, **as directed**; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, wide with wing seal **OR** closed seal, **as directed**.

b. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, wide with wing seal **OR** closed seal, **as directed**.
c. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

2. Insulation Pins and Hangers:
a. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) **OR** 0.135-inch- (3.5-mm-), **as directed**, diameter shank, length to suit depth of insulation indicated.
b. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) **OR** 0.135-inch- (3.5-mm-), **as directed**, diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
c. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
1) Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
2) Spindle: Copper- or zinc-coated, low carbon steel **OR** Aluminum **OR** Stainless steel, **as directed**, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
3) Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
d. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
1) Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.
2) Spindle: Nylon, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).
3) Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
e. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
1) Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
2) Spindle: Copper- or zinc-coated, low carbon steel **OR** Aluminum **OR** Stainless steel, **as directed**, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
3) Adhesive-backed base with a peel-off protective cover.
f. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, galvanized-steel **OR** aluminum **OR** stainless-steel, **as directed**, sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
1) Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
g. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

3. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.
4. Wire: 0.080-inch (2.0-mm) nickel-copper alloy **OR** 0.062-inch (1.6-mm) soft-annealed, stainless steel **OR** 0.062-inch (1.6-mm) soft-annealed, galvanized steel, **as directed**.

M. Corner Angles
1. PVC Corner Angles: 30 mils (0.8 mm) thick, minimum 1 by 1 inch (25 by 25 mm), PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
2. Aluminum Corner Angles: 0.040 inch (1.0 mm) thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005; Temper H-14.
3. Stainless-Steel Corner Angles: 0.024 inch (0.61 mm) thick, minimum 1 by 1 inch (25 by 25 mm), stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 **OR** Type 316, **as directed**.

1.3 EXECUTION

A. Preparation
1. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
OR
Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
a. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range between 140 and 300 deg F (60 and 149 deg C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
b. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
3. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

B. General Installation Requirements
1. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
2. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
3. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
4. Install insulation with longitudinal seams at top and bottom of horizontal runs.
5. Install multiple layers of insulation with longitudinal and end seams staggered.
6. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
7. Keep insulation materials dry during application and finishing.
8. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
9. Install insulation with least number of joints practical.
10. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
a. Install insulation continuously through hangers and around anchor attachments.

b. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
c. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
d. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

11. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
12. Install insulation with factory-applied jackets as follows:
    a. Draw jacket tight and smooth.
    b. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
    c. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) **OR** 4 inches (100 mm), **as directed**, o.c.
        1) For below ambient services, apply vapor-barrier mastic over staples.
    d. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
    e. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
13. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
14. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
15. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
16. For above ambient services, do not install insulation to the following:
    a. Vibration-control devices.
    b. Testing agency labels and stamps.
    c. Nameplates and data plates.
    d. Manholes.
    e. Handholes.
    f. Cleanouts.

C. Penetrations
1. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
    a. Seal penetrations with flashing sealant.
    b. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
    c. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
    d. Seal jacket to roof flashing with flashing sealant.
2. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
3. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
    a. Seal penetrations with flashing sealant.

b. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
c. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
d. Seal jacket to wall flashing with flashing sealant.

4. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
5. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   a. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
6. Insulation Installation at Floor Penetrations:
   a. Pipe: Install insulation continuously through floor penetrations.
   b. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping".

D. Equipment, Tank, And Vessel Insulation Installation
1. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
   a. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 **OR** 50, **as directed**, percent coverage of tank and vessel surfaces.
   b. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
   c. Protect exposed corners with secured corner angles.
   d. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
      1) Do not weld anchor pins to ASME-labeled pressure vessels.
      2) Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
      3) On tanks and vessels, maximum anchor-pin spacing is 3 inches (75 mm) from insulation end joints, and 16 inches (400 mm) o.c. in both directions.
      4) Do not overcompress insulation during installation.
      5) Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
      6) Impale insulation over anchor pins and attach speed washers.
      7) Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
   e. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
   f. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches (150 mm) from each end. Install wire or cable between two circumferential girdles 12 inches (300 mm) o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches (1200 mm) o.c. Use this network for securing insulation with tie wire or bands.
   g. Stagger joints between insulation layers at least 3 inches (75 mm).
   h. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.

i. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
j. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

2. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
   a. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
   b. Seal longitudinal seams and end joints.
3. Insulation Installation on Pumps:
   a. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch (150-mm) centers, starting at corners. Install 3/8-inch- (10-mm-) diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
   b. Fabricate boxes from galvanized steel **OR** aluminum **OR** stainless steel, **as directed**, at least 0.040 inch (1.0 mm) **OR** 0.050 inch (1.3 mm) **OR** 0.060 inch (1.6 mm), **as directed**, thick.
   c. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

E. General Pipe Insulation Installation
1. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
2. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   a. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
   b. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   c. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   d. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
   e. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
   f. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
   g. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

h. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
i. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

3. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
4. Install removable insulation covers at locations indicated. Installation shall conform to the following:
   a. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
   b. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
   c. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
   d. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
   e. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

F. Calcium Silicate Insulation Installation
1. Insulation Installation on Domestic Water Boiler Breechings:
   a. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation material.
   b. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.
   c. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.
2. Insulation Installation on Straight Pipes and Tubes:
   a. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation materials.
   b. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.
   c. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.
3. Insulation Installation on Pipe Flanges:
   a. Install preformed pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
d. Finish flange insulation same as pipe insulation.
4. Insulation Installation on Pipe Fittings and Elbows:
a. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
b. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
c. Finish fittings insulation same as pipe insulation.
5. Insulation Installation on Valves and Pipe Specialties:
a. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
b. Install insulation to flanges as specified for flange insulation application.
c. Finish valve and specialty insulation same as pipe insulation.

G. Cellular-Glass Insulation Installation
1. Insulation Installation on Straight Pipes and Tubes:
a. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
c. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
d. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
2. Insulation Installation on Pipe Flanges:
a. Install preformed pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
d. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.
3. Insulation Installation on Pipe Fittings and Elbows:
a. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
b. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.
4. Insulation Installation on Valves and Pipe Specialties:
a. Install preformed sections of cellular-glass insulation to valve body.
b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
c. Install insulation to flanges as specified for flange insulation application.

H. Flexible Elastomeric Insulation Installation
1. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
2. Insulation Installation on Pipe Flanges:
a. Install pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
d. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3. Insulation Installation on Pipe Fittings and Elbows:
   a. Install mitered sections of pipe insulation.
   b. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
4. Insulation Installation on Valves and Pipe Specialties:
   a. Install preformed valve covers manufactured of same material as pipe insulation when available.
   b. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   c. Install insulation to flanges as specified for flange insulation application.
   d. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

I. Mineral-Fiber Insulation Installation
1. Insulation Installation on Straight Pipes and Tubes:
   a. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   c. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
   d. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
2. Insulation Installation on Pipe Flanges:
   a. Install preformed pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   d. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.
3. Insulation Installation on Pipe Fittings and Elbows:
   a. Install preformed sections of same material as straight segments of pipe insulation when available.
   b. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
4. Insulation Installation on Valves and Pipe Specialties:
   a. Install preformed sections of same material as straight segments of pipe insulation when available.
   b. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   c. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   d. Install insulation to flanges as specified for flange insulation application.

J. Phenolic Insulation Installation
1. General Installation Requirements:

a. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation materials.
b. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with 0.062-inch (1.6-mm) wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.

2. Insulation Installation on Straight Pipes and Tubes:
   a. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   c. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
   d. For insulation with factory-applied jackets with vapor retarders on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
3. Insulation Installation on Pipe Flanges:
   a. Install preformed pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
4. Insulation Installation on Pipe Fittings and Elbows:
   a. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
5. Insulation Installation on Valves and Pipe Specialties:
   a. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
   b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   c. Install insulation to flanges as specified for flange insulation application.

K. Polyisocyanurate Insulation Installation
1. Insulation Installation on Straight Pipes and Tubes:
   a. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
   b. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
   c. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.
2. Insulation Installation on Pipe Flanges:
   a. Install preformed pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch (38-mm) thickness.
   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation.
3. Insulation Installation on Fittings and Elbows:
   a. Install preformed sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
4. Insulation Installation on Valves and Pipe Specialties:
   a. Install preformed sections of polyisocyanurate insulation to valve body.

b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
c. Install insulation to flanges as specified for flange insulation application.

L. Polyolefin Insulation Installation
1. Insulation Installation on Straight Pipes and Tubes:
a. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
2. Insulation Installation on Pipe Flanges:
a. Install pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
d. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
3. Insulation Installation on Pipe Fittings and Elbows:
a. Install mitered sections of polyolefin pipe insulation.
b. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
4. Insulation Installation on Valves and Pipe Specialties:
a. Install cut sections of polyolefin pipe and sheet insulation to valve body.
b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
c. Install insulation to flanges as specified for flange insulation application.
d. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

M. Polystyrene Insulation Installation
1. Insulation Installation on Straight Pipes and Tubes:
a. Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
b. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
c. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.
2. Insulation Installation on Pipe Flanges:
a. Install preformed pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch (38-mm) thickness.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polystyrene block insulation of same thickness as pipe insulation.
3. Insulation Installation on Pipe Fittings and Elbows:
a. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
4. Insulation Installation on Valves and Pipe Specialties:
a. Install preformed section of polystyrene insulation to valve body.
b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
c. Install insulation to flanges as specified for flange insulation application.

N. Field-Applied Jacket Installation
1. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
   a. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
   b. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
   c. Completely encapsulate insulation with coating, leaving no exposed insulation.
2. Where FSK jackets are indicated, install as follows:
   a. Draw jacket material smooth and tight.
   b. Install lap or joint strips with same material as jacket.
   c. Secure jacket to insulation with manufacturer's recommended adhesive.
   d. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
   e. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
3. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
   a. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
4. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.
5. Where PVDC jackets are indicated, install as follows:
   a. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
   b. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches (50 mm) over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
   c. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
   d. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches (850 mm) or less. The 33-1/2-inch- (850-mm-) circumference limit allows for 2-inch- (50-mm-) overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
   e. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

O. Finishes
1. Equipment and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 07.
   a. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
      1) Finish Coat Material: Interior, flat, latex-emulsion size.
2. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
3. Color: Final color as selected by the Owner. Vary first and second coats to allow visual inspection of the completed Work.
4. Do not field paint aluminum or stainless-steel jackets.

P. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
a. Inspect field-insulated equipment, randomly selected by the Owner, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
b. Inspect pipe, fittings, strainers, and valves, randomly selected by the Owner, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
3. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

Q. Domestic Water Boiler Breeching Insulation Schedule
1. Round, exposed breeching and connector insulation shall be one of the following:
a. Calcium Silicate: 4 inches (100 mm) thick.
b. High-Temperature Mineral-Fiber Blanket: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
c. High-Temperature Mineral-Fiber Board: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
2. Round, concealed breeching and connector insulation shall be one of the following:
a. Calcium Silicate: 4 inches (100 mm) thick.
b. High-Temperature Mineral-Fiber Blanket: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
c. High-Temperature Mineral-Fiber Board: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
3. Rectangular, exposed breeching and connector insulation shall be one of the following:
a. Calcium Silicate: 4 inches (100 mm) thick.
b. High-Temperature Mineral-Fiber Blanket: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
c. High-Temperature Mineral-Fiber Board: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
4. Rectangular, concealed breeching and connector insulation shall be one of the following:
a. Calcium Silicate: 4 inches (100 mm) thick.
b. High-Temperature Mineral-Fiber Blanket: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
c. High-Temperature Mineral-Fiber Board: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.

R. Equipment Insulation Schedule
1. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
2. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.
3. Heat-exchanger (water-to-water for domestic water heating service) insulation shall be one of the following:
a. Calcium Silicate: 3 inches (75 mm) thick.
b. Cellular Glass: 3 inches (75 mm) thick.
c. Mineral-Fiber Board: 2 inches (50 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
d. Mineral-Fiber Pipe and Tank: 2 inches (50 mm) thick.
4. Steam-to-hot-water converter insulation shall be one of the following:
a. Calcium Silicate: 3 inches (75 mm) thick.

b. Cellular Glass: 3 inches (75 mm) thick.
c. Mineral-Fiber Board: 2 inches (50 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
d. Mineral-Fiber Pipe and Tank: 2 inches (50 mm) thick.

5. Domestic water pump insulation shall be one of the following:
   a. Cellular Glass: 2 inches (50 mm) thick.
   b. Mineral-Fiber Board: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   c. Phenolic: 1 inch (25 mm) thick.
   d. Polyisocyanurate: 1 inch (25 mm) thick.
6. Domestic chilled-water (potable) pump insulation shall be one of the following:
   a. Cellular Glass: 3 inches (75 mm) thick.
   b. Mineral-Fiber Board: 2 inches (50 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   c. Phenolic: 1 inch (25 mm) thick.
   d. Polyisocyanurate: 1-1/2 inches (38 mm) thick.
7. Domestic hot-water pump insulation shall be one of the following:
   a. Cellular Glass: 2 inches (50 mm) thick.
   b. Mineral-Fiber Board: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   c. Phenolic: 1 inch (25 mm) thick.
   d. Polyisocyanurate: 1 inch (25 mm) thick.
8. Domestic water, domestic chilled-water (potable), and domestic hot-water hydropneumatic tank insulation shall be one of the following:
   a. Cellular Glass: 1-1/2 inches (38 mm) thick.
   b. Flexible Elastomeric: 1 inch (25 mm) thick.
   c. Mineral-Fiber Board: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   d. Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
   e. Phenolic: 1 inch (25 mm) thick.
   f. Polyisocyanurate: 1 inch (25 mm) thick.
   g. Polyolefin: 1 inch (25 mm) thick.
9. Domestic hot-water storage tank insulation shall be one of the following, of thickness to provide an R-value of 12.5:
   a. Cellular glass.
   b. Mineral-Fiber Board: 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   c. Mineral-fiber pipe and tank.
   d. Phenolic.
10. Domestic water storage tank insulation shall be one of the following:
   a. Cellular Glass: 2 inches (50 mm) thick.
   b. Flexible Elastomeric: 1 inch (25 mm) thick.
   c. Mineral-Fiber Board: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   d. Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
   e. Phenolic: 1 inch (25 mm) thick.
   f. Polyisocyanurate: 1 inch (25 mm) thick.
   g. Polyolefin: 1 inch (25 mm) thick.
11. Domestic chilled-water (potable) storage tank insulation shall be one of the following:
   a. Cellular Glass: 2 inches (50 mm) thick.
   b. Flexible Elastomeric: 1 inch (25 mm) thick.
   c. Mineral-Fiber Board: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   d. Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
   e. Phenolic: 1 inch (25 mm) thick.

f. Polyisocyanurate: 1 inch (25 mm) thick.
g. Polyolefin: 1 inch (25 mm) thick.

12. Piping system filter-housing insulation shall be one of the following:
    a. Cellular Glass: 3 inches (75 mm) thick.
    b. Mineral-Fiber Board: 2 inches (50 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
    c. Mineral-Fiber Pipe and Tank: 2 inches (50 mm) thick.

S. Piping Insulation Schedule, General
1. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
2. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
    a. Drainage piping located in crawl spaces.
    b. Underground piping.
    c. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

T. Indoor Piping Insulation Schedule
1. Domestic Cold Water:
    a. NPS 1 (DN 25) and Smaller: Insulation shall be one of the following:
        1) Cellular Glass: 1-1/2 inches (38 mm) thick.
        2) Flexible Elastomeric: 1/2 inch (13 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick.
        3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) **OR** 1 inch (25 mm), **as directed**, thick.
        4) Phenolic: 1 inch (25 mm) thick.
        5) Polyisocyanurate: 1 inch (25 mm) thick.
        6) Polyolefin: 1/2 inch (13 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick.
    b. NPS 1-1/4 (DN 32) and Larger: Insulation shall be one of the following:
        1) Cellular Glass: 1-1/2 inches (38 mm) thick.
        2) Flexible Elastomeric: 1 inch (25 mm) thick.
        3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
        4) Phenolic: 1 inch (25 mm) thick.
        5) Polyisocyanurate: 1 inch (25 mm) thick.
        6) Polyolefin: 1 inch (25 mm) thick.
2. Domestic Hot and Recirculated Hot Water:
    a. NPS 1-1/4 (DN 32) and Smaller: Insulation shall be one of the following:
        1) Cellular Glass: 1-1/2 inches (38 mm) thick.
        2) Flexible Elastomeric: 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick.
        3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) **OR** 1 inch (25 mm), **as directed**, thick.
        4) Phenolic: 1 inch (25 mm) thick.
        5) Polyisocyanurate: 1 inch (25 mm) thick.
        6) Polyolefin: 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick.
    b. NPS 1-1/2 (DN 40) and Larger: Insulation shall be one of the following:
        1) Cellular Glass: 1-1/2 inches (38 mm) thick.
        2) Flexible Elastomeric: 1 inch (25 mm) thick.
        3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
        4) Phenolic: 1 inch (25 mm) thick.
        5) Polyisocyanurate: 1 inch (25 mm) thick.
        6) Polyolefin: 1 inch (25 mm) thick.
3. Domestic Chilled Water (Potable):
    a. All Pipe Sizes: Insulation shall be one of the following:
        1) Cellular Glass: 1-1/2 inches (38 mm) thick.
        2) Flexible Elastomeric: 1 inch (25 mm) thick.

3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
4) Phenolic: 1 inch (25 mm) thick.
5) Polyisocyanurate: 1 inch (25 mm) thick.
6) Polyolefin: 1 inch (25 mm) thick.

4. Stormwater and Overflow:
   a. All Pipe Sizes: Insulation shall be one of the following:
      1) Cellular Glass: 1-1/2 inches (38 mm) thick.
      2) Flexible Elastomeric: 1 inch (25 mm) thick.
      3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
      4) Phenolic: 1 inch (25 mm) thick.
      5) Polyisocyanurate: 1 inch (25 mm) thick.
      6) Polyolefin: 1 inch (25 mm) thick.
5. Roof Drain and Overflow Drain Bodies:
   a. All Pipe Sizes: Insulation shall be one of the following:
      1) Cellular Glass: 1-1/2 inches (38 mm) thick.
      2) Flexible Elastomeric: 1 inch (25 mm) thick.
      3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
      4) Phenolic: 1 inch (25 mm) thick.
      5) Polyisocyanurate: 1 inch (25 mm) thick.
      6) Polyolefin: 1 inch (25 mm) thick.
6. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
   a. All Pipe Sizes: Insulation shall be one of the following:
      1) Flexible Elastomeric: 1/2 inch (13 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick.
      2) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) **OR** 1 inch (25 mm) thick.
      3) Polyolefin: 1/2 inch (13 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm) thick.
7. Sanitary Waste Piping Where Heat Tracing Is Installed:
   a. All Pipe Sizes: Insulation shall be one of the following:
      1) Cellular Glass: 2 inches (50 mm) thick.
      2) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches (38 mm) thick.
      3) Phenolic: 1-1/2 inches (38 mm) thick.
      4) Polyisocyanurate: 1-1/2 inches (38 mm) thick.
8. Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):
   a. All Pipe Sizes: Insulation shall be one of the following:
      1) Cellular Glass: 1-1/2 inches (38 mm) thick.
      2) Flexible Elastomeric: 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick.
      3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) **OR** 1 inch (25 mm), **as directed**, thick.
      4) Phenolic: 1 inch (25 mm) thick.
      5) Polyisocyanurate: 1 inch (25 mm) thick.
      6) Polyolefin: 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick.
9. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet (3 m) of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):
   a. All Pipe Sizes: Insulation shall be one of the following:
      1) Cellular Glass: 1-1/2 inches (38 mm) thick.
      2) Flexible Elastomeric: 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick.
      3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) **OR** 1 inch (25 mm), **as directed**, thick.
      4) Phenolic: 1 inch (25 mm) thick.
      5) Polyisocyanurate: 1 inch (25 mm) thick.
      6) Polyolefin: 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick.
10. Hot Service Drains:
    a. All Pipe Sizes: Insulation shall be one of the following:

1) Calcium Silicate: 1-1/2 inches (38 mm) thick.
2) Cellular Glass: 1-1/2 inches (38 mm) thick.
3) Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch (25 mm) thick.

11. Hot Service Vents:
    a. All Pipe Sizes: Insulation shall be one of the following:
        1) Calcium Silicate: 1-1/2 inches (38 mm) thick.
        2) Cellular Glass: 1-1/2 inches (38 mm) thick.
        3) Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch (25 mm) thick.

U. Outdoor, Aboveground Piping Insulation Schedule
1. Domestic Water Piping:
    a. All Pipe Sizes: Insulation shall be one of the following:
        1) Cellular Glass: 2 inches (50 mm) thick.
        2) Flexible Elastomeric: 2 inches (50 mm) thick.
        3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.
        4) Phenolic: 2 inches (50 mm) thick.
        5) Polyisocyanurate: 2 inches (50 mm) thick.
        6) Polyolefin: 2 inches (50 mm) thick.
        7) Polystyrene: 2 inches (50 mm) thick.
2. Domestic Hot and Recirculated Hot Water:
    a. All Pipe Sizes: Insulation shall be one of the following:
        1) Cellular Glass: 2 inches (50 mm) thick.
        2) Flexible Elastomeric: 2 inches (50 mm) thick.
        3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.
        4) Phenolic: 2 inches (50 mm) thick.
        5) Polyisocyanurate: 2 inches (50 mm) thick.
        6) Polyolefin: 2 inches (50 mm) thick.
3. Sanitary Waste Piping Where Heat Tracing Is Installed:
    a. All Pipe Sizes: Insulation shall be one of the following:
        1) Cellular Glass: 2 inches (50 mm) thick.
        2) Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.
        3) Phenolic: 2 inches (50 mm) thick.
        4) Polyisocyanurate: 2 inches (50 mm) thick.
4. Hot Service Drains:
    a. All Pipe Sizes: Insulation shall be one of the following:
        1) Calcium Silicate: 1-1/2 inches (38 mm) thick.
        2) Cellular Glass: 1-1/2 inches (38 mm) thick.
        3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
5. Hot Service Vents:
    a. All Pipe Sizes: Insulation shall be one of the following:
        1) Calcium Silicate: 1-1/2 inches (38 mm) thick.
        2) Cellular Glass: 1-1/2 inches (38 mm) thick.
        3) Mineral-Fiber, Preformed Pipe Insulation, Type II: 1 inch (25 mm) thick.

V. Outdoor, Underground Piping Insulation Schedule
1. Loose-fill insulation, for belowground piping, is specified in Division 28.
2. Sanitary Waste Piping, All Sizes, Where Heat Tracing Is Installed: Cellular glass, 2 inches (50 mm) thick.
3. Chilled Water, All Sizes: Cellular glass, 2 inches (50 mm) thick.

W. Indoor, Field-Applied Jacket Schedule
1. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
2. If more than one material is listed, selection from materials listed is Contractor's option.
3. Equipment, Concealed:
    a. None.

b. PVC **OR** PVC, Color-Coded by System, **as directed**: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm), **as directed**, thick.
c. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
d. Painted Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
e. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.

4. Equipment, Exposed, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces up to 72 Inches (1800 mm):
   a. None.
   b. PVC **OR** PVC, Color-Coded by System, **as directed**: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm), **as directed**, thick.
   c. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
   d. Painted Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
   e. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.
5. Equipment, Exposed, Larger Than 48 Inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 Inches (1800 mm):
   a. None.
   b. Aluminum **OR** Painted Aluminum, **as directed**, Smooth **OR** Stucco Embossed, **as directed**, with 1-1/4-Inch- (32-mm-) Deep Corrugations **OR** 2-1/2-Inch- (65-mm-) Deep Corrugations **OR** 4-by-1-Inch (100-by-25-mm) Box Ribs, **as directed**: 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
   c. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth **OR** Stucco Embossed, **as directed**, with 1-1/4-Inch- (32-mm-) Deep Corrugations **OR** 2-1/2-Inch- (65-mm-) Deep Corrugations **OR** 4-by-1-Inch (100-by-25-mm) Box Ribs, **as directed**: 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.
6. Piping, Concealed:
   a. None.
   b. PVC **OR** PVC, Color-Coded by System, **as directed**: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm), **as directed**, thick.
   c. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
   d. Painted Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
   e. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.
7. Piping, Exposed:
   a. None.
   b. PVC **OR** PVC, Color-Coded by System, **as directed**: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm), **as directed**, thick.

c. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
d. Aluminum **OR** Painted Aluminum, **as directed**, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
e. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.

X. Outdoor, Field-Applied Jacket Schedule
1. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
2. If more than one material is listed, selection from materials listed is Contractor's option.
3. Equipment, Concealed:
a. None.
b. PVC **OR** PVC, Color-Coded by System, **as directed**: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm), **as directed**, thick.
c. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
d. Aluminum **OR** Painted Aluminum, **as directed**, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
e. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**, 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.
4. Equipment, Exposed, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces up to 72 Inches (1800 mm):
a. Aluminum **OR** Painted Aluminum, **as directed**, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**, with Z-Shaped Locking Seam, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
b. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**, with Z-Shaped Locking Seam, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.
5. Equipment, Exposed, Larger Than 48 Inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 Inches (1800 mm):
a. Aluminum **OR** Painted Aluminum, **as directed**, Smooth **OR** Stucco Embossed, **as directed** with 1-1/4-Inch- (32-mm-) Deep Corrugations **OR** 2-1/2-Inch- (65-mm-) Deep Corrugations **OR** 4-by-1-Inch (100-by-25-mm) Box Ribs, **as directed**: 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
b. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth **OR** Stucco Embossed, **as directed**, with 1-1/4-Inch- (32-mm-) Deep Corrugations **OR** 2-1/2-Inch- (65-mm-) Deep Corrugations **OR** 4-by-1-Inch (100-by-25-mm) Box Ribs, **as directed**: 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.
6. Piping, Concealed:
a. None.
b. PVC **OR** PVC, Color-Coded by System, **as directed**: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm), **as directed**, thick.
c. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.

d. Aluminum **OR** Painted Aluminum, **as directed**, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.

e. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.

7. Piping, Exposed:

a. PVC: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm) **OR** 40 mils (1.0 mm), **as directed**, thick.

b. Aluminum **OR** Painted Aluminum, **as directed**, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**, with Z-Shaped Locking Seam, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.

c. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, ,**as directed,** with Z-Shaped Locking Seam, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.

Y. Underground, Field-Installed Insulation Jacket

1. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 22 07 19 00

Task	Specification	Specification Description
22 07 19 00	21 07 00 00	Fire-Suppression Systems Insulation

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SECTION 22 11 16 00 - DOMESTIC WATER PIPING

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for domestic water piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
   b. Encasement for piping.
   c. Specialty valves.
   d. Flexible connectors.
   e. Water meters furnished by utility company for installation by Contractor.
   OR
   Water meters.
   f. Escutcheons.
   g. Sleeves and sleeve seals.
   h. Wall penetration systems.

C. Performance Requirements

1. Seismic Performance: Domestic water piping and support and installation shall withstand effects of earthquake motions determined according to ASCE/SEI 7.

D. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittal:
   a. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.
3. Field quality-control reports.

E. Quality Assurance

1. Piping materials shall bear label, stamp, or other markings of specified testing agency.
2. Comply with NSF 14 for plastic, potable domestic water piping and components. Include marking "NSF-pw" on piping, **as directed**.
3. Comply with NSF 61 for potable domestic water piping and components.

F. Project Conditions

1. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
   a. Notify the Owner no fewer than two days in advance of proposed interruption of water service.
   b. Do not proceed with interruption of water service without the Owner's written permission.

1.2 PRODUCTS

A. Piping Materials

1. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Copper Tube And Fittings
1. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, drawn temper.
   a. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
   b. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
   c. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
   d. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
   e. Copper Pressure-Seal-Joint Fittings:
      1) NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
      2) NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.
   f. Copper Push-on-Joint Fittings:
      1) Description: Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22; with stainless-steel teeth and EPDM-rubber O-ring seal in each end instead of solder-joint ends.
   g. Copper-Tube Extruded-Tee Connections:
      1) Description: Tee formed in copper tube according to ASTM F 2014.
   h. Grooved-Joint Copper-Tube Appurtenances:
      1) Copper Grooved-End Fittings: ASTM B 75 (ASTM B 75M) copper tube or ASTM B 584 bronze castings.
      2) Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.
2. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) and ASTM B 88, Type L (ASTM B 88M, Type B) water tube, annealed temper.
   a. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
   b. Copper Pressure-Seal-Joint Fittings:
      1) NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
      2) NPS 3 and NPS 4 (DN 80 and DN 100): Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.

C. Ductile-Iron Pipe And Fittings
1. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   a. Standard-Pattern, Mechanical-Joint Fittings: AWWA C110, ductile or gray iron.
   b. Compact-Pattern, Mechanical-Joint Fittings: AWWA C153, ductile iron.
      1) Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
2. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   a. Standard-Pattern, Push-on-Joint Fittings: AWWA C110, ductile or gray iron.
      1) Gaskets: AWWA C111, rubber.
   b. Compact-Pattern, Push-on-Joint Fittings: AWWA C153, ductile iron.
      1) Gaskets: AWWA C111, rubber.
3. Plain-End, Ductile-Iron Pipe: AWWA C151.
   a. Grooved-Joint, Ductile-Iron-Pipe Appurtenances:
      1) Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.

2) Grooved-End, Ductile-Iron-Pipe Couplings: AWWA C606 for ductile-iron-pipe dimensions. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

D. Galvanized-Steel Pipe And Fittings
1. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B, Standard Weight. Include ends matching joining method.
a. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Standard Weight, seamless steel pipe with threaded ends.
b. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
c. Malleable-Iron Unions: ASME B16.39, Class 150, hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface, and female threaded ends.
d. Flanges: ASME B16.1, Class 125, cast iron.
e. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances:
1) Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A 47/A 47M, malleable-iron casting; ASTM A 106/A 106M, steel pipe; or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
2) Grooved-End-Pipe Couplings for Galvanized-Steel Piping: AWWA C606 for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

E. CPVC Piping
1. CPVC Pipe: ASTM F 441/F 441M, Schedule 40 and Schedule 80.
a. CPVC Socket Fittings: ASTM F 438 for Schedule 40 and ASTM F 439 for Schedule 80.
b. CPVC Threaded Fittings: ASTM F 437, Schedule 80.
2. CPVC Piping System: ASTM D 2846/D 2846M, SDR 11, pipe and socket fittings.
3. CPVC Tubing System: ASTM D 2846/D 2846M, SDR 11, tube and socket fittings.

F. PEX Tube And Fittings
1. PEX Distribution System: ASTM F 877, SDR 9 tubing.
a. Fittings for PEX Tube: ASTM F 1807, metal-insert type with copper or stainless-steel crimp rings and matching PEX tube dimensions.
b. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F 877; with plastic or corrosion-resistant-metal valve for each outlet.

G. PVC Pipe And Fittings
1. PVC Pipe: ASTM D 1785, Schedule 40 and Schedule 80.
a. PVC Socket Fittings: ASTM D 2466 for Schedule 40 and ASTM D 2467 for Schedule 80.
b. PVC Schedule 80 Threaded Fittings: ASTM D 2464.

H. Piping Joining Materials
1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.
2. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
3. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
4. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
5. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.
a. Use CPVC solvent cement that has a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
b. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

a. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
b. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

I. Encasement For Piping
1. Standard: ASTM A 674 or AWWA C105.
2. Form: Sheet **OR** Tube, **as directed**.
3. Material: LLDPE film of 0.008-inch (0.20-mm) **OR** LLDPE film of 0.008-inch (0.20-mm) minimum thickness or high-density, cross-laminated PE film of 0.004-inch (0.10-mm) **OR** High-density, cross-laminated PE film of 0.004-inch (0.10-mm), **as directed**, minimum thickness.
4. Color: Black **OR** Natural, **as directed**.

J. Specialty Valves
1. Comply with requirements in Division 22 Section "General-duty Valves For Plumbing Piping" for general-duty metal valves.
2. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.
3. CPVC Union Ball Valves:
a. Description:
1) Standard: MSS SP-122.
2) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
3) Body Material: CPVC.
4) Body Design: Union type.
5) End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket **OR** threaded, **as directed**.
6) End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket **OR** threaded **OR** flanged, **as directed**.
7) Ball: CPVC; full port.
8) Seals: PTFE or EPDM-rubber O-rings.
9) Handle: Tee shaped.
4. PVC Union Ball Valves:
a. Description:
1) Standard: MSS SP-122.
2) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
3) Body Material: PVC.
4) Body Design: Union type.
5) End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket **OR** threaded, **as directed**.
6) End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket **OR** threaded **OR** flanged, **as directed**.
7) Ball: PVC; full port.
8) Seals: PTFE or EPDM-rubber O-rings.
9) Handle: Tee shaped.
5. CPVC Non-Union Ball Valves:
a. Description:
1) Standard: MSS SP-122.
2) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
3) Body Material: CPVC.
4) Body Design: Non-union type.

5) End Connections: Socket or threaded.
6) Ball: CPVC; full or reduced port.
7) Seals: PTFE or EPDM-rubber O-rings.
8) Handle: Tee shaped.

6. PVC Non-Union Ball Valves:
   a. Description:
      1) Standard: MSS SP-122.
      2) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
      3) Body Material: PVC.
      4) Body Design: Non-union type.
      5) End Connections: Socket or threaded.
      6) Ball: PVC; full or reduced port.
      7) Seals: PTFE or EPDM-rubber O-rings.
      8) Handle: Tee shaped.
7. CPVC Butterfly Valves:
   a. Description:
      1) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
      2) Body Material: CPVC.
      3) Body Design: Lug or wafer type.
      4) Seat: EPDM rubber.
      5) Seals: PTFE or EPDM-rubber O-rings.
      6) Disc: CPVC.
      7) Stem: Stainless steel.
      8) Handle: Lever.
8. PVC Butterfly Valves:
   a. Description:
      1) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
      2) Body Material: PVC.
      3) Body Design: Lug or wafer type.
      4) Seat: EPDM rubber.
      5) Seals: PTFE or EPDM-rubber O-rings.
      6) Disc: PVC.
      7) Stem: Stainless steel.
      8) Handle: Lever.
9. CPVC Ball Check Valves:
   a. Description:
      1) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
      2) Body Material: CPVC.
      3) Body Design: Union-type ball check.
      4) End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket **OR** threaded, **as directed**.
      5) End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket **OR** threaded **OR** flanged, **as directed**.
      6) Ball: CPVC.
      7) Seals: EPDM- or FKM-rubber O-rings.
10. PVC Ball Check Valves:
   a. Description:
      1) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
      2) Body Material: PVC.
      3) Body Design: Union-type ball check.

4) End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket **OR** threaded, **as directed**.
5) End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket **OR** threaded **OR** flanged, **as directed**.
6) Ball: PVC.
7) Seals: EPDM- or FKM-rubber O-rings.

11. CPVC Gate Valves:
    a. Description:
        1) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
        2) Body Material: CPVC.
        3) Body Design: Nonrising stem.
        4) End Connections for Valves NPS 2 (DN 50) and Smaller: Socket **OR** Threaded, **as directed**.
        5) End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Socket **OR** Threaded **OR** Flanged, **as directed**.
        6) Gate and Stem: Plastic.
        7) Seals: EPDM rubber.
        8) Handle: Wheel.
12. PVC Gate Valves:
    a. Description:
        1) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
        2) Body Material: PVC.
        3) Body Design: Nonrising stem.
        4) End Connections for Valves NPS 2 (DN 50) and Smaller: Socket **OR** Threaded, **as directed**.
        5) End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Socket **OR** Threaded **OR** Flanged, **as directed**.
        6) Gate and Stem: Plastic.
        7) Seals: EPDM rubber.
        8) Handle: Wheel.

K. Transition Fittings
1. General Requirements:
    a. Same size as pipes to be joined.
    b. Pressure rating at least equal to pipes to be joined.
    c. End connections compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Sleeve-Type Transition Coupling: AWWA C219.
4. Plastic-to-Metal Transition Fittings:
    a. Description: CPVC **OR** PVC, **as directed**, one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert and one solvent-cement-socket threaded, **as directed**, end.
5. Plastic-to-Metal Transition Unions:
    a. Description: CPVC **OR** PVC, **as directed**, four-part union. Include brass or stainless-steel, **as directed**, threaded end, solvent-cement-joint or threaded, **as directed**, plastic end, rubber O-ring, and union nut.

L. Dielectric Fittings
1. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.
2. Dielectric Unions:

a. Description:
1) Pressure Rating: 150 psig (1035 kPa) **OR** 250 psig (1725 kPa), **as directed**, at 180 deg F (82 deg C).
2) End Connections: Solder-joint copper alloy and threaded ferrous.
3. Dielectric Flanges:
a. Description:
1) Factory-fabricated, bolted, companion-flange assembly.
2) Pressure Rating: 150 psig (1035 kPa) **OR** 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
3) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
4. Dielectric-Flange Kits:
a. Description:
1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating: 150 psig (1035 kPa).
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel backing washers.
5. Dielectric Couplings:
a. Description:
1) Galvanized-steel coupling.
2) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
3) End Connections: Female threaded.
4) Lining: Inert and noncorrosive, thermoplastic.
6. Dielectric Nipples:
a. Description:
1) Electroplated steel nipple complying with ASTM F 1545.
2) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
3) End Connections: Male threaded or grooved.
4) Lining: Inert and noncorrosive, propylene.

M. Flexible Connectors
1. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
a. Working-Pressure Rating: Minimum 200 psig (1380 kPa) **OR** 250 psig (1725 kPa), **as directed**.
b. End Connections NPS 2 (DN 50) and Smaller: Threaded copper pipe or plain-end copper tube.
c. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged copper alloy.
2. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
a. Working-Pressure Rating: Minimum 200 psig (1380 kPa) **OR** 250 psig (1725 kPa), **as directed**.
b. End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.
c. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

N. Water Meters
1. Displacement-Type Water Meters:
a. Description:
1) Standard: AWWA C700.
2) Pressure Rating: 150-psig (1035-kPa) working pressure.
3) Body Design: Nutating disc; totalization meter.
4) Registration: In gallons (liters) or cubic feet (cubic meters) as required by utility.
5) Case: Bronze.
6) End Connections: Threaded.
2. Turbine-Type Water Meters:

a. Description:
1) Standard: AWWA C701.
2) Pressure Rating: 150-psig (1035-kPa) working pressure.
3) Body Design: Turbine; totalization meter.
4) Registration: In gallons (liters) or cubic feet (cubic meters) as required by utility company.
5) Case: Bronze.
6) End Connections for Meters NPS 2 (DN 50) and Smaller: Threaded.
7) End Connections for Meters NPS 2-1/2 (DN 65) and Larger: Flanged.

3. Compound-Type Water Meters:
a. Description:
1) Standard: AWWA C702.
2) Pressure Rating: 150-psig (1035-kPa) working pressure.
3) Body Design: With integral mainline and bypass meters; totalization meter.
4) Registration: In gallons (liters) or cubic feet (cubic meters) as required by utility company.
5) Case: Bronze.
6) Pipe Connections: Flanged.

4. Fire-Service-Type Water Meters:
a. Description:
1) Standard: AWWA C703 and UL listing.
2) Pressure Rating: 175-psig (1200-kPa) working pressure.
3) Body Design:
a) Proportional, Detector-Type Water Meters: With meter on bypass.
i. Bypass Meter: AWWA C701, turbine **OR** AWWA C702, compound, **as directed**, type with bronze case; size not less than one-half nominal size of main-line meter.
b) Turbine-Type Water Meters: With strainer, and with meter on bypass.
i. Strainer: Full size, matching water meter.
ii. Bypass Meter: AWWA C701, turbine type with bronze case; not less than NPS 2 (DN 50).
4) Registration: In gallons (liters) or cubic feet (cubic meters) as required by utility company.
5) Case: Bronze.
6) Pipe Connections for Meters NPS 2 (DN 50) and Smaller: Threaded.
7) Pipe Connections for Meters NPS 2-1/2 (DN 65) and Larger: Flanged.

5. Remote Registration System: Direct-reading type complying with AWWA C706; modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.
OR
Remote Registration System: Encoder type complying with AWWA C707; modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

O. Escutcheons
1. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
2. One Piece, Cast Brass: Polished, chrome-plated **OR** rough-brass, **as directed**, finish with setscrews.
3. One Piece, Deep Pattern: Deep-drawn, box-shaped brass with chrome-plated finish.
4. One Piece, Stamped Steel: Chrome-plated finish with setscrew **OR** spring clips, **as directed.**
5. Split Casting, Cast Brass: Polished, chrome-plated **OR** rough-brass, **as directed**, finish with concealed hinge and setscrew.
6. Split Plate, Stamped Steel: Chrome-plated finish with concealed **OR** exposed-rivet, **as directed**, hinge, setscrew **OR** spring clips, **as directed**.
7. One-Piece Floor Plates: Cast-iron flange with holes for fasteners, **as directed**.

8. Split-Casting Floor Plates: Cast brass with concealed hinge.

P. Sleeves
1. Cast-Iron Wall Pipes: Fabricated of cast iron, and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
2. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
3. Molded-PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
4. Molded-PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.
5. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
6. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.
7. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   a. Underdeck Clamp: Clamping ring with setscrews.

Q. Sleeve Seals
1. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe and sleeve.
   a. Sealing Elements: EPDM-rubber **OR** NBR, **as directed**, interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   b. Pressure Plates: Carbon steel **OR** Plastic **OR** Stainless steel, **as directed**.
   c. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, **OR** Stainless steel, **as directed**, of length required to secure pressure plates to sealing elements.

R. Wall Penetration Systems
1. Description: Wall-sleeve assembly, consisting of housing and gland, gaskets, and pipe sleeve.
   a. Carrier-Pipe Deflection: Up to 5 percent without leakage.
   b. Housing: Ductile-iron casting with hub, waterstop, anchor ring, and locking devices. Include gland, bolts, and nuts.
   c. Housing-to-Sleeve Gasket: EPDM rubber **OR** NBR, **as directed**.
   d. Housing-to-Carrier-Pipe Gasket: AWWA C111, EPDM rubber **OR** NBR, **as directed**.
   e. Pipe Sleeve: AWWA C151, ductile-iron pipe **OR** ASTM A 53/A 53M, Schedule 40, zinc-coated steel pipe, **as directed**.

S. Grout
1. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
2. Characteristics: Nonshrink; recommended for interior and exterior applications.
3. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

1.3 EXECUTION

A. Earthwork
1. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

B. Piping Installation
1. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
2. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

3. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
4. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105.
5. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters And Gages For Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.
6. Install shutoff valve immediately upstream of each dielectric fitting.
7. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.
8. Install domestic water piping level with 0.25 percent slope downward toward drain **OR** without pitch, **as directed**, and plumb.
9. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
10. Install seismic restraints on piping. Comply with requirements in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment" for seismic-restraint devices.
11. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
12. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
13. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
14. Install piping adjacent to equipment and specialties to allow service and maintenance.
15. Install piping to permit valve servicing.
16. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
17. Install piping free of sags and bends.
18. Install fittings for changes in direction and branch connections.
19. Install PEX piping with loop at each change of direction of more than 90 degrees.
20. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
21. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters And Gages For Plumbing Piping" for pressure gages.
22. Install thermostats in hot-water circulation piping. Comply with requirements in Division 22 Section "Domestic Water Pumps" for thermostats.
23. Install thermometers on inlet **OR** inlet and outlet, **as directed**, piping from each water heater. Comply with requirements in Division 22 Section "Meters And Gages For Plumbing Piping" for thermometers.

C. Joint Construction
1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
3. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   a. Apply appropriate tape or thread compound to external pipe threads.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
4. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

5. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
6. Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
7. Copper-Tubing, Push-on Joints: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.
8. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
9. Copper-Tubing Grooved Joints: Roll groove end of tube. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for roll-grooved joints.
10. Ductile-Iron-Piping Grooved Joints: Cut groove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join ductile-iron pipe and grooved-end fittings according to AWWA C606 for ductile-iron-pipe, cut-grooved joints.
11. Steel-Piping Grooved Joints: Cut **OR** Roll, **as directed**, groove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
12. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
13. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
    a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
    b. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
    c. PVC Piping: Join according to ASTM D 2855.
14. PEX Piping Joints: Join according to ASTM F 1807.
15. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

D. Valve Installation
1. General-Duty Valves: Comply with requirements in Division 22 Section "General-duty Valves For Plumbing Piping" for valve installations.
2. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 (DN 50) and smaller. Use butterfly or gate valves for piping NPS 2-1/2 (DN 65) and larger.
3. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties".
    a. Hose-End Drain Valves: At low points in water mains, risers, and branches.
    b. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.
4. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 2 (DN 50) and smaller and butterfly valves for piping NPS 2-1/2 (DN 65) and larger. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves.
5. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for calibrated balancing valves.

E. Transition Fitting Installation
1. Install transition couplings at joints of dissimilar piping.
2. Transition Fittings in Underground Domestic Water Piping:

a. NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
b. NPS 2 (DN 50) and Larger: Sleeve-type coupling.
3. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings **OR** unions, **as directed**.

F. Dielectric Fitting Installation
1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric couplings **OR** nipples **OR** unions, **as directed**.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges **OR** flange kits **OR** nipples, **as directed**.
4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

G. Flexible Connector Installation
1. Install flexible connectors in suction and discharge piping connections to each domestic water pump and in suction and discharge manifold connections to each domestic water booster pump, **as directed**.
2. Install bronze-hose flexible connectors in copper domestic water tubing.
3. Install stainless-steel-hose flexible connectors in steel domestic water piping.

H. Water Meter Installation
1. Rough-in domestic water piping for water meter installation, and install water meters, **as directed**, according to utility company's requirements.
2. Water meters will be furnished and installed by utility company.
OR
Install water meters according to AWWA M6 and utility company's requirements.
3. Install displacement-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet and valved bypass around meter unless prohibited by authorities having jurisdiction.
OR
Install turbine-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet and valved bypass around meter unless prohibited by authorities having jurisdiction.
OR
Install compound-type water meters with shutoff valves on water-meter inlet and outlet and on valved bypass around meter. Support meters, valves, and piping on brick or concrete piers.
OR
Install fire-service water meters with shutoff valves on water-meter inlet and outlet and on full-size valved bypass around meter. Support meter, valves, and piping on brick or concrete piers.
4. Install remote registration system according to standards of utility company and of authorities having jurisdiction.

I. Hanger And Support Installation
1. Comply with requirements in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment" for seismic-restraint devices.
2. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for pipe hanger and support products and installation.
a. Vertical Piping: MSS Type 8 or 42, clamps.
b. Individual, Straight, Horizontal Piping Runs:
1) 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
2) Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
3) Longer Than 100 Feet (30 m) If Indicated: MSS Type 49, spring cushion rolls.
c. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
d. Base of Vertical Piping: MSS Type 52, spring hangers.
3. Support vertical piping and tubing at base and at each floor.

4. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (10 mm).
5. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   b. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
   c. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
   d. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
   e. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
   f. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
   g. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.
6. Install supports for vertical copper tubing every 10 feet (3 m).
7. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1-1/4 (DN 32) and Smaller: 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   b. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
   c. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
   d. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
   e. NPS 3 and NPS 3-1/2 (DN 80 and DN 90): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
   f. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
   g. NPS 6 (DN 150): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
   h. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.
8. Install supports for vertical steel piping every 15 feet (4.5 m).
9. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1 (DN 25) and Smaller: 36 inches (900 mm) with 3/8-inch (10-mm) rod.
   b. NPS 1-1/4 to NPS 2 (DN 32 to DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
   c. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
   d. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
   e. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
   f. NPS 8 (DN 200): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.
10. Install supports for vertical CPVC piping every 60 inches (1500 mm) for NPS 1 (DN 25) and smaller, and every 72 inches (1800 mm) for NPS 1-1/4 (DN 32) and larger.
11. Install vinyl-coated hangers for PEX piping with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1 (DN 25) and Smaller: 32 inches (815 mm) with 3/8-inch (10-mm) rod.
12. Install hangers for vertical PEX piping every 48 inches (1200 mm).
13. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 2 (DN 50) and Smaller: 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
   b. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
   c. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
   d. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
   e. NPS 8 (DN 200): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.
14. Install supports for vertical PVC piping every 48 inches (1200 mm).
15. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

J. Connections
   1. Drawings indicate general arrangement of piping, fittings, and specialties.
   2. Install piping adjacent to equipment and machines to allow service and maintenance.

3. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
4. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   a. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
   b. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   c. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 Section(s) "Plumbing Fixtures" OR "Healthcare Plumbing Fixtures" OR "Emergency Plumbing Fixtures" OR "Security Plumbing Fixtures", **as directed**, for connection sizes.
   d. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

K. Escutcheon Installation
1. Install escutcheons for penetrations of walls, ceilings, and floors.
2. Escutcheons for New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
   b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** stamped steel with set screw **OR** stamped steel with set screw or spring clips **OR** stamped steel with spring clips, **as directed**.
   c. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** One piece or split casting, cast brass with polished chrome-plated finish **OR** Split casting, cast brass with polished chrome-plated finish **OR** One piece, stamped steel with set screw **OR** One piece or split plate, stamped steel with set screw **OR** Split plate, stamped steel with set screw, **as directed**.
   d. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish **OR** cast brass with rough-brass finish **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
   e. Bare Piping in Equipment Rooms: One piece, cast brass **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
   f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.
3. Escutcheons for Existing Piping:
   a. Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
   b. Insulated Piping: Split plate, stamped steel with concealed **OR** exposed-rivet, **as directed**, hinge and spring clips.
   c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and spring clips, **as directed**.
   d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and set screw, **as directed**.
   e. Bare Piping in Unfinished Service Spaces: Split casting, cast brass with polished chrome-plated finish **OR** casting, cast brass with rough-brass finish **OR** plate, stamped steel with concealed hinge and set screw or spring clips **OR** plate, stamped steel with concealed or exposed-rivet hinge and set screw or spring clips **OR** plate, stamped steel with exposed-rivet hinge and set screw or spring clips, **as directed**.
   f. Bare Piping in Equipment Rooms: Split casting, cast brass **OR** plate, stamped steel with set screw or spring clips, **as directed**.
   g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

L. Sleeve Installation

1. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
2. Sleeves are not required for core-drilled holes.
3. Permanent sleeves are not required for holes formed by removable PE sleeves.
4. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
5. Install sleeves in new partitions, slabs, and walls as they are built.
6. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.
7. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.
8. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals **OR** wall penetration systems, **as directed**, specified in this Section.
9. Seal space outside of sleeves in concrete slabs and walls with grout.
10. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.
11. Install sleeve materials according to the following applications:
    a. Sleeves for Piping Passing through Concrete Floor Slabs: Molded PE **OR** Molded PVC **OR** Steel pipe, **as directed**.
    b. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Steel pipe **OR** Stack sleeve fittings, **as directed**.
        1) Extend sleeves 2 inches (50 mm) above finished floor level.
        2) For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim" for flashing.
    c. Sleeves for Piping Passing through Gypsum-Board Partitions:
        1) PVC pipe **OR** Steel pipe, **as directed**, sleeves for pipes smaller than NPS 6 (DN 150).
        2) Galvanized-steel sheet sleeves for pipes NPS 6 (DN 150) and larger.
        3) Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.
    d. Sleeves for Piping Passing through Concrete Roof Slabs: Molded PE **OR** Molded PVC **OR** Steel pipe, **as directed**.
    e. Sleeves for Piping Passing through Exterior Concrete Walls:
        1) Steel pipe sleeves for pipes smaller than NPS 6 (DN 150).
        2) Cast-iron wall pipe sleeves for pipes NPS 6 (DN 150) and larger.
        3) Install sleeves that are large enough to provide 1-inch (25-mm) annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
        4) Do not use sleeves when wall penetration systems are used.
    f. Sleeves for Piping Passing through Interior Concrete Walls:
        1) PVC pipe **OR** Steel pipe, **as directed**, sleeves for pipes smaller than NPS 6 (DN 150).
        2) Galvanized-steel sheet sleeves for pipes NPS 6 (DN 150) and larger.
12. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestop materials and installations.

M. Sleeve Seal Installation

1. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.
2. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe

and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

N. Wall Penetration System Installation
1. Install wall penetration systems in new, exterior concrete walls.
2. Assemble wall penetration system components with sleeve pipe. Install so that end of sleeve pipe and face of housing are flush with wall. Adjust locking devices to secure sleeve pipe in housing.

O. Identification
1. Identify system components. Comply with requirements in Division 22 Section "Identification For Plumbing Piping And Equipment" for identification materials and installation.
2. Label pressure piping with system operating pressure.

P. Field Quality Control
1. Perform tests and inspections.
2. Piping Inspections:
   a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
   b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
      2) Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
   c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
   d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
3. Piping Tests:
   a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
   b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
   c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   d. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
   e. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
   f. Prepare reports for tests and for corrective action required.
4. Domestic water piping will be considered defective if it does not pass tests and inspections.
5. Prepare test and inspection reports.

Q. Adjusting
1. Perform the following adjustments before operation:
   a. Close drain valves, hydrants, and hose bibbs.
   b. Open shutoff valves to fully open position.
   c. Open throttling valves to proper setting.
   d. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

1) Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
2) Adjust calibrated balancing valves to flows indicated.

e. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
f. Remove and clean strainer screens. Close drain valves and replace drain plugs.
g. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
h. Check plumbing specialties and verify proper settings, adjustments, and operation.

R. Cleaning

1. Clean and disinfect potable and non-potable, **as directed**, domestic water piping as follows:
   a. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   b. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
      1) Flush piping system with clean, potable water until dirty water does not appear at outlets.
      2) Fill and isolate system according to either of the following:
         a) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
         b) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
      3) Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
      4) Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
2. Clean non-potable domestic water piping as follows:
   a. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   b. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
      1) Flush piping system with clean, potable water until dirty water does not appear at outlets.
      2) Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
3. Prepare and submit reports of purging and disinfecting activities.
4. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

S. Piping Schedule

1. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
2. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
3. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
4. Under-building-slab, domestic water, building service piping, NPS 3 (DN 80) and smaller, shall be one of the following:
   a. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; wrought-copper solder-joint fittings; and brazed **OR** copper pressure-seal fittings; and pressure-sealed, **as directed**, joints.
   b. PVC, Schedule 40 pipe; PVC, Schedule 40 **OR** Schedule 80 pipe; PVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.
5. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 (DN 100 to DN 200) and larger, shall be one of the following:

a. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; wrought-copper solder-joint fittings; and brazed joints.
b. Mechanical-joint, ductile-iron pipe; standard-pattern **OR** compact-pattern, **as directed**, mechanical-joint fittings; and mechanical joints.
c. Push-on-joint, ductile-iron pipe; standard-pattern **OR** compact-pattern, **as directed**, push-on-joint fittings; and gasketed joints.
d. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
e. PVC, Schedule 40 pipe; PVC, Schedule 40 **OR** Schedule 80 pipe; PVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.

6. Under-building slab, combined domestic water, building-service, and fire-service-main piping, NPS 6 to NPS 12 (DN 150 to DN 300), shall be one of the following:
   a. Mechanical-joint, ductile-iron pipe; standard-pattern **OR** compact-pattern, **as directed**, mechanical-joint fittings; and mechanical joints.
   b. Push-on-joint, ductile-iron pipe; standard-pattern **OR** compact-pattern, **as directed**, push-on-joint fittings; and gasketed joints.
   c. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
7. Under-building-slab, domestic water piping, NPS 2 (DN 50) and smaller, shall be one of the following:
   a. Hard **OR** Soft, **as directed**, copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); wrought-copper solder-joint fittings; and brazed **OR** copper pressure-seal-joint fittings; and pressure-sealed, **as directed**, joints.
   b. PVC, Schedule 40 pipe; PVC, Schedule 40 **OR** Schedule 80 pipe; PVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.
8. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be one of the following:
   a. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
   b. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; cast-copper **OR** wrought-copper, **as directed**, solder-joint fittings; and brazed **OR** soldered, **as directed**, joints.
   c. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B, **as directed**; copper pressure-seal-joint fittings; and pressure-sealed joints.
   d. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B) **OR**, **as directed**; copper push-on-joint fittings; and push-on joints.
   e. CPVC, Schedule 40 pipe; CPVC, Schedule 40 **OR** Schedule 80 pipe; CPVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.
   f. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
   g. CPVC Tubing System: CPVC tube; CPVC socket fittings; and solvent-cemented joints. NPS 1-1/2 (DN 40) and NPS 2 (DN 50) CPVC pipe with CPVC socket fittings may be used instead of tubing.
   h. PEX Tube, NPS 1 (DN 25) and smaller; fittings for PEX tube; and crimped joints.
   i. PVC, Schedule 40 pipe; PVC, Schedule 40 **OR** Schedule 80 pipe; PVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.
9. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:
   a. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; cast-copper **OR** wrought-copper, **as directed**, solder-joint fittings; and brazed **OR** soldered, **as directed**, joints.
   b. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; copper pressure-seal-joint fittings; and pressure-sealed joints.
   c. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B, **as directed**; grooved-joint copper-tube appurtenances; and grooved joints.

d. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
e. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
f. CPVC, Schedule 40 pipe; CPVC, Schedule 40 **OR** Schedule 80 pipe; CPVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.
g. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
h. PVC, Schedule 40 pipe; PVC, Schedule 40 **OR** Schedule 80 pipe; PVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.

10. Aboveground domestic water piping, NPS 5 to NPS 8 (DN 125 to DN 200), shall be one of the following:
a. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; cast-copper **OR** wrought-copper, **as directed**, solder-joint fittings; and brazed **OR** soldered, **as directed**, joints.
b. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; grooved-joint copper-tube appurtenances; and grooved joints.
c. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
d. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
e. CPVC, Schedule 40 pipe; CPVC, Schedule 40 **OR** Schedule 80 pipe; CPVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.
f. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
g. PVC, Schedule 40 pipe; PVC, Schedule 40 **OR** Schedule 80 pipe; PVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.

11. Aboveground, combined domestic-water-service and fire-service-main piping, NPS 6 to NPS 12 (DN 150 to DN300), shall be one of the following:
a. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
b. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
c. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.

T. Valve Schedule

1. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
a. Shutoff Duty: Use ball or gate valves for piping NPS 2 (DN 50) and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
b. Throttling Duty: Use ball or globe valves for piping NPS 2 (DN 50) and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
c. Hot-Water Circulation Piping, Balancing Duty: Calibrated **OR** Memory-stop, **as directed**, balancing valves.
d. Drain Duty: Hose-end drain valves.
2. Use check valves to maintain correct direction of domestic water flow to and from equipment.
3. Iron grooved-end valves may be used with grooved-end piping.
4. CPVC and PVC valves matching piping materials may be used.

END OF SECTION 22 11 16 00

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SECTION 22 11 16 00a - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.
3. Galvanized-steel pipe and fittings.
4. Stainless steel drainage pipe and fittings.
5. Ductile-iron pipe and fittings.
6. Copper tube and fittings.
7. ABS pipe and fittings.
8. PVC pipe and fittings.
9. Specialty pipe fittings.
10. Encasement for underground metal piping.

B. Related Requirements:

1. Section 221313 "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.
2. Section 221329 "Sanitary Sewerage Pumps" for effluent and sewage pumps.
3. Section 226600 "Chemical-Waste Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for adhesives.>

C. Shop Drawings: For hubless, single-stack drainage system. Include plans, elevations, sections, and details.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and elevations, or Building Information Model (BIM) drawn to scale, showing items described in this Section and coordinated with all building trades.

B. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.4 FIELD CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service in accordance with requirements indicated:

1. Notify [**Architect**] [**Construction Manager**] [**Owner**] no fewer than [**two**] <**Insert number**> days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without [**Architect's**] [**Construction Manager's**] [**Owner's**] written permission.

1.5 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation are capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: [**10 ft. head of water (30 kPa head of water)**] <**Insert pressure**>.
2. Waste, Force-Main Piping: [**50 psig (345 kPa)**] [**100 psig (690 kPa)**] [**150 psig (1035 kPa)**] <**Insert pressure**>.

B. Seismic Performance: Soil, waste, and vent piping and support and installation to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**] <**Insert requirement**>. See Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment":

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**] [**1.0**].

C. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.2 PIPING MATERIALS

A. Piping materials to bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Pipe and Fittings:

1. Marked with CISPI collective trademark.
2. ASTM A74, [**service**] [**and**] [**extra-heavy**] cast iron.

C. Gaskets: ASTM C564, rubber.

D. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Pipe and Fittings:

1. Marked with CISPI collective trademark.
2. ASTM A888 or CISPI 301.

C. Single-Stack Aerator Fittings: ASME B16.45, hubless, cast-iron aerator and deaerator drainage fittings.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

D. CISPI, Hubless-Piping Couplings:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: ASTM C1277 and CISPI 310.
3. Description: Stainless steel corrugated shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

E. Heavy-Duty, Hubless-Piping Couplings:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: ASTM C1277 and ASTM C1540. <**Insert standard**>.
3. Description: Stainless steel shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

2.5 GALVANIZED-STEEL PIPE AND FITTINGS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Galvanized-Steel Pipe: ASTM A53/A53M, Type E, standard-weight cast iron. Include square-cut-grooved or threaded ends matching joining method.

C. [**Galvanized-**]Cast-Iron Drainage Fittings: ASME B16.12, threaded.

D. Steel Pipe Pressure Fittings:

1. [**Galvanized-**]Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M or ASTM A106/A106M, Schedule 40, seamless steel pipe. Include ends matching joining method.

2. Malleable-Iron Unions: ASME B16.39, Class 150, hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
3. [**Galvanized-**]Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.

E. Cast-Iron Flanges: ASME B16.1, Class 125.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

F. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A536, ductile-iron castings; ASTM A47/A47M, malleable-iron castings; ASTM A234/A234M, forged steel fittings; or ASTM A106/A106M, steel pipes with dimensions matching ASTM A53/A53M, steel pipe, and complying with AWWA C606 for grooved ends.
3. Grooved Mechanical Couplings for Galvanized-Steel Piping: ASTM F1476, Type I. Include ferrous housing sections with continuous curved keys, EPDM-rubber gasket suitable for hot and cold water, and bolts and nuts.

2.6 STAINLESS STEEL DRAINAGE PIPE AND FITTINGS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Comply with requirements of ASME A112.3.1 drainage pattern.

C. Material: [**Type 304 stainless steel**] [**Type 316L stainless steel**] [**Type 304 or 316L stainless steel**].

D. Pipe Construction: Seamless.

E. Internal Sealing Rings: [**EPDM**] [**NBR**] <**Insert material**> [**, marked or color-coded for the application**].

F. Joints: Single or double, socket and spigot ends.

2.7 DUCTILE-IRON PIPE AND FITTINGS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Ductile-Iron, Mechanical-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot ends unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Ductile-Iron, Push-on-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot ends unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Gaskets: AWWA C111/A21.11, rubber.

D. Ductile-Iron, Grooved-Joint Piping: AWWA C151/A21.51, with round-cut-grooved ends in accordance with AWWA C606.

E. Ductile-Iron, Grooved-End Pipe Appurtenances:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Grooved-End, Ductile-Iron Fittings: ASTM A536, ductile-iron castings, with dimensions matching AWWA C110/A 21.10, ductile-iron pipe or AWWA C153/A 21.53, ductile-iron fittings, and complying with AWWA C606 for grooved ends.
3. Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F1476, Type I. Include ferrous housing sections with continuous curved keys, EPDM-rubber center-leg gasket suitable for hot and cold water, and bolts and nuts.

2.8 COPPER TUBE AND FITTINGS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Copper Type DWV Tube: ASTM B306, drainage tube, drawn temper.

C. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

D. Hard Copper Tube: ASTM B88, Type L and Type M (ASTM B88M, Type B and Type C), water tube, drawn temper.

E. Soft Copper Tube: ASTM B88, Type L (ASTM B88M, Type B), water tube, annealed temper.

F. Copper Pressure Fittings:

1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

G. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

H. Solder: ASTM B32, lead free with ASTM B813, water-flushable flux.

2.9 ABS PIPE AND FITTINGS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. NSF Marking: Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

C. Solid-Wall ABS Pipe: ASTM D2661, Schedule 40.

D. Cellular-Core ABS Pipe: ASTM F628, Schedule 40.

E. ABS Socket Fittings: ASTM D2661, made in accordance with ASTM D3311, drain, waste, and vent patterns.

F. Solvent Cement: ASTM D2235.

1. <Double click to insert sustainable design text for solvent cement.>
2. <Double click to insert sustainable design text for solvent cement.>

2.10 PVC PIPE AND FITTINGS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic drain, waste, and vent piping and "NSF-sewer" marking for plastic sewer piping.

C. Solid-Wall PVC Pipe: ASTM D2665 drain, waste, and vent.

D. Cellular-Core PVC Pipe: ASTM F891, Schedule 40.

E. PVC Socket Fittings: ASTM D2665, made in accordance with ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

F. Adhesive Primer: ASTM F656.

1. <Double click to insert sustainable design text for adhesive primer.>
2. <Double click to insert sustainable design text for adhesive primer.>

G. Solvent Cement: ASTM D2564.

1. <Double click to insert sustainable design text for solvent cement.>

2.11 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections of same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Nonpressure Transition Couplings:

   a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
   b. Standard: ASTM C1173.
   c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

d. End Connections: Same size as and compatible with pipes to be joined.
e. Sleeve Materials:

1) For Cast-Iron Soil Pipes: ASTM C564, rubber.
2) For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926 PVC.
3) For Dissimilar Pipes: ASTM D5926 PVC or other material compatible with pipe materials being joined.

4. Shielded, Nonpressure Transition Couplings:

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
b. Standard: ASTM C1460.
c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
d. End Connections: Same size as and compatible with pipes to be joined.

5. Pressure Transition Couplings:

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
b. Standard: AWWA C219.
c. Description: Metal sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
d. Center-Sleeve Material: [**Manufacturer's standard**] [**Carbon steel**] [**Stainless steel**] [**Ductile iron**] [**Malleable iron**].
e. Gasket Material: Natural or synthetic rubber.
f. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
b. Description:

1) Standard: ASSE 1079.
2) Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**] [**150 psig (1035 kPa)**] [**250 psig (1725 kPa)**] <**Insert pressure**>.
3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
b. Description:

1) Standard: ASSE 1079.
2) Factory-fabricated, bolted, companion-flange assembly.
3) Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**] [**150 psig (1035 kPa)**] [**175 psig (1200 kPa)**] [**300 psig (2070 kPa)**] <**Insert pressure**>.
4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>

b. Description:

1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating: [**150 psig (1035 kPa)**] <**Insert pressure**>.
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel backing washers.

5. Dielectric Nipples:

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
b. Description:

1) Standard: IAPMO PS 66.
2) Electroplated steel nipple.
3) Pressure Rating: [**300 psig (2070 kPa) at 225 deg F (107 deg C)**] <**Insert pressure and temperature**>.
4) End Connections: Male threaded or grooved.
5) Lining: Inert and noncorrosive, propylene.

2.12 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A674 or AWWA C105/A 21.5.

B. Material: [**Linear low-density polyethylene film of 0.008-inch (0.20-mm)**] [**or**] [**high-density, cross-laminated polyethylene film of 0.004-inch (0.10-mm)**] minimum thickness.

C. Form: [**Sheet**] [**or**] [**tube**].

D. Color: [**Black**] [**or**] [**natural**] <**Insert color**>.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in [**Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment"**] [**Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment"**].

K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.

1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
2. Use long-turn, double Y-branch, and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.

   a. Straight tees, elbows, and crosses may be used on vent lines.

3. Do not change direction of flow more than 90 degrees.
4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

   a. Reducing size of waste piping in direction of flow is prohibited.

L. Lay buried building waste piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

M. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Waste: Two percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; [**1**] [**2**] <**Insert number**> percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
2. Horizontal Sanitary Waste Piping: [**Two**] <**Insert number**> percent downward in direction of flow.
3. Vent Piping: [**One**] <**Insert number**> percent down toward vertical fixture vent or toward vent stack.

N. Install cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping in accordance with ASTM A674 or AWWA C105/A 21.5.

O. Install steel piping in accordance with applicable plumbing code.

P. Install stainless-steel piping in accordance with ASME A112.3.1 and applicable plumbing code.

Q. Install aboveground copper tubing in accordance with CDA's "Copper Tube Handbook."

R. Install aboveground ABS piping in accordance with ASTM D2661.

S. Install aboveground PVC piping in accordance with ASTM D2665.

T. Install underground [**ABS**] [**and**] [**PVC**] piping in accordance with ASTM D2321.

U. Install engineered soil and waste and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
2. Hubless, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.
3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

V. Install underground, ductile-iron, force-main piping according to AWWA C600.

1. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints.
2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
3. Install encasement on piping in accordance with ASTM A674 or AWWA C105/A 21.5.

W. Install underground, copper, force-main tubing in accordance with CDA's "Copper Tube Handbook."

1. Install encasement on piping in accordance with ASTM A674 or AWWA C105/A 21.5.

X. Install force mains at elevations indicated.

Y. Plumbing Specialties:

1. Install backwater valves in sanitary waster gravity-flow piping.

   a. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."

2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.

   a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
   b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."

3. Install drains in sanitary waste gravity-flow piping.

   a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

Z. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

AA. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

BB. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

CC. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.

C. Hubless, Cast-Iron Soil Piping Coupled Joints:

1. Join hubless, cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1.

1. Cut threads full and clean using sharp dies.
2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

   a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
   c. Do not use pipe sections that have cracked or open welds.

E. Join stainless-steel pipe and fittings with gaskets in accordance with ASME A112.3.1.

F. Join copper tube and fittings with soldered joints in accordance with ASTM B828. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.

G. Grooved Joints: Cut groove ends of pipe in accordance with AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

H. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

I. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join in accordance with ASTM D2235 and ASTM D2661 appendixes.
3. PVC Piping: Join in accordance with ASTM D2855 and ASTM D2665 appendixes.

J. Joint Restraints and Sway Bracing:

1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:

   a. Provide axial restraint for pipe and fittings [**5 inches (125 mm)**] <**Insert dimensions**> and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
   b. Provide rigid sway bracing for pipe and fittings [**4 inches (100 mm)**] <**Insert dimensions**> and larger, upstream and downstream of all changes in direction 45 degrees and greater.
   c. Provide rigid sway bracing for pipe and fittings [**5 inches (125 mm)**] <**Insert dimensions**> and larger, upstream and downstream of all changes in direction and branch openings.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Waste Drainage Piping: [**Unshielded**] [**Shielded**], nonpressure transition couplings.
3. In Aboveground Force Main Piping: Fitting-type transition couplings.
4. In Underground Force Main Piping:

   a. NPS 1-1/2 (DN 40) and Smaller: Fitting-type transition couplings.
   b. NPS 2 (DN 50) and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for [**NPS 2 (DN 50)**] <**Insert pipe size**> and Smaller: Use dielectric [**nipples**] [**unions**].
3. Dielectric Fittings for [**NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**] <**Insert pipe size range**>: Use dielectric [**flanges**] [**flange kits**] [**nipples**].
4. Dielectric Fittings for [**NPS 5 (DN 125)**] <**Insert pipe size**> and Larger: Use dielectric flange kits.

3.5 VALVE INSTALLATION

A. General valve installation requirements for general-duty valve installation are specified in the following Sections:

1. Section 220523.12 "Ball Valves for Plumbing Piping."
2. Section 220523.13 "Butterfly Valves for Plumbing Piping."
3. Section 220523.14 "Check Valves for Plumbing Piping."
4. Section 220523.15 "Gate Valves for Plumbing Piping."

B. Shutoff Valves:

1. Install shutoff valve on each sewage pump discharge.
2. Install [**gate**] [**full-port ball**] valve for piping NPS 2 (DN 50) and smaller.
3. Install [**gate**] <**Insert type**> valve for piping NPS 2-1/2 (DN 65) and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves.[**Use normally closed type unless otherwise indicated.**]
2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
3. Install backwater valves in accessible locations.
4. Comply with requirements for backwater valve specified in Section 221319 "Sanitary Waste Piping Specialties."

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in [**Section 220529 "Hangers and Supports for Plumbing Piping and Equipment"**] [**Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment"**].

1. Install [**carbon-steel**] <**Insert material**> pipe hangers for horizontal piping in noncorrosive environments.
2. Install [**stainless steel**] [**fiberglass**] pipe hangers for horizontal piping in corrosive environments.
3. Install [**carbon-steel**] <**Insert material**> pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42 clamps.
6. Install individual, straight, horizontal piping runs:

   a. 100 Ft. (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Ft. (30 m): MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Ft. (30 m) if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Ft. (30 m) or Longer: MSS Type 44 pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52 spring hangers.

C. Install hangers for [**cast-iron**] [**steel**] [**stainless steel**] [**and**] [**copper**] soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install hangers for [**ABS**] [**and**] [**PVC**] piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting[**, valve,**] and coupling.

F. Support vertical runs of [**cast-iron**] [**steel**] [**stainless steel**] [**and**] [**copper**] soil piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

G. Support vertical runs of [**ABS**] [**and**] [**PVC**] piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Install horizontal backwater valves [**with cleanout cover flush with floor**] [**in pit with pit cover flush with floor**] <**Insert description**>.
6. Comply with requirements for [**backwater valves**] [**cleanouts**] [**and**] [**drains**] specified in Section 221319 "Sanitary Waste Piping Specialties."
7. Equipment: Connect waste piping as indicated.

   a. Provide shutoff valve if indicated and union for each connection.
   b. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main.
2. Sewage Pump: To sewage pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections in accordance with the following unless otherwise indicated:

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary waste and vent piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.

a. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.

a. Close openings in piping system and fill with water to point of overflow, but not less than 10 ft. head of water (30 kPa head of water).
b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
c. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.

a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1 inch wg (250 Pa).
b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
c. Air pressure must remain constant without introducing additional air throughout period of inspection.
d. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

E. Test force-main piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials.

    a. Isolate test source and allow to stand for four hours.
    b. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed [**ABS**] [**and**] [**PVC**] Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.11 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping [**NPS 4 (DN 100) and smaller**] <**Insert pipe size range**> are to be[**any of**] the following:

1. Service cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings[**and hubless, single-stack aerator fittings**]; [**CISPI**] [**heavy-duty**] hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Stainless steel pipe and fittings, sealing rings, and gasketed joints.
5. Copper Type DWV tube, copper drainage fittings, and soldered joints.
6. [**Solid-wall**] [**Cellular-core**] ABS pipe, ABS socket fittings, and solvent-cemented joints.
7. [**Solid-wall**] [**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
8. Dissimilar Pipe-Material Couplings: [**Unshielded**] [**Shielded**], nonpressure transition couplings.

C. Aboveground, soil and waste piping [**NPS 5 (DN 125) and larger**] <**Insert pipe size range**> are to be[**any of**] the following:

1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings [**and hubless, single-stack aerator fittings**]; [**CISPI**] [**heavy-duty**] hubless-piping couplings; and coupled joints.

3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Stainless steel pipe and fittings, sealing rings, and gasketed joints.
5. [**Solid-wall**] [**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
6. Dissimilar Pipe-Material Couplings: [**Unshielded**] [**Shielded**], nonpressure transition couplings.

D. Aboveground, vent piping [**NPS 4 (DN 100) and smaller**] <**Insert pipe size range**> is to be[**any of**] the following:

1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; [**CISPI**] [**heavy-duty**] hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Stainless steel pipe and fittings gaskets, and gasketed joints.
5. Copper Type DWV tube, copper drainage fittings, and soldered joints.

   a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2 (DN 65 and DN 90): Hard copper tube, Type M (Type C); copper pressure fittings; and soldered joints.

6. [**Solid-wall**] [**Cellular-core**] ABS pipe, ABS socket fittings, and solvent-cemented joints.
7. [**Solid-wall**] [**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
8. Dissimilar Pipe-Material Couplings: [**Unshielded**] [**Shielded**], nonpressure transition couplings.

E. Aboveground, vent piping [**NPS 5 (DN 125) and larger**] <**Insert pipe size range**> is to be[**any of**] the following:

1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; [**CISPI**] [**heavy-duty**] hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. [**Solid-wall**] [**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: [**Unshielded**] [**Shielded**], nonpressure transition couplings.

F. Underground, soil, waste, and vent piping [**NPS 4 (DN 100) and smaller**] <**Insert pipe size range**> are to be[**any of**] the following:

1. [**Extra-heavy**] [**Service**] cast-iron soil piping; [**gaskets; and gasketed**] [**caulking materials; and caulked**] joints.
2. Hubless, cast-iron soil pipe and fittings; [**CISPI**] [**heavy-duty**] [**cast-iron**] hubless-piping couplings; and coupled joints.
3. Stainless steel pipe and fittings, gaskets, and gasketed joints.
4. [**Solid-wall**] [**Cellular-core**] ABS pipe, ABS socket fittings, and solvent-cemented joints.
5. [**Solid-wall**] [**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
6. Dissimilar Pipe-Material Couplings: [**Unshielded**] [**Shielded**], nonpressure transition couplings.

G. Underground, soil and waste piping [**NPS 5 (DN 125) and larger**] <**Insert pipe size range**> are to be[**any of**] the following:

1. [**Extra-heavy**] [**Service**], cast-iron soil piping; [**gaskets; and gasketed**] [**caulking materials; and caulked**] joints.
2. Hubless, cast-iron soil pipe and fittings; [**CISPI**] [**heavy-duty**] [**cast-iron**] hubless-piping couplings; coupled joints.
3. [**Solid-wall**] [**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: [**Unshielded**] [**Shielded**], nonpressure transition couplings.

H. Aboveground sanitary-sewage force mains [**NPS 1-1/2 and NPS 2 (DN 40 and DN 50)**] <**Insert pipe size range**> are to be[**any of**] the following:

1. Hard copper tube, Type L (Type B); copper pressure fittings; and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.

I. Aboveground sanitary-sewage force mains [**NPS 2-1/2 to NPS 6 (DN 65 to DN 150)**] <**Insert pipe size range**> are to be[**any of**] the following:

1. Hard copper tube, Type L (Type B); copper pressure fittings; and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.
3. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.

J. Underground sanitary-sewage force mains [**NPS 4 (DN 100) and smaller**] <**Insert pipe size range**> are to be[**any of**] the following:

1. [**Hard**] [**Soft**] copper tube, Type L (Type B); [**wrought-**]copper pressure fittings; and soldered joints.
2. Ductile-iron, mechanical-joint piping and mechanical joints.
3. Ductile-iron, push-on-joint piping and push-on joints.
4. Ductile-iron, grooved-joint piping and grooved joints.
5. Fitting-type transition coupling for piping smaller than NPS 1-1/2 (DN 40) and pressure transition coupling for NPS 1-1/2 (DN 40) and larger if dissimilar pipe materials.

K. Underground sanitary-sewage force mains [**NPS 5 (DN 125) and larger**] <**Insert pipe size range**> are to be[**any of**] the following:

1. Hard copper tube, Type L (Type B); [**wrought-**]copper pressure fittings; and soldered joints.
2. Ductile-iron, mechanical-joint piping and mechanical joints.
3. Ductile-iron, push-on-joint piping and push-on joints.
4. Ductile-iron, grooved-joint piping and grooved joints.
5. Pressure transition couplings if dissimilar pipe materials.

END OF SECTION 22 11 16 00a

SECTION 22 11 16 00b - STORM DRAINAGE PIPING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for storm drainage piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes:
a. Pipe, tube, and fittings.
b. Special pipe fittings.
c. Encasement for underground metal piping.

C. Performance Requirements
1. Components and installation shall be capable of withstanding the following minimum working-pressure, unless otherwise indicated:
a. Storm Drainage Piping: 10-foot head of water (30 kPa).
b. Storm Drainage, Force-Main Piping: 50 psig (345 kPa) **OR** 100 psig (690 kPa) **OR** 150 psig (1035 kPa), **as directed**.
2. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

D. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
a. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.
3. Shop Drawings: For controlled-flow **OR** siphonic roof drainage system, as directed by the Owner. Include calculations, plans, and details. Controlled-Flow Storm Drainage System: Include calculations, plans, and details.
4. Seismic Qualification Certificates: For storm drainage piping, accessories, and components, from manufacturer.
a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
b. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
5. Field quality-control inspection and test reports.

E. Quality Assurance
1. Piping materials shall bear label, stamp, or other markings of specified testing agency.
2. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

F. Project Conditions
1. Interruption of Existing Storm-Drainage Service: Do not interrupt service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
a. Notify the Owner no fewer than two days in advance of proposed interruption of storm-drainage service.

b. Do not proceed with interruption of storm-drainage service without the Owner's written permission.

1.2 PRODUCTS

A. Piping Materials
1. Refer to Part 1.3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining methods for specific services, service locations, and pipe sizes.

B. Hub-And-Spigot, Cast-Iron Soil Pipe And Fittings
1. Pipe and Fittings: ASTM A 74, Service and Extra-Heavy class(es).
2. Gaskets: ASTM C 564, rubber.
3. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

C. Hubless Cast-Iron Soil Pipe And Fittings
1. Pipe and Fittings: ASTM A 888 or CISPI 301.
2. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
   a. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.
   b. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.
   c. Heavy-Duty, Shielded, Cast-Iron Couplings: ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve.
3. Rigid, Unshielded Couplings: ASTM C 1461, sleeve-type, reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Galvanized-Steel Pipe And Fittings
1. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Standard Weight or Schedule 40, galvanized. Include ends matching joining method.
2. Drainage Fittings: ASME B16.12, galvanized, **as directed**, threaded, cast-iron drainage pattern.
3. Pressure Fittings:
   a. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.
   b. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
   c. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, galvanized, **as directed**, standard pattern.
   d. Cast-Iron Flanges: ASME B16.1, Class 125.
   e. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125, galvanized, **as directed**.
4. Grooved-Joint Systems:
   a. Grooved-End, Steel-Piping Fittings: ASTM A 47/A 47M, galvanized, **as directed**, malleable-iron casting; ASTM A 106, galvanized-steel pipe; or ASTM A 536, galvanized, **as directed**, ductile-iron casting; with dimensions matching steel pipe.
   b. Grooved-End, Steel-Piping Couplings: AWWA C606, for steel-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

E. Ductile-Iron, Pipe and Fittings
1. Ductile-Iron, Mechanical-Joint Piping
   a. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot end, unless grooved or flanged ends are indicated.
   b. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.

c. Glands, Gaskets, and Bolts: AWWA C111/A121.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2. Ductile-Iron, Push-on-Joint,
   a. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot end, unless grooved or flanged ends are indicated.
   b. Ductile-Iron Fittings: AWWA C110/A21.10, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
   c. Gaskets: AWWA C111/A21.11, rubber.
3. Ductile Iron, Grooved-Joint Piping:
   a. Ductile-Iron Pipe: AWWA C151/A21.51 with round-cut-grooved ends according to AWWA C606.
   b. Ductile-Iron-Pipe Appurtenances:
      1) Grooved-End, Ductile-Iron Fittings: ASTM A 536, ductile-iron castings with dimensions matching pipe. AWWA C110/A21.10 ductile-iron pipe or AWWA C153/A21.53 ductile-iron fittings and complying with AWWA C606 for grooved ends.
      2) Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys, EPMD-rubber center-leg gasket suitable for hot and cold water, and bolts and nuts.

F. Copper Tube And Fittings
1. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
2. Copper Drainage Fittings: ASME B16.23, cast-copper or ASME B16.29, wrought-copper, solder-joint fittings.
3. Hard Copper Tube: ASTM B 88, Types L and M (ASTM B 88M, Types B and C), water tube, drawn temper.
4. Soft Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B), water tube, annealed temper.
5. Copper Pressure Fittings:
   a. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
   b. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
6. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
   a. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
   b. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
7. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

G. ABS Pipe And Fittings
1. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.
2. Cellular-Core ABS Pipe: ASTM F 628, Schedule 40.
3. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.
4. Solvent Cement: ASTM D 2235
   a. Use ABS solvent cement that has a VOC content of 325 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

H. PVC Pipe And Fittings
1. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
2. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.
3. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
4. Adhesive Primer: ASTM F 656.
   a. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
5. Solvent Cement: ASTM D 2564.

a. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

I. Specialty Pipe Fittings
1. Transition Couplings:
a. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
b. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
c. Unshielded, Nonpressure Transition Couplings:
1) Standard: ASTM C 1173.
2) Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
3) Sleeve Materials:
a) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
b) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
c) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
d. Shielded, Nonpressure Transition Couplings:
1) Standard: ASTM C 1460.
2) Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
e. Pressure Transition Couplings:

f. Standard: AWWA C219.
g. Description: Metal, sleeve-type couplings same size as, with pressure rating at least equal to and ends compatible with, pipes to be joined.
h. Center-Sleeve Material: Manufacturer's standard **OR** Carbon steel **OR** Stainless steel **OR** Ductile iron **OR** Malleable iron, **as directed.**
i. Gasket Material: Natural or synthetic rubber.
j. Metal Component Finish: Corrosion-resistant coating or material.
2. Dielectric Fittings:
a. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
b. Dielectric Unions:
1) Description:
a) Standard: ASSE 1079.
b) Pressure Rating: **150 psig (1035 kPa) OR 250 psig (1725 kPa)** at 180 deg F (82 deg C), **as directed.**
c) End Connections: Solder-joint copper alloy and threaded ferrous.
c. Dielectric Flanges:
1) Description:
a) Standard: ASSE 1079.
b) Factory-fabricated, bolted, companion-flange assembly.
c) Pressure Rating: **150 psig (1035 kPa) OR 175 psig (1200 kPa)** minimum **OR 300 psig (2070 kPa), as directed.**
d) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
d. Dielectric-Flange Insulating Kits:
1) Description:
a) Nonconducting materials for field assembly of companion flanges.

b) Pressure Rating: **150 psig (1035 kPa)**
c) Gasket: Neoprene or phenolic.
d) Bolt Sleeves: Phenolic or polyethylene.
e) Washers: Phenolic with steel-backing washers.

e. Dielectric Nipples:
1) Description:
a) Electroplated steel nipple complying with ASTM F 1545.
b) Pressure Rating: **300 psig (2070 kPa)** at **225 deg F (107 deg C)**.
c) End Connections: Male threaded or grooved.
d) Lining: Inert and noncorrosive, propylene.

J. Encasement For Underground Metal Piping
1. Description: ASTM A 674 or AWWA C105
2. Material: High-density, crosslaminated PE film of 0.004-inch (0.10-mm) **OR** LLDPE film of 0.008-inch (0.20-mm), **as directed**, minimum thickness.
3. Form: Sheet **OR** Tube, **as directed**.
4. Color: Black **OR** Natural, **as directed**.

1.3 EXECUTION

A. Earth Moving
1. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

B. Piping Installation
1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from layout are approved on coordination drawings.
2. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
3. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
4. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
5. Install piping to permit valve servicing.
6. Install piping at indicated slopes.
7. Install piping free of sags and bends.
8. Install fittings for changes in direction and branch connections.
9. Install piping to allow application of insulation.
10. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".
11. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
12. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
13. Install storm drainage piping at the following minimum slopes unless otherwise indicated:
a. Building Storm Drain: 1 percent **OR** 2 percent, **as directed**, downward in direction of flow for piping NPS 3 (DN 80) and smaller; 1 percent **OR** 2 percent**, as directed,** downward in direction of flow for piping NPS 4 (DN 100) and larger.

b. Horizontal Storm-Drainage Piping: **2 percent** downward in direction of flow.

14. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
    a. Install encasement on underground piping according to ASTM A 674 or AWWA C105.
15. Install steel piping according to applicable plumbing code.
16. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
17. Install aboveground ABS piping according to ASTM D 2661.
18. Install aboveground PVC piping according to ASTM D 2665.
19. Install underground ABS and PVC piping according to ASTM D 2321.
20. Install engineered controlled-flow **OR** siphonic**, as directed,** drain specialties and storm drainage piping in locations indicated.
21. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to storm sewer piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
    a. Install encasement on piping according to ASTM A 674 or AWWA C105.
22. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
    a. Install encasement on piping according to ASTM A 674 or AWWA C105.
23. Install force mains at elevations indicated.
24. Plumbing Specialties:
    a. Install backwater valves in storm drainage gravity-flow piping. Comply with requirements for backwater valves specified in Division 33 Section "Storm Utility Drainage Piping".
    b. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping. Comply with requirements for cleanouts specified in Division 33 Section "Storm Utility Drainage Piping".
    c. Install drains in storm drainage gravity-flow piping. Comply with requirements for drains specified in Division 33 Section "Storm Utility Drainage Piping".
25. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
26. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Common Work Results For Plumbing".
27. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Common Work Results For Plumbing".
28. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Common Work Results For Plumbing".

C. Joint Construction

1. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results For Plumbing".
2. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
3. Hub-and-Spigot, Cast-Iron Soil Piping Calked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
4. Hubless Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
5. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
    a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
    b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

6. Join copper tube and fittings with soldered joints according to ASTM B 828 procedure. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.
7. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
8. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
9. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
    a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
    b. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
    c. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

D. Specialty Pipe Fitting Installation
1. Transition Couplings:
    a. Install transition couplings at joints of piping with small differences in OD's.
    b. In Drainage Piping: Unshielded **OR** Shielded, **as directed** nonpressure transition couplings.
    c. In Aboveground Force-Main Piping: Fitting-type transition couplings.
    d. In Underground Force-Main Piping:
        1) NPS 1-1/2 (DN 40) and Smaller: Fitting-type transition couplings.
        2) NPS 2 (DN 50) and Larger: Pressure transition couplings.
2. Dielectric Fittings:
    a. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
    b. Dielectric Fittings for **NPS 2 (DN 50)** and Smaller: Use dielectric nipples **OR** unions, **as directed**.
    c. Dielectric Fittings for **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**: Use dielectric flanges **OR** flange kits **OR** nipples, **as directed.**
    d. Dielectric Fittings for **NPS 5 (DN 125)** and Larger: Use dielectric flange kits.

E. Valve Installation
1. General valve installation requirements are specified in Division 22 Section "General-duty Valves For Plumbing Piping".
2. Shutoff Valves: Install shutoff valve on each sump pump discharge.
    a. Install gate or full-port ball valve for piping NPS 2 (DN 50) and smaller.
    b. Install gate valve for piping NPS 2-1/2 (DN 65) and larger.
3. Check Valves: Install swing check valve, between pump and shutoff valve, on each sump pump discharge.
4. Backwater Valves: Install backwater valves in piping subject to backflow.
    a. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
    b. Install backwater valves in accessible locations.
    c. Comply with requirements for backwater valve specified in Division 22 Section "Storm Drainage Piping Specialties".

F. Hanger And Support Installation
1. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".
2. Comply with requirements for pipe hangers and supports and installation specified in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment".
    a. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
    b. Install stainless-steel **OR** fiberglass pipe hangers, **as directed,** for horizontal piping in corrosive environments.
    c. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.

d. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
e. Vertical Piping: MSS Type 8 or Type 42, clamps.
f. Individual, Straight, Horizontal Piping Runs:
    1) 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    2) Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
    3) Longer Than 100 Feet (30 m), if Indicated: MSS Type 49, spring cushion rolls.
g. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
h. Base of Vertical Piping: MSS Type 52, spring hangers.

3. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting, valve, and coupling.
4. Support vertical piping and tubing at base and at each floor.
5. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
6. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
    b. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
    c. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
    d. NPS 6 (DN 150): 60 inches (1500 mm) with 3/4-inch (19-mm) rod.
    e. NPS 8 to NPS 12 (DN 200 to DN 300): 60 inches (1500 mm) with 7/8-inch (22-mm) rod.
    f. Spacing for 10-foot (3-m) lengths may be increased to 10 feet (3 m). Spacing for fittings is limited to 60 inches (1500 mm).
7. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).
8. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 1-1/4 (DN 32): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
    b. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
    c. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
    d. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
    e. NPS 3 (DN 80): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
    f. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
    g. NPS 6 (DN 150): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
    h. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.
9. Install supports for vertical steel piping every 15 feet (4.5 m).
10. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 1-1/4 (DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
    b. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
    c. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
    d. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
    e. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
    f. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.
11. Install supports for vertical copper tubing every 10 feet (3 m).
12. Install hangers for ABS and PVC piping with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
    b. NPS 3 (DN 80): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
    c. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
    d. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
    e. NPS 8 to NPS 12 (DN 200 to DN 300): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.
13. Install supports for vertical ABS and PVC piping every 48 inches (1200 mm).

14. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

G. Connections
1. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
3. Connect storm drainage piping to roof drains and storm drainage specialties.
   a. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
   b. Install horizontal backwater valves with cleanout cover flush with floor **OR** in pit with pit cover flush with floor, **as directed.**
   c. Comply with requirements for backwater valves, cleanouts and drains specified in Division 22 Section "Storm Drainage Piping Specialties".
4. Connect force-main piping to the following:
   a. Storm Sewer: To exterior force main or storm manhole.
   b. Sump Pumps: To sump pump discharge.
5. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
6. Make connections according to the following unless otherwise indicated:
   a. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
   b. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

H. Identification
1. Identify exposed storm drainage piping. Comply with requirements for identification specified in Division 22 Section "Identification For Plumbing Piping And Equipment".

I. Field Quality Control
1. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
   b. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
2. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
3. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
4. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   a. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   b. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   c. Test Procedure: Test storm drainage piping, except outside leaders, **as directed**, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
   d. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   e. Prepare reports for tests and required corrective action.

5. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   a. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   b. Cap and subject piping to static-water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
   c. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   d. Prepare reports for tests and required corrective action.

J. Cleaning
1. Clean interior of piping. Remove dirt and debris as work progresses.
2. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
3. Place plugs in ends of uncompleted piping at end of day and when work stops.

K. Piping Schedule
1. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
2. Aboveground storm drainage piping NPS 6 (DN 150) and smaller shall be any of the following:
   a. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   b. Hubless, cast-iron soil pipe and fittings; **CISPI, heavy-duty,** hubless-piping couplings; and coupled joints.
   c. Galvanized-steel pipe, drainage fittings, and threaded joints.
   d. Copper tube and fittings in first subparagraph below are only available in NPS 1-1/4 to NPS 8 (DN 32 to DN 200).
   e. Copper DWV tube, copper drainage fittings, and soldered joints.
   f. Solid-wall **OR** Cellular-core ABS pipe, **as directed**, ABS socket fittings, and solvent-cemented joints.
   g. Solid-wall **OR** Cellular-core PVC pipe, **as directed,** PVC socket fittings, and solvent-cemented joints.
   h. Dissimilar Pipe-Material Couplings: Unshielded **OR** Shielded, **as directed,** nonpressure transition couplings.
3. Aboveground, storm drainage piping NPS 8 (DN 200) and larger shall be any of the following:
   a. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   b. Hubless, cast-iron soil pipe and fittings; **CISPI, heavy-duty,** hubless-piping couplings; and coupled joints.
   c. Galvanized-steel pipe, drainage fittings, and threaded joints.
   d. Copper DWV tube, copper drainage fittings, and soldered joints.
   e. Solid-wall **OR** Cellular-core PVC pipe, **as directed**, PVC socket fittings, and solvent-cemented joints.
   f. Dissimilar Pipe-Material Couplings: Unshielded **OR** Shielded, **as directed**, nonpressure transition couplings.
4. Underground storm drainage piping **NPS 6 (DN 150) and smaller** shall be **any of** the following:
   a. Extra Heavy **OR** Service class, **as directed,** cast-iron soil pipe and fittings; gaskets; and gasketed **OR** calking materials; and calked joints, **as directed.**
   b. Hubless, cast-iron soil pipe and fittings; **CISPI, heavy-duty, cast-iron,** hubless-piping couplings; and coupled joints.
   c. Solid-wall **OR** Cellular-core ABS pipe, **as directed**, ABS socket fittings, and solvent-cemented joints.
   d. **Solid-wall OR Cellular-core** PVC pipe, **as directed**, PVC socket fittings, and solvent-cemented joints.

e. Dissimilar Pipe-Material Couplings: Unshielded **OR** Shielded, **as directed**, nonpressure transition couplings.

5. Underground, storm drainage piping **NPS 8 (DN 200) and larger** shall be **any of** the following:
   a. Extra Heavy **OR** Service class, **as directed**, cast-iron soil pipe and fittings; gaskets; and gasketed **OR** calking materials; and calked joints **as directed**,.
   b. Hubless, cast-iron soil pipe and fittings; **CISPI, heavy-duty, cast-iron,** hubless-piping couplings; and coupled joints.
   c. **Solid-wall OR Cellular-core** PVC pipe, **as directed**, PVC socket fittings, and solvent-cemented joints.
   d. Cellular-core, sewer and drain series, PVC pipe; PVC socket fittings; and solvent-cemented joints.
   e. Dissimilar Pipe-Material Couplings: **Unshielded OR Shielded**, **as directed**, nonpressure transition couplings.
6. Aboveground storm drainage force mains **NPS 1-1/2 and NPS 2 (DN 40 and DN 50)** shall be **any of** the following:
   a. Hard copper tube, copper pressure fittings, and soldered joints.
   b. Galvanized-steel pipe, pressure fittings, and threaded joints.
7. Aboveground storm drainage force mains **NPS 2-1/2 to NPS 6 (DN 65 to DN 150)** shall be any of the following:
   a. Hard copper tube, copper pressure fittings, and soldered joints.
   b. Galvanized-steel pipe, pressure fittings, and threaded joints.
   c. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
   d. Fitting-type transition couplings if dissimilar pipe materials.
8. Underground storm drainage force mains NPS 4 (DN 100) and smaller shall be any of the following:
   a. Hard **OR** Soft**, as directed** copper tube; **wrought-**copper pressure fittings; and soldered joints.
   b. Ductile-iron, mechanical-joint piping and mechanical joints.
   c. Ductile-iron, push-on-joint piping and push-on joints.
   d. Ductile-iron, grooved-joint piping and grooved joints.
   e. Fitting-type transition coupling for piping smaller than NPS 1-1/2 (DN 40) and pressure transition coupling for NPS 1-1/2 (DN 40) and larger if dissimilar pipe materials.
9. Underground storm drainage force mains NPS 5 (DN 125) and larger shall be any of the following:
   a. Hard copper tube; **wrought-**copper pressure fittings; and soldered joints.
   b. Ductile-iron, mechanical-joint piping and mechanical joints.
   c. Ductile-iron, push-on-joint piping and push-on joints.
   d. Ductile-iron, grooved-joint piping and grooved joints.
   e. Pressure transition couplings if dissimilar pipe materials.

END OF SECTION 22 11 16 00b

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SECTION 22 11 16 00c - HYDRONIC PIPING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for hydronic piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
a. Hot-water heating piping.
b. Chilled-water piping.
c. Dual-temperature heating and cooling water piping.
d. Condenser-water piping.
e. Glycol cooling-water piping.
f. Makeup-water piping.
g. Condensate-drain piping.
h. Blowdown-drain piping.
i. Air-vent piping.
j. Safety-valve-inlet and -outlet piping.

C. Definitions
1. PTFE: Polytetrafluoroethylene.
2. RTRF: Reinforced thermosetting resin (fiberglass) fittings.
3. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

D. Performance Requirements
1. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
a. Hot-Water Heating Piping: **psig (kPa),** as directed by the Owner at 200 deg F (93 deg C).
b. Chilled-Water Piping: **psig (kPa),** as directed by the Owner at 200 deg F (93 deg C).
c. Dual-Temperature Heating and Cooling Water Piping: **psig (kPa),** ethylene at 200 deg F (93 deg C).
d. Condenser-Water Piping: **psig (kPa),** as directed by the Owner at 150 deg F (66 deg C).
e. Glycol Cooling-Water Piping: **psig (kPa),** as directed by the Owner at 150 deg F (66 deg C).
f. Makeup-Water Piping: 80 psig (552 kPa) at 150 deg F (66 deg C).
g. Condensate-Drain Piping: 150 deg F (66 deg C).
h. Blowdown-Drain Piping: 200 deg F (93 deg C).
i. Air-Vent Piping: 200 deg F (93 deg C).
j. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

E. Submittals
1. Product Data: For each type of the following:
a. Plastic pipe and fittings with solvent cement.
b. RTRP and RTRF with adhesive.
c. Pressure-seal fittings.
d. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
e. Air control devices.

f. Chemical treatment.
g. Hydronic specialties.

2. LEED Submittal:
   a. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.
3. Shop Drawings: Detail, at 1/4 (1:50) scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
4. Welding certificates.
5. Qualification Data: For Installer.
6. Field quality-control test reports.
7. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.
8. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

F. Quality Assurance
1. Installer Qualifications:
   a. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
   b. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by the manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.
2. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
3. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
   a. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   b. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
4. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.2 PRODUCTS

A. Copper Tube And Fittings
1. Drawn-Temper Copper Tubing: ASTM B 88, Type L (ASTM B 88M, Type B) **OR** ASTM B 88, Type M (ASTM B 88M, Type C), **as directed**.
2. Annealed-Temper Copper Tubing: ASTM B 88, Type K (ASTM B 88M, Type A).
3. DWV Copper Tubing: ASTM B 306, Type DWV.
4. Wrought-Copper Fittings: ASME B16.22.
   a. Grooved-End Copper Fittings: ASTM B 75 (ASTM B 75M), copper tube or ASTM B 584, bronze casting.
   b. Grooved-End-Tube Couplings: Rigid pattern, unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, prelubricated, **as directed**, EPDM gasket rated for minimum 230 deg F (110 deg C) for use with housing, and steel bolts and nuts.
5. Copper or Bronze Pressure-Seal Fittings:
   a. Housing: Copper.
   b. O-Rings and Pipe Stops: EPDM.

c. Tools: Manufacturer's special tools.
d. Minimum 200-psig (1379-kPa) working-pressure rating at 250 deg F (121 deg C).
6. Copper, Mechanically Formed Tee Option: For forming T-branch on copper water tube.
7. Wrought-Copper Unions: ASME B16.22.

B. Steel Pipe And Fittings
1. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 1.3 "Piping Applications" Article.
2. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 1.3 "Piping Applications" Article.
3. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 1.3 "Piping Applications" Article.
4. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 1.3 "Piping Applications" Article.
5. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 1.3 "Piping Applications" Article.
6. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
7. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
a. Material Group: 1.1.
b. End Connections: Butt welding.
c. Facings: Raised face.
8. Grooved Mechanical-Joint Fittings and Couplings:
a. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
b. Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
9. Steel Pressure-Seal Fittings:
a. Housing: Steel.
b. O-Rings and Pipe Stop: EPDM.
c. Tools: Manufacturer's special tool.
d. Minimum 300-psig (2070-kPa) working-pressure rating at 230 deg F (110 deg C).
10. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

C. Plastic Pipe And Fittings
1. CPVC Plastic Pipe: ASTM F 441/F 441M, Schedules 40 and 80, plain ends as indicated in Part 1.3 "Piping Applications" Article.
2. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM F 438 for Schedule 40 pipe; ASTM F 439 for Schedule 80 pipe.
3. PVC Plastic Pipe: ASTM D 1785, Schedules 40 and 80, plain ends as indicated in Part 1.3 "Piping Applications" Article.
4. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe; ASTM D 2467 for Schedule 80 pipe.

D. Fiberglass Pipe And Fittings
1. RTRP: ASTM D 2996, filament-wound pipe with tapered bell and spigot ends for adhesive joints.
2. RTRF: Compression or spray-up/contact molded of same material, pressure class, and joining method as pipe.
3. Flanges: ASTM D 4024. Full-face gaskets suitable for the service, minimum 1/8-inch (3.2-mm) thick, 60-70 durometer. ASTM A 307, Grade B, hex head bolts with washers.

E. Joining Materials
1. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
    a. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
        1) Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
        2) Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
3. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
4. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
5. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
6. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
7. Solvent Cements for Joining Plastic Piping:
    a. CPVC Piping: ASTM F 493.
        1) Use CPVC solvent cement that has a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
        2) Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    b. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
        1) Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
        2) Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
8. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.
    a. Use fiberglass adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

F. Transition Fittings
1. Plastic-to-Metal Transition Fittings:
    a. CPVC **OR** PVC, **as directed**, one-piece fitting with one threaded brass or copper insert and one Schedule 80 solvent-cement-joint end.
2. Plastic-to-Metal Transition Unions:
    a. MSS SP-107, CPVC **OR** PVC, **as directed**, union. Include brass or copper end, Schedule 80 solvent-cement-joint end, rubber gasket, and threaded union.

G. Dielectric Fittings
1. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
2. Insulating Material: Suitable for system fluid, pressure, and temperature.
3. Dielectric Unions:
    a. Factory-fabricated union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
4. Dielectric Flanges:
    a. Factory-fabricated companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
5. Dielectric-Flange Kits:
    a. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

b. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.

6. Dielectric Couplings:
   a. Galvanized-steel coupling with inert and noncorrosive thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
7. Dielectric Nipples:
   a. Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

H. Valves
1. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 22 Section(s) "General-duty Valves For Plumbing Piping" OR Division 23 Section(s) "General-duty Valves For Hvac Piping".
2. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Instrumentation And Control For Hvac".
3. Plastic Ball Valves:
   a. Body: One-, two-, or three-piece CPVC or PVC to match piping.
   b. Ball: Full-port CPVC or PVC to match piping.
   c. Seats: PTFE.
   d. Seals: EPDM.
   e. End Connections: Socket, union, or flanged.
   f. Handle Style: Tee shape.
   g. CWP Rating: Equal to piping service.
   h. Maximum Operating Temperature: Equal to piping service.
   i. Comply with MSS SP-122.
4. Plastic Butterfly Valves:
   a. Body: PVC or CPVC to match piping wafer type for installation between flanges.
   b. Disc: EPDM-coated steel.
   c. Seats: PTFE.
   d. Handle Style: Locking lever.
   e. CWP Rating: Equal to piping service.
   f. Maximum Operating Temperature: Equal to piping service.
5. Plastic Check Valves:
   a. Body: One-, two-, or three-piece PVC or CPVC to match piping.
   b. Ends: Socket or flanged.
   c. Seats: PTFE.
   d. Check Style: Swing or ball type.
   e. CWP Rating: Equal to piping service.
   f. Maximum Operating Temperature: Equal to piping service.
6. Bronze, Calibrated-Orifice, Balancing Valves:
   a. Body: Bronze, ball or plug type with calibrated orifice or venturi.
   b. Ball: Brass or stainless steel.
   c. Plug: Resin.
   d. Seat: PTFE.
   e. End Connections: Threaded or socket.
   f. Pressure Gage Connections: Integral seals for portable differential pressure meter.
   g. Handle Style: Lever, with memory stop to retain set position.
   h. CWP Rating: Minimum 125 psig (860 kPa).
   i. Maximum Operating Temperature: 250 deg F (121 deg C).
7. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
   a. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
   b. Ball: Brass or stainless steel.
   c. Stem Seals: EPDM O-rings.
   d. Disc: Glass and carbon-filled PTFE.
   e. Seat: PTFE.

f. End Connections: Flanged or grooved.
g. Pressure Gage Connections: Integral seals for portable differential pressure meter.
h. Handle Style: Lever, with memory stop to retain set position.
i. CWP Rating: Minimum 125 psig (860 kPa).
j. Maximum Operating Temperature: 250 deg F (121 deg C).

8. Diaphragm-Operated, Pressure-Reducing Valves:
   a. Body: Bronze or brass.
   b. Disc: Glass and carbon-filled PTFE.
   c. Seat: Brass.
   d. Stem Seals: EPDM O-rings.
   e. Diaphragm: EPT.
   f. Low inlet-pressure check valve.
   g. Inlet Strainer: removable without system shutdown.
   h. Valve Seat and Stem: Noncorrosive.
   i. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
9. Diaphragm-Operated Safety Valves:
   a. Body: Bronze or brass.
   b. Disc: Glass and carbon-filled PTFE.
   c. Seat: Brass.
   d. Stem Seals: EPDM O-rings.
   e. Diaphragm: EPT.
   f. Wetted, Internal Work Parts: Brass and rubber.
   g. Inlet Strainer: removable without system shutdown.
   h. Valve Seat and Stem: Noncorrosive.
   i. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
10. Automatic Flow-Control Valves:
   a. Body: Brass or ferrous metal.
   b. Piston and Spring Assembly: Stainless steel **OR** Corrosion resistant, **as directed**, tamper proof, self cleaning, and removable.
   c. Combination Assemblies: Include bonze or brass-alloy ball valve.
   d. Identification Tag: Marked with zone identification, valve number, and flow rate.
   e. Size: Same as pipe in which installed.
   f. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
   g. Minimum CWP Rating: 175 psig (1207 kPa) **OR** 300 psig (2070 kPa), **as directed**.
   h. Maximum Operating Temperature: 200 deg F (93 deg C) **OR** 250 deg F (121 deg C), **as directed**.

I. Air Control Devices
1. Manual Air Vents:
   a. Body: Bronze.
   b. Internal Parts: Nonferrous.
   c. Operator: Screwdriver or thumbscrew.
   d. Inlet Connection: NPS 1/2 (DN 15).
   e. Discharge Connection: NPS 1/8 (DN 6).
   f. CWP Rating: 150 psig (1035 kPa).
   g. Maximum Operating Temperature: 225 deg F (107 deg C).
2. Automatic Air Vents:
   a. Body: Bronze or cast iron.
   b. Internal Parts: Nonferrous.
   c. Operator: Noncorrosive metal float.
   d. Inlet Connection: NPS 1/2 (DN 15).

e. Discharge Connection: NPS 1/4 (DN 8).
f. CWP Rating: 150 psig (1035 kPa).
g. Maximum Operating Temperature: 240 deg F (116 deg C).

3. Expansion Tanks:
   a. Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 375 deg F (191 deg C) maximum operating temperature, with taps in bottom of tank for tank fitting and taps in end of tank for gage glass. Tanks shall be factory tested with taps fabricated and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   b. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, 100-gal. (379-L) unit only; sized for compression-tank diameter. Provide tank fittings for 125-psig (860-kPa) working pressure and 250 deg F (121 deg C) maximum operating temperature.
   c. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig (860-kPa) working pressure and 240 deg F (116 deg C) maximum operating temperature; constructed to admit air to compression tank, drain water, and close off system.
   d. Gage Glass: Full height with dual manual shutoff valves, 3/4-inch- (20-mm-) diameter gage glass, and slotted-metal glass guard.
4. Diaphragm-Type **OR** Bladder-Type, **as directed**, Expansion Tanks:
   a. Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 375 deg F (191 deg C) maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   b. Diaphragm **OR** Bladder, **as directed**: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
   c. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
5. Tangential-Type Air Separators:
   a. Tank: Welded steel; ASME constructed and labeled for 125-psig (860-kPa) minimum working pressure and 375 deg F (191 deg C) maximum operating temperature.
   b. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
   c. Tangential Inlet and Outlet Connections: Threaded for NPS 2 (DN 50) and smaller; flanged connections for NPS 2-1/2 (DN 65) and larger.
   d. Blowdown Connection: Threaded.
   e. Size: Match system flow capacity.
6. In-Line Air Separators:
   a. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
   b. Maximum Working Pressure: Up to 175 psig (1207 kPa).
   c. Maximum Operating Temperature: Up to 300 deg F (149 deg C).
7. Air Purgers:
   a. Body: Cast iron with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal.
   b. Maximum Working Pressure: 150 psig (1035 kPa).
   c. Maximum Operating Temperature: 250 deg F (121 deg C).

J. Chemical Treatment
1. Bypass Chemical Feeder: Welded steel construction; 125-psig (860-kPa) working pressure; 5-gal. (19-L) capacity; with fill funnel and inlet, outlet, and drain valves.
   a. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.
2. Ethylene and Propylene Glycol: Industrial grade with corrosion inhibitors and environmental-stabilizer additives for mixing with water in systems indicated to contain antifreeze or glycol solutions.

K. Hydronic Piping Specialties
1. Y-Pattern Strainers:

a. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
b. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
c. Strainer Screen: 40 **OR** 60, **as directed**,-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
d. CWP Rating: 125 psig (860 kPa).

2. Basket Strainers:
a. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
b. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
c. Strainer Screen: 40 **OR** 60, **as directed**,-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
d. CWP Rating: 125 psig (860 kPa).

3. T-Pattern Strainers:
a. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
b. End Connections: Grooved ends.
c. Strainer Screen: 40 **OR** 60, **as directed**,-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
d. CWP Rating: 750 psig (5170 kPa).

4. Stainless-Steel Bellow, Flexible Connectors:
a. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
b. End Connections: Threaded or flanged to match equipment connected.
c. Performance: Capable of 3/4-inch (20-mm) misalignment.
d. CWP Rating: 150 psig (1035 kPa).
e. Maximum Operating Temperature: 250 deg F (121 deg C).

5. Spherical, Rubber, Flexible Connectors:
a. Body: Fiber-reinforced rubber body.
b. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
c. Performance: Capable of misalignment.
d. CWP Rating: 150 psig (1035 kPa).
e. Maximum Operating Temperature: 250 deg F (121 deg C).

6. Expansion fittings are specified in Division 22 Section(s) "Expansion Fittings And Loops For Plumbing Piping" OR Division 23 Section(s) "Expansion Fittings And Loops For Hvac Piping".

1.3 EXECUTION

1. Hot-water heating piping, aboveground, NPS 2 (DN 50) and smaller, shall be any of the following:
a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed **OR** pressure-seal, **as directed**, joints.
b. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe; Class 125, cast-iron **OR** 150, malleable-iron **OR** 250, cast-iron **OR** 300, malleable-iron, **as directed**, fittings; cast-iron flanges and flange fittings; and threaded joints.
c. Schedule 5 steel pipe; steel, pressure-seal couplings and fittings; and pressure-seal joints.
d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.

2. Hot-water heating piping, aboveground, NPS 2-1/2 (DN 65) and larger, shall be any of the following:
a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints.
b. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
c. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.
e. RTRP and RTRF with adhesive or flanged joints.

3. Hot-water heating piping installed belowground and within slabs shall be either of the following:
   a. Type K (A), annealed-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints. Use the fewest possible joints.
   b. RTRP and RTRF with adhesive or flanged joints.
4. Chilled-water piping, aboveground, NPS 2 (DN 50) and smaller, shall be any of the following:
   a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed **OR** pressure-seal, **as directed**, joints.
   b. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe; Class 125, cast-iron **OR** 150, malleable-iron **OR** 250, cast-iron **OR** 300, malleable-iron, **as directed**, fittings; cast-iron flanges and flange fittings; and threaded joints.
   c. Schedule 5 steel pipe; steel, pressure-seal couplings and fittings; and pressure-seal joints.
   d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.
5. Chilled-water piping, aboveground, NPS 2-1/2 (DN 65) and larger, shall be any of the following:
   a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints.
   b. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
   c. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
   d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.
   e. RTRP and RTRF with adhesive or flanged joints.
6. Chilled-water piping installed belowground and within slabs shall be either of the following:
   a. Type K (A), annealed-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints. Use the fewest possible joints.
   b. RTRP and RTRF with adhesive or flanged joints.
7. Dual-temperature heating and cooling water piping, aboveground, NPS 2 (DN 50) and smaller, shall be any of the following:
   a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed **OR** pressure-seal, **as directed**, joints.
   b. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe; Class 125, cast-iron **OR** 150, malleable-iron **OR** 250, cast-iron **OR** 300, malleable-iron, **as directed**, fittings; cast-iron flanges and flange fittings; and threaded joints.
   c. Schedule 5 steel pipe; steel, pressure-seal couplings and fittings; and pressure-seal joints.
   d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.
8. Dual-temperature heating and cooling water piping, aboveground, NPS 2-1/2 (DN 65) and larger, shall be any of the following:
   a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints.
   b. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
   c. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
   d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.
   e. RTRP and RTRF with adhesive or flanged joints.
9. Dual-temperature heating and cooling water piping installed belowground and within slabs shall be either of the following:
   a. Type K (A), annealed-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints. Use the fewest possible joints.
   b. RTRP and RTRF with adhesive or flanged joints.
10. Condenser-water piping, aboveground, NPS 2 (DN 50) and smaller, shall be any of the following:
    a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed **OR** pressure-seal, **as directed**, joints.

b. Schedule 80 **OR** 40 **OR** 30 **OR** 20, **as directed**, steel pipe; Class 125, cast-iron **OR** 150, malleable-iron **OR** 250, cast-iron **OR** 300, malleable-iron, **as directed**, fittings; cast-iron flanges and flange fittings; and threaded joints.
c. Schedule 5 steel pipe; steel, pressure-seal couplings and fittings; and pressure-seal joints.
d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.

11. Condenser-water piping, aboveground, NPS 2-1/2 (DN 65) and larger, shall be any of the following:
    a. Type L (B) **OR** M (C), **as directed**,, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints.
    b. Schedule 80 **OR** 40 **OR** 30 **OR** 20, **as directed**, steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
    c. Schedule 80 **OR** 40 **OR** 30 **OR** 20, **as directed**, steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
    d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.
    e. RTRP and RTRF with adhesive or flanged joints.
12. Condenser-water piping installed belowground and within slabs shall be either of the following:
    a. Type K (A), annealed-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints. Use the fewest possible joints.
    b. RTRP and RTRF with adhesive or flanged joints.
13. Glycol cooling-water piping, aboveground, NPS 2 (DN 50) and smaller, shall be any of the following:
    a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed **OR** pressure-seal, **as directed**, joints.
    b. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe; Class 125, cast-iron **OR** 150, malleable-iron **OR** 250, cast-iron **OR** 300, malleable-iron, **as directed**, fittings; cast-iron flanges and flange fittings; and threaded joints.
    c. Schedule 5 steel pipe; steel, pressure-seal couplings and fittings; and pressure-seal joints.
    d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.
14. Glycol cooling-water piping, aboveground, NPS 2-1/2 (DN 65) and larger, shall be any of the following:
    a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints.
    b. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
    c. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
    d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.
    e. RTRP and RTRF with adhesive or flanged joints.
15. Glycol cooling-water piping installed belowground and within slabs shall be either of the following:
    a. Type K (A), annealed-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints. Use the fewest possible joints.
    b. RTRP and RTRF with adhesive or flanged joints.
16. Makeup-water piping installed aboveground shall be either of the following:
    a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints.
    b. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings, and solvent-welded joints.
17. Makeup-Water Piping Installed Belowground and within Slabs: Type K (A), annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.
18. Condensate-Drain Piping: Type M (C) **OR** DWV, **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered joints or Schedule 40 PVC plastic pipe and fittings and solvent-welded joints, **as directed**.
    OR
    Condensate-Drain Piping: Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.

19. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
20. Air-Vent Piping:
    a. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
    b. Outlet: Type K (A), annealed-temper copper tubing with soldered or flared joints.
21. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.

B. Valve Applications
1. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.
2. Install throttling-duty **OR** calibrated-orifice, balancing, **as directed**, valves at each branch connection to return main.
3. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.
4. Install check valves at each pump discharge and elsewhere as required to control flow direction.
5. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
6. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

C. Piping Installations
1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
2. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
3. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
4. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
5. Install piping to permit valve servicing.
6. Install piping at indicated slopes.
7. Install piping free of sags and bends.
8. Install fittings for changes in direction and branch connections.
9. Install piping to allow application of insulation.
10. Select system components with pressure rating equal to or greater than system operating pressure.
11. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
12. Install drains, consisting of a tee fitting, NPS 3/4 (DN 20) ball valve, and short NPS 3/4 (DN 20) threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
13. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
14. Reduce pipe sizes using eccentric reducer fitting installed with level side down.
15. Install branch connections to mains using mechanically formed, **as directed**, tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
16. Install valves according to Division 22 Section(s) "General-duty Valves For Plumbing Piping" OR Division 23 Section(s) "General-duty Valves For Hvac Piping".
17. Install unions in piping, NPS 2 (DN 50) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

18. Install flanges in piping, NPS 2-1/2 (DN 65) and larger, at final connections of equipment and elsewhere as indicated.
19. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 (DN 20) nipple and ball valve in blowdown connection of strainers NPS 2 (DN 50) and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2 (DN 50).
20. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 22 Section(s) "Expansion Fittings And Loops For Plumbing Piping" OR Division 23 Section(s) "Expansion Fittings And Loops For Hvac Piping".
21. Identify piping as specified in Division 22 Section(s) "Identification For Plumbing Piping And Equipment" OR Division 23 Section(s) "Identification For Hvac Piping And Equipment".

D. Hangers And Supports
1. Hanger, support, and anchor devices are specified in Division 22 Section(s) "Hangers And Supports For Plumbing Piping And Equipment" OR Division 23 Section(s) "Hangers And Supports For Hvac Piping And Equipment". Comply with the following requirements for maximum spacing of supports.
2. Seismic restraints are specified in Division 21 Section(s) "Vibration And Seismic Controls For Fire-suppression Piping And Equipment" OR Division 22 Section(s) "Vibration And Seismic Controls For Plumbing Piping And Equipment" OR Division 23 Section(s) "Vibration And Seismic Controls For Hvac Piping And Equipment".
3. Install the following pipe attachments:
    a. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet (6 m) long.
    b. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet (6 m) or longer.
    c. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.
    d. Spring hangers to support vertical runs.
    e. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
    f. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
4. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
    a. NPS 3/4 (DN 20): Maximum span, 7 feet (2.1 m); minimum rod size, 3/8 inch (10 mm).
    b. NPS 1 (DN 25): Maximum span, 7 feet (2.1 m); minimum rod size, 3/8 inch (10 mm).
    c. NPS 1-1/4 (DN 32): Maximum span, 7 feet (2.1 m); minimum rod size, 3/8 inch (10 mm).
    d. NPS 1-1/2 (DN 40): Maximum span, 9 feet (2.7 m); minimum rod size, 3/8 inch (10 mm).
    e. NPS 2 (DN 50): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (10 mm).
    f. NPS 2-1/2 (DN 65): Maximum span, 11 feet (3.4 m); minimum rod size, 1/2 inch (12 mm).
    g. NPS 3 (DN 80): Maximum span, 12 feet (3.7 m); minimum rod size, 1/2 inch (12 mm).
    h. NPS 3-1/2 (DN 90): Maximum span, 13 feet (4 m); minimum rod size, 1/2 inch (12 mm).
    i. NPS 4 (DN 100): Maximum span, 14 feet (4.3 m); minimum rod size, 5/8 inch (16 mm).
    j. NPS 5 (DN 125): Maximum span, 16 feet (4.9 m); minimum rod size, 5/8 inch (16 mm).
    k. NPS 6 (DN 150): Maximum span, 17 feet (5.2 m); minimum rod size, 3/4 inch (20 mm).
    l. NPS 8 (DN 200): Maximum span, 19 feet (5.8 m); minimum rod size, 3/4 inch (20 mm).
    m. NPS 10 (DN 250): Maximum span, 22 feet (6.7 m); minimum rod size, 7/8 inch (20 mm).
    n. NPS 12 (DN 300): Maximum span, 23 feet (7 m); minimum rod size, 7/8 inch (20 mm).
    o. NPS 14 (DN 350): Maximum span, 25 feet (7.6 m); minimum rod size, 1 inch (24 mm).
    p. NPS 16 (DN 400): Maximum span, 27 feet (8.2 m); minimum rod size, 1 inch (24 mm).
    q. NPS 18 (DN 450): Maximum span, 28 feet (8.5 m); minimum rod size, 1 inch (24 mm).
    r. NPS 20 (DN 500): Maximum span, 30 feet (9.1 m); minimum rod size, 1-1/4 inches (30 mm).
5. Install hangers for drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:
    a. NPS 3/4 (DN 20): Maximum span, 5 feet (1.5 m); minimum rod size, 3/8 inch (10 mm).

b. NPS 1 (DN 25): Maximum span, 6 feet (1.8 m); minimum rod size, 3/8 inch (10 mm).
c. NPS 1-1/4 (DN 32): Maximum span, 7 feet (2.1 m); minimum rod size, 3/8 inch (10 mm).
d. NPS 1-1/2 (DN 40): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).
e. NPS 2 (DN 50): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).
f. NPS 2-1/2 (DN 65): Maximum span, 9 feet (2.7 m); minimum rod size, 1/2 inch (12 mm).
g. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod size, 1/2 inch (12 mm).

6. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
7. Fiberglass Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
8. Support vertical runs at roof, at each floor, and at 10-foot (3-m) intervals between floors.

E. Pipe Joint Construction

1. Join pipe and fittings according to the following requirements and Division 21 specifying piping systems.
2. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
3. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
4. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
5. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
6. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
7. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1.1 "Quality Assurance" Article.
8. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
9. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   b. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
   c. PVC Pressure Piping: Join ASTM D 1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D 2855.
   d. PVC Nonpressure Piping: Join according to ASTM D 2855.
10. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.
11. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.
12. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.
13. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

F. Hydronic Specialties Installation

1. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
   OR
   Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.
2. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.
3. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 (DN 50) and larger.
   OR
   Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.
4. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches (1200 mm) above the floor. Install feeder in minimum NPS 3/4 (DN 20) bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install NPS 3/4 (DN 20) pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.
5. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
   a. Install tank fittings that are shipped loose.
   b. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

   OR
   Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

G. Terminal Equipment Connections
1. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
2. Install control valves in accessible locations close to connected equipment.
3. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
4. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 22 Section(s) "Meters And Gages For Plumbing Piping" OR Division 23 Section(s) "Meters And Gages For Hvac Piping".

H. Chemical Treatment
1. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics:
   a. pH: 9.0 to 10.5.
   b. "P" Alkalinity: 100 to 500 ppm.
   c. Boron: 100 to 200 ppm.
   d. Chemical Oxygen Demand: Maximum 100 ppm. Modify this value if closed system contains glycol.
   e. Corrosion Inhibitor:
      1) Sodium Nitrate: 1000 to 1500 ppm.
      2) Molybdate: 200 to 300 ppm.
      3) Chromate: 200 to 300 ppm.
      4) Sodium Nitrate Plus Molybdate: 100 to 200 ppm each.
      5) Chromate Plus Molybdate: 50 to 100 ppm each.
   f. Soluble Copper: Maximum 0.20 ppm.
   g. Tolyiriazole Copper and Yellow Metal Corrosion Inhibitor: Minimum 10 ppm.
   h. Total Suspended Solids: Maximum 10 ppm.

i. Ammonia: Maximum 20 ppm.
j. Free Caustic Alkalinity: Maximum 20 ppm.
k. Microbiological Limits:
    1) Total Aerobic Plate Count: Maximum 1000 organisms/ml.
    2) Total Anaerobic Plate Count: Maximum 100 organisms/ml.
    3) Nitrate Reducers: 100 organisms/ml.
    4) Sulfate Reducers: Maximum 0 organisms/ml.
    5) Iron Bacteria: Maximum 0 organisms/ml.

2. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.
3. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.
4. Fill systems indicated to have antifreeze or glycol solutions with the following concentrations:
    a. Hot-Water Heating Piping: Minimum percent ethylene, as directed by the Owner **OR** propylene, **as directed**, glycol.
    b. Chilled-Water Piping: Minimum percent ethylene, as directed by the Owner **OR** propylene, **as directed**, glycol.
    c. Dual-Temperature Heating and Cooling Water Piping: Minimum percent, as directed by the Owner ethylene **OR** propylene, **as directed**, glycol.
    d. Glycol Cooling-Water Piping: Minimum percent ethylene, as directed by the Owner. **OR** propylene, **as directed**, glycol.

I. Field Quality Control
1. Prepare hydronic piping according to ASME B31.9 and as follows:
    a. Leave joints, including welds, uninsulated and exposed for examination during test.
    b. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
    c. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
    d. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
    e. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
2. Perform the following tests on hydronic piping:
    a. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
    b. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
    c. Isolate expansion tanks and determine that hydronic system is full of water.
    d. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
    e. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
    f. Prepare written report of testing.
3. Perform the following before operating the system:
    a. Open manual valves fully.
    b. Inspect pumps for proper rotation.
    c. Set makeup pressure-reducing valves for required system pressure.
    d. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).

e. Set temperature controls so all coils are calling for full flow.
f. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
g. Verify lubrication of motors and bearings.

END OF SECTION 22 11 16 00c

SECTION 22 11 16 00d - STEAM AND CONDENSATE PIPING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for steam and condensate piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following for LP and HP steam and condensate piping:
   a. Pipe and fittings.
   b. Strainers.
   c. Flash tanks.
   d. Safety valves.
   e. Pressure-reducing valves.
   f. Steam traps.
   g. Thermostatic air vents and vacuum breakers.
   h. Steam and condensate meters.

C. Definitions
1. HP Systems: High-pressure piping operating at more than 15 psig (104 kPa) as required by ASME B31.1.
2. LP Systems: Low-pressure piping operating at 15 psig (104 kPa) or less as required by ASME B31.9.
3. RTRF: Reinforced thermosetting resin (fiberglass) fittings.
4. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

D. Performance Requirements
1. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures:
   a. HP Steam Piping: <**Insert psig (kPa)**.>
   b. LP Steam Piping: <**Insert psig (kPa).**>
   c. Condensate Piping: <**Insert psig (kPa)**> at 250 deg F (121 deg C).
   d. Makeup-Water Piping: 80 psig (552 kPa) at 150 deg F (66 deg C).
   e. Blowdown-Drain Piping: Equal to pressure of the piping system to which it is attached.
   f. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
   g. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

E. Submittals
1. Product Data: For each type of the following:
   a. RTRP and RTRF with adhesive.
   b. Pressure-reducing and safety valve.
   c. Steam trap.
   d. Air vent and vacuum breaker.
   e. Flash tank.
   f. Meter.
2. Shop Drawings: Detail, 1/4 inch equals 1 foot (1:50) scale, flash tank assemblies and fabrication of pipe anchors, hangers, pipe, multiple pipes, alignment guides, and expansion joints and loops and their attachment to the building structure. Detail locations of anchors, alignment guides, and expansion joints and loops.

3. Welding certificates.
4. Field quality-control test reports.
5. Operation and Maintenance Data: For valves, safety valves, pressure-reducing valves, steam traps, air vents, vacuum breakers, and meters to include in emergency, operation, and maintenance manuals.

F. Quality Assurance
1. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code - Steel."
2. Pipe Welding: Qualify processes and operators according to the following:
   a. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   b. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
3. ASME Compliance: Comply with ASME B31.1, "Power Piping" **AND/OR** ASME B31.9, "Building Services Piping", **as directed**, for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.2 PRODUCTS

A. Copper Tube And Fittings
1. Drawn-Temper Copper Tubing: ASTM B 88, Type L (ASTM B 88M, Type B) **OR** ASTM B 88, Type M (ASTM B 88M, Type C), **as directed**.
2. Annealed-Temper Copper Tubing: ASTM B 88, Type K (ASTM B 88M, Type A).
3. Wrought-Copper Fittings and Unions: ASME B16.22.

B. Steel Pipe And Fittings
1. Steel Pipe: ASTM A 53/A 53M, black steel, plain ends, Type, Grade, and Schedule as indicated in Part 3 piping applications articles.
2. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 150, and 300 as indicated in Part 3 piping applications articles.
3. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300 as indicated in Part 3 piping applications articles.
4. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 piping applications articles.
5. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250 as indicated in Part 3 piping applications articles; raised ground face, and bolt holes spot faced.
6. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
7. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   a. Material Group: 1.1.
   b. End Connections: Butt welding.
   c. Facings: Raised face.
8. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, black steel of same Type, Grade, and Schedule as pipe in which installed.
9. Stainless-Steel Bellows, Flexible Connectors:
   a. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforced, protective jacket.
   b. End Connections: Threaded or flanged to match equipment connected.
   c. Performance: Capable of 3/4-inch (20-mm) misalignment.
   d. CWP Rating: 150-psig (1035-kPa).
   e. Maximum Operating Temperature: 250 deg F (121 deg C).

C. Fiberglass Pipe And Fittings

1. RTRP: ASTM D 2996 filament-wound pipe with tapered bell and spigot ends for adhesive joints.
2. RTRF: Compression or spray-up/contact molded fittings of same material, pressure class, and joining method as pipe.
3. Flanges: ASTM D 4024 full-face gaskets suitable for the service, minimum 1/8 inch (3.2 mm) thick, 60-70 durometer. ASTM A 307, Grade B, hex head bolts with washers.
4. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.

D. Joining Materials
1. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   a. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
      1) Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      2) Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
3. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
4. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
5. Welding Filler Metals: Comply with AWS D10.12 (AWS D10.12M) for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
6. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

E. Dielectric Fittings
1. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
2. Insulating Material: Suitable for system fluid, pressure, and temperature.
3. Dielectric Unions:
   a. Factory-fabricated union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
4. Dielectric Flanges:
   a. Factory-fabricated companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
5. Dielectric-Flange Kits:
   a. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   b. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.

F. Valves
1. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-duty Valves For Hvac Piping".
2. Stop-Check Valves:
   a. Body and Bonnet: Malleable iron.
   b. End Connections: Flanged.
   c. Disc: Cylindrical with removable liner and machined seat.
   d. Stem: Brass alloy.
   e. Operator: Outside screw and yoke with cast-iron handwheel.
   f. Packing: Polytetrafluoroethylene-impregnated packing with two-piece packing gland assembly.
   g. Pressure Class: 250.

G. Strainers
1. Y-Pattern Strainers:

a. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.
b. End Connections: Threaded ends for strainers NPS 2 (DN 50) and smaller; flanged ends for strainers NPS 2-1/2 (DN 65) and larger.
c. Strainer Screen: Stainless-steel, 20 mesh strainer, and perforated stainless-steel basket with 50 percent free area.
d. Tapped blowoff plug.
e. CWP Rating: 250-psig (1725-kPa) working steam pressure.

2. Basket Strainers:
   a. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.
   b. End Connections: Threaded ends for strainers NPS 2 (DN 50) and smaller; flanged ends for strainers NPS 2-1/2 (DN 65) and larger.
   c. Strainer Screen: Stainless-steel, 20 mesh strainer, and perforated stainless-steel basket with 50 percent free area.
   d. CWP Rating: 250-psig (1725-kPa) working steam pressure.

H. Flash Tanks
1. Shop or factory fabricated of welded steel according to ASME Boiler and Pressure Vessel Code, for 150-psig (1035-kPa) rating; and bearing ASME label. Fabricate with tappings for low-pressure steam and condensate outlets, high-pressure condensate inlet, air vent, safety valve, and legs.

I. Safety Valves
1. Bronze **OR** Brass, **as directed**, Safety Valves:
   a. Disc Material: Forged copper alloy.
   b. End Connections: Threaded inlet and outlet.
   c. Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
   d. Pressure Class: 250.
   e. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
   f. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.
2. Cast-Iron Safety Valves:
   a. Disc Material: Forged copper alloy with bronze nozzle.
   b. End Connections: Raised-face flanged inlet and threaded or flanged outlet connections.
   c. Spring: Fully enclosed cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
   d. Pressure Class: 250.
   e. Drip-Pan Elbow: Cast iron and having threaded inlet, outlet, and drain, with threads complying with ASME B1.20.1.
   f. Exhaust Head: Cast iron and having threaded inlet and drain, with threads complying with ASME B1.20.1.
   g. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

J. Pressure-Reducing Valves
1. Size, Capacity, and Pressure Rating: Factory set for inlet and outlet pressures indicated.
2. Description: Pilot-actuated, diaphragm type, with adjustable pressure range and positive shutoff.
3. Body: Cast iron.
4. End Connections: Threaded connections for valves NPS 2 (DN 50) and smaller and flanged connections for valves NPS 2-1/2 (DN 65) and larger.
5. Trim: Hardened stainless steel.
6. Head and Seat: Replaceable, main head stem guide fitted with flushing and pressure-arresting device cover over pilot diaphragm.
7. Gaskets: Non-asbestos materials.

K. Steam Traps
1. Thermostatic Traps:
a. Body: Bronze angle-pattern body with integral union tailpiece and screw-in cap.
b. Trap Type: Balanced-pressure.
c. Bellows: Stainless steel or monel.
d. Head and Seat: Replaceable, hardened stainless steel.
e. Pressure Class: 125.
2. Thermodynamic Traps:
a. Body: Stainless steel with screw-in cap.
b. End Connections: Threaded.
c. Disc and Seat: Stainless steel.
d. Maximum Operating Pressure: 600 psig (4140 kPa).
3. Float and Thermostatic Traps:
a. Body and Bolted Cap: ASTM A 126, cast iron.
b. End Connections: Threaded.
c. Float Mechanism: Replaceable, stainless steel.
d. Head and Seat: Hardened stainless steel.
e. Trap Type: Balanced pressure.
f. Thermostatic Bellows: Stainless steel or monel.
g. Thermostatic air vent capable of withstanding 45 deg F (25 deg C) of superheat and resisting water hammer without sustaining damage.
h. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless steel cage, valve, and seat.
i. Maximum Operating Pressure: 125 psig (860 kPa).
4. Inverted Bucket Traps:
a. Body and Cap: Cast iron.
b. End Connections: Threaded.
c. Head and Seat: Stainless steel.
d. Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.
e. Bucket: Brass or stainless steel.
f. Strainer: Integral stainless-steel inlet strainer within the trap body.
g. Air Vent: Stainless-steel thermostatic vent.
h. Pressure Rating: 250 psig (1725 kPa).

L. Thermostatic Air Vents And Vacuum Breakers
1. Thermostatic Air Vents:
a. Body: Cast iron, bronze or stainless steel.
b. End Connections: Threaded.
c. Float, Valve, and Seat: Stainless steel.
d. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.
e. Pressure Rating: 125 psig (861 kPa) **OR** 300 psig (2068 kPa), **as directed**.
f. Maximum Temperature Rating: 350 deg F (177 deg C).
2. Vacuum Breakers:
a. Body: Cast iron, bronze, or stainless steel.
b. End Connections: Threaded.
c. Sealing Ball, Retainer, Spring, and Screen: Stainless steel.
d. O-ring Seal: EPR.
e. Pressure Rating: 125 psig (861 kPa) **OR** 300 psig (2068 kPa), **as directed**.
f. Maximum Temperature Rating: 350 deg F (177 deg C).

M. Steam Meters
1. Meters shall have a microprocessor to display totalizer flow, flow rate, temperature, pressure, time, and date; alarms for high and low flow rate and temperature.
a. Computer shall have 4 to 20-mA or 2 to 10 volt output for temperature, pressure, and contact closure for flow increments.
b. Independent timers to store four peak flow rates and total flow.

c. Interface compatible with central workstation described in Division 23 Section "Instrumentation And Control For Hvac".
d. Microprocessor Enclosure: NEMA 250, Type 4.

2. Sensor:
 a. Venturi, of stainless-steel **OR** carbon-steel, **as directed**, construction, for insertion in pipeline between flanges. At least 10:1 turndown with plus or minus 1 percent accuracy over full-flow range.
 b. Vortex type with stainless-steel wetted parts and wafer **OR** flange, **as directed**, connections; and with a piezoelectric sensor removable and serviceable without shutting down the process. At least 10:1 turndown with plus or minus 1 percent accuracy over full-flow range.
 c. Spring-loaded, variable-area flowmeter type; density compensated with stainless-steel wetted parts and wafer **OR** flange, **as directed**, connections. At least 10:1 turndown with plus or minus 2 percent accuracy over full-flow range.

N. Condensate Meters
1. Body: Cast iron, bronze, or brass.
2. Turbine: Copper, brass, or stainless steel.
3. Connections: Threaded for NPS 2 (DN 50) and smaller and flanged for NPS 2-1/2 (DN 65).
4. Totalizer: Meters shall have a microprocessor to display flow, flow rate, time, and date; alarms for high and low flow rate, pressure, and temperature.
 a. Computer shall have 4- to 20-mA or 2- to 10-volt output for temperature, pressure, and contact closure for flow increments.
 b. Independent timers to store four peak flow rates and total flow.
 c. Interface compatible with central workstation specified in Division 23 Section "Instrumentation And Control For Hvac".
 d. Microprocessor Enclosure: NEMA 250, Type 4.
5. Pressure Rating: Atmospheric.
6. Maximum Temperature Rating: 250 deg F (121 deg C).

1.3 EXECUTION

A. LP Steam Piping Applications
1. LP Steam Piping, NPS 2 (DN 50) and Smaller: Schedule 40 **OR** 80, **as directed**, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
2. LP Steam Piping, NPS 2-1/2 through NPS 12 (DN 65 through DN 300): Schedule 40 **OR** 80, **as directed**, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
3. LP Steam Piping, NPS 14 through NPS 18 (DN 350 through DN 450): Schedule 30, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
4. LP Steam Piping, NPS 20 (DN 500) and Larger: Schedule 20, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
5. Condensate piping above grade, NPS 2 (DN 50) and smaller, shall be either of the following, **as directed**:
 a. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
 b. RTRP and RTRF with adhesive or flanged joints.
6. Condensate piping above grade, NPS 2-1/2 (DN 65) and larger, shall be either of the following, **as directed**:
 a. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
 b. RTRP and RTRF with adhesive or flanged joints.
7. Condensate piping below grade, NPS 2 (DN 50) and smaller, shall be either of the following, **as directed**:

a. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
b. RTRP and RTRF with adhesive or flanged joints.

8. Condensate piping below grade, NPS 2-1/2 (DN 65) and larger, shall be either of the following, **as directed**:
    a. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
    b. RTRP and RTRF with adhesive or flanged joints.

B. HP Steam Piping Applications
1. HP Steam Piping, NPS 2 (DN 50) and Smaller: Schedule 40 **OR** 80, **as directed**, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
2. HP Steam Piping, NPS 2-1/2 through NPS 12 (DN 65 through DN 300): Schedule 40 **OR** 80, **as directed**, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
3. HP Steam Piping, NPS 14 through NPS 18 (DN 350 through DN 450): Schedule 30, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
4. HP Steam Piping, NPS 20 (DN 500) and Larger: Schedule 20, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
5. Condensate piping above grade, NPS 2 (DN 50) and smaller, shall be either of the following, **as directed**:
    a. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
    b. RTRP and RTRF with adhesive or flanged joints.
6. Condensate piping above grade, NPS 2-1/2 (DN 65) and larger, shall be either of the following, **as directed**:
    a. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
    b. RTRP and RTRF with adhesive or flanged joints.
7. Condensate piping below grade, NPS 2 (DN 50) and smaller, shall be either of the following, **as directed**:
    a. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
    b. RTRP and RTRF with adhesive or flanged joints.
8. Condensate piping below grade, NPS 2-1/2 (DN 65) and larger, shall be either of the following, **as directed**:
    a. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
    b. RTRP and RTRF with adhesive or flanged joints.

C. Ancillary Piping Applications
1. Makeup-water piping installed above grade shall be either of the following, **as directed**:
    a. Drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints.
    b. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings, and solvent welded joints.
2. Makeup-Water Piping Installed below Grade and within Slabs: Annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.
3. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
4. Air-Vent Piping:
    a. Inlet: Same as service where installed.
    b. Outlet: Type K (A) annealed-temper copper tubing with soldered or flared joints.
5. Vacuum-Breaker Piping: Outlet, same as service where installed.
6. Safety-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

D. Valve Applications

1. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.
2. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

E. Piping Installation
1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Use indicated piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
2. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
3. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
4. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
5. Install piping to permit valve servicing.
6. Install piping free of sags and bends.
7. Install fittings for changes in direction and branch connections.
8. Install piping to allow application of insulation.
9. Select system components with pressure rating equal to or greater than system operating pressure.
10. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
11. Install drains, consisting of a tee fitting, NPS 3/4 (DN 20) full port-ball valve, and short NPS 3/4 (DN 20) threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
12. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.
13. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.
14. Reduce pipe sizes using eccentric reducer fitting installed with level side down.
15. Install branch connections to mains using mechanically formed, **as directed**, tee fittings in main pipe, with the branch connected to top of main pipe.
16. Install valves according to Division 23 Section "General-duty Valves For Hvac Piping".
17. Install unions in piping, NPS 2 (DN 50) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
18. Install flanges in piping, NPS 2-1/2 (DN 65) and larger, at final connections of equipment and elsewhere as indicated.
19. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 (DN 20) nipple and full port ball valve in blowdown connection of strainers NPS 2 (DN 50) and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2 (DN 50).
20. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings And Loops For Hvac Piping".
21. Identify piping as specified in Division 23 Section "Identification For Hvac Piping And Equipment".
22. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.
    a. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 300 feet (90 m).
    b. Size drip legs same size as main. In steam mains NPS 6 (DN 150) and larger, drip leg size can be reduced, but to no less than NPS 4 (DN 100).
23. Flash Tank:

a. Pitch condensate piping down toward flash tank.
b. If more than one condensate pipe discharges into flash tank, install a check valve in each line.
c. Install thermostatic air vent at tank top.
d. Install safety valve at tank top.
e. Install full-port ball valve, and swing check valve on condensate outlet.
f. Install inverted bucket or float and thermostatic trap at low-pressure condensate outlet, sized for three times the calculated heat load.
g. Install pressure gage on low-pressure steam outlet according to Division 23 Section "Meters And Gages For Hvac Piping".

F. Steam-Trap Installation
1. Install steam traps in accessible locations as close as possible to connected equipment.
2. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated.

G. Pressure-Reducing Valve Installation
1. Install pressure-reducing valves in accessible location for maintenance and inspection.
2. Install bypass piping around pressure-reducing valves, with globe valve equal in size to area of pressure-reducing valve seat ring, unless otherwise indicated.
3. Install gate valves on both sides of pressure-reducing valves.
4. Install unions or flanges on both sides of pressure-reducing valves having threaded- or flanged-end connections respectively.
5. Install pressure gages on low-pressure side of pressure-reducing valves after the bypass connection according to Division 23 Section "Meters And Gages For Hvac Piping".
6. Install strainers upstream for pressure-reducing valve.
7. Install safety valve downstream from pressure-reducing valve station.

H. Steam Or Condensate Meter Installation
1. Install meters with lengths of straight pipe upstream and downstream according to steam meter manufacturer's instructions.
2. Provide data acquisition wiring. Refer to Division 23 Section "Instrumentation And Control For Hvac".

I. Safety Valve Installation
1. Install safety valves according to ASME B31.1, "Power Piping" **OR** ASME B31.9, "Building Services Piping," **as directed**
2. Pipe safety-valve discharge without valves to atmosphere outside the building.
3. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.
4. Install exhaust head with drain to waste, on vents equal to or larger than NPS 2-1/2 (DN 65).

J. Hangers And Supports
1. Install hangers and supports according to Division 23 Section "Hangers And Supports For Hvac Piping And Equipment". Comply with requirements below for maximum spacing.
2. Seismic restraints are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
3. Install the following pipe attachments:
a. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet (6 m) long.
b. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet (6 m) or longer.
c. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.
d. Spring hangers to support vertical runs.
4. Install hangers with the following maximum spacing and minimum rod sizes:
a. NPS 3/4 (DN 20): Maximum span, 9 feet (2.7 m); minimum rod size, 1/4 inch (6.4 mm).

b. NPS 1 (DN 25): Maximum span, 9 feet (2.7 m); minimum rod size, 1/4 inch (6.4 mm).
c. NPS 1-1/2 (DN 40): Maximum span, 12 feet (3.7 m); minimum rod size, 3/8 inch (10 mm).
d. NPS 2 (DN 50): Maximum span, 13 feet (4 m); minimum rod size, 3/8 inch (10 mm).
e. NPS 2-1/2 (DN 65): Maximum span, 14 feet (4.3 m); minimum rod size, 3/8 inch (10 mm).
f. NPS 3 (DN 80): Maximum span, 15 feet (4.6 m); minimum rod size, 3/8 inch (10 mm).
g. NPS 4 (DN 100): Maximum span, 17 feet (5.2 m); minimum rod size, 1/2 inch (13 mm).
h. NPS 6 (DN 150): Maximum span, 21 feet (6.4 m); minimum rod size, 1/2 inch (13 mm).
i. NPS 8 (DN 200): Maximum span, 24 feet (7.3 m); minimum rod size, 5/8 inch (16 mm).
j. NPS 10 (DN 250): Maximum span, 26 feet (8 m); minimum rod size, 3/4 inch (19 mm).
k. NPS 12 (DN 300): Maximum span, 30 feet (9.1 m); minimum rod size, 7/8 inch (22 mm).
l. NPS 14 (DN 350): Maximum span, 32 feet (9.8 m); minimum rod size, 1 inch (25 mm).
m. NPS 16 (DN 400): Maximum span, 35 feet (10.7 m); minimum rod size, 1 inch (25 mm).
n. NPS 18 (DN 450): Maximum span, 37 feet (11.3 m); minimum rod size, 1-1/4 inches (32 mm).
o. NPS 20 (DN 500): Maximum span, 39 feet (11.9 m); minimum rod size, 1-1/4 inches (32 mm).

5. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
   a. NPS 1/2 (DN 15): Maximum span, 4 feet (1.2 m); minimum rod size, 1/4 inch (6.4 mm).
   b. NPS 3/4 (DN 20): Maximum span, 5 feet (1.5 m); minimum rod size, 1/4 inch (6.4 mm).
   c. NPS 1 (DN 25): Maximum span, 6 feet (1.8 m); minimum rod size, 1/4 inch (6.4 mm).
   d. NPS 1-1/2 (DN 40): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).
   e. NPS 2 (DN 50): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).
   f. NPS 2-1/2 (DN 65): Maximum span, 9 feet (2.7 m); minimum rod size, 3/8 inch (10 mm).
   g. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (10 mm).
6. Support vertical runs at roof, at each floor, and at 10-foot (3-m) intervals between floors.
7. Fiberglass Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

K. Pipe Joint Construction
1. Join pipe and fittings according to the following requirements and Division 21 specifying piping systems.
2. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
3. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
4. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube ends. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
5. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
6. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
7. Welded Joints: Construct joints according to AWS D10.12 (AWS D10.12M), using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
8. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
9. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

L. Terminal Equipment Connections

1. Size for supply and return piping connections shall be the same as or larger than equipment connections.
2. Install traps and control valves in accessible locations close to connected equipment.
3. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
4. Install vacuum breakers downstream from control valve, close to coil inlet connection.
5. Install a drip leg at coil outlet.

M. Field Quality Control
1. Prepare steam and condensate piping according to ASME B31.1, "Power Piping" **AND/OR** ASME B31.9, "Building Services Piping," **as directed,** and as follows:
    a. Leave joints, including welds, uninsulated and exposed for examination during test.
    b. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
    c. Flush system with clean water. Clean strainers.
    d. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
2. Perform the following tests on steam and condensate piping:
    a. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
    b. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.
    c. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
3. Prepare written report of testing.

END OF SECTION 22 11 16 00d

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SECTION 22 11 16 00e - REFRIGERANT PIPING

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for refrigerant piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes refrigerant piping used for air-conditioning applications.

C. Performance Requirements

1. Line Test Pressure for Refrigerant R-134a:
   a. Suction Lines for Air-Conditioning Applications: 115 psig (793 kPa).
   b. Suction Lines for Heat-Pump Applications: 225 psig (1551 kPa).
   c. Hot-Gas and Liquid Lines: 225 psig (1551 kPa).
2. Line Test Pressure for Refrigerant R-407C:
   a. Suction Lines for Air-Conditioning Applications: 230 psig (1586 kPa).
   b. Suction Lines for Heat-Pump Applications: 380 psig (2620 kPa).
   c. Hot-Gas and Liquid Lines: 380 psig (2620 kPa).
3. Line Test Pressure for Refrigerant R-410A:
   a. Suction Lines for Air-Conditioning Applications: 300 psig (2068 kPa).
   b. Suction Lines for Heat-Pump Applications: 535 psig (3689 kPa).
   c. Hot-Gas and Liquid Lines: 535 psig (3689 kPa).

D. Submittals

1. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
   a. Thermostatic expansion valves.
   b. Solenoid valves.
   c. Hot-gas bypass valves.
   d. Filter dryers.
   e. Strainers.
   f. Pressure-regulating valves.
2. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
   a. Shop Drawing Scale: 1/4 inch equals 1 foot (1:50).
   b. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
3. Welding certificates.
4. Field quality-control test reports.
5. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

E. Quality Assurance

1. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

2. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
3. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

F. Product Storage And Handling
1. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.2 PRODUCTS

A. Copper Tube And Fittings
1. Copper Tube: ASTM B 88, Type K or L (ASTM B 88M, Type A or B) **OR** ASTM B 280, Type ACR, **as directed**.
2. Wrought-Copper Fittings: ASME B16.22.
3. Wrought-Copper Unions: ASME B16.22.
4. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
5. Brazing Filler Metals: AWS A5.8.
6. Flexible Connectors:
a. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
b. End Connections: Socket ends.
c. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
d. Pressure Rating: Factory test at minimum 500 psig (3450 kPa).
e. Maximum Operating Temperature: 250 deg F (121 deg C).

B. Steel Pipe And Fittings
1. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; Type, Grade, and wall thickness as selected in Part 3 piping applications articles.
2. Wrought-Steel Fittings: ASTM A 234/A 234M, for welded joints.
3. Steel Flanges and Flanged Fittings: ASME B16.5, steel, including bolts, nuts, and gaskets, bevel-welded end connection, and raised face.
4. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
5. Flanged Unions:
a. Body: Forged-steel flanges for NPS 1 to NPS 1-1/2 (DN 25 to DN 40) and ductile iron for NPS 2 to NPS 3 (DN 50 to DN 80). Apply rust-resistant finish at factory.
b. Gasket: Fiber asbestos free.
c. Fasteners: Four plated-steel bolts, with silicon bronze nuts. Apply rust-resistant finish at factory.
d. End Connections: Brass tailpiece adapters for solder-end connections to copper tubing.
e. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
f. Pressure Rating: Factory test at minimum 400 psig (2760 kPa).
g. Maximum Operating Temperature: 330 deg F (165 deg C).
6. Flexible Connectors:
a. Body: Stainless-steel bellows with woven, flexible, stainless-steel-wire-reinforced protective jacket
b. End Connections:
1) NPS 2 (DN 50) and Smaller: With threaded-end connections.
2) NPS 2-1/2 (DN 65) and Larger: With flanged-end connections.
c. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
d. Pressure Rating: Factory test at minimum 500 psig (3450 kPa).

e. Maximum Operating Temperature: 250 deg F (121 deg C).

C. Valves And Specialties
1. Diaphragm Packless Valves:
a. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
b. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
c. Operator: Rising stem and hand wheel.
d. Seat: Nylon.
e. End Connections: Socket, union, or flanged.
f. Working Pressure Rating: 500 psig (3450 kPa).
g. Maximum Operating Temperature: 275 deg F (135 deg C).
2. Packed-Angle Valves:
a. Body and Bonnet: Forged brass or cast bronze.
b. Packing: Molded stem, back seating, and replaceable under pressure.
c. Operator: Rising stem.
d. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
e. Seal Cap: Forged-brass or valox hex cap.
f. End Connections: Socket, union, threaded, or flanged.
g. Working Pressure Rating: 500 psig (3450 kPa).
h. Maximum Operating Temperature: 275 deg F (135 deg C).
3. Check Valves:
a. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
b. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
c. Piston: Removable polytetrafluoroethylene seat.
d. Closing Spring: Stainless steel.
e. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
f. End Connections: Socket, union, threaded, or flanged.
g. Maximum Opening Pressure: 0.50 psig (3.4 kPa).
h. Working Pressure Rating: 500 psig (3450 kPa).
i. Maximum Operating Temperature: 275 deg F (135 deg C).
4. Service Valves:
a. Body: Forged brass with brass cap including key end to remove core.
b. Core: Removable ball-type check valve with stainless-steel spring.
c. Seat: Polytetrafluoroethylene.
d. End Connections: Copper spring.
e. Working Pressure Rating: 500 psig (3450 kPa).
5. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.
a. Body and Bonnet: Plated steel.
b. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
c. Seat: Polytetrafluoroethylene.
d. End Connections: Threaded.
e. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter, and 24 **OR** 115 **OR** 208, **as directed**,-V ac coil.
f. Working Pressure Rating: 400 psig (2760 kPa).
g. Maximum Operating Temperature: 240 deg F (116 deg C).
h. Manual operator.
6. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
a. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
b. Piston, Closing Spring, and Seat Insert: Stainless steel.
c. Seat Disc: Polytetrafluoroethylene.
d. End Connections: Threaded.
e. Working Pressure Rating: 400 psig (2760 kPa).
f. Maximum Operating Temperature: 240 deg F (116 deg C).
7. Thermostatic Expansion Valves: Comply with ARI 750.

a. Body, Bonnet, and Seal Cap: Forged brass or steel.
b. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
c. Packing and Gaskets: Non-asbestos.
d. Capillary and Bulb: Copper tubing filled with refrigerant charge.
e. Suction Temperature: 40 deg F (4.4 deg C).
f. Superheat: Adjustable **OR** Nonadjustable, **as directed**.
g. Reverse-flow option (for heat-pump applications).
h. End Connections: Socket, flare, or threaded union.
i. Working Pressure Rating: 700 psig (4820 kPa) **OR** 450 psig (3100 kPa), **as directed**.

8. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
   a. Body, Bonnet, and Seal Cap: Ductile iron or steel.
   b. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
   c. Packing and Gaskets: Non-asbestos.
   d. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
   e. Seat: Polytetrafluoroethylene.
   f. Equalizer: Internal **OR** External, **as directed**.
   g. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter, and 24 **OR** 115 **OR** 208, **as directed**,-V ac coil.
   h. End Connections: Socket.
   i. Set Pressure: as directed by the Owner.
   j. Throttling Range: Maximum 5 psig (34 kPa).
   k. Working Pressure Rating: 500 psig (3450 kPa).
   l. Maximum Operating Temperature: 240 deg F (116 deg C).
9. Straight-Type Strainers:
   a. Body: Welded steel with corrosion-resistant coating.
   b. Screen: 100-mesh stainless steel.
   c. End Connections: Socket or flare.
   d. Working Pressure Rating: 500 psig (3450 kPa).
   e. Maximum Operating Temperature: 275 deg F (135 deg C).
10. Angle-Type Strainers:
   a. Body: Forged brass or cast bronze.
   b. Drain Plug: Brass hex plug.
   c. Screen: 100-mesh monel.
   d. End Connections: Socket or flare.
   e. Working Pressure Rating: 500 psig (3450 kPa).
   f. Maximum Operating Temperature: 275 deg F (135 deg C).
11. Moisture/Liquid Indicators:
   a. Body: Forged brass.
   b. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
   c. Indicator: Color coded to show moisture content in ppm.
   d. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
   e. End Connections: Socket or flare.
   f. Working Pressure Rating: 500 psig (3450 kPa).
   g. Maximum Operating Temperature: 240 deg F (116 deg C).
12. Replaceable-Core Filter Dryers: Comply with ARI 730.
   a. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
   b. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
   c. Desiccant Media: Activated alumina **OR** charcoal, **as directed**.
   d. Designed for reverse flow (for heat-pump applications).
   e. End Connections: Socket.
   f. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
   g. Maximum Pressure Loss: 2 psig (14 kPa).

h. Rated Flow: as directed by the Owner.
i. Working Pressure Rating: 500 psig (3450 kPa).
j. Maximum Operating Temperature: 240 deg F (116 deg C).

13. Permanent Filter Dryers: Comply with ARI 730.
    a. Body and Cover: Painted-steel shell.
    b. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
    c. Desiccant Media: Activated alumina **OR** charcoal, **as directed**.
    d. Designed for reverse flow (for heat-pump applications).
    e. End Connections: Socket.
    f. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
    g. Maximum Pressure Loss: 2 psig (14 kPa).
    h. Rated Flow: as directed by the Owner.
    i. Working Pressure Rating: 500 psig (3450 kPa).
    j. Maximum Operating Temperature: 240 deg F (116 deg C).
14. Mufflers:
    a. Body: Welded steel with corrosion-resistant coating.
    b. End Connections: Socket or flare.
    c. Working Pressure Rating: 500 psig (3450 kPa).
    d. Maximum Operating Temperature: 275 deg F (135 deg C).
15. Receivers: Comply with ARI 495.
    a. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
    b. Comply with UL 207; listed and labeled by an NRTL.
    c. Body: Welded steel with corrosion-resistant coating.
    d. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
    e. End Connections: Socket or threaded.
    f. Working Pressure Rating: 500 psig (3450 kPa).
    g. Maximum Operating Temperature: 275 deg F (135 deg C).
16. Liquid Accumulators: Comply with ARI 495.
    a. Body: Welded steel with corrosion-resistant coating.
    b. End Connections: Socket or threaded.
    c. Working Pressure Rating: 500 psig (3450 kPa).
    d. Maximum Operating Temperature: 275 deg F (135 deg C).

D. Refrigerants
1. ASHRAE 34, R-134a: Tetrafluoroethane.
2. ASHRAE 34, R-407C: Difluoromethane/Pentafluoroethane/1,1,1,2-Tetrafluoroethane.
3. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

1.3 EXECUTION

A. Piping Applications For Refrigerant R-134a
1. Suction Lines NPS 1-1/2 (DN 40) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed,** joints.
   OR
   Suction Lines NPS 4 (DN 100) and Smaller **OR** NPS 2 to NPS 4 (DN 50 to DN 100), **as directed**, for Conventional Air-Conditioning Applications: Copper, Type ACR **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed,** joints.
2. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, **as directed**: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed,** joints.
   OR

Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, **as directed**: Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with soldered joints.
OR
Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, **as directed**:
a. NPS 1-1/2 (DN 40) and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed,** joints.
OR
NPS 1-1/2 (DN 40) and Smaller: Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
b. NPS 4 (DN 100): Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
3. Safety-Relief-Valve Discharge Piping: Schedule 40, black-steel and wrought-steel fittings with welded joints.
OR
Safety-Relief-Valve Discharge Piping: Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with soldered joints.
OR
Safety-Relief-Valve Discharge Piping:
a. NPS 1-1/2 (DN 40) and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
OR
NPS 1-1/2 (DN 40) and Smaller: Copper, Type ACR **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
b. NPS 4 (DN 100): Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.

B. Piping Applications For Refrigerant R-407c
1. Suction Lines NPS 1-1/2 (DN 40) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings
OR
Suction Lines NPS 4 (DN 100) and Smaller **OR** NPS 2 to NPS 4 (DN 50 to DN 100), **as directed**, for Conventional Air-Conditioning Applications: Copper, Type ACR **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
2. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, **as directed**: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
OR
Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, **as directed**: Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with soldered joints.
OR
Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, **as directed**:
a. NPS 1 (DN 25) and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
OR
NPS 1 (DN 25) and Smaller: Copper, Type ACR **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
b. NPS 1-1/4 to NPS 2 (DN 32 to DN 50): Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
c. NPS 4 (DN 100): Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with soldered joints.
3. Safety-Relief-Valve Discharge Piping: Schedule 40, black-steel and wrought-steel fittings with welded joints.

OR
Safety-Relief-Valve Discharge Piping: Copper, Type ACR **OR** K (A) **OR** L (B**)**, **as directed**, drawn-temper tubing and wrought-copper fittings with soldered joints.
OR
Safety-Relief-Valve Discharge Piping:
a. NPS 1 (DN 25) and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed **OR** soldered joints.
OR
NPS 1 (DN 25) and Smaller: Copper, Type ACR **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
b. NPS 1-1/4 to NPS 2 (DN 32 to DN 50): Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
c. NPS 4 (DN 100): Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with soldered joints.

C. Piping Applications For Refrigerant R-410a
1. Suction Lines NPS 1-1/2 (DN 40) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
OR
Suction Lines NPS 3-1/2 (DN 90) and Smaller **OR** NPS 2 to NPS 3-1/2 (DN 50 to DN 90), **as directed**, for Conventional Air-Conditioning Applications: Copper, Type ACR **OR** L (B), **as directed,** drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
OR
Suction Lines NPS 4 (DN 100) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with soldered joints.
2. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, **as directed**: Copper, Type ACR **OR** L (B), **as directed**, annealed- or drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
OR
Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, **as directed** Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
OR
Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, **as directed**: Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
OR
Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, **as directed**: Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.
OR
Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, **as directed**:
a. NPS 5/8 (DN 18) and Smaller: Copper, Type ACR **OR** L (B), **as directed**, annealed- or drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
b. NPS 3/4 to NPS 1 (DN 20 to DN 25) and Smaller: Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
c. NPS 1-1/4 (DN 32) and Smaller: Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
d. NPS 1-1/2 to NPS 2 (DN 40 to DN 50): Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.
OR

Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, **as directed**, NPS 2 to NPS 4 (DN 50 to DN 100): Schedule 40, black-steel and wrought-steel fittings with welded joints.

3. Safety-Relief-Valve Discharge Piping: Copper, Type ACR **OR** L (B), **as directed**, annealed- or drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
   OR
   Safety-Relief-Valve Discharge Piping: Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
   OR
   Safety-Relief-Valve Discharge Piping: Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
   OR
   Safety-Relief-Valve Discharge Piping: Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.
   OR
   Safety-Relief-Valve Discharge Piping:
   a. NPS 5/8 (DN 18) and Smaller: Copper, Type ACR **OR** L (B), **as directed**, annealed- or drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
   b. NPS 3/4 to NPS 1 (DN 20 to DN 25) and Smaller: Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
   c. NPS 1-1/4 (DN 32) and Smaller: Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
   d. NPS 1-1/2 to NPS 2 (DN 40 to DN 50): Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.

   OR
   Safety-Relief-Valve Discharge Piping NPS 2 to NPS 4 (DN 50 to DN 100): Schedule 40, black-steel and wrought-steel fittings with welded joints.

D. Valve And Specialty Applications
1. Install diaphragm packless **OR** packed-angle, **as directed**, valves in suction and discharge lines of compressor.
2. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
3. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
4. Except as otherwise indicated, install diaphragm packless **OR** packed-angle, **as directed**, valves on inlet and outlet side of filter dryers.
5. Install a full-sized, three-valve bypass around filter dryers.
6. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
7. Install thermostatic expansion valves as close as possible to distributors on evaporators.
   a. Install valve so diaphragm case is warmer than bulb.
   b. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
   c. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
8. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
9. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
10. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
    a. Solenoid valves.
    b. Thermostatic expansion valves.

c. Hot-gas bypass valves.
d. Compressor.

11. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor, **as directed**.
12. Install receivers sized to accommodate pump-down charge.
13. Install flexible connectors at compressors.

E. Piping Installation

1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
2. Install refrigerant piping according to ASHRAE 15.
3. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
4. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
6. Install piping adjacent to machines to allow service and maintenance.
7. Install piping free of sags and bends.
8. Install fittings for changes in direction and branch connections.
9. Select system components with pressure rating equal to or greater than system operating pressure.
10. Refer to Division 23 Section(s) "Instrumentation And Control For Hvac" AND "Sequence Of Operations For Hvac Controls" for solenoid valve controllers, control wiring, and sequence of operation.
11. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
12. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section "Access Doors And Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
13. Install refrigerant piping in protective conduit where installed belowground.
14. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
15. Slope refrigerant piping as follows:
    a. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
    b. Install horizontal suction lines with a uniform slope downward to compressor.
    c. Install traps and double risers to entrain oil in vertical runs.
    d. Liquid lines may be installed level.
16. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
17. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:
    a. Shot blast the interior of piping.
    b. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
    c. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
    d. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
    e. Finally, draw a clean, dry, lintless cloth through the tube or pipe.

f. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.

18. Install pipe sleeves at penetrations in exterior walls and floor assemblies.
19. Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping".
20. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
21. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.
22. Seal pipe penetrations through exterior walls according to Division 07 Section "Joint Sealants" for materials and methods.
23. Identify refrigerant piping and valves according to Division 23 Section "Identification For Hvac Piping And Equipment".

F. Pipe Joint Construction

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
4. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
5. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
   a. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
   b. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.
6. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   a. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
7. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.
8. Welded Joints: Construct joints according to AWS D10.12/D10.12M.
9. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

G. Hangers And Supports

1. Hanger, support, and anchor products are specified in Division 23 Section "Hangers And Supports For Hvac Piping And Equipment".
2. Install the following pipe attachments:
   a. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet (6 m) long.
   b. Roller hangers and spring hangers for individual horizontal runs 20 feet (6 m) or longer.
   c. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.
   d. Spring hangers to support vertical runs.
   e. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
3. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
   a. NPS 1/2 (DN 15): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
   b. NPS 5/8 (DN 18): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
   c. NPS 1 (DN 25): Maximum span, 72 inches (1800 mm); minimum rod size, 1/4 inch (6.4 mm).

d. NPS 1-1/4 (DN 32): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
e. NPS 1-1/2 (DN 40): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
f. NPS 2 (DN 50): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
g. NPS 2-1/2 (DN 65): Maximum span, 108 inches (2700 mm); minimum rod size, 3/8 inch (9.5 mm).
h. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (9.5 mm).
i. NPS 4 (DN 100): Maximum span, 12 feet (3.7 m); minimum rod size, 1/2 inch (13 mm).

4. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
   a. NPS 2 (DN 50): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (9.5 mm).
   b. NPS 2-1/2 (DN 65): Maximum span, 11 feet (3.4 m); minimum rod size, 3/8 inch (9.5 mm).
   c. NPS 3 (DN 80): Maximum span, 12 feet (3.7 m); minimum rod size, 3/8 inch (9.5 mm).
   d. NPS 4 (DN 100): Maximum span, 14 feet (4.3 m); minimum rod size, 1/2 inch (13 mm).
5. Support multifloor vertical runs at least at each floor.

H. Field Quality Control
1. Perform tests and inspections and prepare test reports.
2. Tests and Inspections:
   a. Comply with ASME B31.5, Chapter VI.
   b. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
   c. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
      1) Fill system with nitrogen to the required test pressure.
      2) System shall maintain test pressure at the manifold gage throughout duration of test.
      3) Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
      4) Remake leaking joints using new materials, and retest until satisfactory results are achieved.

I. System Charging
1. Charge system using the following procedures:
   a. Install core in filter dryers after leak test but before evacuation.
   b. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers (67 Pa). If vacuum holds for 12 hours, system is ready for charging.
   c. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).
   d. Charge system with a new filter-dryer core in charging line.

J. Adjusting
1. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
2. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
3. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
4. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
   a. Open shutoff valves in condenser water circuit.
   b. Verify that compressor oil level is correct.
   c. Open compressor suction and discharge valves.
   d. Open refrigerant valves except bypass valves that are used for other purposes.
   e. Check open compressor-motor alignment and verify lubrication for motors and bearings.
5. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 22 11 16 00e

SECTION 22 11 16 00f - GENERAL-SERVICE COMPRESSED-AIR PIPING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for general-service compressed-air piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes piping and related specialties for general-service compressed-air systems operating at 200 psig (1380 kPa) or less.

C. Definitions
1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CR: Chlorosulfonated polyethylene synthetic rubber.
3. EPDM: Ethylene-propylene-diene terpolymer rubber.
4. HDPE: High-density polyethylene plastic.
5. NBR: Acrylonitrile-butadiene rubber.
6. PE: Polyethylene plastic.
7. PVC: Polyvinyl chloride plastic.
8. High-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures between 150 and 200 psig (1035 and 1380 kPa).
9. Low-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures of 150 psig (1035 kPa) or less.

D. Performance Requirements
1. Seismic Performance: Compressed-air piping and support and installation shall withstand effects of seismic events determined according to SEI/ASCE 7, "Minimum Design Loads for Buildings and Other Structures.".

E. Submittals
1. Product Data: For the following:
   a. Plastic pipes, fittings, and valves.
   b. Dielectric fittings.
   c. Flexible pipe connectors.
   d. Safety valves.
   e. Pressure regulators. Include rated capacities and operating characteristics.
   f. Automatic drain valves.
   g. Filters. Include rated capacities and operating characteristics.
   h. Lubricators. Include rated capacities and operating characteristics.
   i. Quick couplings.
   j. Hose assemblies.
2. Brazing **OR** Welding, **as directed**, certificates.
3. Field quality-control test reports.
4. Operation and maintenance data.

F. Quality Assurance
1. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or to AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
2. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

3. ASME Compliance:
   a. Comply with ASME B31.1, "Power Piping," for high-pressure compressed-air piping.
   b. Comply with ASME B31.9, "Building Services Piping," for low-pressure compressed-air piping.

G. Project Conditions
1. Interruption of Existing Compressed-Air Service: Do not interrupt compressed-air service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary compressed-air service according to requirements indicated:
   a. Notify the Owner no fewer than two days in advance of proposed interruption of compressed-air service.
   b. Do not proceed with interruption of compressed-air service without the Owner's written permission.

1.2 PRODUCTS

A. Pipes, Tubes, And Fittings
1. Schedule 40, Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B, black or hot-dip zinc coated with ends threaded according to ASME B1.20.1.
   a. Steel Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized seamless steel pipe. Include ends matching joining method.
   b. Malleable-Iron Fittings: ASME B16.3, Class 150 or 300, threaded.
   c. Malleable-Iron Unions: ASME B16.39, Class 150 or 300, threaded.
   d. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel, threaded.
   e. Wrought-Steel Butt-Welding Fittings: ASME B16.9, Schedule 40.
   f. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel.
   g. Grooved-End Fittings and Couplings:
      1) Grooved-End Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron casting; with grooves according to AWWA C606 and dimensions matching steel pipe.
      2) Couplings: AWWA C606 or UL 213, for steel-pipe dimensions and rated for 300-psig (2070-kPa) minimum working pressure. Include ferrous housing sections, gasket suitable for compressed air, and bolts and nuts. Provide EDPM gaskets for oil-free compressed air. Provide NBR gaskets if compressed air contains oil or oil vapor.
2. Schedule 5, Steel Pipe: ASTM A 135, carbon steel with plain ends and zinc-plated finish.
   a. Pressure-Seal Fittings: Listed and labeled by a qualified testing agency and FMG-approved, carbon-steel, pressure-seal housing with O-ring end seals suitable for compressed-air piping and rated for 300-psig (2070-kPa) minimum working pressure. Provide EDPM seals for oil-free compressed air. Provide NBR seals if compressed air contains oil or oil vapor.
3. Copper Tube: ASTM B 88, Type K or L (ASTM B 88M, Type A or B) and ASTM B 88, Type M (ASTM B 88M, Type C) seamless, drawn-temper, water tube.
   a. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, wrought copper with dimensions for brazed joints.
   b. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150 or 300.
   c. Copper Unions: ASME B16.22 or MSS SP-123.
   d. Press-Type Fittings, NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
   e. Press-Type Fittings, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
   f. Extruded-Tee Outlets: Procedure for making branch outlets in copper tube according to ASTM F 2014.

g. Grooved-End Fittings and Couplings:
    1) Grooved-End Fittings: ASTM B 75 (ASTM B 75M), copper tube or ASTM B 584, bronze castings.
    2) Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for compressed air, and bolts and nuts. Provide EDPM gasket for oil-free compressed air. Provide NBR gasket if compressed air contains oil or oil vapor.

4. Transition Couplings for Metal Piping: Metal coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
5. PVC Pipe: ASTM D 1785, Schedule 40.
    a. PVC Fittings: ASTM D 2466, Schedule 40, socket type.
6. Blue ABS Piping System: Made of ASTM D 3965, ABS-resin modified to provide shatter-resistant pipe for compressed-air service. Pipe and fittings are light blue and sizes are in millimeters.
    a. Transition Fittings, 20 to 63 mm: Composite union with ABS socket end, CR O-ring, and malleable-iron union nut and threaded end; with construction similar to MSS SP-107, transition union.
    b. Transition Fittings, 90 to 110 mm: Flange assembly with ABS flange, CR gasket, and metal flange of material matching piping to be connected.
    c. Valves, 20 to 63 mm: ABS union ball valve with socket ends.
    d. Valves, 90 to 110 mm: ABS butterfly valve with lever handle.
7. Green ABS Piping System: Made of ASTM D 3965, ABS-resin modified to provide shatter-resistant pipe for compressed-air service. Pipe and fittings are dark green with SDR of 9.0 and same OD as ASTM A 53/A 53M, steel pipe.
    a. Transition Fittings, NPS 1/2 to NPS 2 (DN 15 to DN 50): Composite union with ABS socket end, CR O-ring, ABS union nut, and brass solder-joint end; with construction similar to MSS SP-107, transition union.
    b. Transition Fittings, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): ABS flange, CR gasket, and metal flange of material matching piping to be connected.
    c. Valves, NPS 1/2 to NPS 2 (DN 15 to DN 50): Union ball valve with socket ends.
    d. Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Union ball valve with flanged ends. Include safety exhaust feature in Part 3 "Valve Applications" Article if required.
8. HDPE Piping System: Made of ASTM D 1248, HDPE resin to provide shatter-resistant pipe for compressed-air service. Pipe and fittings are dark blue with pipe dimensions about the same OD as ASTM D 3035, PE pipe.
    a. Transition Fittings, NPS 1/2 to NPS 2 (DN 15 to DN 50): HDPE adapter with one socket end and one end with threaded brass insert.
    b. Transition Fittings, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): HDPE flange, CR gasket, and metal flange of material matching piping to be connected.
    c. Valves, NPS 1/2 to NPS 3 (DN 15 to DN 80): HDPE union ball valve with socket ends.

B. Joining Materials
1. Pipe-Flange Gasket Materials: Suitable for compressed-air piping system contents.
    a. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
        1) Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
        2) Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
3. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
4. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
5. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated.
6. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
7. Solvent Cements for Joining Plastic Piping:

a. ABS Piping: ASTM D 2235.
b. PVC Piping: ASTM D 2564. Include primer complying with ASTM F 656.

C. Valves
1. Metal Ball, Butterfly, Check, Gate, and Globe Valves: Comply with requirements in Division 22 Section "General-duty Valves For Plumbing Piping".

D. Dielectric Fittings
1. General Requirements for Dielectric Fittings: Combination fitting of copper alloy and ferrous materials with insulating material; suitable for system fluid, pressure, and temperature. Include threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
2. Dielectric Unions: Factory-fabricated union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
3. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
4. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   a. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.

E. Flexible Pipe Connectors
1. Bronze-Hose Flexible Pipe Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
   a. Working-Pressure Rating: 200 psig (1380 kPa) **OR** 250 psig (1725 kPa), **as directed**, minimum.
   b. End Connections, NPS 2 (DN 50) and Smaller: Threaded copper pipe or plain-end copper tube.
   c. End Connections, NPS 2-1/2 (DN 65) and Larger: Flanged copper alloy.
2. Stainless-Steel-Hose Flexible Pipe Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
   a. Working-Pressure Rating: 200 psig (1380 kPa) **OR** 250 psig (1725 kPa), **as directed**, minimum.
   b. End Connections, NPS 2 (DN 50) and Smaller: Threaded steel pipe nipple.
   c. End Connections, NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

F. Sleeves
1. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
2. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   a. Underdeck Clamp: Clamping ring with set screws.

G. Escutcheons
1. General Requirements: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.
2. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.
3. One-Piece, Cast-Brass Escutcheons: With set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass, **as directed**.
4. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass, **as directed**.
5. One-Piece, Stamped-Steel Escutcheons: With set screw **OR** spring clips, **as directed**, and chrome-plated finish.

6. Split-Plate, Stamped-Steel Escutcheons: With concealed **OR** exposed-rivet, **as directed**, hinge, set screw **OR** spring clips, **as directed**, and chrome-plated finish.
7. One-Piece, Floor-Plate Escutcheons: Cast iron.
8. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

H. Specialties
1. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet-type safety valve for compressed-air service.
    a. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.
2. Air-Main Pressure Regulators: Bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 250-psig (1725-kPa) inlet pressure, unless otherwise indicated.
    a. Type: Pilot operated.
3. Air-Line Pressure Regulators: Diaphragm **OR** Pilot, **as directed**, operated, bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200-psig (1380-kPa) minimum inlet pressure, unless otherwise indicated.
   OR
   Air-Line Pressure Regulators: Diaphragm operated, aluminum alloy or plastic body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200-psig (1380-kPa) minimum inlet pressure, unless otherwise indicated.
4. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig (1380-kPa) minimum working pressure, capable of automatic discharge of collected condensate. Include mounting bracket if wall mounting is indicated, **as directed**.
5. Coalescing Filters: Coalescing type with activated carbon capable of removing water and oil aerosols; with color-change dye to indicate when carbon is saturated and warning light to indicate when selected maximum pressure drop has been exceeded. Include mounting bracket if wall mounting is indicated, **as directed**.
6. Mechanical Filters: Two-stage, mechanical-separation-type, air-line filters. Equip with deflector plates, resin-impregnated-ribbon-type filters with edge filtration, and drain cock. Include mounting bracket if wall mounting is indicated, **as directed**.
7. Air-Line Lubricators: With drip chamber and sight dome for observing oil drop entering air stream; with oil-feed adjustment screw and quick-release collar for easy bowl removal. Include mounting bracket if wall mounting is indicated, **as directed**.
    a. Provide with automatic feed device for supplying oil to lubricator.

I. Quick Couplings
1. General Requirements for Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.
2. Automatic-Shutoff Quick Couplings: Straight-through brass body with O-ring or gasket seal and stainless-steel or nickel-plated-steel operating parts.
    a. Socket End: With one-way valve and threaded inlet for connection to piping or threaded hose fitting.
    b. Plug End: Flow-sensor-bleeder, check-valve **OR** Straight-through, **as directed**, type with barbed outlet for attaching hose.
3. Valveless Quick Couplings: Straight-through brass body with stainless-steel or nickel-plated-steel operating parts.
    a. Socket End: With O-ring or gasket seal, without valve, and with barbed inlet for attaching hose.
    b. Plug End: With barbed outlet for attaching hose.

J. Hose Assemblies
1. Description: Compatible hose, clamps, couplings, and splicers suitable for compressed-air service, of nominal diameter indicated, and rated for 300-psig (2070-kPa) minimum working pressure, unless otherwise indicated.

a. Hose: Reinforced single **OR** double, **as directed**,-wire-braid, CR-covered hose for compressed-air service.
b. Hose Clamps: Stainless-steel clamps or bands.
c. Hose Couplings: Two-piece, straight-through, threaded brass or stainless-steel O-ring or gasket-seal swivel coupling with barbed ends for connecting two sections of hose.
d. Hose Splicers: One-piece, straight-through brass or stainless-steel fitting with barbed ends for connecting two sections of hose.

K. Grout
1. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
a. Characteristics: Post-hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
b. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
c. Packaging: Premixed and factory packaged.

1.3 EXECUTION

A. Piping Applications
1. Compressed-Air Piping between Air Compressors and Receivers: Use one of the following piping materials for each size range:
a. NPS 2 (DN 50) and Smaller: Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; threaded, malleable-iron fittings; and threaded joints.
b. NPS 2 (DN 50) and Smaller: Schedule 5, galvanized-steel pipe; pressure-seal fittings; and pressure-sealed joints.
c. NPS 2 (DN 50) and Smaller: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
d. NPS 2 (DN 50) and Smaller: Type K or L (Type A or B), copper tube; wrought-copper fittings; and brazed joints.
e. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; threaded, malleable-iron fittings; and threaded joints.
f. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; grooved-end fittings; couplings; and grooved joints.
g. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
h. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Type K or L (Type A or B), copper tube; wrought-copper fittings; and brazed joints.
i. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Type K or L (Type A or B), copper tube; grooved-end copper fittings; couplings; and grooved joints.
j. NPS 5 (DN 125) and Larger: Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; threaded, malleable-iron fittings; and threaded joints.
k. NPS 5 (DN 125) and Larger: Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; grooved-end fittings; couplings; and grooved joints.
l. NPS 5 (DN 125) and Larger: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
m. NPS 5 (DN 125) and Larger: Grooved-end, Type K or L (ASTM B 88M Type A or B), copper tube; grooved-end copper fittings; couplings; and grooved joints.
2. Low-Pressure Compressed-Air Distribution Piping: Use one of the following piping materials for each size range:
a. NPS 2 (DN 50) and Smaller: Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; threaded, malleable-iron fittings; and threaded joints.
b. NPS 2 (DN 50) and Smaller: Schedule 5, galvanized-steel pipe; pressure-seal fittings; and pressure-sealed joints.
c. NPS 2 (DN 50) and Smaller: Type K or L (Type A or B), copper tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.

d. NPS 2 (DN 50) and Smaller: Type K or L (Type A or B), copper tube; press-type fittings; and pressure-sealed joints.
e. NPS 2 (DN 50) and Smaller: 63-mm and smaller, blue ABS pipe and fittings; transition fittings; valves; and solvent-cemented joints.
f. NPS 2 (DN 50) and Smaller: Green ABS pipe and fittings, transition fittings, and valves; and solvent-cemented joints.
g. NPS 2 (DN 50) and Smaller: HDPE pipe, fittings, and valves; and heat-fusion joints.
h. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; threaded, malleable-iron fittings; and threaded joints.
i. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; grooved-end fittings; couplings; and grooved joints.
j. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Type K or L (Type A or B), copper tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
k. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Type K or L (Type A or B), copper tube; grooved-end copper fittings; couplings; and grooved joints.
l. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Type K or L (Type A or B), copper tube; press-type fittings; and pressure-sealed joints.
m. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 90- and 110-mm, blue ABS pipe and fittings; transition fittings; and solvent-cemented joints. Include butterfly valves and flanged joints.
n. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): NPS 3 and NPS 4 (DN 80 and DN 100), green ABS pipe and fittings; transition fittings; and solvent-cemented joints. Include ball valves and flanged joints.
o. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): NPS 3 and NPS 4 (DN 80 and DN 100), HDPE pipe and fittings; valves; and heat-fusion joints.
p. NPS 5 and NPS 6 (DN 125 and DN 150): Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; threaded, malleable-iron fittings; and threaded joints.
q. NPS 5 (DN 125) and Larger: Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; grooved-end fittings; couplings; and grooved joints.
r. NPS 5 to NPS 8 (DN 125 to DN 200): Type K or L (Type A or B), copper tube; grooved-end copper fittings; couplings; and grooved joints.

3. High-Pressure Compressed-Air Distribution Piping: Use one of the following piping materials for each size range:
   a. NPS 2 (DN 50) and Smaller: Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; threaded, malleable-iron fittings; and threaded joints.
   b. NPS 2 (DN 50) and Smaller: Schedule 5, galvanized-steel pipe; pressure-seal fittings; and pressure-sealed joints.
   c. NPS 2 (DN 50) and Smaller: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
   d. NPS 2 (DN 50) and Smaller: Type K or L (Type A or B), copper tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
   e. NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; threaded, malleable-iron fittings; and threaded joints.
   f. NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; grooved-end fittings; couplings; and grooved joints.
   g. NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
   h. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Type K or L (Type A or B), copper tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
   i. NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Type K or L (Type A or B), copper tube; wrought-copper fittings; and brazed joints.
   j. NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Type K or L (Type A or B), copper tube; grooved-end copper fittings; couplings; and grooved joints.
   k. NPS 8 (DN 200) and Larger: Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; grooved-end fittings; couplings; and grooved joints.
   l. NPS 8 (DN 200) and Larger: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.

m. NPS 8 (DN 200): Type K or L (Type A or B), copper tube; grooved-end copper fittings; couplings; and grooved joints.

4. Drain Piping: Use one of the following piping materials:
   a. NPS 2 (DN 50) and Smaller: Type M (Type C) copper tube; wrought-copper fittings; and brazed or soldered joints.
   b. NPS 2 (DN 50) and Smaller: PVC pipe and fittings; and solvent-cemented joints.

B. Valve Applications

1. General-Duty Valves: Comply with requirements in Division 22 Section "General-duty Valves For Plumbing Piping" for metal general-duty valves. Use metal valves, unless otherwise indicated.
   a. Metal General-Duty Valves: Use valve types specified in "Valve Applications" Article in Division 22 Section "General-duty Valves For Plumbing Piping" according to the following:
      1) Low-Pressure Compressed Air: Valve types specified for low-pressure compressed air.
      2) High-Pressure Compressed Air: Valve types specified for medium-pressure compressed air.
      3) Equipment Isolation NPS 2 (DN 50) and Smaller: Safety-exhaust, copper-alloy ball valve with exhaust vent and pressure rating at least as great as piping system operating pressure.
      4) Grooved-end valves may be used with grooved-end piping and grooved joints.
   b. Plastic General-Duty Valves: Provide valves, made by piping manufacturer, that are compatible with piping. Do not use plastic valves between air compressors and receivers.
      1) Blue ABS Piping System: Ball and butterfly valves.
      2) Green ABS Piping System: Ball valves.
      3) HDPE Piping System: Ball valves.

C. Piping Installation

1. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
2. Install piping concealed from view and protected from physical contact by building occupants, unless otherwise indicated and except in equipment rooms and service areas.
3. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.
4. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and to coordinate with other services occupying that space.
5. Install piping adjacent to equipment and machines to allow service and maintenance.
6. Install air and drain piping with 1 percent slope downward in direction of flow.
7. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating, unless otherwise indicated.
8. Equipment and Specialty Flanged Connections:
   a. Use steel companion flange with gasket for connection to steel pipe.
   b. Use cast-copper-alloy companion flange with gasket and brazed **OR** soldered, **as directed**, joint for connection to copper tube. Do not use soldered joints for connection to air compressors or to equipment or machines producing shock or vibration.
9. Flanged joints may be used instead of specified joint for any piping or tubing system.
10. Extended-tee outlets with brazed branch connection may be used for copper tubing, within extruded-tee connection diameter to run tube diameter ratio for tube type, according to Extruded Tee Connections Sizes and Wall Thickness for Copper Tube (Inches) Table in ASTM F 2014.
11. Install eccentric reducers where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
12. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

13. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Division 22 Section "Meters And Gages For Plumbing Piping".
14. Install piping to permit valve servicing.
15. Install piping free of sags and bends.
16. Install fittings for changes in direction and branch connections.
17. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".

D. Joint Construction
1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
4. Welded Joints for Steel Piping: Join according to AWS D10.12/D10.12M.
5. Brazed Joints for Copper Tubing: Join according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
6. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Join according to ASTM B 828 or CDA's "Copper Tube Handbook."
7. Extruded-Tee Outlets for Copper Tubing: Form branches according to ASTM F 2014, with tools recommended by procedure manufacturer, and using operators qualified according to Part 1 "Quality Assurance" Article.
8. Flanged Joints: Use asbestos-free, nonmetallic gasket suitable for compressed air. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.
9. Grooved Joints: Assemble couplings with housing, gasket, lubricant, and bolts. Join according to AWWA C606 for grooved joints. Do not apply lubricant to prelubricated gaskets.
10. Heat-Fusion Joints for PE Piping: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657 for socket-fusion joints.
11. Pressure-Sealed Joints: Join with tools recommended by fitting manufacturer, using operators qualified according to Part 1 "Quality Assurance" Article.
12. Solvent-Cemented Joints for ABS Piping: Clean and dry joining surfaces. Join according to the following:
   a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   b. Join according to ASME B31.9 for solvent-cemented joints and to ASTM D 2235 Appendix.
13. Solvent-Cemented Joints for PVC Piping: Clean and dry joining surfaces. Join according to the following:
   a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   b. Apply primer and join according to ASME B31.9 for solvent-cemented joints and to ASTM D 2672.
14. Dissimilar Metal Piping Material Joints: Use dielectric fittings.

E. Valve Installation
1. General-Duty Valves: Comply with requirements in Division 22 Section "General-duty Valves For Plumbing Piping".
2. Install shutoff valves and unions or flanged joints at compressed-air piping to air compressors.
3. Install shutoff valve at inlet to each automatic drain valve, filter, lubricator, and pressure regulator.
4. Install check valves to maintain correct direction of compressed-air flow to and from compressed-air piping specialties and equipment.

F. Dielectric Fitting Installation
1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. NPS 2 (DN 50) and Smaller: Use dielectric unions.
3. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.
4. NPS 5 (DN 125)and Larger: Use dielectric flange kits.

G. Flexible Pipe Connector Installation
1. Install flexible pipe connectors in discharge piping and in inlet air piping from remote air-inlet filter, **as directed**, of each air compressor.
2. Install bronze-hose flexible pipe connectors in copper compressed-air tubing.
3. Install stainless-steel-hose flexible pipe connectors in steel compressed-air piping.

H. Specialty Installation
1. Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.
2. Install air-main pressure regulators in compressed-air piping at or near air compressors.
3. Install air-line pressure regulators in branch piping to equipment and tools, **as directed**.
4. Install automatic drain valves on aftercoolers, receivers, and dryers. Discharge condensate onto nearest floor drain.
5. Install coalescing filters in compressed-air piping at or near air compressors and upstream from mechanical filters. Mount on wall at locations indicated, **as directed**.
6. Install mechanical filters in compressed-air piping at or near air compressors and downstream from coalescing filters. Mount on wall at locations indicated, **as directed**.
7. Install air-line lubricators in branch piping to machine tools. Mount on wall at locations indicated, **as directed**.
8. Install quick couplings at piping terminals for hose connections.
9. Install hose assemblies at hose connections.

I. Connections
1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment and machine.
2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment and machine.

J. Sleeve Installation
1. Sleeves are not required for core-drilled holes.
2. Permanent sleeves are not required for holes formed by removable PE sleeves.
3. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using galvanized-steel pipe **OR** galvanized-steel sheet **OR** stack sleeve fittings **OR** PVC pipe, **as directed**.
   OR
   Install sleeves for pipes passing through concrete and masonry walls, gypsum board partitions, and concrete floor and roof slabs.
   a. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
   b. Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
4. Install sleeves in new walls and slabs as new walls and slabs are constructed.
5. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   a. PVC **OR** Steel, **as directed**, Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
   b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum board partitions.
   c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to

2 inches (50 mm) above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim" for flashing.
1) Seal space outside of sleeve fittings with grout.
6. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping".

K. Escutcheon Installation
1. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
a. New Piping:
1) Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2) Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** stamped steel with set screw **OR** stamped steel with set screw or spring clips **OR** stamped steel with spring clips, **as directed**.
3) Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** One piece or split-casting, cast brass with polished chrome-plated finish **OR** Split casting, cast brass with polished chrome-plated finish **OR** One piece, stamped steel with set screw **OR** One piece or split plate, stamped steel with set screw **OR** Split plate, stamped steel with set screw, **as directed**.
4) Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish **OR** cast brass with rough-brass finish **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
5) Bare Piping in Equipment Rooms: One piece, cast brass **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
6) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.
b. Existing Piping:
1) Chrome-Plated Piping: Split-casting, cast brass with chrome-plated finish.
2) Insulated Piping: Split-plate, stamped steel with concealed **OR** exposed-rivet, **as directed**, hinge and spring clips.
3) Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and spring clips, **as directed**.
4) Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and set screw, **as directed**.
5) Bare Piping in Unfinished Service Spaces: Split casting, cast brass with polished chrome-plated finish **OR** casting, cast brass with rough-brass finish **OR** plate, stamped steel with concealed hinge and set screw or spring clips **OR** plate, stamped steel with concealed or exposed-rivet hinge and set screw or spring clips **OR** plate, stamped steel with exposed-rivet hinge and set screw or spring clips, **as directed**.
6) Bare Piping in Equipment Rooms: Split casting, cast brass **OR** plate, stamped steel with set screw or spring clips, **as directed**.
7) Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

L. Hanger And Support Installation
1. Comply with requirements in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment" for seismic-restraint devices.
2. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for pipe hanger and support devices.
3. Vertical Piping: MSS Type 8 or 42, clamps.
4. Individual, Straight, Horizontal Piping Runs:
a. 100 Feet (30 m) or Less: MSS Type 1, adjustable, steel clevis hangers.

   b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
5. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
6. Base of Vertical Piping: MSS Type 52, spring hangers.
7. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.
8. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
9. Install hangers for Schedule 40, steel piping with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1/4 to NPS 1/2 (DN 8 to DN 15): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
   b. NPS 3/4 to NPS 1-1/4 (DN 20 to DN 32): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   c. NPS 1-1/2 (DN 40): 12 feet (3.7 m) with 3/8-inch (10-mm) rod.
   d. NPS 2 (DN 50): 13 feet (4 m) with 3/8-inch (10-mm) rod.
   e. NPS 2-1/2 (DN 65): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.
   f. NPS 3 (DN 80): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.
   g. NPS 3-1/2 (DN 90): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.
   h. NPS 4 (DN 100): 17 feet (5.2 m) with 5/8-inch (16-mm) rod.
   i. NPS 5 (DN 125): 19 feet (5.8 m) with 5/8-inch (16-mm) rod.
   j. NPS 6 (DN 150): 21 feet (6.4 m) with 3/4-inch (19-mm) rod.
   k. NPS 8 (DN 200): 24 feet (7.3 m) with 3/4-inch (19-mm) rod.
   l. NPS 10 (DN 250): 26 feet (7.9 m) with 7/8-inch (22-mm) rod.
   m. NPS 12 (DN 300): 30 feet (9.1 m) with 7/8-inch (22-mm) rod.
10. Install supports for vertical, Schedule 40, steel piping every 15 feet (4.6 m).
11. Install hangers for Schedule 5, steel piping with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1/2 (DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
   b. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   c. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
   d. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
   e. NPS 1-1/2 (DN 40): 10 feet (3 m) with 3/8-inch (10-mm) rod.
   f. NPS 2 (DN 50): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.
12. Install supports for vertical, Schedule 5, steel piping every 10 feet (3 m).
13. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1/4 (DN 8): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   b. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
   c. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   d. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
   e. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
   f. NPS 1-1/2 (DN 40): 10 feet (3 m) with 3/8-inch (10-mm) rod.
   g. NPS 2 (DN 50): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.
   h. NPS 2-1/2 (DN 65): 13 feet (4 m) with 1/2-inch (13-mm) rod.
   i. NPS 3 (DN 80): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.
   j. NPS 3-1/2 (DN 90): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.
   k. NPS 4 (DN 100): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.
   l. NPS 5 (DN 125): 18 feet (5.5 m) with 1/2-inch (13-mm) rod.
   m. NPS 6 (DN 150): 20 feet (6 m) with 5/8-inch (16-mm) rod.
   n. NPS 8 (DN 200): 23 feet (7 m) with 3/4-inch (19-mm) rod.
14. Install supports for vertical copper tubing every 10 feet (3 m).
15. Install vinyl-coated hangers for ABS piping with the following maximum horizontal spacing and minimum rod diameters:
   a. All Sizes: Install continuous support for piping with compressed air at normal operating temperature above 100 deg F (38 deg C).
   b. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 30 inches (760 mm) with 3/8-inch (10-mm) rod.

c. NPS 3/4 (DN 20): 38 inches (975 mm) with 3/8-inch (10-mm) rod.
d. NPS 1 (DN 25): 40 inches (1015 mm) with 3/8-inch (10-mm) rod.
e. NPS 1-1/4 (DN 32): 45 inches (1140 mm) with 3/8-inch (10-mm) rod.
f. NPS 1-1/2 (DN 40): 52 inches (1330 mm) with 3/8-inch (10-mm) rod.
g. NPS 2 (DN 50): 58 inches (1470 mm) with 3/8-inch (10-mm) rod.
h. NPS 3 (DN 80): 68 inches (1730 mm) with 1/2-inch (13-mm) rod.
i. NPS 4 (DN 100): 76 inches (1900 mm) with 1/2-inch (13-mm) rod.

16. Install supports for vertical ABS piping every 48 inches (1220 mm).
17. Install vinyl-coated hangers for HDPE piping with the following maximum horizontal spacing and minimum rod diameters:
    a. All Sizes: Install continuous support for piping with compressed air at normal operating temperature above 100 deg F (38 deg C).
    b. NPS 1/2 (DN 15): 30 inches (760 mm) with 3/8-inch (10-mm) rod.
    c. NPS 3/4 (DN 20): 35 inches (890 mm) with 3/8-inch (10-mm) rod.
    d. NPS 1 (DN 25): 40 inches (1015 mm) with 3/8-inch (10-mm) rod.
    e. NPS 1-1/4 (DN 32): 43 inches (1090 mm) with 3/8-inch (10-mm) rod.
    f. NPS 1-1/2 (DN 40): 49 inches (1245 mm) with 3/8-inch (10-mm) rod.
    g. NPS 2 (DN 50): 55 inches (1400 mm) with 3/8-inch (10-mm) rod.
    h. NPS 3 and NPS 4 (DN 80 and DN 100): 96 inches (2440 mm) with 1/2-inch (13-mm) rod.
18. Install supports for vertical HDPE piping every 48 inches (1220 mm).

M. Labeling And Identification
1. Install identifying labels and devices for general-service compressed-air piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification For Plumbing Piping And Equipment".

N. Field Quality Control
1. Perform field tests and inspections.
2. Tests and Inspections:
    a. Piping Leak Tests for Metal Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig (345 kPa) above system operating pressure, but not less than 150 psig (1035 kPa). Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
    b. Piping Leak Tests for ABS Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen, at temperature of 110 deg F (43 deg C) or less, to pressure of 40 psig (275 kPa) above system operating pressure, but not less than 80 psig (550 kPa) **OR** 100 psig (690 kPa), **as directed**, or more than 120 psig (825 kPa). Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
    c. Piping Leak Tests for HDPE Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen, at temperature of 100 deg F (38 deg C) or less, to pressure of 40 psig (275 kPa) above system operating pressure, but not less than 100 psig (690 kPa) **OR** 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, or more than 180 psig (1240 kPa). Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
    d. Repair leaks and retest until no leaks exist.
    e. Inspect filters, lubricators, and pressure regulators for proper operation.
3. Prepare test reports.

END OF SECTION 22 11 16 00f

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SECTION 22 11 16 00g - COMPRESSED-AIR PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for compressed-air piping for laboratory and healthcare facilities. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Compressed-air piping and specialties for nonmedical laboratory facilities, designated "laboratory air," operating at 50 psig (345 kPa) **OR** 100 psig (690 kPa) **OR** 125 psig (860 kPa), **as directed**.
   b. Medical air piping and specialties, designated "medical air," operating at 50 to 55 psig (345 to 380 kPa).
   c. Dental air piping and specialties, designated "dental air," operating at 80 to 100 psig (550 to 690 kPa).
   d. Gas-powered-tool air piping and specialties, designated "instrument air," operating at 175 psig (1200 kPa).
   e. Healthcare laboratory air piping and specialties, designated "medical laboratory air," operating at 100 psig (690 kPa).

C. Definitions
1. D.I.S.S.: Diameter-index safety system.
2. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
3. Medical Compressed-Air Piping Systems: Include medical air, dental air, instrument air, and medical laboratory air piping systems.

D. Submittals
1. Product Data: For the following:
   a. Compressed-air tubes and fittings.
   b. Compressed-air valves and valve boxes.
   c. Medical compressed-air service connections.
   d. Medical compressed-air pressure control panels.
   e. Medical compressed-air manifolds.
   f. Medical compressed-air alarm system components.
2. Shop Drawings: Diagram power, signal, and control wiring.
3. Piping Material Certification: Signed by Installer certifying that medical compressed-air piping materials comply with NFPA 99 requirements.
4. Brazing certificates.
5. Field quality-control test reports.
6. Operation and maintenance data.

E. Quality Assurance
1. Installer Qualifications:
   a. Medical Compressed-Air Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010.
   b. Pressure-Seal Joining Procedure for Copper Tubing: Qualify operators according to training provided by Viega; Plumbing and Heating Systems.

2. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization **OR** is an NRTL, **as directed**, and that is acceptable to authorities having jurisdiction.
   a. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.
3. Source Limitations: Obtain compressed-air service connections of same type and from same manufacturer as service connections provided for in Division 22 Section "Gas Piping For Laboratory And Healthcare Facilities".
4. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
6. ASME Compliance:
   a. Comply with ASME B31.1, "Power Piping," for laboratory compressed-air piping operating at more than 150 psig (1035 kPa).
   b. Comply with ASME B31.9, "Building Services Piping," for laboratory compressed-air piping operating at 150 psig (1035 kPa) or less.
7. Comply with NFPA 99, "Health Care Facilities," for medical compressed-air system materials and installation in healthcare facilities.

F. Project Conditions
1. Interruption of Existing Laboratory and Medical Compressed-Air Service(s): Do not interrupt laboratory or medical compressed-air service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   a. Notify the Owner no fewer than two days in advance of proposed interruption of laboratory and medical compressed-air service(s).
   b. Do not proceed with interruption of laboratory and medical compressed-air service(s) without the Owner's written permission.

1.2 PRODUCTS

A. Pipes, Tubes, And Fittings
1. Copper Medical Gas Tube: ASTM B 819, Type K **OR** Type L, **as directed**, seamless, drawn temper, that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and in blue for Type L tube.
   a. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
   b. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
   c. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.
   d. Press-Type Fittings:
      1) NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
      2) NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
2. Memory-Metal Couplings: Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.

3. Copper Water Tube: ASTM B 88, Type M (ASTM B 88M, Type C), seamless, drawn temper.
    a. Copper Fittings: ASME B16.18, cast-copper or ASME B16.22, wrought-copper, solder-joint pressure type.
    b. Press-Type Fittings:
        1) NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
        2) NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
4. PVC Pipe: ASTM D 1785, Schedule 40.
    a. PVC Fittings: ASTM D 2466, Schedule 40, socket type.

B. Joining Materials
1. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
2. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
3. Threaded-Joint Tape: PTFE.
4. Solvent Cement for Joining PVC Piping: ASTM D 2564. Include primer complying with ASTM F 656.

C. Valves
1. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
2. Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
    a. Pressure Rating: 300 psig (2070 kPa) minimum.
    b. Ball: Full-port, chrome-plated brass.
    c. Seats: PTFE or TFE.
    d. Handle: Lever type with locking device, **as directed**.
    e. Stem: Blowout proof with PTFE or TFE seal.
    f. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
3. Check Valves: In-line pattern, bronze.
    a. Pressure Rating: 300 psig (2070 kPa) minimum.
    b. Operation: Spring loaded.
    c. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
4. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
    a. Pressure Rating: 300 psig (2070 kPa) minimum.
    b. Ball: Full-port, chrome-plated brass.
    c. Seats: PTFE or TFE.
    d. Handle: Lever type with locking device, **as directed**.
    e. Stem: Blowout proof with PTFE or TFE seal.
    f. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
    g. Pressure Gage: Manufacturer installed on one copper-tube extension.
5. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.
    a. Interior Finish: Factory-applied white enamel.
    b. Cover Plate: Aluminum or extruded-anodized aluminum **OR** Satin-chrome finish steel **OR** Stainless steel with NAAMM AMP 503, No. 4 finish, **as directed**, with frangible or removable windows.
    c. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

    OR

    Zone Valve Boxes: Formed or extruded aluminum with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.

a. Interior Finish: Factory-applied white enamel.
b. Cover Plate: Aluminum or extruded-anodized aluminum **OR** Stainless steel with NAAMM AMP 503, No. 4 finish, **as directed**, with frangible or removable windows.
c. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

6. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.
7. Pressure Regulators: Bronze body and trim; spring-loaded, diaphragm-operated relieving type; manual pressure-setting adjustment; rated for 250-psig (1725-kPa) minimum inlet pressure; and capable of controlling delivered air pressure within 0.5 psig for each 10-psig (5.0 kPa for each 100-kPa) inlet pressure.
8. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig (1380-kPa) minimum working pressure, capable of automatic discharge of collected condensate. Include mounting bracket where wall mounting is indicated, **as directed**.

D. Medical Compressed-Air Service Connections

1. Connection Devices: For specific medical compressed-air pressure and service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
   a. Roughing-in Assembly:
      1) Steel outlet box for recessed mounting and concealed piping.
      2) Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed.
      3) Double seals that will prevent air leakage.
      4) ASTM B 819, NPS 3/8 (DN 10) copper outlet tube brazed to valve with service marking and tube-end dust cap.
   b. Finishing Assembly:
      1) Brass housing with primary check valve.
      2) Double seals that will prevent air leakage.
      3) Cover plate with gas-service label.
   c. Quick-Coupler Service Connections: Pressure outlet with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
   d. D.I.S.S. Service Connections: Pressure outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
      1) Medical Air Service Connections: CGA V-5, D.I.S.S. No. 1160.
      2) Instrument Air Service Connections: CGA V-5, D.I.S.S. No. 1160.
   e. Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish **OR** metal, with chrome-plated finish **OR** anodized aluminum, **as directed**, and permanent, color-coded, identifying label matching corresponding service.

E. Medical Compressed-Air Pressure Control Panels

1. Description: Steel box and support brackets for recessed roughing in with stainless-steel or anodized-aluminum cover plate with printed operating instructions. Include manifold assembly consisting of inlet supply valve, inlet supply pressure gage, line-pressure control regulator, outlet supply pressure gage, D.I.S.S. service connection, and piping outlet for remote service connection.
   a. Minimum Working Pressure: 200 psig (1380 kPa).
   b. Line-Pressure Control Regulator: Self-relieving diaphragm type with precision manual adjustment.
   c. Pressure Gages: 0- to 300-psig (0- to 2070-kPa) range.

d. Service Connection: CGA V-5, D.I.S.S. No. 1160, instrument air outlet.
e. Before final assembly, provide temporary dust shield and U-tube for testing.
f. Label cover plate "Air Pressure Control."

F. Medical Compressed-Air Manifolds
1. General Requirements for Medical Compressed-Air Manifolds: Comply with NFPA 99, Ch. 5, "Manifolds for Gas Cylinders without Reserve Supply."
2. Central Control Panel Unit: Weatherproof cabinet, supply and delivery pressure gages, electrical alarm system connections and transformer, indicator lights or devices, manifold connection, pressure changeover switch, line-pressure regulator, shutoff valves, and safety valve.
3. Manifold and Headers: Duplex, nonferrous-metal header for number of cylinders indicated, divided into two equal banks. Units include design for 2000-psig (13.8-MPa) minimum inlet pressure. Include cylinder bank headers with inlet (pigtail) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gage.
4. Compressed-Air Cylinders: Will be furnished by the Owner **OR** Number and type of compressed-air cylinders required for complete manifold systems, **as directed**.
5. Operation: Automatic, pressure-switch-activated changeover from one cylinder bank to the other when first bank becomes exhausted, without line-pressure fluctuation or resetting of regulators and without supply interruption by shutoff of either cylinder bank header.
6. Mounting: Wall with mounting brackets for manifold control cabinet and headers **OR** Floor with support legs for manifold control cabinet, **as directed**.
7. Label manifold control unit with permanent label identifying compressed air and system operating pressure.
8. Medical Air Manifolds: For 4 cylinders and 1250-cu. ft./h (9.85-L/s) **OR** 8 cylinders and 2500-cu. ft./h (19.7-L/s), **as directed**, capacity at 55-psig (380-kPa) line pressure.
9. Instrument Air Manifolds: For 8 cylinders and 2000-cu. ft./h (15.7-L/s) **OR** 12 cylinders and 3000-cu. ft./h (23.6-L/s), **as directed**, capacity at 200-psig (1380-kPa) minimum line pressure.

G. Medical Compressed-Air-Piping Alarm Systems
1. Panels for medical compressed-air piping systems may be combined in single panels with medical vacuum and medical gas piping systems.
2. Components: Designed for continuous service and to operate on power supplied from 120 **OR** 240 **OR** 277, **as directed**,-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
3. Dew Point Monitors: Continuous line monitoring, having panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, factory- or field-installed valved bypass, and visual and cancelable audio signal for dryer site and master alarm panels. Alarm signals when pressure dew point rises above 39 deg F (4 deg C) at 55 psig (380 kPa).
   a. Operation: Chilled-mirror method **OR** Chilled-mirror method or hygrometer moisture analyzer with sensor probe **OR** Hygrometer moisture analyzer with sensor probe, **as directed**.
4. Pressure Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
   a. Low-Pressure Operating Range: 0- to 100-psig (0- to 690-kPa).
   b. High-Pressure Operating Range: Up to 250-psig (1725-kPa).
5. Carbon Monoxide Monitors: Panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, and factory- or field-installed valved bypass. Alarm signals when carbon monoxide level rises above 10 ppm.
6. General Requirements for Medical Compressed-Air Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
   a. Mounting: Exposed, surface **OR** Recessed, **as directed**, installation.
   b. Enclosures: Fabricated from minimum 0.047-inch- (1.2-mm-) thick steel or minimum 0.05-inch- (1.27-mm-) thick aluminum, with knockouts for electrical and piping connections.
7. Master Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.

a. Include alarm signals when the following conditions exist:
   1) Medical Air: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa), backup air compressor is in operation, pressure drop across filter assembly increases more than 2 psig (13.8 kPa), dew point rises above 39 deg F (4 deg C) at 55 psig (380 kPa), carbon monoxide level rises above 10 ppm, and high water level is reached in receiver for liquid-ring, medical air compressor systems.
   2) Dental Air: Pressure drops below 65 psig (450 kPa) or rises above 110 psig (760 kPa), backup air compressor is in operation, pressure drop across filter assembly increases more than 2 psig (13.8 kPa), dew point rises above 50 deg F (10 deg C) at 125 psig (860 kPa), and carbon monoxide level rises above 10 ppm.
   3) Instrument Air: Pressure drops below 165 psig (1140 kPa) or rises above 185 psig (1275 kPa).
   4) Medical Laboratory Air: Pressure drops below 90 psig (630 kPa) or rises above 110 psig (760 kPa).

8. Anesthetizing-Area Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.
   a. Include alarm signals when the following conditions exist:
      1) Medical Air: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
      2) Instrument Air: Pressure drops below 165 psig (1140 kPa) or rises above 185 psig (1275 kPa).
9. Area Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.
   a. Include alarm signals when the following condition exists:
      1) Medical Air: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
10. Dental-Area Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.
   a. Include alarm signals when the following conditions exist:
      1) Dental Air: Pressure drops below 65 psig (450 kPa) or rises above 110 psig (760 kPa), backup air compressor is in operation, pressure drop across filter assembly increases more than 2 psig (13.8 kPa), dew point rises above 50 deg F (10 deg C) at 125 psig (860 kPa), and carbon monoxide level rises above 10 ppm.
      2) Instrument Air: Pressure drops below 165 psig (1140 kPa) or rises above 185 psig (1275 kPa).
11. Medical Laboratory Area Alarm Panels: Separate trouble alarm signals, pressure gages,; and indicators for medical compressed-air piping systems.
   a. Include alarm signals when the following condition exists:
      1) Medical Laboratory Air: Pressure drops below 90 psig (630 kPa) or rises above 110 psig (760 kPa).

H. Computer Interface Cabinet
1. Description: Wall-mounting, welded-steel control cabinet with gasketed door, mounting brackets, grounding device, and white-enamel finish for connection of medical compressed-air- piping-system alarms to facility computer. Include factory-installed signal circuit boards, power transformer, circuit breaker, wiring terminal board, and internal wiring capable of interfacing 20, **as directed**, alarm signals.

I. Compressed-Air-Cylinder Storage Racks
1. Wall Storage Racks: Fabricate racks with chain restraints for upright cylinders as indicated or provide equivalent manufactured wall racks.
2. Freestanding Storage Racks: Fabricate racks as indicated or provide equivalent manufactured storage racks.

J. Flexible Pipe Connectors
1. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
a. Working-Pressure Rating: 200 psig (1380 kPa) **OR** 250 psig (1725 kPa), **as directed**, minimum.
b. End Connections: Threaded copper pipe or plain-end copper tube.

K. Sleeves
1. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
2. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
a. Underdeck Clamp: Clamping ring with set screws.

L. Escutcheons
1. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.
2. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.
3. One-Piece, Cast-Brass Escutcheons: With set screw.
a. Finish: Polished chrome-plated **OR** Rough brass, **as directed**.
4. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
a. Finish: Polished chrome-plated **OR** Rough brass, **as directed**.
5. One-Piece, Stamped-Steel Escutcheons: With set screw **OR** spring clips, **as directed**, and chrome-plated finish.
6. Split-Plate, Stamped-Steel Escutcheons: With concealed **OR** exposed-rivet, **as directed**, hinge, set screw **OR** spring clips, **as directed**, and chrome-plated finish.
7. One-Piece, Floor-Plate Escutcheons: Cast iron.
8. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

M. Grout
1. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
a. Characteristics: Post-hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
b. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
c. Packaging: Premixed and factory packaged.

N. Nitrogen
1. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

1.3 EXECUTION

A. Piping Applications
1. Connect new tubing to existing tubing with memory-metal couplings.
2. Laboratory Air Piping: Use one of the following piping materials for each size range:
a. NPS 4 (DN 100) and Smaller: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
b. NPS 4 (DN 100) and Smaller: Type L, copper medical gas tube; press-type fittings; and pressure-sealed joints.
c. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
3. Medical Air Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

4. Dental Air Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
5. Instrument Air Piping:
   a. NPS 3 (DN 80) and Smaller: Use Type K **OR** Type L, **as directed**, copper medical gas tube; wrought-copper fittings; and brazed joints.
   b. NPS 3-1/2 (DN 90) and Larger: Use Type K, copper medical gas tube; wrought-copper fittings; and brazed joints.
6. Medical Laboratory Air Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
7. Drain Piping: Use one of the following piping materials:
   a. Copper water tube, cast- or wrought-copper fittings, and soldered **OR** press-type fittings, and pressure-sealed, **as directed**, joints.
   b. PVC pipe, PVC fittings, and solvent-cemented joints.

B. Piping Installation
1. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
2. Comply with ASSE Standard #6010 for installation of compressed-air piping.
3. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
4. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
6. Install piping adjacent to equipment and specialties to allow service and maintenance.
7. Install air and drain piping with 1 percent slope downward in direction of flow.
8. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.
9. Install eccentric reducers, if available, where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
10. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.
11. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Division 22 Section "Meters And Gages For Plumbing Piping".
12. Install piping to permit valve servicing.
13. Install piping free of sags and bends.
14. Install fittings for changes in direction and branch connections.
15. Install medical compressed-air piping to medical compressed-air service connections specified in this Section, to medical compressed-air service connections in equipment specified in Division 22 Section "Gas Piping For Laboratory And Healthcare Facilities", and to equipment specified in other Sections requiring medical compressed-air service.
16. Install seismic restraints on compressed-air piping. Seismic-restraint devices are specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".
17. Install compressed-air service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
18. Connect compressed-air piping to air compressors and to compressed-air outlets and equipment requiring compressed-air service.
19. Install unions in copper compressed-air tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.

C. Valve Installation
1. Install shutoff valve at each connection to and from compressed-air equipment and specialties.
2. Install check valves to maintain correct direction of compressed-air flow from compressed-air equipment.
3. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
4. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
5. Install safety valves on compressed-air receivers where required by NFPA 99 and where recommended by specialty manufacturers.
6. Install pressure regulators on compressed-air piping where reduced pressure is required.
7. Install automatic drain valves on equipment, specialties, and piping with drain connection. Run drain piping to floor drain so contents spill over or into it.
8. Install flexible pipe connectors in discharge piping and in inlet air piping from remote air-inlet filter, **as directed**, of each air compressor.

D. Joint Construction
1. Ream ends of PVC pipes and remove burrs.
2. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
3. Threaded Joints: Apply appropriate tape to external pipe threads.
4. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.
5. Soldered Joints: Apply ASTM B 813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B 828.
6. Pressure-Sealed Joints: Join copper tube and press-type fittings with tools recommended by fitting manufacturer.
7. Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.
8. Solvent-Cemented Joints: Clean and dry joining surfaces. Join PVC pipe and fittings according to the following:
   a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   b. Apply primer and join according to ASME B31.9 for solvent-cemented joints, and ASTM D 2672.

E. Compressed-Air Service Component Installation
1. Install compressed-air pressure control panel in walls. Attach to substrate.
2. Install compressed-air manifolds on concrete base, **as directed**, anchored to substrate.
3. Install compressed-air cylinders and connect to manifold piping.
4. Install compressed-air manifolds with seismic restraints as indicated.
5. Install compressed-air-cylinder wall storage racks attached to substrate.

F. Medical Compressed-Air-Piping Alarm System Installation
1. Alarm panels for medical compressed-air piping systems may be combined in single panels with medical vacuum piping systems and medical gas piping systems.
2. Install alarm system components for medical compressed-air-piping according to and in locations required by NFPA 99.
3. Install area and master alarm panels for medical compressed-air piping system where indicated.
4. Install computer interface cabinet with connection to medical compressed-air-piping alarm system and to facility computer.

G. Sleeve Installation
1. Sleeves are not required for core-drilled holes.
2. Permanent sleeves are not required for holes formed by removable PE sleeves.

3. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using galvanized-steel pipe **OR** galvanized-steel sheet **OR** stack sleeve fittings **OR** PVC pipe, **as directed**.
   a. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
   b. Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

   OR

   Install sleeves in new walls and slabs as new walls and slabs are constructed.
4. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   a. PVC **OR** Steel, **as directed**, Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
   b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger penetrating gypsum board partitions.
   c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim" for flashing.
      1) Seal space outside of sleeve fittings with grout.
5. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping".

H. Escutcheon Installation
1. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   a. New Piping:
      1) Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
      2) Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** stamped steel with set screw **OR** stamped steel with set screw or spring clips **OR** stamped steel with spring clips, **as directed**.
      3) Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** One piece or split casting, cast brass with polished chrome-plated finish **OR** Split casting, cast brass with polished chrome-plated finish **OR** One piece, stamped steel with set screw **OR** One piece or split plate, stamped steel with set screw **OR** Split plate, stamped steel with set screw, **as directed**.
      4) Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish **OR** cast brass with rough-brass finish **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
      5) Bare Piping in Equipment Rooms: One piece, cast brass **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
      6) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.
   b. Existing Piping:
      1) Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
      2) Insulated Piping: Split plate, stamped steel with concealed **OR** exposed-rivet, **as directed**, hinge and spring clips.
      3) Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and spring clips, **as directed**.

4) Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and set screw, **as directed**.
5) Bare Piping in Unfinished Service Spaces: Split casting, cast brass with polished chrome-plated finish **OR** casting, cast brass with rough-brass finish **OR** plate, stamped steel with concealed hinge and set screw or spring clips **OR** plate, stamped steel with concealed or exposed-rivet hinge and set screw or spring clips **OR** plate, stamped steel with exposed-rivet hinge and set screw or spring clips, **as directed**.
6) Bare Piping in Equipment Rooms: Split casting, cast brass **OR** plate, stamped steel with set screw or spring clips, **as directed**.
7) Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

I. Hanger And Support Installation
1. Comply with requirements in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment" for seismic-restraint devices.
2. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for pipe hanger and support devices.
3. Vertical Piping: MSS Type 8 or 42, clamps.
4. Individual, Straight, Horizontal Piping Runs:
   a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel, clevis hangers.
   b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable, roller hangers.
5. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for trapeze hangers.
6. Base of Vertical Piping: MSS Type 52, spring hangers.
7. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.
8. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
9. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1/4 (DN 8): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   b. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
   c. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   d. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
   e. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
   f. NPS 1-1/2 (DN 40): 10 feet (3 m) with 3/8-inch (10-mm) rod.
   g. NPS 2 (DN 50): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.
   h. NPS 2-1/2 (DN 65): 13 feet (4 m) with 1/2-inch (13-mm) rod.
   i. NPS 3 (DN 80): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.
   j. NPS 3-1/2 (DN 90): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.
   k. NPS 4 (DN 100): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.
   l. NPS 5 (DN 125): 18 feet (5.5 m) with 1/2-inch (13-mm) rod.
   m. NPS 6 (DN 150): 20 feet (6 m) with 5/8-inch (16-mm) rod.
   n. NPS 8 (DN 200): 23 feet (7 m) with 3/4-inch (19-mm) rod.
10. Install supports for vertical copper tubing every 10 feet (3 m).

J. Labeling And Identification
1. Install identifying labels and devices for nonmedical laboratory compressed-air piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification For Plumbing Piping And Equipment".
2. Install identifying labels and devices for medical compressed-air piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
   a. Medical Air: Black letters on yellow background.

b. Dental Air: Black letters on yellow-and-white diagonal stripe background.
c. Instrument Air: White letters on red background.
d. Medical Laboratory Air: Black letters on yellow-and-white checkerboard background.

K. Field Quality Control For Compressed-Air Piping In Nonmedical Laboratory Facilities
1. Perform tests and inspections of compressed-air piping in nonmedical laboratory facilities and prepare test reports.
2. Tests and Inspections:
a. Piping Leak Tests for Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry nitrogen to pressure of 50 psig (345 kPa) above system operating pressure, but not less than 150 psig (1035 kPa). Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
b. Repair leaks and retest until no leaks exist.
c. Inspect filters and pressure regulators for proper operation.

L. Field Quality Control For Medical Compressed-Air Piping In Healthcare Facilities
1. Perform tests and inspections of medical compressed-air piping systems in healthcare facilities and prepare test reports.
2. Tests and Inspections:
a. Medical Compressed-Air Testing Coordination: Perform tests, inspections, verifications, and certification of medical compressed-air piping systems concurrently with tests, inspections, and certification of medical vacuum piping and medical gas piping systems.
b. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
1) Initial blowdown.
2) Initial pressure test.
3) Cross-connection test.
4) Piping purge test.
5) Standing pressure test for positive-pressure medical compressed-air piping.
6) Repair leaks and retest until no leaks exist.
c. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical compressed-air piping systems and perform the following tests and inspections:
1) Standing pressure test.
2) Individual-pressurization **OR** Individual-pressurization or pressure-differential **OR** Pressure-differential, **as directed**, cross-connection test.
3) Valve test.
4) Master and area alarm tests.
5) Piping purge test.
6) Piping particulate test.
7) Piping purity test.
8) Final tie-in test.
9) Operational pressure test.
10) Medical air purity test.
11) Verify correct labeling of equipment and components.
d. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
1) Inspections performed.
2) Procedures, materials, and gases used.
3) Test methods used.
4) Results of tests.
3. Remove and replace components that do not pass tests and inspections and retest as specified above.

END OF SECTION 22 11 16 00g

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SECTION 22 11 16 00h - VACUUM PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for vacuum piping for laboratory and healthcare facilities. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Laboratory low-vacuum piping and specialties, designated "laboratory low vacuum" operating at 12 inches mercury (40.6 kPa vacuum) **OR** 20 inches mercury (67.7 kPa vacuum), **as directed**.
   b. Laboratory high-vacuum piping and specialties, designated "laboratory high vacuum" operating at 24 inches mercury (81.3 kPa vacuum) **OR** 29 inches mercury (98.2 kPa vacuum), **as directed**.
   c. Medical surgical vacuum piping and specialties, designated "medical vacuum" operating at 15 inches mercury (380 mm mercury or 50.7 kPa vacuum) **OR** 20 inches mercury (510 mm mercury or 67.7 kPa vacuum) **OR** 30 inches mercury (760 mm mercury or 101.4 kPa vacuum), **as directed**.
   d. Waste anesthetic gas disposal piping and specialties, designated "WAGD evacuation" operating at 14 inches mercury (355 mm mercury or 47.2 kPa vacuum) **OR** 15 inches mercury (380 mm mercury or 50.7 kPa vacuum), **as directed**.
   e. Dental vacuum piping and specialties, designated "dental vacuum" operating at 10 inches mercury (255 mm mercury or 33.8 kPa vacuum) **OR** 12 inches mercury (305 mm mercury or 40.6 kPa vacuum), **as directed**.
   f. Oral-evacuation piping and specialties, designated "HVE" operating at 5 inches mercury (127 mm mercury or 16.9 kPa vacuum) **OR** 8 inches mercury (203 mm mercury or 27.0 kPa vacuum), **as directed**.
   g. Healthcare laboratory vacuum piping and specialties, designated "medical laboratory vacuum" operating at 12 inches mercury (40.6 kPa vacuum) **OR** 20 inches mercury (67.7 kPa vacuum) **OR** 24 inches mercury (81.3 kPa vacuum), **as directed**.

C. Definitions
1. D.I.S.S.: Diameter-index safety system.
2. HVE: High-volume (oral) evacuation.
3. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
4. WAGD: Waste anesthetic gas disposal.
5. Medical vacuum piping systems include medical vacuum, WAGD evacuation, dental vacuum, HVE, and medical laboratory vacuum piping systems.

D. Submittals
1. Product Data: For the following:
   a. Vacuum pipes **OR** tubes, **as directed**, and fittings.
   b. Vacuum valves and valve boxes.
   c. Medical vacuum service connections and vacuum-bottle brackets.
2. LEED Submittal:
   a. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.
3. Shop Drawings: Diagram power, signal, and control wiring.

4. Piping Material Certification: Signed by Installer certifying that medical vacuum piping materials comply with NFPA 99 requirements.
5. Qualification Data: For Installer and testing agency.
6. Brazing certificates.
7. Field quality-control test reports.
8. Operation and maintenance data.

E. Quality Assurance
1. Installer Qualifications:
   a. Medical Vacuum Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010.
   b. Extruded-Tee Outlet Procedure: Qualify operators according to training provided by T-DRILL Industries Inc., for making branch outlets.
   c. Pressure-Seal Joining Procedure for Copper Tubing: Qualify operators according to training provided by Viega; Plumbing and Heating Systems.
2. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.
   a. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.
3. Source Limitations: Obtain vacuum service connections of same type and from same manufacture as service connections provided for in Division 22 Section "Gas Piping For Laboratory And Healthcare Facilities".
4. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
6. Comply with ASME B31.9, "Building Services Piping," for vacuum piping in laboratory facilities.
7. NFPA Compliance: Comply with NFPA 99, "Health Care Facilities," for medical vacuum system materials and installation in healthcare facilities.

F. Project Conditions
1. Interruption of Existing Laboratory or Medical Vacuum Service(s): Do not interrupt laboratory or medical vacuum service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   a. Notify the Owner no fewer than two days in advance of proposed interruption of laboratory or medical vacuum service(s).
   b. Do not proceed with interruption of laboratory or medical vacuum service(s) without the Owner's written permission.

1.2 PRODUCTS

A. Pipes, Tubes, And Fittings
1. Copper Medical Gas Tube: ASTM B 819, Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in blue.
   a. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.

b. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
c. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.
d. Press-Type Fittings:
1) NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
2) NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

2. Copper Water Tube: ASTM B 88, Type M (ASTM B 88M, Type C), seamless, drawn temper.
a. Cast-Copper Fittings: ASME B16.18, solder-joint pressure type.
b. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type.
c. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.
d. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.
e. Press-Type Fittings:
1) NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
2) NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

3. Extruded-Tee Outlets: ASTM F 2014 procedure for making branch outlets in copper tube.
4. Memory-Metal Couplings: Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.
5. PVC Pipe: ASTM D 1785, Schedule 40 and Schedule 80.
a. PVC Pressure Fittings: ASTM D 2466, Schedule 40 and ASTM D 2467, Schedule 80; socket type.

B. Joining Materials
1. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
2. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
3. Threaded-Joint Tape: PTFE.
4. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness, full-face type.
5. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.
6. Solvent Cement for Joining PVC Piping: ASTM D 2564. Include primer complying with ASTM F 656.
a. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
b. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Valves
1. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
a. Exception: Factory cleaning and bagging are not required for valves for WAGD service.
2. Copper-Alloy Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
a. Pressure Rating: 300 psig (2070 kPa) minimum.
b. Ball: Full-port, chrome-plated brass.
c. Seats: PTFE or TFE.
d. Handle: Lever type with locking device, **as directed**.
e. Stem: Blowout proof with PTFE or TFE seal.
f. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
3. Bronze Check Valves: In-line pattern.
a. Pressure Rating: 300 psig (2070 kPa) minimum.
b. Operation: Spring loaded.

c. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

4. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
   a. Pressure Rating: 300 psig (2070 kPa) minimum.
   b. Ball: Full-port, chrome-plated brass.
   c. Seats: PTFE or TFE.
   d. Handle: Lever type with locking device, **as directed**.
   e. Stem: Blowout proof with PTFE or TFE seal.
   f. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
   g. Vacuum Gage: Manufacturer installed on one copper-tube extension.
5. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with vacuum gages and in sizes required to permit manual operation of valves.
   a. Interior Finish: Factory-applied white enamel.
   b. Cover Plate: Aluminum or extruded-anodized aluminum **OR** Satin-chrome finish steel **OR** Stainless steel with NAAMM AMP 503, No. 4 finish, **as directed**, with frangible or removable windows.
   c. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.
6. Zone Valve Boxes: Formed or extruded aluminum with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with vacuum gages and in sizes required to permit manual operation of valves.
   a. Interior Finish: Factory-applied white enamel.
   b. Cover Plate: Aluminum or extruded-anodized aluminum **OR** Stainless steel with NAAMM AMP 503, No. 4 finish, **as directed**, with frangible or removable windows.
   c. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.
7. PVC Ball Valves: MSS SP-122, with union ends and 150-psig (1035-kPa) minimum working-pressure rating and suitable for vacuum service.
8. PVC Butterfly Valves: Lug type with lever handle and 150-psig (1035-kPa) minimum working-pressure rating and suitable for vacuum service.
9. PVC Check Valves: Ball-, in-line-, piston-, or swing-check design with flanged or union ends and 70-psig (480-kPa) **OR** 100-psig (690-kPa), **as directed**, minimum working-pressure rating and suitable for vacuum service.
10. Safety Valves: Bronze-body, ASME-construction, pressure-relief type with settings to match system requirements.
11. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig (1380-kPa) minimum working pressure, capable of automatic discharge of collected condensate. Include mounting bracket where wall mounting is indicated.

D. Medical Vacuum Service Connections

1. Connection Devices: For specific medical vacuum service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
   a. Roughing-in Assembly:
      1) Steel outlet box for recessed mounting and concealed piping.
      2) Brass-body inlet block.
      3) Seals that will prevent vacuum leakage.
      4) ASTM B 819, NPS 3/8 (DN 10) copper outlet tube brazed to valve with service marking and tube-end dust cap.
   b. Finishing Assembly:
      1) Brass housing with primary check valve.
      2) Seals that will prevent vacuum leakage.
      3) Cover plate with gas-service label.

c. Quick-Coupler Service Connections: Suction inlets for medical vacuum **OR** medical vacuum and WAGD evacuation **OR** WAGD evacuation, **as directed**, service outlets with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
d. D.I.S.S. Service Connections: Suction inlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
   1) Medical Vacuum Service Connections: CGA V-5, D.I.S.S. No. 1220.
   2) WAGD Evacuation Service Connections: CGA V-5, D.I.S.S. No. 2220.
e. Vacuum Bottle Brackets: One piece, with pattern and finish matching corresponding service cover plate.
f. Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish **OR** metal, with chrome-plated finish **OR** anodized aluminum, **as directed**, and permanent, color-coded, identifying label matching corresponding service.

E. Medical Vacuum Piping Alarm Systems
1. Panels for medical vacuum piping systems may be combined in single panels with medical compressed-air and medical gas piping systems.
2. Components: Designed for continuous service and to operate on power supplied from 120-V **OR** 240-V **OR** 277-V, **as directed**, ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
3. Vacuum Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
   a. Vacuum Operating Range: 0- to 30-in. Hg (0- to 101-kPa vacuum).
4. General Requirements for Medical Vacuum Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
   a. Mounting: Exposed, surface **OR** Recessed, **as directed**, installation.
   b. Enclosures: Fabricated from minimum 0.047-inch- (1.2-mm-) thick steel or minimum 0.05-inch- (1.27-mm-) thick aluminum, with knockouts for electrical and piping connections.
5. Master Alarm Panels: With separate trouble alarm signals, vacuum gages, and indicators for medical vacuum piping systems.
   a. Include alarm signals when the following conditions exist:
      1) Medical Vacuum: Vacuum drops below 12-in. Hg (40 kPa vacuum) and backup vacuum pump is in operation.
      2) WAGD Evacuation: Vacuum drops below 12-in. Hg (40 kPa vacuum).
      3) Dental Vacuum: Vacuum drops below 6-in. Hg (20 kPa vacuum) and backup vacuum producer is in operation.
      4) HVE: 4-in. Hg (13 kPa vacuum) and backup vacuum producer is in operation.
      5) Medical Laboratory Vacuum: Vacuum drops below 10-in. Hg (34 kPa vacuum).
6. Anesthetizing-Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.
   a. Include alarm signals when the following conditions exist:
      1) Medical Vacuum: Vacuum drops below 12-in. Hg (40 kPa vacuum).
      2) WAGD Evacuation: Vacuum drops below 12-in. Hg (40 kPa vacuum).
7. Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.
   a. Include alarm signals when the following condition exists:
      1) Medical Vacuum: Vacuum drops below 12-in. Hg (40 kPa vacuum).
8. Dental Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.
   a. Include alarm signals when the following conditions exist:
      1) Dental Vacuum: Vacuum drops below 6-in. Hg (20 kPa vacuum) and backup vacuum producer is in operation.
      2) HVE: 4-in. Hg (13 kPa vacuum) and backup vacuum producer is in operation.

9. Medical Laboratory Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.
   a. Include alarm signals when the following condition exists:
      1) Medical Vacuum: Vacuum drops below 12-in. Hg (40 kPa vacuum).

F. Computer Interface Cabinet
   1. Description: Wall-mounting, welded-steel, control cabinet with gasketed door, mounting brackets, grounding device, and white-enamel finish for connection of medical vacuum piping system alarms to facility computer. Include factory-installed signal circuit boards, power transformer, circuit breaker, wiring terminal board, and internal wiring capable of interfacing 20 alarm signals.

G. Flexible Pipe Connectors
   1. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
      a. Working-Pressure Rating: 200 psig (1380 kPa) **OR** 250 psig (1725 kPa), **as directed**, minimum.
      b. End Connections: Threaded copper pipe or plain-end copper tube.

H. Sleeves
   1. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
   2. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
      a. Underdeck Clamp: Clamping ring with set screws.

I. Escutcheons
   1. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.
   2. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.
   3. One-Piece, Cast-Brass Escutcheons: With set screw.
      a. Finish: Polished chrome-plated **OR** Rough brass **OR** Polished chrome-plated and rough brass, **as directed**.
   4. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
      a. Finish: Polished chrome-plated **OR** Rough brass **OR** Polished chrome-plated and rough brass, **as directed**.
   5. One-Piece, Stamped-Steel Escutcheons: With set screw **OR** spring clips, **as directed**, and chrome-plated finish.
   6. Split-Plate, Stamped-Steel Escutcheons: With concealed **OR** exposed-rivet, **as directed**, hinge, set screw **OR** spring clips, **as directed**, and chrome-plated finish.
   7. One-Piece, Floor-Plate Escutcheons: Cast iron.
   8. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

J. Grout
   1. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
      a. Characteristics: Post-hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
      b. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
      c. Packaging: Premixed and factory packaged.

K. Nitrogen
   1. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

1.3 EXECUTION

A. Preparation
1. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:
a. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
b. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb (0.453 kg) of chemical to 3 gal. (11.3 L) of water.
1) Scrub to ensure complete cleaning.
2) Rinse with clean, hot water to remove cleaning solution.

B. Piping Applications
1. Connect new copper tubing to existing tubing with memory-metal couplings.
2. Nonhealthcare Laboratory Low Vacuum Piping: Use one of the following piping materials for each size range:
a. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
b. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; press-type fittings; and pressure-sealed joints.
c. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
3. Nonhealthcare Laboratory High Vacuum Piping: Use one of the following piping materials for each size range:
a. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
b. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; press-type fittings; and pressure-sealed joints.
c. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
4. Medical Vacuum Piping: Use one of the following piping materials for each size range:
a. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed joints.
b. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; press-type fittings; and pressure-sealed joints.
c. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed joints.
5. WAGD Evacuation Piping: Use one of the following piping materials for each size range:
a. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed joints.
b. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; press-type fittings; and pressure-sealed joints.
c. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed joints.
6. Dental Vacuum Piping: Use one of the following piping materials for each size range:
a. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
b. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; press-type fittings; and pressure-sealed joints.
c. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
7. HVE Piping: Use one of the following piping materials for each size range:

a. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
b. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; press-type fittings; and pressure-sealed joints.
c. NPS 4 (DN 100) and Smaller: Schedule 40 PVC pipe, Schedule 40 PVC fittings **OR** Schedule 80 PVC pipe, Schedule 80 PVC fittings, **as directed**, and solvent-cemented joints.
d. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
e. NPS 5 to NPS 8 (DN 125 to DN 200): Schedule 40 PVC pipe, Schedule 40 PVC fittings **OR** Schedule 80 PVC pipe, Schedule 80 PVC fittings, **as directed**, and solvent-cemented joints.

8. Medical Laboratory Vacuum Piping: Use one of the following piping materials for each size range:
a. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed joints.
b. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; press-type fittings; and pressure-sealed joints.
c. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed joints.

9. Drain Piping: Use one of the following piping materials:
a. Copper water tube, cast- or wrought-copper fittings, and soldered **OR** press-type fittings, and pressure-sealed, **as directed**, joints.
b. PVC pipe, PVC fittings, and solvent-cemented joints.

C. Piping Installation

1. Drawing plans, schematics, and diagrams indicate general location and arrangement of vacuum piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
2. Comply with ASSE Standard #6010 for installation of vacuum piping.
3. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
4. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
6. Install piping adjacent to equipment and specialties to allow service and maintenance.
7. Install vacuum and drain piping with 1 percent slope downward in direction of flow.
8. Install nipples, unions, and special fittings, and valves with pressure ratings same as or higher than piping pressure rating used in applications below unless otherwise indicated.
9. Install eccentric reducers, if available, where vacuum piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
10. Provide drain leg and drain trap at end of each main and branch and at low points.
11. Install thermometer and vacuum gage on inlet piping to each vacuum producer and on each receiver and separator, **as directed**. Comply with requirements in Division 22 Section "Meters And Gages For Plumbing Piping".
12. Install piping to permit valve servicing.
13. Install piping free of sags and bends.
14. Install fittings for changes in direction and for branch connections. Extruded-tee branch outlets in copper tubing may be made where specified.
15. Install medical vacuum piping to medical vacuum service connections specified in this Section and to equipment specified in other Sections requiring medical vacuum service.

16. Install seismic restraints on vacuum piping. Seismic-restraint devices are specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".
17. Install medical vacuum service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
18. Install medical vacuum bottle bracket adjacent to each wall-mounted medical vacuum service connection suction inlet.
19. Connect vacuum piping to vacuum producers and to equipment requiring vacuum service.
20. Install unions, in copper vacuum tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.
21. Install unions, in PVC vacuum piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.
22. Install flanges, in PVC vacuum piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment, machine, and specialty.

D. Valve Applications
1. Valves for Copper Vacuum Tubing: Use copper alloy ball and bronze check types.
2. Valves for PVC Vacuum Piping:
    a. NPS 4 (DN 100) and Smaller: Use copper alloy ball and bronze **OR** PVC ball, butterfly, and, **as directed**, check types.
    b. NPS 5 (DN 125) and Larger: Use PVC butterfly and check types.

E. Valve Installation
1. Install shutoff valve at each connection to and from vacuum equipment and specialties.
2. Install check valves to maintain correct direction of vacuum flow to vacuum-producing equipment.
3. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
4. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
5. Install safety valves on vacuum receivers, where required by NFPA 99, and where recommended by specialty manufacturers.
6. Install automatic drain valves on equipment, specialties, and piping with drain connection. Run drain piping to floor drain, so contents spill over or into it.
7. Install flexible pipe connectors in suction inlet piping to each vacuum producer.

F. Joint Construction
1. Ream ends of pipes and tubes and remove burrs.
2. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
3. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
4. Threaded Joints: Apply appropriate tape to external pipe threads.
5. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.
6. Soldered Joints: Apply ASTM B 813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B 828.
7. Extruded-Tee Outlets: Form branches in copper tube according to ASTM F 2014, with tools recommended by procedure manufacture.
8. Flanged Joints:
    a. Copper Tubing: Install flange on copper tubes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.
    b. PVC Piping: Install PVC flange on PVC pipes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.
9. Pressure-Sealed Joints: Join copper tube and copper and copper-alloy fittings with tools recommended by fitting manufacturer.
10. Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.
11. Solvent-Cemented Joints: Clean and dry joining surfaces. Join PVC pipe and fittings according to the following:

a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
b. Apply primer and join according to ASME B31.9 for solvent-cemented joints and to ASTM D 2672.

G. Medical Vacuum Piping Alarm System Installation
1. Panels for medical vacuum piping systems may be combined in single panels with medical compressed-air piping systems and medical gas piping systems.
2. Install medical vacuum piping system alarm system components in locations required by and according to NFPA 99.
3. Install medical vacuum piping system area and master alarm panels where indicated.
4. Install computer interface cabinet with connection to medical vacuum piping alarm system and to facility computer.

H. Sleeve Installation
1. Sleeves are not required for core-drilled holes.
2. Permanent sleeves are not required for holes formed by removable PE sleeves.
3. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using galvanized-steel pipe **OR** galvanized-steel sheet **OR** stack sleeve fittings **OR** PVC pipe, **as directed**.
   a. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
   b. Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

   OR

   Install sleeves in new walls and slabs as new walls and slabs are constructed.
4. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   a. PVC **OR** Steel, **as directed**, Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
   b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum board partitions.
   c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim" for flashing.
      1) Seal space outside of sleeve fittings with grout.
5. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping".

I. Escutcheon Installation
1. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   a. New Piping:
      1) Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
      2) Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** stamped steel with set screw **OR** stamped steel with set screw or spring clips **OR** stamped steel with spring clips, **as directed**.
      3) Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** One piece or split casting, cast brass with polished chrome-plated finish **OR** Split casting, cast brass with polished chrome-plated finish **OR** One-piece, stamped steel with set screw **OR** One piece or split plate, stamped steel with set screw **OR** Split plate, stamped steel with set screw, **as directed**.

4) Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish **OR** cast brass with rough-brass finish **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
5) Bare Piping in Equipment Rooms: One piece, cast brass **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
6) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

b. Existing Piping:
1) Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
2) Insulated Piping: Split plate, stamped steel with concealed **OR** exposed-rivet, **as directed**, hinge and spring clips.
3) Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and spring clips, **as directed**.
4) Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and set screw, **as directed**.
5) Bare Piping in Unfinished Service Spaces: Split casting, cast brass with polished chrome-plated finish **OR** casting, cast brass with rough-brass finish **OR** plate, stamped steel with concealed hinge and set screw or spring clips **OR** plate, stamped steel with concealed or exposed-rivet hinge and set screw or spring clips **OR** plate, stamped steel with exposed-rivet hinge and set screw or spring clips, **as directed**.
6) Bare Piping in Equipment Rooms: Split casting, cast brass **OR** plate, stamped steel with set screw or spring clips, **as directed**.
7) Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

J. Hanger And Support Installation
1. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for pipe hanger and support devices.
2. Vertical Piping: MSS Type 8 or 42, clamps.
3. Individual, Straight, Horizontal Piping Runs:
   a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel, clevis hangers.
   b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable, roller hangers.
4. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for trapeze hangers.
5. Base of Vertical Piping: MSS Type 52, spring hangers.
6. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.
7. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
8. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1/4 (DN 8): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   b. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
   c. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   d. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
   e. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
   f. NPS 1-1/2 (DN 40): 10 feet (3 m) with 3/8-inch (10-mm) rod.
   g. NPS 2 (DN 50): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.
   h. NPS 2-1/2 (DN 65): 13 feet (4 m) with 1/2-inch (13-mm) rod.
   i. NPS 3 (DN 80): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.
   j. NPS 3-1/2 (DN 90): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.
   k. NPS 4 (DN 100): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.
   l. NPS 5 (DN 125): 18 feet (5.5 m) with 1/2-inch (13-mm) rod.

m. NPS 6 (DN 150): 20 feet (6 m) with 5/8-inch (16-mm) rod.
n. NPS 8 (DN 200): 23 feet (7 m) with 3/4-inch (19-mm) rod.

9. Install supports for vertical copper tubing every 10 feet (3 m).
10. Install hangers **OR** vinyl-coated hangers, **as directed**, for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 1 (DN 25) and Smaller: 30 inches (760 mm) with 3/8-inch (10-mm) rod.
    b. NPS 1-1/2 to NPS 2 (DN 40 to DN 50): 36 inches (900 mm) with 3/8-inch (10-mm) rod.
    c. NPS 2-1/2 and NPS 3 (DN 65 and DN 80): 42 inches (1150 mm) with 1/2-inch (13-mm) rod.
    d. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1220 mm) with 1/2-inch (13-mm) rod.
    e. NPS 6 and NPS 8 (DN 150 and DN 200): 54 inches (1350 mm) with 5/8-inch (16-mm) rod.
11. Install supports for vertical PVC piping every 48 inches (1220 mm).

K. Labeling And Identification
1. Install identifying labels and devices for laboratory vacuum piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification For Plumbing Piping And Equipment".
2. Install identifying labels and devices for medical vacuum piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
    a. Medical Vacuum: Black letters on white background.
    b. WAGD: White letters on violet background.
    c. Dental Vacuum: Black boxed letters on white-and-black diagonal stripe background.
    d. HVE: Black boxed letters on white-and-black diagonal stripe background.
    e. Medical Laboratory Vacuum: Black boxed letters on white-and-black checkerboard background.

L. Field Quality Control For Laboratory Facility Nonmedical Vacuum Piping
1. Perform tests and inspections of vacuum piping in nonmedical laboratory facilities.
2. Tests and Inspections:
    a. Piping Leak Tests for Vacuum Piping: Test new and modified parts of existing piping. Cap and fill vacuum piping with oil-free, dry nitrogen. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
        1) Test Pressure for Copper Tubing: 100 psig (690 kPa) **OR** 150 psig (1035 kPa), **as directed**.
        2) Test Pressure for PVC Piping: 50 psig (345 kPa) **OR** 100 psig (690 kPa), **as directed**.
    b. Repair leaks and retest until no leaks exist.
    c. Inspect filters for proper operation.
3. Prepare test reports.

M. Field Quality Control For Healthcare Facility Medical Vacuum Piping
1. Perform tests and inspections of medical vacuum piping systems in healthcare facilities and prepare test reports.
2. Tests and Inspections:
    a. Medical Vacuum Testing Coordination: Perform tests, inspections, verifications, and certification of medical vacuum piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical gas piping systems.
    b. Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
        1) Initial blow down.
        2) Initial pressure test.
        3) Cross-connection test.
        4) Piping purge test.

5) Standing pressure test for vacuum systems.
6) Repair leaks and retest until no leaks exist.

c. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical vacuum piping systems and perform the following tests and inspections:
1) Standing pressure test.
2) Individual-pressurization **OR** Pressure-differential, **as directed**, cross-connection test.
3) Valve test.
4) Master and area alarm tests.
5) Piping purge test.
6) Final tie-in test.
7) Operational vacuum test.
8) Verify correct labeling of equipment and components.

d. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
1) Inspections performed.
2) Procedures, materials, and gases used.
3) Test methods used.
4) Results of tests.

3. Remove and replace components that do not pass tests and inspections and retest as specified above.

N. Demonstration
1. Train the Owner's maintenance personnel to adjust, operate, and maintain medical vacuum alarm systems.

END OF SECTION 22 11 16 00h

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SECTION 22 11 16 00i - GAS PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for gas piping for laboratory and healthcare facilities. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes the following:
   a. Carbon dioxide piping and specialties designated "medical carbon dioxide" operating at 50 to 55 psig (345 to 380 kPa).
   b. Helium piping, designated "medical helium" operating at 50 to 55 psig (345 to 380 kPa).
   c. Nitrogen piping and specialties designated "medical nitrogen" operating at 160 to 185 psig (1100 to 1275 kPa) **OR** higher than 200 psig (1380 kPa), **as directed**.
   d. Nitrous oxide piping and specialties designated "medical nitrous oxide" operating at 50 to 55 psig (345 to 380 kPa).
   e. Oxygen piping and specialties designated "medical oxygen" operating at 50 to 55 psig (345 to 380 kPa).

C. Definitions

1. CR: Chlorosulfonated polyethylene synthetic rubber.
2. D.I.S.S.: Diameter-index safety system.
3. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
4. Medical gas piping systems include medical carbon dioxide, medical helium, medical nitrogen, medical nitrous oxide, and medical oxygen nonflammable gas for healthcare facility patient care or for healthcare laboratory applications.
5. Specialty Gas: Gas, other than medical gas, for nonmedical laboratory facility applications.

D. Performance Requirements

1. Seismic Performance: Gas manifolds, Bulk gas storage tanks, Gas manifolds and bulk gas storage tanks, and piping shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

E. Submittals

1. Product Data: For the following:
   a. Tubes and fittings.
   b. Valves and valve boxes.
   c. Medical gas service connections.
   d. Electrical service connections.
   e. Patient service consoles.
   f. Medical nitrogen pressure control panels.
   g. Ceiling columns. Include integral service connections.
   h. Ceiling hose assemblies. Include integral service connections.
   i. Gas manifolds.
   j. Bulk gas storage tanks. Include rated capacities and operating weights.
   k. Medical gas alarm system components.
   l. Gas cylinder storage racks.
2. Shop Drawings: Diagram power, signal, and control wiring.

3. Piping Material Certification: Signed by Installer certifying that medical gas piping materials comply with NFPA 99 requirements.
4. Brazing certificates.
5. Manufacturer Seismic Qualification Certification: Submit certification that gas manifolds and bulk gas storage tanks, accessories, and components will withstand seismic forces defined in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment". Include the following:
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
6. Certificates of Shop Inspection and Data Report for Bulk Gas Storage Tanks: As required by ASME Boiler and Pressure Vessel Code.
7. Field quality-control test reports.
8. Operation and maintenance data.

F. Quality Assurance
1. Installer Qualifications:
   a. Medical Gas Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010 for installers.
2. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the medical gas piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   a. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.
3. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
5. ASME Compliance: Fabricate and label bulk medical gas storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
6. NFPA Compliance:
   a. Comply with NFPA 50, "Bulk Oxygen Systems at Consumer Sites," for bulk oxygen storage tanks.
   b. Comply with NFPA 99, "Health Care Facilities," for medical gas piping system materials and installation.
7. CGA Compliance: Comply with CGA G-8.1, "Nitrous Oxide Systems at Consumer Sites," for bulk nitrous oxide storage tanks.
8. UL Compliance:
   a. Comply with UL 498, "Attachment Plugs and Receptacles," for electrical service connections.
   b. Comply with UL 544, "Medical and Dental Equipment," for medical gas specialties.

G. Project Conditions
1. Interruption of Existing Specialty and Medical Gas Service(s): Do not interrupt specialty or medical gas service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   a. Notify the Owner no fewer than two days in advance of proposed interruption of specialty and medical gas service(s).
   b. Do not proceed with interruption of specialty and medical gas service(s) without the Owner's written permission.

1.2 PRODUCTS

A. Pipes, Tubes, And Fittings
1. Copper Medical Gas Tube: ASTM B 819, Type K **OR** Type L, **as directed**, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and blue for Type L tube.
a. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
b. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
c. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.
d. Press-Type Fittings:
1) NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
2) NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
e. Memory-Metal Couplings: Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory-alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.
2. PVC Pipe: ASTM D 1785, Schedule 40 and Schedule 80.
a. PVC Fittings: ASTM D 2466, Schedule 40 **OR** ASTM D 2467, Schedule 80, **as directed**; socket type.

B. Joining Materials
1. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.
2. Threaded-Joint Tape: PTFE.
3. Solvent Cement for Joining PVC Piping: ASTM D 2564. Include primer complying with ASTM F 656.

C. Valves
1. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
2. Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
a. Pressure Rating: 300 psig (2070 kPa) minimum.
b. Ball: Full-port, chrome-plated brass.
c. Seats: PTFE or TFE.
d. Handle: Lever type with locking device, **as directed**.
e. Stem: Blowout proof with PTFE or TFE seal.
f. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
3. Check Valves: In-line pattern, bronze.
a. Pressure Rating: 300 psig (2070 kPa) minimum.
b. Operation: Spring loaded.
c. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
4. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
a. Pressure Rating: 300 psig (2070 kPa) minimum.
b. Ball: Full-port, chrome-plated brass.
c. Seats: PTFE or TFE.
d. Handle: Lever type with locking device, **as directed**.
e. Stem: Blowout proof with PTFE or TFE seal.
f. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
g. Pressure Gage: Manufacturer-installed on one copper-tube extension.
5. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.
a. Interior Finish: Factory-applied white enamel.

b. Cover Plate: Aluminum or extruded-anodized aluminum **OR** Satin-chrome finish steel **OR** Stainless steel with NAAMM AMP 503, No. 4 finish, **as directed**, with frangible or removable windows.
c. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

OR

Zone Valve Boxes: Formed or extruded aluminum with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.
a. Interior Finish: Factory-applied white enamel.
b. Cover Plate: Aluminum or extruded-anodized aluminum **OR** Stainless steel with NAAMM AMP 503, No. 4 finish, **as directed**, with frangible or removable windows.
c. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

6. Emergency Oxygen Connections: Low-pressure oxygen inlet assembly for connection to building oxygen piping systems.
   a. Enclosure: Weatherproof hinged locking cover with caption similar to "Emergency Low-Pressure Gaseous Oxygen Inlet."
   b. Inlet: Manufacturer-installed, NPS 1 or NPS 1-1/4 (DN 25 or DN 32), ASTM B 819, copper tubing with NPS 1 (DN 25) minimum ball valve and plugged inlet.
   c. Safety Valve: Bronze-body, pressure relief valve set at 75 or 80 psig (520 or 550 kPa).
   d. Instrumentation: Pressure gage.
7. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.
8. Pressure Regulators: Bronze **OR** Stainless-steel, **as directed**, body and trim; spring-loaded, diaphragm-operated, relieving type; manual pressure-setting adjustment; rated for 250-psig (1725-kPa) minimum inlet pressure; and capable of controlling delivered gas pressure within 0.5 psig for each 10-psig (5.0 kPa for each 100-kPa) inlet pressure.

D. Medical Gas Service Connections
1. General Requirements for Medical Gas Service Connections: For specific medical gas pressure and suction service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
   a. Roughing-in Assembly:
      1) Steel outlet box for recessed mounting and concealed piping.
      2) Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed. Suction inlets to be without secondary valve.
      3) Double seals that will prevent gas leakage.
      4) ASTM B 819, NPS 3/8 (DN 10) copper outlet tube brazed to valve with service marking and tube-end dust cap.
   b. Finishing Assembly:
      1) Brass housing with primary check valve.
      2) Double seals that will prevent gas leakage.
      3) Cover plate with gas-service label.
   c. Quick-Coupler Service Connections: Pressure outlets for carbon dioxide, nitrous xide, oxygen, and <**Insert medical gas**> service connections with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
   d. D.I.S.S. Service Connections: Pressure outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
      1) Medical Carbon Dioxide Service Connections: D.I.S.S. No. 1080.

2) Medical Helium Service Connections: D.I.S.S. No. 1060.
3) Medical Nitrogen Service Connections: D.I.S.S. No. 1120.
4) Medical Nitrous Oxide Service Connections: D.I.S.S. No. 1040.
5) Medical Oxygen Service Connections: D.I.S.S. No. 1240.

e. Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish **OR** metal, with chrome-plated finish **OR** anodized aluminum, **as directed**, and permanent, color-coded, identifying label matching corresponding service.

E. Electrical Service Connections
1. Power Outlets: UL 498, Hospital Grade, 125-V receptacles; color selected. Include the following configurations complying with NEMA WD 1:
a. L5-20R, locking type, 20 A, single or duplex.
b. L5-20R, isolated ground, locking type, 20 A, single or duplex.
c. Explosion proof, 20 A, 2 pole, 3 wire, single; suitable for Class I, Group C hazardous location and interchangeable with receptacles used in nonhazardous areas; flush mounted.
d. 5-20R, straight blade, 20 A, duplex.
e. 5-20R, isolated ground, straight blade, 20 A, duplex.
2. Electrical Accessory Outlets: Provide the following configured receptacles in color selected:
a. Patient Equipment Ground Jack: Single pole, 30 A.
b. Patient Monitoring: Single, 5 and 37 pin.
3. Wall Outlet Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish **OR** metal, with chrome-plated finish **OR** anodized aluminum, **as directed**, and permanent identifying label.

F. Patient Service Consoles
1. General Requirements for Patient Service Consoles: Recessed- or semirecessed-mounting wall units with medical gas service connections as specified in "Medical Gas Service Connections" Article and electrical service connections as specified in "Electrical Service Connections" Article, **as directed**. Include labels indicating services, and the following:
a. Recessed- or semirecessed-mounting steel console box or mounting bracket.
b. Concealed supplies.
c. Cover Plate: One piece, anodized aluminum **OR** stainless steel, **as directed**, and permanent identifying label with service connections for the following:
1) Medical Air: Quick-coupler pressure outlet.
2) Medical Oxygen: Quick-coupler pressure outlet.
3) Medical Vacuum: Quick-coupler suction inlet.
4) Medical vacuum bottle bracket.
5) L5-20R, locking type, 20 A, single **OR** duplex, **as directed**.

G. Medical Nitrogen Pressure Control Panels
1. Description: Steel box and support brackets for recessed roughing-in with stainless-steel or anodized-aluminum cover plate with printed operating instructions. Include manifold assembly consisting of inlet supply valve, inlet supply pressure gage, line-pressure control regulator, outlet supply pressure gage, D.I.S.S. service connection, and piping outlet for remote service connection.
a. Minimum Working Pressure: 200 psig (1380 kPa).
b. Line-Pressure Control Regulator: Self-relieving diaphragm type with precision manual adjustment.
c. Pressure Gages: 0- to 300-psig (0- to 2070-kPa) range.
d. Service Connection: CGA V-5, D.I.S.S. No. 1120, nitrogen outlet.
e. Before final assembly, provide temporary dust shield and U-tube for testing.
f. Label cover plate "Nitrogen Pressure Control."

H. Ceiling Columns
1. General Requirements for Ceiling Columns: Ceiling-mounting units with medical gas service connections as specified in "Medical Gas Service Connections" Article and electrical service

connections as specified in "Electrical Service Connections" Article, **as directed**. Include labels indicating services, and the following:
a. Ceiling-Mounting Plate: Manufacturer's standard plate or roughing-in assembly.
b. Exposed Surfaces: Minimum 0.0375-inch- (0.95-mm-) thick stainless steel with NAAMM AMP 503, No. 4 directional polish.
c. Servicing: Include access panels or means of removing shroud.
d. Blank cover plates for cutouts not having service connections.
e. ASTM B 819, NPS 3/8 (DN 10) copper-tube extensions for connection to medical gas systems.
f. Service Connections: Type and number indicated.
g. Dust Covers: For medical gas service connection.

2. Rigid Ceiling Columns: 44-inch- (1120-mm-) long, rectangular fixed column section with 2 **OR** 4, **as directed**, double intravenous medication hooks. Include 0.078-inch- (2.0-mm-) thick, stainless-steel bottom plate with the following service connections:
a. Instrument Air: One D.I.S.S. No. 1160 pressure outlet(s).
b. Medical Air: One quick-coupler **OR** D.I.S.S. No. 1160, **as directed**, pressure outlet(s).
c. Medical Carbon Dioxide: One quick-coupler **OR** D.I.S.S. No. 1080, **as directed**, pressure outlet(s).
d. Medical Helium: One D.I.S.S. No. 1060, pressure outlet(s).
e. Medical Nitrogen: One D.I.S.S. No. 1120 pressure outlet(s).
f. Medical Nitrous Oxide: One quick-coupler **OR** D.I.S.S. No. 1040, **as directed**, pressure outlet(s).
g. Medical Oxygen: Two quick-coupler **OR** D.I.S.S. No. 1240, **as directed**, pressure outlets.
h. Medical Vacuum: Two quick-coupler **OR** D.I.S.S. No. 1220, **as directed**, suction inlets.
i. Vacuum Bottle Brackets: Two.
j. WAGD Evacuation: One quick-coupler **OR** D.I.S.S. No. 2220, **as directed**, suction inlet(s).
k. Power: 2 **OR** 4, **as directed**, L5-20R, locking-type, 20-A, single receptacles.
l. Patient Equipment: 2 **OR** 4, **as directed**, ground-jack, single-pole, 30-A receptacles.

3. Retractable Ceiling Columns: Manually adjustable using release and lock handles capable of locking column in all positions from fully retracted to fully extended; 15-inch- (380-mm-) long, rectangular counterbalanced telescoping section with 2 **OR** 4, **as directed**, double intravenous medication hooks; and 36-inch- (915-mm-) long, fixed column section. Include 0.078-inch- (2.0-mm-) thick, stainless-steel bottom plate with the following service connections:
a. Instrument Air: One D.I.S.S. No. 1160 pressure outlet(s).
b. Medical Air: One quick-coupler **OR** D.I.S.S. No. 1160, **as directed**, pressure outlet(s).
c. Medical Carbon Dioxide: One quick-coupler **OR** D.I.S.S. No. 1080, **as directed**, pressure outlet(s).
d. Medical Helium: One D.I.S.S. No. 1060, pressure outlet(s).
e. Medical Nitrogen: One D.I.S.S. No. 1120 pressure outlet(s).
f. Medical Nitrous Oxide: One quick-coupler **OR** D.I.S.S. No. 1040, **as directed**, pressure outlet(s).
g. Medical Oxygen: Two quick-coupler **OR** D.I.S.S. No. 1240, **as directed**, pressure outlets.
h. Medical Vacuum: Two quick-coupler **OR** D.I.S.S. No. 1220, **as directed**, suction inlets.
i. Vacuum Bottle Brackets: Two.
j. WAGD Evacuation: One quick-coupler **OR** D.I.S.S. No. 2220, **as directed**, suction inlet(s).
k. Power: 2 **OR** 4, **as directed**, L5-20R, locking-type, 20-A, single receptacles.
l. Patient Equipment: 2 **OR** 4, **as directed**, ground-jack, single-pole, 30-A receptacles.

I. Ceiling Hose Assemblies

1. Ceiling Hose Assemblies, General: Ceiling-mounting units with medical gas service connections as specified in "Medical Gas Service Connections" Article and electrical service connections as specified in "Electrical Service Connections" Article, **as directed**. Include labels indicating services, and the following:
a. Ceiling-Mounting Plate: Manufacturer's standard plate or roughing-in assembly.

b. Exposed Surfaces: Minimum 0.0375-inch- (0.95-mm-) thick stainless steel with NAAMM AMP 503, No. 4 directional polish.
c. Servicing: Include access panels or means of removing shroud.
d. Blank cover plates for cutouts not having service connections.
e. ASTM B 819, NPS 3/8 (DN 10) copper-tube extensions for connection to medical gas systems.
f. Service Connections: Type and number indicated.
g. Dust Covers: For medical gas service connection.

2. Hose-Reel Service Assemblies: Individual, concealed, retractable hose-reel units with stainless-steel face plates, steel mounting boxes, factory- or field-fabricated mounting brackets, and color-coded service hoses with adjustable stops and service connections matching hoses. Include 15 feet (4.5 m) minimum of conductive, CR, 1/4- or 5/16-inch- (6.4- or 7.9-mm-) ID, medical gas hoses rated for 200-psig (1380-kPa) minimum working pressure, and the following service connections:
   a. Instrument Air Hose: D.I.S.S. No. 1160 pressure outlet.
   b. Medical Air Hose: Quick-coupler **OR** D.I.S.S. No. 1160, **as directed**, pressure outlet.
   c. Medical Carbon Dioxide Hose: Quick-coupler **OR** D.I.S.S. No. 1080, **as directed**, pressure outlet.
   d. Medical Nitrogen Hose: D.I.S.S. No. 1120 pressure outlet.
   e. Medical Nitrous Oxide Hose: Quick-coupler **OR** D.I.S.S. No. 1040, **as directed**, pressure outlet.
   f. Medical Oxygen Hose: Quick-coupler **OR** D.I.S.S. No. 1240, **as directed**, pressure outlet.
   g. Medical Vacuum Hose: Quick-coupler **OR** D.I.S.S. No. 1220, **as directed**, suction inlet.
   h. WAGD Evacuation Hose: Quick-coupler **OR** D.I.S.S. No. 2220, **as directed**, suction inlet.
   i. Power: L5-20R, locking-type, 20-A, single, power receptacle.
3. Fixed Hose Service Assemblies: Individual, concealed hose connection with stainless-steel face plates, steel mounting boxes, factory- or field-fabricated mounting brackets, and color-coded service hoses with retractor device and service connections matching hoses. Include 72 inches (1830 mm) of conductive, CR, 1/4- or 5/16-inch- (6.4- or 7.9-mm-), ID, medical gas hoses rated for 200-psig (1380-kPa) minimum working pressure, and the following service hose connections:
   a. Instrument Air Hose: D.I.S.S. No. 1160 pressure outlet.
   b. Medical Air Hose: Quick-coupler **OR** D.I.S.S. No. 1160, **as directed**, pressure outlet.
   c. Medical Carbon Dioxide Hose: Quick-coupler **OR** D.I.S.S. No. 1080, **as directed**, pressure outlet.
   d. Medical Nitrogen Hose: D.I.S.S. No. 1120 pressure outlet.
   e. Medical Nitrous Oxide Hose: Quick-coupler **OR** D.I.S.S. No. 1040, **as directed**, pressure outlet.
   f. Medical Oxygen Hose: Quick-coupler **OR** D.I.S.S. No. 1240, **as directed**, pressure outlet.
   g. Medical Vacuum Hose: Quick-coupler **OR** D.I.S.S. No. 1220, **as directed**, suction inlet.
   h. WAGD Evacuation Hose: Quick-coupler **OR** D.I.S.S. No. 2220, **as directed**, suction inlet.
   i. Power: L5-20R, locking-type, 20-A, single, power receptacle.

J. Gas Manifolds

1. Simplex Specialty Gas Manifolds:
   a. Control Panel Unit: Weatherproof cabinet, supply and delivery pressure gages, electrical alarm system connections and transformer, indicator lights or devices, manifold connection, line-pressure regulator, shutoff valves, and safety valve.
   b. Manifold and Header: Nonferrous-metal header for number of cylinders indicated. Units include design for 2000-psig (13.8-MPa) minimum inlet pressure. Include cylinder bank header with inlet (pigtail) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gage.
   c. <**Insert specialty gas**> Manifold: For <**Insert number cylinders**> capacity at 55-psig (380-kPa) line pressure, with electric heater or orifice design that will prevent freezing during high demand.
   d. Specialty Gas Cylinders: Will be furnished by the Owner **OR** Number and type of medical gas cylinders required for complete manifold systems, **as directed**.

e. Label manifold control unit with permanent label identifying specialty gas type and system operating pressure.

f. Mounting: Wall with mounting brackets for manifold control cabinet and header **OR** Floor with support legs for manifold control cabinet, **as directed**.

2. Duplex Specialty Gas Manifolds:

a. Central Control Panel Unit: Weatherproof cabinet, supply and delivery pressure gages, electrical alarm system connections and transformer, indicator lights or devices, manifold connection, line-pressure regulator, shutoff valves, and safety valve.

b. Manifold and Headers: Duplex, nonferrous-metal header for number of cylinders indicated, divided into two equal banks. Units include design for 2000-psig (13.8-MPa) minimum inlet pressure. Include cylinder bank headers with inlet (pigtail) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gage.

c. Operation: Automatic, pressure-switch-activated changeover from one cylinder bank to the other when first bank becomes exhausted, without line-pressure fluctuation or resetting of regulators and without supply interruption by shutoff of either cylinder bank header.

d. <**Insert specialty gas**> Manifold: For <**Insert number cylinders**> capacity at 55-psig (380-kPa) line pressure, with electric heater or orifice design that will prevent freezing during high demand.

e. Specialty Gas Cylinders: Will be furnished by the Owner **OR** Number and type of medical gas cylinders required for complete manifold systems, **as directed**.

f. Label manifold control unit with permanent label identifying specialty gas type and system operating pressure.

g. Mounting: Wall with mounting brackets for manifold control cabinet and headers **OR** Floor with support legs for manifold control cabinet, **as directed**.

3. Medical Gas Manifolds: Comply with NFPA 99, Ch. 5, for high-pressure medical gas cylinders.

a. Central Control Panel Unit: Weatherproof cabinet, supply and delivery pressure gages, electrical alarm system connections and transformer, indicator lights or devices, manifold connection, pressure changeover switch, line-pressure regulator, shutoff valves, and safety valve.

b. Manifold and Headers: Duplex, nonferrous-metal header for number of cylinders indicated, divided into two equal banks. Units include design for 2000-psig (13.8-MPa) minimum inlet pressure, except nitrous oxide manifolds may be designed for 800 psig (5520 kPa) and carbon dioxide manifolds may be designed for 1500 psig (10.35 MPa). Include cylinder bank headers with inlet (pigtail) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gage.

c. Operation: Automatic, pressure-switch-activated changeover from one cylinder bank to the other when first bank becomes exhausted, without line-pressure fluctuation or resetting of regulators and without supply interruption by shutoff of either cylinder bank header.

d. Medical Carbon Dioxide Manifolds: For 2 cylinders and 250-cfh (1.97-L/s) **OR** 4 cylinders and 500-cfh (3.94-L/s), **as directed**, capacity at 55-psig (380-kPa) line pressure.

e. Medical Helium Manifolds: For 2 cylinders and 250-cfh (1.97-L/s) **OR** 4 cylinders and 500-cfh (3.94-L/s), **as directed**, capacity at 55-psig (380-kPa) line pressure.

f. Medical Nitrous Oxide Manifolds: For 8 cylinders and 1333-cfh (10.5-L/s) **OR** 12 cylinders and 2000-cfh (15.7-L/s), **as directed**, capacity at 55-psig (380-kPa) line pressure, with electric heater or orifice design that will prevent freezing during high demand.

g. Medical Nitrogen Manifolds: For 8 cylinders and 2000-cfh (15.7-L/s) **OR** 12 cylinders and 3000-cfh (23.6-L/s), **as directed**, capacity at 180-psig (1240-kPa) **OR** higher than 200-psig (1380-kPa), **as directed**, line pressure.

h. Medical Oxygen Manifolds: For 12 cylinders and 1500-cfh (11.8-L/s) **OR** 20 cylinders 2500-cfh (19.7-L/s), **as directed**, capacity at 55-psig (380-kPa), **as directed**, line pressure.

i. Medical Gas Cylinders: Will be furnished by the Owner **OR** Number and type of medical gas cylinders required for complete manifold systems, **as directed**.

j. Label manifold control unit with permanent label identifying medical gas type and system operating pressure.

k. Mounting: Wall with mounting brackets for manifold control cabinet and headers **OR** Floor with support legs for manifold control cabinet, **as directed**.

K. Bulk Gas Storage Tanks
1. Bulk Specialty Gas Storage Tanks:
2. Bulk Medical Gas Storage Tanks:
a. Bulk Medical Gas Storage Tank Systems: Bulk storage tank with connections for alarm system, continuous supply, and reserve supply that will operate only during emergencies, complying with NFPA 99, "Health Care Facilities."
b. Controls: Include actuating switch for alarm system connection and means for automatic actuating of reserve supply.
c. Bulk Medical Gas Storage Tanks: Vertical mounting, double-wall construction with inner vessel fabricated according to ASME Boiler and Pressure Vessel Code for unfired pressure vessels and suitable for medical gas service. Include insulation and vacuum seal between walls. Fabricate outer shell from carbon steel with factory-applied manufacturer's standard protective paint finish suitable for exterior installation. Include the following features, specialties, and components:
1) Safety Valves: ASME construction with pressure setting to correspond to tank working pressure and as required for component or system being protected.
2) Pressure Gages: For tank pressure and facility service line pressure.
3) Contents Gage: High- and low-level indicator with electric signal circuit connection.
4) Drain Valves: For piping, inner vessel, and outer shell.
5) Fill Assembly: Fill connection, piping, valves, relief devices, and controls.
6) Facility Service Assembly: Piping, valves, relief devices, vaporizer, shutoff valve, pressure regulator, line shutoff valve or check valve, and reserve supply connection for connection to building service piping.
7) Include permanent label showing medical gas type, storage tank capacity, tank pressure rating, vaporizer capacity, and operating instructions.
8) Liquid Oxygen Storage Tank: Nickel-steel or stainless-steel inner vessel with 250-psig (1725-kPa) minimum working pressure. Include electric **OR** steam **OR** ambient vaporizer, **as directed**.
9) Liquid Nitrous Oxide Storage Tank: Steel-alloy inner vessel with 300-psig (2070-kPa) minimum working pressure. Include electric **OR** steam, **as directed**, vaporizer.
d. Oxygen Reserve Supply: Manifold header for high-pressure cylinders, fabricated from copper-tube or brass pipe and fittings and suitable for pressures up to 4000 psig (27.6 MPa). Include header inlet connections complying with CGA V-1, with individual inlet check valves, header shutoff valve, header pressure regulator, line shutoff valve or check valve, pressure gage, and inlet connections for number of cylinders indicated.
e. Nitrous Oxide Reserve Supply: Manifold header for high-pressure cylinders, fabricated from copper-tube or brass pipe and fittings and suitable for pressures up to 4000 psig (27.6 MPa). Include header inlet connections complying with CGA V-1, with individual inlet check valves, header shutoff valve, header pressure regulator, line shutoff valve or check valve, pressure gage, inlet connections for number of cylinders indicated, and electric heater.

L. Medical Gas Piping Alarm Systems
1. Panels for medical gas piping systems may be combined in single panels with medical compressed-air and medical vacuum piping systems.
2. Components: Designed for continuous service and to operate on power supplied from 120 **OR** 240 **OR** 277, **as directed**,-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
3. Pressure Switches or Pressure Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
a. Low-Pressure Operating Range: 0- to 100-psig (0- to 690-kPa).
b. High-Pressure Operating Range: Up to 250-psig (1725-kPa).

4. General Requirements for Medical Gas Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
   a. Mounting: Exposed, surface **OR** Recessed, **as directed**, installation.
   b. Enclosures: Fabricated from minimum 0.047-inch- (1.2-mm-) thick steel or minimum 0.05-inch- (1.27-mm-) thick aluminum, with knockouts for electrical and piping connections.
5. Master Alarm Panels: With separate trouble alarm signals, pressure gages, and indicators for medical gas piping systems.
   a. Include alarm signals when the following conditions exist:
      1) Medical Carbon Dioxide: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa) and changeover is made to alternate bank.
      2) Medical Helium: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa) and changeover is made to alternate bank.
      3) Medical Nitrogen: Pressure drops below 145 psig (1000 kPa) or rises above 200 psig (1380 kPa) and changeover is made to alternate bank.
      4) Medical Nitrous Oxide (for bulk oxygen storage tank system with cylinder reserve): Liquid level is low, pressure downstream from main shutoff valve drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa), changeover is made to reserve, reserve is in use, and reserve level is low.
      5) Medical Nitrous Oxide (for nitrous oxide manifold system): Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa) and changeover is made to alternate bank.
      6) Medical Oxygen (for bulk oxygen storage tank system with cylinder reserve): Liquid level is low, pressure downstream from main shutoff valve drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa), changeover is made to reserve, reserve is in use, reserve level is low, and reserve pressure is low.
      7) Medical Oxygen (for oxygen manifold system): Pressure downstream from main shutoff valve drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa) and changeover is made to alternate bank.
6. Anesthetizing-Area Alarm Panels: Separate trouble alarm signals; pressure gages; and indicators for medical gas piping systems.
   a. Include alarm signals when the following conditions exist:
      1) Medical Carbon Dioxide: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
      2) Medical Helium: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
      3) Medical Nitrous Oxide: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
      4) Medical Nitrogen: Pressure drops below 145 psig (1000 kPa) or rises above 200 psig (1380 kPa).
      5) Medical Oxygen: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
7. Area Alarm Panels: Separate trouble alarm signals; pressure and vacuum gages; and indicators for medical gas piping systems.
   a. Include alarm signals when the following conditions exist:
      1) Oxygen: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
8. Dental Area Alarm Panels: Separate trouble alarm signals; pressure and vacuum gages; and indicators for medical gas piping systems.
   a. Include alarm signals when the following conditions exist:
      1) Medical Nitrogen: Pressure drops below 145 psig (1000 kPa) or rises above 200 psig (1380 kPa) and changeover is made to alternate bank.
      2) Medical Nitrous Oxide (for bulk nitrous oxide storage tank system with cylinder reserve): Liquid level is low, pressure downstream from main shutoff valve drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa), changeover is made to reserve, reserve is in use, and reserve level is low.

3) Medical Nitrous Oxide (for nitrous oxide manifold system): Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa) and changeover is made to alternate bank.
4) Medical Oxygen (for bulk oxygen storage tank system with cylinder reserve): Liquid level is low, pressure downstream from main shutoff valve drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa), changeover is made to reserve, reserve is in use, reserve level is low, and reserve pressure is low.
5) Medical Oxygen (for nitrous oxide manifold system): Pressure downstream from main shutoff valve drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa) and changeover is made to alternate bank.

9. Medical Laboratory Area Alarm Panels: Separate trouble alarm signals; pressure and vacuum gages; and indicators for medical gas piping systems.
   a. Include alarm signals when the following conditions exist:
      1) Medical Carbon Dioxide: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
      2) Medical Helium: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
      3) Medical Oxygen: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).

M. Computer Interface Cabinet
1. Description: Wall-mounting, welded-steel, control cabinet with gasketed door, mounting brackets, grounding device, and white-enamel finish for connection of medical gas system alarms to facility computer. Include factory-installed signal circuit boards, power transformer, circuit breaker, wiring terminal board, and internal wiring capable of interfacing 20, **as directed**, alarm signals.

N. Gas Cylinder Storage Racks
1. Wall Storage Racks: Fabricate racks with chain restraints for upright cylinders as indicated or provide equivalent manufactured wall racks.
2. Freestanding Storage Racks: Fabricate racks as indicated or provide equivalent manufactured storage racks.

O. Sleeves
1. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
2. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   a. Underdeck Clamp: Clamping ring with set screws.

P. Escutcheons
1. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.
2. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.
3. One-Piece, Cast-Brass Escutcheons: With set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass, **as directed**.
4. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass, **as directed**.
5. One-Piece, Stamped-Steel Escutcheons: With set screw **OR** spring clips, **as directed**, and chrome-plated finish.
6. Split-Plate, Stamped-Steel Escutcheons: With concealed **OR** exposed-rivet, **as directed**, hinge, set screw **OR** spring clips, **as directed**, and chrome-plated finish.
7. One-Piece, Floor-Plate Escutcheons: Cast iron.
8. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

Q. Grout

1. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   a. Characteristics: Post-hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   b. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
   c. Packaging: Premixed and factory packaged.

R. Nitrogen
1. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

1.3 EXECUTION

A. Earthwork
1. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling and for underground warning tapes.

B. Piping Applications
1. Nonhealthcare, Specialty Gas Piping: Type L, copper medical gas tube; wrought-copper fittings; and brazed **OR** press-type fittings and pressure-sealed, **as directed**, joints.
2. Nonhealthcare, Specialty Gas Piping NPS 2-1/2 (DN 65) and Smaller: Type K **OR** Type L, **as directed**, copper medical gas tube; wrought-copper fittings; and brazed **OR** press-type fittings and pressure-sealed, **as directed**, joints.
3. Nonhealthcare, Specialty Gas Piping NPS 3 (DN 80) and Larger: Type K, copper tube; wrought-copper fittings; and brazed **OR** press-type fittings and pressure-sealed, **as directed**, joints.
4. Medical Gas Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
5. Medical Gas Piping Except Nitrogen: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
6. Medical Nitrogen Piping: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
7. Medical Nitrogen Piping NPS 2-1/2 (DN 65) and Smaller: Type K **OR** Type L, **as directed**, copper medical gas tube; wrought-copper fittings; and brazed joints.
8. Medical Nitrogen Piping NPS 3 (DN 80) and Larger: Type K, copper tube; wrought-copper fittings; and brazed joints.
9. Protective Conduit: Use PVC pipe, PVC fittings, and solvent-cemented joints.

C. Piping Installation
1. Drawing plans, schematics, and diagrams indicate general location and arrangement of gas piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
2. Comply with ASSE Standard #6010 for installation of medical gas piping.
3. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
4. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
6. Install piping adjacent to equipment and specialties to allow service and maintenance.
7. Install nipples, unions, and special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.
8. Install piping to permit valve servicing.
9. Install piping free of sags and bends.
10. Install fittings for changes in direction and branch connections.

11. Install medical gas piping to medical gas service connections specified in this Section, to medical gas service connections in equipment specified in this Section, and to equipment specified in other Sections requiring medical gas service.
12. Install exterior, buried medical gas piping in protective conduit fabricated with PVC pipe and fittings. Do not extend conduit through foundation wall.
13. Install seismic restraints on gas piping. Seismic-restraint devices are specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".
14. Install medical gas service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
15. Connect gas piping to gas sources and to gas outlets and equipment requiring gas service.
16. Install unions, in copper tubing adjacent to each valve and at final connection to each piece of equipment and specialty.

D. Valve Installation
1. Install shutoff valve at each connection to gas laboratory and healthcare equipment and specialties.
2. Install check valves to maintain correct direction of gas flow from laboratory and healthcare gas supplies.
3. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
4. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
5. Install pressure regulators on gas piping where reduced pressure is required.
6. Install emergency oxygen connection with pressure relief valve and full-size discharge piping to outside, with check valve downstream from pressure relief valve and with ball valve and check valve in supply main from bulk oxygen storage tank.

E. Joint Construction
1. Ream ends of PVC pipes and remove burrs.
2. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
3. Threaded Joints: Apply appropriate tape to external pipe threads.
4. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free, dry nitrogen during brazing.
5. Pressure-Sealed Joints: Join copper tube and press-type fittings with tools recommended by fitting manufacturer.
6. Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.
7. Solvent-Cemented Joints: Clean and dry joining surfaces. Join PVC pipe and fittings according to the following:
   a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   b. Apply primer and join according to ASME B31.9 for solvent-cemented joints and to ASTM D 2672.

F. Gas Service Component Installation
1. Assemble patient service console with service connections. Install with supplies concealed, in walls. Attach console box or mounting bracket to substrate.
2. Install nitrogen pressure-control panels in walls. Attach to substrate.
3. Assemble ceiling columns and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.
4. Assemble ceiling assemblies and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.
5. Install gas manifolds on concrete base, **as directed**, anchored to substrate.
6. Install gas cylinders and connect to manifold piping.

7. Install gas manifolds with seismic restraints as indicated.
8. Install bulk gas storage tanks and reserve supply tanks level on concrete bases. Set tanks and connect gas piping to tanks according to applicable requirements in NFPA 50 for bulk oxygen storage systems, **as directed**. Install tanks level and plumb, firmly anchored to concrete bases; maintain NFPA 50 and tank manufacturer's recommended clearances. Orient tanks so controls and devices are accessible for servicing.
9. Install bulk gas storage tanks and reserve supply tanks with seismic restraints.

G. Medical Gas Piping Alarm System Installation
1. Install medical gas alarm system components in locations required by and according to NFPA 99.
2. Install medical gas area and master alarm panels where indicated.
3. Install computer interface cabinet with connection to medical gas piping alarm system and facility computer.

H. Sleeve Installation
1. Sleeves are not required for core-drilled holes.
2. Permanent sleeves are not required for holes formed by removable PE sleeves.
3. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using galvanized-steel pipe **OR** galvanized-steel sheet **OR** stack sleeve fittings **OR** PVC pipe, **as directed**.
   a. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
   b. Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

   OR

   Install sleeves in new walls and slabs as new walls and slabs are constructed.
4. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   a. PVC **OR** Steel, **as directed**, Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
   b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum board partitions.
   c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim" for flashing.
      1) Seal space outside of sleeve fittings with grout.
5. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping".

I. Escutcheon Installation
1. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   a. New Piping:
      1) Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
      2) Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** stamped steel with set screw **OR** stamped steel with set screw or spring clips **OR** stamped steel with spring clips, **as directed**.
      3) Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** One piece or split casting, cast brass with polished chrome-plated finish **OR** Split casting, cast brass with polished chrome-plated finish **OR** One piece, stamped steel with set screw **OR** One piece or split plate, stamped steel with set screw **OR** Split plate, stamped steel with set screw, **as directed**.

4) Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish **OR** cast brass with rough-brass finish **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
5) Bare Piping in Equipment Rooms: One piece, cast brass **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
6) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

b. Existing Piping:
1) Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
2) Insulated Piping: Split plate, stamped steel with concealed **OR** exposed-rivet, **as directed**, hinge and spring clips.
3) Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and spring clips, **as directed**.
4) Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and set screw, **as directed**.
5) Bare Piping in Unfinished Service Spaces: Split casting, cast brass with polished chrome-plated finish **OR** casting, cast brass with rough-brass finish **OR** plate, stamped steel with concealed hinge and set screw or spring clips **OR** plate, stamped steel with concealed or exposed-rivet hinge and set screw or spring clips **OR** plate, stamped steel with exposed-rivet hinge and set screw or spring clips, **as directed**.
6) Bare Piping in Equipment Rooms: Split casting, cast brass **OR** plate, stamped steel with set screw or spring clips, **as directed**.
7) Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

J. Hanger And Support Installation
1. Comply with requirements in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment" for seismic-restraint devices.
2. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for pipe hanger and support devices.
3. Vertical Piping: MSS Type 8 or 42, clamps.
4. Individual, Straight, Horizontal Piping Runs:
   a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel, clevis hangers.
   b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable, roller hangers.
5. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for trapeze hangers.
6. Base of Vertical Piping: MSS Type 52, spring hangers.
7. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.
8. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
9. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1/4 (DN 8): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   b. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
   c. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   d. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
   e. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
   f. NPS 1-1/2 (DN 40): 10 feet (3 m) with 3/8-inch (10-mm) rod.
   g. NPS 2 (DN 50): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.
   h. NPS 2-1/2 (DN 65): 13 feet (4 m) with 1/2-inch (13-mm) rod.
   i. NPS 3 (DN 80): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.
   j. NPS 3-1/2 (DN 90): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.

k. NPS 4 (DN 100): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.
l. NPS 5 (DN 125): 18 feet (5.5 m) with 1/2-inch (13-mm) rod.
m. NPS 6 (DN 150): 20 feet (6 m) with 5/8-inch (16-mm) rod.
n. NPS 8 (DN 200): 23 feet (7 m) with 3/4-inch (19-mm) rod.

10. Install supports for vertical copper tubing every 10 feet (3 m).

K. Labeling And Identification
1. Install identifying labels and devices for specialty gas piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification For Plumbing Piping And Equipment".
2. Install identifying labels and devices for healthcare medical gas piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
   a. Carbon Dioxide: Black or white letters on gray background.
   b. Helium: White letters on brown background.
   c. Nitrogen: White letters on black background.
   d. Nitrous Oxide: White letters on blue background.
   e. Oxygen: White letters on green background or green letters on white background.

L. Field Quality Control For Laboratory Facility Specialty Gas
1. Perform field tests and inspections of specialty gas piping for nonhealthcare laboratory facilities and prepare test reports.
2. Tests and Inspections:
   a. Piping Leak Tests for Specialty Gas Piping: Test new and modified parts of existing piping. Cap and fill specialty gas piping with oil-free, dry nitrogen to pressure of 50 psig (345 kPa) above system operating pressure, but not less than 150 psig (1035 kPa). Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
   b. Repair leaks and retest until no leaks exist.
   c. Inspect specialty gas regulators for proper operation.

M. Field Quality Control For Healthcare Facility Medical Gas
1. Perform tests and inspections of medical gas piping systems in healthcare facilities and prepare test reports.
2. Tests and Inspections:
   a. Medical Gas Piping Testing Coordination: Perform tests, inspections, verifications, and certification of medical gas piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical vacuum piping systems.
   b. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
      1) Initial blow down.
      2) Initial pressure test.
      3) Cross-connection test.
      4) Piping purge test.
      5) Standing pressure test for positive pressure medical gas piping.
      6) Standing pressure test for vacuum systems.
      7) Repair leaks and retest until no leaks exist.
   c. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical gas piping systems and perform the following tests and inspections:
      1) Standing pressure test.
      2) Individual-pressurization **OR** Pressure-differential, **as directed**, cross-connection test.
      3) Valve test.
      4) Master and area alarm tests.
      5) Piping purge test.

6) Piping particulate test.
7) Piping purity test.
8) Final tie-in test.
9) Operational pressure test.
10) Medical gas concentration test.
11) Medical air purity test.
12) Verify correct labeling of equipment and components.
13) Verify the following source equipment:
    a) Medical gas supply sources.

d. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
1) Inspections performed.
2) Procedures, materials, and gases used.
3) Test methods used.
4) Results of tests.

3. Remove and replace components that do not pass tests and inspections and retest as specified above.

END OF SECTION 22 11 16 00i

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Task	Specification	Specification Description
22 11 16 00	21 05 23 00	Piped Utilities Basic Materials And Methods
22 11 16 00	07 63 00 00	Common Work Results for Fire Suppression
22 11 16 00	07 63 00 00a	Common Work Results for Plumbing
22 11 16 00	07 63 00 00b	Common Work Results for HVAC

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SECTION 22 11 19 00 - ELECTRONIC AIR CLEANERS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for electronic air cleaners. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Electronic air cleaners.
      b. Side-service housings.
      c. Front- and rear-access filter frames.
      d. Filter gages.

C. Submittals
   1. Product Data: For each type of product indicated. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.
   2. LEED Submittal:
      a. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
   3. Shop Drawings: For each electronic air cleaner. Include plans, elevations, sections, details, and attachments to other work.
      a. Show filter assembly, dimensions, materials, and methods of assembly of components.
      b. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.
      c. Wiring Diagrams: For power, signal, and control wiring.
   4. Field quality-control reports.
   5. Operation and Maintenance Data: For each type of filter and housing to include in emergency, operation, and maintenance manuals.

D. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. ASHRAE Compliance:
      a. Comply with applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," and Section 7 - "Construction and Startup."
      b. Comply with ASHRAE 52.1 for arrestance and with ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.
   3. Comply with NFPA 90A and NFPA 90B.
   4. Comply with ARI 850.
   5. Comply with UL 867.

1.2 PRODUCTS

A. Electronic Air Cleaners
   1. Description: Factory-fabricated electronic air cleaner operating by electrostatic precipitation principles.

2. Prefilter Media: Four **OR** Six, **as directed**, alternate layers of galvanized-steel **OR** aluminum **OR** stainless-steel, **as directed**, flat and herringbone-crimp screen.
3. Prefilter: Comply with requirements in Division 23 Section "Particulate Air Filtration" for flat **OR** pleated **OR** ring, **as directed**, panel. Size and airflow capacity shall match those of electronic air cleaners.
    a. Depth: 1 inch (25 mm) **OR** 2 inches (50 mm) **OR** 4 inches (100 mm), **as directed**.
    b. Filter Unit Class: UL 900, Class 1 **OR** Class 2, **as directed**.
    c. Arrestance: 85 percent when tested according to ASHRAE 52.1.
    d. MERV: 8 when tested according to ASHRAE 52.2.
4. Final Filter: Comply with requirements in Division 23 Section "Particulate Air Filtration" for supported bag **OR** unsupported bag **OR** rigid-cell box **OR** V-bank cell **OR** self-supported pocket, **as directed**. Size and airflow capacity shall match those of gas-phase filters.
    a. Depth: 12 inches (300 mm) **OR** 18 inches (450 mm) **OR** 24 inches (600 mm),**as directed**.
    b. Filter Unit Class: UL 900, Class 1 **OR** Class 2, **as directed**.
    c. Arrestance: 85 percent when tested according to ASHRAE 52.1.
    d. MERV: 13 when tested according to ASHRAE 52.2.
5. Collection Cells: Aluminum, independently supported and nested.
    a. Ionizing Section: Alternately spaced grounded struts and charged ionizing wires.
    b. Collecting Section: Alternately grounded and charged plates, with insulators located out of airstream.
6. Power Pack: Self-contained, prewired rectifying unit to convert 120 **OR** 208/240 **OR** 480, **as directed**,-V ac, single-phase, 60-Hz power to approximately 12,000-V dc for ionizer and 6000-V dc for collector; include overload protection, on-off switch, pilot light showing operating status, and access door interlock.
7. Safety Accessories: Manual-reset safety switches and warning lights for filter plenum access doors, signal lights and safety switching upstream and downstream from unit within duct, and enameled high-voltage warning signs.
8. Collection Section Cleaning System:
    a. Detergent Reservoir Tank: 30 gal. (110 L) **OR** 55 gal. (200 L), **as directed**, with pump, motor, solenoid valve, level sensor, backflow preventer, wye-strainer, and ball valve.
    b. Detergent.
    c. Dispensing System: Motor-driven oscillating copper manifolds with brass spray nozzles on each side of the collector.
9. Mist Eliminators: Upstream **OR** Upstream and downstream **OR** Downstream, **as directed**.
10. Controls: Programmable logic controller in remotely mounted NEMA 250, Type 12 enclosure; with integral time clock and manual override.
    a. Contacts for enable-disable control by building automation system.
11. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

B. Fan Section
1. Fan: Forward curved, belt driven.
2. Motor:
    a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
    b. Type: Permanent-split capacitor with SCR for speed adjustment **OR** Electronically commutated motor, **as directed**.
    c. Fan-Motor Assembly Isolation: Rubber isolators.
    d. Enclosure: Totally enclosed, fan cooled, and explosion proof **OR** dust-ignition proof, **as directed**.
    e. Enclosure Materials: Cast iron **OR** Cast aluminum **OR** Rolled steel, **as directed**.
    f. Motor Bearings: Sealed ball.
    g. Unusual Service Conditions:
        1) Ambient Temperature: <**Insert deg F (deg C)**>.

2) Altitude: <**Insert feet (m)**> above sea level.
3) High humidity.

h. Efficiency: Premium efficient.
i. NEMA Design: <**Insert designation**>.
j. Service Factor: <**Insert value**>.
k. Motor Speed: Single speed **OR** Multispeed, **as directed**.
   1) Speed Control: Infinitely adjustable with pneumatic-electric and electronic controls.

C. Cabinet
1. Description: 16-gage galvanized steel with epoxy powder finish for suspended, wall, frame, or duct mounting.

D. Side-Service Housings
1. Description: Factory-assembled, side-service housings, with bottom drain, **as directed**, constructed of galvanized steel **OR** aluminum, **as directed**, and configured for stacking, with flanges to connect to duct or casing system.
2. Access Doors: Hinged with continuous **OR** Continuous, **as directed**, gaskets on perimeter and positive-locking devices.
3. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.
4. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

E. Front- And Rear-Access Filter Frames
1. Framing System: Galvanized-steel **OR** Aluminum, **as directed**, framing members with access for either upstream (front) or downstream (rear) filter servicing, cut to size and prepunched for assembly into modules with bottom drain, **as directed**, and configured for stacking. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation or operation.
2. Prefilters: Incorporate a separate track with spring clips, **as directed**, removable from front or back, **as directed**.
3. Final Filters: Integral tracks to accommodate particulate **OR** gas-phase, **as directed**, disposable filters.
4. Sealing: Factory-installed, positive-sealing device for each row of filters to ensure seal between gasketed filter elements to prevent bypass of unfiltered air.
5. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

F. Filter Gages
1. Diaphragm type, with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.
   a. Diameter: 4-1/2 inches (115 mm) **OR** 2 inches (50 mm), **as directed**.
   b. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5-Inch wg (125 Pa) or Less: 0- to 0.5-inch wg (0 to 125 Pa).
   c. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5- to 1-Inch wg (125 to 250 Pa) or Less: 0- to 1.0-inch wg (0 to 250 Pa).
   d. Scale Range for Filter Media Having a Recommended Final Resistance of 1.0- to 2.0-Inch wg (250 to 500 Pa) or Less: 0- to 2.0-inch wg (0 to 500 Pa).
   e. Scale Range for Filter Media Having a Recommended Final Resistance of 2.0- to 3.0-Inch wg (500 to 750 Pa) or Less: 0- to 3.0-inch wg (0 to 750 Pa).
   f. Scale Range for Filter Media Having a Recommended Final Resistance of 3.0- to 4.0-Inch wg (750 to 1000 Pa) or Less: 0- to 4.0-inch wg (0 to 1000 Pa).
2. Manometer-Type Filter Gage: Molded plastic, with epoxy-coated aluminum scale, logarithmic-curve tube gage, with integral leveling indicator, graduated to read from 0- to 3.0-inch wg (0 to 750 Pa), and accurate within 3 percent of full-scale range.
3. Accessories: Static-pressure tips, tubing, gage connections, and mounting bracket.

1.3 EXECUTION

A. Installation

1. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.
2. Install filters in position to prevent passage of unfiltered air.
3. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.
4. Operate electronic air cleaners for 24 hours as part of startup before filters are put into operation.
5. Install filter-gage, static-pressure taps upstream and downstream from filters. Install filter gages on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.
6. Install and connect water-supply and drainage piping.
7. Coordinate filter installations with duct and air-handling-unit installations.

B. Field Quality Control

1. Perform tests and inspections.
2. Tests and Inspections: Test for leakage of unfiltered air while system is operating.
3. Air filter will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

C. Cleaning

1. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems, clean filter housings and install new prefilter and final-filter media.

END OF SECTION 22 11 19 00

Task	Specification	Specification Description
22 11 19 00	01 22 16 00	No Specification Required
22 11 19 00	21 05 23 00	Piped Utilities Basic Materials And Methods
22 11 19 00	13 12 13 00	Water Distribution
22 11 19 00	07 63 00 00	Common Work Results for Fire Suppression
22 11 19 00	07 63 00 00a	Common Work Results for Plumbing
22 11 19 00	07 63 00 00b	Common Work Results for HVAC
22 11 19 00	22 11 16 00d	Steam And Condensate Piping

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SECTION 22 11 23 13 - WATER DISTRIBUTION PUMPS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for domestic water pumps. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. In-line, sealless centrifugal pumps.
      b. Horizontally mounted, in-line, separately coupled centrifugal pumps.
      c. Horizontally mounted, in-line, close-coupled centrifugal pumps.
      d. Vertically mounted, in-line, close-coupled centrifugal pumps.

C. Definitions
   1. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

D. Submittals
   1. Product Data: For each type of product indicated. Include materials of construction, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   2. Operation and Maintenance Data: For domestic water pumps to include in operation and maintenance manuals.

E. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. UL Compliance: Comply with UL 778 for motor-operated water pumps.

F. Delivery, Storage, And Handling
   1. Retain shipping flange protective covers and protective coatings during storage.
   2. Protect bearings and couplings against damage.
   3. Comply with pump manufacturer's written rigging instructions for handling.

G. Coordination
   1. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.2 PRODUCTS

A. In-Line, Sealless Centrifugal Pumps
   1. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.
   2. Pump Construction:
      a. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
      b. Casing: Bronze, with threaded or companion-flange connections.
      c. Impeller: Plastic.
      d. Motor: Single speed, unless otherwise indicated.

B. Horizontally Mounted, In-Line, Separately Coupled Centrifugal Pumps
1. Description: Factory-assembled and -tested, in-line, single-stage, separately coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shafts mounted horizontal.
2. Pump Construction:
a. Casing: Radially split with threaded companion-flange connections for pumps with NPS 2 (DN 50) pipe connections and flanged connections for pumps with NPS 2-1/2 (DN 65) pipe connections.
b. Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
c. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
d. Coupling: Flexible.
e. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
f. Bearings: Oil-lubricated; bronze-journal or ball type.
g. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
3. Motor: Single speed, with grease-lubricated ball bearings; and resiliently **OR** rigidly, **as directed**, mounted to pump casing.

C. Horizontally Mounted, In-Line, Close-Coupled Centrifugal Pumps
1. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted horizontal.
2. Pump Construction:
a. Casing: Radially split with threaded companion-flange connections for pumps with NPS 2 (DN 50) pipe connections and flanged connections for pumps with NPS 2-1/2 (DN 65) pipe connections.
b. Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
c. Shaft and Shaft Sleeve: Steel shaft with deflector, with copper-alloy shaft sleeve. Include water slinger on shaft between motor and seal.
d. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
e. Bearings: Oil-lubricated; bronze-journal or ball type.
f. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
3. Motor: Single speed, with grease-lubricated ball bearings; and resiliently or rigidly mounted to pump casing.

D. Vertically Mounted, In-Line, Close-Coupled Centrifugal Pumps
1. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted vertical.
2. Pump Construction:
a. Casing: Radially split, cast iron, with wear rings and threaded companion-flange connections for pumps with NPS 2 (DN 50) pipe connections and flanged connections for pumps with NPS 2-1/2 (DN 65) pipe connections. Include pump manufacturer's base attachment for mounting pump on concrete base, **as directed**.
b. Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
c. Shaft and Shaft Sleeve: Stainless-steel or steel **OR** Stainless-steel, **as directed**, shaft, with copper-alloy shaft sleeve.
d. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.
e. Bearings: Oil-lubricated; bronze-journal or ball type.
f. Shaft Coupling: Flexible or rigid type if pump is provided with coupling.
3. Motor: Single speed, with grease-lubricated ball bearings; and rigidly mounted to pump casing.

E. Motors

1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements For Plumbing Equipment".
   a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 22.

F. Controls
1. Pressure Switches: Electric, adjustable for control of water-supply pump.
   a. Type: Water-immersion pressure sensor, for installation in piping.
   b. Enclosure: NEMA 250, Type 4X.
   c. Operation of Pump: On or off.
   d. Transformer: Provide if required.
   e. Power Requirement: 24 V, ac **OR** 120 V, ac, **as directed**.
   f. Settings: Start pump at <**Insert pressure**> and stop pump at <**Insert pressure**>.
2. Thermostats: Electric; adjustable for control of hot-water circulation pump.
   a. Type: Water-immersion temperature sensor, for installation in piping.
   b. Range: 50 to 125 deg F (10 to 52 deg C) **OR** 65 to 200 deg F (18 to 93 deg C) **OR** 100 to 240 deg F (38 to 116 deg C), **as directed**.
   c. Enclosure: NEMA 250, Type 4X.
   d. Operation of Pump: On or off.
   e. Transformer: Provide if required.
   f. Power Requirement: 24 V, ac **OR** 120 V, ac, **as directed**.
   g. Settings: Start pump at 105 deg F (41 deg C) **OR** 110 deg F (43 deg C) **OR** 115 deg F (46 deg C), **as directed**, and stop pump at 120 deg F (49 deg C) **OR** 125 deg F (52 deg C), **as directed**.
3. Timers: Electric, for control of hot-water circulation pump.
   a. Type: Programmable, seven-day clock with manual override on-off switch.
   b. Enclosure: NEMA 250, Type 1.suitable for wall mounting.
   c. Operation of Pump: On or off.
   d. Transformer: Provide if required.
   e. Power Requirement: 24 V, ac **OR** 120 V, ac, **as directed**.
   f. Programmable Sequence of Operation: Up to two on-off cycles each day for seven days.
4. Time-Delay Relays: Electric, for control of hot-water circulation pump between water heater and connected hot-water storage tank.
   a. Type: Adjustable time-delay relay.
   b. Range: Up to five minutes.
   c. Setting: Five minutes.
   d. Enclosure: NEMA 250, Type 4X.
   e. Operation of Pump: On or off.
   f. Transformer: Provide if required.
   g. Power Requirement: 24 V, ac **OR** 120 V, ac, **as directed**.
   h. Programmable Sequence of Operation: Limit pump operation to periods of burner operation plus maximum five minutes after the burner stops.

1.3 EXECUTION

A. Examination
1. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

B. Pump Installation
1. Comply with HI 1.4.
2. Install in-line, sealless centrifugal pumps with shaft horizontal unless otherwise indicated.

3. Install horizontally mounted, in-line, separately coupled and close-coupled centrifugal pumps with shaft(s) horizontal.
4. Install vertically mounted, in-line, close-coupled centrifugal pumps with shaft vertical.
5. Pump Mounting: Install vertically mounted, in-line, close-coupled centrifugal pumps with cast-iron base mounted on concrete base using elastomeric pads **OR** elastomeric mounts **OR** restrained spring isolators, **as directed**. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-place Concrete".
    a. Minimum Deflection: 1/4 inch (6 mm) **OR** 1 inch (25 mm), **as directed**.
    b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
    c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
    d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    e. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install continuous-thread hanger rods and spring hangers **OR** spring hangers with vertical-limit stop, **as directed**, of size required to support pump weight.
    a. Comply with requirements for vibration isolation devices specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment". Fabricate brackets or supports as required.
    b. Comply with requirements for hangers and supports specified in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment".
7. Install pressure switches in water supply piping.
8. Install thermostats in hot-water return piping.
9. Install timers on wall in engineer's office, **as directed**.
10. Install time-delay relays in piping between water heaters and hot-water storage tanks.

C. Connections
1. Comply with requirements for piping specified in Division 22 Section "Domestic Water Piping". Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to pumps to allow service and maintenance.
3. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.
    a. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:
        1) Horizontally mounted, in-line, separately coupled centrifugal pumps.
        2) Horizontally mounted, in-line, close-coupled centrifugal pumps.
        3) Vertically mounted, in-line, close-coupled centrifugal pumps.
        4) Comply with requirements for flexible connectors specified in Division 22 Section "Domestic Water Piping".
    b. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for valves specified in Division 22 Section "General-duty Valves For Plumbing Piping" and comply with requirements for strainers specified in Division 22 Section "Domestic Water Piping Specialties".
    c. Install pressure gage and snubber, **as directed**, at suction of each pump and pressure gage and snubber, **as directed**, at discharge of each pump. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Comply with requirements for pressure gages and snubbers specified in Division 22 Section "Meters And Gages For Plumbing Piping".
4. Comply with Division 22 for electrical connections, and wiring methods.
5. Connect pressure switches, thermostats, time-delay relays, and timers to pumps that they control.
6. Interlock pump between water heater and hot-water storage tank with water heater burner and time-delay relay.

D. Identification
   1. Comply with requirements for identification specified in Division 22 Section "Identification For Plumbing Piping And Equipment" for identification of pumps.

E. Startup Service
   1. Engage a factory-authorized service representative to perform **OR** Perform, **as directed**, startup service.
      a. Complete installation and startup checks according to manufacturer's written instructions.
      b. Check piping connections for tightness.
      c. Clean strainers on suction piping.
      d. Set pressure switches, thermostats, timers, and time-delay relays for automatic starting and stopping operation of pumps.
      e. Perform the following startup checks for each pump before starting:
         1) Verify bearing lubrication.
         2) Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
         3) Verify that pump is rotating in the correct direction.
      f. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
      g. Start motor.
      h. Open discharge valve slowly.
      i. Adjust temperature settings on thermostats.
      j. Adjust timer settings.

F. Adjusting
   1. Adjust domestic water pumps to function smoothly, and lubricate as recommended by manufacturer.
   2. Adjust initial temperature set points.
   3. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION 22 11 23 13

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SECTION 22 11 23 13a - PACKAGED BOOSTER PUMPS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for packaged booster pumps. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Simplex, constant-speed booster pumps.
      b. Multiplex, constant-speed booster pumps.
      c. Simplex, variable-speed booster pumps.
      d. Multiplex, variable-speed booster pumps.

C. Definitions
   1. VFC: Variable-frequency controller(s).

D. Performance Requirements
   1. Seismic Performance: Booster pumps shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
      a. The term "withstand" means "the booster pump will remain in place without separation of any parts from the booster pump when subjected to the seismic forces specified and the booster pump will be fully operational after the seismic event."

E. Submittals
   1. Product Data: For each type of product indicated. Include construction details, material descriptions, and dimensions of individual components and profiles **OR** Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories, **as directed**.
   2. Shop Drawings: For booster pumps. Include plans, elevations, sections, details, and attachments to other work.
      a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      b. Wiring Diagrams: For power, signal, and control wiring.
   3. Seismic Qualification Certificates: For booster pumps, accessories, and components, from manufacturer.
      a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
      c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
   4. Operation and Maintenance Data: For booster pumps to include in emergency, operation, and maintenance manuals.

F. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. ASME Compliance: Comply with ASME B31.9 for piping.
   3. UL Compliance for Packaged Pumping Systems:
      a. UL 508, "Industrial Control Equipment."

b. UL 508A, "Industrial Control Panels."
c. UL 778, "Motor-Operated Water Pumps."
d. UL 1995, "Heating and Cooling Equipment."

4. Booster pumps shall be listed and labeled as packaged pumping systems by testing agency acceptable to authorities having jurisdiction.

G. Delivery, Storage, And Handling
1. Retain protective coatings and flange's protective covers during storage.

H. Coordination
1. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.2 PRODUCTS

A. Simplex, Constant-Speed Booster Pumps
1. Description: Factory-assembled and -tested, fluid-handling system for domestic water, with pump, piping, valves, specialties, and controls, and mounted on base.
2. Pump:
   a. Type: End suction as defined in HI 1.1-1.2 and HI 1.3 for end-suction, close-coupled, single-stage, overhung-impeller, centrifugal pump.
   b. Casing: Radially split; bronze **OR** cast iron **OR** stainless steel, **as directed**.
   c. Impeller: Closed, ASTM B 584 cast bronze **OR** stainless steel, **s directed**; statically and dynamically balanced and keyed to shaft.
   d. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve and deflector.
   e. Seal: Mechanical.
   f. Orientation: Mounted horizontally or vertically.
3. Motor: Single speed, with grease-lubricated or pre-greased, permanently shielded, ball-type bearings, and directly mounted to pump casing. Select motor that will not overload through full range of pump performance curve.
4. Piping: Copper tube and copper fittings **OR** Stainless-steel pipe and fittings **OR** Stainless-steel pipe and fitting headers and copper tube and copper fittings between headers and pump **OR** Galvanized-steel pipe and cast-iron fittings, **as directed**.
5. Valves:
   a. Shutoff Valves NPS 2 (DN 50) and smaller: Gate valve or two-piece, full-port ball valve, in pump suction and discharge piping.
   b. Shutoff Valves NPS 2-1/2 (DN 65) and Larger: Gate valve or lug-type butterfly valve, in pump suction and discharge piping.
   c. Check Valve NPS 2 (DN 50) and smaller: Silent or swing type in pump discharge piping.
   d. Check Valve NPS 2-1/2 (DN 65) and Larger: Silent type in pump discharge piping.
   e. Control Valve: Adjustable, automatic, pilot-operated or direct-acting, pressure-reducing type in pump discharge piping.
   f. Control Valve: Combination adjustable, automatic, pilot-operated or direct-acting pressure-reducing-and-check type in pump discharge piping.
   g. Thermal-Relief Valve: Temperature-and-pressure relief type in pump discharge piping.
6. Dielectric Fittings: With insulating material isolating joined dissimilar metals.
7. Hydropneumatic Tank: Precharged, ASME-construction, **as directed**, diaphragm or bladder tank made of materials complying with NSF 61.
8. Control Panel: Factory installed and connected as an integral part of booster pump; automatic for single-pump, constant-speed operation, with load control and protection functions.
   a. Control Logic: Electromechanical system with switches, relays **OR** Solid-state system with transducers, programmable microprocessor, **as directed**, and other devices in the controller.

b. Motor Controller: NEMA ICS 2, general-purpose, Class A, full-voltage, combination-magnetic type with undervoltage release feature, motor-circuit-protector-type disconnect, and short-circuit protective device.
   1) Control Voltage: 24 **OR** 120, **as directed**,-V ac, with integral control-power transformer.
c. Motor Controller: NEMA ICS 2, solid-state, reduced-voltage type.
   1) Control Voltage: 24 **OR** 120, **as directed**,-V ac, with integral control-power transformer.
d. Enclosure: NEMA 250, Type 1 **OR** Type 3R **OR** Type 4 **OR** Type 12, **as directed**.
e. Motor Overload Protection: Overload relay in each phase.
f. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
g. Pump Operation: Current- or pressure- sensing method.
   1) Time Delay: Controls pump on-off operation; adjustable from 1 to 300 seconds.
h. Instrumentation: Suction and discharge pressure gages.
i. Light: Running light for pump.
j. Thermal-bleed cutoff.
k. Low-suction-pressure **OR** Water-storage-tank, low-level, **as directed**, cutout.
l. High-suction-pressure cutout.
m. Low-discharge-pressure cutout.
n. High-discharge-pressure cutout.
o. Building Automation System Interface: Provide auxiliary contacts for interface to BACnet **OR** LonWorks, **as directed**, building automation system. Building automation systems are specified in Division 23 Section "Instrumentation And Control For Hvac". Include the following:
   1) On-off status of pump.
   2) Alarm status.

9. Base: Structural steel.

B. Multiplex, Constant-Speed Booster Pumps
1. Description: Factory-assembled and -tested, fluid-handling system for domestic water, with pumps, piping, valves, specialties, and controls, and mounted on base.
2. Pumps:
   a. Type: End suction as defined in HI 1.1-1.2 and HI 1.3 for end-suction, close-coupled, single-stage, overhung-impeller, centrifugal pump.
   b. Casing: Radially split; bronze **OR** cast iron **OR** stainless steel, **as directed**.
   c. Impeller: Closed, ASTM B 584 cast bronze **OR** stainless steel, **as directed**; statically and dynamically balanced and keyed to shaft.
   d. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve and deflector.
   e. Seal: Mechanical.
   f. Orientation: Mounted horizontally or vertically.

   OR

   Pumps:
   a. Type: End suction as defined in HI 1.1-1.2 and HI 1.3 for end-suction, frame-mounted, separately coupled, single-stage, overhung-impeller, centrifugal pump. Include back-pullout design, **as directed**.
   b. Casing: Radially split; bronze **OR** cast iron **OR** stainless steel, **as directed**.
   c. Impeller: Closed, ASTM B 584 cast bronze **OR** stainless steel, **as directed**; statically and dynamically balanced and keyed to shaft.
   d. Shaft and Shaft Sleeve: Stainless-steel or steel, **as directed**, shaft, with copper-alloy shaft sleeve and deflector.
   e. Seal: Mechanical.
   f. Bearing: Grease-lubricated or pre-greased, permanently shielded ball type.
   g. Coupling: Flexible, with metal guard.

   OR

   Pumps:

a. Type: In line, single stage as defined in HI 1.1-1.2 and HI 1.3 for in-line, single-stage, close-coupled, overhung-impeller, centrifugal pump.
b. Casing: Radially split; bronze **OR** cast iron **OR** stainless steel, **as directed**.
c. Impeller: Closed, ASTM B 584 cast bronze **OR** stainless steel, **as directed**; statically and dynamically balanced and keyed to shaft.
d. Shaft and Shaft Sleeve: Stainless-steel or steel, **as directed**, shaft, with copper-alloy shaft sleeve.
e. Seal: Mechanical.
f. Bearing: Grease-lubricated or pre-greased, permanently shielded ball type.

OR

Pumps:

a. Type: Vertical, multistage as defined in HI 1.1-1.2 and HI 1.3 for in-line, multistage, separately coupled, overhung-impeller, centrifugal pump.
b. Casing: Cast-iron or steel base and stainless-steel chamber.
c. Impeller: Closed, stainless steel; statically and dynamically balanced and keyed to shaft.
d. Shaft: Stainless steel.
e. Seal: Mechanical.
f. Bearing: Water-lubricated sleeve type.

OR

Pumps:

a. Type: Vertical, can, as defined in HI 2.1-2.2 and HI 2.3 for in-line, barrel or can, lineshaft, vertical pump.
b. Impeller: Closed, stainless steel; statically and dynamically balanced and keyed to shaft.
c. Bowls: Epoxy-coated cast iron **OR** Cast iron, **as directed**.
d. Shaft: Stainless steel.
e. Seals: Mechanical and stuffing-box types.
f. Bearings: Water-lubricated bushing type.

3. Motors: Single speed, with grease-lubricated or pre-greased, permanently shielded, ball-type bearings. Select motors that will not overload through full range of pump performance curve.
4. Piping: Copper tube and copper fittings **OR** Stainless-steel pipe and fittings **OR** Stainless-steel pipe and fitting headers and copper tube and copper fittings between headers and pump **OR** Galvanized-steel pipe and cast-iron fittings, **as directed**.
5. Valves:
   a. Shutoff Valves NPS 2 (DN 50) and smaller: Gate valve or two-piece, full-port ball valve, in each pump's suction and discharge piping.
   b. Shutoff Valves NPS 2-1/2 (DN 65) and Larger: Gate valve or lug-type butterfly valve, in each pump's suction and discharge piping and in inlet and outlet headers, **as directed**.
   c. Check Valves NPS 2 (DN 50) and smaller: Silent or swing type in each pump's discharge piping.
   d. Check Valves NPS 2-1/2 (DN 65) and Larger: Silent type in each pump's discharge piping.
   e. Control Valves: Adjustable, automatic, pilot-operated or direct-acting, pressure-reducing type in each pump's discharge piping.
   f. Control Valves: Combination adjustable, automatic, pilot-operated or direct-acting pressure-reducing-and-check type in each pump's discharge piping.
   g. Thermal-Relief Valve: Temperature-and-pressure relief type in pump's discharge header piping.
6. Dielectric Fittings: With insulating material isolating joined dissimilar metals.
7. Control Panel: Factory installed and connected as an integral part of booster pump; automatic for multiple-pump, constant-speed operation, with load control and protection functions.
   a. Control Logic: Electromechanical system with switches, relays **OR** Solid-state system with transducers, programmable microprocessor, **as directed**, and other devices in the controller.
   b. Motor Controller: NEMA ICS 2, general-purpose, Class A, full-voltage, combination-magnetic type with undervoltage release feature, motor-circuit-protector-type disconnect, and short-circuit protective device.

1) Control Voltage: 24 **OR** 120, **as directed**,-V ac, with integral control-power transformer.

c. Motor Controller: NEMA ICS 2, solid-state, reduced-voltage type.

1) Control Voltage: 24 **OR** 120, **as directed**,-V ac, with integral control-power transformer.

d. Enclosure: NEMA 250, Type 1 **OR** Type 3R **OR** Type 4 **OR** Type 12, **as directed**.

e. Motor Overload Protection: Overload relay in each phase.

f. Starting Devices: Hand-off-automatic selector switch for each pump in cover of control panel, plus pilot device for automatic control.

1) Duplex, Automatic, Alternating Starter: Switches lead pump to lag main pump and to two-pump operation.

2) Triplex, Sequence (Lead-Lag-Lag) Starter: Switches lead pump to one lag main pump and to three-pump operation.

g. Pump Operation and Sequencing: Current- or pressure- sensing method.

1) Time Delay: Controls pump on-off operation; adjustable from 1 to 300 seconds.

h. Instrumentation: Suction and discharge pressure gages.

i. Lights: Running light for each pump.

j. Alarm Signal Device: Sounds alarm when backup pumps are operating.

1) Time Delay: Controls alarm operation; adjustable from 1 to 300 seconds, with automatic **OR** manual, **as directed**, reset.

k. Thermal-bleed cutoff.

l. Low-suction-pressure **OR** Water-storage-tank, low-level, **as directed**, cutout.

m. High-suction-pressure cutout.

n. Low-discharge-pressure cutout.

o. High-discharge-pressure cutout.

p. Building Automation System Interface: Provide auxiliary contacts for interface to BACnet **OR** LonWorks, **as directed**, building automation system. Building automation systems are specified in Division 23 Section "Instrumentation And Control For Hvac". Include the following:

1) On-off status of each pump.

2) Alarm status.

8. Base: Structural steel.

C. Simplex, Variable-Speed Booster Pumps

1. Description: Factory-assembled and -tested, fluid-handling system for domestic water, with pump, piping, valves, specialties, and controls, and mounted on base.

2. Pump:

a. Type: End suction as defined in HI 1.1-1.2 and HI 1.3 for end-suction, close-coupled, single-stage, overhung-impeller, centrifugal pump.

b. Casing: Radially split; bronze **OR** cast iron **OR** stainless steel, **as directed**.

c. Impeller: Closed, ASTM B 584 cast bronze **OR** stainless steel, **as directed**; statically and dynamically balanced and keyed to shaft.

d. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve and deflector.

e. Seal: Mechanical.

f. Orientation: Mounted horizontally or vertically.

3. Motor: Single speed, with grease-lubricated or pre-greased, permanently shielded, ball-type bearings, and directly mounted to pump casing. Select motor that will not overload through full range of pump performance curve.

4. Piping: Copper tube and copper fittings **OR** Stainless-steel pipe and fittings **OR** Stainless-steel pipe and fitting headers and copper tube and copper fittings between headers and pump **OR** Galvanized-steel pipe and cast-iron fittings, **as directed**.

5. Valves:

a. Shutoff Valves NPS 2 (DN 50) and Smaller: Gate valve or two-piece, full-port ball valve, in pump suction and discharge piping.

b. Shutoff Valves NPS 2-1/2 (DN 65) and Larger: Gate valve or lug-type butterfly valve, in pump suction and discharge piping.

c. Check Valve NPS 2 (DN 50) and Smaller: Silent or swing type in pump discharge piping.
d. Check Valve NPS 2-1/2 (DN 65) and Larger: Silent type in pump discharge piping.
e. Thermal-Relief Valve: Temperature-and-pressure relief type in pump discharge piping.

6. Dielectric Fittings: With insulating material isolating joined dissimilar metals.
7. Hydropneumatic Tank: Precharged, ASME-construction, **as directed**, diaphragm or bladder tank made of materials complying with NSF 61.
8. Control Panel: Factory installed and connected as an integral part of booster pump; automatic for single-pump, variable-speed operation, with load control and protection functions.
   a. Control Logic: Solid-state system with transducers, programmable microprocessor, VFC, and other devices in the controller.
   b. Motor Controller: NEMA ICS 2, variable-frequency, solid-state type.
      1) Control Voltage: 24 **OR** 120, **as directed**,-V ac, with integral control-power transformer.
   c. Enclosure: NEMA 250, Type 1 **OR** Type 3R **OR** Type 4 **OR** Type 12, **as directed**.
   d. Motor Overload Protection: Overload relay in each phase.
   e. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
   f. Pump Operation: Pressure-sensing method.
      1) Time Delay: Controls pump on-off operation; adjustable from 1 to 300 seconds.
   g. VFC: Voltage-source, pulse-width, modulating-frequency converter; installed in control panel.
   h. Manual Bypass: Magnetic contactor arranged to transfer to constant-speed operation upon VFC failure.
   i. Instrumentation: Suction and discharge pressure gages.
   j. Light: Running light for pump.
   k. Thermal-bleed cutoff.
   l. Low-suction-pressure **OR** Water-storage-tank, low-level, **as directed**, cutout.
   m. High-suction-pressure cutout.
   n. Low-discharge-pressure cutout.
   o. High-discharge-pressure cutout.
   p. Building Automation System Interface: Provide auxiliary contacts for interface to BACnet **OR** LonWorks, **as directed**, building automation system. Building automation systems are specified in Division 23 Section "Instrumentation And Control For Hvac". Include the following:
      1) On-off status of each pump.
      2) Alarm status.
9. Base: Structural steel.

D. Multiplex, Variable-Speed Booster Pumps
1. Description: Factory-assembled and -tested, fluid-handling system for domestic water, with pumps, piping, valves, specialties, and controls, and mounted on base.
2. Pumps:
   a. Type: End suction as defined in HI 1.1-1.2 and HI 1.3 for end-suction, close-coupled, single-stage, overhung-impeller, centrifugal pump.
   b. Casing: Radially split; bronze **OR** cast iron **OR** stainless steel, **as directed**.
   c. Impeller: Closed, ASTM B 584 cast bronze **OR** stainless steel, **as directed**; statically and dynamically balanced and keyed to shaft.
   d. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve and deflector.
   e. Seal: Mechanical.
   f. Orientation: Mounted horizontally or vertically.
3. Pumps:
   a. Type: End suction as defined in HI 1.1-1.2 and HI 1.3 for end-suction, frame-mounted, separately coupled, single-stage, overhung-impeller, centrifugal pump. Include back-pullout design, **as directed**.
   b. Casing: Radially split; bronze **OR** cast iron **OR** stainless steel, **as directed**.

c. Impeller: Closed, ASTM B 584 cast bronze **OR** stainless steel, **as directed**; statically and dynamically balanced and keyed to shaft.
d. Shaft and Shaft Sleeve: Stainless-steel or steel, **as directed**, shaft, with copper-alloy shaft sleeve and deflector.
e. Seal: Mechanical.
f. Bearing: Grease-lubricated or pre-greased, permanently shielded ball type.
g. Coupling: Flexible, with metal guard.

4. Pumps:
   a. Type: In line, single stage as defined in HI 1.1-1.2 and HI 1.3 for in-line, single-stage, close-coupled, overhung-impeller, centrifugal pump.
   b. Casing: Radially split; bronze **OR** cast iron **OR** stainless steel, **as directed**.
   c. Impeller: Closed, ASTM B 584 cast bronze **OR** stainless steel, **as directed**; statically and dynamically balanced and keyed to shaft.
   d. Shaft and Shaft Sleeve: Stainless-steel or steel, **as directed**, shaft, with copper-alloy shaft sleeve.
   e. Seal: Mechanical.
   f. Bearing: Grease-lubricated or pre-greased, permanently shielded ball type.
5. Pumps:
   a. Type: Vertical, multistage as defined in HI 1.1-1.2 and HI 1.3 for in-line, multistage, separately coupled, overhung-impeller, centrifugal pump.
   b. Casing: Cast-iron or steel base and stainless-steel chamber.
   c. Impeller: Closed, stainless steel; statically and dynamically balanced and keyed to shaft.
   d. Shaft: Stainless steel.
   e. Seal: Mechanical.
   f. Bearing: Water-lubricated sleeve type.
6. Pumps:
   a. Type: Vertical, can, as defined in HI 2.1-2.2 and HI 2.3 for in-line, barrel or can, lineshaft, vertical pump.
   b. Impeller: Closed, stainless steel; statically and dynamically balanced and keyed to shaft.
   c. Bowls: Epoxy-coated cast iron **OR** Cast iron, **as directed**.
   d. Shaft: Stainless steel.
   e. Seals: Mechanical and stuffing-box types.
   f. Bearings: Water-lubricated bushing type.
7. Motors: Single speed, with grease-lubricated or pre-greased, permanently shielded, ball-type bearings. Select motors that will not overload through full range of pump performance curve.
8. Piping: Copper tube and copper fittings **OR** Stainless-steel pipe and fittings **OR** Stainless-steel pipe and fitting headers and copper tube and copper fittings between headers and pump **OR** Galvanized-steel pipe and cast-iron fittings, **as directed**.
9. Valves:
   a. Shutoff Valves NPS 2 (DN 50) and Smaller: Gate valve or two-piece, full-port ball valve, in each pump's suction and discharge piping.
   b. Shutoff Valves NPS 2-1/2 (DN 65) and Larger: Gate valve or lug-type butterfly valve, in each pump's suction and discharge piping and in inlet and outlet headers, **as directed**.
   c. Check Valves NPS 2 (DN 50) and Smaller: Silent or swing type in each pump's discharge piping.
   d. Check Valves NPS 2-1/2 (DN 65) and Larger: Silent type in each pump's discharge piping.
   e. Thermal-Relief Valve: Temperature-and-pressure relief type in pump's discharge header piping.
10. Dielectric Fittings: With insulating material isolating joined dissimilar metals.
11. Control Panel: Factory installed and connected as an integral part of booster pump; automatic for multiple-pump, variable-speed operation, with load control and protection functions.
    a. Control Logic: Solid-state system with transducers, programmable microprocessor, VFC, and other devices in controller. Install VFC for pump motors larger than 25 hp in separate panel; same type as motor control panel enclosure.
    b. Motor Controller: NEMA ICS 2, variable-frequency, solid-state type.

1) Control Voltage: 24 **OR** 120, **as directed**,-V ac, with integral control-power transformer.

c. Enclosure: NEMA 250, Type 1 **OR** Type 3R **OR** Type 4 **OR** Type 12, **as directed**.

d. Motor Overload Protection: Overload relay in each phase.

e. Starting Devices: Hand-off-automatic selector switch for each pump in cover of control panel, plus pilot device for automatic control.

1) Duplex, Automatic, Alternating Starter: Switches lead pump to lag main pump and to two-pump operation.

2) Triplex, Sequence (Lead-Lag-Lag) Starter: Switches lead pump to one lag main pump and to three-pump operation.

f. Pump Operation and Sequencing: Pressure-sensing method or flow-sensing method **OR** Pressure-sensing method for lead pump and flow-sensing method for lag pumps, **as directed**.

1) Time Delay: Controls pump on-off operation; adjustable from 1 to 300 seconds.

g. VFC: Voltage-source, pulse-width, modulating-frequency converter for each **OR** lead, **as directed**, pump.

h. Manual Bypass: Magnetic contactor arranged to transfer to constant-speed operation upon VFC failure.

i. Instrumentation: Suction and discharge pressure gages.

j. Lights: Running light for each pump.

k. Alarm Signal Device: Sounds alarm when backup pumps are operating.

1) Time Delay: Controls alarm operation; adjustable from 1 to 300 seconds, with automatic **OR** manual, **as directed**, reset.

l. Thermal-bleed cutoff.

m. Low-suction-pressure **OR** Water-storage-tank, low-level, **as directed**, cutout.

n. High-suction-pressure cutout.

o. Low-discharge-pressure cutout.

p. High-discharge-pressure cutout.

q. Building Automation System Interface: Provide auxiliary contacts for interface to BACnet **OR** LonWorks, **as directed**, building automation system. Building automation systems are specified in Division 23 Section "Instrumentation And Control For Hvac". Include the following:

1) On-off status of each pump.

2) Alarm status.

12. Base: Structural steel.

E. Motors

1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.

a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in NFPA 70.

1.3 EXECUTION

A. Examination

1. Examine roughing-in for booster pumps to verify actual locations of piping connections before booster-pump installation.

B. Installation

1. Equipment Mounting: Install booster pumps on concrete base using elastomeric pads **OR** elastomeric mounts **OR** restrained spring isolators, **as directed**. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-place Concrete", **as directed**.

a. Minimum Deflection: 1/4 inch (6 mm) **OR** 1 inch (25 mm), **as directed**.
b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
e. Install anchor bolts to elevations required for proper attachment to supported equipment.

2. Equipment Mounting: Install booster pumps using elastomeric pads **OR** elastomeric mounts **OR** restrained spring isolators, **as directed**. Comply with requirements for vibration isolation devices specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".
   a. Minimum Deflection: 1/4 inch (6 mm) **OR** 1 inch (25 mm), **as directed**.
3. Support connected domestic-water piping so weight of piping is not supported by booster pumps.

C. Connections
1. Comply with requirements for piping specified in Division 22 Section "Domestic Water Piping". Drawings indicate general arrangement of piping, fittings, and specialties.
2. Connect domestic-water piping to booster pumps. Install suction and discharge pipe equal to or greater than size of system suction and discharge headers **OR** piping, **as directed**.
   a. Install shutoff valves on piping connections to booster-pump suction and discharge headers **OR** piping, **as directed**. Install ball, butterfly, or gate valves same size as suction and discharge headers **OR** piping, **as directed**. Comply with requirements for general-duty valves specified in Division 22 Section "General-duty Valves For Plumbing Piping".
   b. Install union, flanged, or grooved-joint connections on suction and discharge headers **OR** piping, **as directed**, at connection to domestic-water piping. Comply with requirements for unions and flanges specified in Division 22 Section "Domestic Water Piping".
   c. Install valved bypass, same size as and between piping, at connections to booster-pump suction and discharge headers **OR** piping, **as directed**. Comply with requirements for domestic-water piping specified in Division 22 Section "Domestic Water Piping".
   d. Install flexible connectors, same size as piping, on piping connections to booster-pump suction and discharge headers **OR** piping, **as directed**. Comply with requirements for flexible connectors specified in Division 22 Section "Domestic Water Piping".
   e. Install piping adjacent to booster pumps to allow service and maintenance.

D. Identification
1. Identify system components. Comply with requirements for identification specified in Division 22 Section "Identification For Plumbing Piping And Equipment".

E. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
   a. Perform visual and mechanical inspection.
   b. Leak Test: After installation, charge booster pump and test for leaks. Repair leaks and retest until no leaks exist.
   c. Operational Test: After electrical circuitry has been energized, start booster pumps to confirm proper motor rotation and booster-pump operation.
   d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Pumps and controls will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

F. Startup Service
1. Perform startup service.
   a. Complete installation and startup checks according to manufacturer's written instructions.

G. Adjusting
1. Adjust booster pumps to function smoothly, and lubricate as recommended by manufacturer.
2. Adjust pressure set points.
3. Occupancy Adjustments: When requested within 12 months of date of Final Completion, provide on-site assistance in adjusting booster pump to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

H. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain booster pumps.

END OF SECTION 22 11 23 13a

SECTION 22 11 23 23 - WATER SUPPLY WELLS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for water supply wells. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Cable-tool, Rotary drilled, Reverse-rotary drilled, and Driven water supply wells.
b. Jet, Line-shaft, and Submersible well pumps.

C. Definitions
1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. PA: Polyamide (nylon) plastic.
3. PE: Polyethylene plastic.
4. PP: Polypropylene plastic.
5. PVC: Polyvinyl chloride plastic.

D. Submittals
1. Product Data: Submit certified performance curves and rated capacities of selected well pumps and furnished specialties for each type and size of well pump indicated.
2. Shop Drawings: Show layout and connections for well pumps.
a. Wiring Diagrams: Power, signal, and control wiring.
3. Field quality-control reports.
4. Operation and maintenance data.

E. Quality Assurance
1. Well Driller Qualifications: An experienced water supply well driller licensed in the jurisdiction where Project is located.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
3. Comply with AWWA A100 for water supply wells.

F. Project Conditions
1. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
a. Notify the Owner no fewer than seven days in advance of proposed interruption of water service.
b. Do not proceed with interruption of water service without the Owner's written permission.
2. Well Drilling Water: Provide temporary water and piping for drilling purposes. Provide necessary piping for water supply.

1.2 PRODUCTS

A. Well Casings
1. Steel Casing: AWWA C200, single ply, steel pipe with threaded ends and threaded couplings for threaded joints.

2. ABS Casing: ASTM F 480, ABS, Schedule 40 **OR** 80, **as directed**, bell-and-spigot pipe and couplings for solvent-cemented joints.
3. PVC Casing: ASTM F 480 and NSF 14, **as directed**, PVC, Schedule 40 **OR** 80, **as directed**, bell-and-spigot pipe and couplings for solvent-cemented joints. Include NSF listing mark "NSF wc," **as directed**.
4. Pitless Adapter: Fitting, of shape required to fit onto casing, with waterproof seals.
5. Pitless Unit: Factory-assembled equipment that includes pitless adapter.
6. Well Seals: Casing cap, with holes for piping and cables, that fits into top of casing and is removable, waterproof, and vermin proof.

B. Grout
1. Cement: ASTM C 150, Type II.
2. Aggregates: ASTM C 33, fine and coarse grades.
3. Water: Potable.

C. Water Well Screens
1. Screen Material: Fabricated of ASTM A 666, Type 304 stainless steel, welded; with continuous-slot, V-shaped openings that widen inwardly **OR** tube; with slotted or perforated surface and designed for well-screen applications, **as directed**.
   a. Screen Couplings: Butt-type, stainless-steel coupling rings.
   b. Screen Fittings: Screen, with necessary fittings, closes bottom and makes tight seal between top of screen and well casing.
   c. Maximum Entering Velocity: 0.1 fps (0.03 m/s).

D. Pack Materials
1. Coarse, uniformly graded filter sand, maximum 1/8 inch (3 mm) in diameter.
2. Fine gravel, maximum 1/4 inch (6 mm) in diameter.

E. Jet-Type Well Pumps
1. Description: Shallow **OR** Deep, **as directed**,-well-design, jet well pump; self-priming; centrifugal pump capable of continuous operation; with the following features:
   a. Housing: Cast iron.
   b. Impeller: Single stage **OR** Multistage, **as directed**, centrifugal; fabricated of corrosion-resistant materials.
   c. Seals: Mechanical.
   d. Shaft: Stainless steel.
   e. Motor: Manufacturer's standard, NEMA MG 1 motor, panel, and accessories.
   f. Motor Controls: Electronic; variable speed.
   g. Check valve, ejector, and pressure-control valve.
2. Pump Accessories:
   a. Compression Tanks: Comply with requirements in Division 22 Section "Facility Indoor Potable-water Storage Tanks" **OR** Precharged butyl rubber diaphragm, steel shell, fused polymeric lining, and 100-psig (690-kPa) working pressure, **as directed**.
   b. Pressure Switches: For pump control; for installation in piping.
   c. Water Piping: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with threaded ends.
      1) Cast-Iron Fittings: ASME B16.4, threaded, galvanized.
   d. Water Piping: ASTM D 2239, SIDR Numbers 5.3, 7, or 9 PE pipe; made with PE compound number required to give pressure rating not less than 160 psig (1100 kPa) **OR** 200 psig (1380 kPa), **as directed**. Include NSF listing mark "NSF pw."
      1) Fittings for PE Pipe: ASTM D 2609, made of PA, PP, or PVC with serrated, male insert ends matching inside of pipe. Include bands or crimp rings.

F. Line-Shaft Well Pumps
1. Description: Line-shaft, water **OR** oil, **as directed**,-lubricated, vertical-turbine well pump complying with HI 2.1-2.2 and HI 2.3; with the following features:

a. Impeller Material: Stainless steel **OR** Carbon steel **OR** Bronze, **as directed**.
b. Motor: Full-voltage starting, vertical hollow- or solid-shaft, squirrel-cage induction type complying with ANSI C50.10.
c. Pump Base: Cast iron or fabricated steel.
d. Column Pipe: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with threaded ends and cast-iron or steel threaded couplings.

G. Submersible Well Pumps
1. Description: Submersible, vertical-turbine well pump complying with HI 2.1-2.2 and HI 2.3; with the following features:
a. Impeller Material: Stainless steel **OR** Silicon bronze, **as directed**.
b. Motor: Capable of continuous operation under water, with protected submersible power cable.
c. Column Pipe: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with threaded ends and cast-iron or steel threaded couplings.
d. Discharge Piping: ASTM D 2239, SIDR Numbers 5.3, 7, or 9 PE pipe; made with PE compound number required to give pressure rating not less than 160 psig (1100 kPa) **OR** 200 psig (1380 kPa), **as directed**. Include NSF listing mark "NSF pw."
1) Insert Fittings for PE Pipe: ASTM D 2609, made of PA, PP, or PVC with serrated, male insert ends matching inside of pipe. Include bands or crimp rings.

H. Motors
1. General requirements for motors are specified in Division 22 Section "Common Motor Requirements For Plumbing Equipment".
a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
b. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 22.

1.3 EXECUTION

A. Preparation
1. Pilot-Hole Data: Review pilot-hole test analysis furnished by the Owner.
2. Neighborhood Well Data: Review operating and test analyses.

B. Installation
1. Construct well using cable-tool **OR** rotary drilling **OR** reverse-rotary drilling **OR** driven, **as directed**, method.
2. Take samples of substrata formation at 10-foot (3-m) intervals and at changes in formation throughout entire depth of each water supply well. Carefully preserve samples on-site in glass jars properly labeled for identification.
3. If selecting rotary drilled or reverse-rotary drilled method, excavate for mud pit or provide aboveground structure, acceptable to authorities having jurisdiction, to allow settlement of cuttings and circulation of drill fluids back to well without discharging to on-site waterways.
4. Enlarge pilot hole and install permanent casing, screen, and grout. Install first section of casing with hardened steel driving shoe of an OD slightly larger than casing couplings if threaded couplings are used.
5. Set casing and liners round, plumb, and true to line.
6. Join casing pipe as follows:
a. Ream ends of pipe and remove burrs.
b. Remove scale, slag, dirt, and debris from inside and outside casing before installation.
c. Cut bevel in ends of steel casing pipe and make threaded joints.
d. Clean and make solvent-cemented joints for ABS and PVC casings.
7. If rotary drilled or reverse-rotary drilled well, mix grout in proportions of 1 cu. ft. (0.03 cu. m) or a 94-lb (42.6-kg) sack of cement with 5 to 6 gal. (19 to 23 L) of water. Bentonite clay may be added

in amounts of 3 to 5 lb/cu. ft. (1.4 to 2.3 kg/0.03 cu. m) for a 94-lb (42.6-kg) sack of cement. If bentonite clay is added, water may be increased to 6.5 gal./cu. ft. (25 L/0.03 cu. m) of cement.

8. If rotary drilled or reverse-rotary drilled well, place grout continuously, from bottom to top surface, to ensure filling of annular space in one operation. Do not perform other operations in well within 72 hours after grouting of casing. When quick-setting cement is used, this period may be reduced to 24 hours.
9. Provide permanent casing with temporary well cap. Install with top of casing 36 inches (910 mm) above finished grade, **as directed**.
10. Develop wells to maximum yield per foot (meter) of drawdown.
    a. Extract maximum practical quantity of sand, drill fluid, and other fine materials from water-bearing formation.
    b. Avoid settlement and disturbance of strata above water-bearing formation.
    c. Do not disturb sealing around well casings.
    d. Continue developing wells until water contains no more than 2 ppm of sand by weight when pumped at maximum testing rate.
11. Install jet well pumps with ejector in or attached to pump housing. Place check valve on suction line to prevent drainage of compression tank.
12. Install jet well pumps and pressure and suction lines. Install ejector where pressure and suction lines connect above well screen. Install check valve in suction line, or install foot valve below ejector, to prevent drainage of compression tank.
13. Install line-shaft **OR** submersible, **as directed**, well pumps according to HI 2.1-2.4 and provide access for periodic maintenance.
    a. Before lowering permanent pump into well, lower a dummy pump that is slightly longer and wider than permanent pump to determine that permanent pump can be installed. Correct alignment problems.
    b. Before lowering permanent pump into well, start pump to verify correct rotation.
    c. Securely tighten discharge piping joints.
    d. Locate line-shaft well pump near well bottom; locate motor above grade. Install driver plate to correctly align motor and pump.
    e. Connect motor to submersible pump and locate near well bottom.
        1) Connect power cable while connection points are dry and undamaged.
        2) Do not damage power cable during installation; use cable clamps that do not have sharp edges.
        3) Install water-sealed surface plate that will support pump and piping.

C. Connections
1. Piping installation requirements are specified in Division 22 Section "Facility Water Distribution Piping". Drawings indicate general arrangement of piping, fittings, and specialties.
    a. Connect piping between well pump and water piping.
    b. Connect water distribution system in trench to well pipe at pitless adapter **OR** unit, **as directed**.
    c. Connect building water distribution to well pipe inside well house.
2. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
3. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

D. Well Abandonment
1. Comply with AWWA A100 when abandoning water supply wells. Fill and seal holes and casings and restore ground surface to finished grade.
   OR
   Follow well-abandonment procedures of authorities having jurisdiction. Restore ground surface to finished grade.

E. Field Quality Control

1. Plumbness and Alignment Testing: Comply with AWWA A100.
2. Furnish samples of water-bearing formation to testing laboratory and well-screen manufacturer for mechanical sieve analysis.
3. Prepare reports on static level of ground water, level of water for various pumping rates, and depth to water-bearing strata.
4. Performance Testing: Conduct final pumping tests after wells have been constructed, cleaned, and tested for plumbness and alignment.
   a. Provide discharge piping to conduct water to locations where disposal will not create a nuisance or endanger adjacent property. Comply with requirements of authorities having jurisdiction.
   b. Measure elevation to water level in wells.
   c. Perform two bailer or air-ejection tests to determine expected yield. Test at depths with sufficient quantity of water to satisfy desired yields.
   d. Test Pump: Variable capacity test pump with capacity equal to maximum expected yields at pressure equal to drawdown in wells, plus losses in pump columns and discharge pipes.
   e. Start and adjust test pumps and equipment to required pumping rates.
   f. Record readings of water levels in wells and pumping rates at 30-minute maximum intervals throughout 24-hour minimum period.
   g. Record maximum yields when drawdown is 60 inches (1500 mm) above top of suction screens after designated times.
   h. Operate pumping units continuously for eight hours after maximum drawdown is reached.
   i. Record returning water levels in wells and plot curves of well recovery rates.
   j. Remove sand, stones, and other foreign materials that may become deposited in wells after completing final tests.
5. Water Analysis Testing:
   a. Engage] a qualified testing agency to make bacteriological, physical, and chemical analyses of water from each finished well and report the results. Make analyses according to requirements of authorities having jurisdiction.
      OR
      Analyze water sample from each finished well for bacteriological, physical, and chemical quality and report the results. Make analyses according to requirements of authorities having jurisdiction.

F. Cleaning
1. Disinfect water supply wells according to AWWA A100 and AWWA C654 before testing well pumps.
   OR
   Follow water supply well disinfection procedures required by authorities having jurisdiction before testing well pumps.

G. Protection
1. Water Quality Protection: Prevent well contamination, including undesirable physical and chemical characteristics.
2. Ensure that mud pit will not leak or overflow into streams or wetlands. When well is accepted, remove mud and solids in mud pit from Project site and restore site to finished grade.
3. Provide casings, seals, sterilizing agents, and other materials to eliminate contamination; shut off contaminated water.
4. Exercise care to prevent breakdown or collapse of strata overlaying that from which water is to be drawn.
5. Protect water supply wells to prevent tampering and introducing foreign matter. Retain temporary well cap until installation is complete.

END OF SECTION 22 11 23 23

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SECTION 22 11 23 23a - HYDRONIC PUMPS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for hydronic pumps. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes the following:
   a. Close-coupled, in-line centrifugal pumps.
   b. Close-coupled, end-suction centrifugal pumps.
   c. Separately coupled, horizontal, in-line centrifugal pumps.
   d. Separately coupled, vertical, in-line centrifugal pumps.
   e. Separately coupled, base-mounted, end-suction centrifugal pumps.
   f. Separately coupled, base-mounted, double-suction centrifugal pumps.
   g. Separately coupled, vertical-mounted, double-suction centrifugal pumps.
   h. Separately coupled, vertical-mounted, turbine centrifugal pumps.
   i. Automatic condensate pump units.

C. Definitions

1. Buna-N: Nitrile rubber.
2. EPT: Ethylene propylene terpolymer.

D. Submittals

1. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
2. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
   a. Wiring Diagrams: Power, signal, and control wiring.
3. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

E. Quality Assurance

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. UL Compliance: Comply with UL 778 for motor-operated water pumps.

F. Delivery, Storage, And Handling

1. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
2. Store pumps in dry location.
3. Retain protective covers for flanges and protective coatings during storage.
4. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
5. Comply with pump manufacturer's written rigging instructions.

1.2 PRODUCTS

A. Close-Coupled, In-Line Centrifugal Pumps
1. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically. Rate pump for 125-psig (860-kPa) **OR** 175-psig (1204-kPa) **OR** 250-psig (1720-kPa), **as directed**, minimum working pressure and a continuous water temperature of 200 deg F (93 deg C) **OR** 225 deg F (107 deg C) **OR** 250 deg F (121 deg C), **as directed**.
2. Pump Construction:
   a. Casing: Radially split, cast iron, with replaceable bronze wear rings, **as directed**, threaded gage tappings at inlet and outlet, and threaded companion-flange **OR** union end, **as directed**, connections.
   b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
   c. Pump Shaft: Steel, with copper-alloy shaft sleeve **OR** Stainless steel**, as directed**.
   d. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N **OR** EPT, **as directed**, bellows and gasket. Include water slinger on shaft between motor and seal.
   e. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
   f. Pump Bearings: Permanently lubricated ball bearings **OR** Oil lubricated; bronze-journal or thrust type, **as directed**.
3. Motor: Single speed, with permanently lubricated **OR** grease-lubricated, **as directed**, ball bearings, unless otherwise indicated; and rigidly mounted to pump casing. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".

B. Close-Coupled, End-Suction Centrifugal Pumps
1. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally. Rate pump for 125-psig (860-kPa) **OR** 175-psig (1204-kPa), **as directed**, minimum working pressure and a continuous water temperature of 225 deg F (107 deg C) **OR** 250 deg F (121 deg C), **as directed**.
2. Pump Construction:
   a. Casing: Radially split, cast iron, with replaceable bronze wear rings, **as directed**, drain plug at bottom and air vent at top of volute, threaded gage tappings at inlet and outlet, and threaded companion-flange **OR** flanged, **as directed**, connections.
   b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
   c. Pump Shaft: Steel, with copper-alloy shaft sleeve **OR** Stainless steel, **as directed**.
   d. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N **OR** EPT, **as directed**, bellows and gasket. Include water slinger on shaft between motor and seal.
   e. Pump Bearings: Permanently lubricated ball bearings **OR** Oil lubricated; bronze-journal or thrust type, **as directed**.
   f. Motor: Single speed, with permanently lubricated **OR** grease-lubricated, **as directed**, ball bearings, unless otherwise indicated; rigidly mounted to pump casing with integral pump support. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".

C. Separately Coupled, Horizontal, In-Line Centrifugal Pumps
1. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally. Rate pump for 125-psig (860-kPa) **OR** 175-psig (1204-kPa), **as**

directed, minimum working pressure and a continuous water temperature of 225 deg F (107 deg C) **OR** 250 deg F (121 deg C), **as directed**.

2. Pump Construction:
   a. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and threaded companion-flange **OR** union end, **as directed**, connections.
   b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. Trim impeller to match specified performance.
   c. Pump Shaft: Steel, with copper-alloy shaft sleeve **OR** Stainless steel, **as directed**.
   d. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N **OR** EPT, **as directed**, bellows and gasket. Include water slinger on shaft between motor and seal.
   e. Pump Bearings: Permanently lubricated ball bearings **OR** Oil lubricated; bronze-journal or thrust type, **as directed**.
3. Shaft Coupling: Molded rubber insert with interlocking spider **OR** Interlocking frame with interconnecting springs, **as directed**, capable of absorbing vibration.
4. Motor: Single speed, with permanently lubricated ball **OR** oil-lubricated sleeve, **as directed**, bearings, unless otherwise indicated; and resiliently **OR** rigidly, **as directed**, mounted to pump casing. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".

D. Separately Coupled, Vertical, In-Line Centrifugal Pumps
1. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted vertically. Rate pump for 125-psig (860-kPa) **OR** 175-psig (1204-kPa) **OR** 250-psig (1720-kPa), **as directed**, minimum working pressure and a continuous water temperature of 200 deg F (93 deg C) **OR** 225 deg F (107 deg C) **OR** 250 deg F (121 deg C), **as directed**.
2. Pump Construction:
   a. Casing: Radially split, cast iron, with replaceable bronze wear rings, **as directed**, threaded gage tappings at inlet and outlet, and threaded companion-flange **OR** union end, **as directed**, connections.
   b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
   c. Pump Shaft: Steel, with copper-alloy shaft sleeve **OR** Stainless steel, **as directed**.
   d. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N **OR** EPT, **as directed**, bellows and gasket. Include water slinger on shaft between motor and seal.
   e. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
   f. Pump Bearings: Permanently lubricated ball bearings **OR** Oil lubricated; bronze-journal or thrust type, **as directed**.
3. Shaft Coupling: Axially split spacer coupling.
4. Motor: Single speed, with permanently lubricated **OR** grease-lubricated, **as directed**, ball bearings, unless otherwise indicated; rigidly mounted to pump casing with lifting eye and supporting lugs in motor enclosure. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".

E. Separately Coupled, Base-Mounted, End-Suction Centrifugal Pumps
1. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Rate pump for 125-psig (860-kPa) **OR** 175-psig (1204-kPa) **OR** 250-psig (1720-kPa), **as directed**, minimum working pressure and a continuous water temperature of 200 deg F (93 deg C) **OR** 225 deg F (107 deg C) **OR** 250 deg F (121 deg C), **as directed**.
2. Pump Construction:
   a. Casing: Radially split, cast iron, with replaceable bronze wear rings, **as directed**, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and threaded companion-flange **OR** flanged, **as directed**, connections. Provide integral mount

on volute to support the casing, and attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft, **as directed**.

b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
c. Pump Shaft: Steel, with copper-alloy shaft sleeve **OR** Stainless steel, **as directed**.
d. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N **OR** EPT, **as directed**, bellows and gasket.
e. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
f. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.

3. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor **OR** EPDM coupling sleeve for variable-speed applications, **as directed**.
4. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
5. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.
6. Motor: Single speed, with permanently lubricated **OR** grease-lubricated, **as directed**, ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".

F. Separately Coupled, Base-Mounted, Double-Suction Centrifugal Pumps

1. Description: Factory-assembled and -tested, centrifugal, impeller-between-bearings, separately coupled, double-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Rate pump for 125-psig (860-kPa) **OR** 175-psig (1204-kPa) **OR** 250-psig (1720-kPa), **as directed**, minimum working pressure and a continuous water temperature of 200 deg F (93 deg C) **OR** 225 deg F (107 deg C) **OR** 250 deg F (121 deg C), **as directed**.
2. Pump Construction:
   a. Casing: Radially **OR** Horizontally, **as directed**, split, cast iron, with replaceable bronze wear rings, **as directed**, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and ASME B16.1, Class 125 **OR** 250, **as directed**, flanges. Casing supports shall allow removal and replacement of impeller without disconnecting piping, **as directed**.
   b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. Trim impeller to match specified performance.
   c. Pump Shaft: Stainless steel.
   d. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N **OR** EPT, **as directed**, bellows and gasket.
   e. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
   f. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.
3. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor **OR** EPDM coupling sleeve for variable-speed applications, **as directed**.
4. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
5. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

6. Motor: Single speed, with grease-lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".

G. Separately Coupled, Vertical-Mounted, Double-Suction Centrifugal Pumps
1. Description: Factory-assembled and -tested, centrifugal, impeller-between-bearings, separately coupled, double-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted vertically. Rate pump for 125-psig (860-kPa) **OR** 175-psig (1204-kPa) **OR** 250-psig (1720-kPa), **as directed**, minimum working pressure and a continuous water temperature of 200 deg F (93 deg C) **OR** 225 deg F (107 deg C) **OR** 250 deg F (121 deg C), **as directed**.
2. Pump Construction:
   a. Casing: Radially split, cast iron, with replaceable bronze wear rings, **as directed**, threaded gage tappings at inlet and outlet, drain plug at bottom of volute, mounting support, and ASME B16.1, Class 125 **OR** 250, **as directed**, flanges.
   b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. Trim impeller to match specified performance.
   c. Pump Shaft: Stainless steel.
   d. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N **OR** EPT, **as directed**, bellows and gasket.
   e. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
   f. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.
3. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration.
4. Motor: Single speed, with grease-lubricated ball bearings, unless otherwise indicated; secured to casing. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".

H. Separately Coupled, Vertical-Mounted, Turbine Centrifugal Pumps
1. Description: Factory-assembled and -tested, single-stage **OR** multistage, **as directed**, centrifugal, impeller-between-bearings, end-suction pump as defined in HI 2.1-2.2 and HI 2.3; designed for installation with pump and motor shafts mounted vertically and projecting into a sump. Rate pump for 125-psig (860-kPa) **OR** 175-psig (1204-kPa), **as directed**, minimum working pressure and a continuous water temperature of 200 deg F (93 deg C).
2. Pump Construction:
   a. Pump Bowl: Cast iron, with replaceable bronze wear ring, **as directed**, cone **OR** basket, **as directed**, strainer, and suction bell. Water passages of intermediate bowls shall be coated with porcelain enamel, **as directed**.
   b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. Trim impeller to match specified performance.
   c. Pump Shaft: Carbon **OR** Stainless, **as directed**, steel sized per AWWA E-101.
   d. Pump Bearings: Water-lubricated bronze and rubber sleeve bearings contained in cast-iron housing.
   e. Pump Column: ASTM A 53/A 53M, Grade B steel pipe.
   f. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Seal shall be replaceable without removing the motor or disturbing the piping.
   g. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
3. Shaft Coupling: Keyed with locking collets.
4. Discharge Head: ASME B16.1, Class 125 **OR** 250, **as directed**, discharge flange with threaded gage tapping. Top of discharge head shall have a registered fit to accurately locate the driver.
5. Drive Ratchet: Nonreversing ratchet.

6. Hollow Shaft Motor: Single speed, with grease-lubricated ball bearings, unless otherwise indicated; secured to discharge head. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".

I. Automatic Condensate Pump Units
 1. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include factory- or field-installed check valve and a 72-inch- (1800-mm-) minimum, electrical power cord with plug.

J. Pump Specialty Fittings
 1. Suction Diffuser: Angle pattern, 175-psig (1204-kPa) **OR** 300-psig (2060-kPa), **as directed**, pressure rating, cast **OR** ductile, **as directed**,-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.
 2. Triple-Duty Valve: Angle or straight pattern, 175-psig (1204-kPa) **OR** 300-psig (2060-kPa), **as directed**, pressure rating, cast **OR** ductile, **as directed**,-iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features. Brass gage ports with integral check valve, and orifice for flow measurement.

1.3 EXECUTION

A. Concrete Bases
 1. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Division 23 Section "Common Work Results For Hvac"
  a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
  b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  d. Install anchor bolts to elevations required for proper attachment to supported equipment.
 2. Cast-in-place concrete materials and placement requirements are specified in Division 31.

B. Pump Installation
 1. Comply with HI 1.4 **OR** HI 2.4, **as directed**.
 2. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
 3. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
 4. Install continuous-thread hanger rods and elastomeric hangers **OR** spring hangers **OR** spring hangers with vertical-limit stop, **as directed**, of sufficient size to support pump weight. Vibration isolation devices are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment". Fabricate brackets or supports as required. Hanger and support materials are specified in Division 23 Section "Hangers And Supports For Hvac Piping And Equipment".
 5. Suspend vertically mounted, in-line centrifugal pumps independent of piping. Install pumps with motor and pump shafts vertical. Use continuous-thread hanger rods and elastomeric hangers **OR** spring hangers **OR** spring hangers with vertical-limit stop, **as directed**, of sufficient size to support pump weight. Vibration isolation devices are specified in Division 21 Section(s) "Vibration And Seismic Controls For Fire-suppression Piping And Equipment" AND Division 23 Section(s) "Vibration And Seismic Controls For Hvac Piping And Equipment". Hanger and support materials are specified in Division 22 Section(s) "Hangers And Supports For Plumbing Piping And Equipment" AND Division 23 Section(s) "Hangers And Supports For Hvac Piping And Equipment".

6. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.
   a. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches (19 to 38 mm) between pump base and foundation for grouting.
   b. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.
7. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

C. Alignment
1. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.
2. Comply with pump and coupling manufacturers' written instructions.
3. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation" **OR** HI 2.1-2.5, "Vertical Pumps for Nomenclature, Definitions, Application and Operation",**as directed**.
4. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

D. Connections
1. Piping installation requirements are specified in other Division 21. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to machine to allow service and maintenance.
3. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
4. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
5. Install check valve and throttling **OR** triple-duty, **as directed**, valve on discharge side of pumps.
6. Install Y-type strainer **OR** suction diffuser, **as directed**, and shutoff valve on suction side of pumps.
7. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
8. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.
9. Install check valve and gate or ball valve on each condensate pump unit discharge.
10. Install electrical connections for power, controls, and devices.
11. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
12. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

END OF SECTION 22 11 23 23a

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Task	Specification	Specification Description
22 11 23 23	21 05 23 00	Piped Utilities Basic Materials And Methods

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SECTION 22 12 23 13 - ELECTRIC, DOMESTIC WATER HEATERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for electric, water heaters. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following electric water heaters:
   a. Household, small-capacity electric water heaters.
   b. Household, storage electric water heaters.
   c. Household, collector-to-tank, solar-electric water heaters.
   d. Household, collector-to-tank, heat-exchanger-coil, solar-electric water heaters.
   e. Flow-control, instantaneous electric water heaters.
   f. Thermostat-control, instantaneous electric water heaters.
   g. Light-commercial electric water heaters.
   h. Commercial electric booster heaters.
   i. Commercial, storage electric water heaters.
   j. Compression tanks.
   k. Water heater accessories.

C. Submittals
1. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
2. LEED Submittal:
   a. Product Data for Prerequisite EA 2: Documentation indicating that units comply with ASHRAE/IESNA 90.1, Section 7 - "Service Water Heating."
3. Shop Drawings: Diagram power, signal, and control wiring.
4. Manufacturer Seismic Qualification Certification: Submit certification that commercial water heaters, accessories, and components will withstand seismic forces defined in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".
5. Field quality-control test reports.
6. Operation and maintenance data.
7. Warranty: Special warranty specified in this Section.

D. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
3. ASME Compliance: Where indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
4. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for all components that will be in contact with potable water.

E. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric water heaters that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Structural failures including storage tank and supports.

2) Faulty operation of controls.
3) Deterioration of metals, metal finishes, and other materials beyond normal use.

b. Warranty Period(s): From date of Final Completion:
1) Household Electric Water Heaters:
a) Storage Tank: Five **OR** Six **OR** 10, **as directed**, years.
b) Controls and Other Components: Two **OR** Three, **as directed**, years.
2) Instantaneous Electric Water Heaters: One **OR** Two **OR** Five, **as directed**, year(s).
3) Light-Commercial Electric Water Heaters:
a) Storage Tank: Three **OR** Five, **as directed**, years.
b) Controls and Other Components: Two **OR** Three, **as directed**, years.
4) Commercial Electric Water Heaters:
a) Storage Tank: Three **OR** Five, **as directed**, years.
b) Controls and Other Components: Three **OR** Five, **as directed**, years.
5) Compression Tanks: One year.

1.2 PRODUCTS

A. Household Electric Water Heaters

1. Household, Small-Capacity Electric Water Heaters: Comply with UL 174.

a. Storage-Tank Construction: Corrosion-resistant metal or steel with corrosion-resistant coating, **as directed**.
1) Tappings: ASME B1.20.1 pipe thread.
2) Pressure Rating: 150 psig (1035 kPa).
3) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.

b. Factory-Installed Storage-Tank Appurtenances:
1) Drain Valve: ASSE 1005, if tank has drain outlet. Provide hose-end drain valve in piping for water heaters without drain outlet. Hose-end drain valves are specified in Division 22 Section "Domestic Water Piping Specialties".
2) Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2, **as directed**.
3) Jacket: Steel with enameled finish.
4) Heating Element: Electric, screw-in immersion type.
5) Temperature Control: Adjustable thermostat.
6) Safety Control: High-temperature-limit cutoff device or system.
7) Power Supply Cord: 24 to 72 inches (610 to 1830 mm) with plug.
8) Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 for combination temperature and pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.

2. Household, Standard **OR** Tabletop, **as directed**, Storage Electric Water Heaters: Comply with UL 174.

a. Storage-Tank Construction: Steel.
1) Tappings: ASME B1.20.1 pipe thread.
2) Pressure Rating: 150 psig (1035 kPa).
3) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.

b. Factory-Installed Storage-Tank Appurtenances:
1) Anode Rod: Replaceable magnesium.
2) Dip Tube: Provide unless cold-water inlet is near bottom of tank.
3) Drain Valve: ASSE 1005.
4) Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2, **as directed**.
5) Jacket: Steel with enameled finish.
a) Standard: Cylindrical shape.

b) Tabletop: Rectangular shape, with flat-top work surface and raised back.
6) Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
7) Heating Elements: Two; electric, screw-in immersion type with 12 kW or less total, and wired for nonsimultaneous operation, unless otherwise indicated.
8) Temperature Control: Adjustable thermostat for each element.
9) Safety Control: High-temperature-limit cutoff device or system.
10) Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 for combination temperature and pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.

3. Household, Collector-to-Tank, Solar-Electric Water Heaters: Comply with UL 174 with piping and electrical connections for UL 1279 solar collector system.
   a. Storage-Tank Construction: Steel.
      1) Tappings: ASME B1.20.1 pipe thread.
      2) Pressure Rating: 150 psig (1035 kPa).
      3) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
   b. Factory-Installed Storage-Tank Appurtenances:
      1) Sensor electrical connections and tank stud for sensor.
      2) Anode Rod: Replaceable magnesium.
      3) Dip Tube: Provide unless cold-water inlet is near bottom of tank.
      4) Drain Valve: ASSE 1005.
      5) Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2, **as directed**.
      6) Jacket: Steel with enameled finish.
      7) Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
      8) Heating Element: One; electric, screw-in immersion type with 6 kW or less.
      9) Temperature Control: Adjustable thermostat for each element.
      10) Safety Control: High-temperature-limit cutoff device or system.
      11) Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 for combination temperature and pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.

4. Household, Collector-to-Tank, Heat-Exchanger-Coil, Solar-Electric Water Heaters: Comply with UL 174 with integral coil-type heat exchanger.
   a. Storage-Tank Construction: Steel.
      1) Tappings: ASME B1.20.1 pipe thread.
      2) Pressure Rating: 150 psig (1035 kPa).
      3) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
   b. Factory-Installed Storage-Tank Appurtenances:
      1) Anode Rod: Replaceable magnesium.
      2) Dip Tube: Provide unless cold-water inlet is near bottom of tank.
      3) Drain Valve: ASSE 1005.
      4) Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2, **as directed**.
      5) Jacket: Steel with enameled finish.
      6) Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
      7) Heat Exchanger: Corrosion-resistant-metal immersion coil.
      8) Heating Element: One; electric, screw-in immersion type with 6 kW or less.
      9) Temperature Control: Adjustable thermostat for each element.
      10) Safety Control: High-temperature-limit cutoff device or system.
      11) Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 for combination temperature and pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater

working-pressure rating. Select relief valve with sensing element that extends into storage tank.

B. Instantaneous Electric Water Heaters
1. Flow-Control, Instantaneous Electric Water Heaters: Comply with UL 499 for tankless electric (water heater) heating appliance.
a. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
1) Connections: ASME B1.20.1 pipe thread.
2) Pressure Rating: 150 psig (1035 kPa).
3) Heating Element: Resistance heating system.
4) Temperature Control: Flow-control fitting.
5) Safety Control: High-temperature-limit cutoff device or system.
6) Jacket: Aluminum or steel with enameled finish or plastic.
b. Support: Bracket for wall mounting.
2. Thermostat-Control, Instantaneous Electric Water Heaters: Comply with UL 499 for tankless electric (water heater) heating appliance.
a. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
1) Connections: ASME B1.20.1 pipe thread.
2) Pressure Rating: 150 psig (1035 kPa).
3) Heating Element: Resistance heating system.
4) Temperature Control: Thermostat.
5) Safety Control: High-temperature-limit cutoff device or system.
6) Jacket: Aluminum or steel with enameled finish or plastic.
b. Support: Bracket for wall mounting.

C. Light-Commercial Electric Water Heaters
1. Description: Comply with UL 174 for household, storage electric water heaters.
a. Storage-Tank Construction: Steel, vertical arrangement.
1) Tappings: ASME B1.20.1 pipe thread.
2) Pressure Rating: 150 psig (1035 kPa).
3) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
b. Factory-Installed Storage-Tank Appurtenances:
1) Anode Rod: Replaceable magnesium.
2) Dip Tube: Provide unless cold-water inlet is near bottom of tank.
3) Drain Valve: ASSE 1005.
4) Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2, **as directed**.
5) Jacket: Steel with enameled finish.
6) Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
7) Heating Elements: Two; electric, screw-in immersion type; wired for simultaneous operation, unless otherwise indicated.
8) Temperature Control: Adjustable thermostat for each element.
9) Safety Control: High-temperature-limit cutoff device or system.
10) Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 for combination temperature and pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
c. Special Requirements: NSF 5 construction with legs for off-floor installation.

D. Commercial Electric Water Heaters
1. Commercial Electric Booster Heaters: Comply with UL 1453 requirements for booster-type water heaters.

a. Storage-Tank Construction: Corrosion-resistant metal **OR** Steel, **as directed**.
   1) Tappings: ASME B1.20.1 pipe thread.
   2) Pressure Rating: 150 psig (1035 kPa).
   3) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
b. Factory-Installed Storage-Tank Appurtenances:
   1) Anode Rod: Replaceable magnesium.
   2) Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
   3) Insulation: Comply with ASHRAE/IESNA 90.1.
   4) Jacket: Rectangular shaped, with stainless-steel front panel, unless otherwise indicated.
   5) Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
      a) Option: Booster heaters with 9 kW or less total may have 2 or 3 elements.
      b) Staging: Input not exceeding 18 kW per step.
   6) Temperature Control: Adjustable thermostat, to setting of at least 180 deg F (82 deg C).
   7) Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
   8) Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3, combination temperature and pressure relief valve. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
   9) Gages: Combination temperature and pressure type or separate thermometer and pressure gage.
c. Special Requirements: NSF 5 construction with brackets for undercounter **OR** legs for floor, **as directed**, installation.

2. Commercial, Storage Electric Water Heaters: Comply with UL 1453 requirements for storage-tank-type water heaters.
   a. Storage-Tank Construction: ASME-code **OR** Non-ASME-code, **as directed**, steel horizontal **OR** vertical, **as directed**, arrangement.
      1) Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
         a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
         b) NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
      2) Pressure Rating: 150 psig (1035 kPa).
      3) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
   b. Factory-Installed Storage-Tank Appurtenances:
      1) Anode Rod: Replaceable magnesium.
      2) Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
      3) Insulation: Comply with ASHRAE/IESNA 90.1.
      4) Jacket: Steel with enameled finish.
      5) Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
         a) Staging: Input not exceeding 18 kW per step.
      6) Temperature Control: Adjustable thermostat.
      7) Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
      8) Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
   c. Special Requirements: NSF 5 construction.

d. Building Automation System Interface: Normally closed dry contacts for enabling and disabling water heater.

E. Compression Tanks
1. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
   a. Construction:
      1) Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1, pipe thread.
      2) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
      3) Air-Charging Valve: Factory installed.

F. Water Heater Accessories
1. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
2. Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include pressure setting less than water heater working-pressure rating.
3. Water Heater Stand and Drain-Pan Units: High-density-polyethylene-plastic, 18-inch- (457-mm-) high, enclosed-base stand complying with IAPMO PS 103 and IAS No. 2. Include integral or separate drain pan with raised edge and NPS 1 (DN 25) drain outlet with ASME B1.20.1 pipe thread.
4. Water Heater Stands: Water heater manufacturer's factory-fabricated steel stand for floor mounting and capable of supporting water heater and water. Include dimension that will support bottom of water heater a minimum of 18 inches (457 mm) above the floor.
5. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated steel bracket for wall mounting and capable of supporting water heater and water.
6. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of water heater and include drain outlet not less than NPS 3/4 (DN 20).
7. Piping Manifold Kits: Water heater manufacturer's factory-fabricated inlet and outlet piping arrangement for multiple-unit installation. Include piping and valves for field assembly that are capable of isolating each water heater and of providing balanced flow through each water heater.
8. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2, **as directed**.
9. Water Regulators: ASSE 1003, water-pressure reducing valve. Set at 25-psig- (172.5-kPa-) maximum outlet pressure, unless otherwise indicated.
10. Shock Absorbers: ASSE 1010 or PDI WH 201, Size A water hammer arrester.

G. Source Quality Control
1. Test and inspect water heater storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
2. Hydrostatically test commercial, **as directed**, water heater storage tanks before shipment to minimum of one and one-half times pressure rating.
3. Prepare test reports.

1.3 EXECUTION

A. Water Heater Installation
1. Install commercial water heaters on concrete bases.
   a. Exception: Omit concrete bases for commercial water heaters if installation on stand, bracket, suspended platform, or direct on floor is indicated.

b. Concrete base construction requirements are specified in Division 22 Section "Common Work Results For Plumbing".
2. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
3. Install seismic restraints for light-commercial and commercial water heaters. Anchor to substrate.
4. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
5. Install combination temperature and pressure relief valves in water piping for water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
6. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 Section "Domestic Water Piping Specialties" for hose-end drain valves.
7. Install thermometer on outlet piping of water heaters. Refer to Division 22 Section "Meters And Gages For Plumbing Piping" for thermometers.
8. Install thermometers on inlet and outlet piping of household, collector-to-tank, solar-electric water heaters. Refer to Division 22 Section "Meters And Gages For Plumbing Piping" for thermometers.
9. Install pressure gage(s) on inlet and outlet of commercial electric water- heater piping. Refer to Division 22 Section "Meters And Gages For Plumbing Piping" for pressure gages.
10. Assemble and install inlet and outlet piping manifold kits for multiple water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each water heater. Include shutoff valve, thermometer in each water heater inlet and outlet, and throttling valve in each water heater outlet. Refer to Division 22 Section "General-duty Valves For Plumbing Piping" for general-duty valves and to Division 22 Section "Meters And Gages For Plumbing Piping" for thermometers.
11. Install water regulator, with integral bypass relief valve, in booster-heater inlet piping and water hammer arrester in booster-heater outlet piping.
12. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.
13. Fill water heaters with water.
14. Charge compression tanks with air.

B. Connections
1. Piping installation requirements are specified in other Division 14. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.
3. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
4. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Field Quality Control
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
2. Perform the following field tests and inspections and prepare test reports:
a. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
b. Operational Test: After electrical circuitry has been energized, confirm proper operation.
c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

D. Demonstration
   1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial and instantaneous electric water heaters.

END OF SECTION 22 12 23 13

SECTION 22 12 23 13a - FUEL-FIRED, DOMESTIC WATER HEATERS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for fuel-fired water heaters. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following fuel-fired water heaters:
      a. Household, atmospheric, storage, gas water heaters.
      b. Household, direct-vent, storage, gas water heaters.
      c. Household, power-vent, storage, gas water heaters.
      d. Instantaneous, tankless, gas water heaters.
      e. Commercial, atmospheric, storage, gas water heaters.
      f. Commercial, power-burner, storage, gas water heaters.
      g. Commercial, power-vent, storage, gas water heaters.
      h. Commercial, high-efficiency, gas water heaters.
      i. Commercial, coil-type, finned-tube, gas water heaters.
      j. Commercial, grid-type, finned-tube, gas water heaters.
      k. Household, oil-fired water heaters.
      l. Commercial, oil-fired water heaters.
      m. Large-capacity, oil-fired water heaters.
      n. Dual-fuel, gas and oil-fired water heaters.
      o. Compression tanks.
      p. Water heater accessories.

C. Definitions
   1. LP Gas: Liquefied-petroleum fuel gas.

D. Submittals
   1. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
   2. LEED Submittal:
      a. Product Data for Prerequisite EA 2: Documentation indicating that units comply with ASHRAE/IESNA 90.1, Section 7 - "Service Water Heating."
   3. Shop Drawings: Diagram power, signal, and control wiring.
   4. Manufacturer Seismic Qualification Certification: Submit certification that commercial water heaters, accessories, and components will withstand seismic forces defined in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment". Include the following:
   5. Field quality-control test reports.
   6. Operation and maintenance data.
   7. Warranty: Special warranty specified in this Section.

E. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   2. ASHRAE/IESNA 90.1Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
   3. ASME Compliance:

a. Where ASME-code construction is indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

b. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

4. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9" for all components that will be in contact with potable water.

F. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired water heaters that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Structural failures including storage tank and supports.
      2) Faulty operation of controls.
      3) Deterioration of metals, metal finishes, and other materials beyond normal use.
   b. Warranty Period(s): From date of Final Completion:
      1) Household, Gas Water Heaters:
         a) Storage Tank: Five **OR** Six **OR** 10, **as directed**, years.
         b) Controls and Other Components: Two **OR** Three, **as directed**, years.
      2) Instantaneous, Gas Water Heaters:
         a) Heat Exchanger: Five years.
         b) Controls and Other Components: Three years.
      3) Commercial, Gas Water Heaters:
         a) Storage Tank: Three **OR** Five, **as directed**, years.
         b) Controls and Other Components: Three **OR** Five, **as directed**, years.
      4) Oil-Fired Water Heaters:
         a) Storage Tank: Three **OR** Five, **as directed**, years.
         b) Burner and Controls: One **OR** Two **OR** Three, **as directed**, year(s).
         c) Other Components: Three **OR** Five, **as directed**, years.
      5) Dual-Fuel Water Heaters:
         a) Storage Tank: Three **OR** Five, **as directed**, years.
         b) Burner and Controls: One **OR** Two **OR** Three, **as directed**, year(s).
         c) Other Components: Three **OR** Five, **as directed**, years.
      6) Compression Tanks: One year.

1.2 PRODUCTS

A. Household, Gas Water Heaters

1. Household, Atmospheric, Storage, Gas Water Heaters: Comply with ANSI Z21.10.1/CSA 4.1.
   a. Storage-Tank Construction: Steel.
      1) Tappings: ASME B1.20.1 pipe thread.
      2) Pressure Rating: 150 psig (1035 kPa).
      3) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
   b. Factory-Installed, Storage-Tank Appurtenances:
      1) Anode Rod: Replaceable magnesium.
      2) Dip Tube: Provide unless cold-water inlet is near bottom of tank.
      3) Drain Valve: ASSE 1005.
      4) Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2, **as directed**.
      5) Jacket: Steel with enameled finish.
      6) Burner: For use with atmospheric water heaters and for natural-gas **OR** LP-gas, **as directed**, fuel.
      7) Automatic Ignition: ANSI Z21.20, electric, automatic, gas-ignition system.

8) Temperature Control: Adjustable thermostat.
9) Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
10) Combination Temperature and Pressure Relief Valve: ANSI Z21.22/CSA 4.4. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.

c. Draft Hood: Low-profile-type, draft diverter; complying with ANSI Z21.12.
d. Automatic Damper: ANSI Z21.66, electrically operated **OR** mechanically activated **OR** thermally activated, **as directed**, automatic-vent-damper device with size matching draft hood.

2. Household, Direct-Vent, Storage, Gas Water Heaters: Comply with ANSI Z21.10.1/CSA 4.1.
a. Storage-Tank Construction: Steel.
1) Tappings: ASME B1.20.1 pipe thread.
2) Pressure Rating: 150 psig (1035 kPa).
3) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.

b. Factory-Installed, Storage-Tank Appurtenances:
1) Anode Rod: Replaceable magnesium.
2) Dip Tube: Provide unless cold-water inlet is near bottom of tank.
3) Drain Valve: ASSE 1005.
4) Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2, **as directed**.
5) Jacket: Steel with enameled finish.
6) Burner: For use with direct-vent water heaters and for natural-gas **OR** LP-gas, **as directed**, fuel.
7) Automatic Ignition: ANSI Z21.20, electric, automatic, gas-ignition system.
8) Temperature Control: Adjustable thermostat.
9) Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
10) Combination Temperature and Pressure Relief Valve: ANSI Z21.22/CSA 4.4. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.

c. Direct-Vent System: Through-wall **OR** Through-roof, **as directed**, coaxial- or double-channel, vent assembly with water heater manufacturers' outside intake/exhaust screen.

3. Household, Power-Vent, Storage, Gas Water Heaters: Comply with ANSI Z21.10.1/CSA 4.1.
a. Storage-Tank Construction: Steel.
1) Tappings: ASME B1.20.1 pipe thread.
2) Pressure Rating: 150 psig (1035 kPa).
3) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.

b. Factory-Installed, Storage-Tank Appurtenances:
1) Anode Rod: Replaceable magnesium.
2) Dip Tube: Provide unless cold-water inlet is near bottom of tank.
3) Drain Valve: ASSE 1005.
4) Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2, **as directed**.
5) Jacket: Steel with enameled finish.
6) Burner: For use with power-vent water heaters and for natural-gas **OR** LP-gas, **as directed**, fuel.
7) Automatic Ignition: ANSI Z21.20, electric, automatic, gas-ignition system.
8) Temperature Control: Adjustable thermostat.
9) Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
10) Combination Temperature and Pressure Relief Valve: ANSI Z21.22/CSA 4.4. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.

c. Power-Vent System: Exhaust fan, interlocked with burner.

B. Instantaneous, Gas Water Heaters
1. Description: Comply with ANSI Z21.10.3/CSA 4.3, except storage is not required.
a. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
1) Tappings: ASME B1.20.1 pipe thread.
2) Pressure Rating: 150 psig (1035 kPa).
3) Heat Exchanger: Copper tubing.
4) Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2, **as directed**.
5) Burner: For use with tankless water heaters and for natural-gas **OR** LP-gas, **as directed**, fuel.
6) Automatic Ignition: Manufacturer's proprietary system for automatic, gas ignition.
7) Temperature Control: Adjustable thermostat.
8) Jacket: Metal with enameled finish or plastic.
b. Support: Bracket for wall mounting.

C. Commercial, Gas Water Heaters
1. Commercial, Atmospheric, Storage, Gas Water Heaters: Comply with ANSI Z21.10.3/CSA 4.3.
a. Storage-Tank Construction: ASME-code **OR** Non-ASME-code, **as directed**, steel with 150-psig (1035-kPa) working-pressure rating.
1) Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
b) NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
2) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
3) Lining: Cement **OR** Glass **OR** Nickel plate **OR** Phenolic coating **OR** Sheet copper, **as directed**, complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
b. Factory-Installed, Storage-Tank Appurtenances:
1) Anode Rod: Replaceable magnesium.
2) Dip Tube: Provide unless cold-water inlet is near bottom of tank.
3) Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
4) Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
5) Jacket: Steel with enameled finish.
6) Burner: For use with atmospheric water heaters and for natural-gas **OR** LP-gas, **as directed**, fuel.
7) Automatic Ignition: ANSI Z21.20, electric, automatic, gas-ignition system.
8) Temperature Control: Adjustable thermostat.
9) Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
10) Combination Temperature and Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
c. Special Requirements: NSF 5 construction.
d. Draft Hood: Draft diverter; complying with ANSI Z21.12.
e. Automatic Damper: ANSI Z21.66, electrically operated **OR** mechanically activated **OR** thermally activated, **as directed**, automatic-vent-damper device with size matching draft hood.
f. Building Automation System Interface: Normally closed dry contacts for enabling and disabling water heater.
2. Commercial, Power-Burner, Storage, Gas Water Heaters: Comply with ANSI Z21.10.3/CSA 4.3.

a. Storage-Tank Construction: ASME-code **OR** Non-ASME-code, **as directed**, steel with 150-psig (1035-kPa) working-pressure rating.
   1) Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
      a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
      b) NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
   2) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   3) Lining: Cement **OR** Glass **OR** Nickel plate **OR** Phenolic coating **OR** Sheet copper, **as directed**, complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
b. Factory-Installed, Storage-Tank Appurtenances:
   1) Anode Rod: Replaceable magnesium.
   2) Dip Tube: Provide unless cold-water inlet is near bottom of tank.
   3) Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
   4) Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
   5) Jacket: Steel with enameled finish.
   6) Combination Temperature and Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
c. Burner: Comply with UL 795 for power-burner water heaters and for natural-gas **OR** LP-gas, **as directed**, fuel.
   1) Automatic Ignition: ANSI Z21.20, electric, automatic, gas-ignition system.
d. Temperature Control: Adjustable thermostat.
e. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
f. Special Requirements: NSF 5 construction.
g. Draft Hood: Draft diverter; complying with ANSI Z21.12.
h. Building Automation System Interface: Normally closed dry contacts for enabling and disabling water heater.

3. Commercial, Power-Vent, Storage, Gas Water Heaters: Comply with ANSI Z21.10.3/CSA 4.3.
a. Storage-Tank Construction: ASME-code **OR** Non-ASME-code, **as directed**, steel with 150-psig (1035-kPa) working-pressure rating.
   1) Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
      a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
      b) NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
   2) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   3) Lining: Cement **OR** Glass **OR** Nickel plate **OR** Phenolic coating **OR** Sheet copper, **as directed**, complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
b. Factory-Installed, Storage-Tank Appurtenances:
   1) Anode Rod: Replaceable magnesium.
   2) Dip Tube: Provide unless cold-water inlet is near bottom of tank.
   3) Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
   4) Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
   5) Jacket: Steel with enameled finish.

6) Burner: For use with power-vent water heaters and for natural-gas **OR** LP-gas, **as directed**, fuel.
7) Automatic Ignition: ANSI Z21.20, electric, automatic, gas-ignition system.
8) Temperature Control: Adjustable thermostat.
9) Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
10) Combination Temperature and Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valve with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

c. Special Requirements: NSF 5 construction.
d. Power-Vent System: Exhaust fan, interlocked with burner.
e. Building Automation System Interface: Normally closed dry contacts for enabling and disabling water heater.

4. Commercial, High-Efficiency, Gas Water Heaters: Comply with ANSI Z21.10.3/CSA 4.3.
   a. Description: Manufacturer's proprietary design to provide at least 84 **OR** 85 **OR** 88 **OR** 95, **as directed**, percent combustion efficiency at optimum operating conditions. Following features and attributes may be modified or omitted if water heater otherwise complies with requirements for performance.
   b. Storage-Tank Construction: ASME-code steel with 150-psig (1035-kPa) minimum working-pressure rating.
      1) Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
         a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
         b) NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
      2) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
      3) Lining: Cement **OR** Glass **OR** Nickel plate **OR** Phenolic coating **OR** Sheet copper, **as directed**, complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
   c. Factory-Installed, Storage-Tank Appurtenances:
      1) Anode Rod: Replaceable magnesium.
      2) Dip Tube: Provide unless cold-water inlet is near bottom of tank.
      3) Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
      4) Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
      5) Jacket: Steel with enameled finish.
      6) Combination Temperature and Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
   d. Burner or Heat Exchanger: Comply with UL 795 or approved testing agency requirements for high-efficiency water heaters and for natural-gas **OR** LP-gas, **as directed**, fuel.
   e. Temperature Control: Adjustable thermostat.
   f. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
   g. Building Automation System Interface: Normally closed dry contacts for enabling and disabling water heater.
   h. Draft Hood: Draft diverter; complying with ANSI Z21.12.

5. Commercial, Coil-Type, Finned-Tube, Gas Water Heaters: Comply with ANSI Z21.13 for hot-water boilers.
   a. Description: Packaged unit with boiler, storage tank, pump, piping, and controls.

b. Boiler Construction: ASME code with 160-psig (1100-kPa) working-pressure rating for hot-water-boiler-type water heater.
   1) Heat Exchanger: Helix or spiral, finned-copper-tube coils with bronze headers.
   2) Connections: Factory fabricated of materials compatible with boiler. Attach to boiler before testing.
      a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
      b) NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

c. Boiler Appurtenances:
   1) Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire boiler except connections and controls.
   2) Jacket: Steel with enameled finish.
   3) Burner: For use with coil-type, finned-tube water heaters and for natural-gas **OR** LP-gas, **as directed**, fuel.
   4) Temperature Control: Adjustable, storage tank temperature-control fitting and flow switch, interlocked with circulator and burner.
   5) Safety Control: Automatic, high-temperature-limit cutoff device or system.
   6) Automatic Ignition: Intermittent electronic ignition complying with ANSI Z21.20.

d. Building Automation System Interface: Normally closed dry contacts for enabling and disabling water heater.

e. Support: Steel base or skids.

f. Draft Hood: Draft diverter; complying with ANSI Z21.12.

g. Automatic Damper: ANSI Z21.66, electrically operated **OR** mechanically activated **OR** thermally activated, **as directed**, automatic-vent-damper device with size matching draft hood.

h. Hot-Water Storage Tank: Connected with piping to circulating pump and water heater.
   1) Construction: According to ASME Boiler and Pressure Vessel Code: Section VIII, steel with 150-psig (1035-kPa) **OR** 125-psig (860-kPa), **as directed**, working-pressure rating.
   2) Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
      a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
      b) NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
   3) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   4) Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
   5) Jacket: Steel with enameled finish.
   6) Anode Rods: Factory installed, magnesium.
   7) Drain Valve: Corrosion-resistant metal complying with ASSE 1005, factory installed.
   8) Combination Temperature and Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

i. Circulating Pump: UL 778, all-bronze, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3. Include mechanical seals, 125-psig (860-kPa) minimum working-pressure rating, and 225 deg F (107 deg C) continuous-water-temperature rating.

j. Piping: Copper tubing; copper, solder-joint fittings; and brazed or flanged joints.

k. Mounting: Water heater, tank, and accessories factory mounted on skids.

6. Commercial, Grid-Type, Finned-Tube, Gas Water Heaters: Comply with ANSI Z21.13 for hot-water boilers.
   a. Description: Packaged unit with boiler, storage tank, pump, piping, and controls.

b. Boiler Construction: ASME code with 160-psig (1100-kPa) working-pressure rating for hot-water-boiler-type water heater.
   1) Heat Exchanger: Horizontal, straight, finned-copper tubes with bronze headers.
   2) Connections: Factory fabricated of materials compatible with boiler. Attach to boiler before testing.
      a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
      b) NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
c. Boiler Appurtenances:
   1) Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire boiler except connections and controls.
   2) Jacket: Steel with enameled finish.
   3) Burner: For use with grid-type, finned-tube water heaters and for natural-gas **OR** LP-gas, **as directed**, fuel.
   4) Temperature Control: Adjustable, storage tank temperature-control fitting and flow switch, interlocked with circulator and burner.
   5) Safety Control: Automatic, high-temperature-limit cutoff device or system.
   6) Automatic Ignition: Intermittent electronic ignition complying with ANSI Z21.20.
d. Building Automation System Interface: Normally closed dry contacts for enabling and disabling water heater.
e. Support: Steel base or skids.
f. Draft Hood: Draft diverter; complying with ANSI Z21.12.
g. Automatic Damper: ANSI Z21.66, electrically operated **OR** mechanically activated **OR** thermally activated, **as directed**, automatic-vent-damper device with size matching draft hood.
h. Hot-Water Storage Tank: Connected with piping to circulating pump and water heater.
   1) Construction: According to ASME Boiler and Pressure Vessel Code: Section VIII, steel with 150-psig (1035-kPa) **OR** 125-psig (860-kPa), **as directed**, working-pressure rating.
   2) Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
      a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
      b) NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
   3) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   4) Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
   5) Jacket: Steel with enameled finish.
   6) Anode Rods: Factory installed, magnesium.
   7) Drain Valve: Corrosion-resistant metal complying with ASSE 1005, factory installed.
   8) Combination Temperature and Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
i. Circulating Pump: UL 778, all-bronze, centrifugal, overhung-impeller, separately-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3. Include mechanical seals, 125-psig (860-kPa) minimum working-pressure rating, and 225 deg F (107 deg C) continuous-water-temperature rating.
j. Piping: Copper tubing; copper, solder-joint fittings; and brazed or flanged joints.
k. Mounting: Water heater, tank, and accessories factory mounted on skids.

D. Oil-Fired Water Heaters

1. Household, Oil-Fired Water Heaters: Comply with UL 732 for storage water heaters.
   a. Storage-Tank Construction: Steel.
      1) Tappings: ASME B1.20.1 pipe thread.
      2) Pressure Rating: 150 psig (1035 kPa).
      3) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
   b. Factory-Installed, Storage-Tank Appurtenances:
      1) Anode Rod: Replaceable magnesium.
      2) Dip Tube: Provide unless cold-water inlet is near bottom of tank.
      3) Drain Valve: ASSE 1005.
      4) Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2, **as directed**.
      5) Jacket: Steel with enameled finish.
      6) Temperature Control: Adjustable thermostat.
      7) Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
      8) Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
   c. Oil Burner: Comply with UL 296 for use with No. 2 fuel oil.
   d. Draft Regulator: Barometric type or adjustable-damper device.
2. Commercial, Oil-Fired Water Heaters: Comply with UL 732 for storage water heaters.
   a. Storage-Tank Construction: ASME-code **OR** Non-ASME-code, **as directed**, steel with 150-psig (1035-kPa) minimum working-pressure rating.
      1) Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
         a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
         b) NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
      2) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
      3) Lining: Cement **OR** Glass **OR** Nickel plate **OR** Phenolic coating **OR** Sheet copper, **as directed**, complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
   b. Factory-Installed, Storage-Tank Appurtenances:
      1) Anode Rod: Replaceable magnesium.
      2) Dip Tube: Provide unless cold-water inlet is near bottom of tank.
      3) Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
      4) Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2, **as directed**.
      5) Jacket: Steel with enameled finish.
      6) Temperature Control: Adjustable thermostat.
      7) Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
   c. Oil Burners: Comply with UL 296 for use with No. 2 fuel oil.
   d. Safety Control: Automatic, high-temperature-limit cutoff device or system.
   e. Draft Regulator: Barometric type or adjustable-damper device.
   f. Building Automation System Interface: Normally closed dry contacts for enabling and disabling water heater.
3. Large-Capacity, Oil-Fired Water Heaters: Comply with UL 732 for storage water heaters except when capacity is greater than 120 gal. (454 L).
   a. Storage-Tank Construction: ASME-code steel with 150-psig (1035-kPa) minimum working-pressure rating.

1) Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
   a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
   b) NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
2) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
3) Lining: Cement **OR** Glass **OR** Nickel plate **OR** Phenolic coating **OR** Sheet copper, **as directed**, complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

b. Factory-Installed, Storage-Tank Appurtenances:
   1) Anode Rod: Replaceable magnesium.
   2) Dip Tube: Provide unless cold-water inlet is near bottom of tank.
   3) Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
   4) Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2, **as directed**.
   5) Jacket: Steel with enameled finish.
   6) Temperature Control: Adjustable thermostat.
   7) Safety Control: Automatic, high-temperature-limit cutoff device or system.
   8) Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

c. Oil Burner: Comply with UL 296 for use with No. 2 fuel oil.

d. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.

e. Draft Regulator: Barometric type or adjustable-damper device.

f. Building Automation System Interface: Normally closed dry contacts for enabling and disabling water heater.

E. Dual-Fuel Water Heaters

1. Description: Comply with ANSI Z21.10.3/CSA 4.3 or UL 732 requirements appropriate for dual-fuel, gas and oil-fired water heaters.

a. Storage-Tank Construction: ASME-code steel with 150-psig (1035-kPa) minimum working-pressure rating.
   1) Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
      a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
      b) NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
   2) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   3) Lining: Cement **OR** Glass **OR** Nickel plate **OR** Phenolic coating **OR** Sheet copper, **as directed**, complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

b. Factory-Installed, Storage-Tank Appurtenances:
   1) Anode Rod: Replaceable magnesium.
   2) Dip Tube: Provide unless cold-water inlet is near bottom of tank.
   3) Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
   4) Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2, **as directed**.
   5) Jacket: Steel with enameled finish.
   6) Temperature Control: Adjustable thermostat.

7) Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

c. Dual-Fuel Burners: Combination gas-oil burner assembly, complying with appropriate requirements of UL 795; or comply with UL 296 for oil burners for No. 2 fuel oil and UL 795 for natural-gas **OR** LP-gas, **as directed**, fuel.
d. Safety Control: Automatic, high-temperature-limit cutoff device or system.
e. Vent Connection: According to standards of authorities having jurisdiction for dual-fuel water heaters.
f. Building Automation System Interface: Normally closed dry contacts for enabling and disabling water heater.

F. Compression Tanks

1. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
   a. Construction:
      1) Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
      2) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
      3) Air-Charging Valve: Factory installed.

G. Water Heater Accessories

1. Gas Shutoff Valves: ANSI Z21.15/CGA 9.1, manually operated. Furnish for installation in piping.
2. Gas Pressure Regulators: ANSI Z21.18, appliance type. Include pressure rating, capacity, and pressure differential required between gas supply and water heater.
3. Gas Automatic Valves: ANSI Z21.21, appliance, electrically operated, on-off automatic valve.
4. Combination Temperature and Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select each relief valve with sensing element that extends into storage tank.
   a. Gas Water Heaters: ANSI Z21.22/CSA 4.4.
   b. Oil-Fired Water Heaters: ASME rated and stamped and complying with ASME PTC 25.3.
5. Pressure Relief Valves: Include pressure setting less than working-pressure rating of water heater.
   a. Gas Water Heaters: ANSI Z21.22/CSA 4.4.
   b. Oil-Fired Water Heaters: ASME rated and stamped and complying with ASME PTC 25.3.
6. Water Heater Stand and Drain Pan Units: High-density-polyethylene-plastic, 18-inch- (457-mm-) high, enclosed-base stand complying with IAPMO PS 103 and IAS No. 2. Include integral or separate drain pan with raised edge and NPS 1 (DN 25) drain outlet with ASME B1.20.1 pipe thread.
7. Water Heater Stands: Water heater manufacturer's factory-fabricated steel stand for floor mounting and capable of supporting water heater and water. Provide dimension that will support bottom of water heater a minimum of 18 inches (457 mm) above the floor.
8. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated steel bracket for wall mounting and capable of supporting water heater and water.
9. Drain Pans: Corrosion-resistant metal with raised edge. Provide dimensions not less than base of water heater and include drain outlet not less than NPS 3/4 (DN 20).
10. Piping Manifold Kits: Water heater manufacturer's factory-fabricated inlet and outlet piping arrangement for multiple-unit installation. Include piping and valves for field assembly that is capable of isolating each water heater and of providing balanced flow through each water heater.
11. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2, **as directed**.

H. Source Quality Control

1. Test and inspect water heater storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
2. Hydrostatically test commercial water heater storage tanks before shipment to minimum of one and one-half times pressure rating.
3. Prepare test reports.

1.3 EXECUTION

A. Water Heater Installation
1. Install commercial water heaters on concrete bases.
    a. Exception: Omit concrete bases for commercial water heaters if installation on stand, bracket, suspended platform, or direct on floor is indicated.
    b. Concrete base construction requirements are specified in Division 22 Section "Common Work Results For Plumbing".
2. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
3. Install seismic restraints for commercial water heaters. Anchor to substrate.
4. Install gas water heaters according to NFPA 54.
5. Install gas shutoff valves on gas supplies to gas water heaters without shutoff valves.
6. Install gas pressure regulators on gas supplies to gas water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
7. Install automatic gas valves on gas supplies to gas water heaters, if required for operation of safety control.
8. Install oil-fired water heaters according to NFPA 31.
9. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater, relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
10. Install combination temperature and pressure relief valves in water piping for water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
11. Install water heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 Section "Domestic Water Piping Specialties" for hose-end drain valves.
12. Install thermometer on outlet piping of water heaters. Refer to Division 22 Section "Meters And Gages For Plumbing Piping" for thermometers.
13. Install pressure gage(s) on inlet and outlet piping of commercial, fuel-fired water heater piping. Refer to Division 22 Section "Meters And Gages For Plumbing Piping" for pressure gages.
14. Assemble and install inlet and outlet piping manifold kits for multiple water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each water heater. Include shutoff valve and thermometer in each water heater inlet and outlet, and throttling valve in each water heater outlet. Refer to Division 22 Section "General-duty Valves For Plumbing Piping" for general-duty valves and to Division 22 Section "Meters And Gages For Plumbing Piping" for thermometers.
15. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.
16. Fill water heaters with water.
17. Charge compression tanks with air.

B. Connections

1. Piping installation requirements are specified in other Division 14. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.
3. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
4. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Field Quality Control
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
2. Perform the following field tests and inspections and prepare test reports:
    a. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
    b. Operational Test: After electrical circuitry has been energized, confirm proper operation.
    c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

D. Demonstration
1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain instantaneous and commercial water heaters.

END OF SECTION 22 12 23 13a

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SECTION 22 12 23 26 - UNDERGROUND STORAGE TANKS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of underground storage tanks. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Intent of Work
1. It is the intent of this specification to ensure that the work, as completed, shall meet or exceed all applicable codes, ordinances, rules and regulations of every authority having jurisdiction in the area.
2. The installation shall include all necessary equipment, controls, valves and fittings, excavation, backfill as described or called for on the plans. In some cases, the Contractor shall prepare the plans. In any case, the Contractor shall obtain all permits at its expense.
3. The Contractor shall install equipment in accordance with manufacturer's recommendations. Where drawings (if any) and specification conflict with manufacturer's recommendations, it shall be the Contractor's responsibility to bring this to the attention of the Owner before installation.
4. The overall intent shall be that the Contractor shall provide everything required to make a complete and operational job in every respect.

C. Codes And Standards
1. Reference is to the latest edition of the code or standard unless otherwise noted. Comply with the latest EPA requirements.
2. The codes and standards referred to are the minimum standards. Where the requirements of these specifications and the accompanying drawings (if any) exceed those of the codes and standards, the drawings and specifications shall supersede.
3. The installation shall conform to provisions of the NFPA requirement with latest amendments.
4. The entire installation including all equipment shall conform to The Occupational and Safety Health Act of 1970, and all EPA regulations.

D. Visit To Site: Bidders are advised to visit the site and carefully examine the existing conditions before submitting bids, as no allowance will be made for lack of knowledge of existing conditions where such conditions may reasonably be determined by observation.

E. Permits
1. Obtain all permits required for the installation of this work and pay all fees in connection therewith. Permits and fees involved in removal of any item from the site shall be included.
2. Provide copies of inspection and testing certificates from all agencies and authorities having jurisdiction.

F. Layout Basis
1. The layout, which must be stamped by an Engineer registered in the State in which the Project is located, is based upon the use of particular items of equipment, identified by manufacturer's make and model number. Dimensions, arrangements, efficiency and service connections required for these particular items have been considered in making the layout. Contractor shall submit any deviations proposed with its bid.
2. The Contractor may use the equipment of any manufacturer listed as approved for substitution provided they have the proper connections, capacities, efficiency and dimensions. Variances from the requirements stated herein shall be sustainable reasons for disapproval of the submitted equipment. All costs arising from variances in substituted items shall be paid for by the Contractor.

3. Equivalent products by other manufacturers must be submitted to the the Owner for prior approval at least ten (10) days prior to bid date.

G. Submittals
1. All submittals shall bear a stamp or notation indicating that the Contractor has reviewed the submittals for compliance with drawings, governing authorities and specifications.
2. All submittals shall bear sufficient notations to clearly indicate the specific make, model number, accessories, capacities, options, and specification paragraph numbers.
3. All submittals shall indicate complete compliance with all performance and specification requirements as herein specified and/or indicated or shall specifically list any exceptions. Exceptions shall be subject to approval by the the Owner.
4. The review (by the the Owner) of equipment does not relieve the Contractor of the responsibility for compliance with the contract documents or authorities as specified.
5. Contractor shall coordinate electrical characteristics of equipment with electrical specifications and the available power characteristics.
6. Materials requiring shop drawing submittals shall not be installed prior to shop drawings being reviewed by the the Owner. The Contractor agrees that failure to conform to the above may result in removal of all installed materials that have been disapproved from the project. Installation of specified equipment will be mandatory. Removal of disapproved equipment shall be at the sole expense of the Contractor.
7. Submit the following for review via shop drawings (to be approved or disapproved):
   a. Xerxes or approved equal, double wall (do not unload manually). Size and capacity.
   b. Bury depth.
   c. Bed and backfill (not over 7'-0" traffic and no traffic).
   d. Double walls when continuous vacuum pump and monitor are used require a maximum burial depth of three (3) feet from tank top to grade.
   e. When not subjected to traffic loads, use 24" backfill or 12" minimum backfill plus 4" re-bar reinforced concrete on top.
   f. When subjected to traffic loads, use 36" backfill or 18" minimum backfill plus 6" of re-bar reinforced concrete.
   g. If tank is 12'-0" in diameter (actually, 7'-11" is manufactured for large gallonage) then, no traffic shall be provided with 42" minimum cover, or 38" backfill plus 4" re-bar reinforced concrete. With traffic, use 38" backfill plus 6" of asphalt or 6" of re-bar reinforced concrete.
   h. Monitoring fittings, fiberglass reservoir, vapor sensor 4" tank fittings, tank fill tube insert, venting, stage two vapor recovery system, manway and manway extensions, manway risers, site monitoring wells, barricades, installation check list, hydrostatic tank monitoring.
   i. Job site safety precautions.
   j. Reservoir fiberglass sensor.
   k. Reservoir leak detection.
   l. Electronic control panels, sensor circuit, transmission contact switch power source circuit, alarm bell, alarm bell silence button, control panel false alarms, etc.
   m. Piping sump bottom, usually 28 3/8" x 30".
   n. Flex connectors to piping.
   o. Unions, nipples, manway cover, FRP fitting, opening for stage II vapor recovery line if required.
   p. 3" pipe sump fitting.
   q. When using piping sump sensor equal to Owens Corning fiberglass model PSS, submit system including electrical power supply and signal wiring.
   r. Control panel equal to Owens Corning fiberglass model SB-0011B (single circuit) or SB-0014B (4 circuit) as applicable.
   s. Fiberglass pipe and fittings equal to "Ameron" type Dualoy 3000/L pressure rated and with chemically resistant epoxy resin for the service intended. The Dualoy 3000/L shall be a secondary containment system. No other product piping will be acceptable.

H. Guarantee

1. Contractor shall guarantee that if any materials or workmanship covered by these specifications proves defective within one (1) year, such defects shall be corrected by the Contractor at once without charge to the Owner.

1.2 PRODUCTS:

A. Single-Wall Fiberglass Underground Storage Tanks
1. The tank shall comply with the following governing standards:
a. Underwriters Laboratories, Inc. (UL) Standard 1316. A UL certification plate shall be attached to each tank.
b. National Sanitation Foundation Standard, NSF Standard 61.
c. ANSI/AWWA D120-02 Thermosetting Fiberglass-Reinforced Plastic Tanks.
d. Military Specification No. MIL-T-52777(A)
2. The Contractor shall provide and install the "fiberglass" underground storage tanks. Tanks shall be as manufactured by Xerxes Corporation, Minneapolis, MN or approved equal as judged by the Owner. Follow manufacturer's instructions for installation and testing.
3. Loading Conditions: Tank shall meet the following design criteria:
a. Internal Load: Tank shall be designed to withstand a 5-psig air-pressure test with 5:1 safety factor. When tank is designed for on-site testing, contractor shall individually test tank for leakage prior to installation. Maximum test pressure is 5 psig (3 psig for a 12-foot diameter tank).
b. Vacuum Test: Tanks 10-foot diameter and smaller shall be designed to withstand a vacuum test to 11.5 inches of mercury.
c. Surface Loads: Tank shall withstand surface H-20 axle loads when properly installed according to tank manufacturer`s current Installation Manual and Operating Guidelines.
d. External Hydrostatic Pressure: Tank shall be capable of being buried in ground with 7 feet of overburden over the top of the tank, the hole fully flooded and a safety factor of 5:1 against general buckling.
e. Tank shall support accessory equipment- such as internal pump platforms, drop/fill tubes, submersible pumps and ladders- when installed according to tank manufacturer`s current Installation Manual and Operating Guidelines.
4. Product Storage:
a. Tank shall be capable of storing water products with specific gravity up to 1.1.
b. Tank shall be vented to atmospheric pressure.
c. Tank shall be capable of storing products identified in the manufacturer`s current standard limited warranty.
5. Materials:
a. Tank shall be manufactured with 100% resin and glass-fiber reinforcement No sand fillers.
b. The laminate materials used in the internal coating system of a portable water tank shall conform to the requirements of NSF Standard 61.
c. Tank Dimensions: as directed by the Owner.
6. Manways (Required for Potable Water Tanks): Shall be flanged and 22-inch I.D. **OR** 30-inch I.D (for larger tanks), **as directed,** complete with gasket, bolting hardware and cover. Optional manway extensions shall be FRP.

B. Double-Wall Fiberglass Underground Storage Tanks
1. The Contractor shall provide and install the "fiberglass" underground storage tanks of the specified volume and diameter.
2. The tank shall be of fiberglass. Tank laminates shall be constructed of 100% resin and fiberglass reinforcements without sand fillers. Ribs are to be integrally cast into tank body. Tanks shall bear the listing mark of Underwriters' Laboratories, Inc. Tank shall have an annular space between the primary and secondary shell walls to allow for free flow and containment of all leaked product from primary tank. This space shall be filled at the factory with a brine solution for hydrostatic monitoring. Tanks shall be as manufactured by Xerxes Corporation, Minneapolis, MN or approved equal as judged by the Owner.

3. The tank shall comply with the following governing standards:
    a. ASTM Standard Document No. 4021-81
    b. Underwriters' Laboratories, Inc. (UL.) File #MH-9061 (N) for underground storage of flammable liquids. A UL certification plate shall be attached to each tank.
    c. Military Specification No. MIL-T-52777(A)
    d. Factory Mutual Systems approval J.I. IG4AO.AF
    e. National Sanitation Foundation, Standard 14
    f. National Fire Protection Association (NFPA-30), (NFPA-30A) Flammable and Combustible Liquid Code and (NFPA-31) Standard for Installation of Oil Burning Equipment.
4. The tank shall be capable of the following loading conditions:
    a. Internal load: Tank shall withstand 5 psi air pressure test with 5 to 1 safety factor. Contractor shall test prior to installation as this is to test for leakage. Maximum test pressure is 5 psi.
    b. Vacuum Test: Every tank shall be tested to 11.5 inches (primary tank) and 9.5 inches (secondary tank) mercury vacuum by the tank manufacturer to assure structural integrity.
    c. Surface Loads: Tank shall withstand surface H-20 axle load when properly installed according to current manufacturer's installation instruction (32,000 lbs.).
    d. External hydrostatic pressure: Tank shall withstand 7' of overburden with the hole fully flooded with 7:1 safety factor against buckling.
5. Provide glass fiber-reinforced plastic straps for the tank shown. Provide number and location of straps as specified by the manufacturer. Each strap shall be capable of withstanding the buoyancy load of 25,000 lbs. for 8' tank diameter. Straps shall be standard as supplied by the tank manufacturer. A concrete pad or concrete deadman must be used with anchor straps as recommended by tank manufacturer.
6. The Contractor shall provide fiberglass piping sump with fittings as indicated. The piping sump shall be manufactured by Xerxes Corporation or approved equal and supplied with tanks.
    a. The piping sump shall be installed so that it is suitable for monitoring the double-wall piping system and containment of its product. Piping sump shall be located on tanks 22" minimum manway.
7. All tank fittings shall be standard (proofed tight) as supplied by the tank manufacturer. The tank shall have an opening for one each of the following:
    a. Fill/Manual Gauging
    b. Vent/Overfill/Stage One Vapor Recovery
    c. Pump (pressure system) or supply and return (suction system)
    d. In tank gauging automatic inventory control
    e. Others as shown or required by the operating agency
8. The tank shall have a factory filled brine interstitial and reservoir for continuous monitoring of both inner and outer walls.
9. Tank to be installed per manufacturer installation instructions which will be inspected as it progresses.

C. Spill Protection
1. Universal model 70CD, or approved equal, spill containment shall be used as containment basin for spills during filling. A manual valve, if so required, shall be used to return any spilled product back to tank.

D. Overfill Prevention
1. Universal model 37, or approved equal, float valve is to be used for overfill prevention. The automatic shut off device must stop the flow of product being delivered when tank is 90% full. Access must be provided.

E. Stage One Vapor Recovery
1. Stage one vapor recovery is incorporated into the access assembly of the overfill prevention access way. See drawing for details. (Less than 10,000 gales per month through flow)

F. Stage Two Vapor Recover

1. Piping for stage two vapor recovery will be installed for future use. Required for gasoline motor fuel only. (More than 10,000 gales per month through flow)

G. Tank Trim

1. Surface manholes shall have all cast iron rim and minimum 10" galvanized steel skirt. Tank trim shall have Universal Valve.

H. Submersible Turbine Pump Specifications

1. General Pump Specifications: The pump shall be designed to pump gasoline, diesel, kerosene and jet fuel. The entire pumping assembly shall have UL listing and shall meet all requirements of UL79. The pump discharge head and manifold assembly shall be manufactured from ASTM A 48 Class 30 grey iron. The pump shall be available in 1/3, 3/4, and 1-1/2 hp sizes and shall be manufactured to the proper length as determined by the tank diameter, type of tank, and bury depth. The pump motor shall have a thermal over current overload protector with automatic reset. The pump motor assembly shall be clearly marked with pertinent information including Model, Horsepower, Voltage, Phase, and Manufacturer. The pump motor shall be a permanent split phase capacitor type, and shall incorporate a 15 mfd capacitor. The pumping unit shall not incorporate any flexible diaphragms and all sealing shall be accomplished with "o" ring or UL recognized fiber gaskets. The pump shall have a removable intake screen with openings no greater than 3/32 inch. The pump shall be manufactured by FE Petro, Inc., McFarland, WI. or approved equal as judged by the the Owner.
2. Installation and Maintenance Specifications: The pump shall have a two-wire field connection and an easy access ground wire terminal, and shall incorporate a wire seal plug which will accommodate three wires. The pump shall incorporate a port for line pressure testing that shall be sealed with a 1/4 NPT pipe plug. The pump unit shall have a fully extractable head in order to permit removal of the pump motor assembly without disturbing the discharge piping or the electrical wiring. The product in the pipelines shall be held in place by a line check valve that shall have a minimum sealing of 170 lbs when the pump is not running. The line check valve shall be independent of the removable head and shall be easily accessible. The removal of the extractable portion of the pump shall not disturb product in the pipelines downstream of the check valve. During the removal of the extractable portion of the pump, product contained in the discharge manifold of the pump shall drain automatically into the storage tank. The pump motor shall be interchangeable by horsepower with different manufacturers' product.
3. Operation Specifications: The pump shall have an air/vapor elimination system that returns air or vapors to the underground storage tank through a tube discharging near the top of the pump motor assembly. The pump unit shall contain a built-in expansion relief valve that relieves pressure above pumping pressure but below 50 psi. The pump motor shall utilize the product being pumped for lubrication of the motor bearings and for cooling the stator, and this fluid shall discharge into the underground storage tank at the top of the motor. The pump shall have siphon capability built into the pump as standard.

I. Piping System

1. All piping fittings and adhesives shall be UL listed made of fiberglass double wall. Pipe shall be in compliance with ASTM D 2996 and classified by designation code RTRP-11AF-3111. Pipe shall be filament wind of continuous glass filament. Pipe must have a minimum bend radius of 50 feet on 2" primary (80 feet on 3" secondary) to allow settling of tank. Pipe shall have maximum tensile loads of 1160 lbs, compressive loads 2210 lbs at 75 degrees Fahrenheit on 2" primary. 3" pipe shall have tensile load of 2020 lbs at 75 degrees and compressive loads of 3850 lbs. Pipe to be factory proof tested at 1000 psig-2", 700 psig-3". Pipe shall be Smith Fiberglass Red thread II, or approved equal as judged by the Owner.
2. Vent piping shall not have secondary containment. Vent shall not be sloped less than 1/4" per foot downward to tank.
3. Product piping shall have secondary containment. Product piping shall not be sloped less than 1/8" per foot downward toward tank.
4. All piping must slope back toward tank.

5. All piping must be installed as per manufacturer installation instructions. the Owner shall monitor each installation daily.

J. Leak Detection
1. Tank shall have a Pullulert FD241RRA, or approved equal, float probe mounted on the brine filled hydrostatic reservoir. The system shall monitor both the inner and outer walls of the tank.
   a. Alarm Conditions:
      1) Hydrocarbons in hydrostatic reservoir
      2) A loss of fluid in reservoir
2. Piping shall have a Pollulert FD241RRA, or approved equal, float probe mounted in the piping sump. System shall monitor the piping sump compartment that has to be designed to catch any leaked product from the primary piping system. This probe shall distinguish the difference between water and hydrocarbons and alarm on any one or both conditions.
3. Remote monitoring piping sumps shall be installed only if piping can not be sloped toward tank. The Contractor shall use as many remote monitoring piping sumps as needed to assure that all sections of piping are monitored. All monitoring sumps shall have a Pollulert FD241RRA or approved equal probe for leak detection.
4. Control panel shall have probe status for wet, dry, or hydrocarbon. Alarm conditions are to be selectable. Control panel must have installed relay or provision for installing relays for remote alarms. Control panel shall have both visual and audible alarm. System shall have a two year warranty from date of manufacture. Ground water probes shall be adjustable 1/8" to 2" for product detection. Probes shall be wired by a single cable run. Systems must be UL listed for Class 1, Division 1, Group D locations and meet all existing EPA regulations. Leak detection shall be Pollulert systems or approved equal.
5. Submersible pump shall have a mechanical in-line leak detector with a free floating check valve. Leak detector shall be vaporless LD2000 or approved equal.

K. In Tank Gauging System
1. Gauging system shall provide inventory management designed to continuously monitor underground storage tanks. System must provide information on inventory, delivery of fuel, and product through-put. System must measure fuel levels, water level and fuel temperature. This is to ensure proper compensated level readings. System shall have five temperature sensors, two floats, one for product level, one for water interface. System shall have a 48 character LCD display and internal thermal printer. System shall utilize a magnetostrictive probe and have visual, audible alarm with automatic printout. The system shall be designed to have 16 input on/off devices, RS232 port full duplex with adjustable baud rate. Tank gauging system shall be Pollulert system or approved equal.

L. Test For Pipe
1. Test of the piping system shall be made per manufacturer's recommendations.
2. Furnish the Owner with a certificate stating that all piping has been tested as specified and has been shown to be tight.
3. The piping systems may be tested in sections if necessary, but a final test may be required of the entire piping system at the completion of the system. The final test shall be made while pipe is exposed to view where possible.
4. Both primary and secondary pipe must be tested.

M. Test For Tank
1. Pre-installation: All Xerxes or approved equal tanks shall be tested prior to shipment, but it is required that all tanks be tested by the Contractor prior to installation. After installation and before final backfilling to grade, the tank must be retested to assure that no damage occurred during installation.
2. Hose/Valve Assembly: In order to test the tank, the hose/valve assembly must be connected from the reservoir to a service fitting. The hose/valve assembly will already be connected from the reservoir to a service fitting when the tank is shipped. If the hose/valve assembly is not connected

when the tank is delivered, contact the Customer Service Representative at the Xerxes or other plant nearest you, before attempting to test the tank.

3. Primary (Internal) Tank Test: Prior to installation, check to see that all service and monitor fittings are plugged and tightened, except the service fitting with a temporary plastic plug. Close the valve on the hose/valve assembly. Remove the temporary plastic plug and connect the pressure source to the service fitting. Pressure test the primary (internal) tank to 5 psig for 60 minutes.
4. Secondary (External) Tank Test:
    a. CAUTION: Never pressurize the secondary tank or (annular space) without connecting it to the primary tank. The secondary tank and primary tank will be properly connected if the hose/valve assembly is in place as shipped. Failure to have the secondary tank and primary tank properly connected could potentially result in tank failure and personal injury, and will void all warranties.
    b. While the primary tank is still under pressure, open the valve on the hose/valve assembly until the pressure stabilizes. Once the pressure has stabilized, either add or subtract air pressure to stabilize the pressure at 5 psig. Observe the tank for any liquid on the exterior surface and check the gauge at the pressure source for any drop in pressure.
    c. After completing the test, relieve the pressure at the source.

N. Product Dispenser
1. A fiberglass containment box shall be installed with each product dispenser. Containment box shall be as manufactured by Petro Fiberglass or approved equal. Double wall pipe shall terminate inside containment box. A flex connector as manufactured by Dana Everflex or approved equal shall be used to connect product pipe to the shear valve within the containment box. The shear valve shall be air tested at the factory and shall not lose its seal when its top is removed for service. Shear valve shall be Universal model 521 or approved equal. Each product dispensing hose shall be equipped with a re-connectable breakaway featuring a pressure balancing chamber to prevent nuisance breaks and shall disconnect at 200 lbs. A hose coupling shall separate the breakaway and hose swivel. The nozzle shall have a means of automatically stopping flow if the nozzle is not at the proper dispensing angle. Nozzle shall be of die-cast construction UL listed and have a flow equalizer to maintain 10 GPM flow. Breakaway, hose coupling, hose swivel, and nozzle shall be as manufactured by Husky or approved equal. Dispenser shall be compatible with vapor recovery systems.

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Task	Specification	Specification Description
22 12 23 26	21 05 23 00	Piped Utilities Basic Materials And Methods
22 13 16 00	21 05 23 00	Piped Utilities Basic Materials And Methods
22 13 16 00	22 11 23 23	Water Supply Wells
22 13 16 00	22 05 76 00	Sanitary Sewerage
22 13 16 00	07 63 00 00	Common Work Results for Fire Suppression
22 13 16 00	07 63 00 00a	Common Work Results for Plumbing
22 13 16 00	07 63 00 00b	Common Work Results for HVAC
22 13 16 00	22 11 16 00a	Sanitary Waste And Vent Piping
22 13 16 00	22 11 16 00b	Storm Drainage Piping

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SECTION 22 13 19 00 - HIGH-EFFICIENCY PARTICULATE FILTRATION

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for high-efficiency particulate filtration. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. HEPA rigid-cell box filters.
      b. HEPA V-bank cell filters.
      c. HEPA filter diffusers.
      d. HEPA filter fan modules.
      e. ULPA filters.
      f. 95 percent DOP filters.
      g. Front- and rear-access filter frames.
      h. Side-service housings.
      i. Filter gages.

C. Submittals
   1. Product Data: For each type of product indicated. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.
   2. LEED Submittals:
      a. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with applicable requirements in ASHRAE 62.1, Section 5, "Systems and Equipment."
   3. Shop Drawings: For air filters. Include plans, elevations, sections, details, and attachments to other work.
      a. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
      b. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.
      c. Wiring Diagrams: For power, signal, and control wiring.
   4. Field quality-control reports.
   5. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.

D. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended use.
   2. ASHRAE Compliance:
      a. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
   3. Comply with IEST-RP-CC001.3.
   4. Comply with UL 586.
   5. Comply with IEST-RP-CC007.1.
   6. Comply with NFPA 90A and NFPA 90B.

E. Coordination
   1. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

1.2 PRODUCTS

A. HEPA Rigid-Cell Box Filters
1. Description: Factory-fabricated, disposable, packaged air filters with media perpendicular to airflow and with holding frames.
2. Filter Unit Class: UL 900, Class 1 **OR** Class 2, **as directed**.
3. Media: Fibrous material, constructed so individual pleats are maintained under rated-airflow conditions.
   a. Internal Separators: None **OR** Aluminum in media folds, **as directed**.
   b. Gasket Material: None **OR** Neoprene **OR** Blue gel, **as directed**.
   c. Gasket Location: None **OR** Upstream **OR** Upstream and Downstream **OR** Downstream, **as directed**.
   d. Faceguard Material: Aluminum **OR** Stainless steel, **as directed**.
   e. Faceguard Location: None **OR** Upstream **OR** Upstream and Downstream **OR** Downstream, **as directed**.
4. Filter-Media Frames:
   a. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
   b. Materials: Stainless steel **OR** Fire-retardant plywood **OR** Fabricated aluminum **OR** Fire-retardant particleboard **OR** Galvanized sheet **OR** Non-fire-retardant particleboard, **as directed**.
   c. Style: Box **OR** Double-turned flange **OR** Deep channel **OR** Double-turned flange, one side, **as directed**.
5. Mounting Frames: Welded galvanized steel with gaskets and fasteners; suitable for bolting together into built-up filter banks.

B. HEPA V-Bank Cell Filters
1. Description: Factory-fabricated, disposable, packaged air filters with media at an angle to airflow and with holding frames.
2. Filter Unit Class: UL 900, Class 1 **OR** Class 2, **as directed**.
3. Media: Fibrous material, constructed so individual pleats are maintained under rated-airflow conditions.
   a. Internal Separators: None **OR** Aluminum in media folds, **as directed**.
   b. Gasket Material: None **OR** Neoprene **OR** Blue gel, **as directed**.
   c. Gasket Location: None **OR** Upstream **OR** Upstream and Downstream **OR** Downstream, **as directed**.
   d. Faceguard Material: Aluminum **OR** Stainless steel, **as directed**.
   e. Faceguard Location: None **OR** Upstream **OR** Upstream and Downstream **OR** Downstream, **as directed**.
4. Filter-Media Frames:
   a. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
   b. Materials: Stainless steel **OR** Fire-retardant plywood **OR** Fabricated aluminum **OR** Fire-retardant particleboard **OR** Galvanized sheet **OR** Non-fire-retardant particleboard, **as directed**.
   c. Style: Box **OR** Double-turned flange **OR** Deep channel **OR** Double-turned flange, one side, **as directed**.
5. Mounting Frames: Welded galvanized steel with gaskets and fasteners; suitable for bolting together into built-up filter banks.

C. HEPA Filter Diffusers
1. Description: Factory-fabricated, individually ducted, HEPA filter-holding ceiling modules.
2. Media: Fibrous glass, constructed of continuous sheets with closely spaced pleats with glass filament separators.
   a. Media to Module Side Bond: Urethane sealant.

b. Media to Frame Side Bond: Polyurethane foam **OR** Silicone **OR** Neoprene adhesive **OR** Fiberglass-mat packing **OR** Thermosetting sealant **OR** Knife edge in fluid-filled channel, **as directed**.
c. Application: Class 100 **OR** Class 10 **OR** Class 1, **as directed**, clean room.

3. Casing:
a. Configuration: Ducted inlet **OR** Plenum inlet **OR** Plenum inlet with prefilter, **as directed**.
b. Module Material: Extruded aluminum, 16 gage with mill finish.
c. Suspension: Ceiling grid.

4. Accessories:
a. Diffusion damper.
b. Diffusion-damper adjustment port.
c. Filter test port.

D. HEPA Filter Fan Modules

1. Description: Factory-fabricated, HEPA filter ceiling module with fan.
2. Casing:
a. Configuration: Ducted inlet **OR** Plenum inlet **OR** Plenum inlet with prefilter, **as directed**.
b. Module Material: Extruded aluminum, 16 gage with mill finish.
c. Suspension: Ceiling grid **OR** Independent, **as directed**.
3. Media: Fibrous glass, constructed of continuous sheets with closely spaced pleats with aluminum separators **OR** vinyl-coated aluminum separators **OR** separators of ribbons of filter media, **as directed**.
a. Frame Material: 3/4-inch- (19-mm-) thick, fire-retardant plywood **OR** 3/4-inch- (19-mm-) thick, fire-retardant particleboard **OR** 3/4-inch- (19-mm-) thick plywood **OR** 3/4-inch- (19-mm-) thick particleboard **OR** Galvanized steel **OR** Aluminized steel **OR** Cadmium-plated steel **OR** Stainless steel **OR** Aluminum, **as directed**.
b. Media to Frame Side Bond: Polyurethane foam **OR** Silicone **OR** Neoprene adhesive **OR** Fiberglass-mat packing **OR** Thermosetting sealant **OR** Knife edge in fluid-filled channel, **as directed**.
c. Face Gasket: Neoprene expanded rubber **OR** Ceramic fiber **OR** Silicone, **as directed**.
d. Faceguard: Plastic **OR** Stainless steel, **as directed**.
4. Accessories: Filter test port.
5. Control: Variable speed.
6. Motor:
a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 22.
c. Type: Permanent-split capacitor with SCR for speed adjustment **OR** Electronically commutated motor, **as directed**.
d. Fan-Motor Assembly Isolation: Rubber isolators.
e. Enclosure: Open dripproof **OR** Totally enclosed, fan cooled **OR** Totally enclosed, air over **OR** Open, externally ventilated **OR** Totally enclosed, nonventilated **OR** Severe duty **OR** Explosion proof **OR** Dust-ignition-proof machine, **as directed**.
f. Enclosure Materials: Cast iron **OR** Cast aluminum **OR** Rolled steel, **as directed**.
g. Motor Bearings: <**Insert special requirements**>.
h. Unusual Service Conditions:
1) Ambient Temperature: <**Insert deg F (deg C)**>.
2) Altitude: <**Insert feet (m)**> above sea level.
3) High humidity.
i. Efficiency: Premium efficient.
j. NEMA Design: <**Insert designation**>.
k. Service Factor: <**Insert value**>.
l. Motor Speed: Single speed **OR** Multispeed, **as directed**.
1) Speed Control: Infinitely adjustable with pneumatic-electric and electronic controls.

E. ULPA Filters
1. Description: Factory-fabricated, ULPA filters with holding casing.
2. Media: Fibrous glass, constructed of continuous sheets with closely spaced pleats with aluminum separators **OR** vinyl-coated aluminum separators **OR** separators of ribbons of filter media, **as directed**.
3. Frame Material: 3/4-inch- (19-mm-) thick, fire-retardant plywood **OR** 3/4-inch- (19-mm-) thick, fire-retardant particleboard **OR** 3/4-inch- (19-mm-) thick plywood **OR** 3/4-inch- (19-mm-) thick particleboard **OR** Galvanized steel **OR** Aluminized steel **OR** Cadmium-plated steel **OR** Stainless steel **OR** Aluminum, **adected**.
4. Media to Frame Side Bond: Polyurethane foam **OR** Silicone **OR** Neoprene adhesive **OR** Fiberglass-mat packing **OR** Thermosetting sealant **OR** Knife-edge in fluid-filled channel, **as directed**.
5. Face Gasket: Neoprene expanded rubber **OR** Ceramic fiber **OR** Silicone, **as directed**.
6. Mounting Frames: Construct downstream corners of holding device with cushion pads to protect media. Provide bolted filter-sealing mechanism to mount and continuously seal each individual filter.

F. 95 Percent DOP Filters
1. Description: Factory-fabricated, 95 percent DOP filters with holding casing.
2. Media: Fibrous glass, constructed of continuous sheets with closely spaced pleats with aluminum separators **OR** vinyl-coated aluminum separators **OR** separators of ribbons of filter media, **as directed**.
3. Frame Material: 3/4-inch- (19-mm-) thick, fire-retardant plywood **OR** 3/4-inch- (19-mm-) thick, fire-retardant particleboard **OR** 3/4-inch- (19-mm-) thick plywood **OR** 3/4-inch- (19-mm-) thick particleboard **OR** Galvanized steel **OR** Aluminized steel **OR** Cadmium-plated steel **OR** Stainless steel **OR** Aluminum, **as directed**.
4. Frame Style: Box single header **OR** Double header **OR** Double turned flange **OR** 3/4-inch- (19-mm-) deep channel, **as directed**.
5. Media to Frame Side Bond: Polyurethane foam **OR** Silicone **OR** Neoprene adhesive **OR** Fiberglass-mat packing **OR** Thermosetting sealant **OR** Knife edge in fluid-filled channel, **as directed**.
6. Face Guard Material: Galvanized **OR** Aluminum, **as directed**, mesh.
7. Face Guard Location: Upstream **OR** Upstream and Downstream **OR** Downstream, **as directed**.
8. Gasket Material: Neoprene expanded rubber **OR** Ceramic fiber **OR** Silicone, **as directed**.
9. Gasket Location: Upstream **OR** Upstream and Downstream **OR** Downstream, **as directed**.
10. Mounting Frames: Construct downstream corners of holding device with cushion pads to protect media. Provide bolted filter-sealing mechanism to mount and continuously seal each individual filter.

G. Front- And Rear-Access Filter Frames
1. Framing System: Aluminum framing members with access for either upstream (front) or downstream (rear) filter servicing, cut to size and prepunched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation or operation.
2. Prefilters: Incorporate a separate track, removable from front or back.
3. Sealing: Factory-installed, positive-sealing device for each row of filters to ensure seal between gasketed filter elements to prevent bypass of unfiltered air.
4. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

H. Side-Service Housings
1. Description: Factory-assembled, side-service housings, constructed of 0.064-inch- (1.6-mm-) thick, galvanized steel **OR** stainless steel **OR** double-wall casing with 1-inch (25-mm) insulation, **as directed**, to hold filters. Side servicing is through gasketed access doors on one side, and

housings are capable of connection to other housings. Equip housings with metal slide channel tracks with clamping mechanisms to hold filters, and the following:
a. Pressure tap and fitting.
b. DOP/freon test ports.
c. Decontamination ports.
d. Isolation dampers.
e. Lifting lugs.
2. Prefilters: Integral tracks to accommodate 2-, 4-, and 6-inch- (50-, 100-, and 150-mm-) thick, disposable filters.
3. Access Doors: Continuous gaskets on perimeter and positive-locking swivel, **as directed**, devices. Provide ribbed bagging rim behind access door and PVC bags for bag-in, bag-out arrangement, **as directed**. Arrange so filter cartridges can be loaded from an access door for each tier and section of the following:
a. Combination prefilter and HEPA filter.
OR
Prefilter.
OR
HEPA filter.
b. Upstream and downstream test section.
4. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.
5. Accessories:
a. Filter change-out trays.
b. Document-storage pocket.
c. Filter removal rod.
6. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

I. Filter Gages
1. Diaphragm type with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.
a. Diameter: 4-1/2 inches (115 mm) **OR** 2 inches (50 mm), **as directed**.
b. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5-Inch wg (125 Pa) or Less: 0- to 0.5-inch wg (0 to 125 Pa).
c. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5- to 1.0-Inch wg (125 to 250 Pa) or Less: 0- to 1.0-inch wg (0 to 250 Pa).
d. Scale Range for Filter Media Having a Recommended Final Resistance of 1.0- to 2.0-Inch wg (250 to 500 Pa) or Less: 0- to 2.0-inch wg (0 to 500 Pa).
e. Scale Range for Filter Media Having a Recommended Final Resistance of 2.0- to 3.0-Inch wg (500 to 750 Pa) or Less: 0- to 3.0-inch wg (0 to 750 Pa).
f. Scale Range for Filter Media Having a Recommended Final Resistance of 3.0- to 4.0-Inch wg (750 to 1000 Pa) or Less: 0- to 4.0-inch wg (0 to 1000 Pa).
2. Manometer-Type Filter Gage: Molded plastic, with epoxy-coated aluminum scale, logarithmic-curve tube gage with integral leveling gage; graduated to read from 0- to 3.0-inch wg (0 to 750 Pa) and accurate within 3 percent of full-scale range.
3. Accessories: Static-pressure tips, tubing, gage connections, and mounting bracket.

1.3 EXECUTION

A. Installation
1. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.
2. Install filters in position to prevent passage of unfiltered air.
3. Install filter gage for each filter bank.

4. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters that were used during construction and testing with new, clean filters.
5. Install filter-gage static-pressure tips upstream and downstream from filters. Install filter gages on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.
6. Coordinate filter installations with duct and air-handling unit installations.

B. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
   a. Operate automatic roll filters to demonstrate compliance with requirements.
   b. Test for leakage of unfiltered air while system is operating.
   c. HEPA Filters: Pressurize housing to a minimum of 3.0-inch wg (750 Pa) or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter with soapy water to check for air leaks.
   d. HEPA Filters: Pressurize housing to a minimum of 3.0-inch wg (750 Pa) or to designed operating pressure, whichever is higher; and test housing joints, door seals, and sealing edges of filter for air leaks according to pressure-decay method in ASME N510.
3. Air filter will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

C. Cleaning
1. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION 22 13 19 00

Task	Specification	Specification Description
22 13 19 13	22 13 19 00	High-Efficiency Particulate Filtration

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SECTION 22 13 19 26 - INTERCEPTORS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for interceptors. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Grease interceptors.
      b. Oil interceptors.
      c. Sand interceptors.

C. Definitions
   1. FRP: Fiberglass-reinforced plastic.
   2. PP: Polypropylene plastic.

D. Submittals
   1. Product Data: For each type of metal and plastic interceptor indicated. Include materials of fabrication, dimensions, rated capacities, retention capacities, operating characteristics, size and location of each pipe connection, furnished specialties, and accessories.
   2. Shop Drawings: For each type and size of precast-concrete interceptor indicated.
      a. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.
   3. Coordination Drawings: Interceptors, drawn to scale, on which the following items are shown and coordinated with each other, based on input from Installers of the items involved:
      a. Interceptors.
      b. Piping connections. Include size, location, and elevation of each.
      c. Interface with underground structures and utility services.

E. Project Conditions
   1. Interruption of Existing Sewer Services: Do not interrupt services to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sewer services according to requirements indicated:
      a. Notify the Owner no fewer than seven days in advance of proposed interruption of service.
      b. Do not proceed with interruption of sewer services without the Owner's written permission.

1.2 PRODUCTS

A. Grease Interceptors
   1. Grease Interceptors: Precast concrete complying with ASTM C 913.
      a. Include rubber-gasketed joints, vent connections (if required), manholes, compartments or baffles, and piping or openings to retain grease and to permit wastewater flow, unless directed otherwise.
      b. Structural Design Loads:
         1) Light-Traffic Load: Comply with ASTM C 890, A-8 (ASSHTO HS10-44).
         2) Medium-Traffic Load: Comply with ASTM C 890, A-12 (ASSHTO HS15-44).
         3) Heavy-Traffic Load: Comply with ASTM C 890, A-16 (ASSHTO HS20-44).
         4) Walkway Load: Comply with ASTM C 890, A-03.

c. Resilient Pipe Connectors (if required): ASTM C 923 (ASTM C 923M), cast or fitted into interceptor walls, for each pipe connection.

d. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, **as directed**, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of interceptor to finished grade is less than 60 inches (1500 mm).

e. Grade Rings (if required): Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, to match diameter of manhole frame and cover.

f. Manhole Frames and Covers: Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch- (100-mm-) minimum width flange and 26-inch- (660-mm-) diameter cover.
   1) Ductile Iron: ASTM A 536, Grade 60-40-18, unless otherwise indicated.
   2) Gray Iron: ASTM A 48, Class 35, unless otherwise indicated.
   3) Include indented top design with lettering cast into cover, using wording equivalent to "INTERCEPTOR," or “GREASE INTERCEPTOR,” or “SANITARY SEWER."

B. Oil Interceptors

1. Oil Interceptors: Precast concrete comply with ASTM C 913.

a. Include rubber-gasketed joints, vent connections, manholes, compartments or baffles, and piping or openings to retain grease and to permit wastewater flow.

b. Structural Design Loads:
   1) Light-Traffic Load: Comply with ASTM C 890, A-8 (ASSHTO HS10-44).
   2) Medium-Traffic Load: Comply with ASTM C 890, A-12 (ASSHTO HS15-44).
   3) Heavy-Traffic Load: Comply with ASTM C 890, A-16 (ASSHTO HS20-44).
   4) Walkway Load: Comply with ASTM C 890, A-03.

c. Resilient Pipe Connectors (if required): ASTM C 923 (ASTM C 923M), cast or fitted into interceptor walls, for each pipe connection.

d. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, **as directed**,, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of interceptor to finished grade is less than 60 inches (1500 mm).

e. Grade Rings (if required): Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, to match diameter of manhole frame and cover.

f. Manhole Frames and Covers: Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch- (100-mm-) minimum width flange and 26-inch- (660-mm-) diameter cover.
   1) Ductile Iron: ASTM A 536, Grade 60-40-18, unless otherwise indicated.
   2) Gray Iron: ASTM A 48, Class 35, unless otherwise indicated.
   3) Include indented top design with lettering cast into cover, using wording equivalent to "INTERCEPTOR," or “OIL INTERCEPTOR,” or “SANITARY SEWER."

g. Waste-oil storage tank and piping are specified in Division 23 Section "Facility Fuel-oil Piping".

2. Oil Interceptors: Factory-fabricated, cast-iron or steel body; with removable sediment bucket or strainer, baffles, vents, and flow-control fitting on inlet.

a. Inlet, Outlet, Vent, and Waste-Oil Outlet Piping Connections: Hub, hubless, or threaded, unless otherwise indicated.

b. Extension (if required): Cast-iron or steel shroud, full size of interceptor, extending from top of interceptor to grade.

c. Cover: Cast iron or steel, with steel reinforcement to provide ASTM C 890, A-03, walkway load, **as directed**.
d. Comply with requirements in Division 23 Section "Facility Fuel-oil Piping" for waste-oil storage tank and piping

3. Oil Interceptors: Plastic body; with removable sediment bucket or strainer, baffles, vents, and flow-control fitting on inlet.
   a. Inlet, Outlet, Vent, and Waste-Oil Outlet Piping Connections: Hub, hubless, or threaded, unless otherwise indicated.
   b. Extension (if required): Plastic shroud, full size of interceptor, extending from top of interceptor to grade.
   c. Cover: Plastic with steel reinforcement to provide ASTM C 890, A-03, walkway load, as **directed**.
   d. Waste-oil storage tank and piping are specified in Division 23 Section "Facility Fuel-oil Piping".

C. Sand Interceptors
1. Description: Factory-fabricated, cast-iron or steel body and inlet grate; with settlement chamber and removable basket or strainer.
2. Outlet Piping Connection: Hub, hubless, or threaded, unless otherwise indicated.
3. Grate: Cast iron or steel with reinforcement to provide ASTM C 890, A-03, walkway load, **as directed**.

D. Precast-Concrete Manhole Risers
1. Precast-Concrete Manhole Risers: ASTM C 478 (ASTM C 478M) **OR** ASTM C 913, **as directed**, with rubber-gasket joints.
   a. Structural Design Loads:
      1) Light-Traffic Load: Comply with ASTM C 890, A-8 (ASSHTO HS10-44).
      2) Medium-Traffic Load: Comply with ASTM C 890, A-12 (ASSHTO HS15-44).
      3) Heavy-Traffic Load: Comply with ASTM C 890, A-16 (ASSHTO HS20-44).
      4) Walkway Load: Comply with ASTM C 890, A-03.
   b. Length: From top of underground concrete structure to grade.
   c. Riser Sections: 3-inch (75-mm) minimum thickness and 36-inch (915-mm) diameter.
   d. Top Section: Eccentric cone, unless otherwise indicated. Include top of cone to match grade ring size.
   e. Gaskets: ASTM C 443 (ASTM C 443M), rubber.
   f. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, **as directed**, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals.
2. Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, diameter matching manhole frame and cover, and height as required to adjust the manhole frame and cover to indicated elevation and slope.
3. Manhole Frames and Covers (if required): Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch- (100-mm-) minimum width flange and 26-inch- (660-mm-) diameter cover.
   a. Ductile Iron: ASTM A 536, Grade 60-40-18, unless otherwise indicated.
   b. Gray Iron: ASTM A 48, Class 35, unless otherwise indicated.
   c. Include indented top design with lettering cast into cover, using wording equivalent to the following:
      1) Grease Interceptors in Sanitary Sewerage System: "INTERCEPTOR" **OR** "GREASE INTERCEPTOR" **OR** "SANITARY SEWER", **as directed.**
      2) Oil Interceptors in Sanitary Sewerage System: "INTERCEPTOR" **OR** "OIL INTERCEPTOR" **OR** "SANITARY SEWER", **as directed**.

1.3 EXECUTION

A. Earthwork
   1. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving".

B. Installation
   1. Install precast-concrete interceptors according to ASTM C 891. Set level and plumb.
   2. Install manhole risers from top of underground concrete interceptors to manholes and gratings at finished grade.
   3. Set tops of manhole frames and covers flush with finished surface in pavements. Set tops 3 inches (75 mm) above finish surface elsewhere, unless otherwise indicated.
   4. Set tops of grating frames and grates flush with finished surface.
   5. Set metal and plastic interceptors level and plumb.
   6. Set tops of metal interceptor covers flush with finished surface in pavements. Set tops 3 inches (75 mm) above finish surface elsewhere, unless otherwise indicated.
   7. Install piping and oil storage tanks according to Division 23 Section "Facility Fuel-oil Piping".

C. Connections
   1. Piping installation requirements are specified in other Division 22. Drawings indicate general arrangement of piping, fittings, and specialties.
   2. Make piping connections between interceptors and piping systems.

D. Identification
   1. Identification materials and installation are specified in Division 31 Section "Earth Moving". Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.
      a. Use warning tapes or detectable warning tape over ferrous piping.
      b. Use detectable warning tape over nonferrous piping and over edges of underground structures.

END OF SECTION 22 13 19 26

Task	Specification	Specification Description
22 13 19 26	22 13 19 00	High-Efficiency Particulate Filtration
22 13 19 33	21 05 23 00	Piped Utilities Basic Materials And Methods
22 13 19 33	22 05 76 00	Sanitary Sewerage
22 13 19 33	21 05 23 00a	General-Duty Valves for Plumbing Piping
22 13 19 33	21 05 23 00b	General-Duty Valves for HVAC Piping
22 13 19 33	22 13 19 00	High-Efficiency Particulate Filtration
22 13 19 36	22 13 19 00	High-Efficiency Particulate Filtration
22 13 23 00	22 13 19 26	Interceptors

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SECTION 22 13 29 13 - PACKAGED SEWAGE PUMPING STATIONS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for packaged sewage pumping stations. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes dry-well, packaged pumping stations with dry-well or vacuum-primed sewage pumps.
2. This Section includes wet-well, packaged pumping stations with submersible or submersible grinder or wet-well-mounting sewage pumps.

C. Performance Requirements
1. Pressure Rating of Sewage Pumps and Discharge Piping Components: At least equal to sewage pump discharge pressure, but not less than 125 psig (860 kPa).
2. Pressure Rating of Other Piping Components: At least equal to system operating pressure.

D. Submittals
1. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.
2. Shop Drawings: Show fabrication and installation details for each packaged pumping station. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   a. Wiring Diagrams: Power, signal, and control wiring.
3. Product Certificates: For sewage pumps, signed by product manufacturer.
4. Manufacturer Seismic Qualification Certification
5. Field quality-control test reports.
6. Maintenance Data: For packaged pumping stations to include in maintenance manuals.

E. Quality Assurance
1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Testing Agency Qualifications: Nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
4. Comply with HI 1.1-1.2, "Centrifugal Pumps for Nomenclature and Definitions"; HI 1.3, "Centrifugal Pumps for Design and Application"; and HI 1.4, "Centrifugal Pumps for Installation, Operation and Maintenance," for sewage and sump pumps.
5. Comply with UL 778, "Motor-Operated Water Pumps," for sewage and sump pumps.

F. Project Conditions
1. Interruption of Existing Sanitary Sewer Service: Do not interrupt sanitary sewer service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sanitary sewer service according to requirements indicated:
   a. Notify the Owner no fewer than two days in advance of proposed interruption of sanitary sewer service.

b. Do not proceed with interruption of sanitary sewer service without the Owner's written permission.

1.2 PRODUCTS

A. Dry-Well, Packaged Sewage Pumping Stations
1. Dry-Well, Packaged Sewage Pumping Stations with Dry-Well Sewage Pumps:
a. Description: Factory fabricated, assembled, and tested with wet well for comminutor and collection of sanitary sewage and with dry equipment chamber for sewage pumps, controls, and accessories.
1) Orientation: Shell underground with dry equipment chamber underground with top flush with grade **OR** partially recessed underground **OR** above grade **OR** underground with entrance tube to grade, **as directed**.
2) Shell: Factory fabricated from structural-steel plate **OR** fiberglass, **as directed**.
3) Entrance Tube: From dry compartment to entrance at grade, and of size required to replace largest piece of equipment, but not smaller than 36 inches (914 mm) in diameter.
4) Cathodic Protection: as directed by the Owner, exterior magnesium anode(s).
5) Comminutor: Full size of sewage inlet pipe.
6) Sewage Pumps: Two **OR** Three, **as directed**, dry-well-type, nonclog sewage pumps with controls and piping. Include ASTM A 48/A 48M, Class 25, nonclog, cast-iron impeller capable of passing solids of 3-inch (76-mm) minimum diameter; mechanical or stuffing-box seals; and pedestal-mounted motor.
2. Dry-Well, Packaged Sewage Pumping Stations with Vacuum-Primed Sewage Pumps:
a. Description: Factory fabricated, assembled, and tested with wet well for comminutor and collection of sanitary sewage and with dry equipment chamber for sewage pumps, vacuum pumps, controls, and accessories.
1) Orientation: Shell underground with dry equipment chamber underground with top flush with grade **OR** partially recessed underground **OR** above grade **OR** underground with entrance tube to grade, **as directed**.
2) Shell: Factory fabricated from structural-steel plate **OR** fiberglass, **as directed**.
3) Entrance Tube: From dry compartment to entrance at grade, and of size required to replace largest piece of equipment, but not smaller than 36 inches (914 mm) in diameter.
4) Cathodic Protection: as directed by the Owner, exterior magnesium anode(s).
5) Comminutor: Full size of sewage inlet pipe.
6) Sewage Pumps: Two **OR** Three, **as directed**, dry-chamber-mounting, vacuum-primed, nonclog sewage pumps located in dry compartment above wet pit, with controls and piping. Include ASTM A 48/A 48M, Class 25, nonclog, cast-iron impeller capable of passing solids of 3-inch (76-mm) minimum diameter; mechanical or stuffing-box seals; pedestal-mounted motor; and suction piping extending to bottom of wet pit.
7) Vacuum Pumps: Duplex arrangement with controls, vacuum piping, and vent piping of size and capacity required for system. Include automatic alternator, with manual disconnect switch, to change sequence of lead-lag vacuum pumps at completion of each cycle.

B. Wet-Well, Packaged Sewage Pumping Stations
1. Wet-Well, Packaged Sewage Pumping Stations with Submersible Sewage Pumps:
a. Description: Factory fabricated, assembled, and tested with wet well for comminutor, sewage pumps and collection of sanitary sewage and with sewage pumps and dry equipment chamber for controls and accessories.

1) Orientation: Shell underground with dry equipment chamber underground with top flush with grade **OR** partially recessed underground **OR** above grade **OR** underground with entrance tube to grade, **as directed**.
2) Shell: Factory fabricated from structural-steel plate **OR** fiberglass, **as directed**.
3) Entrance Tube: From dry compartment to entrance at grade, and of size required to replace largest piece of equipment, but not smaller than 36 inches (914 mm) in diameter.
4) Cathodic Protection: as directed by the Owner, exterior magnesium anode(s).
5) Comminutor: Full size of sewage inlet pipe.
6) Sewage Pumps: Two **OR** Three, **as directed**, submersible-type sewage pumps, with guide rail, quick-disconnect system, controls, and piping. Include ASTM A 48/A 48M, Class 25, nonclog, cast-iron impeller capable of passing solids of 3-inch (76-mm) minimum diameter; and hermetically sealed motor with moisture-sensing probe, mechanical seals, and waterproof power cable.

2. Wet-Well, Packaged Sewage Pumping Stations with Submersible Grinder Sewage Pumps:
   a. Description: Factory fabricated, assembled, and tested with wet well for sewage pumps and collection of sanitary sewage and with dry equipment chamber for controls and accessories.
      1) Orientation: Shell underground with dry equipment chamber underground with top flush with grade **OR** partially recessed underground **OR** above grade **OR** underground with entrance tube to grade, **as directed**.
      2) Shell: Factory fabricated from structural-steel plate **OR** fiberglass, **as directed**.
      3) Entrance Tube: From dry compartment to entrance at grade, and of size required to replace largest piece of equipment, but not smaller than 36 inches (914 mm) in diameter.
      4) Cathodic Protection: as directed by the Owner, exterior magnesium anode(s).
      5) Sewage Pumps: Two **OR** Three, **as directed**, submersible grinder-type sewage pumps, with guide rail, quick-disconnect system, controls, and piping. Include stainless-steel grinder impeller and hermetically sealed motor with moisture-sensing probe, mechanical seals, and waterproof power cable.
         a) If Project has more than one wet-well, packaged sewage pumping station with submersible grinder sewage pumps,

3. Wet-Well, Packaged Sewage Pumping Stations with Wet-Well-Mounting Sewage Pumps:
   a. Description: Factory fabricated, assembled, and tested with wet well for comminutor, sewage pumps and collection of sanitary sewage and with suspended sewage pumps and dry equipment chamber for pump motors, controls, and accessories.
      1) Orientation: Shell underground with dry equipment chamber underground with top flush with grade **OR** partially recessed underground **OR** above grade **OR** underground with entrance tube to grade, **as directed**.
      2) Shell: Factory fabricated from structural-steel plate **OR** fiberglass, **as directed**.
      3) Entrance Tube: From dry compartment to entrance at grade, and of size required to replace largest piece of equipment, but not smaller than 36 inches (914 mm) in diameter.
      4) Cathodic Protection: as directed by XXXXcontractingpositiontheXXX, exterior magnesium anode(s).
      5) Comminutor: Full size of sewage inlet pipe.
      6) Sewage Pumps: Two **OR** Three, **as directed**, wet-well-mounting-type, nonclog sewage pumps suspended from dry-compartment floor, with controls and piping. Include ASTM A 48/A 48M, Class 25, nonclog, cast-iron impeller capable of passing solids of 3-inch (76-mm) minimum diameter; grease-lubricated bearings and stuffing-box seal; shaft coupling; and pedestal-mounted motor.

C. Comminutors:
   1. Description: Motor-operated, single- or twin-shaft, cutter- or grinder-design unit with controls; for pipeline installation.
      a. Body: Stainless steel or ductile iron with flanged ends and access plate.

b. Cutting Elements: Motor-driven rotor and stationary cutters or grinders of hardened stainless or heat-treated steel.
c. Motor: Explosion proof, directly connected to body.
d. Control Panel: NEMA 250, Type 12 enclosure for installation in dry equipment chamber.

D. Controls
1. Control Sequence of Operation: Cycle each sewage pump on and off automatically to maintain wet-well sewage level. Automatic control operates both pumps in parallel if wet-well level rises above starting point of low-level pump, until shutoff level is reached. Automatic alternator, with manual disconnect switch, changes sequence of lead-lag sewage pumps at completion of each pumping cycle.
2. Self-Purging, Air-Bubbler System: Senses variations of sewage level in wet well. Include duplex-arrangement oilless air compressors to furnish bubbler air; filters; air-storage reservoir; piping; airflow meter with needle valve adjustment for airflow regulation; sewage depth gage; air-bubbler piping to wet well; and pressure-sensing, dustproof mercury switches.
3. Electrode **OR** Float-Switch **OR** Pressure-Switch **OR** Ultrasonic, **as directed**, System: Senses variations of sewage level in wet well. Include high and low adjustments capable of operating on 6-inch (150-mm) minimum differential of liquid level.
4. Motor Controllers: Magnetic, full voltage, nonreversing. Include undervoltage release, thermal-overload heaters in each phase, manual reset buttons, and hand-automatic selector switches. Include circuit breakers to provide branch-circuit protection for each controller.
5. 120-V accessory controls with 15-A, single-phase circuit breakers or fuses for each item.
6. Control Panel: Enclosure complying with UL 508A and with UL 508A, Supplement SB, **as directed**, with separate compartments and covers for controllers, circuit breakers, transformers, alternators, and single-phase controls. Include 20-A duplex receptacle in NEMA WD 1, Configuration 5-20R mounted on exterior of control panel.
   a. Mounting: Inside, on dry-chamber wall **OR** Outside, on pedestal, at grade, **as directed**.
   b. Enclosure: NEMA 250, Type 1 **OR** 4 **OR** 4X, **as directed**.
7. Install labels on panel face to identify switches and controls.
8. Wiring: Tin-copper wiring.
9. Connection for Portable Generator: Nonautomatic (manual) transfer switch with receptacle matching generator electrical power requirements. Nonautomatic transfer switches are specified in Division 26 Section "Transfer Switches" and receptacles are specified in Division 26 Section "Wiring Devices".

E. Accessories
1. Lighting: Minimum of 2, UL 1571, heavy-duty, cast-metal, wet-location-type fixtures with 100-W bulbs and guards in service area. Locate switches, with pilot lights, at chamber entrance.
2. Submersible Sump Pump:
   a. Discharge Size: NPS 1-1/4 (DN 32) minimum.
   b. Pump End Bell and Motor Shell: Cast iron.
   c. Motor: 1/3 hp, 1750-rpm, hermetically sealed, capacitor-start, with built-in overload protection.
   d. Impeller: ASTM B 584, cast bronze or ASTM B 36/B 36M, brass.
   e. Shaft: Stainless steel.
   f. Bearings: Grease-lubricated, factory-sealed ball bearings.
   g. Seals: Mechanical.
   h. Accessories: Inlet strainer.
   i. Controls: Float switch.
3. Dehumidifier: Electric refrigeration system, adjustable humidistat, reverse-acting thermostat for low-temperature cutoff controls, and condensate pump with drain piping to sump.
   a. Dehumidification system capacity adequate to remove at least 15 pints (7 L) of water per day from service area air that is 80 deg F (27 deg C) with a relative humidity of 60 percent.
4. Ventilation: Electrically powered ventilation system. Include centrifugal blower with 4-inch- (100-mm-) round exhaust vent designed to keep out rain, insects, and other foreign matter; limit switch

to start blower if entrance door or lid is opened; 0- to 15-minute timer; and separate manual switch.

a. Ventilating system capacity to change air in dry equipment chamber every two minutes.

5. Heater: Electric, 1.5 kW minimum, with fan and thermostat control.
6. High-Water Audio Alarm: Horn for audio indication of station high-water level, energized by separate level-detecting device. Include alarm silencer switch and relay in station.
7. Remote Alarm Circuit: Include contacts for connection to remote alarm panel.

F. Motors

1. General requirements for motors are specified in Division 22 Section "Common Motor Requirements For Plumbing Equipment".

G. Miscellaneous Materials

1. Structural Steel: ASTM A 6/A 6M, W or HP shapes, or ASTM A 36/A 36M, plates or beams.
2. Grout: ASTM C 1107, Grade B, nonshrink cement grout.
   a. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
3. Concrete: Concrete is specified in Division 03 Section "Cast-in-place Concrete".

H. Packaged Sewage Pumping Station Fabrication

1. Fabricate shell from structural-steel plate with continuous welds to make watertight and gastight construction.
   a. Walls: 1/4-inch (6.4-mm) minimum thickness.
   b. Top and Bottom Heads: 3/8-inch (9.5-mm) minimum thickness. Weld reinforcing steel to top and bottom heads.
   c. Entrance-Tube Walls: 1/4-inch (6.4-mm) minimum thickness.
   d. Weld steel access ladder and air vent to shell and entrance tube, **as directed**.
   e. Apply three coats of epoxy resin to interior and exterior surfaces.
   f. Include at least two **OR** four, **as directed**, exterior magnesium anode(s) for cathodic protection.
2. Fabricate shell from fiberglass with structural-steel reinforcement.
   a. Attach structural-steel reinforcement to top and bottom heads.
   b. Fabricate shell with continuous joints to make watertight and gastight construction.
   c. Attach air vent to pump chamber and entrance tube, **as directed**.
   d. Ladder: Steel **OR** Fiberglass, **as directed**.
3. Install sump, 18 inches (450 mm) in diameter by 10 inches (254 mm) deep in dry-chamber floor. Slope floor toward sump and fasten rubber mat to floor walkway with cement.
4. Entrance tube may be furnished separately for field installation.
5. Entrance Cover: Waterproof and corrosion resistant, with lock. Include way to open cover from inside tube if cover is locked.
6. Air Vent: Duct fabricated from corrosion-resistant material, extended to above grade, outlet turned down, and with insect screen in outlet.
7. Factory fabricate piping between unit components.
   a. Use galvanized-steel pipe and cast-iron fittings or ductile-iron pipe and fittings.
   b. Use fittings for changes in direction and branch connections.
   c. Flanged and union joints may be used instead of joints specified.
   d. Use dielectric fittings for connections between ferrous- and copper-alloy piping.
8. Piping Connections: Unless otherwise indicated, make the following piping connections:
   a. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment having NPS 2 (DN 50) or smaller threaded pipe connection.
   b. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
9. Valves: Ferrous alloy.
   a. Sewage Pump Piping: Include gate valve on each pump inlet and gate and check valves on each discharge pipe.
   b. Sump Pump Piping: Include ball or gate and check valves on discharge pipe.

c. Compressed-Air Piping: Include ball and check valves on discharge pipe from each air compressor.
d. Vacuum Piping: Include ball and check valves on inlet pipe to each vacuum pump.
10. Wiring: Tin-coated copper.

I. Source Quality Control
1. Test and inspect sewage and sump, **as directed**, pumps according to HI 1.6, "Centrifugal Pump Tests." Include test recordings that substantiate correct performance of pumps at design head, capacity, suction lift, speed, and horsepower.
2. Test accessories and controls through complete cycle. Include test recordings that substantiate correct performance.

1.3 EXECUTION

A. Earthwork
1. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving".

B. Installation
1. Install packaged sewage pumping station components where indicated, according to specific equipment and piping arrangement indicated.
2. Shell Base Supports: Form from structural-steel beams, of number and lengths required to support bottom of shell and to anchor beams to concrete foundation.
a. Use elevator blocks attached to bottom of shell to slope station floor 1 inch in 10 feet (25.4 mm in 3 m) down toward sump.
3. Grout under and around shell. Ensure that there are no voids between foundation slab and underslab of pumping station.
4. Fill voids between shell sidewalls, sleeves, and piping and make watertight seal with grout.
5. Connect anode conductors to grounding lugs on steel housing.
6. Join separate sections of housing by field welding.
7. Field weld entrance tube to housing.

C. Connections
1. Sanitary sewer piping installation requirements are specified in Division 22 Section "Facility Sanitary Sewers". Drawings indicate general arrangement of piping.
2. Install piping adjacent to machine to allow service and maintenance.
3. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
4. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

D. Identification
1. Install identifying labels permanently attached to equipment.
2. Install operating instruction signs permanently attached to equipment or on pumping station wall near equipment.
3. Arrange for installing green warning tape or detectable warning tape over outside edges of underground packaged sewage pumping stations. Tape materials and their installation are specified in Division 31 Section "Earth Moving".

E. Painting
1. Prepare and paint ferrous piping in wet wells, structural-steel supports, and anchor devices with coal-tar epoxy-polyamide paint according to SSPC-Paint 16.
2. Paint field-welded areas to match factory coating.

F. Field Quality Control

1. Testing Agency: Engage a qualified testing agency to perform field tests and inspections and prepare test reports.
2. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.. Report results in writing.
3. Perform tests and inspections and prepare test reports.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
4. Tests and Inspections:
   a. After installing packaged sewage pumping stations and after electrical circuitry has been energized, test for compliance with requirements. Furnish water required for pump tests.
   b. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
   c. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Remove and replace packaged sewage pumping stations that do not pass tests and inspections and retest as specified above.

G. Startup Service
1. Engage a factory-authorized service representative to perform startup service.
   a. Complete installation and startup checks according to manufacturer's written instructions.
   b. Adjust pump, accessory, and control settings, and safety and alarm devices.

H. Demonstration
1. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain packaged sewage pumping stations.

END OF SECTION 22 13 29 13

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SECTION 22 13 29 13a - LIFT STATION

1.1 GENERAL

A. Description Of Work

1. This Specification covers the furnishing and installation of sewage lift stations. Work includes but is not limited to earthwork, installation of watertight precast concrete sump basin, basin access cover, submersible sewage pumps, pump guide rail system, pump control system, valves and piping and electrical connections as required. Specific sizes of basins, pumps, and piping shall be as follows or as directed by the Owner.

B. Submittals

1. Product Data: For each type of product indicated.
   a. Pipe and fittings
   b. Check valves
   c. Gate valves
   d. Submersible sewage grinder pumps
   e. Pump motor
   f. Flexible flanged coupling
2. Operation and Maintenance Data: Include pumps, alarms, and motors. Data for submersible sewage grinder pump station data shall include all information on all equipment, alarm panel and controls, pumps and pump performance curves, and station layout.

C. Delivery, Storage, and Handling of Materials

1. Delivery and Storage: Inspect materials delivered to site for damage. Unload and store with minimum handling. Store materials in enclosures or under protective covering. Store rubber gaskets not to be installed immediately under cover, out of direct sunlight. Do not store materials directly on the ground. Keep interior of pipes and fittings free of dirt and debris.
2. Handling: Handle pipe, fittings, valves, and other accessories in such manner as to ensure delivery to the trench in sound, undamaged condition. Avoid injury to coatings and linings on pipe and fittings; make satisfactory repairs if coatings or linings are damaged. Carry pipe to the trench; do not drag it.

1.2 PRODUCTS

A. Precast Concrete Sump Basin(s)

1. Precast Concrete Sump Basin shall be constructed in conformance with Division 26 Section "Underground Ducts And Raceways For Electrical Systems". Basin shall have an integral bottom base section.
2. Joint Sealant: Seal all joints with EZ Stik Butyl Gasket as manufactured by Concrete Products Supply Co., or approved equal. Install in accordance with manufacturer’s recommendations.
3. Pipe Opening Seals.
4. Waterproofing: Waterproof interior of concrete sump with one coat of Koppers Coal Tar Bitumastic Black or approved equal. Repair all damaged coating before final backfill. Do not coat cover of basin.
5. Access Hatch - Aluminum Hinged Frame and Cover Model EC-3HD by Syracuse Castings, Cicero, NY (315) 699-2601, or approved equal. Frame and cover shall be heavy duty, rated for H-20 Loadings. Frame shall be angle style frame. Material shall be 6061-T6 aluminum for bars, angles and extrusions. 1/4" diamond plate shall be 5086 aluminum. Unit designed heavy duty, for H-20 wheel loads where not subject to high density traffic. Unit supplied with a heavy duty pneu-spring, for ease of operation when opening cover. Each hatch shall be equipped with a hold open arm. Door shall lock open in the 90 degree position. Hinges shall be of heavy duty design. Material shall be a brass alloy with a 65,000 psi tensile strength. Each hinge shall have

a Grade 316 Stainless Steel, 3/8" diameter hinge pin. Exterior of frame, which comes in contact with concrete shall have one coat black bituminous paint. Unit supplied with a recessed stainless steel slamlock. Angle frame must be completely encased in concrete. Both bearing plates must be fully supported by a bed of concrete.

6. The unit shall be supplied with aluminum safety grate. Safety Grate shall be made of 6061-T6 aluminum with a minimum ultimate strength of 38,000 psi and a minimum yield strength of 35,000 psi as per ASTM B221. Grate design shall use safety factors as defined in the "Specifications for Aluminum Structures", by the Aluminum Association, Inc., 5th edition, DEC. 1986 for "Bridge Type Structures."
   a. Grating shall be designed to withstand a minimum live load of 300 pounds per square foot. Deflection shall not exceed 1/150th of the span.
   b. Grate openings shall be 4" x 4", which will allow for visual inspection of the pit once the access hatch is open.
   c. Each grate shall be provided with a stainless steel, safety check chain. Chain will prevent the grating from falling into the pit.
   d. Welding shall be in accordance with ANSI/AWS D1.2 "Structural Welding Code for Aluminum."

B. Submersible Sewage Pump System
1. Submersible sewage effluent pumps shall be sized as directed by the Owner and specified herein. Pump shall be heavy duty cast iron with stainless steel fasteners. The impeller shall be semi-open, non-clog, engineered plastic capable of passing 3/4" solids. Pump motor shall be oil filled. Pumps shall be equal to SHEF Series as manufactured by Hydromatic or approved equal. Specific pump performance data shall conform to the following:

1/2 HP Pumps 230 volt/single phase/60 Hz/2" NPT/ 3450 rpm
40 gpm @ 42 ft. TDH
50 gpm @ 32 ft. TDH
60 gpm @ 18 ft. TDH

1 HP Pumps 230 volt/single phase/60 Hz/2" NPT/3450 rpm
20 gpm @ 80 ft. TDH
30 gpm @ 76 ft. TDH
40 gpm @ 71 ft. TDH
50 gpm @ 65 ft. TDH

C. Duplex Guide Rail System: Complete package system shall be as manufactured by Moran Manufacturing Inc., or approved equal, as follows.
1. The guide rail assembly shall be constructed of Type 304 stainless steel and shall consist of a minimum of two rails, a bottom base plate, a <u>minimum</u> of one cross brace every 18 inches between the rails and a wall brace, all welded together to provide the maximum structural integrity. The rails shall be round to provide a non-binding surface during installation and removal of the pump. The guide rail assembly shall be installed as a one piece unit and shall be bolted with stainless anchor bolts to the basin bottom and the basin wall a minimum of two places each.
2. The pump bracket assembly shall consist of a top bracket and a bottom bracket. The brackets shall be fabricated of 1/4" steel material and shall be painted with coal tar epoxy paint at such rate as to provide a <u>minimum</u> 10 mil thickness. The top bracket shall be attached to the discharge piping above the pump disconnect and shall be constructed in such a manner that pump cannot be removed from the guide rail assembly except when removing pump out the top of the sump basin. The bottom bracket shall be attached to the pump at the discharge connection and shall guide the pump along the guide rail assembly to ensure proper alignment of the pump.

3. A 3/16" min. (7 x 9) stainless steel lifting cable, 10 ft. longer than the sump depth, shall be furnished for lifting and lowering the pump in the sump basin. The stainless steel lifting cable shall be of the 18-8 type 302/304 stainless steel and shall have minimum nominal breaking strength of 15 times the weight of the pump. It shall be substantially attached to the top of the pump and shall have a formed loop at the other end.
4. The discharge piping shall include a cast iron ball check valve, with a natural rubber ball and clean out port with plug for easy access, a brass quick disconnect fitting, with an O-ring stem brass gate valve, per pump. All other piping shall be schedule 40 stainless steel.
5. The station shall have a gate valve extension handle per valve which will allow the gate valve to be operated from a maximum of 6" below the basin cover. The handle shall be constructed of a minimum of 3/8" dia. Type 304 stainless steel. The handle shall be held in place by being attached to the gate valve and by the guide rail wall brace.
6. All internal metal parts that are not brass, galvanized steel, or stainless steel shall be painted with coal-tar epoxy paint to resist corrosion, unless otherwise noted.
7. Mercury level control switches shall be provided for lead pump on, lag pump on and high level alarm, pumps off and low level alarm.
8. The mercury switch shall be encapsulated in polyurethane foam for corrosion and shock resistance. Level switches shall be weighted to hold position in the sump. The cord connecting the control shall be No. 16-2, rated for 13 amps, and shall be type C-SJO. To ensure optimum longevity, mercury contacts shall be of the mercury-to-mercury type and encapsulated in a glass tube and shall be rated for 20 amps at 115 VAC.
9. The manufacturer of the lift station shall furnish a limited warranty for 18 months from the date of shipment or 12 months from start-up (whichever occurs first), that all equipment shall be free from defects in design, materials and workmanship. The lift station manufacturer shall furnish replacement parts for any component proven defective whether of its or other manufacturer during the warranty period, excepting only those items which are normally consumed in service, such as (but not limited to) light bulbs, oil, grease, packing, etc.
10. Installation instructions shall be furnished with the station.

D. Control System
1. This system shall be controlled and protected by a packaged system as manufactured by Rombus, or approved equal. The control shall provide automatic start, stop and alternation of 2 pumps, and shall provide an audible alarm as well as visual indication of high level conditions.
2. The control panel shall be pre-wired in a NEMA 3R weatherproof enclosure, and all necessary components including the following: single phase lightning arrestor for protection of the pumps, NEMA rated contractor and thermal magnetic circuit breaker for each pump, a main control/alarm circuit fused disconnect switch, separately fused control and alarm circuits, panel mounted duplex alternating relays, control relays, and terminal blocks for the connection on all external wiring. Provide a 20 amp/115v convenience outlet in each panel on its own GFCI circuit breaker. Multi-colored circuitry is to be used within the control panel to facilitate trouble shooting.
3. Mounted inside the enclosure shall be hand-off-auto switches and run pilot lights for each pump circuit; normal-off-test switch and alarm pilot light for high level alarm; float test toggle switches for each float to override floats to simulate operation; non-resettable elapsed time meters for each pump.
4. Mounted remotely from the Control Panel shall be a 4" 120V alarm bell and a flashing alarm light.

E. System Operation: As the level in the sump rises to the lead pump on level, the pump selected as lead by the alternator will come on line, and will pump the level down to the pump off level. The pump will then turn off, and the alternator will cycle, selecting the other pump as lead for the next cycle. If, with the lead pump running, the level in the tank continues to rise to the lag pump on level, the lag pump will come on line, alarms will sound, and will run with the lead pump until the pumps off level has been reached. The pumps will then be turned off, and the alternator will cycle. If level continues to drop to the low level alarm float, alarm circuits will be activated.
1. Placing the T-O-N switch into the off position will de-energize the alarm bell and flashing light, but the alarm pilot light will remain illuminated until the alarm condition has been cleared. When the

alarm pilot light is extinguished, the T-O-N switch may be reset to the normal position, and the alarm will stand ready for the next alarm.

1.3 EXECUTION

A. The Contractor shall excavate the station site to the elevations as required to meet project requirements. Compact the subgrade and install crushed stone.

B. Install lift station in accordance with manufacturer's recommendations. Perform additional exterior waterproofing as required to repair original coating and to achieve a watertight sump basin. The discharge piping shall be extended and connected to the sewage force mains. Backfill material shall be approved by the Owner. No backfill material shall have any dimension greater than 6". Backfill material within 15" of basin shall not have a dimension greater than 2".

C. The Lift Station control panel shall be mounted to the building nearby and shall have sufficient cord supplied by the Lift Station manufacturer to avoid any splices. All necessary electrical connections between pumps, flow controls and control panel shall be made in accordance with manufacturer's recommendations. No splices shall be made in the basin. Lightning protection shall be provided in the panel.

D. Install pump power conductors in rigid steel conduit between Lift Station and Control Panel.

E. Upon completion, the Lift Station shall be tested to assure there is no leakage and that the pumps, controls and alarm are operating satisfactorily. The Lift Station manufacturer's representative shall be present during initial start up and testing. Three (3) Lift Station operation and maintenance manuals shall be provided.

END OF SECTION 22 13 29 13a

SECTION 22 13 29 13b - SEWAGE PUMPS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for sewage pumps. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Submersible effluent pumps.
      b. Submersible sewage pumps.
      c. Wet-pit-volute sewage pumps.
      d. Sewage-pump, reverse-flow assemblies.
      e. Sewage-pump basins and basin covers.
      f. Progressing-cavity sewage pumps.
      g. Packaged, submersible sewage-pump units.
      h. Packaged wastewater-pump units.

C. Submittals
   1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   2. Wiring Diagrams: For power, signal, and control wiring.
   3. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

D. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. UL Compliance: Comply with UL 778 for motor-operated water pumps.

E. Delivery, Storage, And Handling
   1. Retain shipping flange protective covers and protective coatings during storage.
   2. Protect bearings and couplings against damage.
   3. Comply with pump manufacturer's written rigging instructions for handling.

F. Coordination
   1. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.2 PRODUCTS

A. Submersible Effluent Pumps
   1. Submersible, Fixed-Position, Single-Seal Effluent Pumps:
      a. Description: Factory-assembled and -tested effluent-pump unit.
      b. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.
      c. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
      d. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron **OR** ASTM A 532/A 532M, abrasion-resistant cast iron **OR** ASTM B 584, cast bronze, **as**

directed, and stainless steel, **as directed**, closed or semiopen design for clear wastewater, and keyed and secured to shaft.

e. Pump and Motor Shaft: Stainless steel **OR** steel, **as directed**, with factory-sealed, grease-lubricated ball bearings.

f. Seal: Mechanical.

g. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
   1) Motor Housing Fluid: Air **OR** Oil, **as directed**.

h. Controls (rod-and-float type):
   1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**.
   2) Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
   3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
   4) Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
   5) High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

i. Controls (float- and pressure-switch types):
   1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**.
   2) Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
   3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
   4) High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

j. Control-Interface Features:
   1) Remote Alarm Contacts: For remote alarm interface.
   2) Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
      a) On-off status of pump.
      b) Alarm status.

2. Submersible, Fixed-Position, Double-Seal Effluent Pumps:

a. Description: Factory-assembled and -tested effluent-pump unit.

b. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.

c. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.

d. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron **OR** ASTM A 532/A 532M, abrasion-resistant cast iron **OR** ASTM B 584, cast bronze, **as directed**, and stainless steel, **as directed**, closed or semiopen design for clear wastewater, and keyed and secured to shaft.

e. Pump and Motor Shaft: Stainless steel **OR** steel, **as directed**, with factory-sealed, grease-lubricated ball bearings.

f. Seals: Mechanical.

g. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.

h. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
   1) Motor Housing Fluid: Air **OR** Oil, **as directed**.

i. Controls (rod-and-float type):
   1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**.
   2) Switch Type: Pedestal-mounted float switch with float rods and rod buttons.

3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
4) Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
5) High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

j. Controls (float- and pressure-switch types):
1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**.
2) Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
4) High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

k. Control-Interface Features:
1) Remote Alarm Contacts: For remote alarm interface.
2) Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
a) On-off status of pump.
b) Alarm status.

3. Submersible, Quick-Disconnect, Single-Seal Effluent Pumps:
a. Description: Factory-assembled and -tested effluent-pump unit with guide-rail supports.
b. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.
c. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.
d. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron **OR** ASTM A 532/A 532M, abrasion-resistant cast iron **OR** ASTM B 584, cast bronze, **as directed**, and stainless steel, **as directed**, closed or semiopen design for clear wastewater, and keyed and secured to shaft.
e. Pump and Motor Shaft: Stainless steel **OR** steel, **as directed**, with factory-sealed, grease-lubricated ball bearings.
f. Seal: Mechanical.
g. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
1) Motor Housing Fluid: Air **OR** Oil, **as directed**.

h. Controls (rod-and-float type):
1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**.
2) Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
4) Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
5) High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

i. Controls (float- and pressure-switch types):
1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**.
2) Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.

4) High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

j. Control-Interface Features:
   1) Remote Alarm Contacts: For remote alarm interface.
   2) Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
      a) On-off status of pump.
      b) Alarm status.

k. Guide-Rail Supports:
   1) Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
   2) Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
   3) Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
   4) Pump Yoke: Motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
   5) Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
   6) Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
   7) Lifting Cable: Stainless steel; attached to pump and cover at manhole.

4. Submersible, Quick-Disconnect, Double-Seal Effluent Pumps:
   a. Description: Factory-assembled and -tested effluent-pump unit with guide-rail supports.
   b. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.
   c. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.
   d. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron **OR** ASTM A 532/A 532M, abrasion-resistant cast iron **OR** ASTM B 584, cast bronze, **as directed**, and stainless steel, **as directed**, closed or semiopen design for clear wastewater, and keyed and secured to shaft.
   e. Pump and Motor Shaft: Stainless steel **OR** steel, **as directed**, with factory-sealed, grease-lubricated ball bearings.
   f. Seals: Mechanical.
   g. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
   h. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
      1) Motor Housing Fluid: Air **OR** Oil, **as directed**.
   i. Controls (rod-and-float type):
      1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**.
      2) Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
      3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
      4) Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
      5) High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
   j. Controls (float- and pressure-switch types):
      1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**.
      2) Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.

3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
4) High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

k. Control-Interface Features:
1) Remote Alarm Contacts: For remote alarm interface.
2) Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
a) On-off status of pump.
b) Alarm status.

l. Guide-Rail Supports:
1) Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
2) Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
3) Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
4) Pump Yoke: Motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
5) Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
6) Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
7) Lifting Cable: Stainless steel; attached to pump and cover at manhole.

B. Submersible Sewage Pumps
1. Submersible, Fixed-Position, Single-Seal Sewage Pumps:
a. Description: Factory-assembled and -tested sewage-pump unit.
b. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
c. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
d. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron **OR** ASTM A 532/A 532M, abrasion-resistant cast iron **OR** ASTM B 584, cast bronze, **as directed**, and stainless steel, **as directed**, nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
e. Pump and Motor Shaft: Stainless steel **OR** steel, **as directed**, with factory-sealed, grease-lubricated ball bearings.
f. Seal: Mechanical.
g. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
1) Motor Housing Fluid: Air **OR** Oil, **as directed**.
h. Controls (rod-and-float type):
1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**.
2) Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
4) Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
5) High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
i. Controls (float- and pressure-switch types):
1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**.

2) Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
4) High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

j. Control-Interface Features:
1) Remote Alarm Contacts: For remote alarm interface.
2) Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
a) On-off status of pump.
b) Alarm status.

2. Submersible, Fixed-Position, Double-Seal Sewage Pumps:
a. Description: Factory-assembled and -tested sewage-pump unit.
b. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
c. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
d. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron **OR** ASTM A 532/A 532M, abrasion-resistant cast iron **OR** ASTM B 584, cast bronze, **as directed**, and stainless steel, **as directed**, nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
e. Pump and Motor Shaft: Stainless steel **OR** steel, **as directed**, with factory-sealed, grease-lubricated ball bearings.
f. Seals: Mechanical.
g. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
h. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
1) Motor Housing Fluid: Air **OR** Oil, **as directed**.

i. Controls (rod-and-float type):
1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**.
2) Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
4) Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
5) High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

j. Controls (float- and pressure-switch types):
1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**.
2) Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
4) High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

k. Control-Interface Features:
1) Remote Alarm Contacts: For remote alarm interface.
2) Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
a) On-off status of pump.

b) Alarm status.

3. Submersible, Quick-Disconnect, Single-Seal Sewage Pumps:
   a. Description: Factory-assembled and -tested sewage-pump unit with guide-rail supports.
   b. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
   c. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.
   d. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron **OR** ASTM A 532/A 532M, abrasion-resistant cast iron **OR** ASTM B 584, cast bronze, **as directed**, and stainless steel, **as directed**, nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
   e. Pump and Motor Shaft: Stainless steel **OR** steel, **as directed**, with factory-sealed, grease-lubricated ball bearings.
   f. Seal: Mechanical.
   g. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
      1) Motor Housing Fluid: Air **OR** Oil, **as directed**.
   h. Controls (rod-and-float type):
      1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**.
      2) Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
      3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
      4) Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
      5) High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
   i. Controls (float- and pressure-switch types):
      1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**.
      2) Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
      3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
      4) High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
   j. Control-Interface Features:
      1) Remote Alarm Contacts: For remote alarm interface.
      2) Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
         a) On-off status of pump.
         b) Alarm status.
   k. Guide-Rail Supports:
      1) Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
      2) Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
      3) Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
      4) Pump Yoke: Motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
      5) Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
      6) Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
      7) Lifting Cable: Stainless steel; attached to pump and cover at manhole.

4. Submersible, Quick-Disconnect, Double-Seal Sewage Pumps:
   a. Description: Factory-assembled and -tested sewage-pump unit with guide-rail supports.
   b. Pump type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
   c. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.
   d. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron **OR** ASTM A 532/A 532M, abrasion-resistant cast iron **OR** ASTM B 584, cast bronze, **as directed**, and stainless steel, **as directed**, nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
   e. Pump and Motor Shaft: Stainless steel **OR** steel, **as directed**, with factory-sealed, grease-lubricated ball bearings.
   f. Seals: Mechanical.
   g. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
   h. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
      1) Motor Housing Fluid: Air **OR** Oil, **as directed**.
   i. Controls (rod-and-float type):
      1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**.
      2) Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
      3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
      4) Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
      5) High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
   j. Controls (float- and pressure-switch types):
      1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**.
      2) Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
      3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
      4) High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
   k. Control-Interface Features:
      1) Remote Alarm Contacts: For remote alarm interface.
      2) Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
         a) On-off status of pump.
         b) Alarm status.
   l. Guide-Rail Supports:
      1) Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
      2) Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
      3) Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
      4) Pump Yoke: Motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
      5) Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
      6) Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.

7) Lifting Cable: Stainless steel; attached to pump and cover at manhole.

5. Submersible, Quick-Disconnect, Grinder Sewage Pumps:
   a. Description: Factory-assembled and -tested, grinder sewage-pump unit with guide-rail supports.
   b. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
   c. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail supports.
   d. Impeller: Bronze or stainless steel; statically and dynamically balanced, with stainless-steel cutter, grinder, or slicer assembly; capable of handling solids; and keyed and secured to shaft.
   e. Pump and Motor Shaft: Stainless steel **OR** steel, **as directed**, with factory-sealed, grease-lubricated ball bearings.
   f. Seal: Mechanical.
   g. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
      1) Motor Housing Fluid: Air **OR** Oil, **as directed**.
   h. Controls (rod-and-float type):
      1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**.
      2) Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
      3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
      4) Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
      5) High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
   i. Controls (float- and pressure-switch types):
      1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**.
      2) Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
      3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
      4) High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
   j. Control-Interface Features:
      1) Remote Alarm Contacts: For remote alarm interface.
      2) Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
         a) On-off status of pump.
         b) Alarm status.
   k. Guide-Rail Supports:
      1) Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
      2) Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
      3) Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
      4) Pump Yoke: Motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
      5) Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
      6) Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
      7) Lifting Cable: Stainless steel; attached to pump and cover at manhole.

6. Submersible, Quick-Disconnect, Progressing-Cavity, Grinder Sewage Pumps:
   a. Description: Factory-assembled and -tested progressing-cavity, grinder sewage-pump unit with guide-rail supports.
   b. Pump Type: Submersible, progressing-cavity, single-screw rotary, grinder sewage pump as defined in HI 3.1-3.5.
   c. Pump Body: Cast iron.
   d. Pump Bearings: Radial and thrust types.
   e. Pump Shaft: Steel.
   f. Rotor: Stainless steel.
   g. Stator: Buna-N **OR** Natural rubber, **as directed**.
   h. Seal: Packing gland and mechanical types.
   i. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
   j. Controls (rod-and-float type):
      1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**.
      2) Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
      3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
      4) Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
      5) High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
   k. Controls (float- and pressure-switch types):
      1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**.
      2) Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
      3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
      4) High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
   l. Control-Interface Features:
      1) Remote Alarm Contacts: For remote alarm interface.
      2) Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
         a) On-off status of pump.
         b) Alarm status.
   m. Guide-Rail Supports:
      1) Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
      2) Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
      3) Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
      4) Pump Yoke: Motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
      5) Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
      6) Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
      7) Lifting Cable: Stainless steel; attached to pump and cover at manhole.

C. Wet-Pit-Volute Sewage Pumps
   1. Description: Factory-assembled and -tested sewage-pump unit.

2. Pump Type: Wet-pit-volute, single-stage, separately-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
3. Pump Casing: Cast iron, with open inlet and threaded or flanged connection for discharge piping.
4. Pump Shaft: Stainless-steel **OR** steel, **as directed**.
5. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron **OR** ASTM A 532/A 532M, abrasion-resistant cast iron **OR** ASTM B 584, cast bronze, **as directed**, nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
6. Sleeve Bearings: Bronze. Include oil-lubricated, intermediate sleeve bearings at 48-inch (1200-mm) maximum intervals if basin depth is more than 48 inches (1200 mm), and grease-lubricated, ball-type thrust bearings.
7. Pump and Motor Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
8. Pump Discharge Piping: Factory or field fabricated, galvanized, ASTM A 53/A 53M, Schedule 40, steel pipe with ASME B16.1, Class 125, cast-iron flanges and flanged fittings or ASME B16.4, Class 125, gray iron threaded fittings, **as directed**.
   a. Modify piping configuration to accommodate reverse-flow assembly.
9. Support Plate: Cast iron or coated steel and strong enough to support pumps, motors, and controls. Refer to Part 1.2 "Sewage-Pump Basins and Basin Covers" Article for requirements.
10. Shaft Seal: Stuffing box, with graphite-impregnated braided-yarn rings and bronze packing gland.
11. Motor: Single-speed; grease-lubricated ball bearings and mounted on vertical, cast-iron pedestal.
12. Controls (rod-and-float type):
    a. Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
    e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
13. Controls (float- and pressure-switch types):
    a. Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**.
    b. Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
14. Control-Interface Features:
    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
       1) On-off status of pump.
       2) Alarm status.

D. Sewage-Pump, Reverse-Flow Assemblies
1. Description: Factory-fabricated, sewage pump reverse-flow assembly for factory or field assembly and installation in sewage pump basin. Include the following corrosion-resistant-metal components:
   a. Inlet Fitting: One combination inlet-overflow strainer fitting.
   b. Valves: Two shutoff valves and two check valves.
   c. Strainers: Two strainer housings with reverse-flow, self-flushing strainers.
   d. Pipe and Fittings: Size and configuration required to connect to sewage pumps and piping.

E. Sewage-Pump Basins And Basin Covers

1. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.
   a. Material: Cast iron **OR** Fiberglass **OR** Polyethylene, **as directed**.
   b. Reinforcement: Mounting plates for pumps, fittings, guide-rail supports if used, and accessories.
   c. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.
2. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.
   a. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.

F. Progressing-Cavity Sewage Pumps
1. Description: Factory-assembled and -tested progressing-cavity, single-screw rotary pump as defined in HI 3.1-3.5.
2. Pump Body: Cast iron with feet for base or floor installation.
3. Pump Bearings: Radial and thrust types.
4. Pump Shaft: Steel.
5. Rotor: Chrome-plated steel.
6. Stator: Buna-N **OR** Natural rubber, **as directed**.
7. Seals: Packing gland and mechanical types.
8. Coupling: Flexible.
9. Motor: Single-speed; grease-lubricated ball bearings.

G. Packaged, Submersible Sewage-Pump Units
1. Packaged, Submersible, Grinder, Sewage-Pump Units:
   a. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, grinder, sewage-pump unit.
   b. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
   c. Pump Casing: Cast iron.
   d. Impeller: Stainless-steel grinder, cutter, or slicer type with shredding ring.
   e. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
   f. Control (for simplex pump unit): Manufacturer's standard panel for one pump.
   g. Controls (for duplex pump unit): Automatic, with mechanical- or mercury-float switches and alternator.
   h. Pump Discharge Piping: Factory or field fabricated, galvanized, ASTM A 53/A 53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray iron threaded fittings, **as directed**.
   i. Basin: Watertight plastic, **as directed**, and of size required for pumps, with inlet pipe connection and gastight cover with pump discharge and vent connections.
2. Packaged, Submersible, Nonclog, Sewage-Pump Units:
   a. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, sewage-pump unit.
   b. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
   c. Pump Casing: Cast iron.
   d. Impeller: Brass or cast iron; statically and dynamically balanced, non-clog design, and capable of handling 2-inch (50-mm) diameter solids.
   e. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

f. Control (for simplex pump units): Manufacturer's standard panel for one pump.
g. Controls (for duplex pump unit): Automatic, with mechanical- or mercury-float switches and alternator.
h. Pump Discharge Piping: Factory or field fabricated, galvanized, ASTM A 53/A 53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray iron threaded fittings, **as directed**.
i. Basin: Watertight plastic, **as directed**, and of size required for pumps, with inlet pipe connection and gastight cover with pump discharge and vent connections.

H. Packaged Wastewater-Pump Units
1. Packaged, Wet-Pit-Volute, Wastewater-Pump Units:
a. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, effluent-pump unit.
b. Pump Type: Wet-pit-volute, single-stage, separately-coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
c. Pump Body and Impeller: Corrosion-resistant materials.
d. Motor: With built-in overload protection and mounted vertically on basin cover.
e. Power Cord: Three-conductor, waterproof cable of length required but not less than 72 inches (1830 mm) and with grounding plug and cable-sealing assembly for connection at pump.
f. Control: Float switch.
g. Pump Discharge Piping: Factory or field fabricated, galvanized, ASTM A 53/A 53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray iron threaded fittings, **as directed**.
h. Basin: Watertight, aluminum, plastic, or coated steel with inlet pipe connection and gastight cover with vent and pump discharge connections.
2. Packaged, Submersible Wastewater-Pump Units:
a. Description: Factory-assembled and -tested, automatic-operation, effluent-pump unit with basin.
b. Pump Type: Submersible, end-suction, single-stage, overhung-impeller, centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
c. Pump Body and Impeller: Corrosion-resistant materials.
d. Pump Seals: Mechanical.
e. Motor: Hermetically sealed, capacitor-start type, with built-in overload protection.
f. Power Cord: Three-conductor, waterproof cable of length required but not less than 72 inches (1830 mm) and with grounding plug and cable-sealing assembly for connection at pump.
g. Control: Float switch.
h. Pump Discharge Piping: Factory or field fabricated, galvanized, ASTM A 53/A 53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray iron threaded fittings, **as directed**.
i. Basin: Watertight plastic with inlet pipe connection and gastight cover with vent and pump discharge connections.

I. Motors
1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements For Plumbing Equipment".
a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 22.
2. Motors for submersible pumps shall be hermetically sealed.

1.3 EXECUTION

A. Earthwork
   1. Excavation and filling are specified in Division 31 Section "Earth Moving".

B. Examination
   1. Examine roughing-in for plumbing piping to verify actual locations of sanitary drainage and vent piping connections before sewage pump installation.

C. Installation
   1. Pump Installation Standards:
      a. Comply with HI 1.4 for installation of centrifugal pumps.
      b. Comply with HI 3.1-3.5 for installation of progressing-cavity sewage pumps.
   2. Equipment Mounting (for equipment supported on slabs-on-grade): Install progressing-cavity sewage pumps on concrete base using elastomeric pads **OR** elastomeric mounts **OR** restrained spring isolators, **as directed**. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-place Concrete".
      a. Minimum Deflection: 1/4 inch (6 mm) **OR** 1 inch (25 mm), **as directed**.
      b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
      c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
      d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
      e. Install anchor bolts to elevations required for proper attachment to supported equipment.
   3. Equipment Mounting: Install progressing-cavity sewage pumps using elastomeric pads **OR** elastomeric mounts **OR** restrained spring isolators, **as directed**. Comply with requirements for vibration isolation devices specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".
      a. Minimum Deflection: 1/4 inch (6 mm) **OR** 1 inch (25 mm), **as directed**.
   4. Equipment Mounting: Install progressing-cavity sewage pumps on vibration isolation equipment base. Comply with requirements specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".
   5. Wiring Method (for pumps with wall-mounted controls): Comply with requirements in Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
   6. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

D. Connections
   1. Comply with requirements for piping specified in Division 22 Section "Sanitary Waste And Vent Piping". Drawings indicate general arrangement of piping, fittings, and specialties.
   2. Install piping adjacent to equipment to allow service and maintenance.

E. Field Quality Control
   1. Perform tests and inspections.
   2. Tests and Inspections:
      a. Perform each visual and mechanical inspection.
      b. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
      c. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
      d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   3. Pumps and controls will be considered defective if they do not pass tests and inspections.

4. Prepare test and inspection reports.

F. Startup Service
1. Engage a factory-authorized service representative to perform **OR** Perform, **as directed**, startup service.
    a. Complete installation and startup checks according to manufacturer's written instructions.

G. Adjusting
1. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.
2. Adjust control set points.

H. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION 22 13 29 13b

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Task	Specification	Specification Description
22 13 29 16	22 13 29 13b	Sewage Pumps
22 13 29 33	01 22 16 00	No Specification Required

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SECTION 22 14 29 13 - SUMP PUMPS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for sump pumps. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Submersible sump pumps.
      b. Wet-pit-volute sump pumps.
      c. Sump-pump basins and basin covers.
      d. Packaged drainage-pump units.

C. Submittals
   1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   2. Wiring Diagrams: For power, signal, and control wiring.
   3. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

D. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. UL Compliance: Comply with UL 778 for motor-operated water pumps.

E. Delivery, Storage, And Handling
   1. Retain shipping flange protective covers and protective coatings during storage.
   2. Protect bearings and couplings against damage.
   3. Comply with pump manufacturer's written rigging instructions for handling.

1.2 PRODUCTS

A. Submersible Sump Pumps
   1. Submersible, Fixed-Position, Single-Seal Sump Pumps:
      a. Description: Factory-assembled and -tested sump-pump unit.
      b. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
      c. Pump Casing: Cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
      d. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron **OR** ASTM A 532/A 532M, abrasion-resistant cast iron **OR** ASTM B 584, cast bronze, **as directed**, semiopen, **as directed**, design for clear wastewater handling, and keyed and secured to shaft.
      e. Pump and Motor Shaft: Stainless steel **OR** steel, **as directed**, with factory-sealed, grease-lubricated ball bearings.
      f. Seal: Mechanical.

g. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
    1) Motor Housing Fluid: Air **OR** Oil, **as directed**.
h. Controls (rod-and-float type):
    1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**.
    2) Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    4) Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
    5) High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
i. Controls (float- and pressure-switch types):
    1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**.
    2) Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
    3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    4) High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
j. Control-Interface Features:
    1) Remote Alarm Contacts: For remote alarm interface.
    2) Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
        a) On-off status of pump.
        b) Alarm status.

2. Submersible, Fixed-Position, Double-Seal Sump Pumps:
    a. Description: Factory-assembled and -tested sump-pump unit.
    b. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
    c. Pump Casing: Cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
    d. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron **OR** ASTM A 532/A 532M, abrasion-resistant cast iron **OR** ASTM B 584, cast bronze, **as directed**, semiopen, **as directed**, design for clear wastewater handling, and keyed and secured to shaft.
    e. Pump and Motor Shaft: Stainless steel **OR** steel, **as directed**, with factory-sealed, grease-lubricated ball bearings.
    f. Seals: Mechanical.
    g. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
    h. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
        1) Motor Housing Fluid: Air **OR** Oil, **as directed**.
    i. Controls (rod-and-float type):
        1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**.
        2) Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
        3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
        4) Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).

5) High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

j. Controls (float- and pressure-switch types):
1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**.
2) Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
4) High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

k. Control-Interface Features:
1) Remote Alarm Contacts: For remote alarm interface.
2) Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
a) On-off status of pump.
b) Alarm status.

B. Wet-Pit-Volute Sump Pumps
1. Description: Factory-assembled and -tested sump-pump unit.
2. Pump Type: Wet-pit-volute, single-stage, separately-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
3. Pump Casing: Cast iron, with strainer inlet and threaded connection for NPS 2 (DN 50) and smaller and flanged connection for NPS 2-1/2 (DN 65) and larger discharge piping.
4. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron **OR** ASTM A 532/A 532M, abrasion-resistant cast iron **OR** ASTM B 584, cast bronze, **as directed**, semiopen, **as directed**, design for clear wastewater handling, and keyed and secured to shaft.
5. Sleeve Bearings: Bronze. Include oil-lubricated, intermediate sleeve bearings at 48-inch (1200-mm) maximum intervals if basin depth is more than 48 inches (1200 mm), and grease-lubricated, ball-type thrust bearings.
6. Pump and Motor Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
7. Pump Discharge Piping: Factory or field fabricated, galvanized, ASTM A 53/A 53M, Schedule 40, steel pipe with ASME B16.1, Class 125, cast-iron flanges and flanged fittings or ASME B16.4, Class 125, gray iron threaded fittings, **as directed**.
8. Support Plate: Cast iron or coated steel and strong enough to support pumps, motors, and controls. Refer to Part 1.2 "Sump-Pump Basins and Basin Covers" Article for requirements.
9. Shaft Seal: Stuffing box, with graphite-impregnated braided-yarn rings and bronze packing gland.
10. Motor: Single-speed; grease-lubricated ball bearings and mounting on vertical, cast-iron pedestal.
11. Controls (rod-and-float type):
a. Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**.
b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
12. Controls (float- and pressure-switch types):
a. Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**.
b. Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.

c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

13. Control-Interface Features:
    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
        1) On-off status of pump.
        2) Alarm status.

C. Sump-Pump Basins And Basin Covers

1. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.
    a. Material: Cast iron **OR** Fiberglass **OR** Polyethylene, **as directed**.
    b. Reinforcement: Mounting plates for pumps, fittings, and accessories.
    c. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.
2. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.
    a. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.

D. Packaged Drainage-Pump Units

1. Packaged Pedestal Drainage-Pump Units:
    a. Description: Factory-assembled and -tested, automatic-operation, freestanding, sump-pump unit.
    b. Pump Type: Wet-pit-volute, single-stage, separately-coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
    c. Pump Casing: Corrosion-resistant material, with strainer inlet, design that permits flow into impeller, and vertical discharge for piping connection.
    d. Impeller: Aluminum, brass, or plastic.
    e. Motor: With built-in overload protection and mounted vertically on sump pump column.
    f. Power Cord: Three-conductor, waterproof cable of length required but not less than 72 inches (1830 mm), with grounding plug and cable-sealing assembly for connection at pump.
    g. Control: Float switch.
2. Packaged Submersible Drainage-Pump Units:
    a. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, sump-pump unit.
    b. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
    c. Casing: Metal.
    d. Impeller: Brass.
    e. Pump Seal: Mechanical.
    f. Motor: Hermetically sealed, capacitor-start type, with built-in overload protection.
    g. Power Cord: Three-conductor, waterproof cable of length required but not less than 72 inches (1830 mm), with grounding plug and cable-sealing assembly for connection at pump.
    h. Pump Discharge Piping: Factory or field fabricated, galvanized, ASTM A 53/A 53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray iron threaded fittings, **as directed**.
    i. Control: Motor-mounted float switch.

j. Basin: Plastic.

E. Motors
1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements For Plumbing Equipment".
    a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
    b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 22.
2. Motors for submersible pumps shall be hermetically sealed.

1.3 EXECUTION

A. Earthwork
1. Excavation and filling are specified in Division 31 Section "Earth Moving".

B. Examination
1. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

C. Installation
1. Pump Installation Standards: Comply with HI 1.4 for installation of sump pumps.

D. Connections
1. Comply with requirements for piping specified in Division 22 Section "Facility Storm Drainage Piping". Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to equipment to allow service and maintenance.

E. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
    a. Perform each visual and mechanical inspection.
    b. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
    c. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
    d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Pumps and controls will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

F. Startup Service
1. Engage a factory-authorized service representative to perform **OR** Perform, **as directed**, startup service.
    a. Complete installation and startup checks according to manufacturer's written instructions.

G. Adjusting
1. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.
2. Adjust control set points.

H. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION 22 14 29 13

Task	Specification	Specification Description
22 14 29 13	21 05 23 00	Piped Utilities Basic Materials And Methods
22 14 29 16	22 13 29 13b	Sewage Pumps

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SECTION 22 15 13 00 - GENERAL-SERVICE PACKAGED AIR COMPRESSORS AND RECEIVERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for general-service packaged air compressors and receivers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Lubricated, reciprocating air compressors.
b. Oil-free, reciprocating air compressors.
c. Oilless, reciprocating air compressors.
d. Oil-free, rotary-screw air compressors.
e. Oil-flooded, rotary-screw air compressors.
f. Oil-free, rotary, sliding-vane air compressors.
g. Oil-sealed, rotary, sliding-vane air compressors.
h. Inlet-air filters.
i. Air-cooled, compressed-air aftercoolers.
j. Water-cooled, compressed-air aftercoolers.
k. Refrigerant compressed-air dryers.
l. Desiccant compressed-air dryers.
m. Computer interface cabinet.

C. Definitions
1. Actual Air: Air delivered from air compressors. Flow rate is delivered compressed air measured in acfm (actual L/s).
2. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
3. Standard Air: Free air at 68 deg F (20 deg C) and 1 atmosphere (29.92 in. Hg) before compression or expansion and measured in scfm (standard L/s).

D. Performance Requirements
1. Delegated Design: Design compressed-air equipment mounting, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Seismic Performance: Compressed-air equipment shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

E. Submittals
1. Product Data: For each type of product indicated.
a. Wiring Diagrams: For power, signal, and control wiring.
2. Delegated-Design Submittal: For compressed-air equipment mounting indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
a. Detail fabrication and assembly of supports.
b. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

3. Seismic Qualification Certificates: For compressed-air equipment, accessories, and components, from manufacturers.
4. Operation and Maintenance Data.

F. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.

1.2 PRODUCTS

A. General Requirements For Packaged Air Compressors And Receivers
1. General Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty air compressors and receivers that deliver air of quality equal to intake air.
2. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.
   a. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.
   b. Motor Controllers: Full-voltage, combination magnetic type with undervoltage release feature and motor-circuit-protector-type disconnecting means and short-circuit protective device.
   c. Control Voltage: 120-V ac or less, using integral control power transformer.
   d. Motor Overload Protection: Overload relay in each phase.
   e. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
   f. Automatic control switches to alternate lead-lag compressors for duplex **OR** sequence lead-lag compressors for multiplex, **as directed**, air compressors.
   g. Instrumentation: Include discharge-air pressure gage, air-filter maintenance indicator, hour meter, compressor discharge-air and coolant temperature gages, and control transformer.
   h. Alarm Signal Device: For connection to alarm system to indicate when backup air compressor is operating.
3. Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   a. Pressure Rating: At least as high as highest discharge pressure of connected compressors, and bearing appropriate code symbols.
   b. Interior Finish: Corrosion-resistant coating.
   c. Accessories: Include safety valve, pressure gage, drain, and pressure-reducing valve.
4. Mounting Frame: Fabricate mounting and attachment to pressure vessel with reinforcement strong enough to resist packaged equipment movement during a seismic event when base is anchored to building structure.

B. Lubricated, Reciprocating Air Compressors
1. Compressor(s): Lubricated, reciprocating-piston type with lubricated compression chamber and crankcase.
   a. Submerged gear-type oil pump.
   b. Oil filter.
   c. Combined high discharge-air temperature and low lubrication-oil pressure switch.
   d. Belt guard totally enclosing pulleys and belts.

C. Oil-Free, Reciprocating Air Compressors
1. Compressor(s): Oil-free, reciprocating-piston type with nonlubricated compression chamber, lubricated crankcase, and of construction that prohibits oil from entering compression chamber.

a. Submerged gear-type oil pump.
b. Oil filter.
c. Combined high discharge-air temperature and low lubrication-oil pressure switch.
d. Belt guard totally enclosing pulleys and belts.

D. Oilless, Reciprocating Air Compressors
1. Compressor(s): Oilless (nonlubricated), reciprocating-piston type, with sealed oil-free bearings, that will deliver air of quality equal to intake air.
a. High discharge-air temperature switch.
b. Belt guard totally enclosing pulleys and belts.

E. Oil-Free, Rotary-Screw Air Compressors
1. Compressor(s): Oil-free, rotary-screw type with nonlubricated helical screws and lubricated gear box, and of construction that prohibits oil from entering compression chamber.
a. Coupling: Nonlubricated, flexible type.
b. Cooling/Lubrication System: Unit-mounted, air-cooled exchanger package prepiped to unit; with air pressure circulation system with coolant stop valve, full-flow coolant filter, and thermal bypass valve.
c. Air Filter: Dry type, with maintenance indicator and cleanable replaceable filter element.
d. Air/Coolant Receiver and Separation System: 150-psig- (1035-kPa-) rated steel tank with ASME safety valve, coolant-level gage, multistage air-coolant separator element, minimum pressure valve, blowdown valve, discharge check valve, coolant stop valve, full-flow coolant filter, and thermal bypass valve.
e. Capacity Control: Capacity modulation between zero and 100 percent air delivery, with operating pressures between 50 and 100 psig (345 and 690 kPa). Include necessary control to hold constant pressure. When air demand is zero, unload compressor by using pressure switch and blowdown valve.

F. Oil-Flooded, Rotary-Screw Air Compressors
1. Compressor(s): Oil-flooded, rotary-screw type with lubricated helical screws and lubricated gear box.
a. Coupling: Nonlubricated, flexible type.
b. Cooling/Lubrication System: Unit-mounted, air-cooled exchanger package prepiped to unit; with air pressure circulation system with coolant stop valve, full-flow coolant filter, and thermal bypass valve.
c. Air Filter: Dry type, with maintenance indicator and cleanable replaceable filter element.
d. Air/Coolant Receiver and Separation System: 150-psig- (1035-kPa-) rated steel tank with ASME safety valve, coolant-level gage, multistage air-coolant separator element, minimum pressure valve, blowdown valve, discharge check valve, coolant stop valve, full-flow coolant filter, and thermal bypass valve.
e. Capacity Control: Capacity modulation between zero and 100 percent air delivery, with operating pressures between 50 and 100 psig (345 and 690 kPa). Include necessary control to hold constant pressure. When air demand is zero, unload compressor by using pressure switch and blowdown valve.

G. Oil-Free, Rotary, Sliding-Vane Air Compressors
1. Compressor(s): Oil-free, nonpulsating, rotary, sliding-vane type with nonlubricated sliding vanes.
a. Cleanable inlet screens.
b. Outlet silencers on discharge connections.

H. Oil-Sealed, Rotary, Sliding-Vane Air Compressors
1. Compressor(s): Nonpulsating, rotary, sliding-vane type with oil-sealed sliding vanes.
a. Cleanable inlet screens.
b. Outlet silencers and oil-mist separators on discharge connections.

I. Inlet-Air Filters

1. Description: Combination inlet-air filter-silencer, suitable for remote installation, for each air compressor.
   a. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
   b. Capacity: Match capacity of air compressor, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.
2. Description: Combination inlet-air filter-silencer, suitable for remote installation, for multiple air compressors.
   a. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
   b. Capacity: Match total capacity of connected air compressors, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.

J. Air-Cooled, Compressed-Air Aftercoolers
   1. Description: Electric-motor-driven, fan-operation, finned-tube unit; rated at 250 psig (1725 kPa) and leak tested at 350-psig (2415-kPa) minimum air pressure; in capacities indicated. Size units to cool compressed air in compressor-rated capacities to 10 deg F (6 deg C) above summertime maximum ambient temperature. Include moisture separator and automatic drain.

K. Water-Cooled, Compressed-Air Aftercoolers
   1. Description: Shell and tube unit, rated at 250 psig (1725 kPa) and leak tested at 350-psig (2415-kPa) minimum air pressure, in capacities indicated. Include moisture separator and automatic drain.

L. Refrigerant Compressed-Air Dryers
   1. Description: Noncycling, air-cooled, electric-motor-driven unit with steel enclosure and capability to deliver 35 deg F (2 deg C), 100-psig (690-kPa) air at dew point. Include automatic ejection of condensate from airstream, step-down transformers, disconnect switches, inlet and outlet pressure gages, thermometers, automatic controls, and filters.

M. Desiccant Compressed-Air Dryers
   1. Description: Twin-tower unit with purge system, mufflers, and capability to deliver plus 10 deg F (minus 12 deg C), 100-psig (690-kPa) air at dew point. Include dew point controlled purge, step-down transformers, disconnect switches, inlet and outlet pressure gages, thermometers, automatic controls, and filters.

N. Computer Interface Cabinet
   1. Description:
      a. Wall mounting.
      b. Welded steel with white enamel finish.
      c. Gasketed door.
      d. Grounding device.
      e. Factory-installed, signal circuit boards.
      f. Power transformer.
      g. Circuit breaker.
      h. Wiring terminal board.
      i. Internal wiring capable of interfacing 20 alarm signals.

O. Motors
   1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements For Plumbing Equipment".
      a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 22.

1.3 EXECUTION

A. Equipment Installation

1. Equipment Mounting:
   a. Install air compressors, aftercoolers, and air dryers on concrete bases using elastomeric pads **OR** elastomeric mounts **OR** restrained spring isolators, **as directed**. Comply with requirements in Division 03 Section "Cast-in-place Concrete". Comply with requirements for vibration isolation devices specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".
      1) Minimum Deflection: 1/4 inch (6 mm) **OR** 1 inch (25 mm), **as directed**.
      2) Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
      3) For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
      4) Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
      5) Install anchor bolts to elevations required for proper attachment to supported equipment.
   b. Install air compressors, aftercoolers, and air dryers using elastomeric pads **OR** elastomeric mounts **OR** restrained spring isolators, **as directed**. Comply with requirements for vibration isolation devices specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".
      1) Minimum Deflection: 1/4 inch (6 mm) **OR** 1 inch (25 mm), **as directed**.
   c. Install air compressors, aftercoolers, and air dryers on vibration isolation inertia bases. Comply with requirements specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".
   d. Install air compressors, aftercoolers, and air dryers on concrete bases. Comply with requirements in Division 03 Section "Cast-in-place Concrete".
      1) Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
      2) For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
      3) Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
      4) Install anchor bolts to elevations required for proper attachment to supported equipment.
   e. Install water-cooled, compressed-air aftercoolers and desiccant compressed-air dryers on concrete bases. Comply with requirements in Division 03 Section "Cast-in-place Concrete".
      1) Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
      2) For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
      3) Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
      4) Install anchor bolts to elevations required for proper attachment to supported equipment.
2. Install compressed-air equipment anchored to substrate.
3. Arrange equipment so controls and devices are accessible for servicing.

4. Maintain manufacturer's recommended clearances for service and maintenance.
5. Install the following devices on compressed-air equipment:
    a. Thermometer, Pressure Gage, and Safety Valve: Install on each compressed-air receiver.
    b. Pressure Regulators: Install downstream from air compressors and dryers.
    c. Automatic Drain Valves: Install on aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.

B. Connections
1. Comply with requirements for piping specified in Division 22 Section "General-service Compressed-air Piping". Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to machine to allow service and maintenance.

C. Identification
1. Identify general-service air compressors and components. Comply with requirements for identification specified in Division 22 Section "Identification For Plumbing Piping And Equipment".

D. Startup Service
1. Perform startup service.
    a. Complete installation and startup checks according to manufacturer's written instructions.
    b. Check for lubricating oil in lubricated-type equipment.
    c. Check belt drives for proper tension.
    d. Verify that air-compressor inlet filters and piping are clear.
    e. Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.
    f. Check safety valves for correct settings. Ensure that settings are higher than air-compressor discharge pressure but not higher than rating of system components.
    g. Check for proper seismic restraints.
    h. Drain receiver tanks.
    i. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
    j. Test and adjust controls and safeties.

E. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain air compressors, aftercoolers, and air dryers.

END OF SECTION 22 15 13 00

Task	Specification	Specification Description
22 15 13 00	23 09 00 00	HVAC Instrumentation And Controls
22 15 19 13	22 15 13 00	General-Service Packaged Air Compressors and Receivers
22 15 19 13	23 09 00 00	HVAC Instrumentation And Controls
22 15 19 19	22 15 13 00	General-Service Packaged Air Compressors and Receivers
22 15 19 19	23 09 00 00	HVAC Instrumentation And Controls

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SECTION 22 31 16 00 - WATER SOFTENERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for water softeners. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes household and commercial water softeners.
    a. Chemicals.
    b. Water testing kits.

C. Definitions
1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. FRP: Fiberglass-reinforced plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

D. Submittals
1. Product Data: For each type of water softener and water testing kit indicated.
2. Shop Drawings: Include plans, elevations, sections, details, and connections to piping systems.
    a. Include wiring diagrams.
3. Manufacturer Seismic Qualification Certification
4. Field quality-control test reports.
5. Operation and Maintenance Data: For water softeners to include in emergency, operation, and maintenance manuals.
6. Warranty: Special warranty specified in this Section.

E. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. ASME Compliance for Steel Tanks: Fabricate and label mineral tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, where indicated.
3. ASME Compliance for FRP Tanks: Fabricate and label mineral tanks to comply with ASME Boiler and Pressure Vessel Code: Section X, where indicated.

F. Warranty
1. Manufacturer's standard form in which manufacturer agrees to repair or replace components of water softener that fail in materials or workmanship within Five years from date of Final Completion.

1.2 PRODUCTS

A. Household Water Softeners
1. Description: Factory-assembled, fully-automatic, pressure-type water softener.
    a. Configuration: Unit with one mineral tank and one brine tank or cabinet-style, combination mineral and brine tank unit with equivalent characteristics.
    b. Mineral Tank: Steel or FRP, with coating or liner suitable for potable-water service and 125-psig (860-kPa) minimum pressure rating.

c. Comply with NSF 61, "Drinking Water System Components--Health Effects."
d. Controls: For fully automatic operation.
e. Brine Tank: Combination measuring and wet-salt storing system.
   1) Tank and Cover Material: FRP or molded PE.
   2) Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawn and freshwater refill.
   3) Size: Large enough for at least two regenerations at full salting.
f. Factory-Installed Accessories:
   1) Piping, valves, tubing, and drains.
   2) Sampling cock.
   3) Main-operating-valve position indicator.

B. Commercial Water Softeners
1. Description: Factory-assembled, pressure-type water softener.
   a. Comply with NSF 61, "Drinking Water System Components--Health Effects."
   b. Configuration: Single unit with one mineral tank **OR** Twin unit with two mineral tanks **OR** Triple unit with three mineral tanks, **as directed**, and one brine tank, factory mounted on skids, **unless directed otherwise**.
   c. Mineral Tanks: FRP, pressure-vessel quality.
      1) Construction: Non-ASME code **OR** Fabricated and stamped to comply with ASME Boiler and Pressure Vessel Code: Section X, "Fiber-Reinforced Plastic Pressure Vessels," **as directed**.
      2) Pressure Rating: 100 psig (690 kPa) **OR** 125 psig (860 kPa), **as directed** , minimum.
      3) Wetted Components: Suitable for water temperatures from 40 to at least 100 deg F (5 to at least 38 deg C) **OR** 40 to at least 120 deg F (5 to at least 49 deg C) **OR** 40 to at least 150 deg F (5 to at least 66 deg C), **as directed**.
      4) Freeboard: 50 percent minimum for backwash expansion above normal resin bed level.
      5) Support Legs or Skirt: Constructed of structural steel, welded to tank before testing and labeling.
      6) Upper Distribution System: Single, point type, fabricated from galvanized-steel pipe and fittings.
      7) Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from nonmetallic pipe and fittings with individual, fine-slotted, nonclogging plastic strainers; arranged for even flow distribution through resin bed.
      8) Liner: PE, ABS, or other material suitable for potable water.
   d. Mineral Tanks: Steel **OR** Stainless steel, **as directed**, electric welded; pressure-vessel quality.
      1) Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.
      2) Construction: Non-ASME code **OR** Fabricated and stamped to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," **as directed**.
      3) Pressure Rating: 100 psig (690 kPa) **OR** 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, minimum.
      4) Wetted Components: Suitable for water temperatures from 40 to at least 100 deg F (5 to at least 38 deg C) **OR** 40 to at least 120 deg F (5 to at least 49 deg C) **OR** 40 to at least 150 deg F (5 to at least 66 deg C), **as directed**.
      5) Freeboard: 50 percent minimum for backwash expansion above normal resin bed level.
      6) Handholes: 4 inches (102 mm) round or 4 by 6 inches (102 by 152 mm) elliptical, in top head and lower sidewall of tanks 30 inches (762 mm) and smaller in diameter.
      7) Manhole: 11 by 15 inches (280 by 380 mm) in top head of tanks larger than 30 inches (762 mm) in diameter.

8) Support Legs or Skirt: Constructed of structural steel, welded to tank before testing and labeling.
9) Finish: Hot-dip galvanized on exterior and interior of tank after fabrication, unless tank is stainless steel.
10) Finish: Exterior of tank spray painted with rust-resistant prime coat, 2- to 3-mil (0.051- to 0.076-mm) dry film thickness. Interior sandblasted and lined with epoxy-polyamide coating, 8- to 10-mil (0.203- to 0.254-mm) dry film thickness.
11) Upper Distribution System: Single, point type, fabricated from galvanized-steel pipe and fittings.
12) Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from PVC pipe and fittings with individual, fine-slotted, nonclogging PE strainers; arranged for even flow distribution through resin bed.
13) Liner: PE, ABS, or other material suitable for potable water.

e. Controls: Automatic; factory mounted on unit and factory wired.
1) Adjustable duration of various regeneration steps.
2) Push-button start and complete manual operation.
3) Electric time clock and switch for automatic operation, except for manual return to service.
4) Sequence of Operation: Program multiport pilot-control valve to automatically pressure-actuate main operating valve through steps of regeneration.
5) Pointer on pilot-control valve shall indicate cycle of operation.
6) Means of manual operation of pilot-control valve if power fails.

f. Controls: Fully automatic; factory mounted on unit and factory wired.
1) Adjustable duration of various regeneration steps.
2) Push-button start and complete manual operation.
3) Electric time clock and switch for fully automatic operation, adjustable to initiate regeneration at any hour of day and any day of week or at fixed intervals.
4) Sequence of Operation: Program multiport pilot-control valve to automatically pressure-actuate main operating valve through steps of regeneration and return to service.
5) Pointer on pilot-control valve shall indicate cycle of operation.
6) Means of manual operation of pilot-control valve if power fails.
7) Main Operating Valves: Industrial, automatic, multiport, diaphragm type with the following features:
a) Slow opening and closing, nonslam operation.
b) Diaphragm guiding on full perimeter from fully open to fully closed.
c) Isolated dissimilar metals within valve.
d) Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.
e) Valve for single mineral-tank unit with internal automatic bypass of raw water during regeneration.
f) Sampling cocks for soft water.
g) Special tools are not required for service.
8) Flow Control: Automatic, to control backwash and flush rates over wide variations in operating pressures, and that does not require field adjustments.
a) Meter Control: Equip each mineral tank with signal-register-head water meter that will produce electrical signal indicating need for regeneration on reaching hand-set total in gallons (liters). Design so signal will continue until reset.
b) Demand-Initiated Control:
i. Equip single mineral-tank units with automatic-reset-head water meter that electrically activates cycle controller to initiate regeneration at preset total in gallons (liters). Design so head automatically resets to preset total in gallons (liters) for next service run.
ii. Equip each mineral tank of twin mineral-tank units with automatic-reset-head water meters that electrically activate cycle controllers to initiate regeneration at preset total in gallons (liters). Design so heads

automatically reset to preset total in gallons (liters) for next service run. Include electrical lockout to prevent simultaneous regeneration of both tanks.

iii. Equip each mineral tank of twin mineral-tank units with automatic-reset-head water meter in common outlet header that electrically activates cycle controller to automatically regenerate one mineral tank at preset total in gallons (liters) and divert flow to other tank. Set to repeat with other tank. Include electrical lockout to prevent simultaneous regeneration of both tanks.

iv. Equip each mineral tank of multiple mineral-tank units with automatic-reset-head water meters that electrically activate cycle controllers to automatically regenerate at preset total in gallons (liters). Design so heads automatically reset to preset total in gallons (liters) for next service run. Include electrical lockouts to prevent simultaneous regeneration of more than one tank.

v. Equip each mineral tank of multiple mineral-tank units with automatic-reset-head water meter in common outlet header that electrically activates cycle controller to automatically regenerate one mineral tank at preset total in gallons (liters) and divert flow to other tanks. Set to repeat with other tanks. Include electrical lockouts to prevent simultaneous regeneration of more than one tank.

g. Brine Tank: Combination measuring and wet-salt storing system.
   1) Tank and Cover Material: Fiberglass, 3/16 inch (4.8 mm) thick; or molded PE, 3/8 inch (9.5 mm) thick.
   2) Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawn and freshwater refill.
   3) Size: Large enough for at least four regenerations at full salting.

h. Factory-Installed Accessories:
   1) Piping, valves, tubing, and drains.
   2) Sampling cocks.
   3) Main-operating-valve position indicators.
   4) Water meters.

2. Capacity and Characteristics:
   a. Service: Cold **OR** Hot, **as directed**, water.
   b. Number of Mineral Tanks: One **OR** Two, **as directed**.

C. Chemicals

1. Mineral: High-capacity, sulfonated-polystyrene ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock.
   a. Exchange Capacity: 30,000 grains/cu. ft. (69 kg/cu. m) of calcium carbonate of resin when regenerated with 15 lb (6.8 kg) of salt.
2. Salt for Brine Tanks: High-purity sodium chloride; free of dirt and foreign material. Rock and granulated forms are not acceptable.
   a. Form: Processed, food-grade salt pellets **OR** plain salt pellets **OR** crystallized solar salt from shallow ponds and milled into irregular particles **OR** plain, brine block salt, **as directed**.

D. Water Testing Sets

1. Description: Manufacturer's standard water-hardness testing apparatus and chemicals with testing procedure instructions. Include metal container suitable for wall mounting.

1.3 EXECUTION

A. Concrete Bases

1. Install concrete bases of dimensions indicated for commercial water softeners. Refer to Division 22 Section "Common Work Results For Plumbing".

B. Water Softener Installation
1. Install household water softeners on floor. Anchor water softener and brine tanks to substrate.
2. Install commercial water softener equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.
3. Install seismic restraints for tanks and floor-mounting accessories and anchor to building structure.
4. Install brine lines and fittings furnished by equipment manufacturer but not specified to be factory installed.
5. Prepare mineral-tank distribution system and underbed for minerals and place specified mineral into mineral tanks.
6. Install water testing sets mounted on wall, unless otherwise indicated, and near water softeners.

C. Connections
1. Piping installation requirements are specified in other Division 14.. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to equipment to allow service and maintenance.
3. Make piping connections between water-softener-unit headers and dissimilar-metal water piping with dielectric fittings. Dielectric fittings are specified in Division 22 Section "Common Work Results For Plumbing".
4. Install shutoff valves on raw-water inlet and soft-water outlet piping of each mineral tank, and on inlet and outlet headers.
   a. Metal general-duty valves are specified in Division 22 Section "General-duty Valves For Plumbing Piping".
   b. Plastic valves are specified in Division 22 Section "Domestic Water Piping".
   c. Exception: Water softeners with factory-installed shutoff valves at locations indicated.
5. Install pressure gages on raw-water inlet and soft-water outlet piping of each mineral tank. Pressure gages are specified in Division 22 Section "Meters And Gages For Plumbing Piping".
   a. Exception: Water softeners with factory-installed pressure gages at locations indicated.
   b. Exception: Household water softeners.
   c. Exception: Water softeners in hot-water service.
6. Install valved bypass water piping around water softeners.
   a. Metal general-duty valves are specified in Division 22 Section "General-duty Valves For Plumbing Piping".
   b. Plastic valves are specified in Division 22 Section "Domestic Water Piping".
   c. Water piping is specified in Division 22 Section "Domestic Water Piping".
   d. Exception: Household water softeners.
   e. Exception: Water softeners in hot-water service.
7. Install drains as indirect wastes to spill into open drains or over floor drains.
8. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
9. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

D. Field Quality Control
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
2. Perform the following field tests and inspections and prepare test reports:
   a. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

b. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.

c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Remove and replace malfunctioning water softeners that do not pass tests and inspections and retest as specified above.

E. Startup Service

1. Engage a factory-authorized service representative to perform startup service.
   a. Complete installation and startup checks according to manufacturer's written instructions.
2. Add water to brine tanks and fill with salt.
   a. Household Water Softeners: Processed food-grade salt pellets **OR** plain salt pellets **OR** crystallized solar salt, **as directed**.
   b. Commercial Water Softeners: Plain salt pellets **OR** Crystallized solar salt **OR** Plain, brine block salt **OR** Food-grade salt pellets, **as directed**.
3. Sample water softener effluent after startup and at three consecutive seven-day intervals (total of four samples), and prepare certified test reports for required water performance characteristics. Comply with the following:
   a. ASTM D 859, "Test Method for Silica in Water."
   b. ASTM D 1067, "Test Methods for Acidity or Alkalinity of Water."
   c. ASTM D 1068, "Test Methods for Iron in Water."
   d. ASTM D 1126, "Test Method for Hardness in Water."
   e. ASTM D 1129, "Terminology Relating to Water."
   f. ASTM D 3370, "Practices for Sampling Water from Closed Conduits."

F. Demonstration

1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial water softeners.

END OF SECTION 22 31 16 00

Task	Specification	Specification Description
22 33 00 00	22 12 23 13	Electric, Domestic Water Heaters
22 33 30 16	22 12 23 13	Electric, Domestic Water Heaters
22 33 30 16	22 12 23 13a	Fuel-Fired, Domestic Water Heaters
22 33 33 00	22 12 23 13	Electric, Domestic Water Heaters
22 34 00 00	22 12 23 13a	Fuel-Fired, Domestic Water Heaters
22 34 36 13	22 12 23 13	Electric, Domestic Water Heaters
22 34 46 11	22 12 23 13a	Fuel-Fired, Domestic Water Heaters

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SECTION 22 35 23 13 - DOMESTIC WATER HEAT EXCHANGERS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for heat exchangers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following heat exchangers:
      a. Heating-fluid-in-coil, instantaneous heat exchangers.
      b. Domestic-water-in-coil, instantaneous heat exchangers.
      c. Heating-fluid-in-U-tube-coil, instantaneous heat exchangers.
      d. Circulating, compact heat exchangers.
      e. Circulating, storage heat exchangers.
      f. Noncirculating, compact heat exchangers.
      g. Noncirculating, storage heat exchangers.
      h. Brazed-plate heat exchangers.
      i. Frame-and-plate heat exchangers.
      j. Heat reclaimers.
      k. Compression tanks.
      l. Heat-exchanger accessories.

C. Submittals
   1. Product Data: For each type and size of heat exchanger indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
   2. Shop Drawings: Diagram power, signal, and control wiring.
   3. Manufacturer Seismic Qualification Certification
   4. Source quality-control test reports.
   5. Field quality-control test reports.
   6. Operation and Maintenance Data: For heat exchangers to include in emergency, operation, and maintenance manuals.
   7. Warranty: Special warranty specified in this Section.

D. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   2. ASME Compliance: Where ASME-code construction is indicated, fabricate and label heat-exchanger storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   3. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9" for all components that will be in contact with water.

E. Warranty
   1. Manufacturer's standard form in which manufacturer agrees to repair or replace components of heat exchangers that fail in materials or workmanship within specified warranty period.
      a. Failures include, but are not limited to, the following:
         1) Structural failures including heat exchanger, storage tank, and supports.
         2) Faulty operation of controls.
         3) Deterioration of metals, metal finishes, and other materials beyond normal use.
      b. Warranty Period(s): From date of Final Completion:

1) Instantaneous Heat Exchangers:
   a) Tube Coil and Shell: One year.
   b) Controls and Other Components: One year.
2) Circulating, Storage Heat Exchangers:
   a) Storage Tank: Five years.
   b) Tube Coil: Five years.
   c) Controls and Other Components: Three years.
3) Noncirculating, Storage Heat Exchangers:
   a) Storage Tank: Five years.
   b) Tube Coil: Five years.
   c) Controls and Other Components: Three years.
4) Plate Heat Exchangers:
   a) Brazed-Plate Type: One year.
   b) Plate-and-Frame Type: One year.
5) Heat Reclaimers: One year.
6) Compression Tanks: One year.

1.2 PRODUCTS

A. Instantaneous Heat Exchangers
1. Heating-Fluid-in-Coil, Instantaneous Heat Exchangers:
   a. Description: Packaged assembly of tank, heat-exchanger coils, controls, and specialties for heating domestic water with heating hot water **OR** steam, **as directed**, in heat-exchanger coils.
   b. Construction: ASME-code, negligible-capacity, copper-lined, carbon-steel shell with 150-psig (1035-kPa) minimum working-pressure rating.
      1) Tappings: Factory fabricated of materials compatible with heat-exchanger shell. Attach tappings to shell before testing and labeling.
         a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
         b) NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
      2) Insulation: Complying with ASHRAE/IESNA 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire shell and nozzle except connections and controls.
      3) Heat-Exchanger Coils: Copper **OR** Copper nickel **OR** Stainless-steel, **as directed**, helix-wound coils for heating fluid with pressure rating equal to or greater than heating-fluid supply pressure.
      4) Temperature Control: Adjustable thermostat that operates control valve and that is capable of maintaining outlet-water temperature within 4 deg F (2 deg C) of setting.
      5) Safety Control: Automatic, high-temperature-limit cutoff device or system.
      6) Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of heat exchanger. Select one relief valve with sensing element that extends into storage tank.
   c. Miscellaneous Components for Heating Hot-Water Unit: Control valve, valves, and piping. Include components fitted for pneumatic control.
   d. Miscellaneous Components for Steam Unit: Strainers, steam-control valve, steam trap, valves, pressure gage, thermometer, and piping. Include components fitted for pneumatic control.
      1) Exception: Steam trap is not required if manufacturer's written instructions direct that it not be used.
   e. Stand: Factory fabricated for floor mounting.

2. Domestic-Water-in-Coil, Instantaneous Heat Exchangers:
   a. Description: Tankless, packaged assembly of heat-exchanger coils, controls, and specialties for heating domestic water in coils with steam in shell.
   b. Construction: ASME code, with cast-iron or steel shell for steam.
      1) Cast-Iron Shell Pressure Rating: 75 psig (517 kPa).
      2) Steel Shell Pressure Rating: 150 psig (1035 kPa).
      3) Insulation: Complying with ASHRAE/IESNA 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire shell and nozzle except connections and controls.
   c. Heat-Exchanger Coils: Spiral-wound, copper or copper-alloy **OR** stainless-steel, **as directed**, coils for domestic water.
   d. Temperature Control: Adjustable thermostat that operates steam-control valve and that is capable of maintaining outlet-water temperature within 3 deg F (2 deg C) of setting.
   e. Safety Control: Automatic, high-temperature-limit cutoff device or system.
   f. Miscellaneous Components: Strainers, steam-control valve, steam trap, valves, and piping.
   g. Stand: Factory fabricated for floor mounting.
3. Heating-Fluid-in-U-Tube-Coil, Instantaneous Heat Exchangers:
   a. Description: Tankless, packaged assembly of heat-exchanger coil, controls, and specialties for heating domestic water in shell with heating hot water **OR** steam, **as directed**, in coil.
   b. Construction: ASME-code, negligible-capacity, copper-lined, carbon-steel or copper-alloy shell with 150-psig (1035-kPa) minimum working-pressure rating.
      1) Configuration: Horizontal **OR** Vertical, **as directed**.
      2) Shell Tappings: Factory fabricated of materials compatible with water heater shell. Attach tappings to shell before testing and labeling.
         a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
         b) NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
      3) Insulation: Complying with ASHRAE/IESNA 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire shell and nozzle except connections and controls.
      4) Heat-Exchanger Coil: Copper, double-wall **OR** single-wall, **as directed**, U tubes for heating fluid.
         a) Tube Pressure Rating: Equal to or greater than heating-fluid supply pressure.
   c. Temperature Control: Adjustable thermostat that operates steam-control valve and that is capable of maintaining outlet-water temperature within 5 deg F (3 deg C) of setting.
   d. Safety Control: Automatic, high-temperature-limit cutoff device or system.
   e. Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of heat exchanger. Select one relief valve with sensing element that extends into shell.
   f. Miscellaneous Components for Heating Hot-Water Unit: Control valve, valves, and piping. Include components fitted for pneumatic control.
   g. Miscellaneous Components for Steam Unit: Strainers, steam-control valve, steam trap, valves, pressure gage, thermometer, and piping. Include components fitted for pneumatic control.
   h. Stand: Factory fabricated for floor mounting.

B. Circulating, Storage Heat Exchangers
1. Circulating, Compact Heat Exchangers:
   a. Description: Packaged, small-capacity, hot-water storage tank with heat-exchanger coil; circulator; controls; and specialties for heating domestic water with heating hot water **OR** steam, **as directed**, in coil.

b. Flow Pattern: Standard-flow arrangement, with water from bottom of storage tank circulated across heat-exchanger coil and returned to tank. Include hot-water outlet located at top of tank and temperature sensor in tank.

c. Storage Tank Construction: ASME-code, vertical; copper-silicon or corrosion-resistant metal with 150-psig (1035-kPa) working-pressure rating. Include nozzle and head for heat-exchanger tube coil.

   1) Configuration: Vertical.
   2) Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing and labeling.
      a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
      b) NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
   3) Insulation: Complying with ASHRAE/IESNA 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire storage tank and nozzle except connections and controls.

d. Heat-Exchanger Coil: NPS 3/4 (DN 20) **OR** NPS 1-1/4 (DN 32), **as directed**, diameter, vented, double-wall, copper or copper-alloy, U tubes with tube sheet and supporting baffles.

   1) Heat-Exchanger Pressure Rating: Equal to or greater than heating-fluid supply pressure.

e. Temperature Control: Adjustable thermostat.

f. Safety Control: Automatic, high-temperature-limit cutoff device or system. Include automatic low-water cutoff device or system.

g. Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of heat exchanger. Select one relief valve with sensing element that extends into storage tank.

h. Gages: Factory-mounted thermometer and pressure gage.

i. Circulating Pump: UL 778, all-bronze, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3. Include mechanical seals, 125-psig (860-kPa) minimum working-pressure rating, and 225 deg F (107 deg C) continuous-water-temperature rating.

   1) Pump Control: Sensor for operating pump and control valve.

j. Miscellaneous Components for Heating Hot-Water Units: Control valve, valves, and piping.

k. Miscellaneous Components for Steam Units: Strainers, steam-control valve, steam trap, valves, and piping.

l. Support: Factory mounted on skids.

m. Energy Management System Interface: Normally closed dry contacts for enabling and disabling heat exchanger.

2. Circulating, Storage Heat Exchangers:

   a. Description: Packaged, large-capacity, hot-water storage tank with heat-exchanger coil, circulator, controls, and specialties for heating domestic water with heating hot water **OR** steam, **as directed**, in coil.

   b. Flow Pattern: Standard-flow arrangement, with water from bottom of storage tank circulated across heat-exchanger coil and returned to tank. Include hot-water outlet located at top of tank and temperature sensor in tank.

   c. Flow Pattern: Reverse-flow arrangement, with water from storage tank drawn across heat-exchanger coil and returned to bottom of tank. Include hot-water outlet and temperature sensor located in or at coil shell.

   d. Storage Tank Construction: ASME-code steel with 125-psig (860-kPa) **OR** 150-psig (1035-kPa), **as directed**, working-pressure rating. Include nozzle and head for heat-exchanger tube coil.

1) Configuration: Horizontal **OR** Vertical, **as directed**.
2) Manhole: 11 by 15 inches (280 by 380 mm) in end head of horizontal **OR** sidewall of vertical, **as directed**, storage tank shell.
3) Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing and labeling.
   a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
   b) NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
4) Lining: Cement **OR** Glass **OR** Nickel plate **OR** Phenolic coating **OR** Sheet copper, **as directed**, complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
5) Anode Rods: Factory installed, magnesium.
6) Insulation: Complying with ASHRAE/IESNA 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire storage tank and nozzle except connections and controls.

e. Heat-Exchanger Coil: NPS 3/4 (DN 20) **OR** NPS 1-1/4 (DN 32), **as directed**, diameter, vented, double-wall, copper or copper-alloy, U tubes with tube sheet and supporting baffles.
   1) Heat-Exchanger Pressure Rating: Equal to or greater than heating-fluid supply pressure.
f. Temperature Control: Adjustable temperature aquastat, mounted in storage tank shell head, unless otherwise indicated.
g. Safety Control: Automatic, high-temperature-limit cutoff device or system. Include automatic low-water cutoff device or system.
h. Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of heat exchanger. Select one relief valve with sensing element that extends into storage tank.
i. Gages: Factory-mounted thermometer and pressure gage.
j. Circulating Pump: UL 778, all-bronze, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3. Include mechanical seals, 125-psig (860-kPa) minimum working-pressure rating, and 225 deg F (107 deg C) continuous-water-temperature rating.
   1) Pump Control: Sensor for operating pump and control valve.
k. Support: Factory mounted on skids.
l. Energy Management System Interface: Normally closed dry contacts for enabling and disabling heat exchanger.

C. Noncirculating, Storage Heat Exchangers
1. Compact Heat Exchangers:
   a. Description: Hot-water storage tank with integral heat-exchanger coil, controls, and specialties for heating domestic water with heating hot water **OR** steam, **as directed**, in coil.
   b. Storage Tank Shell Construction: Steel or stainless steel with 150-psig (1035-kPa) working-pressure rating.
      1) Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
      2) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
      3) Insulation: Complying with ASHRAE/IESNA 90.1 or ASHRAE 90.2, and suitable for operating temperature. Surround entire tank except connections and controls.
      4) Jacket: Steel with enameled finish, unless otherwise indicated.
      5) Anode Rods for Steel Tanks: Factory installed, magnesium.

c. Heat-Exchanger Coil: Copper or stainless-steel coil assembly, permanently installed inside storage tank, for heating fluid. Include working-pressure rating equal to or greater than heating-fluid supply pressure.
d. Temperature Control: Adjustable thermostat.
e. Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include relief valve with relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of heat exchanger. Select relief valve with sensing element that extends into storage tank.

2. Storage Heat Exchangers:
   a. Description: Assembly of hot-water storage tank with separate heat-exchanger coil; controls; and specialties for heating domestic water with heating hot water **OR** steam, **as directed**, in coil.
   b. Storage Tank Construction: ASME-code steel with 125-psig (860-kPa) **OR** 150-psig (1035-kPa), **as directed**, working-pressure rating. Include nozzle and head for heat-exchanger tube coil.
      1) Configuration: Horizontal **OR** Vertical, **as directed**.
      2) Manhole: 11 by 15 inches (280 by 380 mm) in end head of horizontal **OR** sidewall of vertical, **as directed**, storage tank shell.
      3) Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing and labeling.
         a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
         b) NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
      4) Lining: Cement **OR** Glass **OR** Nickel plate **OR** Phenolic coating **OR** Sheet copper, **as directed**, complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
      5) Anode Rods: Factory installed, magnesium.
      6) Insulation: Complying with ASHRAE/IESNA 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire storage tank and nozzle except connections and controls.
   c. Heat-Exchanger Coil: NPS 3/4 (DN 20) **OR** NPS 1-1/4 (DN 32), **as directed**, diameter, vented, double-wall, copper or copper-alloy, U tubes with tube sheet and supporting baffles.
      1) Heat-Exchanger Pressure Rating: Equal to or greater than heating-fluid supply pressure.
   d. Temperature Control: Adjustable temperature aquastat, mounted in storage tank shell head, unless otherwise indicated.
   e. Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of heat exchanger. Select one relief valve with sensing element that extends into storage tank.
   f. Support: Factory mounted on skids.

D. Plate Heat Exchangers
1. Brazed-Plate Heat Exchangers:
   a. Description: Assembly of heat-exchanger plates, permanently brazed together, for using heating hot water **OR** steam, **as directed**, to heat domestic water.
   b. Working-Pressure Rating: 150 psig (1035 kPa) **OR** 200 psig (1380 kPa) **OR** 250 psig (1725 kPa) **OR** 400 psig (2760 kPa), **as directed**, minimum.
   c. Plate Construction: Single **OR** Vented, double, **as directed**, wall.
   d. Plate Material: ASTM A 666, Type 316 stainless steel.
   e. Connections: Stainless steel; threaded.

2. Frame-and-Plate Heat Exchangers:
   a. Description: Assembly of nonfixed-position, heat-exchanger plates, with frame, for using heating hot water **OR** steam, **as directed**, to heat domestic water.
   b. Working-Pressure Rating: 150 psig (1035 kPa) **OR** 200 psig (1380 kPa) **OR** 250 psig (1725 kPa) **OR** 400 psig (2760 kPa), **as directed**, minimum.
   c. Frame:
      1) Carrying and Guide Bars: Carbon steel **OR** Stainless steel, **as directed**.
      2) Fixed, Frame Plate; Pressure Plate; Support Column; and Nuts and Bolts: Carbon steel.
   d. Channel Plates:
      1) Type: Single **OR** Vented, double, **as directed**, wall.
      2) Material: ASTM A 666, Type 304 or 316 stainless steel.
      3) Gasket Material: Butyl or acrylonitrile-butadiene rubber, suitable for potable water.
   e. Connections: Stainless steel suitable for potable water.
      1) NPS 2 (DN 50) and Smaller: Threaded.
      2) NPS 2-1/2 (DN 65) and Larger: Flanged.
   f. Protective Shroud: Steel, covering channel plates.
   g. Insulation: Complying with ASHRAE/IESNA 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire heat exchanger except connections.

E. Heat Reclaimers
1. Description: Waste-heat recovery device complying with and listed according to UL 207 for heat reclaimers. Device includes vertical drainage tube with helical, domestic water preheat coil around drainage tube.
   a. Drainage Tube: ASTM B 306, Type DWV, center, copper drainage tube of size indicated.
   b. Water Preheat Coil: ASTM B 88, Type L (ASTM B 88M, Type B), copper water tube, of size indicated attached to drainage tube.
      1) Working-Pressure Rating: 150 psig (1035 kPa) on potable-water supply tubing.
   c. Capacity and Characteristics:
      1) NPS 2 (DN 50) Drainage Tube:
         a) Domestic Water Preheat Coil: NPS 3/8 (DN 10).
         b) Unit Height: 20 inches (508 mm) **OR** 24 inches (610 mm) **OR** 30 inches (762 mm), **as directed**.
      2) NPS 3 (DN 80) Drainage Tube:
         a) Domestic Water Preheat Coil: NPS 1/2 (DN 15) **OR** NPS 3/4 (DN 20), **as directed**.
         b) Unit Height: 30 inches (762 mm) **OR** 40 inches (1016 mm) **OR** 60 inches (1524 mm), **as directed**.
      3) NPS 4 (DN 100) Drainage Tube:
         a) Domestic-Water Preheat Coil: NPS 1/2 (DN 15) **OR** NPS 3/4 (DN 20), **as directed**.
         b) Unit Height: 30 inches (762 mm) **OR** 40 inches (1016 mm) **OR** 60 inches (1524 mm), **as directed**.

F. Compression Tanks
1. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
   a. Construction:
      1) Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
      2) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
      3) Air-Charging Valve: Factory installed.
   b. Capacity and Characteristics:
      1) Working-Pressure Rating: 100 psig (690 kPa) **OR** 150 psig (1035 kPa), **as directed**.

2) Capacity Acceptable: 2 gal. (7.6 L) **OR** 4 gal. (15.1 L) **OR** 7 gal. (26.5 L) **OR** 10 gal. (37.9 L), **as directed**, minimum.

G. Heat-Exchanger Accessories

1. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of heat exchanger. Select relief valves with sensing element that extends into heat-exchanger storage tank.
2. Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include pressure setting less than working-pressure rating of heat exchanger.
3. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.
4. Source Quality Control
5. Test and inspect heat-exchanger storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
6. Hydrostatically test commercial heat-exchanger storage tanks before shipment to minimum of one and one-half times pressure rating.
7. Prepare test reports.

1.3 EXECUTION

A. Heat-Exchanger Installation

1. Install heat exchangers on concrete bases.
   a. Concrete base construction requirements are specified in Division 22 Section "Common Work Results For Plumbing".
2. Install heat exchangers level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
3. Anchor heat exchangers to substrate.
4. Install seismic restraints for heat exchangers. Anchor to substrate.
5. Install temperature and pressure relief valves in top portion of storage tank shells of heat exchangers with domestic water storage. Use relief valves with sensing elements that extend into shells. Extend relief-valve outlet, with drain piping same as water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
6. Install combination temperature and pressure relief valves in water piping for heat exchangers without storage. Extend relief-valve outlet, with drain piping same as water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
7. Install heat-exchanger drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for heat exchangers that do not have tank drains. Refer to Division 22 Section "Domestic Water Piping Specialties" for hose-end drain valves.
8. Install thermometer on each heat-exchanger domestic-water inlet and outlet piping, and install thermometer on each heat-exchanger heating-fluid inlet and outlet piping. Refer to Division 22 Section "Meters And Gages For Plumbing Piping" for thermometers.
9. Install pressure gages on heat-exchanger heating-fluid piping. Refer to Division 22 Section "Meters And Gages For Plumbing Piping" for pressure gages.
10. Fill heat exchangers with water.
11. Charge compression tanks with air.

B. Connections

1. Piping installation requirements are specified in other Division 14. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to heat exchangers to allow service and maintenance. Arrange piping for easy removal of heat exchangers.

3. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
4. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Field Quality Control
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
2. Perform the following field tests and inspections and prepare test reports:
    a. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
    b. Operational Test: After electrical circuitry has been energized, confirm proper operation.
    c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Remove and replace heat exchangers that do not pass tests and inspections and retest as specified above.

D. Demonstration
1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain heat exchangers.

END OF SECTION 22 35 23 13

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Task	Specification	Specification Description
22 35 23 13	22 12 23 13	Electric, Domestic Water Heaters
22 40 00 00	10 28 19 16	Plumbing Fixtures
22 41 39 00	10 28 19 16	Plumbing Fixtures
22 41 39 00	22 01 40 81	Emergency Plumbing Fixtures
22 42 13 13	10 28 19 16	Plumbing Fixtures
22 42 13 13	22 01 40 81	Emergency Plumbing Fixtures
22 42 13 16	10 28 19 16	Plumbing Fixtures
22 42 13 16	22 01 40 81	Emergency Plumbing Fixtures
22 42 16 13	10 28 19 16	Plumbing Fixtures
22 42 16 13	22 01 40 81	Emergency Plumbing Fixtures
22 42 16 16	10 28 19 16	Plumbing Fixtures
22 42 16 16	22 01 40 81	Emergency Plumbing Fixtures

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SECTION 22 42 19 00 - PORCELAIN STEEL BATHTUB LINERS AND SURROUNDS

DESCRIPTION OF WORK

This specification covers the furnishing and installation of materials for porcelain steel bathtub liners and surrounds. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

GENERAL

System Description

1. Performance Requirements: Comply with following:
   a. Porcelain Enameled Formed Steel Plumbing Fixtures: FS WWP 542b, Section 12, Porcelain Enameled Fixtures:
      1) Specular Gloss: Determined in accordance with ASTM C 346.
         a) Cover Coat: 45 degree specular gloss.
      2) Acid Resistance: Determined in accordance with ASTM C 282.
         a) Cover Coat: Rating of not less than Class A.
      3) Alkali Resistance: Determined in accordance with ASTM C 614.
         a) Cover Coat: Weight Loss: Not exceed 20 mg/square inch.
      4) Abrasion Resistance: Determined in accordance with ASTM C 448.
         a) Surface Abrasion Index of Cover Coat: 40 or higher.
      5) Warpage: Comply with US Dept. of Commerce Commercial Standard (CS) 77, Paragraph 7.1; and US Dept. of Commerce Product Standard (PS) 5, Paragraph 6.2.2.
      6) Rigidity: Comply with PS 5, Paragraph 6.6.2.

Submittals

2. Product Data:
   a. Include porcelain enamel steel samples, backer board material, and joint sealant.

3. Shop Drawings
   a. Indicate proposed method of panel securing method.
   b. Templates: Furnish plumber with templates of all openings required in porcelain enamel wall system to accommodate new plumbing trim.
4. Design Drawings: If required, prepare and submit drawings for approval to applicable governmental agencies and obtain necessary permits and certificates for compliance when required.
5. Samples:
   a. Three samples of steel proposed to be used for bathtub liner and for wall panels.
      1) Samples without porcelain enamel coating.
      2) Sample: Used to calibrate elcometer to determine amount of porcelain enamel coatings applied.
   b. Three samples of each type of porcelain enamel finish on steel for acceptance.
   c. the Owner will retain one set of approved samples.
   d. Keep one set of approved samples at site throughout construction period.
6. Quality Assurance/Control Submittals:
   a. Test Reports: Results of testing by accredited independent laboratory demonstrating compliance of porcelain enamel with Performance Requirements.
   b. Certificates: Manufacturer's written certification that bathtub liners and surrounds meet or exceed specified requirements.

Quality Assurance

7. Materials: Been in general use and satisfactorily performed for minimum of five years. Provide list of locations where such materials have been used.
8. Certifications: Comply with ANSI Z34.2.
9. Regulatory Requirements: Comply with following:
   a. Install bathtub liners and surrounds in accordance with applicable codes and regulations. Should any specified items or requirements conflict with such codes and regulations, consult with the Owner.
   b. Accessibility:
      1) Architectural Barriers Act of 1968 as amended (42 USC 4152-4157) and HUD implementing regulations (24 CFR Part 40).
         a) Uniform Federal Accessibility Standards (UFAS).
      2) Section 504 of the Rehabilitation Act of 1973 as amended (29 USC 794) and HUD implementing regulations 24 CFR Part 8.
      3) Fair Housing Accessibility Guidelines (24 CF1R Chapter 1).
      4) Americans with Disabilities Act of 1990 (ADA) (28 CFR Part 35).
10. Mock-ups: Install one complete mock-up of each typical bathtub liner and surround installation. Comply with Section _____ for bathroom renovation mock-up requirements.
    a. Locations: As directed.
    b. Approved Mock-ups: Standard for rest of work.
    c. Approved Mock-ups: May remain part of completed project.
11. Pre-Installation Meetings: Hold meeting with associated plumbing items installer. Notify the Owner of time and location of meeting.

Project Conditions

12. Existing Conditions:
    a. Existing Utilities: Protect any sewer, water, gas, electric or other pipelines or conduits uncovered during work from damage.
13. Field Measurements: Field measure each bathroom before start of fabrication.

Scheduling And Sequencing

14. Scheduling: Schedule bathtub liner and surround work in coordination with associated plumbing work installer.
15. Scheduling and Completion: Comply with requirements of Detailed Scope of Work.

PRODUCTS

Bathtub Liners And Aprons

16. Description: Prefabricated customized inserts to fit existing bathtubs and provide new, substantial units, capable of supporting bather and coordinated and integrated with bathtub/shower surround system.
    a. Bathtub Liners and Aprons: Completely and uniformly enclose existing bathtubs, obscuring them from view.
    b. New Tub Liners and Aprons: Integrate with existing bathtubs, wall conditions, floor conditions, and plumbing connections to provide complete installation subject to individual dimensional variations in bathtub.
17. Bathtub Liner and Apron Materials: Sheet steel coated with porcelain enamel.
    a. Sheet Steel Thickness: No. 16 gage through 20 gage as specified below:

Gage	No. 16	No. I8	No. 20
Standard Thickness, mm (inch)	1.52 (0.0598)	1.21 (0.0478)	1.01 (0.0398)
Minimum Thickness, mm (inch)	1.37 (0.054)	1.09 (0.043)	0.84 (0.0329)

Bathtub/Shower Surrounds

18. Panel System: Prefabricated panels in solid sections and continuous to cover back and side walls of bathtub/shower, coordinated and integrated with bathtub liners and aprons.
    a. Height of Bathtub/Shower Surround: 1 500 mm (60 inches) above bathtub ledge.
    b. Contractor's Option: One, two, or three piece back wall system.
    c. Where window is located over bathtub, install porcelain enamel on steel on full depth of returns at full length of window stool and at jambs; from window stool to top of surround.
        1) Sill and Jamb System: Not interfere with easy use of and access to window pulls, handles, screen retainers, etc.
    d. Access Panels: Provide easily removable panel to provide access to tub and shower valves. Provide panels with shallow formed edge on all four sides to receive bead of joint sealant.
    e. Method of Securing: Not visible.
19. Panels: Coated with porcelain enamel to provide bright, hard, impervious panels.
    a. Panels: Retain their surface characteristics and resist wear as result of abrasion or scouring, and staining due to use of ordinary household abrasive cleaners in popular use.
    b. Material: Special purpose enameling iron or steel or low metalloid for carbon content, especially manufactured and processed for porcelain enamel units for architectural purposes.
        1) Thickness: 18 through 22 gage steel.
    c. Panel Edges: 90 degree flange formed as part of face panel and of same finish.
20. Wall Clips Supporting Panels: Minimum 20 gage, hot-dipped galvanized.
21. Fastening Devices: As required and in accordance with panel manufacturer's instructions and accepted good industry practices and as approved.
    a. Provide expansion toggle bolts, molly bolls, nylon and other plastic anchors, lead anchors as required for existing wall conditions.

Porcelain Enamel Finish

22. Porcelain Enamel Coating: Hard, impervious arid durable, glass-like coating produced by fusing carefully compounded mixture of mineral substances such as Cryolite, Feldspar, Quartz, Borax, Silica, Tin and Zirconium Oxide Clays at temperatures up to 980 degrees C (1800 degrees F) in accordance with ANSI A112.19.4M.
23. Porcelain Enamel: Apply to all areas of each component, including backs and flanges.
    a. Initial Enamel Coating: Apply to all surfaces and apply additional separately fired coating of chemically resistant porcelain enamel as face coat.
    b. Each coat of Porcelain Enamel: 0.10 to 0.15 mm (0.004 to 0.006 inch) when measured in accordance with ASTM D1186.
    c. Two Coatings of Porcelain Enamel on Exposed Surfaces of Panels: Thickness of 0.20 to 0.05 mm (0.008 to 0.002 inch).
    d. Final Porcelain Enamel Coat: Chemically resistant, complying with Performance Requirements in this Section.
    e. Installed Liner and Surround: Uniform color.
        1) Color: White.

Accessories

24. Bracing Strips/Filler Material/Backer Board: Fire retardant perlite or molded polystyrene material providing zero capillarity water resistance, and permanent insulation properties.
    a. Bracing Strips: Fire retardant molded polystyrene material.
    b. Filler Material: Sound deadening and cushioning material.
    c. Panel Backer Board: Minimum 12.7 mm (112 inch) thick.
25. Joint Sealant: Mildew resistant one-component silicone; FS TT-S-001543A, Class A; ASTM C 920, Type S, Grade NS, Class 25, Uses NT, G, and A.
    a. Color: Match color of porcelain enamel.
26. Bath Accessories: See Division 10 Section “Bath Accessories.”

Fabrication

27. Shop Assembly: Shop assemble panels to greatest extent possible.
    a. Coordinate with bath accessories provided under Division 10 Section “Bath Accessories.”

EXECUTION

Examination

28. Site Verification of Conditions:
    a. Existing Conditions: Examine bathrooms before beginning installation.
    b. Field Measurements: Verify field measurements are as indicated on Shop Drawings.
    c. Do riot proceed with installation until conditions are satisfactory.

Preparation

29. Protection: Comply with requirements of Detailed Scope of Work.
    a. Protect or repair utilities damaged by operations under this Section.
    b. Protect adjacent elements from damage and disfiguration.
    c. Repair or replace damaged elements in accordance with Detailed Scope of Work.
30. Preparation: Prepare bathtubs and surround walls as required for proper installation in accordance with Detailed Scope of Work.

Installation

31. Interface With Other Work: Coordinate installation of bathtub liner and surround wall panel system with installation of bath accessories under Division 10 Section “Bath Accessories” and plumbing work under Division 15 Section “Plumbing.”
32. Bathtub Liners and Aprons:
    a. Installation: Accomplished without removing existing bathtub fixture.
    b. Bracing Strips/Filler Material: Partially line clearance between base of existing bathtubs and tub liner with bracing strips.
    c. Insert new bathtub liner over and into existing bathtub, simultaneously bottoming on and compressing filler material and resting on and being supported by intimate contact with existing bathtub seat and rim on all four sides, to eliminate any movement.
    d. Apron: Install new apron to extension to new bathtub liner ledge or seat portion; by inserting non-corrosive locating pins and/or fasteners as required between floor and roll rim of new tub liner.
    e. Customize bathtub liner Insert in accordance with variable field dimensions into variably sized ledges and seat: both in plant fabrication and field installation as required.
        1) a. Verify dimensions and conditions by visiting each bathroom for work indicated and specified.
33. Tub Surround Wall Panel System: Integrate wall panels with installation of new tub liners.
    a. Panel System: Install as extension of bathtub in upward direction bearing configuration and function of bathtub and shower enclosure.
    b. Install window sill and jamb system where window is located over bathtub in manner not to interfere with easy use of and access to window pulls, handles, screen retainers, etc.
    c. Existing Walls: Remove obstructions, encountered for installation of porcelain enamel panels.
        1) Patch and repair damaged wall board surfaces that are exposed after panel installation in accordance with Detailed Scope of Work.
        2) Backer Board: Provide between wall panels and existing masonry walls.
    d. Method of Securing Panels: Mechanical and not visible.
        1) Provide at least two wall clips on both top and bottom flanges of each panel.
        2) Exposed bolts, screw heads, grommets, battens, channel moldings. or any other fastening devices not allowed.
    e. Access Panels: Seal perimeter with joint sealant for waterproof joint.

f. Joint Sealing: Permanently seal perimeter edges between new panels and existing walls, joints between panels, joints at window sill and jamb system, and comer joint at juncture of back wall with side walls with joint sealant .

34. Joint Sealants: Apply in accordance with manufacturers recommendations.
    a. Surfaces to be Sealed: Clean, dry and free of any foreign matter that would degrade adhesion.
    b. Prime cleaned surfaces in accordance with sealant manufacturer's recommendations.
    c. Protect surfaces adjacent to joints by masking tape before applying sealant. Remove tape upon finishing sealing work.

Cleaning

35. Cleaning: Comply with requirements of Detailed Scope of Work.
    a. Clean bathtub liners and surrounds after installation is completed with materials compatible with porcelain enamel and having no detrimental effects on porcelain enamel.

END OF SECTION 22 42 19 00

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Task	Specification	Specification Description
22 42 19 00	10 28 19 16	Plumbing Fixtures
22 42 19 00	22 01 40 81	Emergency Plumbing Fixtures
22 42 23 00	10 28 19 16	Plumbing Fixtures
22 42 23 00	22 01 40 81	Emergency Plumbing Fixtures
22 42 33 00	10 28 19 16	Plumbing Fixtures
22 42 33 00	22 01 40 81	Emergency Plumbing Fixtures
22 42 39 00	01 22 16 00	No Specification Required
22 42 39 00	10 28 19 16	Plumbing Fixtures
22 42 39 00	22 01 40 81	Emergency Plumbing Fixtures
22 42 43 00	10 28 19 16	Plumbing Fixtures
22 42 43 00	22 01 40 81	Emergency Plumbing Fixtures
22 42 46 00	10 28 19 16	Plumbing Fixtures
22 42 46 00	22 01 40 81	Emergency Plumbing Fixtures

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SECTION 22 43 00 00 - MEDICAL PLUMBING FIXTURES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for medical plumbing fixtures. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following medical plumbing fixtures and related components:
      a. Faucets for lavatories, showers, and sinks.
      b. Laminar-flow, faucet-spout outlets.
      c. Flushometers.
      d. Toilet seats.
      e. Protective shielding guards.
      f. Fixture supports.
      g. Bedpan washers.
      h. Water closets.
      i. Lavatories.
      j. Individual showers.
      k. Patients' combination toilets.
      l. Clinical sinks.
      m. Plaster sinks.
      n. Surgeons' scrub sinks.
      o. Surgeons' instrument sinks.
      p. Bathing units.
      q. Sitz baths.
      r. Bedpan washing equipment.
      s. Hydrotherapy whirlpools.
      t. Outlet boxes.
      u. Morgue equipment.

C. Definitions
   1. Accessible Medical Plumbing Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
   2. Fitting: Device that controls the flow of water into or out of the medical plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads, drains and tailpieces, and traps and waste pipes.
   3. FRP: Fiberglass-reinforced plastic.
   4. PMMA: Polymethyl methacrylate (acrylic) plastic.

D. Submittals
   1. Product Data: For each type of medical plumbing fixture indicated.
   2. LEED Submittal:
      a. Product Data for Credit WE 2, 3.1, and 3.2: Documentation indicating flow and water consumption requirements.
   3. Shop Drawings: Diagram power, signal, and control wiring.
   4. Operation and maintenance data.

E. Quality Assurance

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act", **as directed**; for plumbing fixtures for people with disabilities.
3. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
4. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
5. Select combinations fixtures and trim, faucets, fittings, and other components that are compatible.
6. Comply with the following applicable standards and other requirements specified for medical plumbing fixtures:
    a. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
    b. Plastic Bathtubs: ANSI Z124.1.
    c. Plastic Shower Enclosures: ANSI Z124.2.
    d. Slip-Resistant Bathing Surfaces: ASTM F 462.
    e. Vitreous-China Fixtures: ASME A112.19.2M.
7. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
    a. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
    b. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
    c. Faucets: ASME A112.18.1.
    d. Hose-Connection Vacuum Breakers: ASSE 1011.
    e. Hose-Coupling Threads: ASME B1.20.7.
    f. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
    g. NSF Materials: NSF 61.
    h. Pipe Threads: ASME B1.20.1.
    i. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
    j. Supply Fittings: ASME A112.18.1.
    k. Brass Waste Fittings: ASME A112.18.2.
8. Comply with the following applicable standards and other requirements specified for bathtub and shower faucets:
    a. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
    b. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
    c. Faucets: ASME A112.18.1.
    d. Hand-Held Showers: ASSE 1014.
    e. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
    f. Hose-Coupling Threads: ASME B1.20.7.
    g. Manual-Control Antiscald Faucets: ASTM F 444.
    h. Pipe Threads: ASME B1.20.1.
    i. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
    j. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
    k. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
9. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
    a. Atmospheric Vacuum Breakers: ASSE 1001.
    b. Brass and Copper Supplies: ASME A112.18.1.
    c. Flexible Water Connectors: ASME A112.18.6.
    d. Manual-Operation Flushometers: ASSE 1037.
    e. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
    f. Brass Waste Fittings: ASME A112.18.2.
10. Comply with the following applicable standards and other requirements specified for miscellaneous components:

a. Grab Bars: ASTM F 446.
b. Hose-Coupling Threads: ASME B1.20.7.
c. Off-Floor Fixture Supports: ASME A112.6.1M.
d. Pipe Threads: ASME B1.20.1.
e. Plastic Toilet Seats: ANSI Z124.5.
f. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.2 PRODUCTS

A. Lavatory Faucets
1. Description: Faucet for lavatory-type medical plumbing fixture. Coordinate faucet inlets with supplies, connectors, and fixture holes; coordinate outlet with spout and fixture receptor.
a. Maximum Flow Rate: 2.2 gpm (8.3 L/min.).
b. Body Material: Solid brass.
c. Finish: Polished chrome plate.
d. Type: Single-control mixing **OR** Single-valve nonmixing **OR** Two-handle mixing, **as directed**.
e. Tempering System: Not required **OR** Thermostatic **OR** Pressure balance, **as directed**.
f. Supply Centers: Single hole **OR** 4 inches (102 mm) **OR** 6 inches (152 mm) **OR** 8 inches (203 mm) **OR** 12 inches (305 mm) **OR** Adjustable, **as directed**.
g. Mounting: Deck, exposed **OR** Deck, concealed **OR** Back/wall, exposed **OR** Back/wall, concealed, **as directed**.
h. Handle(s): Single lever **OR** Cross, four arm **OR** Wrist blade, 4 inches (102 mm) **OR** Elbow, 6 inches (152 mm) **OR** Not applicable, **as directed**.
i. Temperature Indicators: Color-coded for hot and cold water.
j. Inlet(s): NPS 3/8 (DN 10) tubing, plain end **OR** NPS 3/8 (DN 10) tubing, with NPS 1/2 (DN 15) male adaptor **OR** NPS 1/2 (DN 15) male shank **OR** NPS 1/2 (DN 15) female shank, **as directed**.
k. Spout: Rigid **OR** Swing **OR** Rigid gooseneck **OR** Swivel gooseneck, **as directed**, brass.
l. Spout Outlet: Aerator **OR** Spray **OR** Laminar flow **OR** Plain end **OR** Spray, 0.5 gpm (1.5 L/min.), **as directed**.
m. Operation: Compression, manual **OR** Noncompression, manual **OR** Automatic, hard-wired electric sensor, **as directed**.
n. Drain: Pop up **OR** See fixture, **as directed**.

B. Shower Faucets
1. Description: Faucet for shower-type medical plumbing fixtures. Include hot- and cold-water indicators; check stops; and shower head, arm, and flange. Coordinate faucet inlets with supplies.
a. Maximum Flow Rate: 2.5 gpm (9.5 L/min.), unless otherwise indicated.
b. Body Material: Solid brass.
c. Finish: Polished chrome plate.
d. Type: Thermostatic **OR** Pressure balance **OR** Thermostatic and pressure balance, **as directed**, with integral or field-installed check stops on hot- and cold-water supplies.
e. Mounting: Exposed **OR** Concealed, **as directed**.
f. Handle(s): Single lever **OR** Cross, four arm **OR** Not applicable, **as directed**.
g. Temperature Indicators: Color-coded for hot and cold water.
h. Diverter Valve: Not required **OR** Integral with mixing valve **OR** Not integral with mixing valve, **as directed**.
i. Backflow Protection Device for Hand-Held Shower: Required **OR** Not required, **as directed**.
j. Operation: Compression, manual **OR** Noncompression, manual **OR** Automatic, hard-wired electric sensor, **as directed**.
k. Antiscald Device: Integral with mixing valve **OR** Not required, **as directed**.

l. Supply Connections: NPS 1/2 (DN 15) **OR** NPS 1/2 (DN 15), union **OR** Sweat, **as directed**.
m. Shower Head Material: Brass with chrome-plated finish.
n. Head Type: Ball joint **OR** Without ball joint **OR** Hand held, slide-bar mounted **OR** Hand held, hook mounted, **as directed**.
o. Spray Pattern: Fixed **OR** Adjustable, **as directed**.
p. Integral Volume Control: Required **OR** Not required, **as directed**.
q. Shower-Arm, Flow-Control Fitting: Not required **OR** 1.5 gpm (5.7 L/min.) **OR** 2.0 gpm (7.6 L/min.), **as directed**.

C. Sink Faucets
1. Description: Faucet for sink-type medical plumbing fixtures. Coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
a. Maximum Flow Rate: 2.5 gpm (9.5 L/min.), unless otherwise indicated.
b. Body Material: Solid brass.
c. Finish: Polished chrome plate **OR** Rough chrome plate, **as directed**.
d. Type: Sink faucet **OR** Clinical-sink faucet with stops in shanks, vacuum breaker, hose-thread outlet, and pail hook, **as directed**.
e. Tempering Device: Thermostatic **OR** Pressure balance **OR** Not required, **as directed**.
f. Mixing Valve: Single control **OR** Two-lever handle, **as directed**.
g. Backflow Protection Device for Hose Outlet: Required **OR** Not required **OR** Not applicable, **as directed**.
h. Supply Centers: Single hole **OR** 4 inches (102 mm) **OR** 6 inches (152 mm) **OR** 8 inches (203 mm) **OR** Adjustable, **as directed**.
i. Mounting: Deck, exposed **OR** Deck, concealed **OR** Back/wall, exposed **OR** Back/wall, concealed, **as directed**.
j. Handle(s): Lever **OR** Knob **OR** Cross, four arm **OR** Wrist blade, 4 inches (102 mm) **OR** Elbow, 6 inches (152 mm) **OR** Not applicable, **as directed**.
k. Temperature Indicators: Color-coded for hot water on left and cold water on right.
l. Inlet(s): NPS 3/8 (DN 10) plain-end tubing **OR** NPS 3/8 (DN 10) tubing with NPS 1/2 (DN 15) male adapter **OR** NPS 1/2 (DN 15) male shank **OR** NPS 1/2 (DN 15) female shank, **as directed**.
m. Spout: Rigid, solid **OR** Swing tubular **OR** Rigid, gooseneck, solid **OR** Swivel, gooseneck, solid, **as directed**, brass with wall brace, **as directed**.
n. Spout Outlet: Aerator **OR** Swivel aerator/spray **OR** Spray **OR** Laminar flow **OR** Hose thread **OR** Plain end, **as directed**.
o. Vacuum Breaker: Required **OR** Not required, **as directed**.
p. Operation: Compression, manual **OR** Noncompression, manual **OR** Automatic, hard-wired electric sensor, **as directed**.

D. Laminar-Flow Faucet-Spout Outlets
1. Description: Chrome-plated-brass faucet-spout outlet that produces non-aerating laminar stream. Include male or female thread that mates with faucet outlet for attachment to faucets where indicated and flow-rate range that includes flow of faucet.

E. Flushometers
1. Description: Flushometer for clinical-sink-type **OR** water-closet-type, **as directed**, medical plumbing fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, **as directed**, control stop with check valve, vacuum breaker, and copper or brass tubing, and polished chrome-plated finish on exposed parts.
a. Internal Design: Diaphragm operation.
b. Style: Exposed **OR** Concealed, **as directed**.
c. Inlet Size: NPS 1 (DN 25).
d. Trip Mechanism: Oscillating, lever-handle actuator **OR** Mechanical, push-button actuator with stainless-steel access plate **OR** Hydraulic, push-button actuator **OR** Foot-pedal

actuator **OR** Hard-wired, electric-sensor actuator **OR** Battery-operated sensor actuator, **as directed**.
e. Consumption: 1.6 gal./flush (6.0 L/flush) **OR** 3.5 gal./flush (13.3 L/flush), **as directed**.
f. Tailpiece Size: NPS 1-1/4 (DN 32) **OR** NPS 1-1/2 (DN 40), **as directed**, and standard length to top of bowl.
g. Integral Bedpan Washer: Not required **OR** Factory fabricated, attached to tailpiece, and with spray head, **as directed**.

F. Toilet Seats
1. Description: Plastic toilet seat for water-closet-type medical plumbing fixture.
a. Material: Molded, solid plastic with antimicrobial agent, **as directed**.
b. Configuration: Closed **OR** Open, **as directed**, front with **OR** without, **as directed**, cover.
c. Size: Elongated, unless otherwise indicated.
d. Class: Standard **OR** Heavy-duty, **as directed**, commercial.
e. Hinge Type: Stainless-steel CK, check **OR** SC, self-sustaining check, **as directed**.
f. Color: White **OR** Black, **as directed**.

G. Protective Shielding Guards
1. Protective Shielding Pipe Covers:
a. Description: Manufactured plastic wraps for covering medical plumbing fixture hot-water supply **OR** hot- and cold-water supplies, **as directed**, and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
2. Protective Shielding Piping Enclosures:
a. Description: Manufactured plastic enclosure for covering medical plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

H. Fixture Supports
1. Water-Closet Supports:
a. Description: Combination carrier designed for accessible **OR** standard, **as directed**, mounting height of wall-mounting, water-closet-type medical plumbing fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.
2. Lavatory Supports:
a. Description: Type I, lavatory carrier with exposed arms and tie rods **OR** Type II, lavatory carrier with concealed arms and tie rod **OR** Type III, lavatory carrier with hanger plate and tie rod, **as directed**, for wall-mounting, lavatory-type medical plumbing fixture. Include steel uprights with feet.
b. Accessible-Fixture Support: Include rectangular steel uprights.
3. Sink Supports:
a. Description: Type I, sink carrier with exposed arms and tie rods **OR** Type II, sink carrier with hanger plate, bearing studs, and tie rod **OR** Type III, sink carrier with hanger plate and exposed arms, **as directed**, for sink-type medical plumbing fixture. Include steel uprights with feet.
4. Bedpan Washers
a. Description: Wall-mounting, hand-held, hand-control **OR** single-pedal, foot-control **OR** double-pedal, hot- and cold-water control, **as directed**, medical plumbing fixture.
1) Hose: 48-inch- (1220-mm-) long rubber or vinyl hose with spray nozzle, wall bracket, and hook.
2) Self-closing valve.
3) Loose-key supply stop.
4) Vacuum Breaker: Wall mounting, atmospheric.
5) Finish: Polished, chrome-plated finish on metal parts exposed after installation.

I. Water Closets

1. Wall-Mounting Water Closets:
   a. Description: Accessible, wall-mounting **OR** Wall-mounting, **as directed**, back-outlet, vitreous-china medical plumbing fixture designed for bedpan washing and flushometer valve operation.
      1) Style: Flushometer valve.
         a) Bowl Type: Elongated with siphon-jet design and bedpan lugs or slots.
         b) Design Consumption: 1.6 gal./flush (6 L/flush).
         c) Color: White.
2. Floor-Mounting Water Closets:
   a. Description: Accessible, floor-mounting **OR** Floor-mounting, **as directed**, floor-outlet, vitreous-china medical plumbing fixture designed for bedpan washing and flushometer valve operation.
      1) Style: Flushometer valve.
         a) Bowl Type: Elongated with siphon-jet design and bedpan lugs or slots. Include bolt caps matching fixture.
         b) Height: Standard **OR** Accessible, **as directed**.
         c) Design Consumption: 1.6 gal./flush (6 L/flush).
         d) Color: White.

J. Lavatories
1. Wall-Mounting Lavatories:
   a. Description: Accessible, wall-mounting **OR** Wall-mounting, **as directed**, vitreous-china medical plumbing fixture.
      1) Type: With back **OR** Ledge back **OR** Shelf back **OR** Slab, **as directed**.
      2) Size: 18 by 15 inches (457 by 381 mm) **OR** 19 by 16 inches (483 by 406 mm) **OR** 20 by 18 inches (508 by 457 mm) **OR** 24 by 20 inches (610 by 508 mm), **as directed**, rectangular.
      3) Faucet Hole Punching: One hole **OR** Three holes, 2-inch (51-mm) centers **OR** Three holes, 4-inch (102-mm) centers, **as directed**.
      4) Faucet Hole Location: Top **OR** Front wall **OR** Inclined panel, **as directed**.
      5) Color: White.
      6) Faucet: Lavatory with pop-up waste **OR** for separate drain, **as directed**.
      7) Supplies: NPS 3/8 (DN 10) chrome-plated copper tubes or flexible connectors, **as directed**, with stops.
      8) Drain: See faucet **OR** Grid **OR** Grid with offset, **as directed**.
         a) Location: Not applicable.
      9) Drain Piping: NPS 1-1/4 (DN 32) **OR** NPS 1-1/4 by NPS 1-1/2 (DN 32 by DN 40), **as directed**, chrome-plated, cast-brass P-trap; NPS 1-1/4 (DN 32) **OR** NPS 1-1/2 (DN 40), **as directed**, 0.032-inch- (0.8-mm-) **OR** 0.045-inch- (1.1-mm-), **as directed**, thick tubular brass waste to wall; and wall escutcheon.
      10) Protective Shielding Guard(s): Designation, as directed by the Owner.
      11) Fixture Support: Lavatory.
2. Counter-Mounting Lavatories:
   a. Description: Accessible, **as directed**, Counter-mounting **OR** Undercounter-mounting, **as directed**, vitreous-china, medical plumbing fixture.
      1) Type: Flat rim with ledge **OR** Self-rimming, **as directed**.
      2) Rectangular Lavatory Size: 18 by 15 inches (457 by 381 mm) **OR** 19 by 16 inches (483 by 406 mm) **OR** 20 by 18 inches (508 by 457 mm) **OR** 24 by 20 inches (610 by 508 mm), **as directed**.
      3) Oval Lavatory Size: 19 by 16 inches (483 by 406 mm) **OR** 20 by 17 inches (508 by 432 mm), **as directed**.
      4) Round Lavatory Size: 18 inches (457 mm) **OR** 19 inches (483 mm), **as directed**, in diameter.
      5) Faucet Hole Punching: One hole **OR** Three holes, 2-inch (51-mm) centers **OR** Three holes, 4-inch (102-mm) centers, **as directed**.

6) Faucet Hole Location: Top **OR** Front wall **OR** Inclined panel, **as directed**.
7) Color: White.
8) Faucet: Lavatory with pop-up waste **OR** for separate drain, **as directed**.
9) Supplies: NPS 3/8 (DN 10) chrome-plated copper tubes or flexible connectors, **as directed**, with stops.
10) Drain: See faucet **OR** Grid **OR** Grid with offset, **as directed**.
    a) Location: Not applicable.
11) Drain Piping: NPS 1-1/4 (DN 32) **OR** NPS 1-1/4 by NPS 1-1/2 (DN 32 by DN 40), **as directed**, chrome-plated, cast-brass P-trap; NPS 1-1/4 (DN 32) **OR** NPS 1-1/2 (DN 40), **as directed**, 0.032-inch- (0.8-mm-) **OR** 0.045-inch- (1.1-mm-), **as directed**, thick tubular brass waste to wall; and wall escutcheon.
12) Protective Shielding Guard(s): Designation, as directed by the Owner.

K. Individual Showers:
1. Description: Accessible, **as directed**, FRP **OR** PMMA, **as directed**, shower enclosure medical plumbing fixture with slip-resistant bathing surface complying with ASTM F 462. Comply with ADA requirements for use by people with disabilities.
   a. Size: 36 by 34 inches (915 by 865 mm) **OR** 42 by 36 inches (1065 by 915 mm) **OR** 43 by 39 inches (1090 by 990 mm) **OR** 48 by 34 inches (1220 by 865 mm) **OR** 52 by 36 inches (1320 by 915 mm) **OR** 60 by 36 inches (1525 by 915 mm) **OR** 72 by 36 inches (1830 by 915 mm), **as directed**.
   b. Surround: One piece.
   c. Color: White.
   d. Faucet: Shower.
   e. Drain: Grid, NPS 2 (DN 50).
      1) Location: Left side **OR** Center **OR** Right side, **as directed**.
   f. Accessories: If not furnished as integral components of specified fixture. Accessories are specified in Division 10 Section "Toilet, Bath, And Laundry Accessories".
      1) Grab bar(s).
      2) Normal-duty **OR** Heavy-duty, **as directed**, shower-curtain rod.
      3) Vinyl **OR** Duck **OR** Antibacterial, **as directed**, shower curtain.
      4) Shower-curtain hooks.
      5) Folding seat, **as directed**.

L. Patients' Combination Toilets
1. Swing-Away, Patients' Combination Toilets:
   a. Description: Factory-fabricated, combination water closet and lavatory medical plumbing fixture.
      1) Cabinet: Fixed installation with storage space and toilet paper holder.
         a) Material: Stainless steel **OR** Stainless steel, plastic laminate, or fiberglass, **as directed**, with laminated-wood or -plastic **OR** solid-plastic **OR** stainless-steel, **as directed**, top surface.
         b) Color: Not applicable.
         c) Mounting: Wall bracket.
      2) Water Closet: Swivel, floor-mounting, back-outlet **OR** floor-outlet, **as directed**, flushometer valve design.
         a) Material: Stainless steel.
         b) Orientation: Left **OR** Right, **as directed**, hand.
         c) Color: Not applicable.
         d) Toilet Seat: White, solid plastic.
         e) Flushometer: Concealed flushometer valve with push-button trip mechanism, check stop, and vacuum breaker on tailpiece.
         f) Fixture Support: Floor plate.
         g) Seal: For outlet.
      3) Lavatory: Counter mounting.
         a) Material: Stainless steel.

b) Color: Not applicable.
c) Faucet: Gooseneck type with wrist-blade handles **OR** Swing-spout type with single lever, **as directed**.
d) Drain: Grid, NPS 1-1/4 (DN 32).
e) Drain Piping: NPS 1-1/4 (DN 32) chrome-plated, cast-brass P-trap; tubular-brass waste to wall; and wall flange.

4) Bedpan Washer: On flushometer valve tailpiece or separate attachment affixed to unit.

2. Static, Patients' Combination Toilets:
a. Description: Factory-fabricated, combination water closet and lavatory fixture.
1) Cabinet: Fixed installation; swing-away cabinet or retractable, water-closet cover design with storage space and toilet paper holder.
a) Material: Stainless steel **OR** Stainless steel, plastic laminate, or fiberglass, **as directed**, with laminated-wood or -plastic **OR** solid-plastic **OR** stainless-steel, **as directed**, top surface.
b) Color: Not applicable.
c) Mounting: Wall bracket.
2) Water Closet: Floor-mounting, floor-outlet, flushometer valve design.
a) Material: Stainless steel or vitreous china.
b) Orientation: Left **OR** Right, **as directed**, hand.
c) Color: Not applicable.
d) Toilet Seat: White, solid plastic.
e) Flushometer: Concealed flushometer valve with push-button trip mechanism, check stop, and vacuum breaker on tailpiece.
f) Seal: For outlet.
3) Lavatory: Counter mounting.
a) Material: Stainless steel.
b) Color: Not applicable.
c) Faucet: Gooseneck type with wrist-blade handles **OR** Swing-spout type with single lever, **as directed**.
d) Drain: Grid, NPS 1-1/4 (DN 32).
e) Drain Piping: NPS 1-1/4 (DN 32) chrome-plated, cast-brass P-trap; tubular-brass waste to wall; and wall flange.
4) Bedpan Washer: On flushometer valve tailpiece or separate attachment affixed to unit.

M. Clinical Sinks
1. Wall-Mounting Clinical Sinks:
a. Description: Wall-mounting, back-outlet, vitreous-china, flushing-rim, service-sink-type medical plumbing fixture.
1) Size: Approximately 25 by 20 inches (635 by 510 mm).
2) Color: White.
3) Rim Guard: Stainless steel on front and also on sides if flat rim.
4) Faucet: Sink, polished, chrome-plated, solid-brass, service-sink faucet type, including integral stops in shanks, vacuum breaker, hose-thread outlet, and pail hook.
2. Floor-Mounting Clinical Sinks:
a. Description: Floor-mounting, bottom-outlet, vitreous-china, flushing-rim, service-sink-type medical plumbing fixture. Include bolt caps.
1) Size: Approximately 27 by 20 inches (685 by 510 mm).
2) Color: White.
3) Rim Guards: Stainless steel on front and sides.
4) Sink Base: 10-inch (25.4-mm) -high, cast terrazzo if required.

5) Faucet: Sink, polished, chrome-plated, solid-brass, service-sink faucet type, including integral stops in shanks, vacuum breaker, hose-thread outlet, and pail hook.

N. Plaster Sinks:
1. Description: Wall-mounting, vitreous-china medical plumbing fixture.
a. Size: 24 by 22 inches (610 by 560 mm) **OR** 30 by 22 inches (760 by 560 mm), **as directed**, with back or ledge faucet holes.
b. Color: White.
c. Faucet Holes: One **OR** Two, **as directed**, in back or ledge.
d. Faucet: Sink.
e. Supplies: NPS 1/2 (DN 15) chrome-plated copper tubes or flexible connectors, **as directed**, with stops.
f. Drain: Grid, NPS 1-1/2 (DN 40) with NPS 1-1/2 (DN 40) to NPS 2 (DN 50) adaptor, **as directed**.
g. Drain Piping: NPS 1-1/2 (DN 40) **OR** NPS 2 (DN 50), **as directed**, chrome-plated brass; 0.045-inch- (1.1-mm-) thick waste to interceptor; interceptor to wall; and wall flange.
h. Plaster Interceptor:
1) Description: Cast-iron or steel body and removable cover with acid-resistant-enameled interior lining and outside coating; removable, corrosion-resistant metal screens or strainer; and NPS 1-1/2 (DN 40) **OR** NPS 2 (DN 50), **as directed**, inlet and outlet.
2. Fixture Support: Sink with white-enameled-steel brackets.

O. Surgeons' Scrub Sinks
1. Stainless-Steel Surgeons' Scrub Sinks:
a. Description: Wall-mounting, sink-type medical plumbing fixture.
1) Size: Approximately 31 by 20 inches (790 by 510 mm) with back with 1 faucet hole.
2) Faucet: Chrome-plated-brass, gooseneck type matching fixture.
3) Operation: Foot-pedal **OR** Knee **OR** Automatic, hard-wired electric sensor, **as directed**, control.
4) Supplies: NPS 1/2 (DN 15) chrome-plated copper tubes or flexible connectors, **as directed**, with stops.
5) Drain: Grid, NPS 1-1/2 (DN 40).
6) Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; 0.045-inch- (1.1-mm-) thick tubular-brass waste to wall; and wall flange.
7) Fixture Support: Sink.
2. Vitreous-China Surgeons' Scrub Sinks:
a. Description: Wall-mounting, sink-type medical plumbing fixture.
1) Size: 28 by 22 inches (710 by 560 mm) **OR** 30 by 22 inches (760 by 560 mm), **as directed**, with back or ledge with 1 faucet hole.
2) Color: White.
3) Faucet: Chrome-plated-brass, gooseneck-type matching fixture.
4) Operation: Foot-pedal **OR** Knee, **as directed**, control.
5) Supplies: NPS 1/2 (DN 15) chrome-plated copper tubes or flexible connectors, **as directed**, with stops.
6) Drain: Grid, NPS 1-1/2 (DN 40).
7) Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; 0.045-inch- (1.1-mm-) thick tubular-brass waste to wall; and wall flange.
8) Fixture Support: Sink.

P. Surgeons' Instrument Sinks:
1. Description: Wall-mounting, stainless-steel, sink-type medical plumbing fixture. Include instrument tray on each side.
a. Size: 28 by 20 inches (710 by 510 mm) with 1 hole for deck-mounting faucet.

b. Faucet: Chrome-plated-brass, gooseneck type matching fixture with knee **OR** foot-pedal, **as directed**, control for mixing hot- and cold-water supplies.
c. Supplies: NPS 1/2 (DN 15) chrome-plated copper tubes or flexible connectors, **as directed**, with stops.
d. Drain: Grid, NPS 1-1/2 (DN 40).
e. Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; 0.045-inch- (1.1-mm-) thick tubular-brass waste to wall; and wall flange.
f. Fixture Support: Sink.

Q. Bathing Units
1. Institutional Bath Tubs:
   a. Description: Enameled, cast-iron, island medical plumbing fixture with separate wall-mounting faucet.
      1) Size: 66 by 30 by 18 inches (1680 by 765 by 455 mm).
      2) Base: Enameled, cast iron to raise rim of bathtub to 28 inches (710 mm) above the floor.
      3) Faucet: Shower **OR** Sink, **as directed**, modified to include tub filler spout.
      4) Supplies: NPS 1/2 (DN 15) chrome-plated copper tubes or flexible connectors, **as directed**, with stops. Include atmospheric vacuum breaker.
      5) Drain: NPS 1-1/2 (DN 40); chrome-plated exposed parts; brass pop-up waste and overflow.
      6) Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; 0.045-inch- (1.1-mm-) thick tubular-brass waste to wall; and wall flange.
2. Bathing Units:
   a. Description: Plastic-tub, institutional side-entry bath **OR** whirlpool-bath, **as directed**, fixture with integral controls.
      1) Tub Size: 60 by 30 inches (1525 by 765 mm).
      2) Controls: Vacuum breakers on supplies, thermostatic mixing valve, tub fill spout, and hand-held shower head.
      3) Supplies: NPS 3/4 (DN 20) **OR** NPS 1 (DN 25), **as directed**, copper tubing with ball, gate, or globe valves.
      4) Drain: NPS 1-1/2 (DN 40) and NPS 2 (DN 50).
      5) Drain Piping: NPS 1-1/2 (DN 40) **OR** NPS 2 (DN 50), **as directed**, cast-brass P-trap, waste to wall, and wall flange. Include combined drain piping if two drains.
3. Bathing Units:
   a. Description: Plastic-tub, institutional side-entry **OR** transfer-lift-entry **OR** slide-on-entry, **as directed**, adjustable-height **OR** fixed-height, **as directed**, bath fixture with integral controls.
      1) Tub Size: 60 by 30 inches (1525 by 765 mm).
      2) Controls: Vacuum breakers on supplies, thermostatic mixing valve, tub fill spout, and hand-held shower head.
      3) Supplies: NPS 3/4 (DN 20) **OR** NPS 1 (DN 25), **as directed**, copper tubing with ball, gate, or globe valves.
      4) Drain: NPS 1-1/2 (DN 40) and NPS 2 (DN 50).
      5) Drain Piping: NPS 1-1/2 (DN 40) **OR** NPS 2 (DN 50), **as directed**, cast-brass P-trap, waste to wall, and wall flange. Include combined drain piping if two drains.
      6) Lift System: Not required.
4. Bathing Units:
   a. Description: Plastic-tub, institutional front-entry shower fixture with integral controls.
      1) Cabinet Size: 35 by 41 inches (889 by 1041 mm).
      2) Controls: Vacuum breakers on supplies, thermostatic mixing valve, tub fill spout, and hand-held shower head.
      3) Supplies: NPS 3/4 (DN 20) **OR** NPS 1 (DN 25), **as directed**, copper tubing with ball, gate, or globe valves.
      4) Drain: NPS 2 (DN 50).
      5) Drain Piping: NPS 2 (DN 50) cast-brass P-trap, waste to wall, and wall flange.

5. Residential Bath Tubs:
   a. Description: Plastic island or against-wall-installation, **as directed**, medical plumbing fixture with side door, seat, and separate wall-mounting faucet.
      1) Size 1
         a) Size: Approximately 60 by 32 by 21 inches (1525 by 815 by 535 mm).
         b) Seat: Integral.
         c) Drain Location: Left **OR** Right, **as directed**, end.
      2) Size 2
         a) Size: Approximately 60 by 42 by 24.5 inches (1525 by 1070 by 620 mm).
         b) Seat: Integral bench **OR** None, **as directed**.
         c) Drain Location: Right end.
      3) Material: PMMA.
      4) Skirt: Front only **OR** Full, on three sides, **as directed**.
      5) Door: Side opening with rubber sealing gasket.
      6) Faucet: Shower **OR** Sink, **as directed**, modified to include tub filler spout.
      7) Supplies: NPS 1/2 (DN 15) chrome-plated copper tubes or flexible connectors, **as directed**, with stops. Include atmospheric vacuum breaker.
      8) Drain: NPS 1-1/2 (DN 40); chrome-plated exposed parts; brass pop-up waste and overflow.
      9) Drain Piping: NPS 1-1/2 (DN 40) cast-brass P-trap and 0.045-inch- (1.1-mm-) thick, tubular-brass waste to wall.

R. Sitz Baths:
1. Description: Pedestal-mounting **OR** Wall-mounting, **as directed**, vitreous-china, perineal bath medical plumbing fixture.
   a. Color: White.
   b. Drain: NPS 1-1/2 (DN 40) with removable overflow attachment.
   c. Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; waste to wall; and wall flange.
   d. Fixture Support: Sink.
   e. Faucet:
      1) Description: Wall-mounting, single-lever-handle, thermostatic-mixing-valve faucet with concealed supplies and wall-mounting thermometer.
         a) Material: Brass body and escutcheon.
         b) Flow Rate: Modified to 1.5 gpm (5.7 L/min.) maximum, unless otherwise indicated.
         c) Finish: Polished chrome plate.
         d) Temperature Indicators: Color-coded for hot and cold water.
   f. Exposed Piping: Chrome-plated; brass pipe or copper tube.

S. Bedpan Washing Equipment
1. Bedpan Washers/Sanitizers:
   a. Description: Recessed-mounting **OR** On-wall-mounting **OR** Pedestal-mounting, **as directed**, medical plumbing fixture for cleaning bedpans and urinals having cast-iron chamber and waste assembly with spray nozzles and enameled-steel **OR** stainless-steel, **as directed**, front panel and cover box.
      1) Controls: Electric, 120-V ac, automatic operation with timer, solenoid valves, and circuit breaker.
      2) Door Mechanism: Foot-pedal operation.
      3) Supplies: NPS 1 (DN 25) cold water and NPS 3/8 (DN 10) hot water **OR** steam, **as directed**.
      4) Drain: NPS 3 (DN 80) P-trap and soil pipe.
      5) Atmospheric Vent: NPS 2 (DN 50).
      6) Mounting Hardware: Matching fixture mounting arrangement.
      7) Accessories:
         a) Bedpan Rack(s): One **OR** Two, **as directed**.

b) Urinal Rack(s): One **OR** Two, **as directed**.
c) Drain Tray(s): One **OR** Two, **as directed**.

2. Bedpan Washers/Disinfectors:
   a. Description: Freestanding-mounting **OR** On-wall-mounting **OR** Undercounter-mounting, **as directed**, medical plumbing fixture for cleaning bedpans and urinals; with steam generator, pump, and spray nozzle.
      1) Controls: Electric, automatic operation.
      2) Cabinet: Stainless steel.
      3) Wash Chamber: Stainless steel.
      4) Supplies: NPS 1/2 (DN 15) cold water and NPS 1/2 (DN 15) hot water.
      5) Drain: NPS 4 (DN 100) P-trap and soil pipe.
      6) Mounting Hardware: Matching fixture mounting arrangement.

T. Hydrotherapy Whirlpools
1. Podiatry Whirlpools:
   a. Description: Stationary, stainless-steel tank for feet and ankles.
      1) Water Capacity: 15 gal. (57 L).
      2) Drain: Waste connection.
      3) Controls.
      4) Thermometer: Control panel or tank mounted.
      5) One electric turbine ejector.
2. Upper-Extremity Whirlpools:
   a. Description: Stationary, pedestal-mounted, stainless-steel tank for arms, hands, and elbows.
      1) Water Capacity: 25 gal. (95 L).
      2) Drain: Waste connection.
      3) One arm support.
      4) Controls.
      5) Thermometer: Control panel or tank mounted.
      6) One electric turbine ejector.
3. High-Tank Body Whirlpools:
   a. Description: Stationary, stainless-steel tank for legs, hip, and back.
      1) Water Capacity: 105 gal. (397 L).
      2) Drain: Waste connection.
      3) Controls.
      4) Thermometer: Control panel or tank mounted.
      5) One electric turbine ejector.
4. Low-Tank Body Whirlpools:
   a. Description: Stationary, extended-length stainless-steel tank for legs, hip, and lower back.
      1) Water Capacity: 105 gal. (397 L).
      2) Drain: Waste connection.
      3) Controls.
      4) Thermometer: Control panel or tank mounted.
      5) Head rest.
      6) One electric turbine ejector.
5. Small, Hubbard Immersion Tanks:
   a. Description: Stationary, butterfly-shaped tank, for full-body massage
      1) Tank Dimensions: 93 by 64 by 22 inches (2362 by 1626 by 560 mm).
      2) Overall Height: 34 to 38 inches (864 to 965 mm).
      3) Water Capacity: 268 gal. (1014 L).
      4) Material: Stainless steel.
      5) Supports: Legs or base.
      6) Controls.
      7) Thermometer: Control panel or tank rim mounted.
      8) Supply: Over-the-rim fill spout.

9) Drains: Two waste connections.
10) Electric Turbine Ejectors: Two; one rail mounted on each side.
11) Thermostatic, mixing-valve assembly.
12) Hose and hand-held shower.
13) Wash-out-hose assembly.
14) Stretcher lift.
15) Overhead electric, **as directed**, hoist.

6. Medium, Hubbard Immersion Tanks:
   a. Description: Stationary, butterfly-shaped tank, for full-body massage.
      1) Tank Dimensions: 100 by 73 by 24 inches (2540 by 1854 by 610 mm).
      2) Overall Height: 34 to 38 inches (864 to 965 mm).
      3) Water Capacity: 377 gal. (1468 L).
      4) Material: Stainless steel.
      5) Supports: Legs or base.
      6) Controls.
      7) Thermometer: Control panel or tank rim mounted.
      8) Supply: Over-the-rim fill spout.
      9) Drain: One waste connection.
      10) Electric Turbine Ejector: One, panel mounted.
      11) Thermostatic, mixing-valve assembly.
      12) Hose and hand-held shower.
      13) Wash-out-hose assembly.
      14) Stretcher lift.
      15) Overhead electric, **as directed**, hoist.

7. Large, Hubbard Immersion Tanks:
   a. Description: Stationary, butterfly-shaped tank, for full-body massage.
      1) Tank Dimensions: 106 by 77 by 22 inches (2692 by 1956 by 560 mm).
      2) Overall Height: 34 inches (864 mm).
      3) Water Capacity: 425 gal. (1609 L).
      4) Material: Stainless steel.
      5) Supports: Legs or base.
      6) Controls.
      7) Thermometer: Control panel or tank rim mounted.
      8) Supply: Over-the-rim fill spout.
      9) Drain(s): One or two waste connections.
      10) Electric Turbine Ejectors: Two; one rail mounted on each side.
      11) Thermostatic, mixing-valve assembly.
      12) Hose and hand-held shower.
      13) Wash-out-hose assembly.
      14) Stretcher lift.
      15) Overhead electric, **as directed**, hoist.

8. Full-Body Immersion Tanks:
   a. Description: Stationary, rectangular tank, for full-body massage
      1) Tank Dimensions: 90 by 32 by 19 inches (2286 by 813 by 483 mm) **OR** 95 by 41 by 22 inches (2413 by 1041 by 560 mm), **as directed**.
      2) Overall Height: 32 or 34 inches (813 or 860 mm).
      3) Water Capacity: 195 gal. (738 L) **OR** 260 gal. (984 L), **as directed**.
      4) Material: Stainless steel.
      5) Supports: Legs or base.
      6) Controls.
      7) Thermometer: Control panel or tank rim mounted.
      8) Supply: Over-the-rim fill spout.
      9) Drain(s): One or two waste connections.
      10) Electric Turbine Ejector: One, tank mounted at end **OR** on rail **OR** on side, **as directed**.
      11) Thermostatic, mixing-valve assembly.

12) Hose and hand-held shower.
13) Wash-out-hose assembly.
14) Stretcher lift.
15) Overhead electric, **as directed**, hoist.

U. Outlet Boxes
1. Dialysis Equipment Outlet Boxes:
a. Description: Recessed-mounting outlet box with water supply and drain connections.
1) Box and Faceplate: Stainless steel.
2) Supply Fitting(s): 1 **OR** 2, **as directed**, NPS 1/2 (DN 15) PVC ball valve(s) and adapter with male hose-thread outlet.
3) Drain: NPS 2 (DN 50) standpipe, P-trap, and direct waste connection to drainage piping.
b. Reinforcement: 2-by-4-inch (50-by-100-mm) fire-retardant-treated-wood blocking between studs. Fire-retardant-treated wood blocking is specified in Division 06 Section "Rough Carpentry".

V. Morgue Equipment
1. Autopsy Tables:
a. Description: Pedestal stainless-steel table with sink; designed for downdraft ventilation.
1) Material: Stainless steel.
2) Overall Size: Approximately 88 by 30 inches (2250 by 760 mm) with deck faucet holes.
3) Faucet: Deck mounted with wrist- or elbow-blade handles.
4) Aspirator: Deck mounted.
5) Removable body supports.
6) Rinse Assembly: Deck-mounted faucet with hose.
7) Disposer: Not required **OR** Required, **as directed**.
8) Fixture Support: Sink.
9) Receptacle: Duplex, hospital grade with ground-fault interruption.
10) Supplies: Chrome-plated copper tubes or flexible connectors, **as directed**, with atmospheric vacuum breakers and stops.
11) Drain: Chrome-plated, cast-brass P-trap and waste to wall.
2. Dissecting Sinks:
a. Description: Wall-mounting sink with backsplash.
1) Material: Stainless steel.
2) Overall Size: 84 by 28 inches (2134 by 711 mm) with back faucet holes.
3) Sink Size: Approximately 30 inches (763 mm) wide.
4) Equipment drawer.
5) Faucet: Back mounted with wrist- or elbow-blade handles.
6) Aspirator: Back mounted.
7) Rinse Assembly: One back-mounted faucet with hose.
8) Disposer: Not required **OR** Required, **as directed**.
9) Fixture Support: Sink.
10) Supplies: Chrome-plated copper tubes or flexible connectors, **as directed**, with atmospheric vacuum breakers and stops.
11) Drain: Chrome-plated, cast-brass P-trap and waste to wall.
12) Back-mounted, hand-held-type eye wash.

1.3 EXECUTION

A. Installation
1. Assemble medical plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

2. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
   a. Use carrier supports with waste fitting and seal for back-outlet fixtures.
   b. Use carrier supports without waste fitting for fixtures with tubular waste piping.
   c. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
3. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
4. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
5. Install wall-mounting fixtures with tubular waste piping attached to supports.
6. Install counter-mounting fixtures in and attached to casework.
7. Install fixtures level and plumb according to roughing-in drawings.
8. Install water-supply piping with stop on each supply to each fixture to be connected to domestic water piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
   a. Exception: Use ball, gate, or globe valve if stops are not specified with fixture. Valves are specified in Division 22 Section "General-duty Valves For Plumbing Piping".
9. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
10. Install flushometer valves for accessible water closets with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
11. Install toilet seats on water closets.
12. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
13. Install shower flow-control fittings with specified maximum flow rates in shower arms.
14. Install traps on fixture outlets.
   a. Exception: Omit trap on fixtures with integral traps.
15. Install escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results For Plumbing".
16. Set showers in leveling bed of cement grout. Grout is specified in Division 22 Section "Common Work Results For Plumbing".
17. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants".

B. Connections
1. Piping installation requirements are specified in other Division 14.. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Connect water supplies from domestic water piping to medical plumbing fixtures.
3. Connect drain piping from medical plumbing fixtures to sanitary waste and vent piping.
4. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
5. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Field Quality Control
1. Verify that installed medical plumbing fixtures are categories and types specified for locations where installed.
2. Check that medical plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
3. Inspect installed medical plumbing fixtures for damage. Replace damaged fixtures and components.
4. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
5. Install fresh batteries in sensor-operated mechanisms.

D. Adjusting
1. Operate and adjust faucets and controls. Replace damaged and malfunctioning medical plumbing fixtures, fittings, and controls.
2. Adjust water pressure at faucets, shower valves, and flushometer valves to produce proper flow and stream.
3. Replace washers and seals of leaking and dripping faucets and stops.

E. Cleaning
1. Clean medical plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
   a. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
   b. Remove sediment and debris from drains.
2. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

F. Protection
1. Provide protective covering for installed fixtures and fittings.
2. Do not allow use of medical plumbing fixtures for temporary facilities unless approved in writing by the Owner.

END OF SECTION 22 43 00 00

Task	Specification	Specification Description
22 43 13 00	10 28 19 16	Plumbing Fixtures
22 43 13 00	22 01 40 81	Emergency Plumbing Fixtures
22 43 16 00	10 28 19 16	Plumbing Fixtures
22 43 16 00	22 01 40 81	Emergency Plumbing Fixtures
22 43 39 00	10 28 19 16	Plumbing Fixtures
22 43 39 00	22 43 00 00	Medical Plumbing Fixtures
22 43 39 00	22 01 40 81	Emergency Plumbing Fixtures
22 43 43 00	10 28 19 16	Plumbing Fixtures
22 45 00 00	22 01 40 81	Emergency Plumbing Fixtures
22 45 13 00	10 28 19 16	Plumbing Fixtures
22 45 13 00	22 01 40 81	Emergency Plumbing Fixtures
22 45 16 00	22 01 40 81	Emergency Plumbing Fixtures
22 45 23 00	10 28 19 16	Plumbing Fixtures
22 45 23 00	22 01 40 81	Emergency Plumbing Fixtures
22 45 26 00	10 28 19 16	Plumbing Fixtures
22 45 26 00	22 01 40 81	Emergency Plumbing Fixtures
22 45 29 00	22 01 40 81	Emergency Plumbing Fixtures
22 45 33 00	10 28 19 16	Plumbing Fixtures
22 45 33 00	22 01 40 81	Emergency Plumbing Fixtures
22 45 36 00	22 01 40 81	Emergency Plumbing Fixtures
22 45 39 00	22 01 40 81	Emergency Plumbing Fixtures

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SECTION 22 46 13 13 - SECURITY PLUMBING FIXTURES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for security plumbing fixtures. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following security plumbing fixtures and related components:
      a. Combination units.
      b. Drinking fountains.
      c. Lavatories.
      d. Service sinks.
      e. Shampoo bowls.
      f. Showers.
      g. Urinals.
      h. Water closets.
      i. Flushometer valves for vitreous-china water closets.
      j. Fixture supports for front-mounting, stainless-steel fixtures and vitreous-china, wall-mounting fixtures.

C. Related Requirements:
   1. Section 224213.13 "Commercial Water Closets."
   2. Section 224213.16 "Commercial Urinals."
   3. Section 224216.13 "Commercial Lavatories."
   4. Section 224216.16 "Commercial Sinks."
   5. Section 224223 "Commercial Showers."
   6. Section 224233 "Wash Fountains."
   7. Section 224300 "Healthcare Plumbing Fixtures."
   8. Section 224500 "Emergency Plumbing Fixtures."
   9. Section 224713 "Drinking Fountains."

D. Definitions
   1. Accessible Fixture: Security plumbing fixture that can be approached and used by people with disabilities.
   2. Back-Mounting-Type Fixture: Security plumbing fixture designed to mount on wall sleeve built into wall so installation and removal of fixture and piping and other components are only accessible from service space behind wall.
   3. Front-Mounting-Type Fixture: Security plumbing fixture designed to mount on fixture support with installation and removal from fixture side of wall, and piping and other components are accessible from access panels in fixture or wall.

E. Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittal:
      a. Product Data for Credit WE 2, 3.1, and 3.2: Documentation indicating flow and water consumption requirements.
   3. Shop Drawings: Diagram power, signal, and control wiring.
   4. Field quality-control test reports.
   5. Operation and maintenance data.

F. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act", **as directed**; about security plumbing fixtures for people with disabilities. Comply with requirements in "Energy Policy Act" about water flow and consumption rates for plumbing fixtures.
3. NSF Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.
4. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

1.2 PRODUCTS

1.3 SOURCE LIMITATIONS

A. Obtain each product type from single manufacturer.

1.4 PERFORMANCE REQUIREMENTS

A. Comply with ASME A112.19.2/CSA B45.1 for vitreous-china plumbing fixtures.

B. Comply with ASME A112.19.3/CSA B45.4 for stainless steel plumbing fixtures.

C. Comply with ASSE 1037/ASME A112.1037/CSA B125.37 for flush valves.

D. Comply with ASME A112.19.5/CSA B45.15 for flush valves and spuds for water closets.

E. Comply with ASME A112.18.1/CSA B125.1 for plumbing supply fittings.

F. Comply with ASME A112.18.2/CSA B125.2 for plumbing waste fittings.

G. Comply with IAPMO Z124.5 for water-closet (toilet) seats.

H. Comply with ASME A112.6.1M for plumbing fixture supports.

I. Comply with ICC A117.1 for ADA-compliant, accessible plumbing fixtures and installation.

J. Comply with ASTM A1045 for flexible PVC gaskets used in connection of vitreous-china water closets to sanitary drainage systems.

K. Comply with ASME A112.4.3 for plastic fittings used in connection of vitreous-china water closets to sanitary drainage systems.

L. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

M. Faucets and bubblers intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61/NSF 372; or are certified in compliance with NSF 61/NSF 372 by an ANSI-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

N. Combination Units
1. Security Combination Units:
a. Description: Back-mounting, cabinet, security plumbing fixture with integral water closet and lavatory; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
1) Water Closet: Comply with IAPMO PS 61 for water-closet component.
a) Bowl: Elongated, with back inlet, integral trap, blowout design with back **OR** siphon-jet design with back **OR** siphon-jet design with floor, **as directed**, outlet and contoured seat.
i. Seat Surface: SSINA No. 7 polished finish.
ii. Punching: Provide two holes for installation of separate toilet seat.
iii. Drain: NPS 4 (DN 100) **OR** NPS 3 (DN 80), **as directed**, horizontal with cleanout and slip joint **OR** vertical, **as directed**.
b) Toilet Seat: ANSI Z124.5, white, **OR** black, **as directed**, commercial, heavy-duty, elongated, open front with cover, **as directed**, with check **OR** self-sustaining **OR** self-sustaining, check, **as directed**, hinges.
c) Flushing Device: Concealed flushometer valve with stainless-steel access panel, push-button mechanism, and 3.5-gal./flush (13.3-L/flush) **OR** 1.6-gal./flush (6.0-L/flush), **as directed**, consumption. Refer to "Flushometer Valves" Article.
2) Lavatory: In top of cabinet.
a) Receptor: Oval **OR** Rectangular, **as directed**, bowl with integral soap depression.
b) Hot- and Cold-Water and Bubbler, **as directed**, Supply Valves: Pneumatic **OR** Mechanical-metering **OR** Electric-solenoid, **as directed**, type with push-button actuation and individual check stop.
c) Filler Spout: Backsplash **OR** Deck, **as directed**, mounted.
d) Drain: Integral punched grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.2 **OR** concealed waste piping to spill into water-closet bowl, **as directed**.
e) Toothbrush Holders: One on each **OR** left **OR** right, **as directed**, side of backsplash.
f) Towel Hooks: One **OR** Two, **as directed**, on each **OR** left **OR** right, **as directed**, side of fixture.
g) Bubbler Location: On backsplash **OR** deck, **as directed**.
3) Cabinet Configuration: Rectangular apron **OR** Five-sided apron with two angled sides **OR** Four-sided apron with angled left side **OR** Four-sided apron with angled right side, **as directed**, made for above-floor **OR** on-floor, **as directed**, installation and with backsplash.
a) Water-Closet Bowl Location: Centered on front **OR** Left of center on front **OR** Right of center on front **OR** On angled left side **OR** On angled right side, **as directed**, of apron.
b) Toilet Paper Holder: Recessed, 0.063-inch (1.6-mm) minimum thickness, stainless steel complying with ASTM A 666, Type 304 and located above water closet and centered in front **OR** in front **OR** right of center in front **OR** left of center in front **OR** in angled right side **OR** in angled left side **OR** in right side **OR** in left side, **as directed**, of apron.
4) Wall Sleeve: Galvanized-steel frame of dimensions required to match and support entire fixture. Include steel bars or other design that will prevent escape if fixture is removed.

O. Drinking Fountains

1. Security Drinking Fountains, Back-Mounting:
   a. Description: Back-mounting, accessible, **as directed**, security plumbing fixture; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      1) Receptor: Bowl or depression in top and with backsplash.
      2) Bubbler Location: On backsplash **OR** deck, **as directed**.
      3) Bubbler Water-Supply Valve: Pneumatic type with push-button actuation.
      4) Drain: Integral punched grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.2.
      5) Wall Sleeve: Galvanized-steel frame of dimensions required to match and support fixture.
2. Security Drinking Fountains, Front-Mounting:
   a. Description: Front-mounting, accessible, **as directed**, security plumbing fixture; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      1) Receptor: Bowl or depression in top and with backsplash.
      2) Bubbler Location: On backsplash **OR** deck, **as directed**.
      3) Bubbler Water-Supply Valve: Pneumatic type with push-button actuation.
      4) Drain: Integral punched grid with NPS 1-1/4 (DN 32) minimum tailpiece, trap, and waste, and complying with ASME A112.18.2.
      5) Access to Internal Components: Vandal-resistant access panels.
      6) Mounting Device: Wall bracket.
      7) Support: Chair carrier. Refer to "Fixture Supports" Article.

P. Lavatories

1. Security Lavatories, Back-Mounting:
   a. Description: Back-mounting, accessible, **as directed**, security plumbing fixture; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      1) Receptor: Oval **OR** Rectangular, **as directed**, bowl with integral soap depression and backsplash.
      2) Hot- and Cold-Water and Bubbler, **as directed**, Supply Valves: Pneumatic **OR** Mechanical-metering **OR** Electric-solenoid, **as directed**, type with push-button actuation and individual check stop.
      3) Filler Spout: Backsplash **OR** Deck, **as directed**, mounted.
      4) Drain: Integral punched grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.2.
      5) Toothbrush Holders: One on each **OR** left **OR** right, **as directed**, side of backsplash.
      6) Towel Hooks: One **OR** Two, **as directed**, on each **OR** left **OR** right, **as directed**, side of fixture.
      7) Bubbler Location: On backsplash **OR** deck, **as directed**.
      8) Wall Sleeve: Galvanized-steel frame of dimensions required to match and support fixture.
2. Security Lavatories, Front-Mounting:
   a. Description: Front-mounting, accessible, **as directed**, security plumbing fixture; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304, stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      1) Receptor: Oval **OR** Rectangular, **as directed**, bowl with integral soap depression and backsplash.

2) Hot- and Cold-Water and Bubbler, **as directed**, Supply Valves: Pneumatic **OR** Mechanical-metering **OR** Electric-solenoid, **as directed**, type with push-button actuation and individual check stop.
3) Filler Spout: Backsplash **OR** Deck, **as directed**, mounted.
4) Drain: Integral punched grid with NPS 1-1/4 (DN 32) minimum tailpiece, trap, and waste complying with ASME A112.18.2.
5) Toothbrush Holders: One on each **OR** left **OR** right, **as directed**, side of backsplash.
6) Towel Hooks: One **OR** Two, **as directed**, on each **OR** left **OR** right, **as directed**, side of fixture.
7) Bubbler Location: On backsplash **OR** deck, **as directed**.
8) Access to Internal Components: Vandal-resistant access panels.
9) Mounting Device: Wall bracket.
10) Support: Chair carrier. Refer to "Fixture Supports" Article.

3. Security Lavatories, Vitreous-China:
a. Description: ASME A112.19.2M, vitreous-china security plumbing fixture made for institutional applications, with integral soap depression and NPS 1-1/4 (DN 32) waste outlet and with factory-installed, push-button, self-closing, chrome-plated brass faucets complying with ASME A112.18.1.
1) Waste: NPS 1-1/4 (DN 32) minimum piping and trap complying with ASME A112.18.2.
2) Mounting Device: Wall bracket.
3) Support: Chair carrier. Refer to "Fixture Supports" Article.

Q. Service Sinks
1. Security Service Sinks:
a. Description: Back-mounting security plumbing fixture made for above-floor **OR** on-floor, **as directed**, installation; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
1) Receptor: Rectangular bowl with high backsplash.
2) Hot- and Cold-Water-Supply Valves: Pneumatic type with push-button actuation and individual check stop.
3) Filler Spout: Backsplash mounted.
4) Drain: Grid with NPS 2 (DN 50) waste and trap complying with ASME A112.18.2.
5) Wall Sleeve: Galvanized-steel frame of dimensions required to match and support fixture.

R. Shampoo Bowls
1. Security Shampoo Bowls:
a. Description: Front-mounting security plumbing fixture made for above-floor **OR** counter-mounting, **as directed**, installation; fabricated from 0.078-inch (2.0-mm) thickness, ASTM A 666, Type 304 stainless steel and corrosion-resistant metal internal piping and bracing.
1) Receptor: Bowl with contoured neck rest.
2) Finish: White **OR** Black, **as directed**, enamel.
3) Exposed Surfaces without Enamel Finish: SSINA No. 4 polished finish.
4) Faucet: Dial single-lever control with vacuum breaker, hose, and spray.
5) Drain: Basket strainer with NPS 1-1/2 (DN 40) tailpiece, trap, and waste to wall complying with ASME A112.18.2.
6) Access to Internal Components: Vandal-resistant access panels.
7) Mounting Device: Wall bracket.
8) Support: Chair carrier. Refer to "Fixture Supports" Article.

S. Showers

1. Security Showers, Back-Mounting, Recessed:
   a. Description: Back-mounting, accessible, **as directed**, recessed security plumbing fixture made with wall plate for flush installation; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      1) Configuration: Wall type with shower head and soap dish.
      2) Tempered-Water-Supply **OR** Hot- and Cold-Water-Supply, **as directed**, Valves: Pneumatic **OR** Mechanical-metering **OR** Electric-solenoid, **as directed**, type with individual check stop.
      3) Shower: Hose with vandal-resistant, hand-held **OR** Vandal-resistant, fixed-type **OR** Vandal-resistant, swivel-type, **as directed**, head.
      4) Soap Dish: Recessed, stainless steel.
      5) Wall Sleeve: Galvanized-steel frame of dimensions required to match and support fixture.
2. Security Showers, Front-Mounting, Recessed:
   a. Description: Front-mounting, accessible, **as directed**, recessed security plumbing fixture made with wall plate for flush installation; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      1) Configuration: Wall type with shower head and soap dish.
      2) Tempered-Water-Supply **OR** Hot- and Cold-Water-Supply, **as directed**, Valves: Pneumatic **OR** Mechanical-metering **OR** Electric-solenoid, **as directed**, type with individual check stop.
      3) Shower: Hose with vandal-resistant, hand-held **OR** Vandal-resistant, fixed-type **OR** Vandal-resistant, swivel-type, **as directed**, head.
      4) Soap Dish: Recessed, stainless steel.
      5) Access to Internal Components: Vandal-resistant access panels.
      6) Mounting Device: Wall-mounting frame.
3. Security Showers, Front-Mounting, Surface Installation:
   a. Description: Front-mounting, accessible, **as directed**, security plumbing fixture made for surface installation; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      1) Configuration: Wall type with shower head and soap dish.
      2) Tempered-Water-Supply **OR** Hot- and Cold-Water-Supply, **as directed**, Valves: Pneumatic **OR** Mechanical-metering **OR** Electric-solenoid, **as directed**, type with individual check stops.
      3) Soap Dish: Recessed, stainless steel.
      4) Access to Internal Components: Vandal-resistant access panels.
      5) Mounting Device: Wall-mounting frame.
4. Security Showers, Back-Mounting, Accessible:
   a. Description: Back-mounting, accessible, cabinet, security plumbing fixture; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      1) Configuration: Cabinet 42 or 44 by 36 inches (1065 or 1120 by 915 mm) **OR** 48 by 36 inches (1220 by 915 mm), **as directed**, with floor and top, **as directed**, with stainless-steel soap dish, towel hook, drain, seat, and grab bar.
      2) Tempered-Water-Supply **OR** Hot- and Cold-Water-Supply, **as directed**, Valves: Pneumatic **OR** Mechanical-metering **OR** Electric-solenoid, **as directed**, type with individual check stops.
      3) Shower: Hose with vandal-resistant, hand-held head.

4) Drain: NPS 2 (DN 50) strainer, waste to wall, and trap complying with ASME A112.18.2.
5) Wall Sleeve: Galvanized-steel frame of dimensions required to match and support fixture.

5. Security Showers, Back-Mounting:
   a. Description: Back-mounting, cabinet, security plumbing fixture; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      1) Configuration: Cabinet 30 by 30 inches (760 by 760 mm) **OR** 32 by 32 inches (815 by 815 mm) **OR** 36 by 36 inches (915 by 915 mm), **as directed**, with floor and top, **as directed**, and with stainless-steel soap dish, towel hook, and drain.
      2) Tempered-Water-Supply **OR** Hot- and Cold-Water-Supply, **as directed**, Valves: Pneumatic **OR** Mechanical-metering **OR** Electric-solenoid, **as directed**, type with individual check stops.
      3) Shower: Vandal-resistant, fixed **OR** Fixed **OR** Swivel, **as directed**,-type head.
      4) Drain: NPS 2 (DN 50) strainer, waste to wall, and trap complying with ASME A112.18.2.
      5) Wall Sleeve: Galvanized-steel frame of dimensions required to match and support fixture.

T. Urinals
1. Security Urinals, Back-Mounting:
   a. Description: Back-mounting security plumbing fixture; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      1) Type and Configuration: Blowout **OR** Washout, **as directed**, type with back inlet and extended shields.
         OR
         Type and Configuration: Washout, trough type, and 36 inches (915 mm) **OR** 48 inches (1220 mm), **as directed**, wide.
      2) Drain: Strainer with NPS 2 (DN 50) tailpiece, trap under fixture, and drain piping.
      3) Flushing Device: Concealed flushometer valve with stainless-steel access panel, push-button mechanism, and 3.5-gal./flush (13.3-L/flush) **OR** 1.5-gal./flush (5.7-L/flush) **OR** 1.0-gal./flush (3.78-L/flush), **as directed**, consumption. Refer to "Flushometer Valves" Article.
      4) Wall Sleeve: Galvanized-steel frame of dimensions required to match and support fixture.
2. Security Urinals, Front-Mounting:
   a. Description: Front-mounting security plumbing fixture; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      1) Type and Configuration: Blowout **OR** Washout, **as directed**, type with back **OR** top, **as directed**, inlet and extended shields.
         OR
         Type and Configuration: Washout, trough type, and 36 inches (915 mm) **OR** 48 inches (1220 mm), **as directed**, wide.
      2) Drain: Strainer with NPS 2 (DN 50) tailpiece, trap under fixture, and drain piping complying with ASME A112.18.2.
      3) Flushing Device: Concealed flushometer valve with stainless-steel access panel, push-button **OR** Exposed flushometer valve with oscillating lever-handle, **as directed**, mechanism, and 3.5-gal./flush (13.3-L/flush) **OR** 1.5-gal./flush (5.7-L/flush) **OR** 1.0-gal./flush (3.78-L/flush), **as directed** consumption. Refer to "Flushometer Valves" Article.

4) Support: Chair carrier. Refer to "Fixture Supports" Article.

3. Security Urinals, Back-Mounting, Wall-And-Floor Installation:
   a. Description: Back-mounting security plumbing fixture made for wall-and-floor installation; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      1) Type and Configuration: Washout, stall type with back inlet.
      2) Drain: Strainer with NPS 2 (DN 50) outlet.
      3) Flushing Device: Concealed flushometer valve with stainless-steel access panel, push-button mechanism, and 1.5-gal./flush (5.7-L/flush) **OR** 1.0-gal./flush (3.78-L/flush), **as directed**, consumption. Refer to "Flushometer Valves" Article.
4. Security Urinals, Front-Mounting, Wall-And-Floor Installation:
   a. Description: Front-mounting security plumbing fixture made for wall-and-floor installation; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      1) Type and Configuration: Washout, stall type with back **OR** top, **as directed**, inlet.
      2) Drain: Strainer with NPS 2 (DN 50) outlet.
      3) Flushing Device: Concealed flushometer valve with stainless-steel access panel, push-button **OR** Exposed flushometer valve with oscillating lever-handle, **as directed**, mechanism, and 1.5-gal./flush (5.7-L/flush) **OR** 1.0-gal./flush (3.78-L/flush), **as directed**, consumption. Refer to "Flushometer Valves" Article.
      4) Support: Chair carrier. Refer to "Fixture Supports" Article.

U. Water Closets
1. Security Water Closets, Back-Mounting, Above Floor Installation:
   a. Description: IAPMO PS 61, back-mounting, accessible, **as directed**, security plumbing fixture made for above-floor installation; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      1) Configuration: Compact design, with bowl on wall flange.
      2) Bowl: Elongated, with back inlet, integral trap, blowout design with back outlet and contoured seat.
         a) Seat Surface: SSINA No. 7 polished finish.
         b) Punching: Provide two holes for installation of separate toilet seat.
         c) Drain: NPS 4 (DN 100) **OR** NPS 3 (DN 80), **as directed**, horizontal with cleanout and slip joint.
      3) Flushing Device: Concealed flushometer valve with stainless-steel access panel, push-button **OR** Exposed flushometer valve with oscillating lever-handle, **as directed**, mechanism, and 3.5-gal./flush (13.3-L/flush) **OR** 1.6-gal./flush (6.0-L/flush), **as directed**, consumption. Refer to "Flushometer Valves" Article.
      4) Toilet Seat, **as directed**: ANSI Z124.5, white, **OR** black, **as directed,** commercial, heavy-duty, elongated, open front with cover, **as directed**, with check **OR** self-sustaining **OR** self-sustaining, check, **as directed**, hinges.
      5) Wall Sleeve: Galvanized-steel frame of dimensions required to match and support fixture. Include steel bars or other design that will prevent escape if fixture is removed.
2. Security Water Closets, Back-Mounting, Off Floor Installation:
   a. Description: IAPMO PS 61, back-mounting, accessible, **as directed**, security plumbing fixture made for off-floor installation; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      1) Configuration: Standard design.

2) Bowl: Elongated, with back **OR** top, **as directed**, inlet, integral trap, blowout **OR** siphon-jet, **as directed**, design with back outlet and contoured seat.
   a) Seat Surface: SSINA No. 7 polished finish.
   b) Punching: Provide two holes for installation of separate toilet seat.
   c) Drain: NPS 4 (DN 100) **OR** NPS 3 (DN 80), **as directed**, horizontal with cleanout and slip joint.
3) Flushing Device: Concealed flushometer valve with stainless-steel access panel, push-button **OR** Exposed flushometer valve with oscillating lever-handle, **as directed**, mechanism, and 3.5-gal./flush (13.3-L/flush) **OR** 1.6-gal./flush (6.0-L/flush), **as directed**, consumption. Refer to "Flushometer Valves" Article.
4) Toilet Seat, **as directed**: ANSI Z124.5, white, **OR** black, **as directed**, commercial, heavy-duty, elongated, open front with cover, **as directed**, with check **OR** self-sustaining **OR** self-sustaining, check, **as directed**, hinges.
5) Wall Sleeve: Galvanized-steel frame of dimensions required to match and support fixture. Include steel bars or other design that will prevent escape if fixture is removed.

3. Security Water Closets, Front-Mounting, Off-Floor Installation:
   a. Description: IAPMO PS 61, front-mounting, accessible, **as directed**, security plumbing fixture made for off-floor installation; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      1) Configuration: Standard design.
      2) Bowl: Elongated, with back **OR** top, **as directed**, inlet, integral trap, blowout **OR** siphon-jet, **as directed**, design with back outlet and contoured seat.
         a) Seat Surface: SSINA No. 7 polished finish.
         b) Punching: Provide two holes for installation of separate toilet seat.
      3) Access to Internal Components: Vandal-resistant access panels.
      4) Flushing Device: Concealed flushometer valve with stainless-steel access panel, push-button **OR** Exposed flushometer valve with oscillating lever-handle, **as directed**, mechanism, and 3.5-gal./flush (13.3-L/flush) **OR** 1.6-gal./flush (6.0-L/flush), **as directed**, consumption. Refer to "Flushometer Valves" Article.
      5) Toilet Seat, **as directed**: ANSI Z124.5, white, **OR** black, **as directed**, commercial, heavy-duty, elongated, open front with cover, **as directed**, with check **OR** self-sustaining **OR** self-sustaining, check, **as directed**, hinges.
      6) Support: Combination support and waste fitting assembly. Refer to "Fixture Supports" Article.

4. Security Water Closets, Back-Mounting, On-Floor Installation:
   a. Description: IAPMO PS 61, back-mounting security plumbing fixture made for on-floor installation; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4, polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      1) Configuration: Standard design.
      2) Bowl: Elongated, with back **OR** top, **as directed**, inlet, integral trap, blowout **OR** siphon-jet, **as directed**, design with back outlet and contoured seat.
         a) Seat Surface: SSINA No. 7 polished finish.
         b) Punching: Provide two holes for installation of separate toilet seat.
         c) Drain: NPS 4 (DN 100) **OR** NPS 3 (DN 80), **as directed**, horizontal with cleanout and slip joint.
      3) Flushing Device: Concealed flushometer valve with stainless-steel access panel, push-button **OR** Exposed flushometer valve with oscillating lever-handle, **as directed**, mechanism, and 3.5-gal./flush (13.3-L/flush) **OR** 1.6-gal./flush (6.0-L/flush), **as directed**, consumption. Refer to "Flushometer Valves" Article.

4) Toilet Seat, **as directed**: ANSI Z124.5, white, **OR** black, **as directed**, commercial, heavy-duty, elongated, open front with cover, **as directed**, with check **OR** self-sustaining **OR** self-sustaining, check, **as directed**, hinges.

5. Security Water Closets, Front-Mounting, On-Floor Installation:
   a. Description: IAPMO PS 61, front-mounting security plumbing fixture made for on-floor installation; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      1) Configuration: Standard design.
      2) Bowl: Elongated, with back **OR** top, **as directed**, inlet, integral trap, siphon-jet design with back **OR** floor, **as directed**, outlet and contoured seat.
         a) Seat Surface: SSINA No. 7 polished finish.
         b) Punching: Provide two holes for installation of separate toilet seat.
      3) Access to Internal Components: Vandal-resistant access panels.
      4) Flushing Device: Concealed flushometer valve with stainless-steel access panel, push-button **OR** Exposed flushometer valve with oscillating lever-handle, **as directed**, mechanism, and 3.5-gal./flush (13.3-L/flush) **OR** 1.6-gal./flush (6.0-L/flush), **as directed**, consumption. Refer to "Flushometer Valves" Article.
      5) Toilet Seat, **as directed**: ANSI Z124.5, white, **OR** black, **as directed**, commercial, heavy-duty, elongated, open front with cover, **as directed**, with check **OR** self-sustaining **OR** self-sustaining, check, **as directed**, hinges.
      6) Support: Combination support and waste fitting assembly. Refer to "Fixture Supports" Article.
6. Security Water Closets, Vitreous-China, Wall-Mounting, On-Floor Installation
   a. Description: ASME A112.19.2M, vitreous-china, wall-mounting and on-floor installation, back-inlet, blowout **OR** siphon-jet, **as directed**, fixture with integral contoured seat and made for institutional applications.
      1) Flushing Device: Concealed flushometer valve with stainless-steel access panel, push-button mechanism, and 3.5-gal./flush (13.3-L/flush) **OR** 1.6-gal./flush (6.0-L/flush), **as directed**, consumption. Refer to "Flushometer Valves" Article.
      2) Support: Combination support and waste fitting assembly. Refer to "Fixture Supports" Article.
7. Security Water Closets, Vitreous-China, Wall-Mounting:
   a. Description: ASME A112.19.2M, vitreous-china, accessible, **as directed**, wall-mounting, back-inlet, blowout fixture with integral contoured seat and made for institutional applications.
      1) Flushing Device: Concealed flushometer valve with stainless-steel access panel, push-button mechanism, and 3.5-gal./flush (13.3-L/flush) consumption. Refer to "Flushometer Valves" Article.
      2) Support: Combination support and waste fitting assembly. Refer to "Fixture Supports" Article.

V. Flushometer Valves
1. Flushing Devices for Vitreous-China Water Closets:
   a. Description: Flushometer valves, trim, and components complying with ASSE 1037. Include brass body, check-stop inlet, diaphragm operation, vacuum breaker, tailpiece, chrome-plated finish on exposed components, and non-hold-open feature on oscillating lever-handle trip mechanism. See fixture type for consumption.

W. Fixture Supports
1. Back-mounting fixtures are installed on wall sleeves. Front-mounting and wall-mounting fixtures are installed on supports specified herein.
2. Off-Floor, Plumbing Fixture Supports:
   a. Description: ASME A112.6.1M carriers with dimensions and trim matching fixture.
      1) Stainless-Steel, Front-Mounting Fixtures: With modifications.

a) Drinking Fountains: Type I drinking fountain carrier.
b) Lavatories: Type III lavatory carrier.
c) Shampoo Bowls: Type II sink carrier.
d) Urinals: Type I urinal carrier with inlet seal unless Type II is required.
e) Water Closets: Combination support and waste fitting assembly.

2) Vitreous-China, Wall-Mounting Fixtures:
a) Lavatories: Type III lavatory carrier.
b) Water Closets: Combination support and waste fitting assembly.

3) Carriers: With vertical steel uprights with feet. Include tie rods, bearing plates, and mounting studs matching fixture to be supported.
4) Combination Support and Waste Fitting Assemblies: With feet and inlet seal.
5) Carriers for Accessible Fixtures: Include rectangular, vertical steel uprights instead of steel pipe uprights.

1.5 EXECUTION

A. Security Plumbing Fixture Installation

1. Install back-mounting-type, stainless-steel security plumbing fixtures as follows:
   a. Install wall sleeve in wall.
   b. Install fixture on wall sleeve; mount components on or attached to wall sleeve with access from accessible service space.
   c. Extend supply piping from service space to fixture.
   d. Install soil and waste piping from fixture and extend into service space.
   e. Install fixture trap in service space instead of below fixture drain.
2. Install front-mounting-type, stainless-steel security plumbing fixtures as follows:
   a. Install fixture support or mounting bracket.
   b. Install fixture on support; mount components inside of or attached to fixture.
   c. Extend supply piping from pipe space to fixture.
   d. Install trap below fixture and extend soil and waste piping into pipe space.
3. Install vitreous-china security plumbing fixtures onto accessible service space as follows:
   a. Install fixture support in service space.
      1) Use combination support and waste fitting assembly for water closet.
      2) Use chair carriers for lavatory.
   b. Install fixture on support.
   c. Install components in service space.
4. Install vitreous-china security plumbing fixtures onto accessible pipe space as follows:
   a. Install fixture support in pipe space.
      1) Use combination support and waste fitting assembly for water closet.
      2) Use carrier support for lavatory.
   b. Install fixture on support.
   c. Install components in pipe space with access panels. See Division 08 Section "Access Doors And Frames" for access panels not in this Section.
5. Install security plumbing fixture outlets with gasket seals.
6. Install fixtures designated "accessible" according to ICC A117.1 for heights, dimensions, and clearances.
7. Install fixtures level and plumb.
8. Install shutoff valves in water-supply piping to fixtures. Use ball, gate, or globe valve if specific type valve is not indicated. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 22 Section "General-duty Valves For Plumbing Piping".
9. Install dielectric fittings in water-supply piping to fixtures if piping and fixture connections are made of different metals. See Division 22 Section "Common Work Results For Plumbing" for dielectric fittings.
10. Install toilet seats on water closets and combination units if seats are indicated.

B. Connections
1. Piping installation requirements are specified in other Division 14. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Connect hot- and cold-water supply piping to security plumbing fixtures. Include supply stops, if specified, or ball valve on each supply. Ball valves are specified in Division 22 Section "General-duty Valves For Plumbing Piping".
3. Connect soil and waste piping to security plumbing fixtures.
4. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
5. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Field Quality Control
1. Perform the following field tests and inspections and prepare test reports:
    a. Testing: After installing security plumbing fixtures and after electrical circuitry has been energized, test for compliance with requirements.
    b. Remove and replace malfunctioning security plumbing fixtures. Retest as specified above after repairs or replacements are made.

D. Adjusting
1. Operate and adjust water-supply flushometers and flow-control valves on security plumbing fixtures.

E. Cleaning
1. Clean security plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
    a. Remove faucet spouts and strainers, remove sediment and debris, and reinstall spouts and strainers.
    b. Remove sediment and debris from drains.
2. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

F. Protection
1. Provide protective covering for installed security plumbing fixtures and fittings.
2. Do not allow use of security plumbing fixtures for temporary facilities unless approved in writing by the Owner.

END OF SECTION 22 46 13 13

Task	Specification	Specification Description
22 46 13 16	22 46 13 13	Security Plumbing Fixtures
22 46 13 19	22 46 13 13	Security Plumbing Fixtures
22 46 16 13	22 46 13 13	Security Plumbing Fixtures
22 46 16 16	22 46 13 13	Security Plumbing Fixtures
22 46 19 00	22 46 13 13	Security Plumbing Fixtures
22 46 56 00	22 46 13 13	Security Plumbing Fixtures

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SECTION 22 47 13 00 - DRINKING FOUNTAINS AND WATER COOLERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for drinking fountains and water coolers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Style F, freestanding drinking fountains.
b. Style W, wall-mounting drinking fountains.
c. Type PB, pressure with bubbler, Style F, freestanding water coolers.
d. Type PB, pressure with bubbler, Style W, wall-mounting water coolers.
e. Fixture supports.

C. Definitions
1. Accessible Drinking Fountain or Water Cooler: Fixture that can be approached and used by people with disabilities.
2. Cast Polymer: Dense, cast-filled-polymer plastic.
3. Drinking Fountain: Fixture with nozzle for delivering stream of water for drinking.
4. Fitting: Device that controls flow of water into or out of fixture.
5. Fixture: Drinking fountain or water cooler unless one is specifically indicated.
6. Remote Water Cooler: Electrically powered equipment for generating cooled drinking water.
7. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

D. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Diagram power, signal, and control wiring.
3. Operation and maintenance data.

E. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for fixtures for people with disabilities.
3. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
4. ARI Standard: Comply with ARI's "Directory of Certified Drinking Water Coolers" for style classifications.
5. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.
6. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants" for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.

1.2 PRODUCTS

A. Drinking Fountains
1. Description: Accessible, Style F, freestanding drinking fountain.
   a. Pedestal:
      1) Material: Concrete **OR** Painted cast iron or steel, **as directed**.
      2) Shape: Rectangular **OR** Round, **as directed,** with offset to receptor **OR** with side receptor(s), **as directed**.
   b. Receptor(s):
      1) Number: One **OR** Two **OR** Three, **as directed**.
      2) Material: Bronze **OR** Chrome-plated brass or stainless steel, **as directed**.
      3) Shape: Rectangular **OR** Round **OR** Rounded front, **as directed**.
      4) Bubbler: One for each receptor, with adjustable stream regulator, located on deck.
   c. Controls: Foot pedal **OR** Push bar **OR** Push button, **as directed,** with adjustable stream regulator.
   d. Access to Internal Components: Panel in pedestal.
   e. Supply: NPS 3/8 (DN 10) **OR** NPS 1/2 (DN 15), **as directed**, with ball, gate, or globe valve.
   f. Drain: Grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.2 **OR** waste to drainage system, **as directed**.
2. Description: Accessible, Style F, antifreeze, freestanding drinking fountain designed to operate without draining into ground.
   a. Pedestal: Rectangular, painted cast iron or steel.
   b. Receptor: Rectangular, chrome-plated brass or stainless steel with bubbler.
   c. Control: Foot pedal with control valve assembly.
   d. Supply: NPS 1/2 (DN 15) with underground shutoff and flow-control valve assembly.
   e. Drain: Grid with NPS 1 (DN 25) **OR** NPS 1-1/4 (DN 32) **OR** NPS 1-1/2 (DN 40), **as directed,** minimum waste to drainage system.
   f. Bury Depth, Grade to Valve Components: 36 inches (915 mm) **OR** 48 inches (1220 mm) **OR** 60 inches (1525 mm), **as directed**.
3. Description: Accessible, Style W, wall-mounting drinking fountain.
   a. Material: Bronze **OR** Metal **OR** Cast polymer **OR** Stainless steel **OR** Vitreous china complying with ASME 112.19.2M for drinking fountains with backsplash, **as directed**.
   b. Receptor Shape: Rectangular **OR** Round **OR** Rounded front, **as directed**.
   c. Back Panel: Stainless-steel wall plate behind drinking fountain.
   d. Bubblers: One **OR** Two **OR** Three, **as directed**, with adjustable stream regulator, located on deck.
   e. Control: Push button **OR** Push bar, **as directed**.
   f. Supply: NPS 3/8 (DN 10) with ball, gate, or globe valve.
   g. Drain: Grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.2.
   h. Support: Type I, water cooler carrier. Refer to "Fixture Supports" Article.
4. Description: Accessible, Style WS, wall-mounting, semirecessed drinking fountain.
   a. Material: Stainless steel **OR** Bronze **OR** Vitreous china complying with ASME A112.19.2M for semirecessed drinking fountains, **as directed**.
   b. Receptor Shape: Concave with projecting bowl.
   c. Bubbler: One, with adjustable stream regulator, located on deck.
   d. Control: Push button **OR** Push bar, **as directed**.
   e. Supply: NPS 3/8 (DN 10) with ball, gate, or globe valve.
   f. Drain: Integral punched grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.2.
   g. Support: Mounting frame or brackets for attaching to substrate.
5. Description: Style RE, stainless-steel, recessed drinking fountain.
   a. Receptor Shape: Concave with flush wall flange.
   b. Bubbler: One, with adjustable stream regulator, located on deck.

c. Control: Push button **OR** bar, **as directed**.
d. Supply: NPS 3/8 (DN 10) with ball, gate, or globe valve.
e. Drain: Grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.2.
f. Support: Mounting frame or brackets for attaching to substrate.

B. Water Coolers
1. Description: ARI 1010, Type PB, pressure with bubbler, Style F, freestanding or Style FW, flush-to-wall water cooler.
    a. Cabinet: All stainless steel **OR** Steel with powder-coat-finish **OR** Vinyl-covered steel with stainless-steel top, **as directed**.
    b. Bubbler: One, with adjustable stream regulator, located on deck.
    c. Control: Push button **OR** Foot pedal, **as directed**.
    d. Supply: NPS 3/8 (DN 10) with ball, gate, or globe valve.
    e. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
    f. Drain: Grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.2.
    g. Cooling System: Electric, with precooler, hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
        1) Capacity: 5 gph (0.0053 L/s) **OR** 8 gph (0.0084 L/s) **OR** 10 gph (0.0105 L/s) **OR** 14 gph (0.0147 L/s), **as directed**, of 50 deg F (10 deg C) cooled water from 80 deg F (27 deg C) inlet water and 90 deg F (32 deg C) ambient air temperature.
        2) Electrical Characteristics: 1/6 **OR** 1/5 **OR** 1/4, **as directed**, hp; 120-V ac; single phase; 60 Hz.
2. Description: ARI 1010, Type PBC, pressure with bubbler and compartment, Style F, freestanding water cooler.
    a. Cabinet: All stainless steel **OR** Vinyl-covered steel with stainless-steel top, **as directed,** with refrigerated compartment in front panel.
    b. Bubbler: One, with adjustable stream regulator, located on deck.
    c. Control: Push button.
    d. Supply: NPS 3/8 (DN 10) with ball, gate, or globe valve.
    e. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
    f. Drain: Grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.2.
    g. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
        1) Capacity: 3 gph (0.0032 L/s) of 50 deg F (10 deg C) cooled water from 80 deg F (27 deg C) inlet water and 90 deg F (32 deg C) ambient air temperature.
        2) Electrical Characteristics: 1/8 hp; 120-V ac; single phase; 60 Hz.
3. Description: Accessible, ARI 1010, Type PB, pressure with bubbler, Style W, wall-mounting water cooler for adult **OR** child, **as directed,**-mounting height.
    a. Cabinet: Single **OR** Bilevel with two attached cabinets **OR** Bilevel with two attached cabinets and with bilevel skirt kit, **as directed**, all stainless steel **OR** vinyl-covered steel with stainless-steel top, **as directed**.
    b. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
    c. Control: Push button **OR** Push bar, **as directed**.
    d. Supply: NPS 3/8 (DN 10) with ball, gate, or globe valve.
    e. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
    f. Drain(s): Grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.1.

g. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
    1) Capacity: 5 gph (0.0053 L/s)\ **OR** 8 gph (0.0084 L/s), **as directed**, of 50 deg F (10 deg C) cooled water from 80 deg F (27 deg C) inlet water and 90 deg F (32 deg C) ambient air temperature.
    2) Electrical Characteristics: 1/6 **OR** 1/5 **OR** 1/4 **OR** 1/3, **as directed,** hp; 120-V ac; single phase; 60 Hz.

h. Support: Type I **OR** II, **as directed**, water cooler carrier. Refer to "Fixture Supports" Article.

4. Description: Accessible, ARI 1010, Type PB, pressure with bubbler, Style WS, semirecessed water cooler.
    a. Cabinet: All stainless steel **OR** Vinyl-covered steel with stainless-steel top, **as directed**.
    b. Bubbler: One, with adjustable stream regulator, located on deck.
    c. Control: Push button **OR** Push bar, **as directed**.
    d. Supply: NPS 3/8 (DN 10) with ball, gate, or globe valve.
    e. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
    f. Drain: Grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.2.
    g. Cooling System: Electric, with precooler, hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
        1) Capacity: 8 gph (0.0084 L/s) **OR** 12 gph (0.0126 L/s), **as directed,** of 50 deg F (10 deg C) cooled water from 80 deg F (27 deg C) inlet water and 90 deg F (32 deg C) ambient air temperature.
        2) Electrical Characteristics: 1/6 **OR** 1/5, **as directed,** hp; 120-V ac; single phase; 60 Hz.
    h. Support: Mounting frame or brackets for attaching to substrate.

5. Description: ARI 1010, Type PB, pressure with bubbler, Style RE, recessed water cooler.
    a. Cabinet: All stainless steel.
    b. Bubbler: One, with adjustable stream regulator, located on deck.
    c. Control: Push button **OR** bar, **as directed**.
    d. Supply: NPS 3/8 (DN 10) with ball, gate, or globe valve.
    e. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
    f. Drain: Grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.2.
    g. Cooling System: Electric, with precooler, hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
        1) Capacity: 8 gph (0.0084 L/s) **OR** 12 gph (0.0126 L/s), **as directed,** of 50 deg F (10 deg C) cooled water from 80 deg F (27 deg C) inlet water and 90 deg F (32 deg C) ambient air temperature.
        2) Electrical Characteristics: 1/6 **OR** 1/5, **as directed,** hp; 120-V ac; single phase; 60 Hz.
    h. Ventilation Grille: Stainless steel, located above **OR** below, **as directed,** fountain.
    i. Support: Mounting frame for attaching to substrate.

C. Water Station Water Coolers

1. Description: Water-station configuration, freestanding, cabinet water cooler with top-mounting glass fillers.
    a. Cabinet: All stainless steel **OR** Enameled-steel panels with stainless-steel top, **as directed**, 0.05 inch (1.3 mm) thick; and 32 inches (813 mm) **OR** 36 inches (915 mm), **as directed**, high.

b. Receptors: Two **OR** Four, **as directed,** stainless-steel bowls, with grid drain and bottom outlet in top; with two facing front and two facing back.
c. Glass Fillers: Two **OR** Four, **as directed**, push-back type **OR** pedestal type, **as directed**, on top, over receptors.
d. Tray Slides: One on front and one on back, stainless steel.
e. Supply: NPS 1/2 (DN 15) with ball, gate, or globe valve, and connected to filter, chiller, and each glass filler.
f. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
g. Drain: Waste piping from each receptor connected to NPS 1-1/4 (DN 32) **OR** NPS 1-1/2 (DN 40), **as directed**, trap and waste to wall **OR** indirect waste to floor receptor, **as directed,** complying with ASME A112.18.2.
h. Cooling System: Electric, complying with ARI 1010, for Type R remote water coolers.
   1) Chassis: Galvanized or corrosion-resistant-coated steel.
   2) Chiller: Hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, and refrigerant.
   3) Storage Tank: 2 gal. (7.6 L) **OR** 4 gal. (15.1 L) **OR** 6 gal. (22.7 L) **OR** 14 gal. (53 L) **OR** 25 gal. (95 L), **as directed**, stainless steel.
   4) Controls: Adjustable thermostat.
   5) One-Hour Peak Capacity Rate: 8 gph (0.0084 L/s) **OR** 12 gph (0.0126 L/s) **OR** 18 gph (0.0189 L/s) **OR** 29 gph (0.0305 L/s) **OR** 50 gph (0.0526 L/s), **as directed,** of 50 deg F (10 deg C) cooled water from 80 deg F (27 deg C) inlet water and 90 deg F (32 deg C) ambient air temperature.
   6) Electrical Characteristics: 1/5 **OR** 1/4 **OR** 1/3 **OR** 1/2 **OR** 3/4, **as directed,** hp; 120 **OR** 240 **OR** 277 **OR** 480, **as directed,**-V ac; single phase; 60 Hz.

2. Description: Water-station configuration, freestanding, cabinet water cooler with front-mounting glass fillers.
   a. Cabinet: All stainless steel **OR** Enameled-steel panels with stainless-steel top, **as directed**, 0.05 inch (1.3 mm) thick; and 42 inches (1067 mm) **OR** 48 inches (1219 mm), **as directed**, high.
   b. Receptors: One **OR** Two, **as directed,** stainless-steel tray(s), with antisplash design, drain, and bottom outlet, in vertical panel(s), with one facing front and one facing back.
   c. Glass Fillers: Two **OR** Four, **as directed**, push-back type, on vertical panel(s), over receptor(s).
   d. Shelves: One **OR** Two, **as directed**, stainless steel, on each side panel.
   e. Supply: NPS 1/2 (DN 15) with ball, gate, or globe valve, and connected to filter, chiller, and each glass filler.
   f. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
   g. Drain: NPS 1-1/4 (DN 32) **OR** NPS 1-1/2 (DN 40), **as directed**, trap and waste to wall **OR** indirect waste to floor receptor, **as directed,** complying with ASME A112.18.2.
   h. Cooling System: Electric, complying with ARI 1010, for Type R remote water coolers.
      1) Chassis: Galvanized or corrosion-resistant-coated steel.
      2) Chiller: Hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, and refrigerant.
      3) Storage Tank: 6 gal. (22.7 L) **OR** 14 gal. (53 L) **OR** 25 gal. (95 L) **OR** 30 gal. (113.6 L) **OR** 40 gal. (151.4 L), **as directed**, stainless steel.
      4) Controls: Adjustable thermostat.
      5) One-Hour Peak Capacity Rate: 18 gph (0.0189 L/s) **OR** 29 gph (0.0305 L/s) **OR** 50 gph (0.0526 L/s) **OR** 65 gph (0.0684 L/s) **OR** 85 gph (0.0894 L/s), **as directed,** of 50 deg F (10 deg C) cooled water from 80 deg F (27 deg C) inlet water and 90 deg F (32 deg C) ambient air temperature.
      6) Electrical Characteristics: 1/3 **OR** 1/2 **OR** 3/4 **OR** 1 **OR** 1-1/2, **as directed**, hp; 120 **OR** 240 **OR** 277 **OR** 480, **as directed,**-V ac; single phase; 60 Hz.

D. Remote Water Coolers

1. Description: ARI 1010, Style R, remote chiller equipment for installation separate from drinking fountains. Include filter, reverse-osmosis system and ultra-violet-disinfection equipment, **as directed**.
   a. Cooling System: Electric.
      1) Chassis: Galvanized or corrosion-resistant-coated steel.
      2) Chiller: Hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, and refrigerant.
      3) Storage Tank: 0.5 gal. (1.9 L) **OR** 4 gal. (15.1 L), **as directed**, stainless steel.
      4) Controls: Adjustable thermostat.
      5) Capacity: 5 gph (0.0053 L/s) **OR** 8 gph (0.0084 L/s) **OR** 14 gph (0.0147 L/s), **as directed,** of 50 deg F (10 deg C) cooled water from 80 deg F (27 deg C) inlet water and 90 deg F (32 deg C) ambient air temperature.
      6) Electrical Characteristics: 1/5 **OR** 1/4 **OR** 1/3, **as directed,** hp; 120 **OR** 240 **OR** 277 **OR** 480, **as directed,**-V ac; single phase; 60 Hz.
   b. Ventilation Grille: Stainless steel.
   c. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.

E. Fixture Supports
1. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.
   a. Type I: Hanger-type carrier with two vertical uprights.
   b. Type II: Bilevel, hanger-type carrier with three vertical uprights.
   c. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

1.3 EXECUTION

A. Applications
1. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.
2. Use mounting frames for recessed water coolers, unless otherwise indicated.
3. Set freestanding and pedestal drinking fountains on floor.
4. Set remote water coolers on floor, unless otherwise indicated.
5. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

B. Installation
1. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.
2. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.
3. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.
4. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 22 Section "General-duty Valves For Plumbing Piping".
5. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
6. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 22 Section "Common Work Results For Plumbing".

7. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants".

C. Connections
   1. Connect fixtures with water supplies, traps, and risers, and with soil, waste, and vent piping. Use size fittings required to match fixtures.
   2. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
   3. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

D. Field Quality Control
   1. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.
      a. Remove and replace malfunctioning units and retest as specified above.
      b. Report test results in writing.

E. Adjusting
   1. Adjust fixture flow regulators for proper flow and stream height.
   2. Adjust water cooler temperature settings.

END OF SECTION 22 47 13 00

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Task	Specification	Specification Description
22 47 13 00	01 22 16 00	No Specification Required
22 47 13 00	10 28 19 16	Plumbing Fixtures
22 47 16 00	01 22 16 00	No Specification Required
22 47 16 00	10 28 19 16	Plumbing Fixtures
22 47 16 00	22 01 40 81	Emergency Plumbing Fixtures
22 47 16 00	22 47 13 00	Drinking Fountains And Water Coolers
22 47 23 00	22 47 13 00	Drinking Fountains And Water Coolers
22 47 26 00	10 28 19 16	Plumbing Fixtures
22 51 13 00	01 22 16 00	No Specification Required
22 51 16 00	01 22 16 00	No Specification Required
22 51 19 00	01 22 16 00	No Specification Required
22 66 53 00	07 63 00 00	Common Work Results for Fire Suppression
22 66 53 00	07 63 00 00a	Common Work Results for Plumbing
22 66 53 00	07 63 00 00b	Common Work Results for HVAC
22 66 53 00	22 11 16 00a	Sanitary Waste And Vent Piping
22 66 53 00	22 11 16 00f	General-Service Compressed-Air Piping

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SECTION 22 66 83 16 - CHEMICAL-WASTE SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for chemical-waste systems for laboratory and healthcare facilities. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

C. Summary
   1. Section Includes:
      a. Single-wall piping.
      b. Double-containment piping.
      c. Field-fabrication containment piping.
      d. Piping specialties.
      e. Neutralization tanks.
      f. Neutralization systems.
      g. Manholes.
      h. Leak-detection systems.

D. Definitions
   1. CR: Chlorosulfonated polyethylene synthetic rubber.
   2. FPM: Vinylidene fluoride-hexafluoro propylene copolymer rubber.

E. Performance Requirements
   1. Single-Wall Piping Pressure Rating: 10 feet head of water (30 kPa).
   2. Double-Containment Piping Pressure Rating:
      a. Carrier Piping: 5-psig (34.5-kPa) air test pressure.
      b. Containment Piping: 5-psig (34.5-kPa) air test pressure.
   3. Field-Fabrication Containment-Piping Pressure Rating: 5-psig (34.5-kPa) air test pressure.
   4. Delegated Design: Design seismic restraints for aboveground piping, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

F. Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittal:
      a. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.
   3. Shop Drawings: For neutralization system and leak-detection system. Include plans, elevations, sections, details, and attachments to other work.
      a. Detail neutralization-system assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      b. Detail leak-detection-system assemblies and indicate required clearances, method of field assembly, components, and location and size of each field connection.
      c. Wiring Diagrams: For power, signal, and control wiring.
   4. Delegated-Design Submittal: For seismic restraints of aboveground piping, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   5. Profile Drawings for Outdoor Underground Piping: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet (1:500) and vertical scale of not

less than 1 inch equals 5 feet (1:50). Indicate underground structures and pipes. Show types, sizes, materials, and elevations of other utilities crossing system piping.
6. Field quality-control test reports.
7. Operation and Maintenance Data: For chemical-waste specialties and neutralization tanks, neutralization systems, and leak-detection systems to include in emergency, operation, and maintenance manuals.

G. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. NFPA Compliance: Comply with NFPA 70, "National Electrical Code."

H. Delivery, Storage, And Handling
1. Deliver and store piping and specialties with sealing plugs in ends or with end protection.
2. Do not store plastic pipe or fittings in direct sunlight.
3. Protect pipe, fittings, and seals from dirt and damage.

I. Project Conditions
1. Interruption of Existing Chemical-Waste Service: Do not interrupt chemical-waste service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary chemical-waste service according to requirements indicated:
   a. Notify the Owner no fewer than two days in advance of proposed interruption of chemical-waste service.
   b. Do not proceed with interruption of chemical-waste service without the Owner's written permission.

1.2 PRODUCTS

A. Single-Wall Pipe And Fittings
1. PE Drainage Pipe and Fittings: Made of ASTM D 4976, PE resin.
   a. Pipe: ASTM F 1412, Schedule 40.
   b. Fittings: ASTM F 1412, Schedule 40, socket-fusion, drainage pattern complying with ASTM D 3311.
2. PP Drainage Pipe and Fittings: ASTM F 1412, pipe extruded and drainage-pattern fittings molded, with Schedule 40 dimensions, from PP resin with fire-retardant additive complying with ASTM D 4101; with fusion **OR** fusion- and mechanical **OR** mechanical, **as directed**,-joint ends.
   a. Exception: Pipe and fittings made from PP resin without fire-retardant additive may be used for underground installation.
3. PVC Drainage Pipe and Fittings: ASTM D 2665, pipe and drainage-pattern fittings.
4. PVDF Drainage Pipe and Fittings: ASTM F 1673, Schedule 40, pipe and drainage-pattern fittings. Include fittings with fusion **OR** fusion- and mechanical **OR** mechanical, **as directed**,-joint ends.
5. Fiberglass Pipe and Fittings, Centrifugally Cast: ASTM D 2997, Type II, Grade 1 **OR** Grade 2, **as directed**, Class A **OR** Class B **OR** Class C, **as directed**, RTRP pipe; with ASTM D 5685, Type 4, RTRF fittings matching pipe; and adhesive-bonding **OR** butt-and-wrap-joint, **as directed**, materials. Include wall thickness that will provide 160-psig (1105-kPa) minimum, sustained water test pressure rating.
6. Fiberglass Pipe and Fittings, Filament Wound: ASTM D 2996, Type I, Grade 1 **OR** Grade 2, **as directed**, Class A **OR** Class B **OR** Class C **OR** Class E **OR** Class F, **as directed**, RTRP pipe; ASTM D 5685, Type 1, RTRF fittings matching pipe; and adhesive-bonding **OR** butt-and-wrap-joint, **as directed**, materials. Include wall thickness that will provide 160-psig (1105-kPa) minimum, sustained water test pressure rating.

7. High-Silicon-Iron, Hub-and-Plain-End Pipe and Fittings: ASTM A 861, pipe and drainage-pattern fittings; acid-resistant packing; and lead calking materials.
8. High-Silicon-Iron, Mechanical-Joint Pipe and Fittings: ASTM A 861, pipe and drainage-pattern fittings; and stainless-steel clamps with TFE inner sleeve and CR outer sleeve.
9. Stainless-Steel Drainage Pipe and Fittings: ASME A112.3.1, ASTM A 666, Type 316L, stainless-steel pipe and drainage-pattern fittings; with socket and spigot ends for gasket joints; and having piping manufacturer's FPM lip-seal rubber gaskets shaped to fit socket groove, with plastic backup ring.
10. Borosilicate Glass Pipe and Fittings: ASTM C 1053, pipe and drainage-pattern fittings; with manufacturer's standard couplings.
    a. Covering: Factory-applied polystyrene for pipe installed underground.
11. Adapters and Transition Fittings: Assemblies with combination of clamps, couplings, adapters, and gaskets; compatible with piping and system liquid; made for joining different piping materials.

B. Double-Containment Pipe And Fittings
1. Description: Factory-fabricated, double-wall pipe and fittings. Sizes indicate carrier-pipe size; with carrier (inner) pipe and fittings; annular-space, carrier-pipe supports; containment (outer) pipe and fittings; and joining materials and fasteners. Include manufacturer's standard piping materials according to the following:
    a. PE, Double-Containment Drainage Pipe and Fittings: Made of ASTM D 4976, PE resin.
        1) Carrier and Containment Pipes: ASTM F 1412, Schedule 40.
        2) Fittings: ASTM F 1412, Schedule 40 drainage pattern complying with ASTM D 3311.
    b. PP, Double-Containment Drainage Pipe and Fittings: Made of ASTM D 4101, PP resin.
        1) Carrier and Containment Pipes: ASTM F 1412, Schedule 40.
        2) Fittings: ASTM F 1412, Schedule 40 drainage pattern complying with ASTM D 3311.
    c. PP/PVC, Double-Containment Drainage Pipe and Fittings:
        1) PP Carrier Pipe: ASTM F 1412, Schedule 40; made of ASTM D 4101, PP resin.
        2) PP Carrier-Pipe Fittings: ASTM F 1412, Schedule 40 drainage pattern complying with ASTM D 3311; made of ASTM D 4101, PP resin.
        3) PVC Containment Pipe: ASTM D 2665, PVC pipe.
        4) PVC Containment Pipe Fittings: ASTM D 2665, PVC drainage pattern.
    d. PVDF, Double-Containment Drainage Pipe and Fittings: Made of ASTM D 3222, PVDF resin.
        1) Carrier and Containment Pipes: ASTM F 1673, Schedule 40.
        2) Fittings: ASTM F 1673, Schedule 40 drainage pattern complying with ASTM D 3311.
    e. PVDF/PVC, Double-Containment Drainage Pipe and Fittings:
        1) PVDF Carrier Pipe: ASTM F 1673, Schedule 40; made of ASTM D 3222, PVDF resin.
        2) PVDF Carrier-Pipe Fittings: ASTM F 1673, Schedule 40 drainage pattern complying with ASTM D 3311; made of ASTM D 3222, PVDF resin.
        3) PVC Containment Pipe: ASTM D 2665, PVC pipe.
        4) PVC Containment Pipe Fittings: ASTM D 2665, PVC drainage pattern.
2. Include design and fabrication of double-containment pipe and fitting assemblies with provision for field installation of cable leak-detection system in annular space between carrier and containment piping.

C. Field-Fabrication Containment Piping
1. Description: Containment split pipe and split fittings with carrier-pipe centralizers. Include manufacturer's fastening devices and materials.
    a. Material: HDPE **OR** PP **OR** Yellow PVC **OR** Clear PVC, **as directed**, pipe and fittings.
    b. Fastening System: FPM gaskets, clamps, and pins.

c. Material: Clear PVC pipe and fittings with adhesive channels, for use with drainage-pattern carrier piping.
d. Fastening System: Adhesive.

D. Joining Materials
1. Couplings: Assemblies with combination of clamps, gaskets, sleeves, and threaded or flanged parts; compatible with piping and system liquid; and made by piping manufacturer for joining system piping.
2. Adapters and Transition Fittings: Assemblies with combination of clamps, couplings, adapters, gaskets, and threaded or flanged parts; compatible with piping and system liquid; and made for joining different piping materials.
3. Flanges: Assemblies of companion flanges and gaskets complying with ASME B16.21 and compatible with system liquid, and bolts and nuts.
4. Solvent Cement for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
   a. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
5. Fiberglass-Pipe Adhesive: As furnished or recommended by pipe manufacturer.
   a. Use fiberglass adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Piping Specialties
1. Plastic Dilution Traps:
   a. Material: Corrosion-resistant PP, with removable base.
   b. End Connections: Mechanical joint.
   c. Dilution Tanks: 1-gal. (3.8-L) capacity, with clear base unless colored base is indicated; with two NPS 1-1/2 (DN 40) top inlets and one NPS 1-1/2 (DN 40) side outlet.
   d. Small Dilution Jars: 1-pint (0.5-L) capacity, with clear base unless colored base is indicated; with NPS 1-1/2 (DN 40) top inlet and NPS 1-1/2 (DN 40) side outlet.
   e. Large Dilution Jars: 1-quart (1-L) capacity; with NPS 1-1/2 (DN 40) top inlet and NPS 1-1/2 (DN 40) side outlet.
2. High-Silicon-Iron Dilution Traps:
   a. Standard: ASTM A 861.
   b. Size: NPS 1-1/2 or NPS 2 (DN 40 or DN 50) as required for fixture and waste.
   c. End Connections: Mechanical.
3. Glass, Drain-Line, Interceptor Traps:
   a. Standard: ASTM C 1053.
   b. Type: Drum trap.
   c. Size: NPS 1-1/2 (DN 40), NPS 2 by NPS 1-1/2 (DN 50 by DN 40), or NPS 2 (DN 50), as required to match connecting piping.
4. Corrosion-Resistant Traps:
   a. Type: P-trap or drum trap.
   b. Size: NPS 1-1/2 or NPS 2 (DN 40 or DN 50), as required to match connected piping.
   c. High-Silicon Iron: ASTM A 861, with horizontal outlet and hub-and-plain or plain ends to match connecting piping.
   d. PP: ASTM D 4101, with mechanical-joint pipe connections.
   e. PVDF: ASTM D 3222, with mechanical-joint pipe connections.
   f. Glass: ASTM C 1053, with coupling pipe connections.
5. High-Silicon-Iron Floor Drains:
   a. Standard: ASTM A 861.
   b. Body: With integral flashing flange and weep holes; and with flashing ring and stainless-steel strip, sediment basin and funnel attachment, **as directed**.

c. Top: 8-3/4-inch (222-mm) diameter with grate.
d. Size: NPS 2, NPS 3, NPS 4, or NPS 6 (DN 50, DN 80, DN 100, or DN 150) outlet as indicated.

6. Stainless-Steel Floor Drains:
   a. Standard: ASME A112.3.1, ASTM A 666, Type 316L.
   b. Body: With 8.5-by-8.5-inch (215-by-215-mm) **OR** 12.4-by-12.4-inch (315-by-315-mm), **as directed**, top with grate.
   c. Outlet: Bottom, of size indicated.
7. PP Floor Drains:
   a. Body: With 7- to 9-inch (178- to 230-mm) top diameter, with flashing flange and weep holes; and with flashing clamp, basket strainer, funnel attachment, and trap-primer connection, **as directed**.
   b. Outlet: Bottom, to match connecting pipe, with NPS 2, NPS 3, NPS 4, or NPS 6 (DN 50, DN 80, DN 100, or DN 150) outlet as indicated.
8. High-Silicon-Iron Cleanouts:
   a. Standard: ASTM A 861, fitting with PTFE gasket and closure plug, of design appropriate for piping application.
9. Stainless-Steel Cleanouts:
   a. Standard: ASME A112.3.1, ASTM A 666, Type 316L, stainless steel.
   b. Aboveground Piping: Cleanout tee of size matching piping.
   c. Underground and Underslab Piping: Floor access cleanout of size matching piping.
10. High-Silicon-Iron Backwater Valves:
   a. Standard: ASTM A 861.
   b. Body: Hub-and-plain end with swing-check valve; and with high-silicon-iron pipe extension of length to reach floor surface, and high-silicon-iron closure plug, **as directed**.
11. Plastic Backwater Valves:
   a. Description: Full-port NPS 3 (DN 80) check valve, PP or PVDF, matching or compatible with system piping and compatible with system liquid, with EPDM seals and flanged ends.
      1) Exception: PVC material for use with PVC piping systems.
12. High-Silicon-Iron Sink Outlets:
   a. Standard: ASTM A 861, high-silicon iron, NPS 1-1/2 (DN 40), with clamping device and 4-, 6-, or 8-inch- (100-, 150-, or 200-mm-) high overflow fitting, as indicated.
13. PP Sink Outlets:
   a. Description: NPS 1-1/2 (DN 40), with clamping device, stopper, and 7-inch- (178-mm-) high overflow fitting.
14. Glass Sink Outlets:
   a. Standard: ASTM C 1053, components for field assembly, NPS 1-1/2 (DN 40); with sink assembly of outlet, strainer, gasket, and locknut; overflow fitting of length indicated; and tailpiece assembly of borosilicate glass and locknut.

F. Neutralization Tanks
1. Plastic Neutralization Tanks:
   a. Description: Corrosion-resistant plastic materials; with removable, gastight cover; interior, sidewall, dip-tube inlet; outlet; vent; and threaded or flanged, sidewall pipe connections.
      1) Material: HDPE **OR** ASTM D 4101, PP, **as directed**.
      2) Tank Capacity: as directed by the Owner.
      3) Dip Tube: On outlet pipe instead of inlet pipe.
      4) Extension: HDPE, PE, or PP.
      5) Traffic Cover: Light-duty **OR** Heavy-duty pedestrian or light-duty vehicular, steel plate over, **as directed**, plastic, bolted.
      6) Limestone: Chips or lumps, with more than 90 percent calcium carbonate content and 1- to 3-inch (25- to 75-mm) diameter.
      OR

Dolomitic Limestone: Chips or lumps, with more than 90 percent combined magnesium carbonate and calcium carbonate content and 1- to 3-inch (25- to 75-mm) diameter.

2. Ceramic Neutralization Tanks:
   a. Description: Corrosion-resistant, cast-ceramic shell; with removable, reinforced-plastic, gastight cover; inlet; interior, sidewall, dip-tube outlet; vent; and bell, sidewall pipe connections.
      1) Extension: Ceramic, of size and length indicated, and with cast-iron manhole frame and cover.
      OR
      Extension: Steel with protective coating, 28-inch (710-mm) diameter, and cast-iron manhole frame and cover.
      2) Limestone: Chips or lumps, with more than 90 percent calcium carbonate content and 1- to 3-inch (25- to 75-mm) diameter.
      OR
      Dolomitic Limestone: Chips or lumps, with more than 90 percent combined magnesium carbonate and calcium carbonate content and 1- to 3-inch (25- to 75-mm) diameter.
3. Collection Tanks: Corrosion-resistant, cast-ceramic shell. Include removable, reinforced-plastic, gastight cover; inlet; vent; and bell, sidewall pipe connections.
   a. Extension: Ceramic **OR** Steel with protective coating, **as directed**, 28-inch (710-mm) minimum diameter, and cast-iron manhole frame and cover.

G. Neutralization Systems
1. Plastic-Tank Neutralization Systems:
   a. Description: Automatic system for neutralizing chemical waste.
      1) Controls: Factory-wired and -tested, 120-V ac, to operate probes, control valves, and metering pumps and to monitor pH of effluent; with wiring and electrical-power terminals.
      2) Panel: NEMA 250, Type 4X enclosure, unless otherwise indicated; with manufacturer's standard features, control devices, and indicators, but not less than the following:
         a) Power light and on/off switch.
         b) pH analyzer with meter and high- and low-pH indicators.
         c) Low caustic- and acid-solution level indicators.
         d) Alarm horn with silencer and reset switch.
         e) Agitator running light with on/off switch.
         f) Running lights with on/off switches for caustic- and acid-solution pumps.
      3) Strip chart recorder with capacity for 30-day record.
      4) Piping between Tanks: Same material as chemical-waste piping system unless otherwise indicated.
      5) Interceptor Tank: Same material as mixing tank; with removable, gastight cover; and sidewall inlet and outlet piping connections.
      6) Neutralization Tank: Same material as mixing tank; with removable, gastight cover; sidewall inlet and outlet piping connections; and vent connection in sidewall or top.
         a) Limestone: Chips or lumps, with more than 90 percent calcium carbonate content and 1- to 3-inch (25- to 75-mm) diameter.
         OR
         Dolomitic Limestone: Chips or lumps, with more than 90 percent combined magnesium carbonate and calcium carbonate content and 1- to 3-inch (25- to 75-mm) diameter.
      7) Mixing Tank: With removable, gastight cover; sidewall inlet and outlet piping connections; vent connection in sidewall or top; neutralizing-solution piping connections; and openings in top for probe and agitator.

a) Material: HDPE **OR** ASTM D 4101, PP, **as directed**.
b) pH Probe: Type and length suitable for mixing-tank size.
c) Agitator: Electric, with stainless-steel shaft and propeller.
8) Caustic-Solution Storage Tank: PP.
a) Caustic Chemical: Sodium hydroxide solution.
9) Acid Storage Tank: PP.
a) Acid Chemical: Sulfuric acid solution.
10) Metering Pumps: Types suitable for neutralizing solutions.
11) Sampling Tank: Same material as mixing tank; with removable, gastight cover; sidewall inlet and outlet piping connections; and opening in top for probe.
a) pH probe: Type and length suitable for sampling-tank size.

2. Ceramic-Tank Neutralization Systems:
a. Description: Automatic system for neutralizing chemical waste.
1) Controls: Factory-wired and -tested, 120-V ac, to operate probes, control valves, and metering pumps and to monitor pH of effluent; with wiring and electrical-power terminals.
2) Panel: NEMA 250, Type 4X enclosure, unless otherwise indicated; with manufacturer's standard features, control devices, and indicators, including the following:
a) Power light and on/off switch.
b) pH analyzer with meter and high- and low-pH indicators.
c) Low caustic- and acid-solution level indicators.
d) Alarm horn with silencer and reset switch.
e) Agitator running light with on/off switch.
f) Running lights with on/off switches for caustic- and acid-solution pumps.
3) Strip chart recorder with capacity for 30-day record.
4) Piping between Tanks: Same material as chemical-waste piping system unless otherwise indicated.
5) Interceptor Tank: Same material as mixing tank; with removable, gastight cover; and sidewall inlet and outlet piping connections.
6) Neutralization Tank: Same material as mixing tank; with removable, gastight cover; sidewall inlet and outlet piping connections; and vent connection in sidewall or top.
a) Limestone: Chips or lumps, with more than 90 percent calcium carbonate content and 1- to 3-inch (25- to 75-mm) diameter.
OR
Dolomitic Limestone: Chips or lumps, with more than 90 percent combined magnesium carbonate and calcium carbonate content and 1- to 3-inch (25- to 75-mm) diameter.
7) Mixing Tank: With removable, gastight cover; sidewall inlet and outlet piping connections; vent connection in sidewall or top; neutralizing-solution piping connections; and openings in top for probe and agitator.
a) Material: Clay, vitrified into ceramic unit.
b) pH Probe: Type and length suitable for mixing tank size.
c) Agitator: Electric, with stainless-steel shaft and propeller.
8) Caustic-Solution Storage Tank: PP.
a) Caustic Chemical: Sodium hydroxide solution.
9) Acid Storage Tank: PP.
a) Acid Chemical: Sulfuric acid solution.
10) Metering Pumps: Types suitable for neutralizing solutions.
11) Sampling Tank: Same material as mixing tank; with removable, gastight cover; sidewall inlet and outlet piping connections; and opening in top for probe.
a) pH probe: Type and length suitable for sampling-tank size.

H. Manholes

1. Description: ASTM F 1759, fabricated from PE components. Include bottom, sidewalls, and top sections; corrosion-resistant, manhole frame and cover; fusion or other watertight joints; and design to prohibit flotation.
   a. Construction: Single wall **OR** Double wall with interstitial space, **as directed**.
   b. Bottom: Channeled.
   c. Connections: Inlets and outlet matching or suitable for piping.
   d. Steps: Manufacturer's standard, fusion welded to sidewall. Omit steps for manholes less than 60 inches (1500 mm) deep.
   e. Top: Include 24-inch- (610-mm-) nominal-diameter frame and cover.

I. Leak-Detection Systems
1. Leak-Detection Systems:
   a. Description: Cable leak-detection system capable of detecting and annunciating fluid leaks; with controls, panel, wiring, cable sensors, probes if required, and piping.
      1) Annunciator Panel: Enclosure with visual and audible alarms and leak location indicator.
      2) Sensors: Electric cable, suitable for insertion into double-containment piping annular space, with capability of detecting fluid leaks and signaling locations of leaks.

J. Sleeves
1. Cast-Iron Wall Pipes: Cast or fabricated of cast iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
2. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
3. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
4. Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, plain ends.
5. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   a. Underdeck Clamp: Clamping ring with set screws.

K. Sleeve Seals
1. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   a. Sealing Elements: EPDM **OR** NBR, **as directed**, interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   b. Pressure Plates: Carbon steel **OR** Plastic **OR** Stainless steel, **as directed**.
   c. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating **OR** Stainless steel, **as directed**, of length required to secure pressure plates to sealing elements.

L. Escutcheons
1. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.
2. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.
3. One-Piece, Stamped-Steel Escutcheons: With set screw **OR** spring clips, **as directed**, and chrome-plated finish.
4. Split-Plate, Stamped-Steel Escutcheons: With concealed **OR** exposed-rivet, **as directed**, hinge, set screw **OR** spring clips, **as directed**, and chrome-plated finish.
5. One-Piece, Floor-Plate Escutcheons: Cast iron.
6. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

M. Grout
1. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

a. Characteristics: Post-hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
b. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
c. Packaging: Premixed and factory packaged.

1.3 EXECUTION

A. Earthwork
1. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

B. Concrete Bases
1. Anchor neutralization tanks and neutralization system tanks to concrete bases.
a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 19-inch (480-mm) centers around full perimeter of base.
b. For installed equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be imbedded.
d. Install anchor bolts to elevations required for proper attachment to supported equipment.
e. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
f. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-place Concrete".
g. Comply with requirements in Division 31 for cast-in-place concrete materials and placement.

C. Piping Installation
1. Chemical-Waste Sewerage Outside the Building:
a. Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground chemical-waste sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
b. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
c. Install manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
d. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
e. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or combination of both.
f. Install drainage piping pitched down in direction of flow, at minimum slope of 1 **OR** 2, **as directed**, percent, unless otherwise indicated.
g. Install drainage piping with 36-inch (915-mm) **OR** 48-inch (1220-mm) **OR** 60-inch (1524-mm) **OR** 72-inch (1830-mm), **as directed**, minimum cover.
h. Install PE drainage piping according to ASTM D 2321 and ASTM F 1668.
i. Install PVC drainage piping according to ASTM D 2321 and ASTM F 1668.
j. Install PVDF drainage piping according to ASTM D 2321 and ASTM F 1668.
k. Install fiberglass piping according to ASTM D 3839 and ASTM F 1668.
l. Install field-fabrication containment piping over new and existing carrier piping. Use containment piping manufacturer's fastening system.

m. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

2. Chemical-Waste Piping Inside the Building:
   a. Install piping next to equipment, accessories, and specialties to allow service and maintenance.
   b. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used unless otherwise indicated.
   c. Flanges may be used on aboveground piping unless otherwise indicated.
   d. Install underground fiberglass piping according to ASTM D 3839.
   e. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
   f. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
   g. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
   h. Install piping at indicated slopes.
   i. Install piping free of sags and bends.
   j. Install fittings for changes in direction and branch connections.
   k. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
      1) New Piping:
         a) Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
         b) Insulated Piping: One-piece, stamped-steel type with spring clips.
         c) Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
         d) Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type **OR** Split-plate, stamped-steel type with concealed hinge **OR** One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge, **as directed**, and set screw.
         e) Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with set screw **OR** spring clips, **as directed**.
         f) Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw **OR** spring clips, **as directed**.
         g) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
      2) Existing Piping:
         a) Insulated Piping: Split-plate, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and spring clips.
         b) Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.
         c) Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
         d) Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and set screw or spring clips.
         e) Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
         f) Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.
   l. Sleeves are not required for core-drilled holes.
   m. Permanent sleeves are not required for holes formed by removable PE sleeves.
   n. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

OR
Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1) Cut sleeves to length for mounting flush with both surfaces.
   a) Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
2) Install sleeves in new walls and slabs as new walls and slabs are constructed.
3) Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   a) PVC **OR** Steel, **as directed**, Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
   b) Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum board partitions.
   c) Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing And Trim" for flashing.
   d) Seal space outside of sleeve fittings with grout.
4) Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

o. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1) Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
   2) Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
   3) Sleeve-Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

p. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1) Sleeve-Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

r. Verify final equipment locations for roughing-in.

D. Piping Specialty Installation
1. Embed floor drains in 4-inch (100-mm) minimum depth of concrete around bottom and sides. Comply with requirements in Division 03 Section "Cast-in-place Concrete" for concrete.
2. Fasten grates to drains if indicated.
3. Set floor drains with tops flush with pavement surface.
4. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Use fittings of same material as sewer pipe at branches for cleanouts and riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in pipe.

a. Set cleanout bodies in earth in cast-in-place concrete block, 18 by 18 by 12 inches (450 by 450 by 300 mm) deep. Set with tops 1 inch (25 mm) above surrounding grade. Set cleanout plugs in concrete pavement with tops flush with pavement surface. Comply with requirements in Division 03 Section "Cast-in-place Concrete" for formwork, reinforcement, and concrete requirements.

5. Install backwater valves in horizontal position. Include riser to cleanout at grade.

E. Joint Construction
1. Chemical-Waste Sewerage Outside the Building:
   a. Plastic-Piping, Electrofusion Joints: Make polyolefin drainage-piping joints according to ASTM F 1290.
   b. Make fiberglass-piping bonded joints according to ASTM D 3839.
   c. Make fiberglass butt-and-wrap joints according to ASTM D 3839.
   d. Join dissimilar pipe materials with adapters compatible with pipe materials being joined.
   e. Join high-silicon-iron, hub-and-plain-end piping with calked joints using acid-resistant packing and lead.
   f. Join high-silicon-iron, mechanical-joint piping with coupled joints using clamps and sleeves.
   g. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.
2. Chemical-Waste Piping Inside the Building:
   a. Plastic-Piping Electrofusion Joints: Make polyolefin drainage-piping joints according to ASTM F 1290.
   b. Fiberglass-Piping Joints: Make joints with piping manufacturer's bonded adhesive.
   c. Dissimilar-Material Piping Joints: Make joints using adapters compatible with both system materials.
   d. Join high-silicon-iron, hub-and-plain-end piping with calked joints using acid-resistant packing and lead.
   e. Join high-silicon-iron, mechanical-joint piping with coupled joints using clamps and sleeves.
   f. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

F. Hanger And Support Installation
1. Pipe sizes in this article refer to aboveground, single-wall piping and carrier piping of containment piping, **as directed**.
2. Comply with requirements in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment" for seismic-restraint devices.
3. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for pipe hanger and support devices. Install the following:
   a. Vertical Piping: MSS Type 8 or MSS Type 42, riser clamps.
   b. Individual, Straight, Horizontal Piping Runs:
      1) 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
      2) Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
      3) Longer Than 100 Feet (30 m), if Indicated: MSS Type 49, spring cushion rolls.
   c. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   d. Base of Vertical Piping: MSS Type 52, spring hangers.
4. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for installation of supports.
5. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting and coupling.
6. Support vertical piping and tubing at base and at each floor.
7. Rod diameter may be reduced 1 size for double-rod hangers, to minimum of 3/8 inch (10 mm).
8. Install vinyl-coated hangers for PP piping with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 2 (DN 50): 33 inches (840 mm) with 3/8-inch (10-mm) rod.
   b. NPS 2-1/2 and NPS 3 (DN 65 and DN 80): 42 inches (1067 mm) with 1/2-inch (13-mm) rod.

c. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1220 mm) with 5/8-inch (16-mm) rod.
d. NPS 6 (DN 150): 48 inches (1220 mm) with 3/4-inch (19-mm) rod.
e. NPS 8 (DN 200): 48 inches (1220 mm) with 7/8-inch (22-mm) rod.

9. Install supports for vertical PP piping every 72 inches (1830 mm).
10. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 1-1/4 (DN 32): 36 inches (910 mm) with 3/8-inch (10-mm) rod.
    b. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 42 inches (1067 mm) with 3/8-inch (10-mm) rod.
    c. NPS 2-1/2 and NPS 3 (DN 65 and DN 80): 42 inches (1067 mm) with 1/2-inch (13-mm) rod.
    d. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1220 mm) with 5/8-inch (16-mm) rod.
    e. NPS 6 (DN 150): 48 inches (1220 mm) with 3/4-inch (19-mm) rod.
    f. NPS 8 to NPS 12 (DN 200 to DN 300): 48 inches (1220 mm) with 7/8-inch (22-mm) rod.
11. Install supports for vertical PVC piping every 48 inches (1220 mm).
12. Install vinyl-coated hangers for PVDF piping with the following maximum horizontal spacing and minimum rod diameters:
    a. All Sizes: Install continuous support for piping with liquid waste at temperatures above 140 deg F (60 deg C).
    b. NPS 1/2 (DN 15) and Smaller: 30 inches (760 mm) with 3/8-inch (10-mm) rod.
    c. NPS 3/4 to NPS 1-1/2 (DN 20 to DN 40): 36 inches (910 mm) with 3/8-inch (10-mm) rod.
    d. NPS 2 (DN 50): 36 inches (910 mm) with 3/8-inch (10-mm) rod.
    e. NPS 2-1/2 and NPS 3 (DN 65 and DN 80): 42 inches (1067 mm) with 1/2-inch (13-mm) rod.
    f. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1220 mm) with 5/8-inch (16-mm) rod.
    g. NPS 6 (DN 150): 48 inches (1220 mm) with 3/4-inch (19-mm) rod.
13. Install supports for vertical PVDF piping NPS 1-1/2 (DN 40) every 48 inches (1220 mm) and NPS 2 (DN 50) and larger every 72 inches (1830 mm).
14. Install vinyl-coated hangers for fiberglass piping with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 2 (DN 50) and Smaller: 10 feet (3 m) with 3/8-inch (10-mm) rod.
    b. NPS 2-1/2 and NPS 3 (DN 65 and DN 80): 10 feet (3 m) with 1/2-inch (13-mm) rod.
    c. NPS 4 and NPS 5 (DN 100 and DN 125): 10 feet (3 m) with 5/8-inch (16-mm) rod.
    d. NPS 6 (DN 150): 10 feet (3 m) with 3/4-inch (19-mm) rod.
    e. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet (3.6 m) with 7/8-inch (22-mm) rod.
15. Install supports for vertical fiberglass piping every 12 feet (3.6 m).
16. Install hangers for stainless-steel drainage piping with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
    b. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
    c. NPS 3 (DN 80): 12 feet (3.6 m) with 1/2-inch (13-mm) rod.
    d. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.6 m) with 5/8-inch (16-mm) rod.
    e. NPS 6 (DN 150): 12 feet (3.6 m) with 3/4-inch (19-mm) rod.
17. Install supports for vertical stainless-steel drainage piping every 15 feet (4.5 m).
18. Install hangers for high-silicon-iron piping with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1520 mm) with 3/8-inch (10-mm) rod.
    b. NPS 3 (DN 80): 60 inches (1520 mm) with 1/2-inch (13-mm) rod.
    c. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1520 mm) with 5/8-inch (16-mm) rod.
    d. NPS 6 (DN 150): 60 inches (1520 mm) with 3/4-inch (19-mm) rod.
    e. NPS 8 to NPS 12 (DN 200 to DN 300): 60 inches (1520 mm) with 7/8-inch (22-mm) rod.
    f. NPS 15 (DN 375): 60 inches (1520 mm) with 1-inch (25-mm) rod.
    g. Spacing for horizontal pipe in 84-inch (2134-mm) lengths may be increased to 84 inches (2134 mm). Spacing for fittings is limited to 60 inches (1520 mm).

19. Install supports for vertical high-silicon-iron piping every 15 feet (4.5 m).
20. Install vinyl-coated hangers for glass piping with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1830 mm) with 3/8-inch (10-mm) rod.
    b. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2440 mm) with 3/8-inch (10-mm) rod.
    c. NPS 3 (DN 80): 96 inches (2440 mm) with 1/2-inch (13-mm) rod.
    d. NPS 4 and NPS 6 (DN 100 and DN 150): 96 inches (2440 mm) with 5/8-inch (16-mm) rod.
21. Install supports for vertical glass piping every 96 inches (2440 mm).
22. Support piping and tubing not listed above according to MSS SP-69.

G. Neutralization Tank Installation
1. Install exterior collection **OR** neutralization, **as directed**, tanks, complete with appurtenances indicated.
    a. Set tops of tank covers flush with finished surface where covers occur in pavements. Set covers 3 inches (76 mm) above finished surface elsewhere unless otherwise indicated.
    b. Include initial fill of limestone for neutralization tanks.
2. Install interior neutralization tanks on smooth and level concrete base **OR** floor surface, **as directed**. Include full initial charge of limestone.

H. Neutralization System Installation
1. Install neutralization systems on smooth and level concrete base **OR** floor surface, **as directed**. Include neutralizing solutions and full initial charge of limestone.

I. Manhole Installation
1. General: Install manholes, complete with appurtenances and accessories indicated. Comply with requirements in Division 22 Section "Facility Sanitary Sewers".
2. Set tops of manhole frames and covers flush with finished surface where manholes occur in pavements. Set tops 3 inches (76 mm) above finished surface elsewhere unless otherwise indicated.

J. Leak-Detection System Installation
1. Single-Pipe, Chemical-Waste Sewerage Piping: Install leak-detection system below piping.
2. Double-Containment Piping: Install leak-detection system in piping annular space.
3. Manholes: Install leak-detection system around bottom of exterior.
4. Install panel in location indicated.

K. Concrete Placement
1. Comply with requirements in Division 03 Section "Cast-in-place Concrete" for concrete supports.
2. Place cast-in-place concrete according to ACI 318/318R.

L. Connections
1. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Make connections to existing piping so finished Work complies as nearly as practical with requirements specified for new Work.
3. Use commercially manufactured wye fittings for sewerage piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting plus 6-inch (150-mm) overlap, with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
4. Protect existing piping to prevent concrete or debris from entering while making connections. Remove debris or other extraneous material that may accumulate.
5. Install piping adjacent to equipment to allow service and maintenance.

M. Labeling And Identification
1. Comply with requirements in Division 22 Section "Identification For Plumbing Piping And Equipment" for labeling of equipment and piping.
a. Use warning tape **OR** detectable warning tape, **as directed**, over ferrous piping.
b. Use detectable warning tape over nonferrous piping and over edges of underground structures.

N. Field Quality Control
1. Inspect interior of sewerage piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (610 mm) of backfill is in place and again at completion of Project.
a. Defects requiring correction include the following:
1) Alignment: Less than full diameter of inside of pipe is visible between inspection points.
2) Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
3) Crushed, broken, cracked, or otherwise damaged piping.
4) Hydrostatic Tests for Drainage Piping:
a) Allowable leakage is a maximum of 50 gal./inch of nominal pipe size per mile (4.6 L/mm of nominal pipe size per kilometer) of pipe, during 24-hour period.
b) Close openings in system and fill with water.
c) Purge air and refill with water.
d) Disconnect water supply.
e) Test and inspect joints for leaks.
5) Air Tests for Drainage Piping: Comply with UNI-B-6.
b. Leaks and loss in test pressure constitute defects that must be repaired.
c. Submit separate reports for each test.
2. Replace leaking sewerage piping using new materials, and repeat testing until leakage is within allowances specified.
3. Perform tests and inspections.
a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
4. Tests and Inspections:
a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect assembled neutralization systems and leak-detection systems and their installation, including piping and electrical connections, and to assist in testing.
b. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Chemical-waste piping will be considered defective if it does not pass tests and inspections.
6. Prepare test and inspection reports.

O. Startup Service
1. Perform startup service for neutralization systems and leak-detection systems.
a. Complete installation and startup checks according to manufacturer's written instructions.
b. Neutralization Systems:
1) Verify that neutralization system is installed and connected according to the Contract Documents.
2) Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 22.
3) Install neutralizing solutions and limestone.
4) Energize circuits.
5) Start and run systems through complete sequence of operations.

6) Adjust operating controls.

c. Leak-Detection Systems:

1) Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 22.
2) Energize circuits.
3) Adjust operating controls.

P. Adjusting

1. Adjust neutralization-system set points.
2. Adjust leak-detection-system control and device settings.

Q. Cleaning

1. Use procedures prescribed by authorities having jurisdiction or, if not prescribed, use procedures described below:
   a. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   b. Clean piping by flushing with potable water.

R. Demonstration

1. Train the Owner's maintenance personnel to adjust, operate, and maintain neutralization systems and leak-detection systems.

S. Piping Schedule

1. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below unless otherwise indicated.
2. Single-Wall, Chemical-Waste Sewerage Piping: Use any of the following piping materials for each size range:
   a. NPS 2 to NPS 4 (DN 50 to DN 100): High-silicon-iron, hub-and-plain-end pipe and fittings and calked **OR** High-silicon-iron, mechanical-joint pipe and fittings and coupled, **as directed**, joints.
   b. NPS 2 to NPS 4 (DN 50 to DN 100): Stainless-steel drainage pipe and fittings and gasketed joints.
   c. NPS 1-1/2 to NPS 4 (DN 40 to DN 100): PE drainage pipe and fittings and heat-fusion joints.
   d. NPS 1-1/2 to NPS 4 (DN 40 to DN 100): PP drainage pipe and fittings and electrofusion joints.
   e. NPS 1-1/2 to NPS 4 (DN 40 to DN 100): PVC drainage pipe and fittings and solvent-cemented joints.
   f. NPS 1-1/2 to NPS 4 (DN 40 to DN 100): PVDF drainage pipe and fittings and electrofusion joints.
   g. NPS 2 to NPS 4 (DN 50 to DN 100): Centrifugally cast **OR** Filament-wound, **as directed**, fiberglass pipe and fittings and butt-and-wrap **OR** bonded, **as directed**, joints.
   h. NPS 1-1/2 to NPS 4 (DN 40 to DN 100): Glass pipe and fittings and coupled joints.
   i. NPS 6 (DN 150): High-silicon-iron, hub-and-plain-end pipe and fittings and calked **OR** High-silicon-iron, mechanical-joint pipe and fittings and coupled, **as directed**, joints.
   j. NPS 6 (DN 150): Stainless-steel drainage pipe and fittings and gasketed joints.
   k. NPS 6 (DN 150): PE drainage pipe and fittings and heat-fusion joints.
   l. NPS 6 (DN 150): PP drainage pipe and fittings and electrofusion joints.
   m. NPS 6 (DN 150): PVC drainage pipe and fittings and solvent-cemented joints.
   n. NPS 6 (DN 150): PVDF drainage pipe and fittings and electrofusion joints.
   o. NPS 6 (DN 150): Centrifugally cast **OR** Filament-wound, **as directed**, fiberglass pipe and fittings and butt-and-wrap **OR** bonded, **as directed**, joints.
   p. NPS 6 (DN 150): Glass pipe and fittings and coupled joints.

q. NPS 8 to NPS 12 (DN 200 to DN 300): High-silicon-iron, hub-and-plain-end pipe and fittings and calked joints.
r. NPS 8 to NPS 12 (DN 200 to DN 300): PP drainage pipe and fittings and electrofusion joints.
s. NPS 8 to NPS 12 (DN 200 to DN 300): PVC drainage pipe and fittings and solvent-cemented joints.
t. NPS 8 to NPS 12 (DN 200 to DN 300): PVDF drainage pipe and fittings and electrofusion joints.
u. NPS 8 to NPS 12 (DN 200 to DN 300): Centrifugally cast **OR** Filament-wound, **as directed**, fiberglass pipe and fittings and butt-and-wrap **OR** bonded, **as directed**, joints.
v. NPS 15 (DN 375): High-silicon-iron, hub-and-plain-end pipe and fittings and calked joints.
w. NPS 15 (DN 375): NPS 16 (DN 400) centrifugally cast **OR** NPS 14 (DN 350) filament-wound, **as directed**, fiberglass pipe and fittings and butt-and-wrap **OR** bonded, **as directed**, joints.

3. Underground, Double-Containment, Chemical-Waste Sewerage Piping: Use any of the following piping materials for each size range:
a. NPS 2 to NPS 12 (DN 50 to DN 300): PE double-containment drainage pipe and fittings.
b. NPS 2 to NPS 12 (DN 50 to DN 300): PP double-containment drainage pipe and fittings.
c. NPS 2 to NPS 12 (DN 50 to DN 300): PP/PVC double-containment drainage pipe and fittings.
d. NPS 2 to NPS 12 (DN 50 to DN 300): PVDF double-containment drainage pipe and fittings.
e. NPS 2 to NPS 12 (DN 50 to DN 300): PVDF/PVC double-containment drainage pipe and fittings.

4. Aboveground Chemical-Waste Piping: Use any of the following piping materials for each size range:
a. NPS 1-1/2 to NPS 6 (DN 40 to DN 150): PP drainage piping and electrofusion **OR** mechanical, **as directed**, joints.
b. NPS 1-1/2 to NPS 6 (DN 40 to DN 150): PVC drainage piping and solvent-cemented joints.
c. NPS 1-1/2 to NPS 6 (DN 40 to DN 150): PVDF drainage piping and electrofusion **OR** mechanical, **as directed**, joints.
d. NPS 1-1/2 to NPS 6 (DN 40 to DN 150): NPS 2 to NPS 6 (DN 50 to DN 150) high-silicon-iron piping with hub-and-plain ends and calked joints.
e. NPS 1-1/2 to NPS 4 (DN 40 to DN 100): High-silicon-iron piping with mechanical-joint ends, mechanical couplings, and coupled joints.
f. NPS 1-1/2 to NPS 6 (DN 40 to DN 150): NPS 2 to NPS 4 (DN 50 to DN 100) stainless-steel drainage piping with socket-and-spigot ends and gasketed joints.
g. NPS 1-1/2 to NPS 6 (DN 40 to DN 150): Borosilicate glass pipe and fittings, couplings, and coupled joints.
h. NPS 8 to NPS 12 (DN 200 to DN 300): PVC drainage pipe and fittings and solvent-cemented joints.
i. NPS 8 to NPS 12 (DN 200 to DN 300): High-silicon-iron piping with hub-and-plain ends and calked joints.

5. Under Slab-on-Grade, Indoor, Chemical-Waste Piping: Use any of the following piping materials for each size range:
a. NPS 1-1/2 to NPS 6 (DN 40 to DN 150): PP drainage piping and electrofusion joints.
b. NPS 1-1/2 to NPS 6 (DN 40 to DN 150): PVC drainage piping and solvent-cemented joints.
c. NPS 1-1/2 to NPS 6 (DN 40 to DN 150): PVDF drainage piping and electrofusion joints.
d. NPS 1-1/2 to NPS 6 (DN 40 to DN 150): NPS 2 to NPS 4 (DN 50 to DN 100) high-silicon-iron piping with hub-and-plain ends and calked joints.
e. NPS 1-1/2 to NPS 6 (DN 40 to DN 150): NPS 2 to NPS 4 (DN 50 to DN 100) stainless-steel drainage piping with socket-and-spigot ends and gasketed joints.

f. NPS 1-1/2 to NPS 6 (DN 40 to DN 150): Borosilicate glass piping with covering, couplings, and coupled joints.
g. NPS 1-1/2 to NPS 6 (DN 40 to DN 150): PE **OR** PP **OR** PP/PVC **OR** PVDF **OR** PVDF/PVC, **as directed**, double-containment drainage piping and manufacturer's standard joints.
h. NPS 8 (DN 200): PVC drainage piping and solvent-cemented joints.
i. NPS 8 (DN 200): High-silicon-iron piping with hub-and-plain ends and calked joints.
j. NPS 8 (DN 200): PE **OR** PP **OR** PP/PVC **OR** PVDF **OR** PVDF/PVC, **as directed**, double-containment drainage piping and manufacturer's standard joints.
k. NPS 10 and NPS 12 (DN 250 and DN 300): PVC drainage piping and solvent-cemented joints.
l. NPS 10 to NPS 15 (DN 250 to DN 375): High-silicon-iron piping with hub-and-plain ends and calked joints.

END OF SECTION 22 66 83 16

Task	Specification	Specification Description
22 67 13 53	07 63 00 00	Common Work Results for Fire Suppression
22 67 13 53	07 63 00 00a	Common Work Results for Plumbing
22 67 13 53	07 63 00 00b	Common Work Results for HVAC
22 67 13 53	22 11 16 00a	Sanitary Waste And Vent Piping

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SECTION 23 01 10 91 - SEQUENCE OF OPERATION

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for sequence of operation. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes control sequences for HVAC systems, subsystems, and equipment.

C. Definitions
   1. DDC: Direct digital control.
   2. VAV: Variable air volume.

D. Heating Control Sequences
   1. Heating-Water Supply Temperature Control:
      a. Input Device: Thermostat **OR** Thermistor temperature sensor **OR** Resistance temperature sensor, **as directed**.
      b. Output Device: Control valve.
      c. Action: Modulate control valve to maintain heating-water supply temperature.
      d. Display:
         1) Heating-water supply temperature.
         2) Heating-water supply temperature set point.
         3) Control-valve position.
   2. Heating-Water Supply Temperature Reset:
      a. Input Device: Electric, outdoor-air-reset controller **OR** Outdoor-air sensor, **as directed**.
      b. Output Device: Unitary controller **OR** DDC system software, **as directed**.
      c. Action: Reset heating-water supply temperature in straight-line relationship with outdoor-air temperature for the following conditions:
         1) 195 deg F (90 deg C) heating water when outdoor-air temperature is minus 30 deg F (minus 35 deg C).
         2) 130 deg F (54 deg C) heating water when outdoor-air temperature is 75 deg F (24 deg C).
         3) 150 deg F (65 deg C) minimum, heating-water temperature.
      d. Display:
         1) Outdoor-air temperature.
         2) Heating-water supply temperature.
         3) Heating-water supply temperature set point.
   3. Control Primary Circulating Pump(s):
      a. Input Device: Thermostat **OR** DDC system, **as directed**.
      b. Output Device: Starter **OR** DDC system command to starter, **as directed**, relay.
      c. Action: Energize pump(s) at outdoor-air temperatures below 65 deg F (18 deg C).
      d. Display:
         1) Outdoor-air temperature.
         2) Operating status of primary circulating pump(s).

E. Central Refrigeration Equipment Sequences
   1. Start and Stop Condenser-Water Pump(s):
      a. Enable: Allow pump to start when water is in cooling tower:
         1) Input Device: Water pressure transducer.

2) Output Device: Hard wired through motor starter; DDC system binary output, **as directed**.
3) Action: Confirm water in cooling-tower sump.

b. Enable: When outdoor-air temperature conditions are met:
1) Input Device: Space thermostat **OR** DDC system outdoor-air temperature, **as directed**.
2) Output Device: Hard wired through motor starter; DDC system binary output, **as directed**.
3) Action: Confirm outdoor-air temperature is above 50 deg F (10 deg C).

c. Enable: When demand conditions are met:
1) Input Device: DDC system software demand.
2) Action: Confirm cooling demand from ventilation system(s).

d. Initiate:
1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
2) Output Device: Time clock **OR** Binary output, **as directed**.
3) Action: Energize pump(s).

e. Display:
1) Low-level cooling-tower sump alarm.
2) Outdoor-air temperature.
3) Cooling (software) demand indication.
4) Time and time schedule.
5) Condenser-water pump(s) on-off status.
6) Condenser-water pump(s) on-off indication.

2. Start and Stop Chilled-Water Pump(s):
a. Input Device: Flow switch in condenser-water circuit.
b. Output Device: Starter **OR** DDC system command to starter, **as directed**, relay.
c. Action: Energize pump(s).
d. Display:
1) Chilled-water flow indication.
2) Chilled-water pump(s) on-off status.
3) Chilled-water pump(s) on-off indication.

3. Start and Stop Cooling-Tower Fans(s):
a. Input Device: Flow switch in condenser-water circuit.
b. Output Device: Starter **OR** DDC system command to starter, **as directed**, relay.
c. Action: Energize fan(s).
d. Display:
1) Condenser-water flow indication.
2) Cooling-tower fan(s) on-off indication.

4. Start and Stop Refrigeration Machine(s):
a. Input Device: Flow switch in condenser-water circuit. Flow switch in chilled-water circuit, **as directed**.
b. Output Device: Refrigeration **OR** DDC system command to refrigeration, **as directed**, machine terminal strip.
c. Action: Energize refrigeration machine(s) internal control circuit.
d. Display:

e. Condenser-water flow indication.
f. Chilled-water flow indication.
g. Refrigeration machine on-off indication.
h. Chilled-water supply and return temperature.
i. Chilled-water temperature control-point adjustment.

5. Start and Stop Chiller(s):
a. Input Device: Flow switches in condenser-water and chilled-water circuit.
b. Output Device: Chiller **OR** DDC system command to chiller, **as directed**, terminal strip.
c. Action: Energize chiller internal control circuit.

d. Display:
    1) Condenser-water flow indication.
    2) Chilled-water flow indication.
    3) Chiller(s) on-off status.
    4) Chiller(s) on-off indication.
    5) Chilled-water supply and return temperature.
    6) Chilled-water temperature control-point adjustment.

6. Alternate Chiller(s):
    a. Input Device: Electric alternator **OR** DDC system software, **as directed**.
    b. Output Device: Chiller **OR** DDC system command to chiller, **as directed**, terminal strip.
    c. Action: Operate chiller(s) on lead-lag, alternating each startup.
    OR
    Action: Adding and dropping chiller(s) as follows: <**Insert sequence and parameters**.>
    d. Display: Chiller(s) on-off indication.
7. Alarm Chiller(s) Start Failure:
    a. Input Device: Chiller control panel terminal strip contact **OR** software signal, **as directed**.
    b. Output Device: Analog control panel **OR** DDC system alarm, **as directed**.
    c. Action: Signal alarm.
    d. Display: Chiller "failure-to-start" indication.
8. Chilled-Water Level:
    a. Input Device: Expansion tank level switch **OR** liquid sensor, **as directed**.
    b. Output Device: Electric relay signal to alarm panel **OR** DDC system alarm, **as directed**.
    c. Action: Signal alarm.
    d. Display: Expansion tank low-level alarm.
9. Chilled-Water Supply Temperature:
    a. Input Device: Temperature sensor **OR** transmitter, **as directed**, in common chilled-water supply piping.
    b. Output Device: Integral chiller controls **OR** DDC system signal to chiller control panel, **as directed**.
    c. Action: Maintain constant leaving chilled-water temperature reset according to highest cooling demand, **as directed**.
        1) Display: Chilled-water supply temperature.
10. Condenser-Water Temperature:
    a. Input Device: Temperature sensor **OR** transmitter, **as directed**, in cooling-tower sump.
    b. Output Device: Bypass control valve **OR** Cooling-tower fan starter relay **OR** DDC system command to cooling-tower fan starter relay, **as directed**.
    c. Action: Modulate control valve open to cooling tower and closed to bypass and cycle tower fan(s) on and off **OR** and to low speed and then to high speed, **as directed**, to maintain 65 deg F (18 deg C) **OR** 70 deg F (21 deg C), **as directed**, sump temperature. Close valve when unoccupied, **as directed**.
    d. Display:
        1) Condenser-water sump (return) control-point temperature.
        2) Condenser-water sump (return) temperature.
        3) Control-valve position.
        4) Cooling-tower fan(s) on-off indication.
        5) Condenser-water supply temperature.
11. Cooling-Tower Sump Heater:
    a. Input Device: Sump temperature sensor **OR** transmitter, **as directed**.
    b. Output Device: Electric relay **OR** DDC system command to electric relay, as directed, and solenoid valve, **as directed**.
    c. Action: Energize sump heater; drain sump on low temperature, **as directed**.
    d. Display:
        1) Cooling-tower sump temperature.
        2) Cooling-tower sump heater on-off indication.
        3) Cooling-tower dump indication.
12. Operator Station Display: Indicate the following on operator workstation display terminal:

a. DDC system graphic.
b. DDC system status, on-off.
c. Low-level cooling-tower sump alarm.
d. Outdoor-air temperature.
e. Cooling (software) demand indication.
f. Time and time schedule.
g. Condenser-water pump(s) on-off status.
h. Condenser-water pump(s) on-off indication.
i. Condenser-water flow indication.
j. Chilled-water pump(s) on-off status.
k. Chilled-water pump(s) on-off indication.
l. Cooling-tower fan(s) on-off indication.
m. Chilled-water flow indication.
n. Refrigeration machine on-off indication.
o. Chilled-water supply temperature.
p. Chilled-water return temperature.
q. Chilled-water temperature control-point adjustment.
r. Chiller(s) on-off status.
s. Chiller(s) on-off indication.
t. Chiller "failure-to-start" indication.
u. Expansion tank low-level alarm.
v. Condenser-water sump (return) control-point temperature.
w. Condenser-water sump (return) temperature.
x. Condenser-water control-valve position.
y. Cooling-tower fan(s) on-off indication.
z. Condenser-water supply temperature.
aa. Cooling-tower sump temperature.
bb. Cooling-tower sump heater on-off indication.
cc. Cooling-tower dump indication.
dd. Chilled-water pressure drop through chiller.
ee. Entering condenser-water temperature.
ff. Leaving condenser-water temperature.
gg. Condenser-water pressure drop through chiller.
hh. Chiller condenser-water supply and return temperature.
ii. Chiller chilled-water supply and return temperature.
jj. System capacity in tons.

F. Air-Handling-Unit Control Sequences
1. Start and Stop Supply Fan(s):
a. Enable: Freeze Protection:
1) Input Device: Duct-mounted averaging element thermostat, located before supply fan.
2) Output Device: Hard wired through motor starter; analog alarm panel **OR** DDC system alarm, **as directed**.
3) Action: Allow start if duct temperature is above 37 deg F (3 deg C); signal alarm if fan fails to start as commanded.
b. Enable: High-Temperature Protection:
1) Input Device: Duct-mounted thermostat, located in return air.
2) Output Device: Hard wired through motor starter; analog alarm panel **OR** DDC system alarm, **as directed**.
3) Action: Allow start if duct temperature is below 300 deg F (150 deg C).
c. Enable: Smoke Control:
1) Input Device: Duct-mounted smoke detector, located in return **OR** supply, **as directed**, air.

2) Output Device: Hard wired through motor starter; analog alarm panel **OR** DDC system alarm, **as directed**.
3) Action: Allow start if duct is free of products of combustion.

d. Initiate: Occupied Time Schedule:
1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
2) Output Device: Time clock **OR** Binary output, **as directed**, to motor starter.
3) Action: Energize fan(s).

e. Initiate: Unoccupied Time Schedule:
1) Input Device: Room thermostat **OR** DDC system demand, **as directed**.
2) Output Device: Room thermostat **OR** Binary output, **as directed**, to motor starter.
3) Action: Energize fan(s).

f. Unoccupied Ventilation:
1) Input Device: Time clock and room thermostat **OR** DDC system time schedule and output, **as directed**.
2) Output Device: Room thermostat **OR** DDC system binary output, **as directed**, to motor starter.
3) Action: Cycle fan(s) during unoccupied periods.

g. Display: Supply-fan on-off indication.

2. Supply Fan(s) Variable-Volume Control:

a. Occupied Time Schedule:
1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
2) Output Device: Time clock **OR** Binary output, **as directed**.
3) Action: Enable control.

b. Volume Control (for fans equipped with variable inlet vanes):
1) Input Device: Static-pressure transmitter **OR** Differential-pressure switch, **as directed**, sensing supply-duct static pressure referenced to conditioned-space static pressure.
2) Output Device: Receiver controller **OR** DDC system analog output **OR** DDC system analog output to digital-to-pneumatic transducer, **as directed**, to modulating damper actuator. Set inlet guide vanes to minimum **OR** closed, **as directed**, position when fan is stopped.
3) Action: Maintain constant supply-duct static pressure.

c. Volume Control (for fans equipped with variable-speed drives):
1) Input Device: Static-pressure transmitter **OR** Differential-pressure switch, **as directed**, sensing supply-duct static pressure referenced to conditioned-space static pressure.
2) Output Device: Receiver controller **OR** DDC system analog output, **as directed**, to motor speed controller. Set variable-speed drive to minimum speed when fan is stopped.
3) Action: Maintain constant supply-duct static pressure.

d. High Pressure:
1) Input Device: Static-pressure transmitter sensing supply-duct static pressure referenced to static pressure outside the duct.
2) Output Device: Receiver controller **OR** DDC system binary output, **as directed**, to alarm panel **OR** motor starter, **as directed**.
3) Action: Stop fan and signal alarm when static pressure rises above excessive-static-pressure set point.

e. Display:
1) Supply-fan-discharge static-pressure indication.
2) Supply-fan-discharge static-pressure set point.
3) Supply-fan airflow rate.
4) Supply-fan inlet vane position **OR** speed, **as directed**.

3. Start and Stop Return Fan(s):

a. Initiate: Occupied Time Schedule:
1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
2) Output Device: Time clock **OR** Binary output, **as directed**, to motor starter.

3) Action: Energize fans when supply fans are energized.

b. Initiate: Unoccupied Time Schedule:
   1) Input Device: Room thermostat **OR** DDC system demand, **as directed**.
   2) Output Device: Room thermostat **OR** Binary output, **as directed**, to motor starter.
   3) Action: Energize fans when supply fans are energized.
c. Unoccupied Ventilation:
   1) Input Device: Time clock and room thermostat **OR** DDC system time schedule and output, **as directed**.
   2) Output Device: Room thermostat **OR** DDC system binary output, **as directed**, to motor starter.
   3) Action: Cycle fan(s) during unoccupied periods.
d. Display: Return-fan on-off indication.

4. Return Fan(s) Variable-Volume Control:
   a. Occupied Time Schedule:
      1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
      2) Output Device: Time clock **OR** Binary output, **as directed**.
      3) Action: Enable control.
   b. Volume Control (for fans equipped with variable inlet vanes):
      1) Input Device: Static-pressure transmitter **OR** Differential-pressure switch, **as directed**, sensing building static pressure referenced to outdoor static pressure.
      2) Output Device: Receiver controller **OR** DDC system analog output **OR** DDC system analog output to digital-to-pneumatic transducer, **as directed**, to modulating damper actuator. Set inlet guide vanes to minimum **OR** closed, **as directed**, position when fan is stopped.
      3) Action: Maintain constant building static pressure.
   c. Volume Control (for fans equipped with variable-speed drives):
      1) Input Device: Static-pressure transmitter **OR** Differential-pressure switch, **as directed**, sensing building static pressure referenced to outdoor static pressure.
      2) Output Device: Receiver controller **OR** DDC system analog output, **as directed**, to motor speed controller. Set variable-speed drive to minimum speed when fan is stopped.
      3) Action: Maintain constant building static pressure.
   d. Display:
      1) Return-air static-pressure indication.
      2) Return-air static-pressure set point.
      3) Return-fan airflow rate.
      4) Return-fan inlet vane position **OR** speed, **as directed**.
      5) Building static-pressure indication.
      6) Building static-pressure set point.

5. Return Fan(s) Variable-Volume Control:
   a. Occupied Time Schedule:
      1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
      2) Output Device: Time clock **OR** Binary output, **as directed**.
      3) Action: Enable control.
   b. Volume Control (for fans equipped with variable inlet vanes):
      1) Input Device: Static-pressure transmitter **OR** Differential-pressure switch, **as directed**, sensing building static pressure referenced to outdoor static pressure.
      2) Output Device: Receiver controller **OR** DDC system analog output **OR** DDC system analog output to digital-to-pneumatic transducer, **as directed**, to modulating damper actuator. Set inlet guide vanes to minimum **OR** closed, **as directed**, position when fan is stopped.
      3) Action: Maintain constant building static pressure.
   c. Volume Control (for fans equipped with variable-speed drives):
      1) Input Device: Static-pressure transmitter **OR** Differential-pressure switch, **as directed**, sensing building static pressure referenced to outdoor static pressure.

2) Output Device: Receiver controller **OR** DDC system analog output, **as directed**, to motor speed controller. Set variable-speed drive to minimum speed when fan is stopped.
3) Action: Maintain constant building static pressure.

d. Display:
1) Return-fan-discharge static-pressure indication.
2) Return-fan-discharge static-pressure set point.
3) Return-fan airflow rate.
4) Return-fan inlet vane position **OR** speed, **as directed**.

6. Preheat Coil:

a. Freeze Protection:
1) Input Device: Duct-mounted averaging element thermostat, located after preheat coil.
2) Output Device: Hard wired through motor starter; analog alarm panel **OR** DDC system alarm, **as directed**.
3) Action: Allow start if duct temperature is above 33 deg F (1 deg C).

b. Occupied Time Schedule:
1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
2) Output Device: Time clock **OR** Binary output, **as directed**, to motor starter.
3) Action: Energize coil circulating pump(s).

c. Supply **OR** Discharge, **as directed**,-Air Temperature:
1) Input Device: Time clock and duct-mounted thermostat **OR** DDC system time schedule and electronic temperature sensor, **as directed**.
2) Output Device: Modulating control valve.
3) Action: Maintain air temperature set point of 55 deg F (13 deg C).

d. Unoccupied Time Schedule:
1) Input Device: Time clock and duct-mounted thermostat mounted in outdoor air **OR** DDC system time schedule and outdoor-air temperature, **as directed**.
2) Output Device: Time clock **OR** Binary output, **as directed**, to motor starter.
3) Action: Energize coil circulating pump(s) when outdoor-air temperature falls below 35 deg F (2 deg C).

e. Display:
1) Preheat-coil air-temperature indication.
2) Preheat-coil air-temperature set point.
3) Preheat-coil pump operation indication.
4) Preheat-coil control-valve position.

7. Mixed-Air Control:

a. Occupied Time Schedule:
1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
2) Output Device: Pneumatic relay **OR** DDC system output, **as directed**.
3) Action: Enable control.

b. Minimum Position:
1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
2) Output Device: Receiver controller **OR** DDC system analog output **OR** DDC system analog output to digital-to-pneumatic transducer, **as directed**, to modulating damper actuator(s).
3) Action: Open minimum outdoor-air dampers **OR** outdoor-air dampers to minimum position, **as directed**.

c. Heating Reset:
1) Input Device: Room thermostat **OR** DDC system software, **as directed**.
2) Output Device: Receiver controller **OR** DDC system analog output **OR** DDC system analog output to digital-to-pneumatic transducer, **as directed**, to modulating damper actuator(s).
3) Action: Close minimum outdoor-air dampers **OR** Set outdoor-air dampers to minimum position, **as directed**.

d. Supply **OR** Mixed, **as directed**,-Air Temperature:

1) Input Device: Duct-mounted thermostat **OR** Electronic temperature sensor, **as directed**.
2) Output Device: Receiver controller **OR** DDC system analog output **OR** DDC system analog output to digital-to-pneumatic transducer, **as directed**, to modulating damper actuator(s).
3) Action: Modulate outdoor-, return-, and relief-air dampers to maintain air temperature set point of 55 deg F (13 deg C).

e. Cooling Reset:
1) Input Device: Outdoor- and return-air, duct-mounted thermostats **OR** electronic temperature sensors, **as directed**.
2) Output Device: Receiver controller **OR** DDC system analog output **OR** DDC system analog output to digital-to-pneumatic transducer, **as directed**, to damper actuator(s).
3) Action: Set outdoor-air dampers to minimum position when outdoor-air temperature exceeds return-air temperature **OR** enthalpy exceeds return-air enthalpy, **as directed**.

f. Unoccupied Time Schedule:
1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
2) Output Device: Receiver controller **OR** DDC system analog output **OR** DDC system analog output to digital-to-pneumatic transducer, **as directed**, to modulating damper actuator(s).
3) Action: Position outdoor- and relief-air dampers closed and return-air dampers open.

g. Display:
1) Mixed-air-temperature indication.
2) Mixed-air-temperature set point.
3) Mixed-air damper position.

8. Humidifier:
a. Occupied Time Schedule:
1) Input Device: Time clock **OR** DDC system time schedule, **as directed**, and airflow switch
2) Output Device: Pneumatic relay **OR** DDC system output, **as directed**.
3) Action: Enable control.

b. Humidity:
1) Input Device: Room humidistat **OR** Return-air, duct-mounted humidistat **OR** DDC system, **as directed**.
2) Output Device: Receiver controller **OR** DDC system analog output **OR** DDC system analog output to digital-to-pneumatic transducer, **as directed**, enables humidifier **OR** modulates control valve to maintain humidity **OR** cycles pump to maintain humidity **OR** cycles pump and modulates control valve to maintain humidity, **as directed**, in straight-line relationship for the following conditions:
a) 20 percent when outdoor-air temperature is minus 30 deg F (minus 35 deg C).
b) 40 percent when outdoor-air temperature is 75 deg F (24 deg C).
3) Action: Modulate outdoor-, return-, and relief-air dampers to maintain air temperature set point of 55 deg F (13 deg C).

c. Display:
1) Relative humidity indication.
2) Relative humidity set point.
3) Relative humidity control-valve position.

9. Filters: During occupied periods, when fan is running, differential air-pressure transmitters exist.
a. Occupied Time Schedule:
1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
2) Output Device: Electric relay **OR** DDC system output, **as directed**.
3) Action: Enable control.

b. Differential Pressure:

1) Input Device: Differential-pressure switches **OR** Pressure transmitter, **as directed**.
2) Output Device: Analog alarm panel **OR** DDC system alarm, **as directed**.
3) Action: Signal alarm on low- and high-pressure conditions.

c. Display:
1) Filter air-pressure-drop indication.
2) Filter low-air-pressure set point.
3) Filter high-air-pressure set point.

10. Hydronic **OR** Steam, **as directed**, Heating Coil:

a. Occupied Time Schedule:
1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
2) Output Device: Time clock **OR** Binary output, **as directed**.
3) Action: Enable control.

b. Supply **OR** Discharge, **as directed**,-Air Temperature:
1) Input Device: Duct-mounted thermostat **OR** Electronic temperature sensor, **as directed**.
2) Output Device: Normally open **OR** closed, **as directed**, modulating control valve.
3) Action: Maintain supply-air temperature set point of 55 deg F (13 deg C).

c. Temperature Reset (for constant-temperature supply-air systems):
1) Input Device: Duct-mounted thermostat **OR** Electronic temperature sensor, **as directed**, in return air.
2) Output Device: Direct to receiver controller **OR** DDC system, **as directed**, in straight-line relationship for the following conditions:
a) 65 deg F (18 deg C) when return-air temperature is 70 deg F (21 deg C).
b) 55 deg F (13 deg C) when return-air temperature is 75 deg F (24 deg C).
3) Action: Reset supply-air temperature set point of 55 deg F (13 deg C).

d. Temperature Reset (for multizone or dual-duct supply-air systems):
1) Input Device: Load analyzer **OR** DDC system, **as directed**, with input from room thermostats **OR** temperature sensors, **as directed**.
2) Output Device: Direct to receiver controller **OR** DDC system, **as directed**.
3) Action: Reset supply-air temperature in response to greatest heating demand.

e. Unoccupied Time Schedule:
1) Input Device: Time clock and room thermostat **OR** DDC system time schedule and output, **as directed**.
2) Output Device: Room thermostat (cycling fan) **OR** DDC system binary output, **as directed**.
3) Action: Enable normal control **OR** Return valve to normal position, **as directed**, when fan is cycled on.

f. Display:
1) Fan-discharge air-temperature indication.
2) Fan-discharge air-temperature set point.
3) Heating-coil air-temperature indication.
4) Heating-coil air-temperature set point.
5) Heating-coil pump operation indication.
6) Heating-coil control-valve position.
7) Hot-deck air-temperature indication.
8) Hot-deck air-temperature set point.

11. Hydronic Cooling Coil:

a. Occupied Time Schedule:
1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
2) Output Device: Time clock **OR** Binary output, **as directed**.
3) Action: Enable control.

b. Supply **OR** Discharge, **as directed**,-Air Temperature:
1) Input Device: Duct-mounted thermostat **OR** Electronic temperature sensor, **as directed**.
2) Output Device: Normally open **OR** closed, **as directed**, modulating control valve.
3) Action: Maintain supply-air temperature set point of 55 deg F (13 deg C).

c. Temperature Reset (for constant-temperature systems):
   1) Input Device: Duct-mounted thermostat **OR** Electronic temperature sensor, **as directed**, in return air.
   2) Output Device: Direct to receiver controller **OR** DDC system, **as directed**, in straight-line relationship for the following conditions:
      a) 65 deg F (18 deg C) when return-air temperature is 70 deg F (21 deg C).
      b) 55 deg F (13 deg C) when return-air temperature is 75 deg F (24 deg C).
   3) Action: Reset supply-air temperature set point of 55 deg F (13 deg C).
d. Temperature Reset (for multizone or dual-duct supply-air systems):
   1) Input Device: Load analyzer **OR** DDC system, **as directed**, with input from room thermostats **OR** temperature sensors, **as directed**.
   2) Output Device: Direct to receiver controller **OR** DDC system, **as directed**.
   3) Action: Reset supply-air temperature in response to greatest heating demand.
e. Unoccupied Time Schedule:
   1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
   2) Output Device: Time clock **OR** Binary output, **as directed**.
   3) Action: Disable control.
f. Display:
   1) Fan-discharge air-temperature indication.
   2) Fan-discharge air-temperature set point.
   3) Cooling-coil air-temperature indication.
   4) Cooling-coil air-temperature set point.
   5) Cooling-coil control-valve position.
   6) Cold-deck air-temperature indication.
   7) Cold-deck air-temperature set point.

12. Multizone Damper Control:
   a. Occupied Time Schedule:
      1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
      2) Output Device: Time clock **OR** Binary output, **as directed**.
      3) Action: Enable control.
   b. Room Temperature:
      1) Input Device: Room thermostat **OR** Electronic temperature sensor, **as directed**.
      2) Output Device: Damper actuator.
      3) Action: Maintain room temperature.
   c. Display:
      1) Room temperature indication.
      2) Room temperature set point.
      3) Multizone damper position.
13. Coordination of Air-Handling Unit Sequences: Ensure that preheat, mixed-air, heating-coil, and cooling-coil controls have common inputs and do not overlap in function.
14. Operator Station Display: Indicate the following on operator workstation display terminal:
   a. DDC system graphic.
   b. DDC system on-off indication.
   c. DDC system occupied/unoccupied mode.
   d. Outdoor-air-temperature indication.
   e. Supply-fan on-off indication.
   f. Supply-fan-discharge static-pressure indication.
   g. Supply-fan-discharge static-pressure set point.
   h. Supply-fan airflow rate.
   i. Supply-fan inlet vane position **OR** speed, **as directed**.
   j. Return-fan on-off indication.
   k. Return-air static-pressure indication.
   l. Return-air static-pressure set point.
   m. Return-fan airflow rate.
   n. Return-fan inlet vane position **OR** speed, **as directed**.

o. Building static-pressure indication.
p. Building static-pressure set point.
q. Preheat-coil air-temperature indication.
r. Preheat-coil air-temperature set point.
s. Preheat-coil pump operation indication.
t. Preheat-coil control-valve position.
u. Mixed-air-temperature indication.
v. Mixed-air-temperature set point.
w. Mixed-air damper position.
x. Relative humidity indication.
y. Relative humidity set point.
z. Relative humidity control-valve position.
aa. Filter air-pressure-drop indication.
bb. Filter low-air-pressure set point.
cc. Filter high-air-pressure set point.
dd. Fan-discharge air-temperature indication.
ee. Fan-discharge air-temperature set point.
ff. Heating-coil air-temperature indication.
gg. Heating-coil air-temperature set point.
hh. Heating-coil pump operation indication.
ii. Heating-coil control-valve position.
jj. Hot-deck air-temperature indication.
kk. Hot-deck air-temperature set point.
ll. Cooling-coil air-temperature indication.
mm. Cooling-coil air-temperature set point.
nn. Cooling-coil control-valve position.
oo. Cold-deck air-temperature indication.
pp. Cold-deck air-temperature set point.
qq. Room temperature indication.
rr. Room temperature set point.
ss. Multizone damper position.

G. Terminal Unit Operating Sequence
1. Cabinet Unit Heater, Hydronic **OR** Steam, **as directed**:
a. Room Temperature:
1) Input Device: Room thermostat **OR** Electronic temperature sensor, **as directed**.
2) Output Device: Room thermostat **OR** DDC system binary output, **as directed**.
3) Action: Cycle fan to maintain temperature.
b. Low-Temperature Safety:
1) Input Device: Line-voltage, on-off thermostat, pipe mounted.
2) Output Device: Hard wired.
3) Action: Stop fan when return heating-water **OR** condensate, **as directed**, temperature falls below 35 deg F (2 deg C).
c. Display:
1) Room temperature indication.
2) Room temperature set point.
2. Cabinet Unit Heater, Electric: Room thermostat cycles fan and sequences stages of heating.
3. Unit Heater, Hydronic **OR** Steam, **as directed**:
a. Room Temperature:
1) Input Device: Room thermostat **OR** Electronic temperature sensor, **as directed**.
2) Output Device: Room thermostat **OR** DDC system binary output, **as directed**.
3) Action: Cycle fan to maintain temperature.
b. Low-Temperature Safety:
1) Input Device: Line-voltage, on-off thermostat, pipe mounted.
2) Output Device: Hard wired.

3) Action: Stop fan when return heating-water **OR** condensate, **as directed**, temperature falls below 35 deg F (2 deg C).

c. Display:
   1) Room temperature indication.
   2) Room temperature set point.

4. Unit Heater, Electric: Room thermostat cycles fan and sequences stages of heating.
5. Combustion-Air Unit Heaters:
   a. Room Temperature:
      1) Input Device: Room thermostat **OR** Electronic temperature sensor, **as directed**.
      2) Output Device: Pneumatic **OR** Electronic, **as directed**, control-valve operator.
      3) Action: Modulate valve to maintain temperature.
   b. Display:
      1) Room temperature indication.
      2) Room temperature set point.
      3) Control-valve position.
6. Radiant Heating Cable, Electric: Room thermostat cycles power.
7. Radiant Heating Panel, Electric: Room thermostat cycles power.
8. Radiant Heating Panel, Hydronic:
   a. Room Temperature:
      1) Input Device: Room thermostat **OR** Electronic temperature sensor, **as directed**.
      2) Output Device: Pneumatic **OR** Electronic, **as directed**, control-valve operator.
      3) Action: Modulate valve to maintain temperature.
   b. Display:
      1) Room temperature indication.
      2) Room temperature set point.
      3) Control-valve position.
9. Two-Pipe, Single-Coil, Fan-Coil Unit:
   a. Occupied Time Schedule:
      1) Input Device: Fan switch **OR** Time clock **OR** DDC system time schedule, **as directed**.
      2) Output Device: Time clock **OR** Binary output, **as directed**.
      3) Action: Start and stop fan and enable control.
   b. Room Temperature:
      1) Input Device: Room thermostat **OR** Electronic temperature sensor, **as directed**, in room **OR** return air, **as directed**.
      2) Output Device: Pneumatic **OR** Electronic, **as directed**, control-valve operator.
      3) Action: Modulate valve to maintain temperature.
   c. DDC System Changeover:
      1) Input Device: Thermostat **OR** Electronic temperature sensor, **as directed**, in supply-water **OR** on supply-water piping **OR** DDC system, **as directed**.
      2) Output Device: Hard-wired relay **OR** DDC system software, **as directed**.
      3) Action: Reverse control-valve action to switch from heating to cooling.
   d. Display:
      1) DDC system graphic.
      2) DDC system on-off indication.
      3) DDC system occupied/unoccupied mode.
      4) Room temperature indication.
      5) Room temperature set point.
      6) Control-valve position.
      7) Supply-water temperature indication.
10. Four-Pipe, Hydronic Fan-Coil Unit:
   a. Occupied Time Schedule:
      1) Input Device: Fan switch **OR** Time clock **OR** DDC system time schedule, **as directed**.
      2) Output Device: Time clock **OR** Binary output, **as directed**.

3) Action: Start and stop fan, and enable control.

b. Room Temperature:
1) Input Device: Room thermostat **OR** Electronic temperature sensor, **as directed**.
2) Output Device: Pneumatic **OR** Electronic, **as directed**, control-valve operators.
3) Action: Modulate multiport control valves to maintain temperature.

c. Display:
1) DDC system graphic.
2) DDC system on-off indication.
3) DDC system occupied/unoccupied mode.
4) Room temperature indication.
5) Room temperature set point.
6) Control-valve position.

11. Unit Ventilator: Room thermostat modulates heating-and-cooling control valves; airstream thermostats modulate outdoor- and return-air dampers as follows:

a. Occupied Time Schedule:
1) Input Device: Fan switch **OR** Time clock **OR** DDC system time schedule, **as directed**.
2) Output Device: Time clock **OR** Binary output, **as directed**.
3) Action: Start and stop fan, move outdoor- and return-air dampers to minimum **OR** maximum, **as directed**, outdoor-air position, and enable control.

b. Room Temperature - Valves:
1) Input Device: Room thermostat **OR** Electronic temperature sensor, **as directed**.
2) Output Device: Pneumatic **OR** Electronic, **as directed**, control-valve operators.
3) Action: Modulate heating-water supply control valve and chilled-water supply control valve in sequence to maintain temperature.

c. Room Temperature - Dampers:
1) Input Device: Thermostat **OR** Electronic temperature sensor, **as directed**, in mixed air.
2) Output Device: Pneumatic **OR** Electronic, **as directed**, control damper actuators.
3) Action: Modulate outdoor- and return-air dampers to maintain temperature.

d. Supply-Air Temperature Limit:
1) Input Device: Thermostat **OR** Electronic temperature sensor, **as directed**, in discharge air.
2) Output Device: Pneumatic **OR** Electronic, **as directed**, control-valve operators and control damper actuators.
3) Action: Override room thermostat to control valves and dampers to prevent discharge air from dropping below a minimum set point.

e. Warm-up Cycle:
1) Input Device: Time clock **OR** DDC system time schedule, **as directed.**
2) Output Device: Hard-wired relay **OR** DDC system binary output, **as directed**.
3) Action: Open heating-water supply control valve, close outdoor-air damper, and open return-air damper.

f. Display:
1) DDC system graphic.
2) DDC system on-off indication.
3) DDC system occupied/unoccupied mode.
4) Room temperature indication.
5) Room temperature set point.
6) Control-valve position.
7) Damper position.

12. Heating Coils, Hydronic **OR** Steam, **as directed**:

a. Room Temperature:
1) Input Device: Room thermostat **OR** Electronic temperature sensor, **as directed**.
2) Output Device: Pneumatic **OR** Electronic **OR** Electric, **as directed**, control-valve operators.
3) Action: Modulate **OR** Cycle, **as directed**, valve to maintain temperature.

b. Display:
   1) Room temperature indication.
   2) Room temperature set point.
   3) Control-valve position.
13. Heating Coils, Electric: Room thermostat cycles coils **OR** sequences stages of heating, **as directed**.
14. Radiators and Convectors, Hydronic **OR** Steam, **as directed**:
   a. Occupancy:
      1) Input Device: Occupancy sensor.
      2) Output Device: DDC system binary output.
      3) Action: Report occupancy and enable occupied temperature set point.
   b. Room Temperature:
      1) Input Device: Room thermostat **OR** Electronic temperature sensor, **as directed**.
      2) Output Device: Pneumatic **OR** Electronic **OR** Electric, **as directed**, control-valve operators.
      3) Action: Modulate **OR** Cycle, **as directed**, valve to maintain temperature.
         a) Occupied Temperature: 75 deg F (24 deg C).
         b) Unoccupied Temperature: 65 deg F (18 deg C).
   c. Display:
      1) Room/area served.
      2) Room temperature indication.
      3) Room temperature set point.
      4) Room temperature set point, occupied.
      5) Room temperature set point, occupied standby.
      6) Room temperature set point, unoccupied.
      7) Control-valve position as percent open.
15. Radiators and Convectors, Electric: Room thermostat cycles coils **OR** sequences stages of heating, **as directed**.
16. Constant-Volume, Terminal Air Units, Hydronic **OR** Steam, **as directed**:
   a. Occupancy:
      1) Input Device: Occupancy sensor.
      2) Output Device: DDC system binary output.
      3) Action: Report occupancy and enable occupied temperature set point.
         a) Occupied Temperature: 75 deg F (24 deg C).
         b) Unoccupied Temperature: 65 deg F (18 deg C).
   b. Room Temperature:
      1) Input Device: Room thermostat **OR** Electronic temperature sensor, **as directed**.
      2) Output Device: Pneumatic **OR** Electronic **OR** Electric, **as directed**, control-valve operators.
      3) Action: Modulate **OR** Cycle, **as directed**, valve to maintain temperature.
   c. Display:
      1) Room/area served.
      2) Room occupied/unoccupied.
      3) Room temperature indication.
      4) Room temperature set point.
      5) Room temperature set point, occupied.
      6) Room temperature set point, unoccupied.
      7) Control-valve position as percent open.
17. VAV, Terminal Air Units with Hydronic **OR** Steam, **as directed**, Coils:
   a. Occupancy:
      1) Input Device: Occupancy sensor.
      2) Output Device: DDC system binary output.
      3) Action: Report occupancy and enable occupied temperature set point.
         a) Occupied Temperature: 75 deg F (24 deg C).
         b) Unoccupied Temperature: 65 deg F (18 deg C).

b. Room Temperature:
   1) Input Device: Room thermostat **OR** Electronic temperature sensor, **as directed**.
   2) Output Device: Pneumatic **OR** Electronic, **as directed**, damper actuators and control-valve operators.
   3) Action: Modulate damper and valve to maintain temperature.
      a) Sequence damper from full open to minimum position, then valve from closed to fully open.

c. Display:
   1) Room/area served.
   2) Room occupied/unoccupied.
   3) Room temperature indication.
   4) Room temperature set point.
   5) Room temperature set point, occupied.
   6) Room temperature set point, unoccupied.
   7) Air-damper position as percent open.
   8) Control-valve position as percent open.

18. Dual-Duct, VAV, Terminal Air Units:
   a. Occupancy:
      1) Input Device: Occupancy sensor.
      2) Output Device: DDC system binary output.
      3) Action: Report occupancy and enable occupied temperature set point.
         a) Occupied Temperature: 75 deg F (24 deg C).
         b) Unoccupied Temperature: 65 deg F (18 deg C).
   b. Room Temperature:
      1) Input Device: Room thermostat **OR** Electronic temperature sensor, **as directed**.
      2) Output Device: Pneumatic **OR** Electronic, **as directed**, damper actuators.
      3) Action: Modulate dampers to maintain temperature.
         a) Sequence when space temperature is below set point: Close VAV damper to minimum position, open hot-deck dampers and close cold-deck dampers, then open VAV damper.
         b) Sequence when space temperature is above set point: Close VAV damper to minimum position, close hot-deck dampers and open cold-deck dampers, then open VAV damper.
   c. Display:
      1) Room/area served.
      2) Room occupied/unoccupied.
      3) Room temperature indication.
      4) Room temperature set point.
      5) Room temperature set point, occupied.
      6) Room temperature set point, unoccupied.
      7) VAV damper position as percent open.
      8) Hot-deck damper position as percent open.
      9) Cold-deck damper position as percent open.

H. Ventilation Sequences

1. Combustion-Air, Makeup Unit Control, Electric: Start fan when served appliance burner starts; room thermostat sequences stages of heating.
2. Combustion-Air, Makeup Unit Control, Hydronic **OR** Steam, **as directed**: Start fan when served appliance burner starts; room thermostat cycles **OR** modulates, **as directed**, control valve.
3. Gravity Roof Ventilator: Occupancy sensor **OR** Room thermostat, **as directed**, opens dampers.
4. Exhaust Fan: Occupancy sensor **OR** Interlock with light switch **OR** Room thermostat, **as directed**, cycles fan.
5. Kitchen Exhaust Fan: Occupancy sensor starts fan and energizes makeup air unit.

1.2 PRODUCTS (Not Applicable)

1.3 EXECUTION (Not Applicable)

END OF SECTION 23 01 10 91

SECTION 23 01 10 91a - TESTING, ADJUSTING, AND BALANCING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for testing, adjusting and balancing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Balancing Air Systems:
1) Constant-volume air systems.
2) Dual-duct systems.
3) Variable-air-volume systems.
4) Multizone systems.
5) Induction-unit systems.
b. Balancing Hydronic Piping Systems:
1) Constant-flow hydronic systems.
2) Variable-flow hydronic systems.
3) Primary-secondary hydronic systems.

C. Definitions
1. AABC: Associated Air Balance Council.
2. NEBB: National Environmental Balancing Bureau.
3. TAB: Testing, adjusting, and balancing.
4. TABB: Testing, Adjusting, and Balancing Bureau.
5. TAB Specialist: An entity engaged to perform TAB Work.

D. Submittals
1. LEED Submittal:
a. Air-Balance Report for LEED Prerequisite EQ 1: Documentation of work performed for ASHRAE 62.1, Section 7.2.2, "Air Balancing."
2. Strategies and Procedures Plan: Within 30 **OR** 60 **OR** 90, **as directed**, days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
3. Certified TAB reports.

E. Quality Assurance
1. TAB Contractor Qualifications: Engage a TAB entity certified by AABC **OR** NEBB **OR** TABB **OR** one who meets the requirements necessary for certification, **as directed**.
a. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC **OR** NEBB **OR** TABB **OR** one who meets the requirements necessary for certification, **as directed**.
b. TAB Technician: Employee of the TAB contractor and who is certified by AABC **OR** NEBB **OR** TABB **OR** one who meets the requirements necessary for certification as a TAB technician, **as directed**.
2. Certify TAB field data reports and perform the following:
a. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
b. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
3. TAB Report Forms: Use standard TAB contractor's forms approved by the Owner **OR** Commissioning Authority, **as directed**.

4. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

F. Project Conditions
1. Full the Owner Occupancy: the Owner will occupy the site and existing building during entire TAB period. Cooperate with the Owner during TAB operations to minimize conflicts with the Owner's operations.
OR
Partial the Owner Occupancy: the Owner may occupy completed areas of building before Final Completion. Cooperate with the Owner during TAB operations to minimize conflicts with the Owner's operations.

1.2 PRODUCTS (Not Applicable)

1.3 EXECUTION

A. Examination
1. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
2. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
3. Examine the approved submittals for HVAC systems and equipment.
4. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
5. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 Section(s) "Metal Ducts" OR "Nonmetal Ducts", **as directed**, and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
6. Examine equipment performance data including fan and pump curves.
   a. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
   b. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
7. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
8. Examine test reports specified in individual system and equipment Sections.
9. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
10. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
11. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
12. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
13. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
14. Examine system pumps to ensure absence of entrained air in the suction piping.
15. Examine operating safety interlocks and controls on HVAC equipment.

16. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

B. Preparation
1. Prepare a TAB plan that includes strategies and step-by-step procedures.
2. Complete system-readiness checks and prepare reports. Verify the following:
   a. Permanent electrical-power wiring is complete.
   b. Hydronic systems are filled, clean, and free of air.
   c. Automatic temperature-control systems are operational.
   d. Equipment and duct access doors are securely closed.
   e. Balance, smoke, and fire dampers are open.
   f. Isolating and balancing valves are open and control valves are operational.
   g. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
   h. Windows and doors can be closed so indicated conditions for system operations can be met.

C. General Procedures For Testing And Balancing
1. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" **OR** ASHRAE 111 **OR** NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" **OR** SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing", **as directed**, and in this Section.
   a. Comply with requirements in ASHRAE 62.1, Section 7.2.2, "Air Balancing."
2. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
   a. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
      OR
      After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories".
   b. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "Hvac Insulation".
3. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
4. Take and report testing and balancing measurements in inch-pound (IP) **OR** metric (SI) **OR** inch-pound (IP) and metric (SI), **as directed,** units.

D. General Procedures For Balancing Air Systems
1. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
2. Prepare schematic diagrams of systems' "as-built" duct layouts.
3. For variable-air-volume systems, develop a plan to simulate diversity.
4. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
5. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
6. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
7. Verify that motor starters are equipped with properly sized thermal protection.
8. Check dampers for proper position to achieve desired airflow path.
9. Check for airflow blockages.
10. Check condensate drains for proper connections and functioning.
11. Check for proper sealing of air-handling-unit components.
12. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts".

E. Procedures For Constant-Volume Air Systems

1. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
   a. Measure total airflow.
      1) Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
   b. Measure fan static pressures as follows to determine actual static pressure:
      1) Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
      2) Measure static pressure directly at the fan outlet or through the flexible connection.
      3) Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
      4) Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
   c. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
      1) Report the cleanliness status of filters and the time static pressures are measured.
   d. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
   e. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
   f. Obtain approval from the Owner **OR** Commissioning Authority, **as directed**, for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 21 for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
   g. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
2. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
   a. Measure airflow of submain and branch ducts.
      1) Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
   b. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
   c. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
3. Measure air outlets and inlets without making adjustments.
   a. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
4. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
   a. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
   b. Adjust patterns of adjustable outlets for proper distribution without drafts.

F. Procedures For Dual-Duct Systems

1. Verify that the cooling coil is capable of full-system airflow, and set mixing boxes at full-cold airflow position for fan volume.
2. Measure static pressure in both hot and cold ducts at the end of the longest duct run to determine that sufficient static pressure exists to operate controls of mixing boxes and to overcome resistance in the ducts and outlets downstream from mixing boxes.
   a. If insufficient static pressure exists, increase airflow at the fan.
3. Test and adjust the constant-volume mixing boxes as follows:
   a. Verify both hot and cold operations by adjusting the thermostat and observing changes in air temperature and volume.
   b. Verify sufficient inlet static pressure before making volume adjustments.
   c. Adjust mixing boxes to indicated airflows within specified tolerances. Measure airflow by Pitot-tube traverse readings or by measuring static pressure at mixing-box taps if provided by mixing-box manufacturer.
4. Do not overpressurize ducts.
5. Remeasure static pressure in both hot and cold ducts at the end of the longest duct run to determine that sufficient static pressure exists to operate controls of mixing boxes and to overcome resistance in the ducts and outlets downstream from mixing boxes.
6. Adjust variable-air-volume, dual-duct systems in the same way as constant-volume, dual-duct systems; adjust maximum- and minimum-airflow setting of each mixing box.

G. Procedures For Variable-Air-Volume Systems
1. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
2. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
   a. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
   b. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
   c. Measure total system airflow. Adjust to within indicated airflow.
   d. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
   e. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
      1) If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
   f. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
      1) Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
   g. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
   h. Record final fan-performance data.
3. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

a. Balance variable-air-volume systems the same as described for constant-volume air systems.
b. Set terminal units and supply fan at full-airflow condition.
c. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
d. Readjust fan airflow for final maximum readings.
e. Measure operating static pressure at the sensor that controls the supply fan if one is installed, and verify operation of the static-pressure controller.
f. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
g. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
    1) If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.
h. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
    1) Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

4. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
    a. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
    b. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
    c. Set terminal units at full-airflow condition.
    d. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
    e. Adjust terminal units for minimum airflow.
    f. Measure static pressure at the sensor.
    g. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

H. Procedures For Multizone Systems
1. Set unit at maximum airflow through the cooling coil.
2. Adjust each zone's balancing damper to achieve indicated airflow within the zone.

I. Procedures For Induction-Unit Systems
1. Balance primary-air risers by measuring static pressure at the nozzles of the top and bottom units of each riser to determine which risers must be throttled. Adjust risers to indicated airflow within specified tolerances.
2. Adjust each induction unit.

J. General Procedures For Hydronic Systems
1. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
2. Prepare schematic diagrams of systems' "as-built" piping layouts.
3. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

a. Open all manual valves for maximum flow.
b. Check liquid level in expansion tank.
c. Check makeup water-station pressure gage for adequate pressure for highest vent.
d. Check flow-control valves for specified sequence of operation, and set at indicated flow.
e. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
f. Set system controls so automatic valves are wide open to heat exchangers.
g. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
h. Check air vents for a forceful liquid flow exiting from vents when manually operated.

K. Procedures For Constant-Flow Hydronic Systems
1. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:
   a. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
      1) If impeller sizes must be adjusted to achieve pump performance, obtain approval from the Owner **OR** Commissioning Authority, **as directed**, and comply with requirements in Division 23 Section "Hydronic Pumps".
   b. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
      1) Monitor motor performance during procedures and do not operate motors in overload conditions.
   c. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
   d. Report flow rates that are not within plus or minus 10 percent of design.
2. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.
3. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.
4. Set calibrated balancing valves, if installed, at calculated presettings.
5. Measure flow at all stations and adjust, where necessary, to obtain first balance.
   a. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
6. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
7. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
   a. Determine the balancing station with the highest percentage over indicated flow.
   b. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
   c. Record settings and mark balancing devices.
8. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
9. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.
10. Check settings and operation of each safety valve. Record settings.

L. Procedures For Variable-Flow Hydronic Systems
1. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

M. Procedures For Primary-Secondary Hydronic Systems
   1. Balance the primary circuit flow first and then balance the secondary circuits.

N. Procedures For Steam Systems
   1. Measure and record upstream and downstream pressure of each piece of equipment.
   2. Measure and record upstream and downstream steam pressure of pressure-reducing valves.
   3. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.
   4. Check settings and operation of each safety valve. Record settings.
   5. Verify the operation of each steam trap.

O. Procedures For Heat Exchangers
   1. Measure water flow through all circuits.
   2. Adjust water flow to within specified tolerances.
   3. Measure inlet and outlet water temperatures.
   4. Measure inlet steam pressure.
   5. Check settings and operation of safety and relief valves. Record settings.

P. Procedures For Motors
   1. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
      a. Manufacturer's name, model number, and serial number.
      b. Motor horsepower rating.
      c. Motor rpm.
      d. Efficiency rating.
      e. Nameplate and measured voltage, each phase.
      f. Nameplate and measured amperage, each phase.
      g. Starter thermal-protection-element rating.
   2. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

Q. Procedures For Chillers
   1. Balance water flow through each evaporator and condenser, **as directed**, to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:
      a. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
      b. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
      c. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
      d. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
      e. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
      f. Capacity: Calculate in tons of cooling.
      g. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

R. Procedures For Cooling Towers
   1. Shut off makeup water for the duration of the test, and verify that makeup and blowdown systems are fully operational after tests and before leaving the equipment. Perform the following tests and record the results:
      a. Measure condenser-water flow to each cell of the cooling tower.
      b. Measure entering- and leaving-water temperatures.

c. Measure wet- and dry-bulb temperatures of entering air.
d. Measure wet- and dry-bulb temperatures of leaving air.
e. Measure condenser-water flow rate recirculating through the cooling tower.
f. Measure cooling-tower spray pump discharge pressure.
g. Adjust water level and feed rate of makeup water system.
h. Measure flow through bypass.

S. Procedures For Condensing Units
1. Verify proper rotation of fans.
2. Measure entering- and leaving-air temperatures.
3. Record compressor data.

T. Procedures For Boilers
1. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.
2. Steam Boilers: Measure and record entering-water temperature and flow and leaving-steam pressure, temperature, and flow.

U. Procedures For Heat-Transfer Coils
1. Measure, adjust, and record the following data for each water coil:
   a. Entering- and leaving-water temperature.
   b. Water flow rate.
   c. Water pressure drop.
   d. Dry-bulb temperature of entering and leaving air.
   e. Wet-bulb temperature of entering and leaving air for cooling coils.
   f. Airflow.
   g. Air pressure drop.
2. Measure, adjust, and record the following data for each electric heating coil:
   a. Nameplate data.
   b. Airflow.
   c. Entering- and leaving-air temperature at full load.
   d. Voltage and amperage input of each phase at full load and at each incremental stage.
   e. Calculated kilowatt at full load.
   f. Fuse or circuit-breaker rating for overload protection.
3. Measure, adjust, and record the following data for each steam coil:
   a. Dry-bulb temperature of entering and leaving air.
   b. Airflow.
   c. Air pressure drop.
   d. Inlet steam pressure.
4. Measure, adjust, and record the following data for each refrigerant coil:
   a. Dry-bulb temperature of entering and leaving air.
   b. Wet-bulb temperature of entering and leaving air.
   c. Airflow.
   d. Air pressure drop.
   e. Refrigerant suction pressure and temperature.

V. Procedures For Testing, Adjusting, And Balancing Existing Systems
1. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
   a. Measure and record the operating speed, airflow, and static pressure of each fan.
   b. Measure motor voltage and amperage. Compare the values to motor nameplate information.
   c. Check the refrigerant charge.
   d. Check the condition of filters.
   e. Check the condition of coils.
   f. Check the operation of the drain pan and condensate-drain trap.
   g. Check bearings and other lubricated parts for proper lubrication.

h. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

2. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
   a. New filters are installed.
   b. Coils are clean and fins combed.
   c. Drain pans are clean.
   d. Fans are clean.
   e. Bearings and other parts are properly lubricated.
   f. Deficiencies noted in the preconstruction report are corrected.
3. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
   a. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
   b. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
   c. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
   d. Balance each air outlet.

W. Tolerances

X. Set HVAC system's air flow rates and water flow rates within the following tolerances:
   a. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
   b. Air Outlets and Inlets: Plus or minus 10 percent.
   c. Heating-Water Flow Rate: Plus or minus 10 percent.
   d. Cooling-Water Flow Rate: Plus or minus 10 percent.

Y. Reporting
1. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
2. Status Reports: Prepare weekly **OR** biweekly **OR** monthly, **as directed**, progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

Z. Final Report
1. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
   a. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
   b. Include a list of instruments used for procedures, along with proof of calibration.
2. Final Report Contents: In addition to certified field-report data, include the following:
   a. Pump curves.
   b. Fan curves.
   c. Manufacturers' test data.
   d. Field test reports prepared by system and equipment installers.
   e. Other information relative to equipment performance; do not include Shop Drawings and product data.
3. General Report Data: In addition to form titles and entries, include the following data:

a. Title page.
b. Name and address of the TAB contractor.
c. Project name.
d. Project location.
e. Architect's name and address.
f. Engineer's name and address.
g. Contractor's name and address.
h. Report date.
i. Signature of TAB supervisor who certifies the report.
j. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
k. Summary of contents including the following:
    1) Indicated versus final performance.
    2) Notable characteristics of systems.
    3) Description of system operation sequence if it varies from the Contract Documents.
l. Nomenclature sheets for each item of equipment.
m. Data for terminal units, including manufacturer's name, type, size, and fittings.
n. Notes to explain why certain final data in the body of reports vary from indicated values.
o. Test conditions for fans and pump performance forms including the following:
    1) Settings for outdoor-, return-, and exhaust-air dampers.
    2) Conditions of filters.
    3) Cooling coil, wet- and dry-bulb conditions.
    4) Face and bypass damper settings at coils.
    5) Fan drive settings including settings and percentage of maximum pitch diameter.
    6) Inlet vane settings for variable-air-volume systems.
    7) Settings for supply-air, static-pressure controller.
    8) Other system operating conditions that affect performance.

4. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
    a. Quantities of outdoor, supply, return, and exhaust airflows.
    b. Water and steam flow rates.
    c. Duct, outlet, and inlet sizes.
    d. Pipe and valve sizes and locations.
    e. Terminal units.
    f. Balancing stations.
    g. Position of balancing devices.
5. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
    a. Unit Data:
        1) Unit identification.
        2) Location.
        3) Make and type.
        4) Model number and unit size.
        5) Manufacturer's serial number.
        6) Unit arrangement and class.
        7) Discharge arrangement.
        8) Sheave make, size in inches (mm), and bore.
        9) Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
        10) Number, make, and size of belts.
        11) Number, type, and size of filters.
    b. Motor Data:
        1) Motor make, and frame type and size.
        2) Horsepower and rpm.
        3) Volts, phase, and hertz.
        4) Full-load amperage and service factor.
        5) Sheave make, size in inches (mm), and bore.
        6) Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

c. Test Data (Indicated and Actual Values):
   1) Total air flow rate in cfm (L/s).
   2) Total system static pressure in inches wg (Pa).
   3) Fan rpm.
   4) Discharge static pressure in inches wg (Pa).
   5) Filter static-pressure differential in inches wg (Pa).
   6) Preheat-coil static-pressure differential in inches wg (Pa).
   7) Cooling-coil static-pressure differential in inches wg (Pa).
   8) Heating-coil static-pressure differential in inches wg (Pa).
   9) Outdoor airflow in cfm (L/s).
   10) Return airflow in cfm (L/s).
   11) Outdoor-air damper position.
   12) Return-air damper position.
   13) Vortex damper position.

6. Apparatus-Coil Test Reports:
   a. Coil Data:
      1) System identification.
      2) Location.
      3) Coil type.
      4) Number of rows.
      5) Fin spacing in fins per inch (mm) o.c.
      6) Make and model number.
      7) Face area in sq. ft. (sq. m).
      8) Tube size in NPS (DN).
      9) Tube and fin materials.
      10) Circuiting arrangement.
   b. Test Data (Indicated and Actual Values):
      1) Air flow rate in cfm (L/s).
      2) Average face velocity in fpm (m/s).
      3) Air pressure drop in inches wg (Pa).
      4) Outdoor-air, wet- and dry-bulb temperatures in deg F (deg C).
      5) Return-air, wet- and dry-bulb temperatures in deg F (deg C).
      6) Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
      7) Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
      8) Water flow rate in gpm (L/s).
      9) Water pressure differential in feet of head or psig (kPa).
      10) Entering-water temperature in deg F (deg C).
      11) Leaving-water temperature in deg F (deg C).
      12) Refrigerant expansion valve and refrigerant types.
      13) Refrigerant suction pressure in psig (kPa).
      14) Refrigerant suction temperature in deg F (deg C).
      15) Inlet steam pressure in psig (kPa).

7. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
   a. Unit Data:
      1) System identification.
      2) Location.
      3) Make and type.
      4) Model number and unit size.
      5) Manufacturer's serial number.
      6) Fuel type in input data.
      7) Output capacity in Btu/h (kW).
      8) Ignition type.
      9) Burner-control types.
      10) Motor horsepower and rpm.

11) Motor volts, phase, and hertz.
12) Motor full-load amperage and service factor.
13) Sheave make, size in inches (mm), and bore.
14) Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

b. Test Data (Indicated and Actual Values):
1) Total air flow rate in cfm (L/s).
2) Entering-air temperature in deg F (deg C).
3) Leaving-air temperature in deg F (deg C).
4) Air temperature differential in deg F (deg C).
5) Entering-air static pressure in inches wg (Pa).
6) Leaving-air static pressure in inches wg (Pa).
7) Air static-pressure differential in inches wg (Pa).
8) Low-fire fuel input in Btu/h (kW).
9) High-fire fuel input in Btu/h (kW).
10) Manifold pressure in psig (kPa).
11) High-temperature-limit setting in deg F (deg C).
12) Operating set point in Btu/h (kW).
13) Motor voltage at each connection.
14) Motor amperage for each phase.
15) Heating value of fuel in Btu/h (kW).

8. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

a. Unit Data:
1) System identification.
2) Location.
3) Coil identification.
4) Capacity in Btu/h (kW).
5) Number of stages.
6) Connected volts, phase, and hertz.
7) Rated amperage.
8) Air flow rate in cfm (L/s).
9) Face area in sq. ft. (sq. m).
10) Minimum face velocity in fpm (m/s).

b. Test Data (Indicated and Actual Values):
1) Heat output in Btu/h (kW).
2) Air flow rate in cfm (L/s).
3) Air velocity in fpm (m/s).
4) Entering-air temperature in deg F (deg C).
5) Leaving-air temperature in deg F (deg C).
6) Voltage at each connection.
7) Amperage for each phase.

9. Fan Test Reports: For supply, return, and exhaust fans, include the following:

a. Fan Data:
1) System identification.
2) Location.
3) Make and type.
4) Model number and size.
5) Manufacturer's serial number.
6) Arrangement and class.
7) Sheave make, size in inches (mm), and bore.
8) Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

b. Motor Data:
1) Motor make, and frame type and size.
2) Horsepower and rpm.
3) Volts, phase, and hertz.
4) Full-load amperage and service factor.

5) Sheave make, size in inches (mm), and bore.
6) Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
7) Number, make, and size of belts.

c. Test Data (Indicated and Actual Values):
1) Total airflow rate in cfm (L/s).
2) Total system static pressure in inches wg (Pa).
3) Fan rpm.
4) Discharge static pressure in inches wg (Pa).
5) Suction static pressure in inches wg (Pa).

10. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

a. Report Data:
1) System and air-handling-unit number.
2) Location and zone.
3) Traverse air temperature in deg F (deg C).
4) Duct static pressure in inches wg (Pa).
5) Duct size in inches (mm).
6) Duct area in sq. ft. (sq. m).
7) Indicated air flow rate in cfm (L/s).
8) Indicated velocity in fpm (m/s).
9) Actual air flow rate in cfm (L/s).
10) Actual average velocity in fpm (m/s).
11) Barometric pressure in psig (Pa).

11. Air-Terminal-Device Reports:

a. Unit Data:
1) System and air-handling unit identification.
2) Location and zone.
3) Apparatus used for test.
4) Area served.
5) Make.
6) Number from system diagram.
7) Type and model number.
8) Size.
9) Effective area in sq. ft. (sq. m).

b. Test Data (Indicated and Actual Values):
1) Air flow rate in cfm (L/s).
2) Air velocity in fpm (m/s).
3) Preliminary air flow rate as needed in cfm (L/s).
4) Preliminary velocity as needed in fpm (m/s).
5) Final air flow rate in cfm (L/s).
6) Final velocity in fpm (m/s).
7) Space temperature in deg F (deg C).

12. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

a. Unit Data:
1) System and air-handling-unit identification.
2) Location and zone.
3) Room or riser served.
4) Coil make and size.
5) Flowmeter type.

b. Test Data (Indicated and Actual Values):
1) Air flow rate in cfm (L/s).
2) Entering-water temperature in deg F (deg C).
3) Leaving-water temperature in deg F (deg C).
4) Water pressure drop in feet of head or psig (kPa).
5) Entering-air temperature in deg F (deg C).

6) Leaving-air temperature in deg F (deg C).

13. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
    a. Unit Data:
        1) Unit identification.
        2) Location.
        3) Service.
        4) Make and size.
        5) Model number and serial number.
        6) Water flow rate in gpm (L/s).
        7) Water pressure differential in feet of head or psig (kPa).
        8) Required net positive suction head in feet of head or psig (kPa).
        9) Pump rpm.
        10) Impeller diameter in inches (mm).
        11) Motor make and frame size.
        12) Motor horsepower and rpm.
        13) Voltage at each connection.
        14) Amperage for each phase.
        15) Full-load amperage and service factor.
        16) Seal type.
    b. Test Data (Indicated and Actual Values):
        1) Static head in feet of head or psig (kPa).
        2) Pump shutoff pressure in feet of head or psig (kPa).
        3) Actual impeller size in inches (mm).
        4) Full-open flow rate in gpm (L/s).
        5) Full-open pressure in feet of head or psig (kPa).
        6) Final discharge pressure in feet of head or psig (kPa).
        7) Final suction pressure in feet of head or psig (kPa).
        8) Final total pressure in feet of head or psig (kPa).
        9) Final water flow rate in gpm (L/s).
        10) Voltage at each connection.
        11) Amperage for each phase.
14. Instrument Calibration Reports:
    a. Report Data:
        1) Instrument type and make.
        2) Serial number.
        3) Application.
        4) Dates of use.
        5) Dates of calibration.

AA. Inspections
1. Initial Inspection:
    a. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
    b. Check the following for each system:
        1) Measure airflow of at least 10 percent of air outlets.
        2) Measure water flow of at least 5 percent of terminals.
        3) Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
        4) Verify that balancing devices are marked with final balance position.
        5) Note deviations from the Contract Documents in the final report.
2. Final Inspection:
    a. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by the Owner **OR** Commissioning Authority, **as directed**.

b. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of the Owner **OR** Commissioning Authority, **as directed**.
c. the Owner **OR** Commissioning Authority, **as directed**, shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
d. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
e. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

3. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
   a. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
   b. If the second final inspection also fails, the Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.
4. Prepare test and inspection reports.

BB. Additional Tests
1. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
2. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 23 01 10 91a

Task	Specification	Specification Description
23 01 20 91	23 01 10 91	Sequence Of Operation
23 01 20 91	23 01 10 91a	Testing, Adjusting, And Balancing

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SECTION 23 01 30 51 - AIR DUCT CLEANING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for HVAC air-distribution system cleaning. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes cleaning HVAC air-distribution equipment, ducts, plenums, and system components.

C. Definitions
1. ASCS: Air systems cleaning specialist.
2. NADCA: National Air Duct Cleaners Association.

D. Submittals
1. Qualification Data: For an ASCS.
2. Strategies and procedures plan.
3. Cleanliness verification report.

E. Quality Assurance
1. ASCS Qualifications: A certified member of NADCA **OR** one who meets the requirements necessary for certification, **as directed.**
   a. Certification: Employ an ASCS certified by NADCA **OR** one who meets the requirements necessary for certification, **as directed,** on a full-time basis.
   b. Supervisor Qualifications: Certified as an ASCS by NADCA **OR** one who meets the requirements necessary for certification, **as directed**.
2. UL Compliance: Comply with UL 181 and UL 181A for fibrous-glass ducts.
3. Cleaning Conference: Conduct conference at Project site.

1.2 PRODUCTS (Not Used)

1.3 EXECUTION

A. Examination
1. Examine HVAC air-distribution equipment, ducts, plenums, and system components to determine appropriate methods, tools, and equipment required for performance of the Work.
2. Perform "Project Evaluation and Recommendation" according to NADCA ACR 2006.
3. Prepare written report listing conditions detrimental to performance of the Work.
4. Proceed with work only after unsatisfactory conditions have been corrected.

B. Preparation
1. Prepare a written plan that includes strategies and step-by-step procedures. At a minimum, include the following:
   a. Supervisor contact information.
   b. Work schedule including location, times, and impact on occupied areas.
   c. Methods and materials planned for each HVAC component type.
   d. Required support from other trades.
   e. Equipment and material storage requirements.

f. Exhaust equipment setup locations.
2. Use the existing service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry and for inspection.
3. Comply with NADCA ACR 2006, "Guidelines for Constructing Service Openings in HVAC Systems" Section.

C. Cleaning
1. Comply with NADCA ACR 2006.
2. Remove visible surface contaminants and deposits from within the HVAC system.
3. Systems and Components to Be Cleaned:
   a. Air devices for supply and return air.
   b. Air-terminal units.
   c. Ductwork:
      1) Supply-air ducts, including turning vanes and reheat coils, to the air-handling unit.
      2) Return-air ducts to the air-handling unit.
      3) Exhaust-air ducts.
   d. Air-Handling Units:
      1) Interior surfaces of the unit casing.
      2) Coil surfaces compartment.
      3) Condensate drain pans.
      4) Fans, fan blades, and fan housings.
   e. Filters and filter housings.
4. Collect debris removed during cleaning. Ensure that debris is not dispersed outside the HVAC system during the cleaning process.
5. Particulate Collection:
   a. For particulate collection equipment, include adequate filtration to contain debris removed. Locate equipment downwind and away from all air intakes and other points of entry into the building.
   b. HEPA filtration with 99.97 percent collection efficiency for particles sized 0.3 micrometer or larger shall be used where the particulate collection equipment is exhausting inside the building,
6. Control odors and mist vapors during the cleaning and restoration process.
7. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning. Restore them to their marked position on completion of cleaning.
8. System components shall be cleaned so that all HVAC system components are visibly clean. On completion, all components must be returned to those settings recorded just prior to cleaning operations.
9. Clean all air-distribution devices, registers, grilles, and diffusers.
10. Clean visible surface contamination deposits according to NADCA ACR 2006 and the following:
    a. Clean air-handling units, airstream surfaces, components, condensate collectors, and drains.
    b. Ensure that a suitable operative drainage system is in place prior to beginning wash-down procedures.
    c. Clean evaporator coils, reheat coils, and other airstream components.
11. Duct Systems:
    a. Create service openings in the HVAC system as necessary to accommodate cleaning.
    b. Mechanically clean duct systems specified to remove all visible contaminants so that the systems are capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).
12. Debris removed from the HVAC system shall be disposed of according to applicable Federal, state, and local requirements.
13. Mechanical Cleaning Methodology:
    a. Source-Removal Cleaning Methods: The HVAC system shall be cleaned using source-removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and to safely remove these contaminants from the facility. No cleaning

method, or combination of methods, shall be used that could potentially damage components of the HVAC system or negatively alter the integrity of the system.

1) Use continuously operating vacuum-collection devices to keep each section being cleaned under negative pressure.
2) Cleaning methods that require mechanical agitation devices to dislodge debris that is adhered to interior surfaces of HVAC system components shall be equipped to safely remove these devices. Cleaning methods shall not damage the integrity of HVAC system components or damage porous surface materials such as duct and plenum liners.

b. Cleaning Mineral-Fiber Insulation Components:
1) Fibrous-glass thermal or acoustical insulation elements present in equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment while the HVAC system is under constant negative pressure and shall not be permitted to get wet according to NADCA ACR 2006.
2) Cleaning methods used shall not cause damage to fibrous-glass components and will render the system capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).
3) Fibrous materials that become wet shall be discarded and replaced.

14. Coil Cleaning:
a. Measure static-pressure differential across each coil.
b. See NADCA ACR 2006, "Coil Surface Cleaning" Section. Type 1, or Type 1 and Type 2, cleaning methods shall be used to render the coil visibly clean and capable of passing Coil Cleaning Verification (see applicable NADCA ACR 2006).
c. Coil drain pans shall be subject to NADCA ACR 2006, "Non-Porous Surfaces Cleaning Verification." Ensure that condensate drain pans are operational.
d. Electric-resistance coils shall be de-energized, locked out, and tagged before cleaning.
e. Cleaning methods shall not cause any appreciable damage to, cause displacement of, inhibit heat transfer, or cause erosion of the coil surface or fins, and shall comply with coil manufacturer's written recommendations when available.
f. Rinse thoroughly with clean water to remove any latent residues.

15. Antimicrobial Agents, Coatings, and Sanitizers:
a. Apply antimicrobial agents, coatings, and sanitizers if active fungal growth is reasonably suspected or where unacceptable levels of fungal contamination have been verified. Apply antimicrobial agents and coatings according to manufacturer's written recommendations and EPA registration listing after the removal of surface deposits and debris.
b. When used, antimicrobial treatments, coatings, and sanitizers shall be applied after the system is rendered clean.
c. Apply antimicrobial agents, coatings, and sanitizers directly onto surfaces of interior ductwork. Fogging is prohibited.
d. Sanitizing agent products shall be registered by the EPA as specifically intended for use in HVAC systems and ductwork.

D. Cleanliness Verification
1. Verify cleanliness according to NADCA ACR 2006, "Verification of HVAC System Cleanliness" Section.
2. Verify HVAC system cleanliness after mechanical cleaning and before applying any treatment or introducing any treatment-related substance to the HVAC system, including biocidal agents, coatings, and sanitizers.
3. Perform visual inspection for cleanliness. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection for cleanliness.
4. Additional Verification:
a. Perform surface comparison testing or NADCA vacuum test.
b. Conduct NADCA vacuum gravimetric test analysis for nonporous surfaces.
5. Verification of Coil Cleaning:

a. Measure static-pressure differential across each coil.
b. Coil will be considered clean if cleaning restored the coil static-pressure differential within 10 percent of <**Insert inches wg (Pa)**>, the differential measured when the coil was first installed.
OR
Coil will be considered clean if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection.

6. Prepare a written cleanliness verification report. At a minimum, include the following:
   a. Written documentation of the success of the cleaning.
   b. Site inspection reports, initialed by supervisor, including notation on areas of inspection, as verified through visual inspection.
   c. Surface comparison test results if required.
   d. Gravimetric analysis (nonporous surfaces only).
   e. System areas found to be damaged.
7. Photographic Documentation: Comply with requirements listed in Scope of Work.

E. Restoration
1. Restore and repair HVAC air-distribution equipment, ducts, plenums, and components according to NADCA ACR 2006, "Restoration and Repair of Mechanical Systems" Section.
2. Restore service openings capable of future reopening. Comply with requirements in Division 23 Section "Metal Ducts". Include location of service openings in Project closeout report.
3. Replace fibrous-glass materials that cannot be restored by cleaning or resurfacing. Comply with requirements in Division 23 Section(s) "Metal Ducts" AND "Nonmetal Ducts"
4. Replace damaged insulation according to Division 23 Section "Hvac Insulation",
5. Ensure that closures do not hinder or alter airflow.
6. New closure materials, including insulation, shall match opened materials and shall have removable closure panels fitted with gaskets and fasteners.
7. Reseal fibrous-glass ducts. Comply with requirements in Division 23 Section "Nonmetal Ducts".

END OF SECTION 23 01 30 51

Task	Specification	Specification Description
23 01 30 51	23 01 10 91	Sequence Of Operation
23 01 30 51	23 01 10 91a	Testing, Adjusting, And Balancing

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SECTION 23 01 30 61 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Double-wall rectangular ducts and fittings.
3. Single-wall round[**and flat-oval**] ducts and fittings.
4. Double-wall round[**and flat-oval**] ducts and fittings.
5. Sheet metal materials.
6. Duct liner.
7. Sealants and gaskets.
8. Hangers and supports.

B. Related Requirements:

1. Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraint devices and installation.
2. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
3. Section 233116 "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
4. Section 233119 "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
5. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 DEFINITIONS

A. OSHPD: Office of Statewide Health Planning and Development (State of California).

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

B. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for HVAC units.>
2. <Double click to insert sustainable design text for adhesives.>
3. <Double click to insert sustainable design text for sealants.>
4. <Double click to insert sustainable design text for laboratory test reports for antimicrobial coatings.>

C. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top [**and bottom**]of ducts.
5. Dimensions of [**main**] [**all**] duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment[**, seismic restraints,**] and vibration isolation.
13. <**Insert lists of areas or systems requiring Shop Drawings**>.

D. Delegated Design Submittals:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations[**, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation**] for selecting hangers and supports[**and seismic restraints**].

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: A single set of plans or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Welding certificates.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. [**AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.**]
2. [**AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.**]
3. [**AWS D9.1/D9.1M, "Sheet Metal Welding Code," for duct joint and seam welding.**]

B. Mockups:

1. Before installing duct systems, build mockups representing static-pressure classes in excess of [**3 (750)**] <**Insert static-pressure class**> inch wg (Pa). Build mockups to comply with the following requirements, using materials indicated for the completed Work:

   a. [**Five**] <**Insert number**> transverse joints.
   b. [**One**] <**Insert number**> access door(s).

c. [**Two**] <**Insert number**> typical branch connections, each with at least one elbow.
d. [**Two**] <**Insert number**> typical flexible duct or flexible-connector connections for each duct and apparatus.
e. [**One**] <**Insert number**> 90-degree turn(s) with turning vanes.
f. [**One**] <**Insert number**> fire damper(s).
g. [**One**] <**Insert number**> smoke damper(s).
h. Perform leakage tests specified in "Field Quality Control" Article. Revise mockup construction and perform additional tests as required to achieve specified minimum acceptable results.

2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and with performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports[**and seismic restraints**] are to withstand the effects of gravity[**and seismic**] loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" [**and**] [**ASCE/SEI 7**] <**Insert applicable building code**>. [**Seismically brace duct hangers and supports in accordance with**] [**SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."**] [**SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems - OSHPD Edition."**] <**Insert reference document.**>

1. Seismic Hazard Level (SHL): [**AA**] [**A**] [**B**] [**C**] [**D**].
2. Connection Level: [**1**] [**2**].
3. <**Insert requirement**>.

C. Seismic Performance: Ductwork to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**] <**Insert requirement**>. See Section 230548 "Vibration and Seismic Controls for HVAC."

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**] [**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

D. Wind Performance: Ducts are to withstand the effects of wind determined in accordance with to [**ASCE/SEI 7**] <**Insert requirement**>. See Section 230548 "Vibration and Seismic Controls for HVAC."

E. Airstream Surfaces: Surfaces in contact with airstream comply with requirements in ASHRAE 62.1.

F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."

G. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

H. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.
2. For ducts exposed to weather, construct of [**Type 304**] [**Type 316**] stainless steel indicated by manufacturer to be suitable for outdoor installation.

B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. For ducts with longest side less than 36 inches (914 mm), select joint types in accordance with Figure 2-1.
2. For ducts with longest side 36 inches (914 mm) or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.
3. [**Where specified for specific applications, all joints are to be welded.**]

C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."[**All longitudinal seams are to be Pittsburgh lock seams unless otherwise specified for specific application.**]

1. [**Where specified for specific applications, all joints are to be welded.**]

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain double-wall rectangular ducts and fittings from single manufacturer.

C. Rectangular Ducts: Fabricate ducts with indicated dimensions for clear internal dimensions of the inner duct.

D. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.
2. For ducts exposed to weather, construct outer duct of [**Type 304**] [**Type 316**] stainless steel indicated by manufacturer to be suitable for outdoor installation.

E. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. For ducts with longest side less than 36 inches (914 mm), select joint types in accordance with Figure 2-1.
2. For ducts with longest side 36 inches (914 mm) or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.
3. [**Where specified for specific applications, all joints are to be welded.**]

F. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."[**All longitudinal seams are to be Pittsburgh lock seams unless otherwise specified for specific application.**]

1. [**Where specified for specific applications, all joints are to be welded.**]

G. Interstitial Insulation, Fibrous Glass: Duct liner complying with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Maximum Thermal Conductivity: [**0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K)**] <**Insert conductivity**> at 75 deg F (24 deg C) mean temperature.
2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.
4. Cover insulation with polyester film complying with UL 181, Class 1.

H. Interstitial Insulation, Flexible Elastomeric: Duct liner complying with ASTM C534/C534M, Type II for sheet materials, and with NFPA 90A or NFPA 90B.

1. Maximum Thermal Conductivity: [**0.25 Btu x in./h x sq. ft. x deg F (0.034 W/m x K)**] <**Insert conductivity**> at 75 deg F (24 deg C) mean temperature.

I. Inner Duct: Minimum 24-gauge (0.7-mm) [**perforated galvanized sheet steel having 3/32-inch- (2.4-mm-) diameter perforations, with overall open area of 23 percent**] [**solid galvanized sheet steel**].

2.4 SINGLE-WALL ROUND[**AND FLAT-OVAL**] DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.

2. For ducts exposed to weather, construct of [**Type 304**] [**Type 316**] stainless steel indicated by manufacturer to be suitable for outdoor installation.
3. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain single-wall round[**and flat oval**] ducts and fittings from single manufacturer.

C. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

D. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than [**60 (1524)**] <**Insert dimension**> Inches (mm) in Diameter: Flanged.

E. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches (1830 mm) in width (major dimension) with butt-welded longitudinal seams.

F. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.5 DOUBLE-WALL ROUND[**AND FLAT-OVAL**] DUCTS AND FITTINGS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain double-wall round[**and flat oval**] ducts and fittings from single manufacturer.

C. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.

D. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.
2. For ducts exposed to weather, construct outer duct of [**Type 304**] [**Type 316**] stainless steel indicated by manufacturer to be suitable for outdoor installation.
3. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

   a. Transverse Joints in Ducts Larger Than [**60 (1524)**] <**Insert dimension**> Inches (mm) in Diameter: Flanged.

4. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

   a. Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.
   b. Fabricate flat-oval ducts larger than 72 inches (1830 mm) in width (major dimension) with butt-welded longitudinal seams.

5. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Inner Duct: Minimum 24-gauge (0.7-mm) [**perforated galvanized sheet steel having 3/32-inch- (2.4-mm-) diameter perforations, with overall open area of 23 percent**] [**solid galvanized sheet steel**].

F. Interstitial Insulation, Fibrous Glass: Duct liner complying with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Maximum Thermal Conductivity: [**0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K)**] <**Insert conductivity**> at 75 deg F (24 deg C) mean temperature.
2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.
4. Cover insulation with polyester film complying with UL 181, Class 1.

G. Interstitial Insulation, Flexible Elastomeric: Duct liner complying with ASTM C534/C534M, Type II for sheet materials, and with NFPA 90A or NFPA 90B.

1. Maximum Thermal Conductivity: [**0.25 Btu x in./h x sq. ft. x deg F (0.034 W/m x K)**] <**Insert conductivity**> at 75 deg F (24 deg C) mean temperature.

2.6 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials are to be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: [**G60 (Z180)**] [**G90 (Z275)**].
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: [**G60 (Z180)**] [**G90 (Z275)**].
2. Minimum Thickness for Factory-Applied PVC Coating: 4 mils (0.10 mm) thick[**on sheet metal surface of ducts and fittings exposed to corrosive conditions, and minimum 1 mil (0.025 mm) thick on opposite surface**].
3. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.

D. Carbon-Steel Sheets: Comply with ASTM A1008/A1008M, with oiled, matte finish for exposed ducts.

E. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304 or 316, as indicated in "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish is to be No. 2B, No. 2D, No. 3, or No. 4 as indicated in "Duct Schedule" Article.

F. Aluminum Sheets: Comply with ASTM B209 (ASTM B209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

G. Factory- or Shop-Applied Antimicrobial Coating:

1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating is to be applied to the exterior surface.
2. Antimicrobial compound is to be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Coating containing the antimicrobial compound is to have a hardness of 2H, minimum, when tested in accordance with ASTM D3363.
4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
5. Shop-Applied Coating Color: [**Black**] [**White**].
6. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.

H. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

I. Tie Rods: Galvanized steel, 1/4-inch- (6-mm-) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch- (10-mm-) minimum diameter for lengths longer than 36 inches (900 mm).

2.7 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain fibrous-glass duct liner from single manufacturer.
3. Maximum Thermal Conductivity:

   a. Type I, Flexible: [**0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K)**] <**Insert conductivity**> at 75 deg F (24 deg C) mean temperature.
   b. Type II, Rigid: [**0.23 Btu x in./h x sq. ft. x deg F (0.033 W/m x K)**] <**Insert conductivity**> at 75 deg F (24 deg C) mean temperature.

4. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound is to be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
5. [**Solvent**] [**Water**]-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C916.

   a. <Double click to insert sustainable design text for adhesive.>

b. <Double click to insert sustainable design text for adhesive.>

B. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C534/C534M, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain flexible elastomeric duct liner from single manufacturer.
3. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
4. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

a. <Double click to insert sustainable design text for adhesive.>
b. <Double click to insert sustainable design text for adhesive.>

C. Fibrous-Glass-Free, Natural-Fiber Duct Liner: Made from partially recycled cotton or polyester products and containing no fiberglass. Airstream surface overlaid with fire-resistant facing to prevent surface erosion by airstream, complying with NFPA 90A or NFPA 90B. Treat natural-fiber products with antimicrobial coating.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain fibrous-glass-free, natural-fiber duct liner from single manufacturer.
3. Maximum Thermal Conductivity: [**0.24 Btu x in./h x sq. ft. x deg F (0.034 W/m x K)**] <**Insert conductivity**> at 75 deg F (24 deg C) mean temperature when tested in accordance with ASTM C518.
4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with ASTM E84; certified by an NRTL.
5. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

a. <Double click to insert sustainable design text for adhesive.>
b. <Double click to insert sustainable design text for adhesive.>

D. Polyolefin Duct Liner: Cross-linked, partially open-cell polyolefin foam sheet or roll materials, with reinforced aluminum foil facing and adhesive backing, complying with NFPA 90A or NFPA 90B; sheet (Type II) complying with ASTM C1427.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain polyolefin duct liner from single manufacturer.
3. Foam Core Density: 1.5 pcf (25 kg/cm).
4. Maximum Thermal Conductivity: [**0.25 Btu x in./h x sq. ft. x deg F (0.036 W/m x K)**] <**Insert conductivity**> at 75 deg F (24 deg C) mean temperature when tested in accordance with ASTM C518.
5. Minimum Noise Reduction Coefficient (NRC): 0.50 for 3/8-inch (10-mm) thickness, 0.45 for 5/8-inch (15-mm) thickness, 0.55 for 1-inch (24-mm) thickness, 0.55 for 2-1/8-inch (54-mm) thickness.
6. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
7. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

a. <Double click to insert sustainable design text for adhesive.>
b. <Double click to insert sustainable design text for adhesive.>

E. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, [**0.106-inch- (2.6-mm-)**] [**0.135-inch- (3.5-mm-)**] diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick [**galvanized steel**] [**aluminum**] [**stainless steel**]; with beveled edge sized as required to hold insulation securely in place, but not less than 1-1/2 inches (38 mm) in diameter.

F. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm (12.7 m/s) or greater.
7. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

    a. Fan discharges.
    b. Intervals of lined duct preceding unlined duct.
    c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm (12.7 m/s) or where indicated.

9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.

    a. Sheet Metal Inner Duct Perforations: 3/32-inch (2.4-mm) diameter, with an overall open area of 23 percent.

10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.8 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets are to be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: [**3 inches (76 mm)**] [**4 inches (102 mm)**] [**6 inches (152 mm)**].
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10 inch wg (2500 Pa), positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. <Double click to insert sustainable design text for sealant.>
11. <Double click to insert sustainable design text for sealants.>

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10 inch wg (2500 Pa), positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. <Double click to insert sustainable design text for sealant.>
9. <Double click to insert sustainable design text for sealants.>
10. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive or negative.
11. Service: Indoor or outdoor.
12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. <Double click to insert sustainable design text for sealant.>
7. <Double click to insert sustainable design text for sealants.>

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:

1. Seal is to provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg (0.14 L/s per sq. m at 250 Pa) and is to be rated for10-inch wg (2500-Pa) static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.9 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Galvanized-steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.

E. Steel Cables for Stainless Steel Ducts: Stainless steel complying with ASTM A492.

F. Steel Cable End Connections: Galvanized-steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless Steel Ducts: Stainless steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.

B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts in maximum practical lengths with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.

H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches (38 mm).

J. Install fire[**, combination fire/smoke,**] and smoke dampers where indicated on Drawings and as required by code, and by local authorities having jurisdiction. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers and specific installation requirements of the damper UL listing.

K. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation.[**Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."**]

M. Elbows: Use long-radius elbows wherever they fit.

1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches (300 mm) and smaller and a minimum of five segments for 14 inches (350 mm) and larger.

N. Branch Connections: Use lateral or conical branch connections.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 ADDITIONAL INSTALLATION REQUIREMENTS FOR TYPE 1 COMMERCIAL KITCHEN GREASE HOOD EXHAUST DUCT

A. Install ducts in accordance with NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operation"; SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; and SMACNA's "Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines" unless otherwise indicated.

B. Install all ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.

C. All ducts exposed to view are to be constructed of stainless steel as per "Duct Schedule" Article. All ducts concealed from view are to be [**stainless**] [**carbon**] steel as per "Duct Schedule" Article.

D. All joints are to be welded and are to be telescoping, bell, or flange joint as per NFPA 96.

E. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of [**20 (6)**] [**12 (3.7)**] <**Insert dimension**> feet (m) in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings.

F. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

3.4 ADDITIONAL INSTALLATION REQUIREMENTS FOR EXHAUST DUCTS SERVING COMMERCIAL DISHWASHERS AND OTHER HIGH-HUMIDITY LOCATIONS

A. Install dishwasher exhaust ducts and other exhaust ducts from wet, high-humidity locations without dips and traps that may hold water. Slope ducts a minimum of 2 percent back to dishwasher or toward drain.

B. Provide a drain pocket at each low point and at the base of each riser with a 1-inch (25-mm) trapped copper drain from each drain pocket to open site floor drain.

C. Minimize number of transverse seams.

D. Do not locate longitudinal seams on bottom of duct.

3.5 ADDITIONAL INSTALLATION REQUIREMENTS FOR LABORATORY EXHAUST AND FUME HOOD EXHAUST DUCTS

A. Install ducts in accordance with NFPA 45, "Fire Protection for Laboratories Using Chemicals."

B. Install exhaust ducts without dips and traps that may hold water. Slope ducts a minimum of 2 percent back to hood or inlet. Where indicated on Drawings, install trapped drain piping.

C. Connect duct to fan, fume hood, and other equipment indicated on Drawings.

3.6 DUCTWORK EXPOSED TO WEATHER

A. All external joints are to [**be welded**] [**have secure watertight mechanical connections**]. Seal all openings to provide weatherproof construction.

B. Construct ductwork to resist external loads of wind, snow, ice, and other effects of weather. Provide necessary supporting structures.

C. Single Wall:

1. Ductwork is to be [**Type 304**] [**Type 316**] stainless steel.
2. Ductwork is to be galvanized steel.

a. If duct outer surface is uninsulated, protect outer surface with suitable paint. Paint materials and application requirements are specified in Section 099113 "Exterior Painting."

3. Where ducts have external insulation, provide weatherproof aluminum jacket. See Section 230713 "Duct Insulation."

D. Double Wall:

1. Ductwork complies with requirements in "Double-Wall Rectangular Ducts and Fittings" or "Double-Wall Round [**and Flat-Oval**]Ducts and Fittings" Article.
2. Ductwork outer wall is to be [**Type 304**] [**Type 316**] stainless steel indicated by manufacturer to be suitable for outdoor installation.
3. Provide interstitial insulation.

3.7 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts at a minimum to the following seal classes in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class C.
4. Outdoor, Return-Air Ducts: Seal Class C.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.8 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints. Coordinate with Section 230548 "Vibration and Seismic Controls for HVAC."

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches (610 mm) of each elbow and within 48 inches (1220 mm) of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet (5 m).

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.9 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. See Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraint installation requirements.

3.10 DUCTWORK CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.11 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.12 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.

2. Test the following systems:

   a. Ducts with a Pressure Class Higher Than 3-Inch wg (750 Pa): Test representative duct sections[**, selected by Architect from sections installed,**] totaling no less than 25 percent of total installed duct area for each designated pressure class.
   b. Supply Ducts with a Pressure Class of [**2- (500)**] [**3- (750)**] [**4- (1000)**] <**Insert number**> Inch wg (Pa) or Higher: Test representative duct sections[**, selected by Architect from sections installed,**] totaling no less than [**50**] [**100**] <**Insert number**> percent of total installed duct area for each designated pressure class.
   c. Return Ducts with a Pressure Class of [**2- (500)**] [**3- (750)**] [**4- (1000)**] <**Insert number**> Inch wg (Pa) or Higher: Test representative duct sections[**, selected by Architect from sections installed,**] totaling no less than [**50**] [**100**] <**Insert number**> percent of total installed duct area for each designated pressure class.
   d. Exhaust Ducts with a Pressure Class of [**2- (500)**] [**3- (750)**] [**4- (1000)**] <**Insert number**> Inch wg (Pa) or Higher: Test representative duct sections[**, selected by Architect from sections installed,**] totaling no less than [**50**] [**100**] <**Insert number**> percent of total installed duct area for each designated pressure class.
   e. Outdoor-Air Ducts with a Pressure Class of [**2- (500)**] [**3- (750)**] [**4- (1000)**] <**Insert number**> Inch wg (Pa) or Higher: Test representative duct sections[**, selected by Architect from sections installed,**] totaling no less than [**50**] [**100**] <**Insert number**> percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.
5. Test for leaks before applying external insulation.
6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
7. Give [**seven**] <**Insert number**> days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness in accordance with "Description of Method 3 - NADCA Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

   a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media is to not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.13 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. For cleaning of existing ductwork, see Section 230130.52 "Existing HVAC Air Distribution System Cleaning."

C. Use duct cleaning methodology as indicated in NADCA ACR.

D. Use service openings for entry and inspection.

1. Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers, coils, and any other locations where required for inspection and cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

E. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

F. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

G. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans in accordance with NADCA ACR. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents in accordance with manufacturer's written instructions after removal of surface deposits and debris.

3.14 STARTUP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.15 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.
2. Underground Ducts: Concrete-encased, [**galvanized sheet steel**] [**PVC-coated, galvanized sheet steel with thicker coating on duct exterior**] [**stainless steel**].
3. <**Insert requirements**>.

B. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units <**Insert equipment**>:

a. Pressure Class: Positive [**1- (250)**] [**2- (500)**] <**Insert number**>inch wg (Pa).
b. Minimum SMACNA Seal Class: [**A**] [**B**] [**C**].
c. SMACNA Leakage Class for Rectangular: [**2**] [**4**] [**8**] [**16**].
d. SMACNA Leakage Class for Round and Flat Oval: [**2**] [**4**] [**8**] [**16**].

2. Ducts Connected to Constant-Volume Air-Handling Units <**Insert equipment**>:

a. Pressure Class: Positive [**2- (500)**] [**3- (750)**] <**Insert number**>inch wg (Pa).
b. Minimum SMACNA Seal Class: [**A**] [**B**].
c. SMACNA Leakage Class for Rectangular: [**2**] [**4**] [**8**] [**16**].
d. SMACNA Leakage Class for Round and Flat Oval: [**2**] [**4**] [**8**] [**16**].

3. Ducts Connected to Variable-Air-Volume Air-Handling Units <**Insert equipment**>:

a. Pressure Class: Positive [**3- (750)**] [**4- (1000)**] <**Insert number**>inch wg (Pa).
b. Minimum SMACNA Seal Class: [**A**] [**B**].
c. SMACNA Leakage Class for Rectangular: [**2**] [**4**] [**8**] [**16**].
d. SMACNA Leakage Class for Round and Flat Oval: [**2**] [**4**] [**8**] [**16**].

4. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class: Positive [**2- (500)**] [**3- (750)**] [**4- (1000)**] <**Insert number**>inch wg (Pa).
b. Minimum SMACNA Seal Class: [**A**] [**B**] [**C**].
c. SMACNA Leakage Class for Rectangular: [**2**] [**4**] [**8**] [**16**].
d. SMACNA Leakage Class for Round and Flat Oval: [**2**] [**4**] [**8**] [**16**].

C. Return Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units <**Insert equipment**>:

a. Pressure Class: Positive or negative [**1- (250)**] [**2- (500)**] <**Insert number**>inch wg (Pa).
b. Minimum SMACNA Seal Class: [**A**] [**B**] [**C**].
c. SMACNA Leakage Class for Rectangular: [**2**] [**4**] [**8**] [**16**].

d. SMACNA Leakage Class for Round and Flat Oval: [**2**] [**4**] [**8**] [**16**].

2. Ducts Connected to Air-Handling Units <**Insert equipment**>:

   a. Pressure Class: Positive or negative [**2- (500)**] [**3- (750)**] <**Insert number**>inch wg (Pa).
   b. Minimum SMACNA Seal Class: [**A**] [**B**] [**C**].
   c. SMACNA Leakage Class for Rectangular: [**2**] [**4**] [**8**] [**16**].
   d. SMACNA Leakage Class for Round and Flat Oval: [**2**] [**4**] [**8**] [**16**].

3. Ducts Connected to Equipment Not Listed above:

   a. Pressure Class: Positive or negative [**2- (500)**] [**3- (750)**] [**4- (1000)**] <**Insert number**>inch wg (Pa).
   b. Minimum SMACNA Seal Class: [**A**] [**B**] [**C**].
   c. SMACNA Leakage Class for Rectangular: [**2**] [**4**] [**8**] [**16**].
   d. SMACNA Leakage Class for Round and Flat Oval: [**2**] [**4**] [**8**] [**16**].

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

   a. Pressure Class: Negative [**1- (250)**] [**2- (500)**] [**3- (750)**] <**Insert number**>inch wg (Pa).
   b. Minimum SMACNA Seal Class: [**A**] [**B**] [**C**] if negative pressure, and A if positive pressure.
   c. SMACNA Leakage Class for Rectangular: [**2**] [**4**] [**8**] [**16**].
   d. SMACNA Leakage Class for Round and Flat Oval: [**2**] [**4**] [**8**] [**16**].

2. Ducts Connected to Air-Handling Units <**Insert equipment**>:

   a. Pressure Class: Positive or negative [**2- (500)**] [**3- (750)**] <**Insert number**>inch wg (Pa).
   b. Minimum SMACNA Seal Class: [**A**] [**B**] [**C**] if negative pressure, and [**A**] [**B**] [**C**] if positive pressure.
   c. SMACNA Leakage Class for Rectangular: [**2**] [**4**] [**8**] [**16**].
   d. SMACNA Leakage Class for Round and Flat Oval: [**2**] [**4**] [**8**] [**16**].

3. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96.

   a. Exposed to View: Type 304, stainless steel sheet, [**No. 4**] [**No. 3**] <**Insert finish**> finish.
   b. Concealed: [**Type 304, stainless steel sheet, No. 2D finish**] [**Carbon-steel sheet**].
   c. Welded seams and joints.
   d. Pressure Class: Positive or negative [**2- (500)**] [**3- (750)**] [**4- (1000)**] <**Insert number**>inch wg (Pa).
   e. Airtight/watertight.

4. Ducts Connected to Dishwashers, Dishwasher Hoods, and Other High-Humidity Locations:

   a. Type 304, stainless steel sheet.
   b. Exposed to View: [**No. 4**] [**No. 3**] <**Insert finish**> finish.
   c. Concealed: [**No. 2D**] <**Insert finish**> finish.
   d. Welded longitudinal seams; welded or flanged transverse joints with watertight EPDM gaskets.
   e. Pressure Class: Positive or negative [**2- (500)**] [**3- (750)**] <**Insert number**>inch wg (Pa).
   f. Airtight/watertight.

5. Ducts Connected to Fans Exhausting Fume Hood, Laboratory, and Process (ASHRAE 62.1, Class 3 and Class 4) Air:

a. [**Type 316**] [**Type 304**], stainless steel sheet.

1) Exposed to View: [**No. 4**] [**No. 3**] <**Insert finish**> finish.
2) Concealed: [**No. 2B**] [**No. 2D**] <**Insert finish**> finish.

b. PVC-coated, galvanized sheet steel with thicker coating on duct interior.
c. Pressure Class: Positive or negative [**3- (750)**] [**4- (1000)**] [**6- (1500)**] <**Insert number**>inch wg (Pa).
d. [**Minimum SMACNA Seal Class A**] [**Welded seams and joints**].
e. [**SMACNA Leakage Class 2.**]
f. [**Airtight/watertight.**]

6. Ducts Connected to Equipment Not Listed above:

a. Pressure Class: Positive or negative [**2- (500)**] [**3- (750)**] [**4- (1000)**] <**Insert number**>inch wg (Pa).
b. Minimum SMACNA Seal Class: [**A**] [**B**] if negative pressure; A if positive pressure.
c. SMACNA Leakage Class for Rectangular: [**2**] [**4**] [**8**] [**16**].
d. SMACNA Leakage Class for Round and Flat Oval: [**2**] [**4**] [**8**] [**16**].

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units <**Insert equipment**>:

a. Pressure Class: Positive or negative [**1- (250)**] [**2- (500)**] <**Insert number**>inch wg (Pa).
b. Minimum SMACNA Seal Class: [**A**] [**B**] [**C**].
c. SMACNA Leakage Class for Rectangular: [**8**] [**16**].
d. SMACNA Leakage Class for Round and Flat Oval: [**8**] [**16**].

2. Ducts Connected to Air-Handling Units <**Insert equipment**>:

a. Pressure Class: Positive or negative [**2- (500)**] [**3- (750)**] <**Insert number**>inch wg (Pa).
b. Minimum SMACNA Seal Class: [**A**] [**B**].
c. SMACNA Leakage Class for Rectangular: [**2**] [**4**] [**8**] [**16**].
d. SMACNA Leakage Class for Round and Flat Oval: [**2**] [**4**] [**8**] [**16**].

3. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class: Positive or negative [**2- (500)**] [**3- (750)**] [**4- (1000)**] <**Insert number**>inch wg (Pa).
b. Minimum SMACNA Seal Class: [**A**] [**B**].
c. SMACNA Leakage Class for Rectangular: [**2**] [**4**] [**8**] [**16**].
d. SMACNA Leakage Class for Round and Flat Oval: [**2**] [**4**] [**8**] [**16**].

F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: [**Galvanized steel**] [**Carbon steel coated with zinc-chromate primer**] [**Galvanized steel or carbon steel coated with zinc-chromate primer**].
2. PVC-Coated Ducts:

a. Exposed to Airstream: Match duct material.
b. Not Exposed to Airstream: [**Galvanized**] [**Match duct material**].

3. Stainless Steel Ducts:

a. Exposed to Airstream: Match duct material.
b. Not Exposed to Airstream: [**Galvanized**] [**Match duct material**].

4. Aluminum Ducts: [**Aluminum**] [**or**] [**galvanized steel coated with zinc chromate**].

G. Liner:

1. Supply-Air Ducts: [**Fibrous glass, Type I**] [**Flexible elastomeric**] [**Fibrous-glass-free, natural fiber**] [**Polyolefin**], [**5/8 (15)**] [**1 (25)**] [**1-1/2 (38)**] [**2 (51)**] <**Insert dimension**> inch (mm) thick.
2. Return-Air Ducts: [**Fibrous glass, Type I**] [**Flexible elastomeric**] [**Fibrous-glass-free, natural fiber**] [**Polyolefin**], [**5/8 (15)**] [**1 (25)**] [**1-1/2 (38)**] [**2 (51)**] <**Insert dimension**> inch (mm) thick.
3. Exhaust-Air Ducts: [**Fibrous glass, Type I**] [**Flexible elastomeric**] [**Fibrous-glass-free, natural fiber**] [**Polyolefin**], [**5/8 (15)**] [**1 (25)**] <**Insert dimension**> inch (mm) thick.
4. Supply Fan Plenums: [**Fibrous glass, Type II**] [**Flexible elastomeric**] [**Fibrous-glass-free, natural fiber**] [**Polyolefin**], [**5/8 (15)**] [**1 (25)**] [**1-1/2 (38)**] [**2 (51)**] <**Insert dimension**> inch (mm) thick.
5. Return- and Exhaust-Fan Plenums: [**Fibrous glass, Type II**] [**Flexible elastomeric**] [**Fiberglass-free, natural fiber**] [**Polyolefin**], [**5/8 (15)**] [**1 (25)**] [**1-1/2 (38)**] [**2 (51)**] <**Insert dimension**> inches (mm) thick.
6. Transfer Ducts: [**Fibrous glass, Type I**] [**Flexible elastomeric**] [**Fibrous-glass-free, natural fiber**] [**Polyolefin**], [**5/8 (15)**] [**1 (25)**] [**1-1/2 (38)**] [**2 (51)**] <**Insert dimension**> inch (mm) thick.

H. Double-Wall Duct Interstitial Insulation:

1. Supply-Air Ducts: [**1 (25)**] [**1-1/2 (38)**] [**2 (51)**] <**Insert dimension**> inch (mm) thick.
2. Return-Air Ducts: [**1 (25)**] [**1-1/2 (38)**] [**2 (51)**] <**Insert dimension**> inch (mm) thick.
3. Exhaust-Air Ducts: [**1 (25)**] [**1-1/2 (38)**] [**2 (51)**] <**Insert dimension**> inch (mm) thick.

I. Elbow Configuration:

1. Rectangular Duct - Requirements for Different Velocities: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Velocity 1000 fpm (5 m/s) or Lower:

1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s):

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

c. Velocity 1500 fpm (7.6 m/s) or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct - Requirements for All Velocities: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

   a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
   b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
   c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

   a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

      1) Velocity 1000 fpm (5 m/s) or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
      2) Velocity 1000 to 1500 fpm (5 to 7.6 m/s): 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
      3) Velocity 1500 fpm (7.6 m/s) or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
      4) Radius-to Diameter Ratio: 1.5.

   b. Round Elbows, [**12 (305)**] <**Insert dimension**> Inches (mm) and Smaller in Diameter: Stamped or pleated.
   c. Round Elbows, [**14 (356)**] <**Insert dimension**> Inches (mm) and Larger in Diameter: [**Standing seam**] [**Welded**].

J. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

   a. Rectangular Main to Rectangular Branch: 45-degree entry.
   b. Rectangular Main to Round Branch: Conical spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

   a. Velocity 1000 fpm (5 m/s) or Lower: 90-degree tap.
   b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s): Conical tap.
   c. Velocity 1500 fpm (7.6 m/s) or Higher: 45-degree lateral.

END OF SECTION 23 01 30 61

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SECTION 23 01 50 61 - CAST-IRON BOILERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for cast-iron boilers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes packaged cast-iron boilers, trim, and accessories for generating hot water or steam with the following configurations and burners:
   a. Factory and Field assembled.
   b. Atmospheric gas, Sealed-combustion, gas, Forced-draft, gas, Oil, and Combination gas and oil burner.

C. Submittals
1. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
2. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.
   a. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.
      1) Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
      2) Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and equipment mounting frames.
   b. Wiring Diagrams: Power, signal, and control wiring.
3. Manufacturer Seismic Qualification Certification: Submit certification that boiler, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment". Include the following:
4. Source quality-control test reports.
5. Field quality-control test reports.
6. Operation and maintenance data.
7. Warranty: Special warranty specified in this Section.

D. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
3. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
4. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."
5. I=B=R Compliance: Boilers shall be tested and rated according to HI's "Rating Procedure for Heating Boilers" and "Testing Standard for Commercial Boilers," with I=B=R emblem on a nameplate affixed to boiler.
6. UL Compliance: Test boilers for compliance with UL 726, "Oil-Fired Boiler Assemblies **OR** UL 726, "Oil-Fired Boiler Assemblies," and UL 795, "Commercial-Industrial Gas Heating

Equipment **OR** UL 795, "Commercial-Industrial Gas Heating Equipment", **as directed**. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

E. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace controls and heat exchangers of boilers that fail in materials or workmanship within specified warranty period.
   a. Warranty Period for Controls: Two years from date of Final Completion.
   b. Warranty Period for Heat Exchangers: Five **OR** 10 **OR** 20, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Manufactured Units
1. Description: Factory fabricated and assembled **OR** field assembled, **as directed**.
   a. Cast-iron sections shall be sealed pressure tight and held together with tie rods set on an insulated steel base, **as directed**; including insulated jacket and flue-gas vent connection.
      OR
      Ship cast-iron sections disassembled with all materials and equipment, including seals, tie rods, and insulated jacket and flue-gas vent connection for field assembly.
2. Cast-Iron Section Design:
   a. Configuration: Wet base **OR** back **OR** leg, **as directed**.
   b. Number of Passes: Single **OR** Multiple, **as directed**.
   c. Sectional Joints: High-temperature sealant to seal flue-gas passages not in contact with heating medium, tapered cast-iron push nipples, **OR** O-ring gaskets, **OR** fiber roping, **as directed**, and held together with tie rods.
   d. Drain and blowdown tappings.
   e. Return injection tube to equalize water flow to all sections.
   f. Crown inspection tappings with brass plugs.
   g. Built-in air separator.
3. Combustion Chamber: Equipped with ceramic-fiber target wall **OR** refractory **OR** insulation, **as directed**, and flame observation ports, front and back.
4. Casing:
   a. Jacket: Sheet metal **OR** Galvanized sheet metal, **as directed**, with snap-in or interlocking closures and baked-enamel **OR** powder-coated, **as directed**, protective finish.
   b. Insulation: Minimum 1-inch- (25-mm-) **OR** 2-inch- (50-mm-), **as directed**, thick, mineral-fiber insulation surrounding the heat exchanger.
   c. Combustion Chamber Access: Refractory lined, hinged, front.
   d. Access: For cleaning between cast-iron sections.
   e. Draft Hood: Flue canopy and top **OR** rear, **as directed**, flue connection shall be constructed of aluminized **OR** stainless, **as directed**, steel containing adjustable outlet damper assembly.
   f. Insulated base constructed of aluminized steel to permit boiler to be installed on combustible floor.
   g. Mounting Frame: Steel rails to mount assembled boiler package on concrete base.
      1) Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment" when mounting base is anchored to building structure.
   h. Control Cabinet: Sheet metal casing shall cover all controls, gas train, and burner.
5. Draft Diverter: Steel assembly integral with boiler casing **OR** Separate galvanized-steel assembly, **as directed**.

B. Burner: For Atmospheric Gas Burners.

1. Burner Tubes and Orifices: Stainless steel **OR** Cast iron, **as directed**, for natural **OR** propane, **as directed**, gas.
2. Gas Train: Control devices and full-modulation **OR** on-off **OR** low-high-low, **as directed**, control sequence shall comply with requirements in ASME CSD-1 **OR** FMG **OR** IRI **OR** UL, **as directed**.
OR
Gas Train: Combination gas valve with manual shutoff, pressure regulator, and pilot adjustment.
3. Pilot: Standing **OR** Intermittent-electric-spark, **as directed**, pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

C. Burner: For Residential-Size Boilers With Sealed-Combustion Burners.
1. Burner Tubes and Orifices: Stainless steel **OR** Cast iron, **as directed**, for natural **OR** propane, **as directed**, gas.
2. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.
   a. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
      1) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
3. Gas Train: Combination gas valve with manual shutoff, pressure regulator, and pilot adjustment.
4. Pilot: Standing **OR** Intermittent-electric-spark, **as directed**, pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

D. Burner: For Forced-Draft Burners.
1. Burner: Welded construction with multivane, stainless-steel, flame-retention diffuser for natural **OR** propane, **as directed**, gas.
2. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.
   a. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
      1) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
3. Gas Train: Control devices and modulating **OR** on-off **OR** low-high-low, **as directed**, control sequence shall comply with requirements in ASME CSD-1 **OR** FMG **OR** IRI **OR** UL, **as directed**.
4. Pilot: Intermittent **OR** Interrupted, **as directed**,-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.
5. Flue-Gas Recirculation: Burner connections shall be equipped for recirculating flue gas.
   a. Maximum Oxides of Nitrogen Emissions: 20 **OR** 30, **as directed**, ppm.

E. Burner: For Oil Burners.
1. Burner: Welded construction with multivane, stainless-steel, flame-retention diffuser for fuel oil.
2. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.
   a. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
      1) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
3. Oil Supply: Control devices and modulating **OR** on-off **OR** low-high-low, **as directed**, control sequence shall comply with requirements in ASME CSD-1 **OR** FMG **OR** IRI **OR** UL, **as directed**.
   a. Oil Pump: Two-stage, gear-type oil pump integral to and directly driven by blower, **as directed**, shall be capable of producing 300-psig (2070-kPa) discharge pressure and 15-inch Hg (50.7-kPa) vacuum.
   b. Oil Piping Specialties:
      1) Suction-line, manual, gate valve.
      2) Removable-mesh oil strainer.
      3) 0- to 30-inch Hg (0- to 101.3-kPa) vacuum; 0- to 30-psig (0- to 207-kPa) vacuum-pressure gage.

4) 0- to 300-psig (0- to 2070-kPa) oil-nozzle pressure gage.
5) Nozzle-line, solenoid-safety-shutoff oil valve.

4. Pilot: Intermittent **OR** Interrupted, **as directed**,-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff solenoid using cadmium sulfide **OR** UV scanner, **as directed**, flame-safety control.
5. Flue-Gas Recirculation: Burner connections shall be equipped for recirculating flue gas.
   a. Maximum Oxides of Nitrogen Emissions: 30 ppm.

F. Burner: For Combination Gas And Oil Burners.
1. Burner: Welded construction with multivane, stainless-steel, flame-retention diffuser for fuel oil and natural **OR** propane, **as directed**, gas.
2. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.
   a. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
      1) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
3. Oil Supply: Control devices and modulating **OR** on-off **OR** low-high-low, **as directed**, control sequence shall comply with requirements in ASME CSD-1 **OR** FMG **OR** IRI **OR** UL, **as directed**.
   a. Oil Pump: Two-stage, gear-type oil pump integral to and directly driven by blower, **as directed**, shall be capable of producing 300-psig (2070-kPa) discharge pressure and 15-inch Hg (50.7-kPa) vacuum.
   b. Oil Piping Specialties:
      1) Suction-line, manual, gate valve.
      2) Removable-mesh oil strainer.
      3) 0- to 30-inch Hg (0- to 101.3-kPa) vacuum; 0- to 30-psig (0- to 207-kPa) vacuum-pressure gage.
      4) 0- to 300-psig (0- to 2070-kPa) oil-nozzle pressure gage.
      5) Nozzle-line, solenoid-safety-shutoff oil valve.
4. Gas Train: Control devices and modulating **OR** on-off **OR** low-high-low, **as directed**, control sequence shall comply with requirements in ASME CSD-1 **OR** FMG **OR** IRI **OR** UL, **as directed**.
5. Gas Pilot: Intermittent **OR** Interrupted, **as directed**,-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.
6. Oil Pilot: Intermittent **OR** Interrupted, **as directed**,-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff solenoid with cadmium sulfide **OR** UV scanner, **as directed**, flame-safety control.
7. Flue-Gas Recirculation: Burner connections shall be equipped for recirculating flue gas.
   a. Maximum Oxides of Nitrogen Emissions: 20 **OR** 30, **as directed**, ppm.

G. Trim: For Hot-Water Boilers.
1. Include devices sized to comply with ANSI B31.9, "Building Services Piping."
2. Aquastat Controllers: Operating, firing rate, **as directed**, and high limit.
3. Safety Relief Valve: ASME rated.
4. Pressure and Temperature Gage: Minimum 3-1/2-inch- (89-mm-) diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.
5. Boiler Air Vent: Automatic **OR** Manual, **as directed**.
6. Drain Valve: Minimum NPS 3/4 (DN 20) hose-end gate valve.
7. Tankless Heater: Carbon-steel header with copper-tube heat exchanger, mounted in an upper port of cast-iron sections and sealed with fiber gasket.
   a. Tappings NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
   b. Tappings NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

H. Trim: For Steam Boilers.
 1. Include devices sized to comply with ANSI B31.9, "Building Services Piping."
 2. Pressure Controllers: Operating, firing rate, **as directed**, and high limit.
 3. Safety Relief Valve:
  a. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.
  b. Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.
   1) Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
 4. Pressure Gage: Minimum 3-1/2-inch (89-mm) diameter. Gage shall have normal operating pressure about 50 percent of full range.
 5. Water Column: Minimum 12-inch (300-mm) glass gage with shutoff cocks.
 6. Drain Valves: Minimum NPS 3/4 (DN 20) or nozzle size with hose-end connection.
 7. Blowdown Valves: Factory-installed bottom and surface, slow-acting blowdown valves same size as boiler nozzle.
 8. Stop Valves: Boiler inlets and outlets, except safety relief valves or preheater inlet and outlet, shall be equipped with stop valve in an accessible location as near as practical to boiler nozzle and same size as or larger than nozzle. Valves larger than NPS 2 (DN 50) shall have rising stem.
 9. Stop-Check Valves: Factory-installed, stop-check valve and stop valve at boiler outlet with free-blow drain valve factory installed between the two valves and visible when operating stop-check valve.
 10. Tankless Heater: Carbon-steel header with copper-tube heat exchanger, mounted in an upper port of cast-iron sections and sealed with fiber gasket.
  a. Tappings NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
  b. Tappings NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

I. Controls
 1. Refer to Division 23 Section "Instrumentation And Control For Hvac".
 OR
 Boiler operating controls shall include the following devices and features:
  a. Control transformer.
  b. Set-Point Adjust: Set points shall be adjustable.
  c. Operating Pressure Control for Steam Boilers: Factory wired and mounted to cycle burner.
  d. Low-Water Cutoff and Pump Control for Steam Boilers: Cycle feedwater pump(s) for makeup water control.
  e. Sequence of Operation for Hot-Water Boilers: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain space temperature in response to thermostat with heat anticipator located in heated space.
  OR
  Sequence of Operation for Hot-Water Boilers: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 0 deg F (minus 17 deg C) outside-air temperature, set supply-water temperature at 200 deg F (93 deg C); at 60 deg F (15 deg C) outside-air temperature, set supply-water temperature at 140 deg F (60 deg C).
  f. Sequence of Operation for Steam Boilers: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain a constant steam pressure. Maintain pressure set point plus or minus 10 percent.
   1) Include automatic, alternating-firing sequence for multiple boilers.
 2. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
  a. High Cutoff: Manual **OR** Automatic, **as directed**, reset stops burner if operating conditions rise above maximum boiler design temperature **OR** pressure, **as directed**.

b. Low-Water Cutoff Switch: Electronic for hot-water boilers or Float and electronic for steam boilers probe shall prevent burner operation on low water. Cutoff switch shall be manual **OR** automatic, **as directed**,-reset type.
c. Blocked Vent Safety Switch for Atmospheric Burners: Manual-reset switch factory mounted on draft diverter.
d. Rollout Safety Switch for Atmospheric Burners: Factory mounted on boiler combustion chamber.
e. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

3. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
   a. Hardwired Points:
      1) Monitoring: On/off status, common trouble alarm **OR** low water level alarm, **as directed**.
      2) Control: On/off operation, hot water supply temperature set-point adjustment **OR** steam pressure adjustment, **as directed**.
   b. A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

J. Electrical Power
1. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 22..
2. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
   a. House in NEMA 250, Type 1 enclosure.
   b. Wiring shall be numbered and color-coded to match wiring diagram.
   c. Install factory wiring outside of an enclosure in a metal raceway.
   d. Field power interface shall be to wire lugs **OR** fused disconnect switch **OR** nonfused disconnect switch **OR** circuit breaker, **as directed**.
   e. Provide branch power circuit to each motor and to controls with disconnect switch or circuit breaker, **as directed**.
   f. Provide each motor with overcurrent protection.

K. Source Quality Control
1. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
2. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
3. Allow the Owner access to source quality-control testing of boilers. Notify the Owner 14 days in advance of testing.

1.3 EXECUTION

A. Boiler Installation
1. Install boilers level on concrete base. Concrete base is specified in Division 23 Section "Common Work Results For Hvac" and concrete materials and installation requirements are specified in Division 31..
2. Vibration Isolation: Elastomeric isolator pads **OR** mounts, **as directed**, with a minimum static deflection of 0.25 inch (6.35 mm). Vibration isolation devices and installation requirements are

specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
3. Install gas-fired boilers according to NFPA 54.
4. Install oil-fired boilers according to NFPA 31.
5. Assemble boiler sections in sequence and seal between each section if boiler is not delivered fully assembled.
6. Assemble and install boiler trim.
7. Install electrical devices furnished with boiler but not specified to be factory mounted.
8. Install control wiring to field-mounted electrical devices.

B. Connections
1. Piping installation requirements are specified in other Division 21. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to boiler to allow service and maintenance.
3. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
4. Connect oil piping full size to burner inlet with shutoff valve and union.
5. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.
6. Connect steam and condensate piping to supply-, return-, and blowdown-boiler tappings with shutoff valve and union or flange at each connection.
7. Install piping from safety relief valves to nearest floor drain, for hot-water boilers.
8. Install piping from safety valves to drip-pan elbow and to nearest floor drain, for steam boilers.
9. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
10. Connect breeching full size to boiler outlet. Comply with requirements in Division 23 Section "Breechings, Chimneys, And Stacks" for venting materials.
11. Install flue-gas recirculation duct from vent to burner. Comply with requirements in Division 23 Section "Breechings, Chimneys, And Stacks" for recirculation duct materials.
12. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
13. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Field Quality Control
1. Perform tests and inspections and prepare test reports.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Tests and Inspections:
   a. Perform installation and startup checks according to manufacturer's written instructions.
   b. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
   c. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
   d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
      1) Burner Test: Adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency.
      2) Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature **OR** steam pressure, **as directed**.
      3) Set field-adjustable switches and circuit-breaker trip ranges as indicated.
3. Remove and replace malfunctioning units and retest as specified above.
4. Occupancy Adjustments: When requested within 12 months of date of Final Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

5. Performance Tests, **as directed**:
   a. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
   b. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
   c. Perform field performance tests to determine capacity and efficiency of boilers.
      1) For dual-fuel boilers, perform tests for each fuel.
      2) Test for full capacity.
      3) Test for boiler efficiency at low fire 20, 40, 60, 80, 100, 80, 60, 40, and 20 percent of full capacity. Determine efficiency at each test point.
   d. Repeat tests until results comply with requirements indicated.
   e. Provide analysis equipment required to determine performance.
   f. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
   g. Notify the Owner in advance of test dates.
   h. Document test results in a report and submit to the Owner.

D. Demonstration
   1. Train the Owner's maintenance personnel to adjust, operate, and maintain boilers.

END OF SECTION 23 01 50 61

Task	Specification	Specification Description
23 01 50 61	01 22 16 00	No Specification Required
23 01 50 61	22 11 16 00c	Hydronic Piping

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SECTION 23 01 60 71 - CONDENSING UNITS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for condensing units. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes air-cooled and water-cooled condensing units.

C. Submittals

1. Product Data: For each condensing unit, include rated capacities, operating characteristics, furnished specialties, and accessories. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Shop Drawings: Signed and sealed by a qualified professional engineer.
   a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints, **as directed**, and for designing vibration isolation bases.
   b. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
   c. Wiring Diagrams: Power, signal, and control wiring.
3. Manufacturer Seismic Qualification Certification: Submit certification that condensing units, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment". Include the following:
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
4. Field quality-control test reports.
5. Operation and maintenance data.
6. Warranty: Special warranty specified in this Section.
7. LEED Submittal:
   a. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.

D. Quality Assurance

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Code for Mechanical Refrigeration."
3. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
4. ASME Compliance: Fabricate and label water-cooled condensing units to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

E. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Compressor failure.
      2) Condenser coil leak.

b. Warranty Period: Four **OR** Five **OR** 10, **as directed**, years from date of Final Completion.
c. Warranty Period (Compressor Only): Five **OR** 10, **as directed**, years from date of Final Completion.
d. Warranty Period (Condenser Coil Only): Five years from date of Final Completion.

1.2 PRODUCTS

A. Condensing Units, Air Cooled, 1 To 5 Tons (3.5 TO 17.6 kW)
1. Description: Factory assembled and tested, consisting of compressor, condenser coil, fan, motors, refrigerant reservoir, and operating controls.
2. Compressor: Scroll, hermetically sealed, with rubber vibration isolators.
a. Motor: Single **OR** Two, **as directed**, speed, and includes thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
b. Two-Speed Compressor: Include manual-reset, high-pressure switch and automatic-reset, low-pressure switch.
c. Accumulator: Suction tube.
d. Refrigerant Charge: R-407C **OR** R-410A, **as directed**.
3. Condenser Coil: Seamless copper-tube, aluminum-fin coil; circuited for integral liquid subcooler, with removable drain pan and brass service valves with service ports.
4. Condenser Fan: Direct-drive, aluminum propeller fan; with permanently lubricated, totally enclosed fan motor with thermal-overload protection and ball bearings, **as directed**.
5. Accessories:
a. Coastal Filter: Mesh screen to protect condenser coil from salt damage.
b. Crankcase heater.
c. Cycle Protector: Automatic-reset timer to prevent rapid compressor cycling.
d. Electronic programmable thermostat **OR** Low-voltage thermostat and subbase, **as directed**, to control condensing unit and evaporator fan.
e. Evaporator Freeze Thermostat: Temperature-actuated switch that stops unit when evaporator reaches freezing temperature.
f. Filter-dryer.
g. High-Pressure Switch: Automatic-reset switch cycles compressor off on high refrigerant pressure.
h. Liquid-line solenoid.
i. Low Ambient Controller: Cycles condenser fan to permit operation down to 0 deg F (minus 18 deg C) with time-delay relay to bypass low-pressure switch, **as directed**.
OR
Low Ambient Controller: Controls condenser fan speed to permit operation down to minus 20 deg F (minus 29 deg C) with time-delay relay to bypass low-pressure switch, **as directed**.
j. Low-Pressure Switch: Automatic-reset switch cycles compressor off on low refrigerant pressure.
k. PE mounting base to provide a permanent foundation.
l. Precharged and insulated suction and liquid tubing.
m. Sound Hood: Wraps around sound attenuation cover for compressor.
n. Thermostatic expansion valve.
o. Time-Delay Relay: Continues operation of evaporator fan after compressor shuts off.
6. Unit Casing: Galvanized steel, finished with baked enamel; with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Mount service valves, fittings, and gage ports on exterior of casing.

B. Condensing Units, Air Cooled, 6 To 120 Tons (21 TO 422 kW)
1. Description: Factory assembled and tested, air cooled; consisting of casing, compressors, condenser coils, condenser fans and motors, and unit controls.

2. Compressor: Hermetic or semihermetic compressor designed for service with crankcase sight glass, crankcase heater, and backseating service access valves on suction and discharge ports.
   a. Capacity Control: Cylinder unloading **OR** Hot-gas bypass, **as directed**.
   b. Refrigerant Charge: R-407C **OR** R-410A **OR** HFC-134a, **as directed**.
3. Condenser Coil: Seamless copper-tube, aluminum-fin coil, including subcooling circuit and backseating liquid-line service access valve. Factory pressure test coils, then dehydrate by drawing a vacuum and fill with a holding charge of nitrogen or refrigerant.
4. Condenser Fans: Propeller-type vertical discharge; either directly or belt driven. Include the following:
   a. Permanently lubricated ball-bearing motors.
   b. Separate motor for each fan.
   c. Dynamically and statically balanced fan assemblies.
5. Operating and safety controls include the following:
   a. Manual-reset, high-pressure cutout switches.
   b. Automatic-reset, low-pressure cutout switches.
   c. Low oil pressure cutout switch.
   d. Compressor-winding thermostat cutout switch.
   e. Three-leg, compressor-overload protection.
   f. Control transformer.
   g. Magnetic contactors for compressor and condenser fan motors.
   h. Timer to prevent excessive compressor cycling.
6. Accessories:
   a. Electronic programmable thermostat **OR** Low-voltage thermostat and subbase, **as directed**, to control condensing unit and evaporator fan.
   b. Low Ambient Controller: Cycles condenser fan to permit operation down to 0 deg F (minus 18 deg C) with time-delay relay to bypass low-pressure switch, **as directed**.
      OR
      Low Ambient Controller: Controls condenser fan speed to permit operation down to minus 20 deg F (minus 29 deg C) with time-delay relay to bypass low-pressure switch, **as directed**.
   c. Gage Panel: Package with refrigerant circuit suction and discharge gages.
   d. Hot-gas bypass kit.
   e. Part-winding-start timing relay, circuit breakers, and contactors.
7. Unit Casings: Designed for outdoor installation with weather protection for components and controls and with removable panels for required access to compressors, controls, condenser fans, motors, and drives. Additional features include the following:
   a. Steel, galvanized or zinc coated, for exposed casing surfaces; treated and finished with manufacturer's standard paint coating.
   b. Perimeter base rail with forklift slots and lifting holes to facilitate rigging.
   c. Gasketed control panel door.
   d. Nonfused disconnect switch, factory mounted and wired, for single external electrical power connection.
   e. Condenser coil hail guard **OR** grille, **as directed**, to protect coil from physical damage.

C. Condensing Units, Water Cooled
1. Description: Factory assembled and tested, water cooled; consisting of compressors, water-cooled condensers, bases, and unit controls.
2. Compressor: Hermetic or serviceable hermetic type; with oil pump, operating oil charge, and suction and discharge shutoff valves. Factory mounted on base using spring isolators. Include the following:
   a. Thermally protected compressor motor.
   b. Crankcase heater.
   c. Capacity control using cylinder unloading, suction pressure controlled and discharge pressure operated, designed for unloaded start.
   d. Refrigerant Charge: R-407C **OR** R-410A **OR** HFC-134a, **as directed**.

3. Condenser: Single-pass, tube-in-tube coaxial type; with seamless, integral-finned, copper tube and steel outer shell with water-regulating valve.
   OR
   Condenser: Multipass, shell-and-tube type; with replaceable, seamless, integral-finned copper tubes; positive-liquid subcooling circuit; pressure relief device; liquid-level test cock; purge connection; liquid-line shutoff valve; and angle valve for connection of water-regulating valve.
   a. Unit Construction: ASME stamped, **as directed**, for refrigerant-side working pressure of 385 psig (2650 kPa) and water-side working pressure of 250 psig (1720 kPa).
4. Accessories include the following:
   a. Discharge-line muffler.
   b. Gage panel containing gages for suction, discharge, and oil pressure.
   c. Electric solenoid cylinder unloaders.
   d. Pump-down relay package.
   e. Crankcase cover plates with equalizer connections.
5. Controls: Factory-mounted and -wired panel with the following:
   a. Timer to prevent short cycling.
   b. High- and low-refrigerant-pressure safety controls.
   c. Power- and control-circuit terminal blocks.
   d. Compressor motor starter.
   e. Control-circuit on-off switch.
   f. Control-circuit fuse.

D. Motors
1. General requirements for motors are specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
   a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   b. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 22.

E. Source Quality Control
1. Verification of Performance: Rate condensing units according to ARI 210/240, ARI 340/360, or ARI 365.
   a. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."
2. Test and inspect shell and tube condensers according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Testing Requirements: Factory test sound-power-level ratings according to ARI 270.

1.3 EXECUTION

A. Installation
1. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.
2. Install condensing units on concrete base. Concrete base is specified in Division 23 Section "Common Work Results For Hvac" and concrete materials and installation requirements are specified in Division 31.
3. Concrete Bases:
   a. Install dowel rods to connect concrete base to concrete slab. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of the base.
   b. For equipment supported on structural slab, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

d. Install anchor bolts to elevations required for proper attachment to supported equipment.
e. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

4. Install roof-mounting units on equipment supports specified in Division 07.
5. Vibration Isolation: Mount condensing units on rubber pads with a minimum deflection of 1/4 inch (6.35 mm). Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
OR
Vibration Isolation: Mount condensing units on restrained spring isolators with a minimum deflection specified by the Owner. Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
6. Maintain manufacturer's recommended clearances for service and maintenance.
7. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

B. Connections
1. Piping installation requirements are specified in other Division 21. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to machine to allow service and maintenance.
3. Connect precharged refrigerant tubing to unit's quick-connect fittings. Install tubing so it does not interfere with access to unit. Install furnished accessories.
4. Connect refrigerant piping to air-cooled condensing units; maintain required access to unit. Install furnished field-mounted accessories. Refrigerant piping and specialties are specified in Division 23 Section "Refrigerant Piping".
5. Connect refrigerant and condenser-water piping to water-cooled condensing units. Maintain clear tube removal space. Refrigerant piping and specialties are specified in Division 23 Section "Refrigerant Piping" and condenser-water piping and specialties are specified in Division 22 Section(s) "Domestic Water Piping" OR Division 23 Section(s) "Hydronic Piping", **as directed**.

C. Field Quality Control
1. Perform the following field tests and inspections and prepare test reports:
   a. Perform electrical test and visual and mechanical inspection.
   b. Leak Test: After installation, charge systems with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
   c. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.
   d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   e. Verify proper airflow over coils.
2. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
3. Remove and replace malfunctioning condensing units and retest as specified above.

D. Startup Service
1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
   a. Inspect for physical damage to unit casing.
   b. Verify that access doors move freely and are weathertight.
   c. Clean units and inspect for construction debris.
   d. Verify that all bolts and screws are tight.
   e. Adjust vibration isolation and flexible connections.
   f. Verify that controls are connected and operational.
2. Lubricate bearings on fans.
3. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
4. Adjust fan belts to proper alignment and tension.

5. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.
6. Measure and record airflow over coils.
7. Verify proper operation of condenser capacity control device.
8. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
9. After startup and performance test, lubricate bearings and adjust belt tension, **as directed**.

E. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain condensing units.

END OF SECTION 23 01 60 71

SECTION 23 05 13 00 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for common motor requirements for HVAC equipment. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

C. Coordination
   1. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
      a. Motor controllers.
      b. Torque, speed, and horsepower requirements of the load.
      c. Ratings and characteristics of supply circuit and required control sequence.
      d. Ambient and environmental conditions of installation location.

1.2 PRODUCTS

A. General Motor Requirements
   1. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
   2. Comply with NEMA MG 1 unless otherwise indicated.
   3. Comply with IEEE 841 for severe-duty motors.

B. Motor Characteristics
   1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) above sea level.
   2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

C. Polyphase Motors
   1. Description: NEMA MG 1, Design B, medium induction motor.
   2. Efficiency: Energy efficient, as defined in NEMA MG 1.
   3. Service Factor: 1.15.
   4. Multispeed Motors: Variable torque.
      a. For motors with 2:1 speed ratio, consequent pole, single winding.
      b. For motors with other than 2:1 speed ratio, separate winding for each speed.
   5. Multispeed Motors: Separate winding for each speed.
   6. Rotor: Random-wound, squirrel cage.
   7. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
   8. Temperature Rise: Match insulation rating.
   9. Insulation: Class F.
   10. Code Letter Designation:
      a. Motors 15 HP and Larger: NEMA starting Code F or Code G.

b. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

11. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

D. Polyphase Motors With Additional Requirements

1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
2. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   a. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   b. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   c. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   d. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
3. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

E. Single-Phase Motors

1. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
   a. Permanent-split capacitor.
   b. Split phase.
   c. Capacitor start, inductor run.
   d. Capacitor start, capacitor run.
2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 HP and Smaller: Shaded-pole type.
5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

1.3 EXECUTION (Not Applicable)

END OF SECTION 23 05 13 00

SECTION 23 05 16 00 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for expansion fittings and loops for HVAC piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Flexible, ball-joint, packed expansion joints.
   b. Slip-joint packed expansion joints.
   c. Expansion-compensator packless expansion joints.
   d. Flexible-hose packless expansion joints.
   e. Metal-bellows packless expansion joints.
   f. Rubber packless expansion joints.
   g. Grooved-joint expansion joints.
   h. Pipe loops and swing connections.
   i. Alignment guides and anchors.

C. Performance Requirements

1. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
2. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

D. Submittals

1. Product Data: For each type of product indicated.
2. Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   a. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
   b. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
   c. Alignment Guide Details: Detail field assembly and attachment to building structure.
   d. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.
3. Welding certificates.
4. Product Certificates: For each type of expansion joint, from manufacturer.
5. Maintenance Data: For expansion joints to include in maintenance manuals.

E. Quality Assurance

1. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. ASME Boiler and Pressure Vessel Code: Section IX.

1.2 PRODUCTS

A. Packed Expansion Joints

1. Flexible, Ball-Joint, Packed Expansion Joints:

a. Standards: ASME Boiler and Pressure Vessel Code: Section II, "Materials"; and ASME B31.9, "Building Services Piping," for materials and design of pressure-containing parts and bolting.
b. Material: Carbon-steel assembly with asbestos-free composition packing.
c. Design: For 360-degree rotation and angular deflection.
d. Minimum Pressure Rating: 250 psig at 400 deg F (1725 kPa at 204 deg C).
e. Angular Deflection for NPS 6 (DN 150) and Smaller: 30 degree minimum.
f. Angular Deflection for NPS 8 (DN 200) and Larger: 15 degree minimum.
g. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
h. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

2. Slip-Joint Packed Expansion Joints:
a. Standard: ASTM F 1007.
b. Material: Carbon steel with asbestos-free PTFE packing.
c. Design: With internal guide and injection device for repacking under pressure. Include drip connection if used for steam piping.
d. Configuration: Single joint **OR** Single joint with base and double joint with base, **as directed**, class(es) unless otherwise indicated.
e. End Connections: Flanged or weld ends to match piping system.

B. Packless Expansion Joints
1. Metal, Expansion-Compensator Packless Expansion Joints:
a. Minimum Pressure Rating: 150 psig (1035 kPa) **OR** 175 psig (1200 kPa), **as directed**, unless otherwise indicated.
b. Configuration for Copper Tubing: Two-ply, phosphor-bronze bellows with copper pipe ends.
1) End Connections for Copper Tubing NPS 2 (DN 50) and Smaller: Solder joint or threaded.
2) End Connections for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Threaded.
c. Configuration for Steel Piping: Two-ply, stainless-steel bellows; steel-pipe end connections; and carbon-steel shroud.
1) End Connections for Steel Pipe NPS 2 (DN 50) and Smaller: Threaded.
2) End Connections for Steel Pipe NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged **OR** Weld, **as directed**.

2. Rubber, Expansion-Compensator Packless Expansion Joints:
a. Material: Twin reinforced-rubber spheres with external restraining cables.
b. Minimum Pressure Rating: 150 psig at 170 deg F (1035 kPa at 77 deg C) unless otherwise indicated.
c. End Connections for NPS 2 (DN 50) and Smaller: Threaded.

3. Flexible-Hose Packless Expansion Joints:
a. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
b. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
c. Expansion Joints for Copper Tubing NPS 2 (DN 50) and Smaller: Copper-alloy fittings with solder-joint end connections.
1) Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F (3100 kPa at 21 deg C) and 340 psig at 450 deg F (2340 kPa at 232 deg C) ratings.
2) Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F (4830 kPa at 21 deg C) and 500 psig at 450 deg F (3450 kPa at 232 deg C) ratings.
d. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Copper-alloy fittings with threaded end connections.
1) Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F (2070 kPa at 21 deg C) and 225 psig at 450 deg F (1550 kPa at 232 deg C) ratings.

2) Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F (2890 kPa at 21 deg C) and 315 psig at 450 deg F (2170 kPa at 232 deg C) ratings.

e. Expansion Joints for Steel Piping NPS 2 (DN 50) and Smaller: Carbon-steel fittings with threaded end connections.
1) Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F (3100 kPa at 21 deg C) and 325 psig at 600 deg F (2250 kPa at 315 deg C) ratings.
2) Stainless-steel hoses and double-braid, stainless-steel sheaths with 700 psig at 70 deg F (4830 kPa at 21 deg C) and 515 psig at 600 deg F (3550 kPa at 315 deg C) ratings.

f. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Carbon-steel fittings with flanged **OR** weld, **as directed**, end connections.
1) Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F (1380 kPa at 21 deg C) and 145 psig at 600 deg F (1000 kPa at 315 deg C) ratings.
2) Stainless-steel hoses and double-braid, stainless-steel sheaths with 275 psig at 70 deg F (1900 kPa at 21 deg C) and 200 psig at 600 deg F (1380 kPa at 315 deg C) ratings.

g. Expansion Joints for Steel Piping NPS 8 to NPS 12 (DN 200 to DN 300): Carbon-steel fittings with flanged **OR** weld, **as directed**, end connections.
1) Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg F (860 kPa at 21 deg C) and 90 psig at 600 deg F (625 kPa at 315 deg C) ratings.
2) Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F (1130 kPa at 21 deg C) and 120 psig at 600 deg F (830 kPa at 315 deg C) ratings.

h. Expansion Joints for Steel Piping NPS 14 (DN 350) and Larger: Carbon-steel fittings with flanged **OR** weld, **as directed**, end connections.
1) Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F (1130 kPa at 21 deg C) and 120 psig at 600 deg F (830 kPa at 315 deg C) ratings.

4. Metal-Bellows Packless Expansion Joints:
a. Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
b. Type: Circular, corrugated bellows with external tie rods.
c. Minimum Pressure Rating: 150 psig (1035 kPa) **OR** 175 psig (1200 kPa), **as directed**, unless otherwise indicated.
d. Configuration: Single joint **OR** Single joint with base and double joint with base, **as directed**, class(es) unless otherwise indicated.
e. Expansion Joints for Copper Tubing: Single **OR** Multi, **as directed**,-ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.
1) End Connections for Copper Tubing NPS 2 (DN 50) and Smaller: Solder joint or threaded.
2) End Connections for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Solder joint or threaded.
3) End Connections for Copper Tubing NPS 5 (DN 125) and Larger: Flanged.
f. Expansion Joints for Steel Piping: Single **OR** Multi, **as directed**,-ply stainless-steel bellows, steel pipe ends, and carbon-steel shroud.
1) End Connections for Steel Pipe NPS 2 (DN 50) and Smaller: Threaded.
2) End Connections for Steel Pipe NPS 2-1/2 (DN 65) and Larger: Flanged **OR** Weld, **as directed**.

5. Rubber Packless Expansion Joints:
a. Standards: ASTM F 1123 and FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."
b. Material: Fabric-reinforced rubber complying with FSA-NMEJ-703.

c. Arch Type: Single **OR** Multiple, **as directed**, arches with external control rods, **as directed**.
d. Spherical Type: Single **OR** Multiple, **as directed**, spheres with external control rods, **as directed**.
e. Minimum Pressure Rating for NPS 1-1/2 to NPS 4 (DN 40 to DN 100): 150 psig (1035 kPa) at 220 deg F (104 deg C).
f. Minimum Pressure Rating for NPS 5 and NPS 6 (DN 125 and DN 150): 140 psig (966 kPa) at 200 deg F (93 deg C).
g. Minimum Pressure Rating for NPS 8 to NPS 12 (DN 200 to DN 300): 140 psig (966 kPa) at 180 deg F (82 deg C).
h. Material for Fluids Containing Acids, Alkalies, or Chemicals: BR **OR** CSM **OR** EPDM, **as directed**.
i. Material for Fluids Containing Gas, Hydrocarbons, or Oil: Buna-N **OR** CR, **as directed**.
j. Material for Water: BR **OR** Buna-N **OR** CR **OR** CSM **OR** EPDM **OR** NR, **as directed**.
k. End Connections: Full-faced, integral steel flanges with steel retaining rings.

C. Grooved-Joint Expansion Joints
1. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.
2. Standard: AWWA C606, for grooved joints.
3. Nipples: Galvanized, **as directed**, ASTM A 53/A 53M, Schedule 40, Type E or S, steel pipe with grooved ends.
4. Couplings: Five **OR** Seven **OR** 10 **OR** 12, **as directed**, flexible type for steel-pipe dimensions. Include ferrous housing sections, Buna-N gasket suitable for diluted acid, alkaline fluids, and cold and hot water **OR** EPDM gasket suitable for cold and hot water, **as directed**, and bolts and nuts.

D. Alignment Guides And Anchors
1. Alignment Guides:
a. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.
2. Anchor Materials:
a. Steel Shapes and Plates: ASTM A 36/A 36M.
b. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
c. Washers: ASTM F 844, steel, plain, flat washers.
d. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
1) Stud: Threaded, zinc-coated carbon steel.
2) Expansion Plug: Zinc-coated steel.
3) Washer and Nut: Zinc-coated steel.
e. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
1) Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
2) Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
3) Washer and Nut: Zinc-coated steel.

1.3 EXECUTION

A. Expansion-Joint Installation
1. Install expansion joints of sizes matching sizes of piping in which they are installed.

2. Install packed-type expansion joints with packing suitable for fluid service.
3. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
4. Install rubber packless expansion joints according to FSA-NMEJ-702.
5. Install grooved-joint expansion joints to grooved-end steel piping

B. Pipe Loop And Swing Connection Installation
1. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
2. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.
3. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.
4. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

C. Alignment-Guide And Anchor Installation
1. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
2. Install one **OR** two, **as directed**, guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
3. Attach guides to pipe and secure guides to building structure.
4. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
5. Anchor Attachments:
   a. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   b. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.
6. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
   a. Anchor Attachment to Steel Structural Members: Attach by welding.
   b. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
7. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 23 05 16 00

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Task	Specification	Specification Description
23 05 16 00	22 05 16 00	Expansion Fittings and Loops for Plumbing Piping
23 05 17 00	21 05 23 00	Piped Utilities Basic Materials And Methods
23 05 17 00	07 63 00 00	Common Work Results for Fire Suppression
23 05 17 00	07 63 00 00a	Common Work Results for Plumbing
23 05 17 00	07 63 00 00b	Common Work Results for HVAC
23 05 19 00	21 05 23 00	Piped Utilities Basic Materials And Methods
23 05 19 00	07 63 00 00	Common Work Results for Fire Suppression
23 05 19 00	07 63 00 00a	Common Work Results for Plumbing
23 05 19 00	07 63 00 00b	Common Work Results for HVAC
23 05 19 00	21 05 19 00	Meters and Gages for Plumbing Piping
23 05 19 00	21 05 19 00a	Meters and Gages for HVAC Piping
23 05 23 00	01 22 16 00	No Specification Required
23 05 23 00	21 05 23 00	Piped Utilities Basic Materials And Methods
23 05 23 00	13 12 13 00	Water Distribution
23 05 23 00	21 05 23 00a	General-Duty Valves for Plumbing Piping
23 05 23 00	21 05 23 00b	General-Duty Valves for HVAC Piping
23 05 23 00	22 05 76 00a	Storm Drainage Piping Specialties
23 05 23 00	22 11 16 00c	Hydronic Piping
23 05 23 00	22 11 16 00e	Refrigerant Piping
23 05 23 00	22 11 23 23a	Hydronic Pumps
23 05 23 00	22 11 16 00f	General-Service Compressed-Air Piping

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SECTION 23 05 29 00 - STEAM DISTRIBUTION

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for steam distribution. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes underground piping outside the building for distribution of steam and condensate.

C. Performance Requirements
   1. Provide components and installation capable of producing steam piping systems with the following minimum working-pressure ratings:
      a. Steam Piping: 15 psig (104 kPa) **OR** 125 psig (860 kPa), **as directed**.
      b. Condensate Piping: 100 psig (690 kPa).

D. Submittals
   1. Product Data:
   2. Shop Drawings:
   3. Welding certificates.
   4. Source quality-control test reports.
   5. Field quality-control test reports.

E. Quality Assurance
   1. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.
   2. ASME Compliance: Comply with ASME B31.1, "Power Piping" **OR** ASME B31.9, "Building Services Piping," **as directed**, for materials, products, and installation.
   3. ASME Compliance: Safety valves and pressure vessels shall bear appropriate ASME labels.

F. Project Conditions
   1. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
      a. Notify the Owner no fewer than two days in advance of proposed utility interruptions.
      b. Do not proceed with utility interruptions without written permission.

1.2 PRODUCTS

A. Piping Materials
   1. Refer to Article 1.3 "Piping Application" for applications of pipes, tubes, fittings, and joining methods.
   2. Refer to Division 33 Section "Common Work Results For Utilities" for commonly used joining materials.

B. Steel Pipes And Fittings
   1. Steel Pipe: ASTM A 53/A 53M, Type E, Grade A, Standard Weight; with plain ends.
   2. Nipples: ASTM A 733, Standard Weight, seamless, carbon-steel pipe complying with ASTM A 53/A 53M.

3. Malleable-Iron, Threaded Fittings: ASME B16.3, Classes 150 and 300, with threads according to ASME B1.20.1.
4. Cast-Iron, Threaded Fittings: ASME B16.4, Classes 125 and 250, standard pattern, with threads according to ASME B1.20.1.
5. Steel Welding Fittings: ASME B16.9 and ASTM A 234/A 234M, seamless or welded.

C. Conduit Piping
1. Description: Factory-fabricated and -assembled, airtight and watertight, drainable, pressure-tested piping with conduit, inner pipe supports, and insulated carrier piping. Fabricate so insulation can be dried in place by forcing dry air through conduit.
2. Carrier Pipe: Steel pipe complying with ASTM A 53/A 53M, Type E, Grade A with beveled **OR** socket, **as directed**, ends for welded joints.
3. Carrier Pipe Insulation:
    a. Mineral-Wool Pipe Insulation: ASTM C 547, Type I, molded.
        1) Apparent Thermal Conductivity (k-Value): 0.31 at 200 deg F (0.044 at 93 deg C) mean temperature.
        2) Density: Maximum 10 lb/cu. ft. (160 kg/cu. m) average.
        3) Compressive Strength: 10 psig (69 kPa) minimum at 5 percent deformation.
        4) Bands: ASTM A 666, Type 304, stainless steel, 3/4 inch (19 mm) wide, 0.020 inch (0.5 mm) thick.
    b. Calcium Silicate Pipe Insulation: ASTM C 533, Type I; preformed, incombustible, inorganic, with non-asbestos fibrous reinforcement.
        1) Thermal Conductivity (k-Value): 0.60 at 500 deg F (0.087 at 260 deg C).
        2) Dry Density: 15 lb/cu. ft. (240 kg/cu. m) maximum.
        3) Compressive Strength: 60 psig (414 kPa) minimum at 5 percent deformation.
        4) Bands: ASTM A 666, Type 304, stainless steel, 3/4 inch (19 mm) wide, 0.020 inch (0.5 mm) thick.
    c. Polyisocyanurate Foam Pipe Insulation: ASTM C 591, preformed, rigid, cellular.
        1) Thermal Conductivity (k-Value): 0.14 at 75 deg F (0.020 at 24 deg C).
        2) Service Temperature: Minus 250 to plus 400 deg F (Minus 156 to plus 204 deg C).
        3) Moisture Absorption: ASTM D 2842, maximum 0.054 percent by volume.
        4) Minimum 90 percent closed cell.
        5) Dry Density: 2 lb/cu. ft. (32 kg/cu. m) maximum.
        6) Compressive Strength: 35 psig (242 kPa) minimum at 5 percent deformation.
        7) Water-Vapor Transmission: 1.26 perm inches (1.83 ng/Pa x s x m) according to ASTM E 96.
    d. Polyurethane Foam Pipe Insulation: ASTM C 591, preformed, rigid, cellular.
        1) Thermal Conductivity (k-Value): 0.13 at 75 deg F (0.019 at 24 deg C).
        2) Service Temperature: Minus 250 to plus 200 deg F (Minus 156 to plus 93 deg C).
        3) Moisture Absorption: ASTM D 2842, maximum 0.054 percent by volume.
        4) Minimum 90 percent closed cell.
        5) Dry Density: 2 lb/cu. ft. (32 kg/cu. m) maximum.
        6) Compressive Strength: 35 psig (242 kPa) minimum at 5 percent deformation.
        7) Water-Vapor Transmission: 1.26 perm inches (1.83 ng/Pa x s x m) according to ASTM E 96.
4. Minimum Clearance:
    a. Between Carrier Pipe Insulation and Conduit: 1 inch (25 mm).
    b. Between Insulation of Multiple Carrier Pipes: 3/16 inch (4.75 mm).
    c. Between Bottom of Carrier Pipe Insulation and Conduit: 1 inch (25 mm).
    d. Between Bottom of Bare, Carrier Pipe and Casing: 1-3/8 inches (35 mm).
5. Conduit: Spiral wound, steel. Finish conduit with 2 coats of fusion-bonded epoxy, minimum 20 mils (0.50 mm) thick. Cover with polyurethane foam insulation with a high-density polyethylene jacket; thickness indicated in Part 1.3 "Piping Application" Article, **as directed**.
6. Conduit: Spiral wound, bare steel. Cover with polyurethane foam insulation with a high-density polyethylene jacket; thickness indicated in Part 1.3 "Piping Application" Article.

7. Carrier Piping Supports within Conduit: Corrugated galvanized steel with a maximum spacing of 10 feet (3 m).
8. Fittings: Factory-fabricated and -insulated elbows and tees. Elbows may be bent pipe equal to carrier pipe. Tees shall be factory fabricated and insulated, and shall be compatible with the carrier pipe.
9. Expansion Offsets and Loops: Size casing to contain piping expansion.
10. Conduit accessories include the following:
    a. Water Shed: Terminal end protector for carrier pipes entering building through floor, 3 inches (75 mm) deep and 2 inches (50 mm) larger than casing; terminate casing 20 inches (500 mm) above the floor level.
    b. Guides and Anchors: Steel plate welded to carrier pipes and to casing, complete with vent and drainage openings inside casing.
    c. End Seals: Steel plate welded to carrier pipes and to casing, complete with drain and vent openings on vertical centerline.
    d. Gland Seals: Packed stuffing box and gland follower mounted on steel plate, welded to end of casing, permitting axial movement of carrier piping, with drain and vent connections on vertical centerline.
    e. Joint Kit: Half-shell, pourable or split insulation and shrink-wrap sleeve.
11. Source Quality Control: Factory test the conduit to 15 psig (105 kPa) for a minimum of 2 minutes with no change in pressure. Factory test the carrier pipe to 150 percent of the operating pressure of system. Furnish test certificates.

D. Cased Piping
1. Description: Factory-fabricated piping with carrier pipe, insulation, and casing.
2. Carrier Pipe: Steel pipe complying with ASTM A 53/A 53M, Type E, Grade A with beveled **OR** socket, **as directed**, ends for welded joints.
3. Carrier Pipe Insulation:
    a. Polyurethane Foam Pipe Insulation: ASTM C 591, preformed, rigid, cellular.
        1) Thermal Conductivity (k-Value): 0.13 at 75 deg F (0.019 at 24 deg C).
        2) Service Temperature: Minus 250 to plus 200 deg F (Minus 156 to plus 93 deg C).
        3) Moisture Absorption: ASTM D 2842, maximum 0.054 percent by volume.
        4) Minimum 90 percent closed cell.
        5) Dry Density: 2 lb/cu. ft. (32 kg/cu. m) maximum.
        6) Compressive Strength: 35 psig (242 kPa) minimum at 5 percent deformation.
        7) Water-Vapor Transmission: 1.26 perm inches (1.83 ng/Pa x s x m) according to ASTM E 96.
4. Casing: High-density polyethylene **OR** Filament-wound, fiberglass-reinforced polyester resin **OR** PVC, **as directed**.
5. Casing accessories include the following:
    a. Joint Kit: Half-shell, pourable or split insulation, casing sleeve, and shrink-wrap sleeve.
    b. Expansion Blanket: Elastomeric foam, formed to fit over piping.
    c. End Seals: Shrink wrap the casing material to seal watertight around casing and carrier pipe.
6. Source Quality Control: Factory test the carrier pipe to 150 percent of the operating pressure of system. Furnish test certificates.

E. Loose-Fill Insulation
1. Granular, Loose-Fill Insulation: Inorganic, nontoxic, nonflammable, sodium potassium aluminum silicate with calcium carbonate filler. Include chemical treatment that renders insulation hydrophobic.
    a. Thermal Conductivity (k-Value): 0.60 at 175 deg F (0.087 at 79 deg C) and 0.65 at 300 deg F (0.094 at 149 deg C).
    b. Application Temperature Range: 35 to 800 deg F (2 to 426 deg C).
    c. Dry Density: 40 to 42 lb/cu. ft. (640 to 672 kg/cu. m).
    d. Strength: 12,000 lb/sq. ft. (58 600 kg/sq. m).

2. Powder, Loose-Fill Insulation: Inert, nontoxic, nonflammable, calcium carbonate particles. Include chemical treatment that renders insulation hydrophobic.
    a. Thermal Conductivity (k-Value): ASTM C 177, 0.58 at 100 deg F (0.084 at 37 deg C) and 0.68 at 300 deg F (0.098 at 149 deg C).
    b. Application Temperature Range: Minus 273 to plus 480 deg F (Minus 169 to plus 250 deg C).
    c. Dry Density: Approximately 60 lb/cu. ft. (960 kg/cu. m).
    d. Strength: 12,000 lb/sq. ft. (58 600 kg/sq. m).

1.3 EXECUTION

A. Earthwork: Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

B. Piping Application
1. Steam Piping: Schedule 40 **OR** Schedule 80, **as directed**, steel pipe with cast-iron, threaded fittings and threaded **OR** steel fittings and welded **OR** ductile-iron, grooved-end fittings and mechanical, **as directed**, joints; granular **OR** powder, **as directed**, loose-fill insulation.
2. Steam Piping: Conduit piping with mineral-wool **OR** calcium silicate **OR** polyisocyanurate **OR** polyurethane, **as directed**, carrier-pipe insulation and with coated, **unless directed otherwise to be** coated and insulated, conduit.
    a. Insulation Thickness: 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**.
3. Condensate Piping: Schedule 40 **OR** Schedule 80, **as directed**, steel pipe with cast-iron, threaded fittings and threaded **OR** steel welding fittings and welded **OR** ductile-iron, grooved-end fittings and mechanical, **as directed**, joints; granular **OR** powder, **as directed**, loose-fill insulation.
4. Condensate Piping: Conduit piping with mineral-wool **OR** calcium silicate **OR** polyisocyanurate **OR** polyurethane, **as directed**, carrier-pipe insulation and with coated **OR** coated and insulated, **as directed**, conduit.
    a. Insulation Thickness: 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**.
5. Condensate Piping: Cased piping with polyurethane carrier-pipe insulation.

C. Piping Installation
1. General Locations and Arrangements: Drawings indicate general location and arrangement of piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, unless deviations to layout are approved.
2. Remove any standing water in the bottom of trench.
3. Bed the pipe on a minimum 6-inch (150-mm) layer of granular fill material with a minimum 6-inch (150-mm) clearance between the pipes.
4. Do not insulate piping or backfill piping trench until field quality-control testing has been completed and results approved.
5. Install piping at uniform grade of 0.2 percent downward in direction of flow or as indicated.
6. Install condensate piping at uniform grade of 0.4 percent downward in direction of flow.
7. Install components with pressure rating equal to or greater than system operating pressure.
8. Install piping free of sags and bends.
9. Install fittings for changes in direction and branch connections.
10. Refer to Division 23 Section "Common Work Results For Hvac" for sleeves and mechanical sleeve seals through exterior building walls.
11. Secure anchors with concrete thrust blocks. Concrete is specified in Division 03 Section "Cast-in-place Concrete".
12. Connect to steam and condensate piping where it passes through the building wall. Steam and condensate piping inside the building is specified in Division 23 Section "Steam And Condensate Heating Piping".

D. Loose-Fill Insulation Installation
1. Do not disturb the bottom of trench, or compact and stabilize it to ensure proper support.
2. Remove any standing water in the bottom of trench.
3. Form insulation trench by excavation or by installing drywall side forms to establish the required height and width of the insulation.
4. Support piping with proper pitch, separation, and clearance to backfill or side forms using temporary supporting devices that can be removed after back filling with insulation.
5. Place insulation and backfill after field quality-control testing has been completed and results approved.
6. Apply bitumastic coating to carbon-steel anchors and guides. Pour concrete thrust blocks and anchors. Refer to Division 03 Section "Cast-in-place Concrete" for concrete and reinforcement.
7. Wrap piping at expansion loops and offsets with mineral-wool insulation of thickness appropriate for calculated expansion amount.
8. Pour loose-fill insulation to required dimension agitating insulation to eliminate voids around piping.
9. Remove temporary hangers and supports.
10. Cover loose-fill insulation with polyethylene sheet a minimum of 4 mils (0.10 mm) thick, and empty loose-fill insulation bags on top.
11. Manually backfill 6 inches (150 mm) of clean backfill. If mechanical compaction is required manually backfill to 12 inches (300 mm) before using mechanical-compaction equipment.

E. Joint Construction
1. Refer to Division 33 Section "Common Work Results For Utilities" for basic piping joint construction.
2. Keyed-Coupling Joints: Cut- or roll-groove pipes. Assemble joints with keyed couplings, gaskets, lubricant, and bolts.
3. Conduit and Cased Piping Joints: Assemble sections and finish joints with pourable or split insulation, exterior jacket sleeve, and apply shrink-wrap seals as required by manufacturer's written installation instructions.

F. Identification: Install continuous plastic underground warning tapes during back filling of trenches for underground steam and condensate distribution piping. Locate 6 to 8 inches (150 to 200 mm) below finished grade, directly over piping. Refer to Division 31 Section "Earth Moving" for warning-tape materials and devices and their installation.

G. Field Quality Control
1. Prepare steam and condensate piping for testing according to ASME B31.1 and ASME B31.9 and as follows:
   a. Leave joints, including welds, uninsulated and exposed for examination during test.
   b. Isolate equipment. Do not subject equipment to test pressure.
   c. Install relief valve set at pressure no more than one-third higher than test pressure.
   d. Fill system with temperature water. Where there is risk of freezing, air or a safe, compatible liquid may be used.
   e. Use vents installed at high points to release trapped air while filling system. Use drip legs installed at low points for complete removal of liquid.
2. Test steam and condensate piping as follows:
   a. Subject steam and condensate piping to hydrostatic test pressure that is not less than 1.5 times the design pressure.
   b. After hydrostatic test pressure has been applied for 10 minutes, examine joints for leakage. Remake leaking joints using new materials and repeat hydrostatic test until no leaks exist.
3. Test conduit as follows:
   a. Seal vents and drains and subject conduit to 15 psig (105 kPa) for 4 hours with no loss of pressure. Repair leaks and retest as required.
4. Prepare a written report of testing.

END OF SECTION 23 05 29 00

SECTION 23 05 29 00a - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for hangers and supports for HVAC piping and equipment. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Metal pipe hangers and supports.
      b. Trapeze pipe hangers.
      c. Fiberglass pipe hangers.
      d. Metal framing systems.
      e. Fiberglass strut systems.
      f. Thermal-hanger shield inserts.
      g. Fastener systems.
      h. Pipe stands.
      i. Equipment supports.

C. Definitions
   1. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

D. Performance Requirements
   1. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
   2. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
      a. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
      b. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
      c. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

E. Submittals
   1. Product Data: For each type of product indicated.
   2. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
      a. Trapeze pipe hangers.
      b. Metal framing systems.
      c. Fiberglass strut systems.
      d. Pipe stands.
      e. Equipment supports.
   3. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
      a. Detail fabrication and assembly of trapeze hangers.
      b. Design Calculations: Calculate requirements for designing trapeze hangers.

4. Welding certificates.

F. Quality Assurance
1. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.2 PRODUCTS

A. Metal Pipe Hangers And Supports
1. Carbon-Steel Pipe Hangers and Supports:
a. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
b. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
c. Nonmetallic Coatings: Plastic coating, jacket, or liner.
d. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
e. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel **OR** stainless steel, **as directed**.
2. Stainless-Steel Pipe Hangers and Supports:
a. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
b. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
c. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
3. Copper Pipe Hangers:
a. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
b. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel **OR** stainless steel, **as directed**.

B. Trapeze Pipe Hangers
1. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

C. Fiberglass Pipe Hangers
1. Clevis-Type, Fiberglass Pipe Hangers:
a. Description: Similar to MSS SP-58, Type 1, steel pipe hanger except hanger is made of fiberglass or fiberglass-reinforced resin.
b. Hanger Rods: Continuous-thread rod, washer, and nuts made of fiberglass, polyurethane or stainless steel.
2. Strap-Type, Fiberglass Pipe Hangers:
a. Description: Similar to MSS SP-58, Type 9 or Type 10, steel pipe hanger except hanger is made of fiberglass-reinforced resin.
b. Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of stainless steel.

D. Metal Framing Systems
1. MFMA Manufacturer Metal Framing Systems:
a. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
b. Standard: MFMA-4.
c. Channels: Continuous slotted steel channel with inturned lips.

d. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
e. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel **OR** stainless steel, **as directed**.
f. Metallic Coating: Electroplated zinc **OR** Hot-dipped galvanized **OR** Mill galvanized **OR** In-line, hot galvanized **OR** Mechanically-deposited zinc, **as directed**.
OR
Paint Coating: Vinyl **OR** Vinyl alkyd **OR** Epoxy **OR** Polyester **OR** Acrylic **OR** Amine **OR** Alkyd, **as directed**.
OR
Plastic Coating: PVC **OR** Polyurethane **OR** Epoxy **OR** Polyester, **as directed**.
OR
Combination Coating: as directed by the Owner.

2. Non-MFMA Manufacturer Metal Framing Systems:
   a. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
   b. Standard: Comply with MFMA-4.
   c. Channels: Continuous slotted steel channel with inturned lips.
   d. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
   e. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel **OR** stainless steel, **as directed**.
   f. Coating: Zinc **OR** Paint **OR** PVC, **as directed**.

E. Fiberglass Strut Systems
1. Description: Shop- or field-fabricated pipe-support assembly similar to MFMA-4 for supporting multiple parallel pipes.
   a. Channels: Continuous slotted fiberglass or other plastic channel with inturned lips.
   b. Channel Nuts: Fiberglass nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
   c. Hanger Rods: Continuous-thread rod, nuts, and washer made of fiberglass **OR** stainless steel, **as directed**.

F. Thermal-Hanger Shield Inserts
1. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.
2. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig (688-kPa), ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength.
3. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
4. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
5. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

G. Fastener Systems
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated **OR** stainless-, **as directed**, steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

H. Pipe Stands

1. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
2. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
3. Low-Type, Single-Pipe Stand: One-piece plastic **OR** stainless-steel, **as directed**, base unit with plastic roller, for roof installation without membrane penetration.
4. High-Type, Single-Pipe Stand:
    a. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
    b. Base: Plastic **OR** Stainless steel, **as directed**.
    c. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
    d. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
5. High-Type, Multiple-Pipe Stand:
    a. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
    b. Bases: One or more; plastic.
    c. Vertical Members: Two or more protective-coated-steel channels.
    d. Horizontal Member: Protective-coated-steel channel.
    e. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
6. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

I. Equipment Supports
1. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

J. Miscellaneous Materials
1. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
2. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
    a. Properties: Nonstaining, noncorrosive, and nongaseous.
    b. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

1.3 EXECUTION

A. Hanger And Support Installation
1. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
2. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
    a. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
    b. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
3. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.

4. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
5. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled fiberglass struts.
6. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
7. Fastener System Installation:
    a. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
    b. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
8. Pipe Stand Installation:
    a. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
    b. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 Section "Roof Accessories" for curbs.
9. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
10. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
11. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
12. Install lateral bracing with pipe hangers and supports to prevent swaying.
13. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
14. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
15. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
16. Insulated Piping:
    a. Attach clamps and spacers to piping.
        1) Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
        2) Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
        3) Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
    b. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
        1) Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
    c. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
        1) Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
    d. Shield Dimensions for Pipe: Not less than the following:
        1) NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
        2) NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
        3) NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.

4) NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
5) NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.

e. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
f. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

B. Equipment Supports
1. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
2. Grouting: Place grout under supports for equipment and make bearing surface smooth.
3. Provide lateral bracing, to prevent swaying, for equipment supports.

C. Metal Fabrications
1. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
2. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
3. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   b. Obtain fusion without undercut or overlap.
   c. Remove welding flux immediately.
   d. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

D. Adjusting
1. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
2. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

E. Painting
1. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   a. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

   OR

   Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 07 OR Division 09 Section(s) "High-performance Coatings", **as directed**.
2. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

F. Hanger And Support Schedule
1. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
2. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
3. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

4. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
5. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
6. Use stainless-steel pipe hangers and fiberglass pipe hangers and fiberglass strut systems and stainless-steel or corrosion-resistant attachments for hostile environment applications.
7. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
8. Use padded hangers for piping that is subject to scratching.
9. Use thermal-hanger shield inserts for insulated piping and tubing.
10. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
    a. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
    b. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C),pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
    c. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
    d. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
    e. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
    f. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).
    g. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
    h. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
    i. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
    j. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
    k. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
    l. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
    m. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
    n. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
    o. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
    p. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
    q. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
    r. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction might occur.

s. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
t. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 (DN 50 to DN 600) if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
u. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

11. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
    a. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
    b. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.
12. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
    a. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
    b. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
    c. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
    d. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
    e. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.
13. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
    a. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
    b. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
    c. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
    d. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
    e. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
    f. C-Clamps (MSS Type 23): For structural shapes.
    g. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
    h. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
    i. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
    j. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
    k. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
    l. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
        1) Light (MSS Type 31): 750 lb (340 kg).
        2) Medium (MSS Type 32): 1500 lb (680 kg).
        3) Heavy (MSS Type 33): 3000 lb (1360 kg).
    m. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
    n. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
    o. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

14. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
    a. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
    b. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
    c. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
15. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
    a. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
    b. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
    c. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
    d. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
    e. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
    f. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
    g. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
    h. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
        1) Horizontal (MSS Type 54): Mounted horizontally.
        2) Vertical (MSS Type 55): Mounted vertically.
        3) Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
16. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
17. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
18. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 23 05 29 00a

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Task	Specification	Specification Description
23 05 29 00	21 05 23 00	Piped Utilities Basic Materials And Methods
23 05 29 00	07 63 00 00	Common Work Results for Fire Suppression
23 05 29 00	07 63 00 00a	Common Work Results for Plumbing
23 05 29 00	07 63 00 00b	Common Work Results for HVAC
23 05 29 00	22 05 29 00	Hangers and Supports for Plumbing Piping and Equipment

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SECTION 23 05 48 13 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of vibration and seismic controls for HVAC piping and equipment. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes the following:
   a. Isolation pads.
   b. Isolation mounts.
   c. Restrained elastomeric isolation mounts.
   d. Freestanding and Restrained spring isolators.
   e. Housed spring mounts.
   f. Elastomeric hangers.
   g. Spring hangers.
   h. Spring hangers with vertical-limit stops.
   i. Pipe riser resilient supports.
   j. Resilient pipe guides.
   k. Freestanding and Restrained air-mounting system.
   l. Restrained vibration isolation roof-curb rails.
   m. Seismic snubbers.
   n. Restraining braces and cables.
   o. Steel and Inertia, vibration isolation equipment bases.

C. Definitions

1. IBC: International Building Code.
2. ICC-ES: ICC-Evaluation Service.
3. OSHPD: Office of Statewide Health Planning and Development for the State of California.

D. Performance Requirements

1. Wind-Restraint Loading:
   a. Basic Wind Speed: As required to meet Project requirements.
   b. Building Classification Category: I **OR** II **OR** III **OR** IV, **as directed**.
   c. Minimum 10 lb/sq. ft. (48.8 kg/sq. m) multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.
2. Seismic-Restraint Loading:
   a. Site Class as Defined in the IBC: A **OR** B **OR** C **OR** D **OR** E **OR** F, **as directed**.
   b. Assigned Seismic Use Group or Building Category as Defined in the IBC: I **OR** II **OR** III, **as directed**.
      1) Component Importance Factor: 1.0 **OR** 1.5, **as directed**.
      2) Component Response Modification Factor: 1.5 **OR** 2.5 **OR** 3.5 **OR** 5.0, **as directed**.
      3) Component Amplification Factor: 1.0 **OR** 2.5, **as directed**.
   c. Design Spectral Response Acceleration at Short Periods (0.2 Second): Percentage as directed.
   d. Design Spectral Response Acceleration at 1-Second Period: Percentage as directed.

E. Submittals

1. Product Data: For each product indicated.

2. Delegated-Design Submittal: For vibration isolation and seismic-restraint calculations and details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
3. Welding certificates.
4. Qualification Data: For professional engineer.
5. Field quality-control test reports.

F. Quality Assurance
1. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
2. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
3. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

1.2 PRODUCTS

A. Vibration Isolators
1. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
    a. Resilient Material: Oil- and water-resistant neoprene **OR** rubber **OR** hermetically sealed compressed fiberglass, **as directed**.
2. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
    a. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
    b. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
3. Restrained Mounts: All-directional mountings with seismic restraint.
    a. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
    b. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
4. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
    a. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
    b. Minimum Additional Travel: 50 percent of the required deflection at rated load.
    c. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
    d. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
    e. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- (6-mm-) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig (3447 kPa).

f. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

5. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
   a. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
   b. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
   c. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   d. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   e. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   f. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.
   a. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
   b. Base: Factory drilled for bolting to structure.
   c. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch (6-mm) travel up or down before contacting a resilient collar.
7. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.
8. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
   a. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
   b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   f. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
   g. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
9. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
   a. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
   b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   f. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
   g. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
   h. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

10. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- (13-mm-) thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig (3.45 MPa) and for equal resistance in all directions.
11. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- (13-mm-) thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

B. Air-Mounting Systems
   1. Air Mounts: Freestanding, single or multiple, compressed-air bellows.
      a. Assembly: Upper and lower steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows.
      b. Maximum Natural Frequency: 3 Hz.
      c. Operating Pressure Range: 25 to 100 psig (172 to 690 kPa).
      d. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
      e. Leveling Valves: Minimum of 3 required to maintain leveling within plus or minus 1/8 inch (3 mm).
   2. Restrained Air Mounts: Housed compressed-air bellows.
      a. Assembly: Upper and lower steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows and spring, with angle-iron frame having vertical-limit stops and channel-section top with leveling adjustment and attachment screws.
      b. Maximum Natural Frequency: 3 Hz.
      c. Operating Pressure Range: 25 to 100 psig (172 to 690 kPa).
      d. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
      e. Leveling Valves: Minimum of 3 required to maintain leveling within plus or minus 1/8 inch (3 mm).

C. Restrained Vibration Isolation Roof-Curb Rails
   1. General Requirements for Restrained Vibration Isolation Roof-Curb Rails: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind, **as directed**, forces.
   2. Lower Support Assembly: Formed sheet-metal section containing adjustable and removable steel springs that support upper frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind, **as directed**, forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches (50 mm) of rigid, glass-fiber insulation on inside of assembly.
   3. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch- (6-mm-) thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
      a. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or wind, **as directed**, restraint.
         1) Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.
         2) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
         3) Minimum Additional Travel: 50 percent of the required deflection at rated load.

4) Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

b. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
1) Resilient Material: Oil- and water-resistant standard neoprene **OR** natural rubber **OR** hermetically sealed compressed fiberglass, **as directed**.

4. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch (6 mm) thick.
5. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

D. Vibration Isolation Equipment Bases
1. Steel Base: Factory-fabricated, welded, structural-steel bases and rails.
a. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
1) Include supports for suction and discharge elbows for pumps.
b. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
c. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
2. Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
a. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
1) Include supports for suction and discharge elbows for pumps.
b. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
c. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
d. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

E. Seismic-Restraint Devices
1. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of ICC-ES **OR** OSHPD **OR** an agency acceptable to authorities having jurisdiction, **as directed**.
a. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
2. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
a. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
b. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
c. Maximum 1/4-inch (6-mm) air gap, and minimum 1/4-inch- (6-mm-) thick resilient cushion.
3. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

4. Restraint Cables: ASTM A 603 galvanized-steel **OR** ASTM A 492 stainless-steel, **as directed**, cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
5. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections **OR** Reinforcing steel angle clamped, **as directed**, to hanger rod.
6. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
7. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
8. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
9. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
10. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

F. Factory Finishes
1. Finish
a. Manufacturer's standard prime-coat finish ready for field painting.
OR
Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
1) Powder coating on springs and housings.
2) All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3) Baked enamel or powder coat for metal components on isolators for interior use.
4) Color-code or otherwise mark vibration isolation and seismic-control and wind-control, **as directed**, devices to indicate capacity range.

1.3 EXECUTION

A. Applications
1. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES **OR** OSHPD **OR** an agency acceptable to authorities having jurisdiction, **as directed**.
2. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
3. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

B. Vibration-Control And Seismic-Restraint Device Installation
1. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
2. Equipment Restraints:

a. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
b. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
c. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES **OR** OSHPD **OR** an agency acceptable to authorities having jurisdiction, **as directed**, providing required submittals for component.

3. Piping Restraints:
   a. Comply with requirements in MSS SP-127.
   b. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
   c. Brace a change of direction longer than 12 feet (3.7 m).
4. Install cables so they do not bend across edges of adjacent equipment or building structure.
5. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES **OR** OSHPD **OR** an agency acceptable to authorities having jurisdiction, **as directed**, providing required submittals for component.
6. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
7. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
8. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
9. Drilled-in Anchors:
   a. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
   b. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   c. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
   d. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
   e. Set anchors to manufacturer's recommended torque, using a torque wrench.
   f. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

C. Accommodation Of Differential Seismic Motion
   1. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.

D. Field Quality Control
   1. Perform tests and inspections.
   2. Tests and Inspections:
      a. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.

b. Schedule test with the Owner before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
c. Obtain approval before transmitting test loads to structure. Provide temporary load-spreading members.
d. Test at least four of each type and size of installed anchors and fasteners selected.
e. Test to 90 percent of rated proof load of device.
f. Measure isolator restraint clearance.
g. Measure isolator deflection.
h. Verify snubber minimum clearances.
i. Air-Mounting System Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
j. Air-Mounting System Operational Test: Test the compressed-air leveling system.
k. Test and adjust air-mounting system controls and safeties.
l. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
3. Remove and replace malfunctioning units and retest as specified above.
4. Prepare test and inspection reports.

E. Adjusting
1. Adjust isolators after piping system is at operating weight.
2. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
3. Adjust air-spring leveling mechanism.
4. Adjust active height of spring isolators.
5. Adjust restraints to permit free movement of equipment within normal mode of operation.

F. Demonstration
1. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems.

END OF SECTION 23 05 48 13

Task	Specification	Specification Description
23 05 48 13	01 22 16 00	No Specification Required
23 05 48 13	21 05 23 00	Piped Utilities Basic Materials And Methods
23 05 48 13	21 05 48 13	Vibration And Seismic Controls For Fire-Suppression Piping And Equipment
23 05 48 13	22 05 48 13	Vibration And Seismic Controls For Plumbing Piping And Equipment
23 05 48 13	22 11 16 00c	Hydronic Piping
23 05 48 13	22 11 16 00d	Steam And Condensate Piping
23 05 48 13	22 11 16 00e	Refrigerant Piping
23 05 48 13	22 11 16 00f	General-Service Compressed-Air Piping

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SECTION 23 05 53 00 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for identification for HVAC piping and equipment. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Equipment labels.
b. Warning signs and labels.
c. Pipe labels.
d. Duct labels.
e. Stencils.
f. Valve tags.
g. Warning tags.

C. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Equipment Labels
1. Metal Labels for Equipment:
a. Material and Thickness: Brass, 0.032-inch (0.8-mm) **OR** Stainless steel, 0.025-inch (0.64-mm) **OR** Aluminum, 0.032-inch (0.8-mm) **OR** anodized aluminum, 0.032-inch (0.8-mm), **as directed**, minimum thickness, and having predrilled or stamped holes for attachment hardware.
b. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
c. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
d. Fasteners: Stainless-steel rivets **OR** self-tapping screws, **as directed**.
e. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
2. Plastic Labels for Equipment:
a. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) **OR** 1/8 inch (3.2 mm), **as directed**, thick, and having predrilled holes for attachment hardware.
b. Letter Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
c. Background Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
d. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
e. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
f. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
g. Fasteners: Stainless-steel rivets **OR** self-tapping screws, **as directed**.

h. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

3. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
4. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

B. Warning Signs And Labels

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) **OR** 1/8 inch (3.2 mm), **as directed**, thick, and having predrilled holes for attachment hardware.
2. Letter Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
3. Background Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets **OR** self-tapping screws, **as directed**.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
9. Label Content: Include caution and warning information, plus emergency notification instructions.

C. Pipe Labels

1. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
2. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover **OR** cover full, **as directed**, circumference of pipe and to attach to pipe without fasteners or adhesive.
3. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
4. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   a. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
   b. Lettering Size: At least 1-1/2 inches (38 mm) high.

D. Duct Labels

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) **OR** 1/8 inch (3.2 mm), **as directed**, thick, and having predrilled holes for attachment hardware.
2. Letter Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
3. Background Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets **OR** self-tapping screws, **as directed**.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

9. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
   a. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
   b. Lettering Size: At least 1-1/2 inches (38 mm) high.

E. Stencils
1. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches (32 mm) for ducts; and minimum letter height of 3/4 inch (19 mm) for access panel and door labels, equipment labels, and similar operational instructions.
   a. Stencil Material: Aluminum **OR** Brass **OR** Fiberboard, **as directed**.
   b. Stencil Paint: Exterior, gloss, alkyd enamel **OR** acrylic enamel, **as directed**, black unless otherwise indicated. Paint may be in pressurized spray-can form.
   c. Identification Paint: Exterior, alkyd enamel **OR** acrylic enamel, **as directed**, in colors according to ASME A13.1 unless otherwise indicated.

F. Valve Tags
1. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
   a. Tag Material: Brass, 0.032-inch (0.8-mm) **OR** Stainless steel, 0.025-inch (0.64-mm) **OR** Aluminum, 0.032-inch (0.8-mm) **OR** anodized aluminum, 0.032-inch (0.8-mm), **as directed**, minimum thickness, and having predrilled or stamped holes for attachment hardware.
   b. Fasteners: Brass wire-link chain **OR** beaded chain **OR** S-hook, **as directed.**
2. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   a. Valve-tag schedule shall be included in operation and maintenance data.

G. Warning Tags
1. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
   a. Size: 3 by 5-1/4 inches (75 by 133 mm) minimum **OR** Approximately 4 by 7 inches (100 by 178 mm), **as directed**.
   b. Fasteners: Brass grommet and wire **OR** Reinforced grommet and wire or string, **as directed**.
   c. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
   d. Color: Yellow background with black lettering.

1.3 EXECUTION

A. Preparation
1. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

B. Equipment Label Installation
1. Install or permanently fasten labels on each major item of mechanical equipment.
2. Locate equipment labels where accessible and visible.

C. Pipe Label Installation
1. Piping Color-Coding: Painting of piping is specified in Division 09 Section(s) "Interior Painting" OR "High-performance Coatings", **as directed**.

2. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles **OR** complying with ASME A13.1**, as directed**, on each piping system.
   a. Identification Paint: Use for contrasting background.
   b. Stencil Paint: Use for pipe marking.
3. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   a. Near each valve and control device.
   b. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   c. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   d. At access doors, manholes, and similar access points that permit view of concealed piping.
   e. Near major equipment items and other points of origination and termination.
   f. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
   g. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
4. Pipe Label Color Schedule:
   a. Chilled-Water Piping:
      1) Background Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
      2) Letter Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
   b. Condenser-Water Piping:
      1) Background Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
      2) Letter Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **asa directed**.
   c. Heating Water Piping:
      1) Background Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
      2) Letter Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
   d. Refrigerant Piping:
      1) Background Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
      2) Letter Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
   e. Low-Pressure Steam Piping:
      1) Background Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
      2) Letter Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
   f. High-Pressure Steam Piping:
      1) Background Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
      2) Letter Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
   g. Steam Condensate Piping:
      1) Background Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.
      2) Letter Color: Black **OR** Blue **OR** Red **OR** White **OR** Yellow, **as directed**.

D. Duct Label Installation
1. Install plastic-laminated **OR** self-adhesive, **as directed**, duct labels with permanent adhesive on air ducts in the following color codes:
   a. Blue: For cold-air supply ducts.
   b. Yellow: For hot-air supply ducts.
   c. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
   d. ASME A13.1 Colors and Designs: For hazardous material exhaust.
2. Stenciled Duct Label Option: Stenciled labels, showing service and flow direction, may be provided instead of plastic-laminated duct labels, at Installer's option, if lettering larger than 1 inch (25 mm) high is needed for proper identification because of distance from normal location of required identification.
3. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet (15 m) in each space where ducts are exposed or concealed by removable ceiling system.

E. Valve-Tag Installation
1. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
2. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
a. Valve-Tag Size and Shape:
1) Chilled Water: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, round **OR** square, **as directed**.
2) Condenser Water: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, round **OR** square, **as directed**.
3) Refrigerant: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, round **OR** square, **as directed**.
4) Hot Water: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, round **OR** square, **as directed**.
5) Gas: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, round **OR** square, **as directed**.
6) Low-Pressure Steam: 1-1/2 inches (38 mm)2 inches (50 mm), **as directed**, round **OR** square, **as directed**.
7) High-Pressure Steam: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, round **OR** square, **as directed**.
8) Steam Condensate: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, round **OR** square, **as directed**.
b. Valve-Tag Color:
1) Chilled Water: Natural **OR** Green, **as directed.**
2) Condenser Water: Natural **OR** Green, **as directed.**
3) Refrigerant: Natural **OR** Green, **as directed**.
4) Hot Water: Natural **OR** Green, **as directed**.
5) Gas: Natural **OR** Yellow, **as directed**.
6) Low-Pressure Steam: Natural **OR** Yellow, **as directed**.
7) High-Pressure Steam: Natural **OR** Green, **as directed**.
8) Steam Condensate: Natural **OR** Green, **as directed**.
c. Letter Color:
1) Chilled Water: Black **OR** White, **as directed**.
2) Condenser Water: Black **OR** White, **as directed**.
3) Refrigerant: Black **OR** White, **as directed**.
4) Hot Water: Black **OR** White, **as directed**.
5) Gas: Black **OR** White, **as directed**.
6) Low-Pressure Steam: Black **OR** White, **as directed**.
7) High-Pressure Steam: Black **OR** White, **as directed**.
8) Steam Condensate: Black **OR** White, **as directed**.

F. Warning-Tag Installation
1. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 23 05 53 00

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Task	Specification	Specification Description
23 05 53 00	22 05 53 00	Identification for Plumbing Piping and Equipment
23 05 53 00	23 01 10 91	Sequence Of Operation

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SECTION 23 05 66 00 - INTERLOCKING RESILIENT FLOORING

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for interlocking resilient flooring. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Performance Requirements
   1. Static Coefficient of Friction: Provide products with the following values as determined by testing identical products per ASTM C 2047 for level surfaces:
      a. Minimum of 0.65.
   2. Americans with Disabilities Act (ADA): Whether indicated or not, the products specified herein must comply with Americans with Disabilities Act Guidelines (ADAG).
   3. Performance Characteristics: Provide tiles that meet the following:
      a. Abrasion Resistance: Less than 0.4 grams (0.9%) at 1000 cycles using a 500 gram H-18 wheel (ASTM D-3389
      b. Shore A Hardness of 83 (+/- 5) per ASTM D-2240.
      c. Meets Standard Specification for Solid Vinyl Tile ASTM F-1700, 1996 (except as to size, thickness and squareness, which standards are specific to a 12” x 12” VCT Tile)
      d. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm., per ASTM E 648
      e. Smoke Generated by Solid Materials, ASTM 662, NFPA 258: NFPA 0-450, passes
      f. Solvent/Stain Resistance: Comply with ASTM F-925-96.

C. Submittals
   1. Product Data: Provide product data for each type of product indicated.
   2. Shop Drawings: Provide shop drawings indicating installation details including border tiles, floor patterns made by varying colors of tiles, layout, colors, widths, and dimensions of game lines, and locations of athletic equipment floor inserts.
   3. Samples: Submit samples for each type, color, and pattern of flooring indicated, 6-inch- (150-mm-) square samples of same thickness and material indicated for the Work.
   4. Maintenance Data: Submit maintenance data for each type of flooring indicated to include in maintenance manuals specified in Division 1.
   5. Tile Test reports: Indicated and interpret test results for compliance of special-purpose tile with specified requirements.

D. Quality Assurance
   1. Product Characteristics: Flooring tiles shall be made from a minimum of 70 percent recycled materials.
   2. Source Limitations: Obtain each type, color, and pattern of product specified from one source with resources to provide products of consistent quality in appearance and physical properties without delaying the Work.
   3. Fire- Test-Response Characteristics: Provide products with a Class I critical radiant flux classification , as determined by testing identical products per ASTM E 648 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

E. Delivery, Storage, And Handling
   1. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storing.
   2. Store materials to prevent deterioration. Store tiles on flat surfaces.
   3. Move products into spaces where they will be installed at least 48 hours before installation, unless a longer conditioning period is recommended in writing by the tile manufacturer. Do not

install products until they are at the same temperature as the space where they are to be installed.

F. Project Conditions
1. Install products after other finishing operations, including painting, are completed.
2. Provide as follows:
   a. Maintain a temperature of not less than 70 degree F (21 degree C) or more than 95 degree F (35 degree C) in installation spaces for at least 48 hours before installation, during installation, and for at least 48 hours after installation, unless manufacturer's written recommendations specify longer time periods. After post-installation period, maintain a temperature of not less than 55 degree F (13 degree C) or more than 95 degree F (35 degree C).

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of interlocking resilient flooring installation as follows:
   a. Against wear for a period of 10 years from date of Final Completion.
   b. Manufacturing defects for a period of 1 year from date of Final Completion.

1.2 PRODUCTS

A. Specialty Vinyl Floor Tile
1. Product: Subject to compliance with requirements, provide the following or approved equivalent:
   a. “FreeStyle” as manufactured by SelecTech, Inc., Taunton, MA, (877-738-4537).
2. Material: Recycled composite fiber reinforced vinyl.
3. Style: Solid surface.
4. Installation Method: Free lay without adhesive, interlocking.
5. Size: 18.5 inches (470 mm) square (nominal).
6. Thickness: 0.375 inch (9.5 mm).
7. Weight: Not less than 5.5 pounds (2.27 kg) per tile.
8. Color and Pattern as selected by the the Owner.
9. Fire Rating: Class I.
10. Static Load Resistance: 750 psi with maximum 0.006 indention, per ASTM F 970.

B. Specialty Resilient Flooring
1. Product: Subject to compliance with requirements, provide the following or approved equivalent:
   a. “SelecTile Industrial” as manufactured by SelecTech, Inc., Taunton, MA, (877-738-4537).
2. Material: Recycled composite fiber reinforced vinyl
   a. Black - 100%.
   b. Gray & colors - 10%.
3. Style: Smooth **OR** Coin **OR** Diamond, **as directed**, surface.
4. Installation Method: Free lay without adhesive, unless directed otherwise, interlocking.
5. Size: 23.75 inches (603 mm) square (nominal).
6. Thickness: 0.22 inch (5.59 mm).
7. Weight: Not less than 6.0 pounds (2.72 kg) per tile.
8. Color and Pattern as selected by the the Owner.
9. Fire Rating: Class I.
10. Static Load Resistance: 1,000 psi with maximum 0.006 indention, per ASTM F 970.
11. Transition Strip: Interlocking, 24” x 2” (61 cm x 5.1 cm), color as selected.
12. Corner Piece: Interlocking, 2” x 2” (5.1 cm x 5.1 cm), color as selected

C. Accessories
1. Trowelable Leveling and Patching Compound: Latex-modified, hydraulic-cement-based formulation approved by flooring manufacturer.

2. Barrier Coating: Provide “Nu-Flor #500" as manufactured by W.F. Taylor or an approved equivalent by the flooring manufacturer.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions where installation of products will occur, with Installer present, for compliance with manufacturer's requirements. Verify that substrates and conditions are satisfactory for flooring installation and comply with requirements.
2. Concrete Substrates: Verify that concrete slabs comply with ASTM F 710 and the following:
a. Slab substrates are dry and cured.
b. Substrates are free of cracks, ridges, depressions, scale, and foreign deposits
3. Wood Subfloor Substrates: Verify the following:
a. Underlayment over subfloor complies with requirements specified in Division 6 Section "Rough Carpentry."
b. Underlayment surface is free of irregularities that may show through surface, or stain floor covering.
4. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, and depressions in substrates.
2. Broom and vacuum clean substrates to be covered immediately before product installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust. Proceed with installation only after unsatisfactory conditions have been corrected.
3. Scrape existing adhesives off the existing floor substrate and seal with barrier coating.

C. Flooring Installation, General
1. Mix tiles from several boxes to avoid adverse color variations in the final installation. Open several boxes at one time to ensure that color variations do not occur in one area.
2. Scribe, cut, and fit flooring to butt neatly and tightly to vertical surfaces, equipment anchors, floor outlets, and other interruptions of floor surface.
3. Extend floor coverings into toe spaces, door reveals, closets, and similar openings, unless otherwise indicated.
4. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating subfloor markings on finish flooring. Use nonpermanent, non-staining marking device.
5. Whether indicated or not, provide a minimum of a 1/4 inch (6.35 mm) gap for FreeStyle or 3/8 inch (9.53 mm) for SelecTile around the perimeter of the flooring tiles to allow for expansion and contraction.

D. Tile Installation
1. Installation shall be in accordance with manufacturer’s printed instructions.
2. Lay out tiles from center marks established with principal walls.
a. Ignoring minor wall offsets, lay out so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths narrower than one-third of a tile at perimeter.
b. Lay tiles as follows room axis, unless otherwise indicated.
1) Square with the room axis.
2) At a 45 degree angle.
3) As indicated.
3. Match tiles for color and pattern by selecting them from cartons of the same batch and mixing tiles as recommended in writing by manufacturer.
a. Lay tiles in the following pattern:
1) Basket-weave pattern with grain direction alternating in adjacent tiles
2) Pattern of colors and sizes indicated on Drawings.

E. Cleaning And Protecting
1. Perform the following operations immediately after installing flooring products:
a. Sweep and vacuum floor thoroughly.
b. Do not wash floor until after waiting period recommended in writing by flooring manufacturer.
c. Damp mop floor to remove marks and soil using method and cleaner recommended in writing by flooring manufacturer.
d. Seal floor with an acrylic floor finish using method and sealer recommended in writing by flooring manufacturer.
2. Protect flooring against mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods indicated or recommended in writing by flooring manufacturer.
a. Do not move heavy or sharp objects directly over floor surfaces. Place plywood or hardboard panels over flooring and under objects while they are being moved. Slide or roll objects over panels without moving panels.

END OF SECTION 23 05 66 00

Task	Specification	Specification Description
23 05 93 00	02 41 13 13	Selective Demolition
23 05 93 00	01 71 23 16	Cutting and Patching
23 05 93 00	23 01 10 91	Sequence Of Operation
23 05 93 00	23 01 10 91a	Testing, Adjusting, And Balancing

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SECTION 23 07 13 00 - HVAC INSULATION

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for HVAC insulation. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Insulation Materials:
         1) Calcium silicate.
         2) Cellular glass.
         3) Flexible elastomeric.
         4) Mineral fiber.
         5) Phenolic.
         6) Polyisocyanurate.
         7) Polyolefin.
         8) Polystyrene.
      b. Fire-rated insulation systems.
      c. Insulating cements.
      d. Adhesives.
      e. Mastics.
      f. Lagging adhesives.
      g. Sealants.
      h. Factory-applied jackets.
      i. Field-applied fabric-reinforcing mesh.
      j. Field-applied cloths.
      k. Field-applied jackets.
      l. Tapes.
      m. Securements.
      n. Corner angles.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittal:
      a. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
   3. Shop Drawings:
      a. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
      b. Detail attachment and covering of heat tracing inside insulation.
      c. Detail insulation application at pipe expansion joints for each type of insulation.
      d. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
      e. Detail removable insulation at piping specialties, equipment connections, and access panels.
      f. Detail application of field-applied jackets.
      g. Detail application at linkages of control devices.
      h. Detail field application for each equipment type.
   4. Field quality-control reports.

D. Quality Assurance

1. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
    a. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
    b. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

E. Delivery, Storage, And Handling

1. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.2 PRODUCTS

A. Insulation Materials

1. Comply with requirements in Part 1.3 schedule articles for where insulating materials shall be applied.
2. Products shall not contain asbestos, lead, mercury, or mercury compounds.
3. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
4. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
5. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
6. Calcium Silicate:
    a. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
    b. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
    c. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.
7. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
    a. Block Insulation: ASTM C 552, Type I.
    b. Special-Shaped Insulation: ASTM C 552, Type III.
    c. Board Insulation: ASTM C 552, Type IV.
    d. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
    e. Preformed Pipe Insulation with Factory-Applied ASJ **OR** ASJ-SSL, **as directed**: Comply with ASTM C 552, Type II, Class 2.
    f. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
8. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
9. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I **OR** II with factory-applied vinyl jacket **OR** III with factory-applied FSK jacket **OR** III with factory-applied FSP jacket, **as directed**. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
10. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.

11. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation without factory-applied jacket **OR** with factory-applied ASJ **OR** with factory-applied FSK jacket, **as directed**. For equipment applications, provide insulation without factory-applied jacket **OR** with factory-applied ASJ **OR** with factory-applied FSK jacket, **as directed**. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
12. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.
13. Mineral-Fiber, Preformed Pipe Insulation:
    a. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, without factory-applied jacket **OR** with factory-applied ASJ **OR** with factory-applied ASJ-SSL, **as directed**. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
    b. Type II, 1200 deg F (649 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, without factory-applied jacket **OR** with factory-applied ASJ **OR** with factory-applied ASJ-SSL, **as directed**. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
14. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.
15. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ **OR** FSK jacket, **as directed**, complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
16. Phenolic:
    a. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
    b. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
    c. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
    d. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
        1) Preformed Pipe Insulation: None **OR** ASJ, **as directed**.
        2) Board for Duct and Plenum Applications: None **OR** ASJ, **as directed**.
        3) Board for Equipment Applications: None **OR** ASJ, **as directed**.
17. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.
    a. Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F (0.027 W/m x K) at 75 deg F (24 deg C) after 180 days of aging.
    b. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less for thickness up to 1-1/2 inches (38 mm) as tested by ASTM E 84.
    c. Fabricate shapes according to ASTM C 450 and ASTM C 585.
    d. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
        1) Pipe Applications: None **OR** ASJ **OR** ASJ-SSL **OR** PVDC **OR** PVDC-SSL, **as directed**.
        2) Equipment Applications: None **OR** ASJ **OR** ASJ-SSL **OR** PVDC **OR** PVDC-SSL, **as directed**.
18. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.
19. Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C 578, Type IV or Type XIII, except thermal conductivity (k-value) shall not exceed

0.26 Btu x in./h x sq. ft. x deg F (0.038 W/m x K) after 180 days of aging. Fabricate shapes according to ASTM C 450 and ASTM C 585.

B. Fire-Rated Insulation Systems
1. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F (927 deg C). Comply with ASTM C 656, Type II, Grade 6. tested and certified to provide a 1-hour **OR** 2-hour, **as directed**, fire rating by a NRTL acceptable to authority having jurisdiction.
2. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 1-hour **OR** 2-hour, **as directed**, fire rating by a NRTL acceptable to authority having jurisdiction.

C. Insulating Cements
1. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
2. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
3. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

D. Adhesives
1. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
2. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F (10 to 427 deg C).
   a. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Cellular-Glass, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F (minus 59 to plus 149 deg C).
   a. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
4. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   a. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
5. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   a. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140 deg F (29 to plus 60 deg C).
7. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
   a. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
8. PVC Jacket Adhesive: Compatible with PVC jacket.
   a. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Mastics
1. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
   a. For indoor applications, use mastics that have an approved VOC content or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
   a. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.

b. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
c. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
d. Color: White.

3. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
   a. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.03 metric perm) at 35-mil (0.9-mm) dry film thickness.
   b. Service Temperature Range: 0 to 180 deg F (Minus 18 to plus 82 deg C).
   c. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
   d. Color: White.
4. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
   a. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30-mil (0.8-mm) dry film thickness.
   b. Service Temperature Range: Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).
   c. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
   d. Color: White.
5. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
   a. Water-Vapor Permeance: ASTM F 1249, 3 perms (2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
   b. Service Temperature Range: Minus 20 to plus 200 deg F (Minus 29 to plus 93 deg C).
   c. Solids Content: 63 percent by volume and 73 percent by weight.
   d. Color: White.

F. Lagging Adhesives
1. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
   a. For indoor applications, use lagging adhesives that have an approved VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
   c. Service Temperature Range: Minus 50 to plus 180 deg F (Minus 46 to plus 82 deg C).
   d. Color: White.

G. Sealants
1. Joint Sealants:
   a. Materials shall be compatible with insulation materials, jackets, and substrates.
   b. Permanently flexible, elastomeric sealant.
   c. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
   d. Color: White or gray.
   e. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. FSK and Metal Jacket Flashing Sealants:
   a. Materials shall be compatible with insulation materials, jackets, and substrates.
   b. Fire- and water-resistant, flexible, elastomeric sealant.
   c. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
   d. Color: Aluminum.
   e. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
   a. Materials shall be compatible with insulation materials, jackets, and substrates.
   b. Fire- and water-resistant, flexible, elastomeric sealant.
   c. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
   d. Color: White.
   e. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

H. Factory-Applied Jackets

1. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
   c. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
   d. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
   e. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms (0.013 metric perms) when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
   f. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms (0.007 metric perms) when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
   g. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

I. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perms) when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

J. Field-Applied Fabric-Reinforcing Mesh
1. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. (68 g/sq. m) with a thread count of 10 strands by 10 strands/sq. inch (4 strands by 4 strands/sq. mm) for covering pipe and pipe fittings.
2. Woven Glass-Fiber Fabric for Duct and Equipment Insulation: Approximately 6 oz./sq. yd. (203 g/sq. m) with a thread count of 5 strands by 5 strands/sq. inch (2 strands by 2 strands/sq. mm) for covering equipment.
3. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. inch (4 strands by 4 strands/sq. mm), in a Leno weave, for duct, equipment, and pipe.

K. Field-Applied Cloths
1. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. (271 g/sq. m).

L. Field-Applied Jackets
1. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
2. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
3. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   a. Adhesive: As recommended by jacket material manufacturer.
   b. Color: White **OR** Color-code jackets based on system. Color as selected by the Owner, **as directed**.
   c. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
      1) Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
   d. Factory-fabricated tank heads and tank side panels.
4. Metal Jacket:

a. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005, Temper H-14.
   1) Sheet and roll stock ready for shop or field sizing **OR** Factory cut and rolled to size, **as directed**.
   2) Finish and thickness are indicated in field-applied jacket schedules.
   3) Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 2.5-mil- (0.063-mm-) thick Polysurlyn, **as directed**.
   4) Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 2.5-mil- (0.063-mm-) thick Polysurlyn, **as directed**.
   5) Factory-Fabricated Fitting Covers:
      a) Same material, finish, and thickness as jacket.
      b) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      c) Tee covers.
      d) Flange and union covers.
      e) End caps.
      f) Beveled collars.
      g) Valve covers.
      h) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

b. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
   1) Sheet and roll stock ready for shop or field sizing **OR** Factory cut and rolled to size, **as directed**.
   2) Material, finish, and thickness are indicated in field-applied jacket schedules.
   3) Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 2.5-mil- (0.063-mm-) thick Polysurlyn, **as directed**.
   4) Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 2.5-mil- (0.063-mm-) thick Polysurlyn, **as directed**.
   5) Factory-Fabricated Fitting Covers:
      a) Same material, finish, and thickness as jacket.
      b) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      c) Tee covers.
      d) Flange and union covers.
      e) End caps.
      f) Beveled collars.
      g) Valve covers.
      h) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

5. Underground Direct-Buried Jacket: 125-mil- (3.2-mm-) thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
6. Self-Adhesive Outdoor Jacket: 60-mil- (1.5-mm-) thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white **OR** stucco-embossed, **as directed**, aluminum-foil facing.
7. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms (0.013 metric perms) when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
8. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms (0.007 metric perms) when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
9. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

M. Tapes
1. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   a. Width: 3 inches (75 mm).
   b. Thickness: 11.5 mils (0.29 mm).
   c. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   d. Elongation: 2 percent.
   e. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   f. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
2. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   a. Width: 3 inches (75 mm).
   b. Thickness: 6.5 mils (0.16 mm).
   c. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   d. Elongation: 2 percent.
   e. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   f. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
3. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
   a. Width: 2 inches (50 mm).
   b. Thickness: 6 mils (0.15 mm).
   c. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
   d. Elongation: 500 percent.
   e. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.
4. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
   a. Width: 2 inches (50 mm).
   b. Thickness: 3.7 mils (0.093 mm).
   c. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
   d. Elongation: 5 percent.
   e. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.
5. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
   a. Width: 3 inches (75 mm).
   b. Film Thickness: 4 mils (0.10 mm).
   c. Adhesive Thickness: 1.5 mils (0.04 mm).
   d. Elongation at Break: 145 percent.
   e. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.
6. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
   a. Width: 3 inches (75 mm).
   b. Film Thickness: 6 mils (0.15 mm).
   c. Adhesive Thickness: 1.5 mils (0.04 mm).
   d. Elongation at Break: 145 percent.
   e. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.

N. Securements
1. Bands:
   a. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 **OR** Type 316, **as directed**; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, wide with wing seal **OR** closed seal, **as directed**.
   b. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, wide with wing seal **OR** closed seal, **as directed**.
   c. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
2. Insulation Pins and Hangers:

a. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) **OR** 0.135-inch- (3.5-mm-), **as directed**, diameter shank, length to suit depth of insulation indicated.
b. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) **OR** 0.135-inch- (3.5-mm-), **as directed**, diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
c. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
    1) Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
    2) Spindle: Copper- or zinc-coated, low carbon steel **OR** Aluminum **OR** Stainless steel, **as directed**, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
    3) Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
d. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
    1) Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.
    2) Spindle: Nylon, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).
    3) Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
e. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
    1) Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
    2) Spindle: Copper- or zinc-coated, low carbon steel **OR** Aluminum **OR** Stainless steel, **as directed**, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
    3) Adhesive-backed base with a peel-off protective cover.
f. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, galvanized-steel **OR** aluminum **OR** stainless-steel, **as directed**, sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
    1) Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
g. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

3. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.
4. Wire: 0.080-inch (2.0-mm) nickel-copper alloy **OR** 0.062-inch (1.6-mm) soft-annealed, stainless steel **OR** 0.062-inch (1.6-mm) soft-annealed, galvanized steel, **as directed**.

O. Corner Angles
1. PVC Corner Angles: 30 mils (0.8 mm) thick, minimum 1 by 1 inch (25 by 25 mm), PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

2. Aluminum Corner Angles: 0.040 inch (1.0 mm) thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005; Temper H-14.
3. Stainless-Steel Corner Angles: 0.024 inch (0.61 mm) thick, minimum 1 by 1 inch (25 by 25 mm), stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 **OR** Type 316, **as directed**.

1.3 EXECUTION

A. Preparation

1. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
   OR
   Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
   a. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range between 140 and 300 deg F (60 and 149 deg C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
   b. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
3. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

B. General Installation Requirements

1. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
2. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
3. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
4. Install insulation with longitudinal seams at top and bottom of horizontal runs.
5. Install multiple layers of insulation with longitudinal and end seams staggered.
6. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
7. Keep insulation materials dry during application and finishing.
8. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
9. Install insulation with least number of joints practical.
10. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
    a. Install insulation continuously through hangers and around anchor attachments.
    b. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
    c. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

d. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

11. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
12. Install insulation with factory-applied jackets as follows:
    a. Draw jacket tight and smooth.
    b. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
    c. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) **OR** 4 inches (100 mm), **as directed**, o.c.
        1) For below ambient services, apply vapor-barrier mastic over staples.
    d. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
    e. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
13. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
14. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
15. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
16. For above ambient services, do not install insulation to the following:
    a. Vibration-control devices.
    b. Testing agency labels and stamps.
    c. Nameplates and data plates.
    d. Manholes.
    e. Handholes.
    f. Cleanouts.

C. Penetrations

1. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
    a. Seal penetrations with flashing sealant.
    b. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
    c. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
    d. Seal jacket to roof flashing with flashing sealant.
2. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
3. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
    a. Seal penetrations with flashing sealant.
    b. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
    c. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
    d. Seal jacket to wall flashing with flashing sealant.

4. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
5. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches (50 mm).
    a. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
6. Insulation Installation at Floor Penetrations:
    a. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches (50 mm).
    b. Pipe: Install insulation continuously through floor penetrations.
    c. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping".

D. Equipment, Tank, And Vessel Insulation Installation
1. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
    a. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 **OR** 50, **as directed**, percent coverage of tank and vessel surfaces.
    b. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
    c. Protect exposed corners with secured corner angles.
    d. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
        1) Do not weld anchor pins to ASME-labeled pressure vessels.
        2) Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
        3) On tanks and vessels, maximum anchor-pin spacing is 3 inches (75 mm) from insulation end joints, and 16 inches (400 mm) o.c. in both directions.
        4) Do not overcompress insulation during installation.
        5) Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
        6) Impale insulation over anchor pins and attach speed washers.
        7) Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
    e. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
    f. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches (150 mm) from each end. Install wire or cable between two circumferential girdles 12 inches (300 mm) o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches (1200 mm) o.c. Use this network for securing insulation with tie wire or bands.
    g. Stagger joints between insulation layers at least 3 inches (75 mm).
    h. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.

i. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
j. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

2. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
a. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
b. Seal longitudinal seams and end joints.

3. Insulation Installation on Pumps:
a. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch (150-mm) centers, starting at corners. Install 3/8-inch- (10-mm-) diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
b. Fabricate boxes from galvanized steel **OR** aluminum **OR** stainless steel, **as directed**, at least 0.040 inch (1.0 mm) **OR** 0.050 inch (1.3 mm) **OR** 0.060 inch (1.6 mm), **as directed**, thick.
c. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

E. General Pipe Insulation Installation

1. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

2. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
a. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
b. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
c. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
d. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
e. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
f. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
g. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
h. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and

unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

i. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

3. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

4. Install removable insulation covers at locations indicated. Installation shall conform to the following:
   a. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
   b. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
   c. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
   d. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
   e. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

F. Calcium Silicate Insulation Installation

1. Insulation Installation on Boiler Breechings and Ducts:
   a. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation material.
   b. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.
   c. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

2. Insulation Installation on Straight Pipes and Tubes:
   a. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation materials.
   b. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.
   c. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

3. Insulation Installation on Pipe Flanges:
   a. Install preformed pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
d. Finish flange insulation same as pipe insulation.

4. Insulation Installation on Pipe Fittings and Elbows:
   a. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
   b. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
   c. Finish fittings insulation same as pipe insulation.
5. Insulation Installation on Valves and Pipe Specialties:
   a. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   b. Install insulation to flanges as specified for flange insulation application.
   c. Finish valve and specialty insulation same as pipe insulation.

G. Cellular-Glass Insulation Installation
1. Insulation Installation on Straight Pipes and Tubes:
   a. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   c. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
   d. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
2. Insulation Installation on Pipe Flanges:
   a. Install preformed pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
   d. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.
3. Insulation Installation on Pipe Fittings and Elbows:
   a. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
   b. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.
4. Insulation Installation on Valves and Pipe Specialties:
   a. Install preformed sections of cellular-glass insulation to valve body.
   b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   c. Install insulation to flanges as specified for flange insulation application.

H. Flexible Elastomeric Insulation Installation
1. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
2. Insulation Installation on Pipe Flanges:
   a. Install pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

d. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3. Insulation Installation on Pipe Fittings and Elbows:

a. Install mitered sections of pipe insulation.

b. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

4. Insulation Installation on Valves and Pipe Specialties:

a. Install preformed valve covers manufactured of same material as pipe insulation when available.

b. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

c. Install insulation to flanges as specified for flange insulation application.

d. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

I. Mineral-Fiber Insulation Installation

1. Insulation Installation on Straight Pipes and Tubes:

a. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

c. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.

d. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

2. Insulation Installation on Pipe Flanges:

a. Install preformed pipe insulation to outer diameter of pipe flange.

b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.

d. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

3. Insulation Installation on Pipe Fittings and Elbows:

a. Install preformed sections of same material as straight segments of pipe insulation when available.

b. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

4. Insulation Installation on Valves and Pipe Specialties:

a. Install preformed sections of same material as straight segments of pipe insulation when available.

b. When preformed sections are not available, install mitered sections of pipe insulation to valve body.

c. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

d. Install insulation to flanges as specified for flange insulation application.

5. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

a. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 **OR** 50, **as directed**, percent coverage of duct and plenum surfaces.
b. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
c. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
   1) On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
   2) On duct sides with dimensions larger than 18 inches (450 mm), place pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   3) Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   4) Do not overcompress insulation during installation.
   5) Impale insulation over pins and attach speed washers.
   6) Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
d. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
   1) Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   2) Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches (75 mm).
e. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (450 mm) o.c.
f. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
g. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

6. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
a. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 **OR** 50, **as directed**, percent coverage of duct and plenum surfaces.
b. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
c. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
   1) On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
   2) On duct sides with dimensions larger than 18 inches (450 mm), space pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

3) Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
4) Do not overcompress insulation during installation.
5) Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

d. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
1) Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
2) Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches (75 mm).

e. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

f. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

J. Phenolic Insulation Installation
1. General Installation Requirements:
a. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation materials.
b. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with 0.062-inch (1.6-mm) wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.
2. Insulation Installation on Straight Pipes and Tubes:
a. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
c. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
d. For insulation with factory-applied jackets with vapor retarders on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
3. Insulation Installation on Pipe Flanges:
a. Install preformed pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
4. Insulation Installation on Pipe Fittings and Elbows:
a. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
5. Insulation Installation on Valves and Pipe Specialties:

a. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
c. Install insulation to flanges as specified for flange insulation application.

K. Polyisocyanurate Insulation Installation
1. Insulation Installation on Straight Pipes and Tubes:
a. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
b. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
c. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.
2. Insulation Installation on Pipe Flanges:
a. Install preformed pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch (38-mm) thickness.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation.
3. Insulation Installation on Fittings and Elbows:
a. Install preformed sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
4. Insulation Installation on Valves and Pipe Specialties:
a. Install preformed sections of polyisocyanurate insulation to valve body.
b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
c. Install insulation to flanges as specified for flange insulation application.

L. Polyolefin Insulation Installation
1. Insulation Installation on Straight Pipes and Tubes:
a. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
2. Insulation Installation on Pipe Flanges:
a. Install pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
d. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
3. Insulation Installation on Pipe Fittings and Elbows:
a. Install mitered sections of polyolefin pipe insulation.
b. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
4. Insulation Installation on Valves and Pipe Specialties:
a. Install cut sections of polyolefin pipe and sheet insulation to valve body.
b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
c. Install insulation to flanges as specified for flange insulation application.

d. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

M. Polystyrene Insulation Installation
1. Insulation Installation on Straight Pipes and Tubes:
a. Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
b. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
c. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.
2. Insulation Installation on Pipe Flanges:
a. Install preformed pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch (38-mm) thickness.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polystyrene block insulation of same thickness as pipe insulation.
3. Insulation Installation on Pipe Fittings and Elbows:
a. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
4. Insulation Installation on Valves and Pipe Specialties:
a. Install preformed section of polystyrene insulation to valve body.
b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
c. Install insulation to flanges as specified for flange insulation application.

N. Field-Applied Jacket Installation
1. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
a. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
b. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
c. Completely encapsulate insulation with coating, leaving no exposed insulation.
2. Where FSK jackets are indicated, install as follows:
a. Draw jacket material smooth and tight.
b. Install lap or joint strips with same material as jacket.
c. Secure jacket to insulation with manufacturer's recommended adhesive.
d. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
e. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
3. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
a. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
4. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.
5. Where PVDC jackets are indicated, install as follows:

a. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
b. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches (50 mm) over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
c. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
d. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches (850 mm) or less. The 33-1/2-inch- (850-mm-) circumference limit allows for 2-inch- (50-mm-) overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
e. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

O. Fire-Rated Insulation System Installation
1. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
2. Insulate duct access panels and doors to achieve same fire rating as duct.
3. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Firestopping".

P. Finishes
1. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 07.
a. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
1) Finish Coat Material: Interior, flat, latex-emulsion size.
2. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
3. Color: Final color as selected by the Owner. Vary first and second coats to allow visual inspection of the completed Work.
4. Do not field paint aluminum or stainless-steel jackets.

Q. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
a. Inspect ductwork, randomly selected by the Owner, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
b. Inspect field-insulated equipment, randomly selected by the Owner, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
c. Inspect pipe, fittings, strainers, and valves, randomly selected by the Owner, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations

of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

3. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

R. Boiler Breeching Insulation Schedule

1. Round, exposed breeching and connector insulation shall be one of the following:
   a. Calcium Silicate: 4 inches (100 mm) thick.
   b. High-Temperature Mineral-Fiber Blanket: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
   c. High-Temperature Mineral-Fiber Board: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
2. Round, concealed breeching and connector insulation shall be one of the following:
   a. Calcium Silicate: 4 inches (100 mm) thick.
   b. High-Temperature Mineral-Fiber Blanket: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
   c. High-Temperature Mineral-Fiber Board: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
3. Rectangular, exposed breeching and connector insulation shall be one of the following:
   a. Calcium Silicate: 4 inches (100 mm) thick.
   b. High-Temperature Mineral-Fiber Blanket: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
   c. High-Temperature Mineral-Fiber Board: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
4. Rectangular, concealed breeching and connector insulation shall be one of the following:
   a. Calcium Silicate: 4 inches (100 mm) thick.
   b. High-Temperature Mineral-Fiber Blanket: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
   c. High-Temperature Mineral-Fiber Board: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.

S. Duct Insulation Schedule, General

1. Plenums and Ducts Requiring Insulation:
   a. Indoor, concealed supply and outdoor air.
   b. Indoor, exposed supply and outdoor air.
   c. Indoor, concealed return located in nonconditioned space.
   d. Indoor, exposed return located in nonconditioned space.
   e. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
   f. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
   g. Indoor, concealed oven and warewash exhaust.
   h. Indoor, exposed oven and warewash exhaust.
   i. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
   j. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
   k. Outdoor, concealed supply and return.
   l. Outdoor, exposed supply and return.
2. Items Not Insulated:
   a. Fibrous-glass ducts.
   b. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
   c. Factory-insulated flexible ducts.
   d. Factory-insulated plenums and casings.
   e. Flexible connectors.
   f. Vibration-control devices.
   g. Factory-insulated access panels and doors.

T. Indoor Duct And Plenum Insulation Schedule
1. Concealed, round and flat-oval, supply-air duct insulation shall be one of the following:
   a. Flexible Elastomeric: 1 inch (25 mm) thick.
   b. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
   c. Mineral-Fiber Board: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   d. Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
   e. Polyolefin: 1 inch (25 mm) thick.
2. Concealed, round and flat-oval, return-air duct insulation shall be one of the following:
   a. Flexible Elastomeric: 1 inch (25 mm) thick.
   b. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
   c. Mineral-Fiber Board: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   d. Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
   e. Polyolefin: 1 inch (25 mm) thick.
3. Concealed, round and flat-oval, outdoor-air duct insulation shall be one of the following:
   a. Flexible Elastomeric: 1 inch (25 mm) thick.
   b. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
   c. Mineral-Fiber Board: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   d. Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
   e. Polyolefin: 1 inch (25 mm) thick.
4. Concealed, round and flat-oval, exhaust-air duct insulation shall be one of the following:
   a. Flexible Elastomeric: 1 inch (25 mm) thick.
   b. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
   c. Mineral-Fiber Board: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   d. Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
   e. Polyolefin: 1 inch (25 mm) thick.
5. Concealed, rectangular, supply-air duct insulation shall be one of the following:
   a. Flexible Elastomeric: 1 inch (25 mm) thick.
   b. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
   c. Mineral-Fiber Board: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   d. Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
   e. Polyolefin: 1 inch (25 mm) thick.

6. Concealed, rectangular, return-air duct insulation shall be one of the following:
   a. Flexible Elastomeric: 1 inch (25 mm) thick.
   b. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
   c. Mineral-Fiber Board: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   d. Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
   e. Polyolefin: 1 inch (25 mm), **as directed**, thick.
7. Concealed, rectangular, outdoor-air duct insulation shall be one of the following:
   a. Flexible Elastomeric: 1 inch (25 mm) thick.
   b. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
   c. Mineral-Fiber Board: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   d. Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
   e. Polyolefin: 1 inch (25 mm), **as directed**, thick.
8. Concealed, rectangular, exhaust-air duct insulation between isolation damper and penetration of building exterior shall be one of the following:
   a. Flexible Elastomeric: 1 inch (25 mm) thick.
   b. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
   c. Mineral-Fiber Board: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   d. Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
   e. Polyolefin: 1 inch (25 mm) thick.
9. Concealed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket **OR** board, **as directed**; thickness as required to achieve 2-hour fire rating.
10. Concealed, supply-air plenum insulation shall be one of the following:
   a. Flexible Elastomeric: 1 inch (25 mm) thick.
   b. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
   c. Mineral-Fiber Board: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   d. Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
   e. Polyolefin: 1 inch (25 mm) thick.
11. Concealed, return-air plenum insulation shall be one of the following:
   a. Flexible Elastomeric: 1 inch (25 mm) thick.
   b. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
   c. Mineral-Fiber Board: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.

d. Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
e. Polyolefin: 1 inch (25 mm) thick.

12. Concealed, outdoor-air plenum insulation shall be one of the following:
    a. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
    b. Mineral-Fiber Board: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
    c. Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
13. Concealed, exhaust-air plenum insulation shall be one of the following:
    a. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
    b. Mineral-Fiber Board: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
    c. Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
14. Exposed, round and flat-oval, supply-air duct insulation shall be one of the following:
    a. Flexible Elastomeric: 1 inch (25 mm) thick.
    b. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
    c. Mineral-Fiber Board: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
    d. Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
    e. Polyolefin: 1 inch (25 mm) thick.
15. Exposed, round and flat-oval, return-air duct insulation shall be one of the following:
    a. Flexible Elastomeric: 1 inch (25 mm) thick.
    b. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
    c. Mineral-Fiber Board: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
    d. Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
    e. Polyolefin: 1 inch (25 mm) thick.
16. Exposed, round and flat-oval, outdoor-air duct insulation shall be one of the following:
    a. Flexible Elastomeric: 1 inch (25 mm) thick.
    b. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
    c. Mineral-Fiber Board: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
    d. Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
    e. Polyolefin: 1 inch (25 mm) thick.
17. Exposed, round and flat-oval, exhaust-air duct insulation shall be one of the following:
    a. Flexible Elastomeric: 1 inch (25 mm) thick.

b. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
c. Mineral-Fiber Board: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
d. Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
e. Polyolefin: 1 inch (25 mm) thick.

18. Exposed, rectangular, supply-air duct insulation shall be one of the following:
a. Flexible Elastomeric: 1 inch (25 mm) thick.
b. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
c. Mineral-Fiber Board: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96 kg/cu. m), **as directed**, nominal density.
d. Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
e. Polyolefin: 1 inch (25 mm) thick.

19. Exposed, rectangular, return-air duct insulation shall be one of the following:
a. Flexible Elastomeric: 1 inch (25 mm) thick.
b. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
c. Mineral-Fiber Board: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
d. Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
e. Polyolefin: 1 inch (25 mm) thick.

20. Exposed, rectangular, outdoor-air duct insulation shall be one of the following:
a. Flexible Elastomeric: 1 inch (25 mm) thick.
b. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
c. Mineral-Fiber Board: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
d. Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
e. Polyolefin: 1 inch (25 mm) thick.

21. Exposed, rectangular, exhaust-air duct insulation shall be one of the following:
a. Flexible Elastomeric: 1 inch (25 mm) thick.
b. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
c. Mineral-Fiber Board: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
d. Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
e. Polyolefin: 1 inch (25 mm) thick.

22. Exposed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket **OR** board, **as directed**; thickness as required to achieve 2-hour fire rating.

23. Exposed, supply-air plenum insulation shall be one of the following:
    a. Flexible Elastomeric: 1 inch (25 mm) thick.
    b. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
    c. Mineral-Fiber Board: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
    d. Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
    e. Polyolefin: 1 inch (25 mm) thick.
24. Exposed, return-air plenum insulation shall be one of the following:
    a. Flexible Elastomeric: 1 inch (25 mm) thick.
    b. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
    c. Mineral-Fiber Board: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
    d. Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
    e. Polyolefin: 1 inch (25 mm) thick.
25. Exposed, outdoor-air plenum insulation shall be one of the following:
    a. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
    b. Mineral-Fiber Board: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
    c. Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
26. Exposed, exhaust-air plenum insulation shall be one of the following:
    a. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
    b. Mineral-Fiber Board: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
    c. Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.

U. Aboveground, Outdoor Duct And Plenum Insulation Schedule
1. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.
2. Concealed, round and flat-oval, supply-air duct insulation shall be one of the following:
    a. Mineral-Fiber Blanket: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
    b. Mineral-Fiber Board: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
    c. Phenolic: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
3. Concealed, round and flat-oval, return-air duct insulation shall be one of the following:
    a. Mineral-Fiber Blanket: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.

b. Mineral-Fiber Board: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
c. Phenolic: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.

4. Concealed, round and flat-oval, outdoor-air duct insulation shall be one of the following:
   a. Mineral-Fiber Blanket: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed,** and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
   b. Mineral-Fiber Board: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   c. Phenolic: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
5. Concealed, rectangular, supply-air duct insulation shall be one of the following:
   a. Mineral-Fiber Blanket: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
   b. Mineral-Fiber Board: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   c. Phenolic: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
6. Concealed, rectangular, return-air duct insulation shall be one of the following:
   a. Mineral-Fiber Blanket: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m, **as directed**, nominal density.
   b. Mineral-Fiber Board: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   c. Phenolic: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
7. Concealed, supply-air plenum insulation shall be one of the following:
   a. Mineral-Fiber Blanket: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
   b. Mineral-Fiber Board: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   c. Phenolic: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
8. Concealed, return-air plenum insulation shall be one of the following:
   a. Mineral-Fiber Blanket: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
   b. Mineral-Fiber Board: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   c. Phenolic: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
9. Exposed, round and flat-oval, supply-air duct insulation shall be one of the following:
   a. Mineral-Fiber Blanket: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
   b. Mineral-Fiber Board: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   c. Phenolic: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
10. Exposed, round and flat-oval, return-air duct insulation shall be one of the following:

a. Mineral-Fiber Blanket: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
b. Mineral-Fiber Board: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
c. Phenolic: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.

11. Exposed, rectangular, supply-air duct insulation shall be one of the following:
   a. Mineral-Fiber Blanket: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
   b. Mineral-Fiber Board: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   c. Phenolic: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
12. Exposed, rectangular, return-air duct insulation shall be one of the following:
   a. Mineral-Fiber Blanket: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
   b. Mineral-Fiber Board: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   c. Phenolic: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
13. Exposed, supply-air plenum insulation shall be one of the following:
   a. Mineral-Fiber Blanket: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
   b. Mineral-Fiber Board: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   c. Phenolic: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
14. Exposed, return-air plenum insulation shall be one of the following:
   a. Mineral-Fiber Blanket: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, and 0.75-lb/cu. ft. (12-kg/cu. m) **OR** 1.5-lb/cu. ft. (24-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m), **as directed**, nominal density.
   b. Mineral-Fiber Board: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   c. Phenolic: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.

V. Equipment Insulation Schedule
1. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
2. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.
3. Chillers: Insulate cold surfaces on chillers, including, but not limited to, evaporator bundles, condenser bundles, heat-recovery bundles, suction piping, compressor inlets, tube sheets, water boxes, and nozzles with one of the following:
   a. Cellular Glass: 2 inches (50 mm) thick.
   b. Flexible Elastomeric: 1 inch (25 mm) thick.
   c. Mineral-Fiber Board: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   d. Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
   e. Phenolic: 1 inch (25 mm) thick.
   f. Polyisocyanurate: 1 inch (25 mm) thick.
   g. Polyolefin: 1 inch (25 mm) thick.
4. Heat-exchanger (water-to-water for cooling service) insulation shall be one of the following:

a. Cellular Glass: 2 inches (50 mm) thick.
b. Flexible Elastomeric: 1 inch (25 mm) thick.
c. Mineral-Fiber Board: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
d. Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
e. Phenolic: 1 inch (25 mm) thick.
f. Polyisocyanurate: 1 inch (25 mm) thick.
g. Polyolefin: 1 inch (25 mm) thick.

5. Heat-exchanger (water-to-water for heating service) insulation shall be one of the following:
   a. Calcium Silicate: 3 inches (75 mm) thick.
   b. Cellular Glass: 3 inches (75 mm) thick.
   c. Mineral-Fiber Board: 2 inches (50 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   d. Mineral-Fiber Pipe and Tank: 2 inches (50 mm) thick.
6. Steam-to-hot-water converter insulation shall be one of the following:
   a. Calcium Silicate: 3 inches (75 mm) thick.
   b. Cellular Glass: 3 inches (75 mm) thick.
   c. Mineral-Fiber Board: 2 inches (50 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   d. Mineral-Fiber Pipe and Tank: 2 inches (50 mm) thick.
7. Hot-water-to-steam converter insulation shall be one of the following:
   a. Calcium Silicate: 3 inches (75 mm) thick.
   b. Cellular Glass: 3 inches (75 mm) thick.
   c. Mineral-Fiber Board: 2 inches (50 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   d. Mineral-Fiber Pipe and Tank: 2 inches (50 mm) thick.
8. Chilled-water pump insulation shall be one of the following:
   a. Cellular Glass: 3 inches (75 mm) thick.
   b. Mineral-Fiber Board: 2 inches (50 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   c. Phenolic: 2 inches (50 mm) thick.
   d. Polyisocyanurate: 1-1/2 inches (38 mm) thick.
9. Condenser-water pump insulation shall be one of the following:
   a. Cellular Glass: 2 inches (50 mm) thick.
   b. Mineral-Fiber Board: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   c. Phenolic: 1 inch (25 mm) thick.
   d. Polyisocyanurate: 1-1/2 inches (38 mm) thick.
10. Dual-service heating and cooling pump insulation shall be one of the following:
   a. Cellular Glass: 3 inches (75 mm) thick.
   b. Mineral-Fiber Board: 2 inches (50 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   c. Phenolic: 2 inches (50 mm) thick.
   d. Polyisocyanurate: 1 inch (25 mm) thick.
11. Heating-hot-water pump insulation shall be one of the following:
   a. Calcium Silicate: 3 inches (75 mm) thick.
   b. Cellular Glass: 3 inches (75 mm) thick.
   c. Mineral-Fiber Board: 2 inches (50 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
12. Heat-recovery pump insulation shall be one of the following:
   a. Cellular Glass: 2 inches (50 mm) thick.
   b. Mineral-Fiber Board: 2 inches (50 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   c. Phenolic: 1 inch (25 mm) thick.
   d. Polyisocyanurate: 1-1/2 inches (38 mm) thick.

13. Steam condensate pump and boiler feedwater pump insulation shall be one of the following:
    a. Calcium Silicate: 3 inches (75 mm) thick.
    b. Cellular Glass: 3 inches (75 mm) thick.
    c. Mineral-Fiber Board: 2 inches (50 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
    d. Mineral-Fiber Pipe and Tank: 2 inches (50 mm) thick.
14. Chilled-water expansion/compression tank insulation shall be one of the following:
    a. Cellular Glass: 1-1/2 inches (38 mm) thick.
    b. Flexible Elastomeric: 1 inch (25 mm) thick.
    c. Mineral-Fiber Board: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
    d. Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
    e. Phenolic: 1 inch (25 mm) thick.
    f. Polyisocyanurate: 1 inch (25 mm) thick.
    g. Polyolefin: 1 inch (25 mm) thick.
15. Condenser-water expansion/compression tank insulation shall be one of the following:
    a. Cellular Glass: 1-1/2 inches (38 mm) thick.
    b. Flexible Elastomeric: 1 inch (25 mm) thick.
    c. Mineral-Fiber Board: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
    d. Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
    e. Phenolic: 1 inch (25 mm) thick.
    f. Polyisocyanurate: 1 inch (25 mm) thick.
    g. Polyolefin: 1 inch (25 mm) thick.
16. Dual-service heating and cooling expansion/compression tank insulation shall be one of the following:
    a. Cellular Glass: 1-1/2 inches (38 mm) thick.
    b. Flexible Elastomeric: 1 inch (25 mm) thick.
    c. Mineral-Fiber Board: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
    d. Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
    e. Phenolic: 1 inch (25 mm) thick.
    f. Polyisocyanurate: 1 inch (25 mm) thick.
    g. Polyolefin: 1 inch (25 mm) thick.
17. Heating-hot-water expansion/compression tank insulation shall be one of the following:
    a. Calcium Silicate: 2 inches (50 mm) thick.
    b. Cellular Glass: 1-1/2 inches (38 mm) thick.
    c. Mineral-Fiber Board: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
    d. Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
18. Heat-recovery expansion/compression tank insulation shall be one of the following:
    a. Cellular Glass: 1-1/2 inches (38 mm) thick.
    b. Flexible Elastomeric: 1 inch (25 mm) thick.
    c. Mineral-Fiber Board: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
    d. Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
    e. Phenolic: 1 inch (25 mm) thick.
    f. Polyisocyanurate: 1 inch (25 mm) thick.
    g. Polyolefin: 1 inch (25 mm) thick.
19. Chilled-water air-separator insulation shall be one of the following:
    a. Cellular Glass: 2 inches (50 mm) thick.
    b. Flexible Elastomeric: 1 inch (25 mm) thick.
    c. Mineral-Fiber Board: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
    d. Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
    e. Phenolic: 1 inch (25 mm) thick.

f. Polyisocyanurate: 1 inch (25 mm) thick.
g. Polyolefin: 1 inch (25 mm) thick.

20. Condenser-water air-separator insulation shall be one of the following:
a. Cellular Glass: 2 inches (50 mm) thick.
b. Flexible Elastomeric: 1 inch (25 mm) thick.
c. Mineral-Fiber Board: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
d. Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
e. Phenolic: 1 inch (25 mm) thick.
f. Polyisocyanurate: 1 inch (25 mm) thick.
g. Polyolefin: 1 inch (25 mm) thick.

21. Dual-service heating and cooling air-separator insulation shall be one of the following:
a. Cellular Glass: 2 inches (50 mm) thick.
b. Flexible Elastomeric: 1 inch (25 mm) thick.
c. Mineral-Fiber Board: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
d. Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
e. Phenolic: 1 inch (25 mm) thick.
f. Polyisocyanurate: 1 inch (25 mm) thick.
g. Polyolefin: 1 inch (25 mm) thick.

22. Heating-hot-water air-separator insulation shall be one of the following:
a. Calcium Silicate: 3 inches (75 mm) thick.
b. Cellular Glass: 3 inches (75 mm) thick.
c. Mineral-Fiber Board: 2 inches (50 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
d. Mineral-Fiber Pipe and Tank: 2 inches (50 mm) thick.

23. Heat-recovery air-separator insulation shall be one of the following:
a. Cellular Glass: 2 inches (50 mm) thick.
b. Flexible Elastomeric: 1 inch (25 mm) thick.
c. Mineral-Fiber Board: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
d. Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
e. Phenolic: 1 inch (25 mm) thick.
f. Polyisocyanurate: 1 inch (25 mm) thick.
g. Polyolefin: 1 inch (25 mm) thick.

24. Thermal storage tank (brine, water, ice) insulation shall be one of the following:
a. Cellular Glass: 4 inches (100 mm) thick.
b. Mineral-Fiber Board: 3 inches (75 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
c. Mineral-Fiber Pipe and Tank: 3 inches (75 mm) thick.
d. Phenolic: 3 inches (75 mm) thick.
e. Polyisocyanurate (Outdoor Application Only): 3 inches (75 mm) thick.
f. Polystyrene (Outdoor Application Only): 3 inches (75 mm) thick.

25. Deaerator insulation shall be one of the following:
a. Calcium Silicate: 3 inches (75 mm) thick.
b. Cellular Glass: 3 inches (75 mm) thick.
c. Mineral-Fiber Board: 2 inches (50 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
d. Mineral-Fiber Pipe and Tank: 2 inches (50 mm) thick.

26. Steam condensate tank and receiver insulation shall be one of the following:
a. Calcium Silicate: 3 inches (75 mm) thick.
b. Cellular Glass: 3 inches (75 mm) thick.
c. Mineral-Fiber Board: 2 inches (50 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
d. Mineral-Fiber Pipe and Tank: 2 inches (50 mm) thick.

27. Steam flash-tank, flash-separator, and blow-off-tank insulation shall be one of the following:
    a. Calcium Silicate: 3 inches (75 mm) thick.
    b. Cellular Glass: 3 inches (75 mm) thick.
    c. Mineral-Fiber Board: 2 inches (50 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
    d. Mineral-Fiber Pipe and Tank: 2 inches (50 mm) thick.
28. Piping system filter-housing insulation shall be one of the following:
    a. Cellular Glass: 3 inches (75 mm) thick.
    b. Mineral-Fiber Board: 2 inches (50 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
    c. Mineral-Fiber Pipe and Tank: 2 inches (50 mm) thick.
29. Outdoor, aboveground, heated, fuel-oil storage tank insulation shall be one of the following:
    a. Cellular Glass: 3 inches (75 mm) thick.
    b. Mineral-Fiber Board: 2 inches (50 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
    c. Mineral-Fiber Pipe and Tank: 2 inches (50 mm) thick.
    d. Polyisocyanurate: 1-1/2 inches (38 mm) thick.

W. Piping Insulation Schedule, General
1. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
2. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
    a. Drainage piping located in crawl spaces.
    b. Underground piping.
    c. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

X. Indoor Piping Insulation Schedule
1. Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):
    a. All Pipe Sizes: Insulation shall be one of the following:
        1) Cellular Glass: 1-1/2 inches (38 mm) thick.
        2) Flexible Elastomeric: 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick.
        3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) **OR** 1 inch (25 mm), **as directed**, thick.
        4) Phenolic: 1 inch (25 mm) thick.
        5) Polyisocyanurate: 1 inch (25 mm) thick.
        6) Polyolefin: 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick.
2. Chilled Water and Brine, 40 Deg F (5 Deg C) and below:
    a. NPS 3 (DN 80) and Smaller: Insulation shall be one of the following:
        1) Cellular Glass: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
        2) Mineral-Fiber, Preformed Pipe, Type I **OR** Pipe Insulation Wicking System, **as directed**: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
        3) Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick.
        4) Polyisocyanurate: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, thick.
    b. NPS 4 (DN 100) to NPS 12 (DN 300): Insulation shall be one of the following:
        1) Cellular Glass: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick.
        2) Mineral-Fiber, Preformed Pipe, Type I **OR** Pipe Insulation Wicking System, **as directed**: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
        3) Phenolic: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick.
        4) Polyisocyanurate: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, thick.
    c. NPS 14 (DN 350) and Larger: Insulation shall be one of the following:
        1) Cellular Glass: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick.

2) Mineral-Fiber, Preformed Pipe, Type I **OR** Pipe Insulation Wicking System, **as directed**: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick.
3) Phenolic: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick.
4) Polyisocyanurate: 1-1/2 inches (38 mm) thick.

3. Chilled Water and Brine, above 40 Deg F (5 Deg C):
   a. NPS 12 (DN 300) and Smaller: Insulation shall be one of the following:
      1) Cellular Glass: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
      2) Flexible Elastomeric: 1 inch (25 mm) thick.
      3) Mineral-Fiber, Preformed Pipe, Type I **OR** Pipe Insulation Wicking System, **as directed**: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
      4) Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick.
      5) Polyisocyanurate: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, thick.
      6) Polyolefin: 1 inch (25 mm) thick.
   b. NPS 14 (DN 350) and Larger: Insulation shall be one of the following:
      1) Cellular Glass: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick.
      2) Mineral-Fiber Preformed Pipe, Type I **OR** Pipe Insulation Wicking System, **as directed**: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick.
      3) Phenolic: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick.
      4) Polyisocyanurate: 1-1/2 inches (38 mm) thick.
4. Condenser-Water Supply and Return:
   a. NPS 12 (DN 300) and Smaller: Insulation shall be one of the following:
      1) Cellular Glass: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
      2) Flexible Elastomeric: 1 inch (25 mm) thick.
      3) Mineral-Fiber, Preformed Pipe, Type I: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
      4) Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, thick.
      5) Polyisocyanurate: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, thick.
      6) Polyolefin: 1 inch (25 mm) thick.
   b. NPS 14 (DN 350) and Larger: Insulation shall be one of the following:
      1) Cellular Glass: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick.
      2) Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick.
      3) Phenolic: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick.
      4) Polyisocyanurate: 1-1/2 inches (38 mm) thick.
5. Heating-Hot-Water Supply and Return, 200 Deg F (93 Deg C) and below:
   a. NPS 12 (DN 300) and Smaller: Insulation shall be one of the following:
      1) Cellular Glass: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
      2) Mineral-Fiber, Preformed Pipe, Type I: 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**, thick.
      3) Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick.
      4) Polyisocyanurate: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, thick.
   b. NPS 14 (DN 350) and Larger: Insulation shall be one of the following:
      1) Cellular Glass: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick.
      2) Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick.
      3) Phenolic: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick.
      4) Polyisocyanurate: 1-1/2 inches (38 mm) thick.

6. Heating-Hot-Water Supply and Return, above 200 Deg F (93 Deg C):
   a. NPS 3/4 (DN 20) and Smaller: Insulation shall be one of the following:
      1) Calcium Silicate: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick.
      2) Cellular Glass: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick.
      3) Mineral-Fiber, Preformed Pipe, Type I or II: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
   b. NPS 1 (DN 25) and Larger: Insulation shall be one of the following:
      1) Calcium Silicate: 3 inches (75 mm) **OR** 4 inches (100 mm), **as directed**, thick.
      2) Cellular Glass: 3 inches (75 mm) **OR** 4 inches (100 mm), **as directed**, thick.
      3) Mineral-Fiber, Preformed Pipe, Type I or II: 3 inches (75 mm) **OR** 4 inches (100 mm), **as directed**, thick.
7. Steam and Steam Condensate, 350 Deg F (177 Deg C) and below:
   a. NPS 3/4 (DN 20) and Smaller: Insulation shall be one of the following:
      1) Calcium Silicate: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick.
      2) Cellular Glass: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick.
      3) Mineral-Fiber, Preformed Pipe, Type I or II: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
   b. NPS 1 (DN 25) and Larger: Insulation shall be one of the following:
      1) Calcium Silicate: 3 inches (75 mm) **OR** 4 inches (100 mm), **as directed**, thick.
      2) Cellular Glass: 3 inches (75 mm) **OR** 4 inches (100 mm), **as directed**, thick.
      3) Mineral-Fiber, Preformed Pipe, Type I or II: 3 inches (75 mm) **OR** 4 inches (100 mm), **as directed**, thick.
8. Steam and Steam Condensate, above 350 Deg F (177 Deg C):
   a. NPS 3/4 (DN 20) and Smaller: Insulation shall be one of the following:
      1) Calcium Silicate: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick.
      2) Cellular Glass: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick.
      3) Mineral-Fiber, Preformed Pipe, Type I or II: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
   b. NPS 1 (DN 25) and Larger: Insulation shall be one of the following:
      1) Calcium Silicate: 3 inches (75 mm) **OR** 4 inches (100 mm), **as directed**, thick.
      2) Cellular Glass: 3 inches (75 mm) **OR** 4 inches (100 mm), **as directed**, thick.
      3) Mineral-Fiber, Preformed Pipe, Type I or II: 3 inches (75 mm) **OR** 4 inches (100 mm), **as directed**, thick.
9. Refrigerant Suction and Hot-Gas Piping:
   a. All Pipe Sizes: Insulation shall be one of the following:
      1) Cellular Glass: 1-1/2 inches (38 mm) thick.
      2) Flexible Elastomeric: 1 inch (25 mm) thick.
      3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
      4) Phenolic: 1 inch (25 mm) thick.
      5) Polyisocyanurate: 1 inch (25 mm) thick.
      6) Polyolefin: 1 inch (25 mm) thick.
10. Refrigerant Suction and Hot-Gas Flexible Tubing:
   a. All Pipe Sizes: Insulation shall be one of the following:
      1) Flexible Elastomeric: 1 inch (25 mm) thick.
      2) Polyolefin: 1 inch (25 mm) thick.
11. Dual-Service Heating and Cooling, 40 to 200 Deg F (5 to 93 Deg C):
   a. NPS 12 (DN 300) and Smaller: Insulation shall be one of the following:
      1) Cellular Glass: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
      2) Mineral-Fiber, Preformed Pipe, Type I: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, thick.
      3) Phenolic: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick.
      4) Polyisocyanurate: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, thick.
   b. NPS 14 (DN 350) and Larger: Insulation shall be one of the following:
      1) Cellular Glass: 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick.

2) Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick.
3) Phenolic: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, thick.
4) Polyisocyanurate: 1-1/2 inches (38 mm) thick.

12. Heat-Recovery Piping:
    a. All Pipe Sizes: Insulation shall be one of the following:
        1) Cellular Glass: 1-1/2 inches (38 mm) thick.
        2) Flexible Elastomeric: 1 inch (25 mm) thick.
        3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
        4) Phenolic: 1 inch (25 mm) thick.
        5) Polyisocyanurate: 1 inch (25 mm) thick.
        6) Polyolefin: 1 inch (25 mm) thick.
13. Hot Service Drains:
    a. All Pipe Sizes: Insulation shall be one of the following:
        1) Calcium Silicate: 1-1/2 inches (38 mm) thick.
        2) Cellular Glass: 1-1/2 inches (38 mm) thick.
        3) Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch (25 mm) thick.
14. Hot Service Vents:
    a. All Pipe Sizes: Insulation shall be one of the following:
        1) Calcium Silicate: 1-1/2 inches (38 mm) thick.
        2) Cellular Glass: 1-1/2 inches (38 mm) thick.
        3) Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch (25 mm) thick.

Y. Outdoor, Aboveground Piping Insulation Schedule
1. Chilled Water and Brine:
    a. All Pipe Sizes: Insulation shall be one of the following:
        1) Cellular Glass: 3 inches (75 mm) thick.
        2) Flexible Elastomeric: 3 inches (75 mm) thick.
        3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 3 inches (75 mm) thick.
        4) Phenolic: 2 inches (50 mm) thick.
        5) Polyisocyanurate: 2 inches (50 mm) thick.
        6) Polyolefin: 3 inches (75 mm) thick.
        7) Polystyrene: 2 inches (50 mm) thick.
2. Condenser-Water Supply and Return:
    a. All Pipe Sizes: Insulation shall be one of the following:
        1) Cellular Glass: 2 inches (50 mm) thick.
        2) Flexible Elastomeric: 2 inches (50 mm) thick.
        3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.
        4) Phenolic: 2 inches (50 mm) thick.
        5) Polyisocyanurate: 2 inches (50 mm) thick.
        6) Polyolefin: 2 inches (50 mm) thick.
        7) Polystyrene: 2 inches (50 mm) thick.
3. Heating-Hot-Water Supply and Return, 200 Deg F (93 Deg C) and below:
    a. All Pipe Sizes: Insulation shall be one of the following:
        1) Cellular Glass: 3 inches (75 mm) thick.
        2) Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.
        3) Phenolic: 2 inches (50 mm) thick.
        4) Polyisocyanurate: 2 inches (50 mm) thick.
4. Heating-Hot-Water Supply and Return, above 200 Deg F (93 Deg C):
    a. All Pipe Sizes: Insulation shall be one of the following:
        1) Calcium Silicate: 3 inches (75 mm) thick.
        2) Cellular Glass: 3 inches (75 mm) thick.
        3) Mineral-Fiber, Preformed Pipe Insulation, Type I or II: 2 inches (50 mm) thick.
5. Steam and Steam Condensate, 350 Deg F (177 Deg C) and below:

a. All Pipe Sizes: Insulation shall be one of the following:
1) Calcium Silicate: 4 inches (100 mm) thick.
2) Cellular Glass: 4 inches (100 mm) thick.
3) Mineral-Fiber, Preformed Pipe Insulation, Type I or II: 3 inches (75 mm) thick.

6. Steam and Steam Condensate, above 350 Deg F (177 Deg C):
a. All Pipe Sizes: Insulation shall be one of the following:
1) Calcium Silicate: 5 inches (125 mm) thick.
2) Cellular Glass: 5 inches (125 mm) thick.
3) Mineral-Fiber, Preformed Pipe Insulation, Type I or II: 4 inches (100 mm) thick.

7. Refrigerant Suction and Hot-Gas Piping:
a. All Pipe Sizes: Insulation shall be one of the following:
1) Cellular Glass: 2 inches (50 mm) thick.
2) Flexible Elastomeric: 2 inches (50 mm) thick.
3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.
4) Phenolic: 2 inches (50 mm) thick.
5) Polyisocyanurate: 2 inches (50 mm) thick.
6) Polyolefin: 2 inches (50 mm) thick.
7) Polystyrene: 2 inches (50 mm) thick.

8. Refrigerant Suction and Hot-Gas Flexible Tubing:
a. All Pipe Sizes: Insulation shall be one of the following:
1) Flexible Elastomeric: 2 inches (50 mm) thick.
2) Polyolefin: 2 inches (50 mm) thick.

9. Heat-Recovery Piping:
a. All Pipe Sizes: Insulation shall be one of the following:
1) Cellular Glass: 2 inches (50 mm) thick.
2) Flexible Elastomeric: 2 inches (50 mm) thick.
3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.
4) Phenolic: 2 inches (50 mm) thick.
5) Polyisocyanurate: 2 inches (50 mm) thick.
6) Polyolefin: 2 inches (50 mm) thick.
7) Polystyrene: 2 inches (50 mm) thick.

10. Dual-Service Heating and Cooling:
a. All Pipe Sizes: Insulation shall be one of the following:
1) Cellular Glass: 3 inches (75 mm) thick.
2) Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.
3) Phenolic: 2 inches (50 mm) thick.
4) Polyisocyanurate: 2 inches (50 mm) thick.

11. Hot Service Drains:
a. All Pipe Sizes: Insulation shall be one of the following:
1) Calcium Silicate: 1-1/2 inches (38 mm) thick.
2) Cellular Glass: 1-1/2 inches (38 mm) thick.
3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

12. Hot Service Vents:
a. All Pipe Sizes: Insulation shall be one of the following:
1) Calcium Silicate: 1-1/2 inches (38 mm) thick.
2) Cellular Glass: 1-1/2 inches (38 mm) thick.
3) Mineral-Fiber, Preformed Pipe Insulation, Type II: 1 inch (25 mm) thick.

13. Fuel Oil Piping, Heated:
a. All Pipe Sizes: Insulation shall be one of the following:
1) Cellular Glass: 2 inches (50 mm) thick.
2) Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.

Z. Outdoor, Underground Piping Insulation Schedule
1. Loose-fill insulation, for belowground piping, is specified in Division 28.
2. Chilled Water, All Sizes: Cellular glass, 2 inches (50 mm) thick.
3. Condenser-Water Supply and Return, All Sizes: Cellular glass, 2 inches (50 mm) thick.

4. Heating-Hot-Water Supply and Return, All Sizes, 200 Deg F (93 Deg C) and below: Cellular glass, 3 inches (75 mm) thick.
5. Heating-Hot-Water Supply and Return, All Sizes, above 200 Deg F (93 Deg C):
    a. Calcium Silicate: 3 inches (75 mm) thick.
    b. Cellular Glass: 3 inches (75 mm) thick.
6. Steam and Steam Condensate, All Sizes, 350 Deg F (177 Deg C) and below:
    a. Calcium Silicate: 4 inches (100 mm) thick.
    b. Cellular Glass: 4 inches (100 mm) thick.
7. Steam and Steam Condensate, All Sizes, above 350 Deg F (177 Deg C):
    a. Calcium Silicate: 5 inches (125 mm) thick.
    b. Cellular Glass: 5 inches (125 mm) thick.
8. Dual-Service Heating and Cooling, All Sizes, 40 to 200 Deg F (4 to 93 Deg C): Cellular glass, 3 inches (75 mm) thick.
9. Fuel Oil Piping, All Sizes, Heated: Cellular glass, 2 inches (50 mm) thick.

AA. Indoor, Field-Applied Jacket Schedule
1. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
2. If more than one material is listed, selection from materials listed is Contractor's option.
3. Ducts and Plenums, Concealed:
    a. None.
    b. PVC **OR** PVC, Color-Coded by System, **as directed**: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm), **as directed**, thick.
    c. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
    d. Painted Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
    e. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.
4. Ducts and Plenums, Exposed:
    a. None.
    b. PVC **OR** PVC, Color-Coded by System, **as directed**: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm), **as directed**, thick.
    c. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
    d. Painted Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
    e. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.
5. Equipment, Concealed:
    a. None.
    b. PVC **OR** PVC, Color-Coded by System, **as directed**: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm), **as directed**, thick.
    c. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
    d. Painted Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.

e. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.

6. Equipment, Exposed, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces up to 72 Inches (1800 mm):
   a. None.
   b. PVC **OR** PVC, Color-Coded by System, **as directed**: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm), **as directed**, thick.
   c. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
   d. Painted Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
   e. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.
7. Equipment, Exposed, Larger Than 48 Inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 Inches (1800 mm):
   a. None.
   b. Aluminum **OR** Painted Aluminum, **as directed**, Smooth **OR** Stucco Embossed, **as directed**, with 1-1/4-Inch- (32-mm-) Deep Corrugations **OR** 2-1/2-Inch- (65-mm-) Deep Corrugations **OR** 4-by-1-Inch (100-by-25-mm) Box Ribs, **as directed**: 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
   c. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth **OR** Stucco Embossed, **as directed**, with 1-1/4-Inch- (32-mm-) Deep Corrugations **OR** 2-1/2-Inch- (65-mm-) Deep Corrugations **OR** 4-by-1-Inch (100-by-25-mm) Box Ribs, **as directed**: 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.
8. Piping, Concealed:
   a. None.
   b. PVC **OR** PVC, Color-Coded by System, **as directed**: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm), **as directed**, thick.
   c. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
   d. Painted Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
   e. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.
9. Piping, Exposed:
   a. None.
   b. PVC **OR** PVC, Color-Coded by System, **as directed**: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm), **as directed**, thick.
   c. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
   d. Painted Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
   e. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.

BB. Outdoor, Field-Applied Jacket Schedule

1. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
2. If more than one material is listed, selection from materials listed is Contractor's option.
3. Ducts and Plenums, Concealed:
   a. None.
   b. PVC **OR** PVC, Color-Coded by System, **as directed**: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm), **as directed**, thick.
   c. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
   d. Painted Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
   e. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.
4. Ducts and Plenums, Exposed, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces up to 72 Inches (1800 mm):
   a. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
   b. Painted Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
   c. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.
5. Ducts and Plenums, Exposed, Larger Than 48 Inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 Inches (1800 mm):
   a. Aluminum **OR** Painted Aluminum, **as directed**, Smooth **OR** Stucco Embossed, **as directed**, with 1-1/4-Inch- (32-mm-) Deep Corrugations **OR** 2-1/2-Inch- (65-mm-) Deep Corrugations **OR** 4-by-1-Inch (100-by-25-mm) Box Ribs, **as directed**: 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
   b. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth **OR** Stucco Embossed, **as directed**, with 1-1/4-Inch- (32-mm-) Deep Corrugations **OR** 2-1/2-Inch- (65-mm-) Deep Corrugations **OR** 4-by-1-Inch (100-by-25-mm) Box Ribs, **as directed**: 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.
6. Equipment, Concealed:
   a. None.
   b. PVC **OR** PVC, Color-Coded by System, **as directed**: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm), **as directed,** thick.
   c. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
   d. Painted Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
   e. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.
7. Equipment, Exposed, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces up to 72 Inches (1800 mm):
   a. Aluminum **OR** Painted Aluminum, **as directed**, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**, with Z-Shaped Locking Seam, **as directed**: 0.016 inch (0.41 mm)

OR 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.

b. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed** with Z-Shaped Locking Seam, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.

8. Equipment, Exposed, Larger Than 48 Inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 Inches (1800 mm):
   a. Aluminum **OR** Painted Aluminum, **as directed**, Smooth **OR** Stucco Embossed, **as directed**, with 1-1/4-Inch- (32-mm-) Deep Corrugations **OR** 2-1/2-Inch- (65-mm-) Deep Corrugations **OR** 4-by-1-Inch (100-by-25-mm) Box Ribs, **as directed**: 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
   b. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth **OR** Stucco Embossed, **as directed**, with 1-1/4-Inch- (32-mm-) Deep Corrugations **OR** 2-1/2-Inch- (65-mm-) Deep Corrugations **OR** 4-by-1-Inch (100-by-25-mm) Box Ribs, **as directed**: 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.
9. Piping, Concealed:
   a. None.
   b. PVC **OR** PVC, Color-Coded by System, **as directed**: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm), **as directed**, thick.
   c. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
   d. Painted Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
   e. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.
10. Piping, Exposed:
   a. PVC: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm) **OR** 40 mils (1.0 mm), **as directed**, thick.
   b. Aluminum **OR** Painted Aluminum, **as directed**, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**, with Z-Shaped Locking Seam, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
   c. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**, with Z-Shaped Locking Seam, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.

CC. Underground, Field-Installed Insulation Jacket
1. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 23 07 13 00

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Task	Specification	Specification Description
23 07 16 00	23 07 13 00	HVAC Insulation

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SECTION 23 09 00 00 - HVAC INSTRUMENTATION AND CONTROLS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for HVAC instrumentation and controls. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

C. Definitions
1. DDC: Direct digital control.
2. I/O: Input/output.
3. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.
4. MS/TP: Master slave/token passing.
5. PC: Personal computer.
6. PID: Proportional plus integral plus derivative.
7. RTD: Resistance temperature detector.

D. System Performance
1. Comply with the following performance requirements:
   a. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
   b. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
   c. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
   d. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
   e. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
   f. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
   g. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
   h. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
      1) Water Temperature: Plus or minus 1 deg F (0.5 deg C).
      2) Water Flow: Plus or minus 5 percent of full scale.
      3) Water Pressure: Plus or minus 2 percent of full scale.
      4) Space Temperature: Plus or minus 1 deg F (0.5 deg C).
      5) Ducted Air Temperature: Plus or minus 1 deg F (0.5 deg C).
      6) Outside Air Temperature: Plus or minus 2 deg F (1.0 deg C).
      7) Dew Point Temperature: Plus or minus 3 deg F (1.5 deg C).
      8) Temperature Differential: Plus or minus 0.25 deg F (0.15 deg C).
      9) Relative Humidity: Plus or minus 5 percent.
      10) Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
      11) Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
      12) Airflow (Terminal): Plus or minus 10 percent of full scale.

13) Air Pressure (Space): Plus or minus 0.01-inch wg (2.5 Pa).
14) Air Pressure (Ducts): Plus or minus 0.1-inch wg (25 Pa).
15) Carbon Monoxide: Plus or minus 5 percent of reading.
16) Carbon Dioxide: Plus or minus 50 ppm.
17) Electrical: Plus or minus 5 percent of reading.

E. Submittals
1. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
    a. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
    b. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
    c. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
    a. Bill of materials of equipment indicating quantity, manufacturer, and model number.
    b. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
    c. Wiring Diagrams: Power, signal, and control wiring.
    d. Details of control panel faces, including controls, instruments, and labeling.
    e. Written description of sequence of operation.
    f. Schedule of dampers including size, leakage, and flow characteristics.
    g. Schedule of valves including flow characteristics.
    h. DDC System Hardware:
        1) Wiring diagrams for control units with termination numbers.
        2) Schematic diagrams and floor plans for field sensors and control hardware.
        3) Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
    i. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
    j. Controlled Systems:
        1) Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
        2) Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
        3) Written description of sequence of operation including schematic diagram.
        4) Points list.
3. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.
4. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with LonWorks.
5. Software and Firmware Operational Documentation: Include the following:
    a. Software operating and upgrade manuals.
    b. Program Software Backup: On a magnetic media or compact disc, complete with data files.
    c. Device address list.
    d. Printout of software application and graphic screens.
    e. Software license required by and installed for DDC workstations and control systems.

6. Software Upgrade Kit: For the Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.
7. Field quality-control test reports.
8. Operation and maintenance data.

F. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. Comply with ASHRAE 135 for DDC system components.

G. Delivery, Storage, And Handling
1. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
2. System Software: Update to latest version of software at Project completion.

1.2 PRODUCTS

A. Control System
1. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.
2. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.
3. Control system shall include the following:
   a. Building intrusion detection system specified in Division 28 Section "Intrusion Detection".
   b. Building clock control system specified in Division 27 Section "Clock Systems".
   c. Building lighting control system specified in Division 26 Section "Network Lighting Controls".
   d. Fire alarm system specified in Division 28 Section(s) "Digital, Addressable Fire-alarm System" OR "Zoned (dc Loop) Fire-alarm System", **as directed**.

B. DDC Equipment
1. Operator Workstation: One **OR** Two, **as directed**, PC-based microcomputer(s) with minimum configuration as follows:
   a. Motherboard: With 8 integrated USB 2.0 ports, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.
   b. Processor: Intel Pentium 4, <**Insert clock speed**> MHz.
   c. Random-Access Memory: 512 MB.
   d. Graphics: Video adapter, minimum 1280 x 1024 **OR** 1600 x 1200, **as directed**, pixels, 64-MB video memory, with TV out.
   e. Monitor: 17 inches (430 mm) **OR** 19 inches (480 mm), **as directed**, LCD color.
   f. Keyboard: QWERTY, 105 keys in ergonomic shape.
   g. Floppy-Disk Drive: 1.44 MB.
   h. Hard-Disk Drive: 80 GB.
   i. CD-ROM Read/Write Drive: 48x24x48.
   j. Mouse: Three button, optical.
   k. Uninterruptible Power Supply: 2 kVa.
   l. Operating System: Microsoft Windows XP Professional with high-speed Internet access.
      1) ASHRAE 135 Compliance: Workstation shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

2) LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA 709.1 datalink/physical layer protocol.

m. Printer: Black-and-white, laser-jet type as follows:
1) Print Head: 1200 x 1200 dpi resolution.
2) Paper Handling: Minimum of 250 sheet trays.
3) Print Speed: Minimum of 120 characters per second.

n. Printer: Color, ink-jet type as follows:
1) Print Head: 4800 x 1200 dpi optimized color resolution.
2) Paper Handling: Minimum of 100 sheets.
3) Print Speed: Minimum of 17 ppm in black and 12 ppm in color.

o. Application Software:
1) I/O capability from operator station.
2) System security for each operator via software password and access levels.
3) Automatic system diagnostics; monitor system and report failures.
4) Database creation and support.
5) Automatic and manual database save and restore.
6) Dynamic color graphic displays with up to 10 screen displays at once.
7) Custom graphics generation and graphics library of HVAC equipment and symbols.
8) Alarm processing, messages, and reactions.
9) Trend logs retrievable in spreadsheets and database programs.
10) Alarm and event processing.
11) Object and property status and control.
12) Automatic restart of field equipment on restoration of power.
13) Data collection, reports, and logs. Include standard reports for the following:
    a) Current values of all objects.
    b) Current alarm summary.
    c) Disabled objects.
    d) Alarm lockout objects.
    e) Logs.
14) Custom report development.
15) Utility and weather reports.
16) Workstation application editors for controllers and schedules.
17) Maintenance management.

p. Custom Application Software:
1) English language oriented.
2) Full-screen character editor/programming environment.
3) Allow development of independently executing program modules with debugging/simulation capability.
4) Support conditional statements.
5) Support floating-point arithmetic with mathematic functions.
6) Contains predefined time variables.

2. Diagnostic Terminal Unit: Portable notebook-style, PC-based microcomputer terminal capable of accessing system data by connecting to system network with minimum configuration as follows:

a. System: With one integrated USB 2.0 port, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.
b. Processor: Intel Pentium 4, <**Insert clock speed**> MHz.
c. Random-Access Memory: 128 MB.
d. Graphics: Video adapter, minimum 800 x 600 **OR** 1024 x 768, **as directed**, pixels, 64-MB video memory.
e. Monitor: 17 inches (430 mm) **OR** 19 inches (480 mm), **as directed**, LCD color.
f. Keyboard: QWERTY 105 keys in ergonomic shape.
g. Floppy-Disk Drive: 1.44 MB.
h. Hard-Disk Drive: 800 MB.
i. CD-ROM Read/Write Drive: 48x24x48.
j. Pointing Device: Touch pad or other internal device.

3. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
   a. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
   b. Stand-alone mode control functions operate regardless of network status. Functions include the following:
      1) Global communications.
      2) Discrete/digital, analog, and pulse I/O.
      3) Monitoring, controlling, or addressing data points.
      4) Software applications, scheduling, and alarm processing.
      5) Testing and developing control algorithms without disrupting field hardware and controlled environment.
   c. Standard Application Programs:
      1) Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
      2) HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
      3) Chiller Control Programs: Control function of condenser-water reset, chilled-water reset, and equipment sequencing.
      4) Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
      5) Remote communications.
      6) Maintenance management.
      7) Units of Measure: Inch-pound and SI (metric).
   d. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
   e. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
   f. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA 709.1 datalink/physical layer protocol.
4. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
   a. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
   b. Stand-alone mode control functions operate regardless of network status. Functions include the following:
      1) Global communications.
      2) Discrete/digital, analog, and pulse I/O.
      3) Monitoring, controlling, or addressing data points.
   c. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
   d. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
   e. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA 709.1 datalink/physical layer protocol.
5. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
   a. Binary Inputs: Allow monitoring of on-off signals without external power.
   b. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
   c. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.

d. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights, **as directed**.
e. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer, **as directed**.
f. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
g. Universal I/Os: Provide software selectable binary or analog outputs.

6. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
   a. Output ripple of 5.0 mV maximum peak to peak.
   b. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
   c. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.
7. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
   a. Minimum dielectric strength of 1000 V.
   b. Maximum response time of 10 nanoseconds.
   c. Minimum transverse-mode noise attenuation of 65 dB.
   d. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

C. Unitary Controllers
1. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
   a. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
   b. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock, **as directed**. Perform automatic system diagnostics; monitor system and report failures.
   c. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.
   d. LonWorks Compliance: Communicate using EIA/CEA 709.1 datalink/physical layer protocol using LonTalk protocol.
   e. Enclosure: Dustproof rated for operation at 32 to 120 deg F (0 to 50 deg C).
   f. Enclosure: Waterproof rated for operation at 40 to 150 deg F (5 to 65 deg C).

D. Alarm Panels
1. Unitized cabinet with suitable brackets for wall or floor mounting. Fabricate of 0.06-inch- (1.5-mm-) thick, furniture-quality steel or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish. Provide common keying for all panels, **as directed**.
2. Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted on hinged cover.
   a. Alarm Condition: Indicating light flashes and horn sounds.
   b. Acknowledge Switch: Horn is silent and indicating light is steady.
   c. Second Alarm: Horn sounds and indicating light is steady.
   d. Alarm Condition Cleared: System is reset and indicating light is extinguished.
   e. Contacts in alarm panel allow remote monitoring by independent alarm company.

E. Analog Controllers
1. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.
2. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F (minus 23 to plus 21 deg C), and single- or double-pole contacts.
3. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.
   a. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.
4. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.
5. Receiver Controllers: Single- or multiple-input models with control-point adjustment, direct or reverse acting with mechanical set-point adjustment with locking device, proportional band adjustment, authority adjustment, and proportional control mode.
   a. Remote-control-point adjustment shall be plus or minus 20 percent of sensor span, input signal of 3 to 13 psig (21 to 90 kPa).
   b. Proportional band shall extend from 2 to 20 percent for 5 psig (35 kPa).
   c. Authority shall be 20 to 200 percent.
   d. Air-supply pressure of 18 psig (124 kPa), input signal of 3 to 15 psig (21 to 103 kPa), and output signal of zero to supply pressure.
   e. Gages: 1-1/2 inches (38 mm) **OR** 2-1/2 inches (64 mm) **OR** 3-1/2 inches (89 mm), **as directed**, in diameter, 2.5 percent wide-scale accuracy, and range to match transmitter input or output pressure.

F. Time Clocks
1. Seven-day, programming-switch timer with synchronous-timing motor and seven-day dial; continuously charged, nickel-cadmium-battery-driven, eight-hour, power-failure carryover; multiple-switch trippers; minimum of two and maximum of eight signals per day with two normally open and two normally closed output contacts.
2. Solid-state, programmable time control with 4 **OR** 8, **as directed**, separate programs each with up to 100 on-off operations; 1-second resolution; lithium battery backup; keyboard interface and manual override; individual on-off-auto switches for each program; 365-day calendar with 20 programmable holidays; choice of fail-safe operation for each program; system fault alarm; and communications package allowing networking of time controls and programming from PC.

G. Electronic Sensors
1. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
2. Thermistor Temperature Sensors and Transmitters:
   a. Accuracy: Plus or minus 0.5 deg F (0.3 deg C) **OR** 0.36 deg F (0.2 deg C), **as directed**, at calibration point.
   b. Wire: Twisted, shielded-pair cable.
   c. Insertion Elements in Ducts: Single point, 8 inches (200 mm) **OR** 18 inches (460 mm), **as directed**, long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
   d. Averaging Elements in Ducts: 36 inches (915 mm) long, flexible **OR** 72 inches (1830 mm) long, flexible **OR** 18 inches (460 mm) long, rigid, **as directed**; use where prone to temperature stratification or where ducts are larger than 10 sq. ft. (1 sq. m).
   e. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches (64 mm).
   f. Room Sensor Cover Construction: Manufacturer's standard locking covers.
      1) Set-Point Adjustment: Concealed **OR** Exposed, **as directed**.
      2) Set-Point Indication: Concealed **OR** Keyed **OR** Exposed, **as directed**.

3) Thermometer: Concealed **OR** Exposed **OR** Red-reading glass **OR** Spiral bimetal, **as directed**.
4) Color: As selected from manufacturer's full range.
5) Orientation: Vertical **OR** Horizontal, **as directed**.

g. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
h. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

3. RTDs and Transmitters:
   a. Accuracy: Plus or minus 0.2 percent at calibration point.
   b. Wire: Twisted, shielded-pair cable.
   c. Insertion Elements in Ducts: Single point, 8 inches (200 mm) **OR** 18 inches (460 mm), **as directed**, long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
   d. Averaging Elements in Ducts: 18 inches (460 mm) long, rigid **OR** 24 inches (610 mm) long, rigid **OR** 48 inches (1200 mm) long, rigid **OR** 24 feet (7.3 m) long, flexible, **as directed**; use where prone to temperature stratification or where ducts are larger than 9 sq. ft. (0.84 sq. m); length as required.
   e. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches (64 mm).
   f. Room Sensor Cover Construction: Manufacturer's standard locking covers.
      1) Set-Point Adjustment: Concealed **OR** Exposed, **as directed**.
      2) Set-Point Indication: Concealed **OR** Keyed **OR** Exposed\, **as directed**.
      3) Thermometer: Concealed **OR** Exposed **OR** Red-reading glass **OR** Spiral bimetal, **as directed**.
      4) Color: As selected from manufacturer's full range.
      5) Orientation: Vertical **OR** Horizontal, **as directed**.
   g. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
   h. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.
4. Humidity Sensors: Bulk polymer sensor element.
   a. Accuracy: 5 **OR** 2, **as directed**, percent full range with linear output.
   b. Room Sensor Range: 20 to 80 percent relative humidity.
   c. Room Sensor Cover Construction: Manufacturer's standard locking covers.
      1) Set-Point Adjustment: Concealed **OR** Exposed, **as directed**.
      2) Set-Point Indication: Concealed **OR** Keyed **OR** Exposed, **as directed**.
      3) Thermometer: Concealed **OR** Exposed **OR** Red-reading glass **OR** Spiral bimetal, **as directed**.
      4) Color: As selected from manufacturer's full range.
      5) Orientation: Vertical **OR** Horizontal, **as directed**.
   d. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
   e. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of 32 to 120 deg F (0 to 50 deg C) **OR** minus 22 to plus 185 deg F (minus 30 to plus 85 deg C) **OR** minus 40 to plus 170 deg F (minus 40 to plus 76 deg C), **as directed**.
   f. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.
5. Pressure Transmitters/Transducers:
   a. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
      1) Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
      2) Output: 4 to 20 mA.
      3) Building Static-Pressure Range: 0- to 0.25-inch wg (0 to 62 Pa).
      4) Duct Static-Pressure Range: 0- to 5-inch wg (0 to 1240 Pa).

b. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure; linear output 4 to 20 mA.
c. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure and tested to 300-psig (2070-kPa); linear output 4 to 20 mA.
d. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
e. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

6. Room Sensor Cover Construction: Manufacturer's standard locking covers.
   a. Set-Point Adjustment: Concealed **OR** Exposed, **as directed**.
   b. Set-Point Indication: Concealed **OR** Keyed **OR** Exposed, **as directed**.
   c. Thermometer: Concealed **OR** Exposed **OR** Red-reading glass **OR** Spiral bimetal, **as directed**.
   d. Color: As selected from manufacturer's full range.
   e. Orientation: Vertical **OR** Horizontal, **as directed**.
7. Room sensor accessories include the following:
   a. Insulating Bases: For sensors located on exterior walls.
   b. Guards: Locking; heavy-duty, transparent plastic; mounted on separate base **OR** Metal wire, tamperproof **OR** Locking, solid metal, ventilated, **as directed**.
   c. Adjusting Key: As required for calibration and cover screws.

H. Pneumatic Sensors
1. Pneumatic Transmitters: Vibration and corrosion resistant.
   a. Space-Temperature Sensors: Linear-output type, 50 to 100 deg F (10 to 38 deg C) range, with blank locking covers matching room thermostats.
   b. Room Return-Air Temperature Sensors: Linear-output type with bimetal sensing element and corrosion-proof construction, 50 to 100 deg F (10 to 38 deg C) range, designed to be mounted in light troffers.
   c. Duct-Mounted or Immersion-Type Temperature Sensors: Range as required for 3- to 15-psig (21- to 103-kPa) output signal.
   d. Temperature Transmitters: Rigid-stem type with bimetal sensing elements unless averaging is required, 3- to 15-psig (21- to 103-kPa) output signal.
      1) Averaging-Element Sensors: Single- or multiple-unit capillary elements.
      2) Tamperproof Sensors: Corrosion-resistant construction, suitable for mounting on vibrating surface with exposed capillary protected with temperature-compensated armor or protective tubing.
      3) Pipe-Mounted Temperature-Sensing Elements: Rod-and-tube type; with separable wells filled with heat-conductive compound.
      4) Outdoors: Provide bulb shield with mounting bracket.
   e. Space and Duct Humidity Transmitters: One pipe, directly proportional, with minimum sensing span of 20 to 80 percent relative humidity for 3- to 15-psig (21- to 103-kPa) output signal, corrosion resistant and temperature compensated, and with factory-calibrated adjustment.
      1) Space Mounting: With covers to match thermostats.
   f. Differential-Pressure Transmitters: One pipe, direct acting for gas, liquid, or steam service; pressure sensor and transmitter of linear-output type; with range of 0 to 50 psig (0 to 344 kPa), and 3- to 15-psig (21- to 103-kPa) output signal.
   g. Differential-Air-Pressure Transmitters: One pipe, direct acting, double bell; unidirectional with suitable range for expected input; and temperature compensated.
      1) Accuracy: 5 percent of full range and 2 percent of full scale at midrange.
      2) Output Signal: 3 to 15 psig (21 to 103 kPa).
2. Digital-to-Pneumatic Transducers: Convert plus or minus 12-V dc pulse-width-modulation outputs, or continuous proportional current or voltage to 0 to 20 psig (0 to 140 kPa).
3. Pneumatic Valve/Damper Position Indicator: Potentiometer mounted in enclosure with adjustable crank-arm assembly connected to damper to transmit 0 to 100 percent valve/damper travel.

I. Status Sensors
1. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg (0 to 1240 Pa).
2. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig (55 to 414 kPa), piped across pump.
3. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.
4. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.
5. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.
6. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
7. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
8. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

J. Gas Detection Equipment
1. Carbon Monoxide Detectors: Single or multichannel, dual-level detectors using solid-state plug-in sensors with a 3-year minimum life; suitable over a temperature range of 32 to 104 deg F (0 to 40 deg C); with 2 factory-calibrated alarm levels at 50 and 100 **OR** 35 and 200, **as directed**, ppm.
2. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F (minus 5 to plus 55 deg C) and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output;, for wall mounting.
3. Oxygen Sensor and Transmitter: Single detectors using solid-state zircon cell sensing; suitable over a temperature range of minus 32 to plus 1100 deg F (0 to 593 deg C) and calibrated for 0 to 5 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting.
4. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment; for flush mounting.

K. Flow Measuring Stations
1. Duct Airflow Station: Combination of air straightener and multiport, self-averaging pitot tube station.
   a. Casing: Galvanized-steel frame.
   b. Flow Straightener: Aluminum honeycomb, 3/4-inch (20-mm) parallel cell, 3 inches (75 mm) deep.
   c. Sensing Manifold: Copper manifold with bullet-nosed static pressure sensors positioned on equal area basis.

L. Thermostats
1. Combination Thermostat and Fan Switches: Line-voltage thermostat with push-button or lever-operated fan switch.
   a. Label switches "FAN ON-OFF" **OR** "FAN HIGH-LOW-OFF" **OR** "FAN HIGH-MED-LOW-OFF", **as directed**.
   b. Mount on single electric switch box.
2. Electric, solid-state, microcomputer-based room thermostat with remote sensor.
   a. Automatic switching from heating to cooling.
   b. Preferential rate control to minimize overshoot and deviation from set point.
   c. Set up for four separate temperatures per day.
   d. Instant override of set point for continuous or timed period from 1 hour to 31 days.
   e. Short-cycle protection.

f. Programming based on weekday, Saturday, and Sunday **OR** every day of week, **as directed**.
g. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
h. Battery replacement without program loss.
i. Thermostat display features include the following:
   1) Time of day.
   2) Actual room temperature.
   3) Programmed temperature.
   4) Programmed time.
   5) Duration of timed override.
   6) Day of week.
   7) System mode indications include "heating," "off," "fan auto," and "fan on."

3. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F (13 to 30 deg C) set-point range, and 2 deg F (1 deg C) maximum differential.
4. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85 deg F (13 to 30 deg C) set-point range, and 2 deg F (1 deg C) maximum differential.
   a. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
   b. Selector Switch: Integral, manual on-off-auto.
5. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.
   a. Bulbs in water lines with separate wells of same material as bulb.
   b. Bulbs in air ducts with flanges and shields.
   c. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
   d. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
   e. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
   f. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.
6. Fire-Protection Thermostats: Listed and labeled by an NRTL acceptable to authorities having jurisdiction; with fixed or adjustable settings to operate at not less than 75 deg F (24 deg C) above normal maximum operating temperature, and the following:
   a. Reset: Manual.
      OR
      Reset: Automatic, with control circuit arranged to require manual reset at central control panel; with pilot light and reset switch on panel labeled to indicate operation.
7. Pneumatic Room Thermostats: One **OR** Two **OR** Three, **as directed**, pipe(s), fully proportional with adjustable throttling range and tamperproof locking settings, direct or reverse acting as required. Factory calibrated at 2.5 psig/deg F (17.2 kPa/deg C).
   a. Factory Calibration: 2.5 psig/deg F (17.2 kPa/deg C).
   b. Range: 45 to 85 deg F (7 to 30 deg C).
   c. Sensitivity Adjustment Range: 1 to 4 psig/deg F (7 to 27.6 kPa/deg C).
   d. Dual-Temperature Thermostats: Automatic changeover from normal setting to lower setting for unoccupied cycles, with manual-reset lever to permit return to normal temperatures during unoccupied cycles, with automatic reset to normal during next cycle of operation.
   e. Limits: Field adjustable, to limit setting cooling set point below 75 deg F (24 deg C), and heating set point above 75 deg F (24 deg C).
   f. Room Thermostat Cover Construction: Manufacturer's standard locking covers.
      1) Set-Point Adjustment: Concealed **OR** Exposed, **as directed**.

2) Set-Point Indication: Concealed **OR** Keyed **OR** Exposed, **as directed**.
3) Thermometer: Concealed **OR** Exposed **OR** Red-reading glass **OR** Spiral bimetal, **as directed**.
4) Color: As selected from manufacturer's full range.
5) Orientation: Vertical **OR** Horizontal, **as directed**.

g. Room thermostat accessories include the following:
1) Insulating Bases: For thermostats located on exterior walls.
2) Thermostat Guards: Locking; heavy-duty, transparent plastic; mounted on separate base **OR** Metal wire, tamperproof **OR** Locking, solid metal, ventilated, **as directed**.
3) Adjusting Key: As required for calibration and cover screws.
4) Aspirating Boxes: For flush-mounted aspirating thermostats.
5) Set-Point Adjustment: 1/2-inch- (13-mm-) diameter, adjustment knob.

8. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.
9. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.
10. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-, **as directed**, reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or below set point.
    a. Bulb Length: Minimum 20 feet (6 m).
    b. Quantity: One thermostat for every 20 sq. ft. (2 sq. m) of coil surface.
11. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-, **as directed**, reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or above set point.
    a. Bulb Length: Minimum 20 feet (6 m).
    b. Quantity: One thermostat for every 20 sq. ft. (2 sq. m) of coil surface.
12. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, with molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig (172 kPa), and cast housing with position indicator and adjusting knob.

M. Humidistats
1. Pneumatic Room Humidistats: Wall-mounting, proportioning type with adjustable throttling range, 20 to 90 **OR** 55 to 95 **OR** 25 to 65, **as directed**, percent operating range, and cover matching room thermostat cover.
2. Duct-Mounting Humidistats: Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.
3. Pneumatic Duct-Mounting Humidistats: Proportioning type with adjustable throttling range, 20 to 90 **OR** 55 to 95 **OR** 25 to 65, **as directed**, percent operating range, in galvanized-steel duct box.

N. Actuators
1. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
    a. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
    b. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
    c. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
    d. Spring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).
    e. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).

f. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).

2. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
   a. Valves: Size for torque required for valve close off at maximum pump differential pressure.
   b. Dampers: Size for running torque calculated as follows:
      1) Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
      2) Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.
      3) Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft (49.6 kg-cm/sq. m) of damper.
      4) Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. (37.2 kg-cm/sq. m) of damper.
      5) Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
      6) Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.
   c. Coupling: V-bolt and V-shaped, toothed cradle.
   d. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
   e. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
   f. Power Requirements (Two-Position Spring Return): 24 **OR** 120 **OR** 230, **as directed**,-V ac.
   g. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
   h. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
   i. Temperature Rating: Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C) **OR** 40 to 104 deg F (5 to 40 deg C), **as directed**.
   j. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F (Minus 30 to plus 121 deg C).
   k. Run Time: 12 seconds open, 5 seconds closed **OR** 30 seconds **OR** 60 seconds **OR** 120 seconds, **as directed**.
3. Pneumatic Valve Operators: Rolling-diaphragm, spring-loaded, piston type with spring range as required and start-point adjustment and positioning relay, **as directed**. Operator shall maintain full shutoff at maximum pump differential pressure.
4. Pneumatic Damper Operators: Rolling-diaphragm, piston type with adjustable stops and spring return, sized to operate with sufficient reserve power to provide smooth modulating action or two-position action. Where actuators operate in sequence, provide pilot positioners.
   a. Pilot Positioners: With the following characteristics:
      1) Start Point: Adjustable from 2 to 12 psig (14 to 83 kPa).
      2) Operating Span: Adjustable from 5 to 13 psig (35 to 90 kPa).
      3) Linearity: Plus or minus 10 percent of output signal span.
      4) Hysteresis: 3 percent of span.
      5) Response: 0.25-psig (1723-Pa) input change.
      6) Maximum Pilot Signal Pressure: 20 psig (140 kPa).
      7) Maximum Control Air-Supply Pressure: 60 psig (410 kPa).
   b. Actuator Housing: Molded or die-cast zinc or aluminum. Terminal unit actuators may be high-impact plastic with ambient temperature rating of 50 to 140 deg F (10 to 60 deg C) unless located in return-air plenums, **as directed**.
   c. Inlet-Vane Operators: High pressure, with pilot positioners.

O. Control Valves
1. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
2. Hydronic system globe valves shall have the following characteristics:

a. NPS 2 (DN 50) and Smaller: Class 125 **OR** 250, **as directed**, bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
b. NPS 2-1/2 (DN 65) and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
c. Internal Construction: Replaceable plugs and stainless-steel or brass seats.
   1) Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
   2) Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.
d. Sizing: 3-psig (21-kPa) **OR** 5-psig (35-kPa), **as directed**, maximum pressure drop at design flow rate or the following:
   1) Two Position: Line size.
   2) Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
   3) Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.
e. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
f. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

3. Steam system globe valves shall have the following characteristics:
   a. NPS 2 (DN 50) and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
   b. NPS 2-1/2 (DN 65) and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
   c. Internal Construction: Replaceable plugs and stainless-steel seats.
      1) Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
      2) Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.
   d. Sizing: For pressure drop based on the following services:
      1) Two Position: 20 percent of inlet pressure.
      2) Modulating 15-psig (103-kPa) Steam: 80 percent of inlet steam pressure.
      3) Modulating 16- to 50-psig (110- to 350-kPa) Steam: 50 percent of inlet steam pressure.
      4) Modulating More Than 50-psig (350-kPa) Steam: As indicated.
   e. Flow Characteristics: Modified linear characteristics.
   f. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of operating (inlet) pressure.
4. Butterfly Valves: 200-psig (1380-kPa), 150-psig (1034-kPa) maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
   a. Body Style: Wafer **OR** Lug **OR** Grooved, **as directed**.
   b. Disc Type: Nickel-plated ductile iron **OR** Aluminum bronze **OR** Elastomer-coated ductile iron **OR** Epoxy-coated ductile iron, **as directed**.
   c. Sizing: 1-psig (7-kPa) maximum pressure drop at design flow rate.
5. Terminal Unit Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.
   a. Rating: Class 125 for service at 125 psig (860 kPa) and 250 deg F (121 deg C) operating conditions.
   b. Sizing: 3-psig (21-kPa) maximum pressure drop at design flow rate, to close against pump shutoff head.

c. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

6. Self-Contained Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.
   a. Rating: Class 125 for service at 125 psig (860 kPa) and 250 deg F (121 deg C) operating conditions.
   b. Thermostatic Operator: Wax **OR** Liquid, **as directed**,-filled integral **OR** remote, **as directed**, sensor with integral **OR** remote, **as directed**, adjustable dial.

P. Dampers

1. Dampers: AMCA-rated, parallel **OR** opposed, **as directed**,-blade design; 0.108-inch- (2.8-mm-) minimum thick, galvanized-steel or 0.125-inch- (3.2-mm-) minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- (1.6-mm-) thick galvanized steel with maximum blade width of 8 inches (200 mm) and length of 48 inches (1220 mm).
   a. Secure blades to 1/2-inch- (13-mm-) diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated sintered bronze **OR** nylon, **as directed**, blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
   b. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).
   c. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
   OR
   Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. (50 L/s per sq. m) of damper area, at differential pressure of 4-inch wg (1000 Pa) when damper is held by torque of 50 in. x lbf (5.6 N x m); when tested according to AMCA 500D.

Q. Air Supply

1. Control and Instrumentation Tubing: Copper tubing complying with ASTM B 88, Type K (ASTM B 88M, Type A) or ASTM B 280 Type ACR.
   a. Fittings: Cast-bronze solder fittings complying with ASME B16.18; or wrought-copper solder fittings complying with ASME B16.22, except forged-brass compression-type fittings at connections to equipment.
   b. Joining Method: Soldered or brazed.
   OR
   Control and Instrumentation Tubing: ASTM D 2737 Type FR plenum-rated polyethylene, flame-retardant, nonmetallic tubing rated for 30 psig (207 kPa) and ambient temperature range of 10 to 150 deg F (minus 13 to plus 65 deg C) with flame-retardant harness for multiple tubing.
   c. Fittings: Compression or push-on polyethylene fittings.
2. Tank: ASME storage tank with drain test cock, automatic moisture removal trap, tank relief valve, and rubber-cork vibration isolation mounting pads.
3. Duplex Air Compressor: Capacity to supply compressed air to temperature-control system.
   a. Pressure control with adjustable electric contacts, set to start and stop both compressors at different pressures.
   b. Electrical alternation set with motor starters and disconnect to operate compressors alternately or on time schedule.
4. Simplex Air Compressor: Tank-mounting compressor with capacity to supply compressed air to temperature-control system, with starter and disconnect.
   a. Pressure control with adjustable electric contacts, set to start and stop compressor.
5. Compressor Type: Reciprocating **OR** Scroll, **as directed**.
6. Size compressor and tank to operate compressor not more than 20 **OR** 30, **as directed**, minutes during a 60-minute period.
7. Compressor Accessories: Low-resistance intake-air filter, and belt guards.

8. System Accessories: Air filter rated for 97 percent efficiency at rated airflow, and combination filter/pressure-reducing station or separate filter and pressure-reducing station.
9. Refrigerated Air Dryer: Self-contained, refrigerated air dryer complete with heat exchangers, moisture separator, internal wiring and piping, and with manual bypass valve.
    a. Heat Exchangers: Air-to-refrigerant coils with centrifugal-type moisture separator and automatic trap assembly.
    b. Refrigeration Unit: Hermetically sealed, operating to maintain dew point of 13 deg F (minus 11 deg C) at 20 psig (140 kPa), housed in steel cabinet with access door and panel.
    c. Accessories: Air-inlet temperature gage, air-inlet pressure gage, on-off switch, high-temperature light, power-on light, refrigerant gage on back, air-outlet temperature gage, air-outlet pressure gage, and with contacts for remote indication of power status and high-temperature alarm.
10. Desiccant Dryer: Obtains dew point in pneumatic air piping between compressor and tank at least 15 deg F (minus 9 deg C) below inlet-air dew point at design conditions.
11. Pressure Gages: Black letters on white background, 2-1/2 inches (64 mm) in diameter, flush or surface mounting, with front calibration screw to match sensor, and having a graduated scale in psig (kPa).
12. Instrument Pressure Gages: Black letters on white background, 1-1/2 inches (38 mm) in diameter, stem mounted, with suitable dial range.
13. Diaphragm Control and Instrument Valves: 1/4-inch (6-mm) forged-brass body with reinforced polytetrafluoroethylene diaphragm, stainless-steel spring, and color-coded phenolic handle.
14. Gage Cocks: Tee or level handle, bronze, rated for 125 psig (860 kPa).
15. Relays: For summing, reversing, and amplifying highest or lowest pressure selection; with adjustable I/O ratio.
16. Switches: With indicating plates and accessible adjustment; calibrated and marked.
17. Pressure Regulators: Zinc or aluminum castings with elastomeric diaphragm, balanced construction to automatically prevent pressure buildup, and producing flat reduced-pressure curve.
18. Particle Filters: Zinc or aluminum castings with 97 percent filtration efficiency at rated airflow, quick-disconnect service devices, and aluminum or plastic bowl with metal guard and manual drain cock.
19. Combination Filter/Regulators: Zinc or aluminum castings with elastomeric diaphragm, balanced construction to automatically prevent pressure buildup, and producing flat reduced-pressure curve; with threaded pipe connections, quick-disconnect service devices, and aluminum or plastic bowl with metal guard and manual drain cock.
20. Airborne Oil Filter: Filtration efficiency of 99.9 percent for airborne lubricating oil particles of 0.025 micron or larger.
21. Pressure Relief Valves: ASME rated and labeled.
    a. High Pressure: Size for installed capacity.
    b. Low Pressure: Size for installed capacity of pressure regulators and set at 20 percent above low pressure.
22. Pressure-Reducing Stations: Two parallel pressure regulators.

R. Control Cable
1. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling".

1.3 EXECUTION

A. Installation
1. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
2. Connect and configure equipment and software to achieve sequence of operation specified.

3. Mount compressor and tank unit on elastomeric mounts **OR** spring isolators with 1-inch (25 mm) static deflection **OR** restrained spring isolators with 1-inch (25-mm) static deflection, **as directed**. Vibration isolators are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment". Isolate air supply with wire-braid-reinforced rubber hose. Secure and anchor according to manufacturer's written instructions and seismic-control requirements.
   a. Pipe manual and automatic drains to nearest floor drain.
   b. Supply instrument air from compressor units through filter, pressure-reducing valve, and pressure relief valve, with pressure gages and shutoff and bypass valves.
4. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches (1220 mm) **OR** 60 inches (1530 mm), **as directed**, above the floor.
   a. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
5. Install guards on thermostats in the following locations:
   a. Entrances.
   b. Public areas.
   c. Where indicated.
6. Install automatic dampers according to Division 23 Section "Air Duct Accessories".
7. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
8. Install labels and nameplates to identify control components according to Division 23 Section "Identification For Hvac Piping And Equipment".
9. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping".
10. Install steam and condensate instrument wells, valves, and other accessories according to Division 23 Section "Steam And Condensate Heating Piping".
11. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping".
12. Install duct volume-control dampers according to Division 21 specifying air ducts.
13. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling".

B. Pneumatic Piping Installation
1. Install piping in mechanical equipment rooms inside mechanical equipment enclosures, in pipe chases, or suspended ceilings with easy access.
   a. Install copper tubing with maximum unsupported length of 36 inches (915 mm), for tubing exposed to view.
   b. Install polyethylene tubing in metallic raceways or electrical metallic tubing. Electrical metallic tubing materials and installation requirements are specified in Division 26 Section "Underfloor Raceways For Electrical Systems".
2. Install terminal single-line connections, less than 18 inches (460 mm) in length, with copper or polyethylene tubing run inside flexible steel protection.
3. In concealed locations such as pipe chases and suspended ceilings with easy access, install copper **OR** polyethylene bundled and sheathed **OR** polyethylene tubing in electrical metallic, **as directed**, tubing. Electrical metallic tubing materials and installation requirements are specified in Division 26 Section "Raceway And Boxes For Electrical Systems".
4. In concrete slabs, furred walls, or ceilings with no access, install copper or polyethylene tubing in electrical metallic tubing or vinyl-jacketed polyethylene tubing.
   a. Protect embedded-copper and vinyl-jacketed polyethylene tubing with electrical metallic tubing extending 6 inches (150 mm) above finished slab and 6 inches (150 mm) into slab. Pressure test tubing before and after pour for leak and pinch.
   b. Install polyethylene tubing in electrical metallic tubing extending 6 inches (150 mm) above floor line; pull tubing into electrical metallic tubing after pour.
5. Install tubing with sufficient slack and flexible connections to allow for vibration of piping and equipment.
6. Purge tubing with dry, oil-free compressed air before connecting control instruments.

a. Bridge cabinets and doors with flexible connections fastened along hinge side; protect against abrasion. Tie and support tubing.

7. Number-code or color-code control air piping for future identification and service of control system, except local individual room control tubing.
8. Pressure Gages or Test Plugs: Install on branch lines at each receiver controller and on signal lines at each transmitter, except individual room controllers.

C. Electrical Wiring And Connection Installation

1. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway And Boxes For Electrical Systems".
2. Install building wire and cable according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
3. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling".
   a. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
   b. Install exposed cable in raceway.
   c. Install concealed cable in raceway.
   d. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
   e. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
   f. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
   g. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
4. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
5. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

D. Field Quality Control

1. Perform the following field tests and inspections and prepare test reports:
   a. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
   b. Test and adjust controls and safeties.
   c. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   d. Pressure test control air piping at 30 psig (207 kPa) or 1.5 times the operating pressure for 24 hours, with maximum 5-psig (35-kPa) loss.
   e. Pressure test high-pressure control air piping at 150 psig (1034 kPa) and low-pressure control air piping at 30 psig (207 kPa) for 2 hours, with maximum 1-psig (7-kPa) loss.
   f. Test calibration of pneumatic **OR** electronic, **as directed**, controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
   g. Test each point through its full operating range to verify that safety and operating control set points are as required.
   h. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
   i. Test each system for compliance with sequence of operation.
   j. Test software and hardware interlocks.
2. DDC Verification:
   a. Verify that instruments are installed before calibration, testing, and loop or leak checks.
   b. Check instruments for proper location and accessibility.
   c. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.

d. Check instrument tubing for proper fittings, slope, material, and support.
e. Check installation of air supply for each instrument.
f. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
g. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
h. Check temperature instruments and material and length of sensing elements.
i. Check control valves. Verify that they are in correct direction.
j. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
k. Check DDC system as follows:
   1) Verify that DDC controller power supply is from emergency power supply, if applicable.
   2) Verify that wires at control panels are tagged with their service designation and approved tagging system.
   3) Verify that spare I/O capacity has been provided.
   4) Verify that DDC controllers are protected from power supply surges.

3. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

E. Adjusting
1. Calibrating and Adjusting:
   a. Calibrate instruments.
   b. Make three-point calibration test for both linearity and accuracy for each analog instrument.
   c. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
   d. Control System Inputs and Outputs:
      1) Check analog inputs at 0, 50, and 100 percent of span.
      2) Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
      3) Check digital inputs using jumper wire.
      4) Check digital outputs using ohmmeter to test for contact making or breaking.
      5) Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
   e. Flow:
      1) Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
      2) Manually operate flow switches to verify that they make or break contact.
   f. Pressure:
      1) Calibrate pressure transmitters at 0, 50, and 100 percent of span.
      2) Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
   g. Temperature:
      1) Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
      2) Calibrate temperature switches to make or break contacts.
   h. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
   i. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
   j. Provide diagnostic and test instruments for calibration and adjustment of system.
   k. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
2. Adjust initial temperature and humidity set points.

3. Occupancy Adjustments: When requested within 12 months of date of Final Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

F. Demonstration

1. Train the Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls.

END OF SECTION 23 09 00 00

SECTION 23 09 23 53 - ENCLOSED CONTROLLERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for enclosed controllers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes the following enclosed controllers rated 600 V and less:
    a. Full-voltage manual.
    b. Full-voltage magnetic.
    c. Reduced-voltage magnetic.
    d. Reduced-voltage solid state.
    e. Multispeed.

C. Definitions
1. CPT: Control power transformer.
2. MCCB: Molded-case circuit breaker.
3. MCP: Motor circuit protector.
4. N.C.: Normally closed.
5. N.O.: Normally open.
6. OCPD: Overcurrent protective device.
7. SCR: Silicon-controlled rectifier.

D. Performance Requirements
1. Seismic Performance: Enclosed controllers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

E. Submittals
1. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.
2. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.
    a. Show tabulations of the following:
        1) Each installed unit's type and details.
        2) Factory-installed devices.
        3) Nameplate legends.
        4) Short-circuit current rating of integrated unit.
        5) Listed and labeled for integrated short-circuit current (withstand) rating of OCPDs in combination controllers by an NRTL acceptable to authorities having jurisdiction.
        6) Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.
    b. Wiring Diagrams: For power, signal, and control wiring.
3. Qualification Data: For qualified testing agency.
4. Seismic Qualification Certificates: For enclosed controllers, accessories, and components, from manufacturer.
    a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

5. Field quality-control reports.
6. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. Include the following:
   a. Routine maintenance requirements for enclosed controllers and installed components.
   b. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
   c. Manufacturer's written instructions for setting field-adjustable overload relays.
   d. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.
7. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
8. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

F. Quality Assurance
1. Testing Agency Qualifications: Member company of NETA or an NRTL **OR** one who meets the requirements necessary for certification, **as directed.**.
   a. Testing Agency's Field Supervisor: Currently certified by NETA **OR** one who meets the requirements necessary for certification, **as directed,** to supervise on-site testing.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Comply with NFPA 70.
4. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".

G. Delivery, Storage, And Handling
1. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
2. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install temporary electric heating, with at least 250 W per controller **OR** connect factory-installed space heaters to temporary electrical service, **as directed**.

H. Project Conditions
1. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   a. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
   b. Altitude: Not exceeding 6600 feet (2010 m).
2. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
   a. Notify the Owner no fewer than two days in advance of proposed interruption of electrical systems.
   b. Indicate method of providing temporary utilities.
   c. Do not proceed with interruption of electrical systems without the Owner's written permission.
   d. Comply with NFPA 70E.

I. Coordination
1. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
2. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
3. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.2 PRODUCTS

A. Full-Voltage Controllers
1. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.
2. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
    a. Configuration: Nonreversing **OR** Reversing **OR** Two speed, **as directed**.
    b. Flush **OR** Surface, **as directed**, mounting.
    c. Red **OR** Green, **as directed**, pilot light.
    d. Additional Nameplates: FORWARD and REVERSE for reversing switches **OR** HIGH and LOW for two-speed switches, **as directed**.
3. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
    a. Configuration: Nonreversing **OR** Two speed, **as directed**.
    b. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type **OR** melting alloy type, **as directed**.
    c. Flush **OR** Surface, **as directed**, mounting.
    d. Red **OR** Green, **as directed**, pilot light.
    e. Additional Nameplates: HIGH and LOW for two-speed controllers.
4. Integral Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
    a. Configuration: Nonreversing **OR** Reversing **OR** Two speed, **as directed**.
    b. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters and sensors in each phase, matched to nameplate full-load current of actual protected motor and having appropriate adjustment for duty cycle; external reset push button; bimetallic type **OR** melting alloy type, **as directed**.
    c. Flush **OR** Surface, **as directed**, mounting.
    d. Red **OR** Green, **as directed**, pilot light.
    e. Additional Nameplates: FORWARD and REVERSE for reversing controllers **OR** HIGH and LOW for two-speed controllers, **as directed**.
    f. N.O. **OR** N.C., **as directed**, auxiliary contact.
5. Magnetic Controllers: Full voltage, across the line, electrically held.
    a. Configuration: Nonreversing **OR** Reversing, **as directed**.
    b. Contactor Coils: Pressure-encapsulated type with coil transient suppressors, **as directed**.
        1) Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
    c. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
    d. Control Circuits: 24 **OR** 120, **as directed**,-V ac; obtained from integral CPT, with primary and secondary fuses, **as directed**, with CPT **OR** control power source, **as directed**, of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
        1) CPT Spare Capacity: 50 **OR** 100 **OR** 200, **as directed**, VA.
    e. Melting Alloy Overload Relays:

1) Inverse-time-current characteristic.
2) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic.
3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

f. Bimetallic Overload Relays:
1) Inverse-time-current characteristic.
2) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic.
3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
4) Ambient compensated.
5) Automatic resetting.

g. Solid-State Overload Relay:
1) Switch or dial selectable for motor running overload protection.
2) Sensors in each phase.
3) Class 10 **OR** Class 20 **OR** Class 10/20 selectable, **as directed**, tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
5) Analog communication module.

h. N.C. **OR** N.O., **as directed**, isolated overload alarm contact.

i. External overload reset push button.

6. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.

a. Fusible Disconnecting Means:
1) NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class J **OR** Class R **OR** indicated, **as directed**, fuses.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
3) Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.

b. Nonfusible Disconnecting Means:
1) NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
3) Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.

c. MCP Disconnecting Means:
1) UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
3) Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
4) N.C. **OR** N.O., **as directed**, alarm contact that operates only when MCP has tripped.
5) Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

d. MCCB Disconnecting Means:
1) UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
2) Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
3) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
4) Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.

5) N.C. **OR** N.O., **as directed**, alarm contact that operates only when MCCB has tripped.

B. Reduced-Voltage Magnetic Controllers
1. General Requirements for Reduced-Voltage Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A; closed-transition; adjustable time delay on transition.
2. Reduced-Voltage Magnetic Controllers: Reduced voltage, electrically held.
a. Configuration:
1) Wye-Delta Controller: Four contactors, with a three-phase starting resistor/reactor bank.
2) Part-Winding Controller: Separate START and RUN contactors, field-selectable for 1/2- or 2/3-winding start mode, with either six- or nine-lead motors; with separate overload relays for starting and running sequences.
3) Autotransformer Reduced-Voltage Controller: Medium-duty service, with integral overtemperature protection; taps for starting at 50, 65, and 80 percent of line voltage; two START and one RUN contactors.
b. Contactor Coils: Pressure-encapsulated type with coil transient suppressors, **as directed**.
1) Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
c. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
d. Control Circuits: 24 **OR** 120, **as directed**,-V ac; obtained from integral CPT, with primary and secondary fuses, **as directed**, with CPT **OR** control power source, **as directed**, of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
1) CPT Spare Capacity: 50 **OR** 100 **OR** 200, **as directed**, VA.
e. Melting Alloy Overload Relays:
1) Inverse-time-current characteristic.
2) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic.
3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
f. Bimetallic Overload Relays:
1) Inverse-time-current characteristic.
2) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic.
3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
4) Ambient compensated.
5) Automatic resetting.
g. Solid-State Overload Relay:
1) Switch or dial selectable for motor running overload protection.
2) Sensors in each phase.
3) Class 10 **OR** Class 20 **OR** Class 10/20 selectable, **as directed**, tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
5) Analog communication module.
h. N.C. **OR** N.O., **as directed**, isolated overload alarm contact.
i. External overload reset push button.
3. Combination Reduced-Voltage Magnetic Controller: Factory-assembled combination of reduced-voltage magnetic controller, OCPD, and disconnecting means.
a. Fusible Disconnecting Means:
1) NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class J **OR** Class R **OR** indicated, **as directed**, fuses.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

3) Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.

b. Nonfusible Disconnecting Means:
   1) NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
   2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
   3) Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.

c. MCP Disconnecting Means:
   1) UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
   2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
   3) Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
   4) N.C. **OR** N.O., **as directed**, alarm contact that operates only when MCP has tripped.
   5) Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

d. MCCB Disconnecting Means:
   1) UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
   2) Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   3) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
   4) Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
   5) N.C. **OR** N.O., **as directed**, alarm contact that operates only when MCCB has tripped.

C. Reduced-Voltage Solid-State Controllers

1. General Requirements for Reduced-Voltage Solid-State Controllers: Comply with UL 508.
2. Reduced-Voltage Solid-State Controllers: An integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and keypad, bypass contactor, and overload relay; suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.
   a. Configuration: Standard duty **OR** Severe duty, **as directed**; nonreversible **OR** reversible, **as directed**.
   b. Starting Mode: Voltage ramping **OR** Current limit **OR** Torque control **OR** Torque control with voltage boost, **as directed**; field selectable, **as directed**.
   c. Stopping Mode: Coast to stop **OR** Adjustable torque deceleration **OR** Adjustable braking, **as directed**; field selectable, **as directed**.
   d. Shorting (Bypass) Contactor: Operates automatically when full voltage is applied to motor, and bypasses the SCRs. Solid-state controller protective features shall remain active when the shorting contactor is in the bypass mode.
   e. Shorting and Input Isolation, **as directed**, Contactor Coils: Pressure-encapsulated type; manufacturer's standard operating voltage, matching control power or line voltage, depending on contactor size and line-voltage rating. Provide coil transient suppressors, **as directed**.
   f. Logic Board: Identical for all ampere ratings and voltage classes, with environmental protective coating.
   g. Control Circuits: 24 **OR** 120, **as directed**,-V ac; obtained from integral CPT, with primary and secondary fuses, **as directed**, with CPT **OR** control power source, **as directed**, of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
      1) CPT Spare Capacity: 100 **OR** 200, **as directed**, VA.

h. Adjustable acceleration-rate control using voltage or current ramp, and adjustable starting torque control with up to 400 percent current limitation for 20 seconds.
i. SCR bridge shall consist of at least two SCRs per phase, providing stable and smooth acceleration with **OR** without, **as directed**, external feedback from the motor or driven equipment.
j. Keypad, front accessible; for programming the controller parameters, functions, and features; shall be manufacturer's standard and include not less than the following functions:
    1) Adjusting motor full-load amperes, as a percentage of the controller's rating.
    2) Adjusting current limitation on starting, as a percentage of the motor full-load current rating.
    3) Adjusting linear acceleration and deceleration ramps, in seconds.
    4) Initial torque, as a percentage of the nominal motor torque.
    5) Adjusting torque limit, as a percentage of the nominal motor torque.
    6) Adjusting maximum start time, in seconds.
    7) Adjusting voltage boost, as a percentage of the nominal supply voltage.
    8) Selecting stopping mode, and adjusting parameters.
    9) Selecting motor thermal overload protection class between 5 and 30.
    10) Activating and de-activating protection modes.
    11) Selecting or activating communication modes.
k. Digital display, front accessible; for showing motor, controller, and fault status; shall be manufacturer's standard and include not less than the following:
    1) Controller Condition: Ready, starting, running, stopping.
    2) Motor Condition: Amperes, voltage, power factor, power, and thermal state.
    3) Fault Conditions: Controller thermal fault, motor overload alarm and trip, motor underload, overcurrent, shorted SCRs, line or phase loss, phase reversal, and line frequency over or under normal.
l. Controller Diagnostics and Protection:
    1) Microprocessor-based thermal protection system for monitoring SCR and motor thermal characteristics, and providing controller overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
    2) Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and underload conditions; and line frequency over or under normal.
    3) Input isolation contactor that opens when the controller diagnostics detect a faulted solid-state component or when the motor is stopped.
    OR
    Shunt trip that opens the disconnecting means when the controller diagnostics detect a faulted solid-state component.
m. Remote Output Features:
    1) All outputs prewired to terminal blocks.
    2) Form C status contacts that change state when controller is running.
    3) Form C alarm contacts that change state when a fault condition occurs.
n. Optional Features:
    1) Analog output for field-selectable assignment of motor operating characteristics; 0 to 10-V dc **OR** 4 to 20-mA dc, **as directed**.
    2) Additional field-assignable Form C contacts, as indicated, for alarm outputs.
    3) Surge suppressors in solid-state power circuits providing three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
    4) Full-voltage bypass contactor operating automatically **OR** manually, with NORMAL/BYPASS selector switch, **as directed**. Power contacts shall be totally enclosed, double break, and silver-cadmium oxide; and assembled to allow inspection and replacement without disturbing line or load wiring.
    5) Melting Alloy Overload Relays:
        a) Inverse-time-current characteristic.
        b) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic.

c) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

6) Bimetallic Overload Relays:
   a) Inverse-time-current characteristic.
   b) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic.
   c) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
   d) Ambient compensated.
   e) Automatic resetting.
7) Solid-State Overload Relay:
   a) Switch or dial selectable for motor running overload protection.
   b) Sensors in each phase.
   c) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
   d) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
   e) Analog communication module.
8) N.C. **OR** N.O., **as directed**, isolated overload alarm contact.
9) External overload reset push button.

3. Combination Reduced-Voltage Solid-State Controller: Factory-assembled combination of reduced-voltage solid-state controller, OCPD, and disconnecting means.
   a. Fusible Disconnecting Means:
      1) NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class J **OR** Class L **OR** indicated, **as directed**, fuses.
      2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
      3) Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
   b. MCP Disconnecting Means:
      1) UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
      2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
      3) Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
      4) N.C. **OR** N.O., **as directed**, alarm contact that operates only when MCP has tripped.
      5) Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.
   c. MCCB Disconnecting Means:
      1) UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
      2) Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
      3) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
      4) Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
      5) N.C. **OR** N.O., **as directed**, alarm contact that operates only when MCCB has tripped.
   d. Molded-Case Switch Disconnecting Means:
      1) UL 489, NEMA AB 1, and NEMA AB 3, with in-line fuse block for Class J or L power fuses (depending on ampere rating), providing an interrupting capacity to comply with available fault currents; MCCB with fixed, high-set instantaneous trip only.
      2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

3) Auxiliary contacts "a" and "b" arranged to activate with molded-case switch handle.
4) N.C. **OR** N.O., **as directed**, alarm contact that operates only when molded-case switch has tripped.

D. Multispeed Magnetic Controllers
1. General Requirements for Multispeed Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A.
2. Multispeed Magnetic Controllers: Two speed, full voltage, across the line, electrically held.
a. Configuration: Nonreversing **OR** Reversing, **as directed**; consequent pole **OR** two winding, **as directed**.
b. Contactor Coils: Pressure-encapsulated type with coil transient suppressors, **as directed**.
1) Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
c. Power Contacts: Totally enclosed, double break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
d. Control Circuits: 24 **OR** 120, **as directed**,-V ac; obtained from integral CPT, with primary and secondary fuses, **as directed**, with CPT **OR** control power source, **as directed**, of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
1) CPT Spare Capacity: 50 **OR** 100 **OR** 200, **as directed**, VA.
e. Compelling relays shall ensure that motor will start only at low speed.
f. Accelerating timer relays shall ensure properly timed acceleration through speeds lower than that selected.
g. Decelerating timer relays shall ensure automatically timed deceleration through each speed.
h. Antiplugging timer relays shall ensure a time delay when transferring from FORWARD to REVERSE and back.
i. Melting Alloy Overload Relays:
1) Inverse-time-current characteristic.
2) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic.
3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
j. Bimetallic Overload Relays:
1) Inverse-time-current characteristic.
2) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic.
3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
4) Ambient compensated.
5) Automatic resetting.
k. Solid-State Overload Relay:
1) Switch or dial selectable for motor running overload protection.
2) Sensors in each phase.
3) Class 10 **OR** Class 20 **OR** Class 10/20 selectable, **as directed**, tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
5) Analog communication module.
l. N.C. **OR** N.O., **as directed**, isolated overload alarm contact.
m. External overload reset push button.
3. Combination Multispeed Magnetic Controller: Factory-assembled combination of reduced-voltage magnetic controller, OCPD, and disconnecting means.
a. Fusible Disconnecting Means:
1) NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class J **OR** Class R **OR** indicated, **as directed**, fuses.

2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
3) Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.

b. Nonfusible Disconnecting Means:
1) NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
3) Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.

c. MCP Disconnecting Means:
1) UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
3) Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
4) N.C. **OR** N.O., **as directed**, alarm contact that operates only when MCP has tripped.
5) Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

d. MCCB Disconnecting Means:
1) UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
2) Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
3) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
4) Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
5) N.C. **OR** N.O., **as directed**, alarm contact that operates only when MCCB has tripped.

E. Enclosures

1. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
a. Dry and Clean Indoor Locations: Type 1.
b. Outdoor Locations: Type 3R **OR** Type 4X, **as directed**.
c. Kitchen **OR** Wash-Down, **as directed**, Areas: Type 4X, stainless steel.
d. Other Wet or Damp Indoor Locations: Type 4.
e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.
f. Hazardous Areas Indicated on Drawings: Type 7 **OR** Type 9, **as directed**.

F. Accessories

1. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
a. Push Buttons, Pilot Lights, and Selector Switches: Heavy **OR** Standard, **as directed**,-duty, oiltight, **as directed**, type.
1) Push Buttons: Covered **OR** Lockable **OR** Recessed **OR** Shielded **OR** Shrouded **OR** Unguarded, **as directed**, types; maintained **OR** momentary, **as directed**, as indicated.
2) Pilot Lights: Incandescent **OR** LED **OR** Neon **OR** Resistor **OR** Transformer, **as directed**, types; colors as indicated; push to test, **as directed**.
3) Selector Switches: Rotary type.

b. Elapsed Time Meters: Heavy duty with digital readout in hours; nonresettable **OR** resettable, **as directed**.

c. Meters: Panel type, 2-1/2-inch (64-mm) minimum size with 90- or 120-degree scale and plus or minus two percent accuracy. Where indicated, provide selector switches with an off position.

2. N.C. **OR** N.O. **OR** Reversible N.C./N.O., **as directed**, auxiliary contact(s).
3. Control Relays: Auxiliary and adjustable pneumatic **OR** solid-state, **as directed**, time-delay relays.
4. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
5. Breather and drain assemblies, to maintain interior pressure and release condensation in Type 4 **OR** Type 4X **OR** Type 7 **OR** Type 9, **as directed**, enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
6. Space heaters, with N.C. auxiliary contacts, to mitigate condensation in Type 3R **OR** Type 4X **OR** Type 12, **as directed**, enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
7. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
8. Cover gaskets for Type 1 enclosures.
9. Terminals for connecting power factor correction capacitors to the line **OR** load, **as directed**, side of overload relays.
10. Spare control wiring terminal blocks, quantity as indicated; unwired **OR** wired, **as directed**.

1.3 EXECUTION

A. Examination
1. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
2. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation
1. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers And Supports For Electrical Systems".
2. Floor-Mounted Controllers: Install enclosed controllers on 4-inch (100-mm) nominal-thickness concrete base. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-place Concrete".
   a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   d. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Seismic Bracing: Comply with requirements specified in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
4. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
5. Install fuses in each fusible-switch enclosed controller.
6. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses".
7. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

8. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
9. Install power factor correction capacitors. Connect to the line **OR** load, **as directed**, side of overload relays. If connected to the load side of overload relays, adjust overload heater sizes to accommodate the reduced motor full-load currents.
10. Comply with NECA 1.

C. Identification
1. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".
    a. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
    b. Label each enclosure with engraved nameplate.
    c. Label each enclosure-mounted control and pilot device.

D. Control Wiring Installation
1. Install wiring between enclosed controllers and remote devices and facility's central control system, **as directed**. Comply with requirements in Division 26 Section "Control-voltage Electrical Power Cables".
2. Bundle, train, and support wiring in enclosures.
3. Connect selector switches and other automatic-control selection devices where applicable.
    a. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
    b. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

E. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Perform tests and inspections.
3. Acceptance Testing Preparation:
    a. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
    b. Test continuity of each circuit.
4. Tests and Inspections:
    a. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment, **as directed**.
    b. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
    c. Test continuity of each circuit.
    d. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify the Owner before starting the motor(s).
    e. Test each motor for proper phase rotation.
    f. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
    g. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
    h. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
        1) Initial Infrared Scanning: After Final Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each multi-pole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.
        2) Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multi-pole enclosed controller 11 months after date of Final Completion.

3) Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

i. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

5. Enclosed controllers will be considered defective if they do not pass tests and inspections.
6. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

F. Adjusting

1. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
2. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
3. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify the Owner before increasing settings.
4. Set the taps on reduced-voltage autotransformer controllers at 50 **OR** 65 **OR** 80, **as directed**, percent.
5. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state controllers.
6. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study", **as directed**.

G. Protection

1. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.
2. Replace controllers whose interiors have been exposed to water or other liquids prior to Final Completion.

H. Demonstration

1. Train the Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers, and to use and reprogram microprocessor-based, reduced-voltage solid-state controllers, **as directed**.

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Task	Specification	Specification Description
23 09 23 53	23 09 00 00	HVAC Instrumentation And Controls
23 09 43 00	23 09 00 00	HVAC Instrumentation And Controls

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SECTION 23 11 23 00 - RELIEF WELLS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for relief wells. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. Shop Drawings: Submit shop drawings.
   2. Statements
      a. Before installation, all well screen shall be approved.
      b. The filter pack material and its gradation shall be approved before it is placed.
      c. Submit the cement grout mixture proportion to be used in plugging abandoned wells.
   3. Reports: Submit sampling and testing reports for each relief well, logs of the borings, well screen and riser pipe, backfill material, and pump tests. Register each well with the state as required by the state in which the well is installed.

C. Regulatory Requirements: The state statutory and regulatory requirements form a part of this specification.

1.2 PRODUCTS

A. Well Screen: The Contractor may, at its option, furnish and install well screen of any of the alternate types specified. The clear inside diameter of the screen shall be as directed by the Owner. Screen openings shall be uniform in size and pattern, and shall be spaced approximately equally around the circumference of the pipe.
   1. PVC Pipe Screen: Pipe, fittings, and screen shall be of the size and types specified. Pipe, fittings, and screen shall conform to ASTM D 1784, ASTM D 1785, ASTM D 2466, or ASTM D 2467. All joints in the PVC pipe shall include couplings and shall be glued with a solvent cement conforming to ASTM D 2564. The PVC pipe strength properties shall be equivalent to PVC 1120 Schedule 40 **OR** 80, **as directed**, unthreaded plastic pipe.
      a. Couplings: Couplings shall be bonded socket **OR** threaded, **OR** certilock, **as directed**, type. Fittings shall be produced of the same material and equal quality as specified for plastic pipe screen. Socket type fitting connections of pipe sections shall be bonded with solvent cement. The determination of the proportions and preparation of adhesives, the method of application, and the procedure used for making and curing the connections shall be the responsibility of the Contractor. The system for making joints at the relief well site shall provide a curing period adequate to develop the ultimate strength of the solvent cement. Self-tapping screws or other devices for holding pipe in the couplings during the setting period may be utilized as long as the screws do not penetrate the inside of the pipe. In no case shall a newly-made joint in the casing be stressed, lowered into the relief well, or be submerged in water prior to complete curing of the solvent cement adhesive.
      b. Perforations: The PVC well screen shall be mill slot **OR** continuous wire wrapped rod base **OR** continuous wire wrapped rod base on perforated pipe **OR** continuous wire wrapped on perforated pipe screen **OR** similar to that manufactured by Johnson Well Equipment, Inc., Pensacola, FL, telephone (904) 453-3131, **as directed**. All well screen shall have smooth, sharp-edged openings free of burns, chipped edges, or broken areas on the interior and exterior surfaces of the pipe. The slots or groups of slots shall be distributed in a uniform pattern around the periphery of the pipe and shall be oriented with the length of the slot parallel to, normal to, or diagonal with the axis of the pipe.

2. Fiberglass Pipe Screen: Fiberglass pipe screen and fittings shall be manufactured from thermosetting epoxy resins and glass fiber by either a centrifugal casting process or by a filament winding process. Glass fiber used shall be continuous filament, electrical glass with a finish compatible with epoxy resins. Each glass fiber or filament shall be thoroughly impregnated with epoxy resin. Fiberglass pipe wall thickness, strength and durability requirements shall be equivalent to the Fiberglass/Epoxy pipe produced by Fiberglass Resources Corporation of Farmingdale, New York or Burgess Well Company, Inc., Minden, Nebraska, telephone (308) 832-1642. All fiberglass pipe and fittings shall be round and straight, of uniform quality and workmanship, and free from all defects including indentation, delamination, bends, cracks, blisters, porosity, dry spots, resin segregation and resin-starved areas. The inside of the pipe and fittings shall be smooth and uniform. The impregnation of the glass fiber with resin shall be such that when the pipe is cut or slotted, no fraying or looseness of glass fiber occurs.
   a. Couplings: Couplings for fiberglass pipe sections shall be socket threaded or mechanical key-type couplings. The couplings shall be manufactured of the same materials used for the fiberglass pipe specified herein and may be either cast integrally with the pipe sections or as separate components for attachment to the pipe in the manufacturers plant. Key-type couplings shall consist of male and female halves designed for joining and locking together by means of a key strip inserted in grooves in the coupling halves. The minimum wall thickness remaining at any grooved section shall not be less than the minimum thickness specified for pipe. Key strips and locking strips shall be of fiberglass, plastic or other non-corrosive material capable of withstanding shearing and bearing stresses equivalent to the design load for the coupling. Socket type fitting connections of the pipe sections shall be bonded with epoxy adhesive. The epoxy materials and bonding agents shall be as recommended by the pipe manufacturer. Self-tapping screws or other devices for holding adhesive-joined pipe in the couplings during the curing period may be utilized. In no case shall a newly-made joint in the casing pipe be lowered into the relief well, or be submerged in water prior to complete curing of the adhesive.
   b. Perforations: All fiberglass well screen shall be mill slot **OR** continuous wire wrapped rod base, **as directed**. All relief well screen shall have smooth, sharp-edged openings free of burrs, chipped edges, or broken areas on the interior and exterior surfaces of the pipe. The slots or groups of slots shall be distributed in a uniform pattern around the periphery of the pipe and shall be oriented with the length of the slot parallel to, normal to, or diagonal with the axis of the pipe.
3. Steel Pipe Screen: Steel well screen shall consist of perforated or slotted sections of steel pipe conforming to the requirements of ASTM A 53.
   a. Couplings: Couplings for steel pipe screen shall be welded joints or threaded couplings. Welding shall be performed in accordance with requirements in ASME B31.9. Couplings shall meet the material requirements specified for steel pipe screen, except perforations shall be omitted. All threaded pipe and fittings shall be threaded in accordance with ASME B1.20.1. All threaded pipe sections may be field connected. Couplings shall be given the same protection against corrosion as specified for the well screen pipe. Protective coatings damaged while making couplings shall have the areas recoated.
   b. Perforations: All steel pipe to be used as relief well screen shall be provided with perforations which shall consist of either machine-cut slots; drilled or punched openings. The slots or groups of slots shall be distributed in a uniform pattern around the periphery of the pipe and shall be oriented with the length of the slot parallel to, normal to, or diagonal with the axis of the pipe. The pattern of the openings shall be uniformly spaced around the periphery of the pipe.
4. Stainless Steel Well Screen: The perforated well screen and fittings shall be fabricated entirely from stainless steel conforming to ASTM A 312/A 312M, Type 304, 304-L, 316 or 316-L. The well screen shall be of stainless steel with a keystone wire-wrapped continuous slot strainer equivalent to that manufactured by Howard Smith Screen Company, Houston, TX, telephone (713) 869-5771 or Johnson Screens, St. Paul, MN 55164, telephone (612) 636-3900.
   a. Couplings: Couplings for the stainless steel well screen shall consist of the same material as the well screen and shall be threaded, flanged, and/or fitted with a welding ring. The

couplings shall conform in design to the couplings recommended by the manufacturer of the well screen.

b. Tailpipe for Well Screen: The tailpipe for each well screen shall be made of the same material and at least the same minimum thickness as the riser pipe and shall include a bottom plug.

B. Riser Pipe: The relief well riser pipe material and method of manufacture shall conform to the requirements specified in paragraph WELL SCREEN, except that the screen perforations or opening shall be omitted. The relief well riser pipe diameter and discharge details shall be as directed. Couplings to the well screen and between riser pipe sections shall be as specified in paragraph COUPLING.

C. Filter Pack: Material for the filter pack around the riser pipes and screens shall be a washed grave, **OR** washed sand **OR** dry processed sand, **as directed**, composed of hard, tough, and durable particles free from adherent coating. The filter pack shall not be crushed stone. The filter pack material shall contain no detrimental quantities of organic matter nor soft, friable, thin, or elongated particles in accordance with the quality requirements in ASTM C 33, Table 1 and Table 3, Class 5S, and in ASTM E 11, Table 1.

D. Outlet For Relief Well: Check Valve.

1. The check valve shall be a one piece reinforced all rubber (neoprene) check valve with an integral elastomer flange similar and equal to the Red Valve Series 35, manufactured by Red Valve Company, Inc., 700 North Bell Ave., Pittsburgh, PA 15106, telephone (412) 279-0044. The backup ring for the check valve shall be stainless steel. Stainless steel bolts, washers, and nuts shall be used to fasten the valves onto the flanged end of the pipes. The check valve shall be installed with the flared end duck bill in a vertical position.

   OR

   Fabricate check valves of brass **OR** stainless steel **OR** aluminum, **as directed**, plate, threaded fasteners and rods. Fabricate sealing disc of silicone sponge rubber free of porous areas, foreign materials, and visible defects.
2. Workmanship and metalwork fabrication of check valves shall be as directed. Install check valves accurately vertically and adjust to the required elevation.

E. Concrete: Concrete shall conform to the requirements specified in Division 03 Section "Cast-in-place Concrete".

1.3 EXECUTION

A. Drilling: Wells may be drilled by the reverse rotary circulation method or other method approved, which will ensure proper placement of the well screen, riser pipe, and filter pack. Methods which involve radical displacement of the formation, or which may reduce the yield of the well, will not be permitted. Excavated material shall be disposed of as directed.

1. Reverse Circulation Method: If the reverse circulation method is used for drilling wells, all of the drilling fluid shall be removed from the filter pack and the natural pervious formation. If in the opinion of the Owner the walls of the hole above the top of the filter pack require support during development operations, a temporary casing similar to that specified in paragraph TEMPORARY CASING shall be placed so as to extend from the ground surface to at least 3 ft (1 m) below the top of the filter pack. The diameter of the hole shall be such as will permit the placement of the minimum thickness of filter pack as specified in paragraph FILTER PACK PLACEMENT. The drilling fluid shall be a suspension of fine grained soil or shall be a commercial product of a recognized manufacturer, shall be approved by the Owner, and shall have the characteristic of being readily removable from the filter pack and the walls of the formation by development as specified in paragraph DEVELOPMENT. The use of bentonite will not be permitted.
2. Temporary Casing: Temporary well casing of either iron or steel of sufficient length to case to the bottom of all borings shall be available at the construction site. the Owner will direct the use of a temporary casing to the bottom of the boring during drilling and placement of screen, riser, and

filter pack when it believes it is necessary to provide adequate support to the sides of the hole. When the walls of the boring will require support only during development operations a temporary casing will be required to extend only to a depth 3 ft (3 m) below the top of the filter pack. The temporary casing, shall have sufficient thickness to retain its shape and maintain a true section throughout its depth, and may be in sections of any convenient length. The temporary casing shall be such as to permit its removal without disturbing the filter pack, riser, or well screen. The setting of temporary casing shall be such that no cavity will be created outside of it at any point along its length. In the event the temporary casing should become unduly distorted or bent it shall be discarded and a new casing shall be used during installation of any additional relief wells.

B. Installation Of Riser Pipe And Screen

1. Assembly: All riser pipe and screen shall be in good condition before installation and all couplings and other accessory parts shall be securely fastened in place. The successive lengths of pipe shall be arranged to provide accurate placement of the screen sections in the bore hole. The riser-pipe shall be provided with an approved cap and a flanged top section, the top of which shall be set at the elevation directed. Centralizers shall be attached to the assembled riser pipe and screen in such numbers and of a type that they will satisfactorily center the riser pipe and screen in the well and will hold it securely in position while the filter pack material is being placed.
2. Joints: Sections of relief well pipe shall be joined together as specified in paragraph COUPLINGS. Joints shall be designed and constructed to have the strength of the pipe and where possible a strength capable to support the weight of the relief well stem as it is lowered into the hole. When not practicable to construct joints that will support the weight of the relief well stem, the stem shall be supported at the lower end by any approved means that will assure that the joints do not open while being lowered into place in the well.
3. Installation: The assembled riser pipe and screen shall be placed in the bore hole in such manner as to avoid jarring impacts and to ensure that the assembly is centered and not damaged or disconnected. The screen shall be suspended in the hole and not resting on the bottom of the hole. After the screen and riser pipe have been placed, a filter pack shall be constructed around the screen section as specified in paragraph FILTER PACK PLACEMENT and the well developed as specified in paragraph DEVELOPMENT. The top of the riser pipe shall be held at the designated elevation during placement of the filter pack.
4. Check for Plumbness and Alignment: The well shall be constructed and all casing set round, plumb, and true. The Contractor shall perform the following tests after the installation of the well but prior to backfilling, and before its acceptance. Additional tests may be made during the performance of the work at the option of the Contractor. Should the Contractor fail to correct, at no additional cost to the Owner, any faulty alignment or plumbness disclosed as a result of these tests, the Owner may refuse to accept the well. the Owner may waive the requirements for plumbness if in its judgement the Contractor has exercised all possible care in constructing the well and the defect is due to circumstances beyond its control or if the utility of the completed well is not materially affected or if the cost of necessary remedial measures will be excessive. In no event will the provisions with respect to alignment be waived.
   a. Plumbness: Plumbness shall be tested by use of a plumb line. The plummet shall be suspended from a small diameter wire rope and its point of suspension shall be in the exact center of the plummet. The plummet shall be sufficiently heavy to stretch the wire rope taut. The wire rope shall pass over a guide sheave which shall be positioned above the top of the well and adjusted horizontally so that the plummet hangs in the center of the well. Displacement of the wire rope during the plumbness check shall be measured by means of a transparent plastic sheet on which a number of concentric circles shall be scribed or drawn, and which is centered on the top of the well. The exact center of these circles shall be marked, and then a slot, slightly larger than the plumb line and extending from this center to the edge, shall be cut in the plastic sheet. As the plummet is lowered, any out-of-plumb condition of the well will be indicated by the wire rope tending to drift away from the center, and the plastic sheet shall be rotated until the slot is oriented in the direction of this drift, while at all times maintaining the center of the concentric circles coincident with the center of the well. Measurement of the amount of drift shall be made

along the edge of the slot for each increment by which the plummet is lowered into the well. Drift at any depth shall be determined by multiplying the measured plumb line displacement by the total length of the plumb line and dividing the result by the fixed distance between the guide sheave and the top of the well. If desired, alignment may be calculated from the plumbness data in lieu of the alignment check described in paragraph ALIGNMENT. Should the well vary from the vertical in excess of allowable, the plumbness of the well shall be corrected by the Contractor at no additional cost to the Owner.

b. Alignment: Alignment shall be tested by lowering into the well a section of cylinder or a dummy of the same length. The outside diameter of cylinder shall be smaller than the inside diameter of the well. Should the cylinder fail to move freely throughout the length of the well, the alignment of the well shall be corrected by the Contractor at no additional expense to the Owner.

C. Filter Pack Placement: After the well screen and riser pipe have been installed, the filter pack material shall be placed by tremie, when using a well graded material, in an approved manner such that segregation will not occur. When using a uniform graded filter material, the material may be poured around the well screen at a rate that will prevent bridging of the material. The material shall be placed around all sides of the screen to assure that the screen is not pushed against the side of the bore hole causing the screen to come in contact with foundation material or prevent the proper thickness of filter from being placed uniformly around the screen. The filter pack shall be placed at a constant rate from the start of placement until it has reached the elevation directed. If a tremie is required, a double string of tremie pipe shall be used. The pipes shall be placed on opposite sides of the screen and/or casing, that is, 180 degrees apart, and shall be guided in such a manner that they will remain in this position throughout the placing process. The tremie pipes shall be set in place, filled completely with filter pack prior to being lifted off the bottom of the hole. The filter pack in the tremie pipe shall be kept above the water surface in the well throughout the placing process. In no case shall the gradation of the filter pack fall outside of the range specified in paragraph FILTER PACK.

D. Development

1. General: Following placement of filter pack materials, the Contractor shall develop the relief well by jetting, surging, intermittent pumping, or other approved methods as may be necessary to give the maximum yield of water. At the time of development of any relief well, the well shall be free of drawdown or surcharge effects due to pump testing, developing or drilling at another location. The Contractor shall be responsible for maintaining at the relief well the needed access and work area and clearance in the relief well necessary to accomplish development. The Contractor shall furnish, install, or construct the necessary discharge line and troughs to conduct and dispose of the discharge a sufficient distance from the work areas to prevent damage. Development shall be conducted to achieve a stable well of maximum efficiency and shall be continued until a satisfactory sand test, as specified in paragraph SAND TEST, is obtained. As development proceeds, filter pack material shall be added to the annular space around the screen to maintain the top elevation of the filter pack to the specified elevation. The Contractor shall provide an open tube or other approved means for accurately determining the water level in the well under all conditions. If at any time during the development process it becomes apparent in the opinion of the Owner that the well may be damaged, development operations shall be immediately terminated. the Owner may require a change in method if the method selected does not accomplish the desired results. the Owner may order that wells which continue to produce excessive amounts of fines after development for 6 hours be abandoned, plugged, and backfilled, and may require the Contractor to construct new wells nearby. All materials pulled into the well by the development process shall be removed prior to performing the pumping test.

a. Jetting: Jetting should be performed using either a single or double ring jet. The jetting tool shall be constructed of high-strength material and conservatively designed and proportioned so that it will withstand high pressures. The jetting tool shall have two hydraulically balanced nozzles spaced 180 degrees **OR** four diameter holes spaced 90 degrees, **as directed**, apart and which shall exert the jetting force horizontally through the screen slots. The rings shall be constructed such that the tips of the jets shall be within 1/2 in. (13 mm) from the inner surface of the well screen. The pump used in conjunction with the jetting tool shall be capable of providing a minimum jetting fluid exit velocity of 150 feet per second (45 meters per second). Prior to commencing jetting, and following each jetting cycle, all sand and/or other materials shall be removed from inside the screen. All wells shall be pumped during the jetting cycle to remove incoming sand and other material. Such pumping shall be at a rate not less than 115 percent of the rate at which fluid is introduced through the jetting tool. This will allow a flow of material into the well as it is being developed. Water used for development shall be free of sand. the Owner may require other means of developing the well such as intermittent pumping method, variation of the intermittent pumping method, or surge block if it appears that the development of the well is not producing the desired results.

b. Intermittent Pumping: Intermittent pumping shall be performed by pumping the well at a capacity sufficient to produce a rapid drawdown, stopping the pump (backflow through pump will not be permitted) to permit the water surface to rise to its former elevation, and repeating this procedure. Cycle time for this procedure will vary as directed but will not be more than 3 cycles per minute. A deep well turbine pump, or electric submersible pump with check valve, shall be used with any attachment necessary to accomplish rapid starting and stopping for intermittent pumping. The intake shall be set below the maximum expected drawdown in the well. Prior to commencing intermittent pumping, and periodically during development by this method, all sand and/or other materials shall be removed from inside the screen. The amount of drawdown may be decreased if, in the opinion of the Owner, the efficiency of the well might otherwise be impaired.

c. Surging: Surging of the well shall require use of a circular block which is smaller in diameter than the inside diameter of the relief well and is constructed of a material which will not damage the screen if the block comes in contact with the screen, and a bailer or pump to remove materials drawn into the well. The surging shall be continued for a period of approximately one hour or until little or no additional material from the foundation or filter pack can be pulled through the screen. The surge block shall be moved by a steady motion up and down the full length of the well screen. Prior to commencing surging, and periodically during development by this method, all sand and/or other materials shall be removed from inside the screen. All materials pulled into the well by the surging process shall be removed by the Contractor.

E. Backfilling: After the well has been developed, additional filter pack shall be added if necessary to meet the requirements of paragraph FILTER PACK PLACEMENT. Then the annular space above the filter pack, shall be backfilled by first placing a layer of concrete sand on the filter pack and then filling the remainder of the space up to the finished ground surface **OR** well pit, **as directed**, with grout or concrete. The concrete backfill shall be placed to a depth at least equal to the existing impervious blanket. For PVC riser pipe, after the well has been developed, additional filter pack shall be added if necessary for it to meet the requirements of paragraph FILTER PACK PLACEMENT. Then the remaining annular space above the filter pack shall be backfilled by first placing a layer of concrete sand on the filter pack and then filling the remainder of the space up to the finished ground surface **OR** well pit, **as directed**, with bentonite. The temporary casing, if used, shall be withdrawn in increments as the backfill is placed. The Contractor shall fill with impervious material to original grade all pits such as those incidental to the reverse rotary circulation method of drilling.

F. Plugging Of Abandoned Wells: The Contractor has the option of attempting to remove the well screen. If the well screen can be removed, the Contractor will grout the bore hole starting from the bottom of the hole. The grouting shall start at the elevation of the bottom of the tailpipe of the well. If the well screen can not be removed or breaks off during the removal attempt, the Contractor shall still be responsible for grouting the well from the bottom of the tailpipe to within 3 ft (1 m) of ground surface. Either of the above abandonment procedures may require the Contractor to redrill the hole so that the bore hole can be grouted. The well shall be grouted from the bottom of the tailpipe. After the grout has setup the riser pipe shall be cutoff. Then the hole shall be backfilled. The cement grout mixture proportion to be used shall be submitted for approval.

G. Tests

1. Pump Test: Upon completion but before acceptance, each well shall be subjected to a pump test of which a sand test will form a part. The Contractor shall provide a deep well turbine pump, capable of producing the specified drawdowns over periods of time sufficient to satisfactorily perform the pump test specified herein. The intake shall be set below the maximum expected drawdown in the well. The amount of sand shall be measured after each test. The pump shall be complete with either gasoline, diesel, or electric motor of adequate size. In case an electric motor is used, the Contractor shall provide, without additional cost to the Owner, the electric power and the necessary wiring. The Contractor shall provide an open tube or other approved means for accurately determining the water level in the well. The Contractor shall furnish and install an orifice meter of approved design or other approved equipment for the purpose of measuring the discharge from the well during the pumping test. The Contractor shall furnish, install, or construct the necessary pipe discharge line, troughs, or ditches necessary to dispose of the pumping test discharge a sufficient distance from the work area to prevent damage. The tests will be conducted under the direction of the Owner and may be made as soon as each well is completed. Test data will be recorded by the Owner. The Contractor shall test each well by pumping continuously for a minimum of 6 hours. Prior to starting the pump test all material shall be removed from the bottom of the well. If the test is interrupted, other than by order of the Owner, prior to the completion of the specified period of continuous operation, the test shall be re-run. In addition to the required pumping test, the Owner may direct the Contractor to perform additional pump tests. Such additional testing shall conform in general to the requirements specified herein except that the duration of the tests and the approximate draw-down will be determined by the Owner. In the event that sand or other material collects in the well as a result of the pump test, accurate measurements shall be taken as to the quantity of material in the well and all such material shall be removed by the Contractor. Upon completion of the pump test, the Contractor shall remove all equipment, discharge lines, electrical lines, lumber, and debris, and shall backfill any excavated areas with impervious material.
2. Sand Test: As part of each Pump Test or at the end of each intermittent pumping a determination of the amount of sand (filter pack and/or foundation material) a well is producing shall be performed. Prior to starting the sand test all material shall be removed from the bottom of the tailpipe. After the pump is at the desired pumping rate the flow from the discharge shall be diverted into a container that will collect all the sand being carried by the water **OR** through a Rossum Sand Tester, **as directed**. Upon completion of the test the amount of sand in the tailpipe shall be determined to verify that no material is being deposited in the bottom of the well.
3. Filter Pack Sampling and Testing: The Contractor shall verify that all materials conform to the specifications before delivery to the project. The particle size distribution of the filter pack shall be sampled and tested by the Contractor in accordance with ASTM C 136 and ASTM D 75. Within 48 hours before being placed in the relief well to be back-filled, the filter pack shall be sampled from the material stockpiled at the project site. There shall be at least one particle size distribution test on the filter pack for each well. A pump test shall be performed in accordance with technical provisions herein specified.
4. Reports: Reports shall include, for each relief well, logs of the boring, elevations of the well screen, top of riser pipe, bottom of the tailpipe, filter pack gradation, quantity of filter pack added during development, pump test, sand test, and report of backfilling. The log of backfill material shall include the filter pack particle size distribution test data, and notes concerning installation and development of the relief well. The pump test log shall include the duration of the test and the draw-down response data with time in the pumped well, in adjacent wells, and in nearby piezometers. The relief well log and the pump test log shall be submitted to the Owner. The Contractor shall also submit a report of the well installation to the appropriate public agency and in the form required by state statutory and/or regulatory requirements specified in paragraph REGULATORY REQUIREMENTS.

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SECTION 23 11 23 00a - MONITORING WELLS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for monitoring wells including drilling, casing, well screen, gravel packing, grouting, development, monitoring device, and incidental related work complete and ready for operation. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. General Requirements
1. Each system, including equipment, materials, installation, and performance, shall be in accordance with local, State, and Federal regulations, ASTM D 5092, and EPA 600-4-89-034 except as modified herein. Consider the advisory or recommended provisions to be mandatory, as though the word "shall" has been substituted for the word "should" wherever it appears. Reference to the "Project Representative" and the "Owner" shall be interpreted to mean the Owner. Additional requirements are included under Division 01 Section "Temporary Facilities And Controls". Mark and secure monitoring wells to avoid unauthorized access and tampering.

C. Submittals:
1. Shop Drawings: Well construction.
2. Product Data
   a. Well casing
   b. Well screen
   c. Filter pack
   d. Neat cement grout
   e. Bentonite seal
3. Certificates
   a. Well Drilling/Development Material Handling Plan
   b. Health and Safety Plan
   c. Field Sampling and Laboratory Testing Plan
   d. Treatment facility permit
   e. Installation Survey Report
   f. Well Development Report
   g. Borehole Analysis Report
4. Closeout Submittals
   a. Well Construction Permit
   b. Shipment manifests
   c. Delivery certificates
   d. Treatment and disposal certificates

D. Delivery, Storage, And Handling
1. Deliver materials in an undamaged condition. Unload and store with minimal handling. Store materials in on-site enclosures or under protective coverings. Store plastic piping and jointing materials, and rubber gaskets under cover, out of direct sunlight. Store materials off the ground. Keep insides of pipes and fittings free of dirt and debris. Replace defective or damaged materials with new materials.

E. Quality Assurance
1. Required Drawings: Submit well construction drawings showing components and details of well casing, well screen, filter pack, annular seal, and associated items. Drawings shall be prepared by a State certified professional geologist or hydrogeologist, or by a State registered professional

civil engineer, hereafter referred to as the Contractor's Professional Consultant (CPC). Drawings shall be sealed.

2. Well Drilling/Development Material Handling Plan: A material handling plan shall be furnished by the Contractor 15 days prior to initiation of the work that describes phases of dealing with the potentially contaminated soil and groundwater, including the following: a schedule to be employed in the well drilling and development stages, a sequence of operations, the method of drilling and development, material hauling, proposed equipment, handling of the contaminated materials, soil and water testing requirements, and safety precautions and requirements.
3. Health and Safety Plan (HASP): Describe safety precautions for each phase of the project as specifically related to handling of soil and water removed during well drilling and development operations. Identify appropriate requirements of 29 CFR 1910 and COE EM-385-1-1. Identify safety equipment and procedures to be available and used during the project. Furnish the name and qualifications based on education, training, and work experience of the proposed Health and Safety Officer (HASO) and the members of the drill crew. The CPC may perform the responsibilities of the HASO if properly qualified.
4. Field Sampling and Laboratory Testing Plan: Describe field sampling methods and quality control procedures. Identify laboratory and laboratory methods to be used for contamination testing. Sample reports shall show sample identification for location, date, time, sample method, contamination level, name of individual sampler, identification of laboratory, and quality control procedures.
5. Treatment Facility Permit: Verification that the proposed treatment facility is permitted to accept the contaminated materials specified, prior to the start of excavation.
6. Well Development Report: Provide report, containing the following data for each well: project name and location, well designation, date and time of well installation, date and time of well development, static water level from top of well casing before development and 24 hours after development, field measurements of pH, temperature, and specific conductivity, depth of well from top of casing to bottom of well, screen length, description of development methodology size/capacity of pump or bailer, pumping rate, and recharge rate.
7. Well Construction Permit: Submit a completed permit application and a proposed method of construction to the appropriate state agency prior to construction of the well. Construction of the wells will not be allowed until an approved Well Construction Permit has been submitted to the Owner.
8. Shipment Manifests: Copies of manifests and other documentation required for shipment of waste materials within 24 hours after removal of waste from the site. Shipment manifests shall be signed by the Owner.
9. Delivery Certificates: Verification that the wastes were actually delivered to the approved treatment facility, within 7 days of shipment.
10. Treatment and Disposal Certificates: Verification that the wastes were successfully treated and remediated to the levels specified herein.

1.2 PRODUCTS

A. Well Casing
1. Stainless Steel Piping: ASTM A 312/A 312M, Type 304, Schedule 40S, with flush threaded joint end fittings. Threaded joints shall be wrapped with fluoropolymer tape, and provided with nitrile O-ring gaskets.
2. PVC Piping: ASTM F 480, Type 1, Grade 1, PVC 12454, NSF wc or NSF pw, Schedule 40 **OR** 80, **as directed**, with flush threaded joint fittings. Threaded joints shall be wrapped with fluoropolymer tape, and provided with nitrile O-ring gaskets.

B. Well Screen: Well screens shall be located as directed. The length of each screen shall be as directed. Slot size shall be as required to meet project requirements. Slotted openings shall be distributed uniformly around the circumference of the screen. Open area shall approach the formation's natural porosity.

1. Stainless Steel Screens: ASTM A 312/A 312M, Type 304, Schedule 40S, continuous slot construction, wire wound, with flush threaded joint ends.
2. PVC Screens: ASTM D 1785, PVC 1120, NSF wc or NSF pw, Schedule 40 **OR** 80, **as directed**, screen, Schedule 80, machine-slotted construction, flush threaded joint ends. Slots shall be even in width, length, and separation.

C. Primary Filter Pack: Provide clean, durable, well-rounded, and washed quartz or granite, with less than 5 percent non-siliceous material. The filter pack shall not contain organic matter or friable materials. The filter pack shall allow free flow of water in the well, and shall prevent the infiltration of aquifer materials. Filter pack shall have a 30 percent finer than (d-30) grain size size as required to meet project requirements, and a uniformity coefficient less than 2.5, in accordance with ASTM C 117 and ASTM C 136.

D. Secondary Filter Pack: Gradation in accordance with ASTM D 5092. Provide clean, durable, well-rounded, and washed quartz or granite. Pack shall not contain organic matter or friable materials.

E. Annular Sealants
1. Bentonite Seal: Provide powdered, granular, pelletized, or chipped sodium **OR** calcium, **as directed**, montmorillonite in sealed containers from a commercial source, free of impurities. Diameter of pellets shall be less than one fifth the diameter of the borehole annular space to prevent bridging. Bentonite base grout shall be in accordance with ASTM D 5092.
2. Neat Cement Grout: Provide neat cement grout in accordance with ASTM D 5092. Cement shall be in accordance with ASTM C 150. Quick setting admixtures shall not be allowed. Drilling mud or cuttings shall not be used as a sealing material.

F. Bottom Plugs: Provide flush threaded solid plug at the bottom of the well. Plug shall be the same material as the well casing **OR** screen to which it is attached, **as directed**. Joints shall be wrapped with fluoropolymer tape and provided with nitrile O-ring gaskets.

G. Locking Well Cap: Provide flush threaded, weatherproof, and non-removable locking well cap on the top of the well. Well cap shall be of the same material as the well casing to which it is attached. Well cap shall accommodate padlock. Provide a long shackled padlock in accordance with ASTM F 883. Provide two keys for the padlock, and turn them over to the Owner. Locks at the well site shall be keyed alike.

H. Well Head Completions: Clearly mark and secure the well to avoid unauthorized access and tampering. Cast the words "MONITORING WELL" on the well head cover. Provide a sign reading, "WELL IS FOR MONITORING AND IS NOT SAFE FOR DRINKING." Provide stamped metal identification tag as follows:

DO NOT DISTURB
ID #: Date:
Installed By:
Total Depth:
Screened Interval:
TOC Elevation:
Other:
For Information, Call:

1. Aboveground Completions: Provide protective outer casing around the well casing extending above grade. The diameter of the protective outer casing shall be a minimum of 4 in. (100 mm) larger than the well casing diameter. The top of the protective outer casing shall extend a minimum of 6 in. (150 mm) above the top of the well casing cap. The protective outer casing shall be set in cement grout and the bottom of the protective well casing shall extend below the depth of the frost line **OR** to the depth indicated, **as directed**. A 1/4 in. (6 mm) diameter weep hole shall be drilled in the protective outer casing 3 in. (75 mm) above the ground surface. The annular space between the protective outer casing and the well casing shall be filled with pea gravel or coarse sand to just below the level of the cap on the well casing. The locking well cap

shall be provided on top of the protective outer casing. Provide 6 in. (150 mm) diameter steel pipe bollards, filled with concrete as indicated to protect the exposed well head.

a. Protective Outer Casing and Bollards: ASTM A 53, Type E or S, Grade B.

b. Well Casing Cap: Provide cap on top of the protective outer casing. Cap shall be flush threaded and of the same material as the protective outer casing. Threaded joints shall be wrapped with fluoropolymer tape and provided with nitrile O-ring gaskets.

2. At-Grade Completions: Provide cast iron **OR** aluminum, **as directed**, vault box, 30 by 30 in. (750 by 750 mm) **OR** 12 in. (300 mm) diameter, **as directed**, with watertight frame and cover. Vault shall support H-20 loading for traffic areas **OR** a 100,000 lb. (45,360 kg) loading for airfield locations, **as directed**. The frame shall be 6 in. (150 mm) deep, and shall be set in a concrete collar a minimum of 8 in. (200 mm) thick, and extending 4 in. (100 mm) beyond the edge of the frame in all directions. Frame and concrete collar shall be set flush with the level of the existing pavement **OR** set 3 in. (75 mm) above the existing grade, **as directed**. Locking well cap shall be provided on top of the well casing, which will terminate inside the vault as indicated.

I. Polyethylene Sheeting: ASTM D 4397.

1.3 EXECUTION

A. General: Notify the Owner at least 15 days prior to commencement of work. Locations of wells shall be as indicated. Drilling, installation, and development of the monitoring wells shall be supervised, directed, and monitored by the CPC. Drilling, sampling, and well development equipment introduced to the well shall be decontaminated before and after each use in accordance with ASTM D 5088.

B. Drilling: Borehole shall be advanced using conventional 10 in. (250 mm) hollow-stem auger **OR** solid auger **OR** rotary wash, **as directed**, drilling methods. If it is the opinion of the CPC that an alternate drilling method is required, justification for a boring method change shall be submitted to the Owner, and approval for the change granted prior to drilling. Drill crew shall be experienced and trained in drilling and safety requirements for contaminated sites.

1. Sampling: Obtain samples in accordance with ASTM D 1586 or ASTM D 1587. Perform standard penetration tests at the following depths 0.0 to 1.5 ft (0 to 450 mm); 1.5 to 3.0 ft (450 to 900 mm); 3.0 to 4.5 ft (900 to 1350 mm); and 5 ft (1500 mm) centers or at changes in soil formation thereafter. Each soil sample shall be screened in the field with an organic vapor analyzer/flame ionization device (OVA/FID) capable of detecting vapors to a minimum of one ppm. Log boring in accordance with ASTM D 2487 and ASTM D 2488. Groundwater elevation shall be indicated.

2. Analysis: The CPC shall review the log data from each borehole and compare the data with the well design requirements. The CPC shall verify the adequacy of the well design, or shall offer a proposed modification to the design based on the geologic and hydrogeologic data obtained from the borehole. This review and analysis shall be conducted for each borehole **OR** for one borehole considered representative of the entire project, **as directed**. The CPC shall submit the borehole boring logs, the analysis of the well design, and any proposed design modifications to the Owner in a Borehole Analysis Report. Any modifications to the well design approved by the Owner shall be considered a change to the contract documents and shall be negotiated in accordance with the "CHANGES" clause.

3. Alignment: Verify that the well is straight by lowering a 10 ft (3 m) section of steel pipe 1/4 in. (6 mm) smaller in diameter than the inside diameter of the casing in to the well. For wells deeper than 200 ft (60 m), Contractor shall verify that the well is plumb.

C. Soil Removed From The Borehole

1. Temporary Containment of Soil Removed from the Borehole: Soil removed from the borehole shall be placed in a temporary containment area. Provide a temporary containment area near the well site. Cover containment area with 10 mil (0.25 mm) reinforced polyethylene sheeting. Place soil removed from the borehole[s] on the impervious barrier and cover with 6 mil (0.15 mm) reinforced polyethylene sheeting. Provide a straw bale berm around the outer limits of the

containment area and cover with polyethylene sheets. Secure edges of sheets with weights to keep the polyethylene sheeting in place. Water runoff shall be diverted from the stockpiled material. As an option, soil may be stockpiled in trucks suitable for transporting contaminated soils as specified herein.

2. Testing Requirements for Stockpiled Soils
   a. Sampling: A minimum of one composite sample shall be developed and analyzed for each required test for every 100 cu. yds. (76.4 cu. m) or fraction thereof from a composite stockpile of soil removed from all well sites. To develop a composite sample of the size necessary to run the required tests, the Contractor shall take several samples from different areas along the surface and in the center of the stockpile. These samples shall be combined and thoroughly mixed to develop the composite sample.
   b. Testing
      1) The soil shall contain no free liquid as demonstrated by EPA SW-846, Method 9095, paint filter liquids test.
      2) The sum of benzene, toluene, ethyl benzene, and xylene (BTEX) concentrations shall be determined by using EPA SW-846, Method 5030/8020.
      3) TPH (total petroleum hydrocarbons) concentrations shall be determined by using EPA SW-846, Method 8015, which has been modified for use with soil.
      4) Material shall be tested for TOX (total organic halogens) in accordance with EPA SW-846, Method 9020.
      5) Material shall be analyzed for full TCLP in accordance with EPA SW-846, Method 1311 and for ignitability, corrosivity, and reactivity.
      6) Material shall be tested for polychlorinated biphenyls (PCB's) in accordance with EPA SW-846, Method 8080.
      7) Moisture content of the sample shall be determined in accordance with EPA Method 160.3.
   c. Disposal of Stockpiled Soils
      1) Soils exhibiting TPH less than 100 ppm, BTEX less than 10 ppm, TOX less than 100 ppm, passing TCLP tests, and testing negative for PCB's shall be considered clean as shall be disposed of on-site, as directed by the Owner.
      2) Soils failing the TCLP test or exhibiting TOX greater than 100 ppm shall be managed in accordance with applicable State and local regulations. Payment for disposal of materials failing the TCLP metals test or TOX test shall be made in accordance with the "CHANGES" clause of the General Conditions.
      3) If the concentration of total BTEX is greater than 10 ppm or TPH greater than 100 ppm, the soil shall be treated and disposed of at a permitted soil recycling facility.

D. Well Installation: Well installation shall be in accordance with ASTM D 5092 and EPA 600-4-89-034, and as indicated on the well construction drawings submitted by the CPC and approved by the Owner. Borehole shall be stable and shall be verified straight before beginning installation.

1. Casings and Screens: Well casings, screens, plugs, and caps shall be decontaminated prior to delivery by the manufacturer and shall be certified clean. Materials shall be delivered, stored, and handled in such manner as to ensure that grease, oil, or other contaminants do not contact any portion of the well screen and casing assembly prior to installation. If directed by the Owner, the well screen and casing assembly shall be cleaned with high pressure water prior to installation. Personnel shall wear clean cotton or surgical gloves while handling the assembly. Centralizers shall be used to ensure that the well screen and casing assembly is installed concentrically in the borehole. When the assembly has been installed at the appropriate elevation, it shall be adequately secured to preclude movement during placement of the filter packs and annular seals. The top of the well casing shall be capped during filter pack placement.
2. Primary and Secondary Filter Packs: Primary and secondary filter packs shall be placed as indicated on the approved well construction drawings to fill the entire annular space between the screen and casing assembly and the outside wall of the borehole. Place both the primary and secondary filters with a tremie pipe in accordance with EPA 600-4-89-034 and ASTM D 5092. Placement of the primary and secondary filters by gravity or free fall methods is not allowed. Control speed of filter placement to prevent bridging and to allow for settlement. Prior to

commencement of work, equipment and methods required to place filters shall be approved by the Owner.

3. Bentonite Seal: Bentonite shall be placed as a slurry through a tremie pipe. Control speed of bentonite placement to prevent bridging or segregation of slurry. Additional water shall be added to the annular space as directed by the CPC to ensure complete hydration of the bentonite. Bentonite shall cure a minimum of 48 hours before the placement of cement grout to ensure complete hydration and expansion of the bentonite.
4. Neat Cement Grout: Cement grout shall be placed in the annular space above the bentonite seal as indicated on the well construction drawings. Cement grout shall be placed as a slurry through a tremie pipe, and injected under pressure to reduce chance of voids. Grout shall be injected in one continuous operation until full strength grout flows out at the ground surface without evidence of drilling cuttings or fluid. Cement grout shall cure a minimum of 48 hours before beginning well development operations.
5. Well Head Completions: Well head completions shall be as indicated and as specified herein.

E. Well Development: Well development shall be in accordance with EPA 600-4-89-034 and ASTM D 5092 except as modified herein. Bailing, surging, and pumping/overpumping/backwashing are acceptable development methods. Air surging and jetting are prohibited. Method of development shall be chosen by the CPC and approved by the Owner. Well development shall not begin until the well installation is complete and accepted by the Owner. Well development operations shall be conducted continuously until development water flows clear and free of drilling fluids, cuttings, or other materials. At such time representative water samples shall be tested for pH, temperature, and specific conductivity in accordance with EPA 600-4-79-20. Samples shall be taken every 3 hours. When stabilized readings of these parameters, as accepted by the Owner, have been achieved for 12 consecutive hours, well development operations shall cease.

F. Water From Well Development Operations: Water from the well development operations shall be containerized in accordance with State and local regulations. One sample shall be taken and analyzed for each required test for every 1000 gallons (3780 liters) of stored water from well development operations.

1. Testing
   a. The sum of benzene, toluene, ethyl benzene, and xylene (BTEX) concentrations shall be determined by using EPA SW-846, Method 8020.
   b. TPH (total petroleum hydrocarbons) concentrations shall be determined by using EPA SW-846, Method 8015.
2. Disposal of Containerized Water
   a. Water exhibiting TPH less than 0.5 ppm and BTEX less than 1 ppb shall be considered clean and shall be disposed of on-site as directed by the Owner.
   b. If the concentration of total BTEX is greater than 1 ppb or TPH greater than 0.5 ppm, the water shall be treated and disposed of at a permitted facility.

G. Transportation Of Contaminated Soil And Water: The Contractor shall be solely responsible for complying with Federal, State, and local requirements for transporting contaminated materials through the applicable jurisdictions and shall bear responsibility and cost for any noncompliance. In addition to those requirements, the Contractor shall do the following:

1. Inspect and document vehicles and containers for proper operation and covering.
2. Inspect vehicles and containers for proper markings, manifest documents, and other requirements for waste shipment.
3. Perform and document decontamination procedures prior to leaving the worksite and again before leaving the disposal site.

H. Disposal Of Contaminated Soil And Water: Contaminated materials removed from the site shall be disposed of in a treatment/disposal facility permitted to accept such materials.

I. Installation Survey: Upon completion of well installation and development and acceptance by the Owner therefor, the Contractor vertical and horizontal position of each well shall be determined by a registered land surveyor licensed in the State where the work is located . The survey shall document the vertical elevations of the top of the casing pipe and the ground surface elevation adjacent to each well. Survey shall be accurate to the nearest 0.01 ft (3 mm). This data shall be submitted with a well location map as the Installation Survey Report.

J. Cleanup: Upon completion of the well construction, remove debris and surplus materials from the jobsite.

END OF SECTION 23 11 23 00a

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SECTION 23 11 23 00b - FACILITY NATURAL-GAS PIPING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for facility natural gas piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Pipes, tubes, and fittings.
b. Piping specialties.
c. Piping and tubing joining materials.
d. Valves.
e. Pressure regulators.
f. Service meters.
g. Mechanical sleeve seals.
h. Grout.
i. Concrete bases.

C. Definitions
1. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
2. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
3. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Performance Requirements
1. Minimum Operating-Pressure Ratings:
a. Piping and Valves: 100 psig (690 kPa) minimum unless otherwise indicated.
b. Service Regulators: 65 psig (450 kPa) **OR** 100 psig (690 kPa), **as directed**, minimum unless otherwise indicated.
c. Minimum Operating Pressure of Service Meter: 5 psig (34.5 kPa) **OR** 10 psig (69 kPa) **OR** 20 psig (138 kPa) **OR** 65 psig (450 kPa), **as directed**.
2. Natural-Gas System Pressure within Buildings: 0.5 psig (3.45 kPa) or less **OR** More than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa) **OR** More than 2 psig (13.8 kPa) but not more than 5 psig (34.5 kPa), **as directed**.
OR
Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa), and is reduced to secondary pressure of 0.5 psig (3.45 kPa) or less.
OR
Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 2 psig (13.8 kPa) but not more than 5 psig (34.5 kPa), and is reduced to secondary pressure of more than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa).
OR
Natural-Gas System Pressures within Buildings: Three pressure ranges. Primary pressure is more than 2 psig (13.8 kPa) but not more than 5 psig (34.5 kPa), and is reduced to secondary pressures of more than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa), and is reduced again to pressures of 0.5 psig (3.45 kPa) or less.

3. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

E. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
3. Delegated-Design Submittal: For natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   a. Detail fabrication and assembly of seismic restraints.
   b. Design Calculations: Calculate requirements for selecting seismic restraints.
4. Welding certificates.
5. Field quality-control reports.
6. Operation and maintenance data.

F. Quality Assurance
1. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Delivery, Storage, And Handling
1. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
2. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
3. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
4. Protect stored PE pipes and valves from direct sunlight.

H. Project Conditions
1. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
   a. Notify Owner no fewer than two days in advance of proposed interruption of natural-gas service.
   b. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.2 PRODUCTS

A. Pipes, Tubes, And Fittings
1. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
   a. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
   b. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
   c. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.

d. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   1) Material Group: 1.1.
   2) End Connections: Threaded or butt welding to match pipe.
   3) Lapped Face: Not permitted underground.
   4) Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
   5) Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

e. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
   1) Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

f. Mechanical Couplings:
   1) Stainless-steel **OR** Steel, **as directed**, flanges and tube with epoxy finish.
   2) Buna-nitrile seals.
   3) Stainless-steel **OR** Steel, **as directed**, bolts, washers, and nuts.
   4) Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
   5) Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.

2. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.
   a. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
   b. Coating: PE with flame retardant.
      1) Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
         a) Flame-Spread Index: 25 or less.
         b) Smoke-Developed Index: 50 **OR** 450, **as directed**, or less.
   c. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
   d. Striker Plates: Steel, designed to protect tubing from penetrations.
   e. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
   f. Operating-Pressure Rating: 5 psig (34.5 kPa).

3. Aluminum Tubing: Comply with ASTM B 210 and ASTM B 241/B 241M.
   a. Aluminum Alloy: Alloy 5456 is prohibited.
   b. Protective Coating: Factory-applied coating capable of resisting corrosion on tubing in contact with masonry, plaster, insulation, water, detergents, and sewerage.
   c. Flare Fittings: Comply with ASME B16.26 and SAE J513.
      1) Copper-alloy fittings.
      2) Metal-to-metal compression seal without gasket.
      3) Dryseal threads shall comply with ASME B1.20.3.

4. Drawn-Temper Copper Tube: Comply with ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B) **OR** ASTM B 837, Type G, **as directed**.
   a. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
   b. Bronze Flanges and Flanged Fittings: ASME B16.24, Class 150.
      1) Gasket Material: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
      2) Bolts and Nuts: ASME B18.2.1, carbon steel or stainless steel.
   c. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch (0.56 mm) thick.

5. Annealed-Temper Copper Tube: Comply with ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B) **OR** ASTM B 837, Type G, **as directed**.
   a. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
   b. Flare Fittings: Comply with ASME B16.26 and SAE J513.

1) Copper fittings with long nuts.
2) Metal-to-metal compression seal without gasket.
3) Dryseal threads complying with ASME B1.20.3.

c. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch (0.56 mm) thick.

6. Tin-Lined Copper Tube: ASTM B 280, seamless, annealed, with interior tin-plated lining.

a. Flare Fittings: Comply with ASME B16.26 and SAE J513.
1) Copper fittings with long nuts.
2) Metal-to-metal compression seal without gasket.
3) Dryseal threads complying with ASME B1.20.3.

7. PE Pipe: ASTM D 2513, SDR 11.

a. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.

b. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

c. Anodeless Service-Line Risers: Factory fabricated and leak tested.
1) Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
2) Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. Vent casing aboveground, **as directed**.
3) Aboveground Portion: PE transition fitting.
4) Outlet shall be threaded or flanged or suitable for welded connection.
5) Tracer wire connection.
6) Ultraviolet shield.
7) Stake supports with factory finish to match steel pipe casing or carrier pipe.

d. Transition Service-Line Risers: Factory fabricated and leak tested.
1) Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
2) Outlet shall be threaded or flanged or suitable for welded connection.
3) Bridging sleeve over mechanical coupling.
4) Factory-connected anode.
5) Tracer wire connection.
6) Ultraviolet shield.
7) Stake supports with factory finish to match steel pipe casing or carrier pipe.

e. Plastic Mechanical Couplings, NPS 1-1/2 (DN 40) and Smaller: Capable of joining PE pipe to PE pipe.
1) PE body with molded-in, stainless-steel support ring.
2) Buna-nitrile seals.
3) Acetal collets.
4) Electro-zinc-plated steel stiffener.

f. Plastic Mechanical Couplings, NPS 2 (DN 50) and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
1) Fiber-reinforced plastic body.
2) PE body tube.
3) Buna-nitrile seals.
4) Acetal collets.
5) Stainless-steel bolts, nuts, and washers.

g. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
1) Stainless-steel **OR** Steel, **as directed**, flanges and tube with epoxy finish.
2) Buna-nitrile seals.
3) Stainless-steel **OR** Steel, **as directed**, bolts, washers, and nuts.
4) Factory-installed anode for steel-body couplings installed underground.

B. Piping Specialties
1. Appliance Flexible Connectors:
a. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
b. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
c. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
d. Corrugated stainless-steel tubing with polymer coating.
e. Operating-Pressure Rating: 0.5 psig (3.45 kPa).
f. End Fittings: Zinc-coated steel.
g. Threaded Ends: Comply with ASME B1.20.1.
h. Maximum Length: 72 inches (1830 mm).
2. Quick-Disconnect Devices: Comply with ANSI Z21.41.
a. Copper-alloy convenience outlet and matching plug connector.
b. Nitrile seals.
c. Hand operated with automatic shutoff when disconnected.
d. For indoor or outdoor applications.
e. Adjustable, retractable restraining cable.
3. Y-Pattern Strainers:
a. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
b. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
c. Strainer Screen: 40 **OR** 60, **as directed**,-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
d. CWP Rating: 125 psig (862 kPa).
4. Basket Strainers:
a. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
b. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
c. Strainer Screen: 40 **OR** 60, **as directed**,-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
d. CWP Rating: 125 psig (862 kPa).
5. T-Pattern Strainers:
a. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
b. End Connections: Grooved ends.
c. Strainer Screen: 40 **OR** 60, **as directed**,-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
d. CWP Rating: 750 psig (5170 kPa).
6. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

C. Joining Materials
1. Joint Compound and Tape: Suitable for natural gas.
2. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
3. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F (540 deg C) complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

D. Manual Gas Shutoff Valves
1. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
2. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller: Comply with ASME B16.33.
a. CWP Rating: 125 psig (862 kPa).

b. Threaded Ends: Comply with ASME B1.20.1.
c. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
d. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
e. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
f. Service Mark: Valves 1-1/4 inches (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.

3. General Requirements for Metallic Valves, NPS 2-1/2 (DN 65) and Larger: Comply with ASME B16.38.
   a. CWP Rating: 125 psig (862 kPa).
   b. Flanged Ends: Comply with ASME B16.5 for steel flanges.
   c. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   d. Service Mark: Initials "WOG" shall be permanently marked on valve body.
4. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
   a. Body: Bronze, complying with ASTM B 584.
   b. Ball: Chrome-plated brass.
   c. Stem: Bronze; blowout proof.
   d. Seats: Reinforced TFE; blowout proof.
   e. Packing: Separate packnut with adjustable-stem packing threaded ends.
   f. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   g. CWP Rating: 600 psig (4140 kPa).
   h. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   i. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
5. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
   a. Body: Bronze, complying with ASTM B 584.
   b. Ball: Chrome-plated bronze.
   c. Stem: Bronze; blowout proof.
   d. Seats: Reinforced TFE; blowout proof.
   e. Packing: Threaded-body packnut design with adjustable-stem packing.
   f. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   g. CWP Rating: 600 psig (4140 kPa).
   h. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   i. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
6. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.
   a. Body: Bronze, complying with ASTM B 584.
   b. Ball: Chrome-plated bronze.
   c. Stem: Bronze; blowout proof.
   d. Seats: Reinforced TFE.
   e. Packing: Threaded-body packnut design with adjustable-stem packing.
   f. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   g. CWP Rating: 600 psig (4140 kPa).
   h. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   i. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
7. Bronze Plug Valves: MSS SP-78.
   a. Body: Bronze, complying with ASTM B 584.
   b. Plug: Bronze.

c. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
d. Operator: Square head or lug type with tamperproof feature where indicated.
e. Pressure Class: 125 psig (862 kPa).
f. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
g. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

8. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.
   a. Body: Cast iron, complying with ASTM A 126, Class B.
   b. Plug: Bronze or nickel-plated cast iron.
   c. Seat: Coated with thermoplastic.
   d. Stem Seal: Compatible with natural gas.
   e. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   f. Operator: Square head or lug type with tamperproof feature where indicated.
   g. Pressure Class: 125 psig (862 kPa).
   h. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   i. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
9. Cast-Iron, Lubricated Plug Valves: MSS SP-78.
   a. Body: Cast iron, complying with ASTM A 126, Class B.
   b. Plug: Bronze or nickel-plated cast iron.
   c. Seat: Coated with thermoplastic.
   d. Stem Seal: Compatible with natural gas.
   e. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   f. Operator: Square head or lug type with tamperproof feature where indicated.
   g. Pressure Class: 125 psig (862 kPa).
   h. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   i. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
10. PE Ball Valves: Comply with ASME B16.40.
   a. Body: PE.
   b. Ball: PE.
   c. Stem: Acetal.
   d. Seats and Seals: Nitrile.
   e. Ends: Plain or fusible to match piping.
   f. CWP Rating: 80 psig (552 kPa).
   g. Operating Temperature: Minus 20 to plus 140 deg F (Minus 29 to plus 60 deg C).
   h. Operator: Nut or flat head for key operation.
   i. Include plastic valve extension.
   j. Include tamperproof locking feature for valves where indicated on Drawings.
11. Valve Boxes:
   a. Cast-iron, two-section box.
   b. Top section with cover with "GAS" lettering.
   c. Bottom section with base to fit over valve and barrel a minimum of 5 inches (125 mm) in diameter.
   d. Adjustable cast-iron extensions of length required for depth of bury.
   e. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

E. Motorized Gas Valves
1. Automatic Gas Valves: Comply with ANSI Z21.21.
   a. Body: Brass or aluminum.
   b. Seats and Disc: Nitrile rubber.
   c. Springs and Valve Trim: Stainless steel.

d. Normally closed.
e. Visual position indicator.
f. Electrical **OR** Mechanical, **as directed**, operator for actuation by appliance automatic shutoff device.

2. Electrically Operated Valves: Comply with UL 429.
a. Pilot operated.
b. Body: Brass or aluminum.
c. Seats and Disc: Nitrile rubber.
d. Springs and Valve Trim: Stainless steel.
e. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
f. NEMA ICS 6, Type 4, coil enclosure.
g. Normally closed.
h. Visual position indicator.

F. Earthquake Valves

1. Earthquake Valves: Comply with ASCE 25.
a. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
b. Maximum Operating Pressure: 5 psig (34.5 kPa).
c. Cast-aluminum body with nickel-plated chrome steel internal parts.
d. Nitrile-rubber valve washer.
e. Sight windows for visual indication of valve position.
f. Threaded end connections complying with ASME B1.20.1.
g. Wall mounting bracket with bubble level indicator.

2. Earthquake Valves: Comply with ASCE 25.
a. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
b. Maximum Operating Pressure: 0.5 psig (3.45 kPa) **OR** 7 psig (48 kPa) **OR** 60 psig (414 kPa), **as directed**.
c. Cast-aluminum body with stainless-steel internal parts.
d. Nitrile-rubber, reset-stem o-ring seal.
e. Valve position, open or closed, indicator.
f. Composition valve seat with clapper held by spring or magnet locking mechanism.
g. Level indicator.
h. End Connections: Threaded for valves NPS 2 (DN 50) and smaller; flanged for valves NPS 2-1/2 (DN 65) and larger.

G. Pressure Regulators

1. General Requirements:
a. Single stage and suitable for natural gas.
b. Steel jacket and corrosion-resistant components.
c. Elevation compensator.
d. End Connections: Threaded for regulators NPS 2 (DN 50) and smaller; flanged for regulators NPS 2-1/2 (DN 65) and larger.

2. Service Pressure Regulators: Comply with ANSI Z21.80.
a. Body and Diaphragm Case: Cast iron or die-cast aluminum.
b. Springs: Zinc-plated steel; interchangeable.
c. Diaphragm Plate: Zinc-plated steel.
d. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
e. Orifice: Aluminum; interchangeable.
f. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
g. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
h. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
i. Overpressure Protection Device: Factory mounted on pressure regulator.

j. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
k. Maximum Inlet Pressure: 100 psig (690 kPa).

3. Line Pressure Regulators: Comply with ANSI Z21.80.
a. Body and Diaphragm Case: Cast iron or die-cast aluminum.
b. Springs: Zinc-plated steel; interchangeable.
c. Diaphragm Plate: Zinc-plated steel.
d. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
e. Orifice: Aluminum; interchangeable.
f. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
g. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
h. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
i. Overpressure Protection Device: Factory mounted on pressure regulator.
j. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
k. Maximum Inlet Pressure: 2 psig (13.8 kPa) **OR** 5 psig (34.5 kPa) **OR** 10 psig (69 kPa), **as directed**.

4. Appliance Pressure Regulators: Comply with ANSI Z21.18.
a. Body and Diaphragm Case: Die-cast aluminum.
b. Springs: Zinc-plated steel; interchangeable.
c. Diaphragm Plate: Zinc-plated steel.
d. Seat Disc: Nitrile rubber.
e. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
f. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
g. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
h. Maximum Inlet Pressure: 1 psig (6.9 kPa) **OR** 2 psig (13.8 kPa) **OR** 5 psig (34.5 kPa), **as directed**.

H. Service Meters

1. Diaphragm-Type Service Meters: Comply with ANSI B109.1 **OR** ANSI B109.2, **as directed**.
a. Case: Die-cast aluminum.
b. Connections: Steel threads.
c. Diaphragm: Synthetic fabric.
d. Diaphragm Support Bearings: Self-lubricating.
e. Compensation: Continuous temperature and pressure, **as directed**.
f. Meter Index: Cubic feet **OR** Liters **OR** Cubic feet and liters, **as directed**.
g. Meter Case and Index: Tamper resistant.
h. Remote meter reader compatible.
i. Maximum Inlet Pressure: 100 psig (690 kPa).
j. Pressure Loss: Maximum 0.5-inch wg (124 Pa) **OR** 2.0-inch wg (498 Pa), **as directed**.
k. Accuracy: Maximum plus or minus 1.0 percent.

2. Rotary-Type Service Meters: Comply with ANSI B109.3.
a. Case: Extruded aluminum.
b. Connection: Flange.
c. Impellers: Polished aluminum.
d. Rotor Bearings: Self-lubricating.
e. Compensation: Continuous temperature and pressure, **as directed**.
f. Meter Index: Cubic feet **OR** Liters **OR** Cubic feet and liters, **as directed**.
g. Tamper resistant.
h. Remote meter reader compatible.
i. Maximum Inlet Pressure: 100 psig (690 kPa).
j. Accuracy: Maximum plus or minus 2.0 percent.

3. Turbine Meters: Comply with ASME MFC-4M.
   a. Housing: Cast iron or welded steel.
   b. Connection Threads or Flanges: Steel.
   c. Turbine: Aluminum or plastic.
   d. Turbine Bearings: Self-lubricating.
   e. Compensation: Continuous temperature and pressure, **as directed**.
   f. Meter Index: Cubic feet **OR** Liters **OR** Cubic feet and liters, **as directed**.
   g. Tamper resistant.
   h. Remote meter reader compatible.
   i. Maximum Inlet Pressure: 100 psig (690 kPa).
   j. Accuracy: Maximum plus or minus 2.0 percent.
4. Service-Meter Bars:
   a. Malleable- or cast-iron frame for supporting service meter.
   b. Include offset swivel pipes, meter nuts with o-ring seal, and factory- or field-installed dielectric unions.
   c. Omit meter offset swivel pipes if service-meter bar dimensions match service-meter connections.
5. Service-Meter Bypass Fittings:
   a. Ferrous, tee, pipe fitting with capped side inlet for temporary natural-gas supply.
   b. Integral ball-check bypass valve.

I. Dielectric Fittings
1. Dielectric Unions:
   a. Minimum Operating-Pressure Rating: 150 psig (1034 kPa).
   b. Combination fitting of copper alloy and ferrous materials.
   c. Insulating materials suitable for natural gas.
   d. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.
2. Dielectric Flanges:
   a. Minimum Operating-Pressure Rating: 150 psig (1034 kPa).
   b. Combination fitting of copper alloy and ferrous materials.
   c. Insulating materials suitable for natural gas.
   d. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.
3. Dielectric-Flange Kits:
   a. Minimum Operating-Pressure Rating: 150 psig (1034 kPa).
   b. Companion-flange assembly for field assembly.
   c. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or PE bolt sleeves, phenolic washers, and steel backing washers.
   d. Insulating materials suitable for natural gas.
   e. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

J. Sleeves
1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

K. Mechanical Sleeve Seals
1. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   a. Sealing Elements: EPDM **OR** NBR, **as directed**, interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
   b. Pressure Plates: Plastic **OR** Carbon steel **OR** Stainless steel, **as directed**.

c. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating **OR** Stainless steel, **as directed**, of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

L. Escutcheons
1. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to fit around pipe or tube, and OD that completely covers opening.
2. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.
3. One-Piece, Cast-Brass Escutcheons: With set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass, **as directed**.
4. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass, **as directed**.
5. One-Piece, Stamped-Steel Escutcheons: With set screw **OR** spring clips, **as directed**, and chrome-plated finish.
6. Split-Plate, Stamped-Steel Escutcheons: With concealed **OR** exposed-rivet, **as directed**, hinge, set screw **OR** spring clips, **as directed**, and chrome-plated finish.
7. One-Piece, Floor-Plate Escutcheons: Cast-iron floor plate.
8. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

M. Grout
1. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   a. Characteristics: Post-hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   b. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
   c. Packaging: Premixed and factory packaged.

N. Labeling And Identifying
1. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored yellow.

1.3 EXECUTION

A. Preparation
1. Close equipment shutoff valves before turning off natural gas to premises or piping section.
2. Inspect natural-gas piping according to NFPA 54 **OR** the International Fuel Gas Code, **as directed**, to determine that natural-gas utilization devices are turned off in piping section affected.
3. Comply with NFPA 54 **OR** the International Fuel Gas Code, **as directed**, requirements for prevention of accidental ignition.

B. Outdoor Piping Installation
1. Comply with NFPA 54 **OR** the International Fuel Gas Code, **as directed**, for installation and purging of natural-gas piping.
2. Install underground, natural-gas piping buried at least 36 inches (900 mm) below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.
   a. If natural-gas piping is installed less than 36 inches (900 mm) below finished grade, install it in containment conduit.
3. Install underground, PE, natural-gas piping according to ASTM D 2774.
4. Steel Piping with Protective Coating:
   a. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.

b. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
OR
Replace pipe having damaged PE coating with new pipe.

5. Copper Tubing with Protective Coating:
   a. Apply joint cover kits over tubing to cover, seal, and protect joints.
   b. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
6. Install fittings for changes in direction and branch connections.
7. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   a. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
   b. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
8. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
9. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
10. Install pressure gage downstream **OR** upstream and downstream, **as directed**, from each service regulator. Pressure gages are specified in Division 23 Section "Meters And Gages For Hvac Piping".

C. Indoor Piping Installation

1. Comply with NFPA 54 **OR** the International Fuel Gas Code, **as directed**, for installation and purging of natural-gas piping.
2. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
3. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
4. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
5. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
6. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
7. Locate valves for easy access.
8. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
9. Install piping free of sags and bends.
10. Install fittings for changes in direction and branch connections.
11. Install escutcheons at penetrations of interior walls, ceilings, and floors.
    a. New Piping:
       1) Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
       2) Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
       OR
       Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
       3) Piping at Ceiling Penetrations in Finished Spaces: One-piece **OR** Split-casting, **as directed**, cast-brass type with polished chrome-plated finish.
       OR

Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type **OR** Split-plate, stamped-steel type with concealed hinge, **as directed**, and set screw.

4) Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated **OR** rough-brass, **as directed**, finish.
OR
Piping in Unfinished Service Spaces: One-piece, stamped-steel type with set screw **OR** spring clips, **as directed**.

5) Piping in Equipment Rooms: One-piece, cast-brass type.

Piping in Equipment Rooms: One-piece, stamped-steel type with set screw **OR** spring clips, **as directed**.

6) Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

b. Existing Piping:

1) Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
OR
Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.

2) Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
OR
Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.

3) Piping in Unfinished Service Spaces: Split-casting, cast-brass type with polished chrome-plated **OR** rough-brass, **as directed**, finish.
OR
Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and set screw or spring clips.

4) Piping in Equipment Rooms: Split-casting, cast-brass type.
OR
Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.

5) Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

12. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping".
13. Verify final equipment locations for roughing-in.
14. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
15. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
    a. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
16. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
17. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
18. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

a. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.

b. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches (38 mm) of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.

c. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.

d. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
   1) Exception: Tubing passing through partitions or walls does not require striker barriers.

e. Prohibited Locations:
   1) Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
   2) Do not install natural-gas piping in solid walls or partitions.

19. Use concentric reducer fittings to make reductions in pipe sizes.
20. Connect branch piping from top or side of horizontal piping.
21. Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
22. Do not use natural-gas piping as grounding electrode.
23. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
24. Install pressure gage downstream **OR** upstream and downstream, **as directed**, from each line regulator. Pressure gages are specified in Division 23 Section "Meters And Gages For Hvac Piping".

D. Service-Meter Assembly Installation
1. Install service-meter assemblies aboveground, on concrete bases.
2. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.
3. Install strainer on inlet of service-pressure regulator and meter set.
4. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.
5. Install metal shutoff valves upstream from service meters. Install dielectric fittings downstream from service meters.
6. Install service meters downstream from pressure regulators.
7. Install metal bollards to protect meter assemblies. Comply with requirements in Division 05 Section "Metal Fabrications" for pipe bollards.

E. Valve Installation
1. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
2. Install underground valves with valve boxes.
3. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
4. Install earthquake valves aboveground outside buildings according to listing.
5. Install anode for metallic valves in underground PE piping.

F. Piping Joint Construction
1. Ream ends of pipes and tubes and remove burrs.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Threaded Joints:

a. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
b. Cut threads full and clean using sharp dies.
c. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
d. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
e. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

4. Welded Joints:
   a. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
   b. Bevel plain ends of steel pipe.
   c. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
5. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
6. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
7. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.
8. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
   a. Plain-End Pipe and Fittings: Use butt fusion.
   b. Plain-End Pipe and Socket Fittings: Use socket fusion.

G. Hanger And Support Installation
1. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
2. Comply with requirements for pipe hangers and supports specified in Division 23 Section "Hangers And Supports For Hvac Piping And Equipment".
3. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
   a. NPS 1 (DN 25) and Smaller: Maximum span, 96 inches (2438 mm); minimum rod size, 3/8 inch (10 mm).
   b. NPS 1-1/4 (DN 32): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
   c. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
   d. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): Maximum span, 10 feet (3 m); minimum rod size, 1/2 inch (13 mm).
   e. NPS 4 (DN 100) and Larger: Maximum span, 10 feet (3 m); minimum rod size, 5/8 inch (15.8 mm).
4. Install hangers for horizontal drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:
   a. NPS 3/8 (DN 10): Maximum span, 48 inches (1220 mm); minimum rod size, 3/8 inch (10 mm).
   b. NPS 1/2 and NPS 5/8 (DN 15 and DN 18): Maximum span, 72 inches (1830 mm); minimum rod size, 3/8 inch (10 mm).
   c. NPS 3/4 and NPS 7/8 (DN 20 and DN 22): Maximum span, 84 inches (2134 mm); minimum rod size, 3/8 inch (10 mm).
   d. NPS 1 (DN 25): Maximum span, 96 inches (2440 mm); minimum rod size, 3/8 inch (10 mm).
5. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:
   a. NPS 3/8 (DN 10): Maximum span, 48 inches (1220 mm); minimum rod size, 3/8 inch (10 mm).

b. NPS 1/2 (DN 15): Maximum span, 72 inches (1830 mm); minimum rod size, 3/8 inch (10 mm).
c. NPS 3/4 (DN 20) and Larger: Maximum span, 96 inches (2440 mm); minimum rod size, 3/8 inch (10 mm).

H. Connections
1. Connect to utility's gas main according to utility's procedures and requirements.
2. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
3. Install piping adjacent to appliances to allow service and maintenance of appliances.
4. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches (1800 mm) of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
5. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

I. Labeling And Identifying
1. Comply with requirements in Division 23 Section "Identification For Hvac Piping And Equipment" for piping and valve identification.
OR
Install detectable warning tape directly above gas piping, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

J. Painting
1. Comply with requirements in Division 07 for painting interior and exterior natural-gas piping.
2. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
   a. Alkyd System: MPI EXT 5.1D.
      1) Prime Coat: Alkyd anticorrosive metal primer.
      2) Intermediate Coat (for a Premium Grade system): Exterior alkyd enamel matching topcoat.
      3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
      4) Color: Gray, **unless directed otherwise**.
3. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
   a. Latex Over Alkyd Primer System: MPI INT 5.1Q.
      1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
      2) Intermediate Coat (for a Premium Grade system): Interior latex matching topcoat.
      3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
      4) Color: Gray, **unless directed otherwise**.
   b. Alkyd System: MPI INT 5.1E.
      1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
      2) Intermediate Coat (for a Premium Grade system): Interior alkyd matching topcoat.
      3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
      4) Color: Gray, **unless directed otherwise**.
4. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

K. Concrete Bases
1. Concrete Bases: Anchor equipment to concrete base according to seismic codes at Project.
   a. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.

b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
c. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
d. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
e. Install anchor bolts to elevations required for proper attachment to supported equipment.
f. Use 3000-psig (20.7-MPa), **unless directed otherwise**, 28-day, compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-place Concrete".

L. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
a. Test, inspect, and purge natural gas according to NFPA 54 **OR** the International Fuel Gas Code, **as directed**, and authorities having jurisdiction.
3. Natural-gas piping will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

M. Outdoor Piping Schedule
1. Underground natural-gas piping shall be one of the following:
a. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
b. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
c. Annealed **OR** Drawn, **as directed**,-temper copper tube with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
2. Aboveground natural-gas piping shall be one of the following:
a. Steel pipe with malleable-iron fittings and threaded joints.
b. Steel pipe with wrought-steel fittings and welded joints.
c. Annealed **OR** Drawn, **as directed**,-temper copper tube with wrought-copper fittings and brazed joints.
3. Branch Piping in Cast-in-Place Concrete to Single Appliance: Annealed-temper copper tube with wrought-copper fittings and brazed **OR** flared, **as directed**, joints. Install piping embedded in concrete with no joints in concrete.
4. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

N. Indoor Piping Schedule For System Pressures Less Than 0.5 psig (3.45 kPa)
1. Aboveground, branch piping NPS 1 (DN 25) and smaller shall be one of the following:
a. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
b. Annealed-temper, tin-lined copper tube with flared joints and fittings.
c. Annealed-temper, copper tube with wrought-copper fittings and brazed **OR** flared, **as directed**, joints.
d. Aluminum tube with flared fittings and joints.
e. Steel pipe with malleable-iron fittings and threaded joints.
2. Aboveground, distribution piping shall be one of the following:
a. Steel pipe with malleable-iron fittings and threaded joints.
b. Steel pipe with wrought-steel fittings and welded joints.
c. Drawn-temper copper tube with wrought-copper fittings and brazed joints.
3. Underground, below building, piping shall be one of the following:
a. Steel pipe with malleable-iron fittings and threaded joints.
b. Steel pipe with wrought-steel fittings and welded joints.
4. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

5. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

O. Indoor Piping Schedule For System Pressures More Than 0.5 psig (3.45 kPa) And Less Than 5 psig (34.5 kPa)
  1. Aboveground, branch piping NPS 1 (DN 25) and smaller shall be one of the following:
     a. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
     b. Annealed-temper, tin-lined copper tube with flared joints and fittings.
     c. Annealed-temper, copper tube with wrought-copper fittings and brazed **OR** flared, **as directed**, joints.
     d. Aluminum tube with flared fittings and joints.
     e. Steel pipe with malleable-iron fittings and threaded joints.
  2. Aboveground, distribution piping shall be one of the following:
     a. Steel pipe with malleable-iron fittings and threaded joints.
     b. Steel pipe with steel welding fittings and welded joints.
     c. Drawn-temper copper tube with wrought-copper fittings and brazed joints.
  3. Underground, below building, piping shall be one of the following:
     a. Steel pipe with malleable-iron fittings and threaded joints.
     b. Steel pipe with wrought-steel fittings and welded joints.
  4. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.
  5. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

P. Indoor Piping Schedule For System Pressures More Than 5 psig (34.5 kPa)
  1. Aboveground Piping: Maximum operating pressure more than 5 psig (34.5 kPa).
  2. Aboveground, Branch Piping: Steel pipe with steel welding fittings and welded joints.
  3. Aboveground, distribution piping shall be one of the following:
     a. Steel pipe with steel welding fittings and welded joints.
     b. Drawn-temper copper tube with wrought-copper fittings and brazed joints.
  4. Underground, below building, piping shall be one of the following:
     a. Steel pipe with malleable-iron fittings and threaded joints.
     b. Steel pipe with wrought-steel fittings and welded joints.
  5. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
  6. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

Q. Underground Manual Gas Shutoff Valve Schedule
  1. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.
  2. Underground:
     a. PE valves.
     b. NPS 2 (DN 50) and Smaller: Bronze plug valves.
     c. NPS 2-1/2 (DN 65) and Larger: Cast-iron, lubricated **OR** nonlubricated, **as directed**, plug valves.

R. Aboveground Manual Gas Shutoff Valve Schedule
  1. Valves for pipe sizes NPS 2 (DN 50) and smaller at service meter shall be one of the following:
     a. One-piece, bronze ball valve with bronze trim.
     b. Two-piece, full **OR** regular, **as directed**,-port, bronze ball valves with bronze trim.

c. Bronze plug valve.

2. Valves for pipe sizes NPS 2-1/2 (DN 65) and larger at service meter shall be one of the following:
   a. Two-piece, full **OR** regular, **as directed**,-port, bronze ball valves with bronze trim.
   b. Bronze plug valve.
   c. Cast-iron, nonlubricated plug valve.
3. Distribution piping valves for pipe sizes NPS 2 (DN 50) and smaller shall be one of the following:
   a. One-piece, bronze ball valve with bronze trim.
   b. Two-piece, full **OR** regular, **as directed**,-port, bronze ball valves with bronze trim.
   c. Bronze plug valve.
4. Distribution piping valves for pipe sizes NPS 2-1/2 (DN 65) and larger shall be one of the following:
   a. Two-piece, full **OR** regular, **as directed**,-port, bronze ball valves with bronze trim.
   b. Bronze plug valve.
   c. Cast-iron, nonlubricated **OR** lubricated, **as directed**, plug valve.
5. Valves in branch piping for single appliance shall be one of the following:
   a. One-piece, bronze ball valve with bronze trim.
   b. Two-piece, full **OR** regular, **as directed**,-port, bronze ball valves with bronze trim.
   c. Bronze plug valve.

END OF SECTION 23 11 23 00b

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SECTION 23 11 23 00c - FACILITY LIQUEFIED-PETROLEUM GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes LPG distribution pipe, fittings, related components, and appurtenances that convey liquefied-petroleum gas (LPG) in its vapor phase from point of connection with existing or new storage container, or from utility service main to building service.

B. Products include the following:

1. Steel pipe and fittings.
2. CSST and fittings.
3. Aluminum tubing and fittings.
4. Copper tubing and fittings.
5. PE pipe, tubing, and fittings.
6. Polyamide pipe, tubing, and fittings.
7. Mechanical couplings.
8. Piping specialties.
9. Valves.
10. Pressure regulators.
11. Service meters.
12. Dielectric fittings.
13. Storage containers.
14. Vaporizers.

1.2 DEFINITIONS

A. CSST: Corrugated stainless steel tubing.

B. CWP: Cold working pressure.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

E. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

F. LPG: Liquefied-petroleum gas.

G. PE: Polyethylene.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Piping specialties.
2. CSST with associated components.
3. Valves: Include pressure rating, capacity, settings, and electrical connection data of selected models.
4. Pressure Regulators: Indicate pressure ratings and capacities.
5. Service Meters: Indicate pressure ratings and capacities. Include bypass fittings, meter bars, and supports.
6. Dielectric fittings.
7. Storage containers.
8. Transport truck-unloading specialties.
9. Vaporizers.

B. Shop Drawings: Provide plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawings Scale: [**1/4 inch per foot (1:50)**] <**Insert scale**>.
2. Detail mounting, supports, and valve arrangements for service meter assembly and pressure regulator assembly.

C. Delegated Design Submittals: Comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of seismic restraints.
2. Design Calculations: Calculate requirements for selecting seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and details, drawn to scale, on which LPG piping is indicated and coordinated with other installations, using input from installers of the items involved.

B. Site Survey: Plans, drawn to scale, on which LPG piping is shown and coordinated with other services and utilities.

C. Seismic Qualification Data: Submit certification that vaporizer, air mixer, storage container supports, accessories, and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Certificates:

1. Welding certificates.

E. Field Quality-Control Submittals:

1. Field quality-control reports.

F. Qualification Statements: For professional engineer.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For LPG equipment and accessories.

1.6 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators in accordance with ASME BVPC.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing LPG piping according to requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store pipes and tubes with protective PE coating to avoid damaging coating and protect from direct sunlight.

D. Protect stored PE pipes, tubing, and valves from direct sunlight.

1.8 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Interruption of Existing LPG Service: Do not interrupt LPG service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of LPG supply according to requirements indicated:

1. Notify [**Architect**] [**Construction Manager**] [**Owner**] no fewer than [**two**] <**Insert number**> days in advance of proposed interruption of LPG service.
2. Do not proceed with interruption of LPG service without [**Architect's**] [**Construction Manager's**] [**Owner's**] written permission.

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Section 083113 "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each product type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Comply with requirements of NFPA 58[**, and**] [**, NFPA 54**] [**, and**] [**, the International Fuel Gas Code**] for LPG distribution system, including materials, installation, and testing.

B. Comply with requirements of authorities having jurisdiction.

C. Comply with requirements of utility company supplying LPG.

D. Minimum Operating-Pressure Ratings:

1. Minimum Operating Pressure for Piping and Valves: [**125 psig (862 kPa)**] <**Insert pressure**> unless otherwise indicated.
2. Minimum Operating Pressure of Service Meter: [**5 psig (34.5 kPa)**] [**10 psig (69 kPa)**] [**20 psig (138 kPa)**] [**65 psig (450 kPa)**] <**Insert pressure**>.

E. LPG System Pressure within Buildings:

1. System Pressure within Buildings, One Pressure Range: [**0.5 psig (3.45 kPa) or less**] [**More than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa)**] [**More than 2 psig (13.8 kPa) but not more than 5 psig (34.5 kPa)**].
2. System Pressure within Buildings, Two Pressure Ranges, Not More Than 2 psig (13.8 kPa): Primary pressure is more than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa) and is reduced to secondary pressure of 0.5 psig (3.45 kPa) or less.
3. System Pressure within Buildings, Two Pressure Ranges, Not More Than 5 psig (34.5 kPa): Primary pressure is more than 2 psig (13.8 kPa) but not more than 5 psig (34.5 kPa) and is reduced to secondary pressure of more than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa).
4. System Pressure within Buildings, Three Pressure Ranges: Primary pressure is more than 2 psig (13.8 kPa) but not more than 5 psig (34.5 kPa), is reduced to secondary pressures of more than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa), and is reduced again to pressures of 0.5 psig (3.45 kPa) or less.

F. Delegated Design: Design restraints and anchors for LPG piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

H. Seismic Performance: Vaporizers and storage container supports are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**] <**Insert requirement**>. See Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

1. The term "withstand" means "the piping/unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the piping system will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**] [**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.3 PIPE, TUBING, AND FITTINGS

A. Steel Pipe and Fittings:

1. Steel Pipe: ASTM A53/A53M black steel, Schedules 40 and 80, Type E or S, Grade B.
2. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
3. Wrought-Steel Welding Fittings: ASTM A234/A234M for butt welding and socket welding.
4. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
5. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

   a. Material Group: 1.1.
   b. End Connections: Threaded or butt welding to match pipe.
   c. Lapped Face: Not permitted underground.
   d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
   e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground, and stainless steel underground.

6. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

   a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

B. CSST and Fittings:

1. CSST:

   a. <u><Double click here to find, evaluate, and insert list of manufacturers and products.></u>

   b. Standard: ANSI LC 1/CSA 6.26.
   c. Tubing: ASTM A240/A240M, corrugated, Series 300 stainless steel.
   d. Jacket - Electrically Insulative and UV-Resistant Polymer with Flame Retardant:

      1) Surface-Burning Characteristics: As determined by testing identical products in accordance with ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

         a) Flame-Spread Index: [**25**] <**Insert value**> or less.
         b) Smoke-Developed Index: [**50**] [**450**] <**Insert value**> or less.

   e. Jacket - with Fully Vent-Capable PE Sleeve: Include associated fittings suitable for locations requiring vented containment.

2. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with CSST and suitable for metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.

3. Striker Plates: Steel, designed to protect tubing from penetrations.
4. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections are to comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
5. Operating-Pressure Rating: 25 psig (172 kPa).

C. Aluminum Tubing and Fittings:

1. Aluminum Tubing: ASTM B210/B210M and ASTM B241/B241M.

   a. Material: Aluminum Alloy 5456 is prohibited.

2. Flare Fittings: Comply with ASME B16.26 and SAE J513.

   a. Copper-alloy fittings.
   b. Metal-to-metal compression seal without gasket.
   c. Dryseal threads are to comply with ASME B1.20.3.

3. Protective Coating: Factory-applied coating suitable for resisting corrosion on tubing in contact with masonry, plaster, insulation, water, detergents, and sewerage.

D. Copper Tubing and Fittings:

1. Drawn-Temper Copper Tube: [**ASTM B88, Type K (ASTM B88M, Type A)**] [**ASTM B88, Type L (ASTM B88M, Type B)**] [**ASTM B837, Type G**].
2. Annealed-Temper Copper Tube: [**ASTM B88, Type K (ASTM B88M, Type A)**] [**ASTM B88, Type L (ASTM B88M, Type B)**] [**ASTM B837, Type G**].
3. Tin-Lined Copper Tube: ASTM B280, seamless, annealed, with interior tin-plated lining.
4. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
5. Bronze Flanges and Flanged Fittings: ASME B16.24, Class 150.

   a. Gasket Material: ASME B16.20, metallic, flat, asbestos-free, aluminum o-rings and spiral-wound metal gaskets.

6. Bolts and Nuts: ASME B18.2.1, carbon steel or stainless steel.
7. Flare Fittings: ASME B16.26 and SAE J513.

   a. Copper fittings with long nuts.
   b. Metal-to-metal compression seal without gasket.
   c. Dryseal threads complying with ASME B1.20.3.
8. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch (0.56 mm) thick.

E. PE Pipe, Tubing, and Fittings:

1. PE Pipe and Tubing: ASTM D2513, SDR 11.
2. PE Fittings: ASTM D2683, socket-fusion type or ASTM D3261, butt-fusion type.
3. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D2513, SDR 11, and steel pipe complying with ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
4. Anodeless Service-Line Risers: Factory fabricated and leak tested.

   a. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet.
   b. Casing: Steel pipe complying with ASTM A53/A53M, Schedule 40, black steel, Type E or S, Grade B with corrosion-protective coating covering.[**Vent casing aboveground.**]
   c. Aboveground Portion: PE transition fitting.

d. Outlet is to be threaded or flanged or suitable for welded connection.
e. Tracer wire connection.
f. Ultraviolet shield.
g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

5. Transition Service-Line Risers: Factory fabricated and leak tested.

a. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet connected to steel pipe complying with ASTM A53/A53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
b. Outlet is to be threaded or flanged or suitable for welded connection.
c. Bridging sleeve over mechanical coupling.
d. Factory-connected anode.
e. Tracer wire connection.
f. Ultraviolet shield.
g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

F. Polyamide Pipe, Tubing, and Fittings:

1. Polyamide pipe, tubing, and fittings: ASTM F2945.

2.4 COUPLINGS

A. Plastic Mechanical Couplings, NPS 1-1/2 (DN 40) and Smaller:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Standard: ASTM D2513.
3. PE body.
4. Elastomeric seals.
5. Independent gripping collets.
6. Couplings are suitable for joining PE pipe to PE pipe.

B. Plastic Mechanical Couplings, NPS 2 (DN 50) and Larger:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Standard: ASTM D2513.
3. Plastic body.
4. Body tube.
5. Seals.
6. Collets.
7. Stainless steel bolts, nuts, and washers.
8. Couplings are to be suitable for joining PE pipe to PE pipe, or steel pipe to PE pipe.

C. Steel Mechanical Couplings:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. [**Stainless steel**] [**Steel**] flanges and tube with epoxy finish.
3. Buna-nitrile seals.
4. [**Stainless steel**] [**Steel**] bolts, washers, and nuts.
5. Factory-installed anode for steel-body couplings installed underground.
6. Couplings are to be suitable for joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

2.5 PIPING SPECIALTIES

A. Flexible Piping Joints:

1. Approved for LPG service.
2. Stainless steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
3. Minimum working pressure of 250 psig (1723 kPa) and 250 deg F (121 deg C) operating temperature.
4. Flanged- or threaded-end connections to match equipment connected and to be capable of minimum 3/4-inch (20-mm) misalignment.
5. Maximum 36-inch (914-mm) length for liquid LPG lines.

B. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: ANSI Z21.75.
4. CSST with polymer coating.
5. Operating-Pressure Rating: 0.5 psig (3.45 kPa).
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: ASME B1.20.1.
8. Maximum Length: 72 inches (1830 mm).

C. Quick-Disconnect Devices:

1. Standard: ANSI Z21.41/CSA 6.9.
2. Copper-alloy convenience outlet and matching plug connector.
3. Nitrile seals.
4. Hand operated with automatic shutoff when disconnected.
5. For indoor or outdoor applications.
6. Adjustable, retractable restraining cable.

D. Y-Pattern Strainers:

1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: [**40**] [**60**]-mesh startup strainer and perforated stainless steel basket with 50 percent free area.
4. CWP Rating: 125 psig (862 kPa).

E. Basket Strainers:

1. Body: ASTM A126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: [**40**] [**60**]-mesh startup strainer and perforated stainless steel basket with 50 percent free area.
4. CWP Rating: 125 psig (862 kPa).

F. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.

3. Strainer Screen: [**40**] [**60**]-mesh startup strainer and perforated stainless steel basket with 57 percent free area.
4. CWP Rating: 750 psig (5170 kPa).

G. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.6 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for LPG.

B. Welding Filler Metals: AWS D10.12/D10.12M.

C. Brazing Filler Metals: AWS A5.8/A5.8M alloy with melting point greater than 1000 deg F (540 deg C).

2.7 MANUAL GAS SHUTOFF VALVES

A. Manual Gas Shutoff Valves - Metallic:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Description: Metallic ball valve or metallic plug valve of type indicated in schedules under Part 3.
3. Standards:

    a. ANSI Z21.15/CSA 9.1.
    b. ASME B16.33.
    c. ASME B16.44.
    d. ANSI LC 4/CSA 6.32.

4. System Pressure Rating: [**0.5 psig (3.45 kPa) or less**] [**More than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa)**] [**More than 2 psig (13.8 kPa) but not more than 5 psig (34.5 kPa)**] [**More than 5 psig (34.5 kPa) but not more than 125 psig (862 kPa)**] <**Insert pressure**>.

5. End Connections:

    a. Threaded Ends: ASME B1.20.1.
    b. Dryseal Threads on Flare Ends: ASME B1.20.3.
    c. Flanged Ends: ASME B16.5 for steel flanges.
6. Tamperproof locking feature.

B. Manual Gas Shutoff Ball Valves - PE:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Standard: ASME B16.40.
3. Body: PE.
4. Ball: Polypropylene.
5. Stem: Acetal.
6. Seats and Seals: NBR.
7. Ends: Plain or fusible to match piping.
8. CWP Rating: [**80 psig (552 kPa)**] <**Insert pressure**>.
9. Operating Temperature: [**Minus 20 to plus 140 deg F (Minus 29 to plus 60 deg C)**] <**Insert temperature range**>.

10. Operator: Nut or flat head for key operation.
11. Plastic valve extension.
12. Tamperproof locking feature.

C. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches (125 mm) in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head and with stem of length required to operate valve.

2.8 MOTORIZED GAS VALVES

A. Hydrostatic Relief Valves:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Standard: NFPA 58.
3. Operating Pressure: [**350 psig (2413 kPa)**] <**Insert pressure**>.
4. Body: Brass.
5. Spring: Stainless steel.
6. Disc and Seat: NBR.
7. Brass body and stainless steel, spring-operated valve with resilient rubber disc seat and protective cap.
8. Factory set and tested.
9. Valve is to reseat after relieving pressure.

B. Electrically Operated Automatic Gas Valves:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Standards:

   a. ANSI Z21.21.
   b. UL 429.
   c. FM Global approved.

3. Pilot operated.
4. Body: Brass or aluminum.
5. Seats and Disc: Nitrile rubber.
6. Springs and Valve Trim: Stainless steel.
7. Coil: Continuous-duty, molded enclosure, replaceable.
8. Normally closed.
9. Visual position indicator.
10. Electrical Characteristics: [**120 V ac, 60 Hz**] [**24 V ac, 60 Hz**] [**24 V dc**] <**Insert value**>.

2.9 EARTHQUAKE VALVES

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Seismically activated automatic gas shutoff valve.

C. Standard: ASCE/SEI 25.

D. Maximum Operating Pressure: [**10 psig (69 kPa)**] [**60 psig (414 kPa)**] <**Insert pressure**>.

E. Sight windows for visual indication of valve position.

F. Threaded complying with ASME B1.20.1.

G. Threaded for valves NPS 4 (DN 100) and smaller; or flanged for valves NPS 2 (DN 50) and larger.

2.10 PRESSURE REGULATORS

A. Service Pressure Regulators:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Standards:

    a. NFPA 58.
    b. ANSI Z21.80/CSA 6.22.

3. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet and no pressure-sensing piping external to the regulator.
4. Pressure regulator is to maintain discharge pressure-setting downstream and is not to exceed 150 percent of design discharge pressure at shutoff.
5. Maximum Inlet Pressure: [**100 psig (690 kPa)**] <**Insert pressure**>.
6. Maximum Outlet Pressure: [**2 psig (13.8 kPa)**] [**5 psig (34.5 kPa)**] [**10 psig (69 kPa)**] [**20 psig (138 kPa)**] <**Insert pressure**>.
7. End Connections: Threaded for regulators NPS 2 (DN 50) and smaller; flanged for regulators NPS 2-1/2 (DN 65) and larger.
8. Overpressure Protection Device: Factory mounted on pressure regulator.
9. Atmospheric Vent: Factory- or field-installed, stainless steel screen in opening if not connected to vent piping.

B. Line-Pressure Regulators:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Standards:

    a. NFPA 58.
    b. ANSI Z21.80/CSA 6.22.

3. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet and no pressure-sensing piping external to the regulator.
4. Pressure regulator is to maintain discharge pressure-setting downstream and is not exceed 150 percent of design discharge pressure at shutoff.
5. Maximum Inlet Pressure: [**2 psig (13.8 kPa)**] [**5 psig (34.5 kPa)**] [**10 psig (69 kPa)**] <**Insert pressure**>.
6. Maximum Outlet Pressure: [**2 psig (13.8 kPa)**] [**5 psig (34.5 kPa)**] <**Insert pressure**>.
7. End Connections: Threaded for regulators NPS 2 (DN 50) and smaller; flanged for regulators NPS 2-1/2 (DN 65) and larger.

8. Overpressure Protection Device: Factory mounted on pressure regulator.
9. Atmospheric Vent: Factory- or field-installed, stainless steel screen in opening if not connected to vent piping.

C. Appliance Pressure Regulators:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Standards:

a. NFPA 58.
b. ANSI Z21.18/CSA 6.3.

3. Regulator may include vent-limiting device, instead of vent connection, if approved by authorities having jurisdiction.
4. Maximum Inlet Pressure: [**1 psig (6.9 kPa)**] [**2 psig (13.8 kPa)**] [**5 psig (34.5 kPa)**] <**Insert pressure**>.
5. Maximum Outlet Pressure: [**1 psig (6.9 kPa)**] [**2 psig (13.8 kPa)**] <**Insert pressure**>.
6. End Connections: Threaded for regulators NPS 2 (DN 50) and smaller; flanged for regulators NPS 2-1/2 (DN 65) and larger.

2.11 SERVICE METERS

A. Diaphragm-Type Service Meters:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Standard: [**ANSI B109.1**] [**ANSI B109.2**].
3. Case: Die-cast aluminum.
4. Connections: Steel threads.
5. Diaphragm: Synthetic fabric.
6. Diaphragm Support Bearings: Self-lubricating.
7. Compensation: Continuous temperature[**and pressure**].
8. Meter Index: [**Cubic feet**] [**Liters**] [**Cubic feet and liters**].
9. Meter Case and Index: Tamper resistant.
10. Remote meter reader compatible.
11. Maximum Inlet Pressure: [**100 psig (690 kPa)**] <**Insert pressure**>.
12. Pressure Loss: Maximum [**0.5 inch wg (124 Pa)**] [**2.0 inch wg (498 Pa)**] <**Insert pressure differential**>.
13. Accuracy: Maximum plus or minus [**1.0**] <**Insert number**> percent.

B. Rotary-Type Service Meters:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Standard: ANSI B109.3.
3. Case: Extruded aluminum.
4. Connection: Flange.
5. Impellers: Polished aluminum.
6. Rotor Bearings: Self-lubricating.
7. Compensation: Continuous temperature[**and pressure**].
8. Meter Index: [**Cubic feet**] [**Liters**] [**Cubic feet and liters**].
9. Tamper resistant.
10. Remote meter reader compatible.

11. Maximum Inlet Pressure: [**100 psig (690 kPa)**] <**Insert pressure**>.
12. Accuracy: Maximum plus or minus [**2.0**] <**Insert number**> percent.

C. Turbine Meters:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Standard: ASME MFC.4M.
3. Housing: Cast iron or welded steel.
4. Connection Threads or Flanges: Steel.
5. Turbine: Aluminum or plastic.
6. Turbine Bearings: Self-lubricating.
7. Compensation: Continuous temperature[**and pressure**].
8. Meter Index: [**Cubic feet**] [**Liters**] [**Cubic feet and liters**].
9. Tamper resistant.
10. Remote meter reader compatible.
11. Maximum Inlet Pressure: [**100 psig (690 kPa)**] <**Insert pressure**>.
12. Accuracy: Maximum plus or minus [**2.0**] <**Insert number**> percent.

D. Service-Meter Bars:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Malleable- or cast-iron frame for supporting service meter.
3. Include offset swivel pipes, meter nuts with o-ring seal, and factory- or field-installed dielectric unions.
4. Omit meter offset swivel pipes if service-meter bar dimensions match service-meter connections.

E. Service-Meter Bypass Fittings:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Ferrous, tee, pipe fitting with capped side inlet for temporary LPG supply.
3. Integral ball-check bypass valve.

2.12 DIELECTRIC FITTINGS

A. Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Standard: ASSE 1079.
3. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**] [**150 psig (1035 kPa)**] [**250 psig (1725 kPa)**].
4. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Standard: ASSE 1079.

3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**] [**150 psig (1035 kPa)**] [**175 psig (1200 kPa)**] [**300 psig (2070 kPa)**] <**Insert pressure**>.
5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. <u><Double click here to find, evaluate, and insert list of manufacturers and products.></u>

2. Nonconducting materials for field assembly of companion flanges.
3. Pressure Rating: [**150 psig (1035 kPa)**] <**Insert pressure**>.
4. Gasket: Neoprene or phenolic.
5. Bolt Sleeves: Phenolic or PE.
6. Washers: Phenolic with steel backing washers.

2.13 STORAGE CONTAINERS

A. <u><Double click here to find, evaluate, and insert list of manufacturers and products.></u>

B. Description: Factory-designed, -fabricated, and -tested containers.

C. Standards:

1. NFPA 58.
2. ASME BPVC-VIII-1.
3. UL 125.
4. UL 842.
5. Department of Transportation (DOT) Regulations.

D. Provide all appurtenances as required by NFPA 58, qualified to UL 125:

1. Vapor-shutoff valve.
2. Liquid-shutoff valve.
3. Pressure-relief valve.
4. Fixed maximum liquid level gauge.
5. Filler valve.
6. Overfilling protection device.
7. Actuated liquid withdrawal excess-flow valve.
8. Provide container appurtenances with a minimum service pressure rating of 250 psig (1724 kPa).
9. <**Insert additional items required**>.

E. Provide exposed metal surfaces mechanically cleaned, primed, and painted for resistance to corrosion for outdoor installation.

F. Provide ladders for access to valves more than 72 inches (1830 mm) aboveground.

G. Stainless Steel Nameplate: Attach to aboveground storage container or to adjacent structure for underground storage container.

1. Name and address of supplier or trade name of container.
2. Water capacity in gallons and liters.
3. Design pressure in psig and kPa.

a. Statement: "This container does not contain a product having a vapor pressure in excess of <**Insert maximum pressure in psig (kPa) at 100 deg F (37.8 deg C)**>."
b. Outside surface area in square feet and square meters.
c. Year of manufacture.
d. Shell thickness in inches and millimeters.
e. Overall length in feet and meters.
f. OD in feet and meters.
g. Manufacturer's serial number.
h. ASME code label.

4. Felt support pads and two concrete or painted-steel saddles per storage container. Corrosion protection required at container-to-felt contact.
5. Tie straps for each saddle.
6. Straps and anchors for tie-down slab.
7. Asphalt-based coating for corrosion protection.
8. Container connections and valves protected in manway at top of storage container.
9. Manway equipped with ventilation louvers.

2.14 TRANSPORT TRUCK UNLOADING FACILITY

A. Transport Truck Unloading Facility: Provide in accordance with the requirements in NFPA 58.

1. Support structure consisting of a minimum 6-inch (150-mm) steel channel or 6-by-4-inch (150-by-100-mm) rectangular steel tubing, a minimum of 36 inches (914 mm) above and below grade.
2. Liquid-fill and vapor-return, quick-disconnect fittings.
3. Liquid- and vapor-shutoff valves with hydrostatic relief valves mounted between the quick-disconnect fittings and shutoff valves.
4. Excess-flow safety shutoff valve in vapor-return line.
5. Backflow check valve in liquid-fill line.
6. Remote emergency shutoff valve station with underground cable to the vapor emergency shutoff valve.

2.15 VAPORIZERS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Factory-fabricated, -assembled, -calibrated, and -tested vaporizers.

C. Standards:

1. NFPA 58.
2. ASME BPVC-VIII-1.
3. NFPA 70.
4. FM Global labeled.

D. Vaporizers - Direct-Type, Direct-Fired Heat Exchanger:

1. ASME-rated and -stamped, LPG, vaporizer coil contained in an insulated enclosure insulated with a burner.
2. Burner Tubes and Orifices: Stainless steel.
3. Gas Train: Control devices and burner-control sequence are to be FM Global labeled. Provide shutoff valve, high- and low-pressure safety switches, pressure regulator, and main- and pilot-control valves.
4. Burner Operating Controls:

a. Controls are to maintain safe operating conditions.
b. High-Pressure Cutoff: Manual reset stops burner if operating conditions rise above maximum design pressure.
c. Operating Vapor-Pressure Control: Factory piped and mounted to control burner.

E. Vaporizers - Indirect-Type, Direct-Fired Heat Exchanger:

1. ASME-rated and -stamped, LPG, vaporizer vessel with a replaceable, immersion-type, electric heating element.
2. Heating Element Operating Controls:

a. Controls are to maintain safe operating conditions.
b. Operating Vapor-Pressure Control: Factory wired and mounted to control heating element.
c. High-Pressure Cutoff: Manual reset stops burner if operating conditions rise above maximum design pressure.
d. Alarm Bell and Rotary Beacon: Factory mounted on control panel with silence switch; is to sound alarm for out-of-normal conditions.
e. Control Transformer: 115 V maximum control voltage.

F. Vaporizers - Direct-Type, Water-Bath Heat Exchanger:

1. ASME-rated and -stamped, helical, LPG, vaporizer coil submerged in water bath. Straight, steel fire tubes welded into steel headers.
2. Water Bath:

a. Water bath filled with water/glycol solution designed to prevent freezing at [**minus 30 deg F (minus 34 deg C)**] <**Insert temperature**>.
b. Water-bath, high- and low-level sight glasses.
c. Low-water cutoff to stop burner and annunciate alarm.
d. Water/glycol fill and vent fitting.
e. Minimum NPS 3/4 (DN 20) hose-end drain valves.
f. Operating high- and low-limit aquastat controllers.
g. Water-bath temperature gage; a minimum of 2-1/2 inches (63 mm) in diameter. Gauges are to have operating-temperature ranges, so normal operating range is at approximately 50 percent of full range.

3. Burner Tubes and Orifices: Stainless steel.
4. Gas Train: Control devices and burner-modulation control sequence is to be FM Global labeled. Provide shutoff valve, high- and low-pressure safety switches, pressure regulator, and main- and pilot-control valves.
5. Burner Operating Controls:

a. Operating controls are to maintain safe operating conditions.
b. Operating Water-Bath Temperature Control: Factory wired and mounted to control burner.
c. High-Temperature and High-Pressure Cutoff: Manual reset stops burner if operating conditions rise above maximum design temperature or vapor pressure.
d. Alarm Bell and Rotary Beacon: Factory mounted on control panel with silence switch; is to sound alarm for out-of-normal conditions.
e. Control Transformer: 115 V maximum control voltage.

G. Vaporizers - Indirect-Type, [**Steam**][**Hot Water**] Heat Exchanger:

1. ASME-rated and -stamped, LPG vaporizer with immersion tubes containing [**steam**] [**hot water**] and LPG in surrounding shell.
2. Operating Controls:

a. Controls are to maintain safe operating conditions.
b. High-Temperature and High-Pressure Cutoff: Manual reset if operating conditions rise above maximum design temperature or pressure.
c. Alarm Bell and Rotary Beacon: Factory mounted on control panel with silence switch; sound alarm for out-of-normal conditions.
d. Control Transformer: 115 V maximum control voltage.

H. Building Management System Interface: Factory-installed hardware and software to enable building management system to monitor and control set points and display vaporizer status and alarms.

I. Capacities and Characteristics:

1. Heating Fuel: [**Propane**] [**Butane**] [**Electric**].
2. Vaporization Heat Exchanger:

   a. Minimum Working-Pressure Rating: [**250 psig (1723 kPa)**] <**Insert value**>.
   b. Test Pressure: [**375 psig (2586 kPa)**] <**Insert value**>.

3. LPG Vaporization Rate: <**Insert gph (mL/s)**>.
4. Entering-LPG Temperature: [**Minus 30 deg F (Minus 34 deg C)**] <**Insert temperature**>.
5. Leaving-LPG Temperature: [**80 deg F (26.7 deg C)**] <**Insert temperature**>.
6. Discharge-LPG Pressure: [**90 psig (621 kPa)**] <**Insert value**>.
7. Burner Gas Input: <**Insert Btu/h (kW)**>.
8. Electric Burner Input: <**Insert kilowatts**>.
9. [**Atmospheric**] <**Insert psig (kPa)**>.
10. [**160 deg F (71 deg C)**] <**Insert temperature**>.
11. Electrical Characteristics:

   a. Volts: [**120**] [**240**] [**480**] <**Insert number**> V.
   b. Phase: [**Single**] [**Three**].
   c. Hertz: 60.
   d. Minimum Circuit Ampacity: <**Insert number**> A.
   e. Maximum Overcurrent Protection: <**Insert number**> A.

2.16 DETECTABLE WARNING TAPE

A. Acid- and alkali-resistant PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for LPG piping system to verify actual locations of piping connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.3 PREPARATION

A. Close equipment-shutoff valves before turning off LPG to premises or piping section.

B. Inspect LPG piping in accordance with code(s) and authority having jurisdiction to determine that LPG utilization devices are turned off in piping section affected.

C. Comply with requirements of code(s) and authority having jurisdiction for prevention of accidental ignition.

3.4 INSTALLATION OF OUTDOOR PIPING

A. Comply with code and authority having jurisdiction requirements for installation and purging of LPG piping.

B. Install underground, LPG piping buried a minimum of [**12 inches (300 mm)**] <**Insert dimension**> below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

C. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
3. Replace pipe having damaged PE coating with new pipe.

D. Copper Tubing with Protective Coating:

1. Apply joint cover kits over tubing to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.

E. Install fittings for changes in direction and branch connections.

F. Joints for connection to inlets and outlets on vaporizers, regulators, and valves may be flanged or threaded to match the equipment.

G. Install pressure gauge [**downstream**] [**upstream and downstream**] from each service regulator. Pressure gauges are specified in Section 230519 "Meters and Gauges for HVAC Piping."

3.5 INSTALLATION OF INDOOR PIPING

A. Comply with requirements of the code(s) and authority having jurisdiction for installation and purging of LPG piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction.

D. Install piping in concealed locations unless otherwise indicated. Piping in equipment rooms and service areas may be installed exposed. Piping is not to be installed in inaccessible locations.

1. Conceal piping in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
2. Except as specified below, install concealed piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints, as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

a. Above Accessible Ceilings: Piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.

1) Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

b. In Floors: Install piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches (38 mm) of concrete. Piping may not be in physical contact with other metallic structures, such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
c. In Floor Channels: Channels must have cover and be open to space above cover for ventilation.
d. In Walls or Partitions: Protect piping installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.

1) Exception: Piping passing through partitions or walls does not require striker barriers.

e. Prohibited Locations:

1) Do not install piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
2) Do not install piping in return-air plenums.
3) Do not install piping in solid walls or partitions.

f. Under the Building: Install in vented containment conduit or CSST with integral vented sleeve and associated fittings.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Locate valves for easy access from a standing position.

G. Install LPG piping at uniform grade of 2 percent down toward drip and sediment traps.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Comply with requirements in Sections specifying gas-fired appliances and equipment, and verify final appliance and equipment locations for roughing-in.

K. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where readily accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of three pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

L. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors, and terminate with weatherproof vent cap.

M. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

N. Connect branch piping from top or side of horizontal piping.

O. Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

P. Do not use LPG piping as grounding electrode.

Q. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

R. Install pressure gauge [**downstream**] [**upstream and downstream**] from each line regulator. Pressure gauges are specified in Section 230519 "Meters and Gauges for HVAC Piping."

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.6 INSTALLATION OF SERVICE-METER ASSEMBLY

A. Install service-meter assemblies aboveground[**, on concrete bases**].

B. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.

C. Install strainer on inlet of service-pressure regulator and meter set.

D. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.

E. Install metal shutoff valves upstream from service meters. Install dielectric fittings downstream from service meters.

F. Install service meters downstream from pressure regulators.

G. Install metal bollards to protect meter assemblies. Comply with requirements in Section 055000 "Metal Fabrications" for pipe bollards.

3.7 INSTALLATION OF VALVES

A. Install manual gas shutoff valve for each gas appliance ahead of CSST, aluminum, or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install earthquake valves aboveground outside buildings according to listing.

E. Install anode for metallic valves in underground PE piping.

F. Do not install valves in return-air plenums.

3.8 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full ID of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints in accordance with AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints in accordance with AWS's "Brazing Handbook," Ch. 22, "Pipe and Tube."

F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for LPG service. Install gasket concentrically positioned.

G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

H. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join in accordance with ASTM D2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.9 PIPING CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install LPG piping electrically continuous and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance in accordance with NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas-shutoff valves and unions. Install valve within 72 inches (1830 mm) of each gas-fired appliances and equipment. Install union between valve and appliances or equipment.

3.10 INSTALLATION OF TRANSPORT TRUCK UNLOADING FACILITY

A. Install transport truck unloading in a cast-in-place concrete base, 48 inches (1220 mm) square by 36 inches (914 mm) deep. Set top of concrete base at least 6 inches (150 mm) above finished grade.

B. Install remote emergency shutoff station with cable release in an accessible location, a minimum of 25 ft. (7.6 m) and a maximum of 100 ft. (30 m) away from transport truck unloading.

C. Install at least two 6-inch- (150-mm-) diameter metal bollards set in and filled with concrete on both sides of transport truck unloading. Bollard length is to be at least 48 inches (1220 mm) above and below grade, with concrete encasement a minimum of 12 inches (300 mm) in diameter.

3.11 INSTALLATION OF STORAGE CONTAINER

A. Do not install storage containers in a pit.

B. Fill storage container to at least 80 percent capacity with [**butane**] [**propane**].

C. Install piping connections with swing joints or flexible connectors to allow for storage container settlement and for thermal expansion and contraction.

D. Ground containers in accordance with NFPA 780. Grounding is specified in Section 264113 "Lightning Protection for Structures."

E. Set storage containers in felt pads on concrete or steel saddles. Install corrosion protection at container-to-felt contact.

F. Install tie-downs over storage containers on saddles with proper tension.

G. Set concrete saddles on dowels set in concrete base. Anchor steel saddles to concrete base.

H. Set storage container on concrete ballast base large enough to offset buoyancy of empty storage container immersed in water.

I. Install tie-down straps over container anchored in ballast base, and repair damaged coating.

J. Backfill with a minimum coverage for underground or mounded storage containers in accordance with NFPA 58.

K. Backfill with pea gravel as required in Section 312000 "Earth Moving."

L. Install cathodic protection for storage container. Cathodic protection is specified in Section 134713 "Cathodic Protection."

3.12 INSTALLATION OF VAPORIZER

A. Install vaporizer with access space for periodic maintenance.

B. Set vaporizers on and anchor to concrete base.

C. Connect liquid line from pump set, and connect vapor supply to distribution piping.

D. Install backup connection from vapor space of container to inlet of pressure-regulating valve at vaporizer discharge to bypass the vaporizer during maintenance. Install shutoff valves to change source from vaporizer to storage container.

3.13 INSTALLATION OF LABELING AND IDENTIFICATION

A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches (305 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

C. Label and identify gas piping and pressure outside a multitenant building by tenant.

3.14 CONCRETE BASES

A. Anchor equipment to concrete base in accordance with Project codes.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on [**18-inch (451-mm)**] <**Insert dimension**> centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Use [**3000 psig (20.7 MPa)**] <**Insert value**>, 28-day, compressive-strength concrete and reinforcement, as specified in Section 033000 "Cast-in-Place Concrete."

3.15 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Comply with requirements of the code(s) and authority having jurisdiction for testing, inspection, and purging of LPG installation.

B. LPG installation will be considered defective if it does not pass tests and inspections. Defective products are to be replaced.

C. Prepare test and inspection reports.

3.16 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**] [**Train**] Owner's maintenance personnel to adjust, operate, and maintain LPG equipment.

3.17 OUTDOOR PIPING SCHEDULE

A. Underground piping is to be[**one of**] the following:

1. PE pipe, tubing, and fittings joined by heat-fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
2. Polyamide pipe, tubing, and fittings terminated in an accessible location.
3. Schedule 40, steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
4. [**Annealed**] [**Drawn**]-temper copper tube, Type L (Type B) with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
5. Containment Conduit: Schedule 40, steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
6. CSST tubing and fittings with integral vented sleeve terminated in an accessible location.

B. Aboveground piping is to be[**one of**] the following:

1. CSST and fittings.
2. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
3. Schedule 40, steel pipe with wrought-steel fittings and welded joints, or mechanical couplings.
4. [**Annealed**] [**Drawn**]-temper copper tube, Type L (Type B,) with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.

C. Branch Piping in Cast-in-Place Concrete to Single Appliance: Annealed-temper copper, with wrought-copper fittings and [**brazed**] [**flared**] joints. Install piping embedded in concrete with no pipe joints in concrete.

3.18 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG (3.45 kPa)

A. Aboveground piping is to be[**one of**] the following:

1. CSST and fittings.
2. Annealed-temper, tin-lined copper tube with flared joints and fittings.
3. Annealed-temper copper tube with wrought-copper fittings and [**brazed**] [**flared**] joints.
4. Aluminum tube with flared fittings and joints.
5. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
6. Schedule 40, steel pipe with wrought-steel fittings and welded joints.
7. Drawn-temper copper tube, Type L (Type B) with wrought-copper fittings and brazed joints.

B. Underground, below building, piping is to be[**one of**] the following:

1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
2. Schedule 40, steel pipe with wrought-steel fittings and welded joints.
3. Containment Conduit: Schedule 40, steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
4. Containment Conduit Vent Piping: Schedule 40, steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.19 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG (3.45 kPa) AND LESS THAN 5 PSIG (34.5 kPa)

A. Aboveground piping is to be[**one of**] the following:

1. CSST and fittings.
2. Annealed-temper, tin-lined copper tube with flared joints and fittings.
3. Annealed-temper copper tube, Type L (Type B) with wrought-copper fittings and [**brazed**] [**flared**] joints.
4. Aluminum tube with flared fittings and joints.
5. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
6. Schedule 40, steel pipe with steel welding fittings and welded joints.
7. Drawn-temper copper tube, [**Type L (Type B)**] [**Type G**] with wrought-copper fittings and brazed joints.

B. Underground, below building, piping is to be[**one of**] the following:

1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
2. Schedule 40, steel pipe with wrought-steel fittings and welded joints.
3. Containment Conduit: Schedule 40, steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.
4. Containment Conduit Vent Piping: Schedule 40, steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.20 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 5 PSIG (34.5 kPa)

A. Aboveground Piping: Maximum operating pressure more than [**5 psig (34.5 kPa)**] <**Insert pressure**>.

B. Aboveground piping is to be[**one of**] the following:

1. CSST and fittings.
2. Schedule 40, steel pipe with steel welding fittings and welded joints.
3. Drawn-temper copper tube, [**Type L (Type B)**] [**Type G**] with wrought-copper fittings and brazed joints.

C. Underground, below building, piping is to be[**one of**] the following:

1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
2. Schedule 40, steel pipe with wrought-steel fittings and welded joints.
3. Containment Conduit: Schedule 40, steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

4. Containment Conduit Vent Piping: Schedule 40, steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.21 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.

B. Underground Vapor Piping:

1. PE valves.
2. NPS 2 (DN 50) and Smaller: Bronze, [**lubricated**] [**nonlubricated**] plug valves.
3. NPS 2-1/2 (DN 65) and Larger: Cast-iron, [**lubricated**] [**nonlubricated**] plug valves.

3.22 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe NPS 2 (DN 50) and smaller is to be[**one of**] the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, [**full**] [**regular**]-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

B. Valves for pipe NPS 2-1/2 (DN 65) and larger is to be[**one of**] the following:

1. Two-piece, [**full**] [**regular**]-port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, [**nonlubricated**] [**lubricated**] plug valve.

END OF SECTION 23 11 23 00c

Task	Specification	Specification Description
23 11 23 00	21 05 23 00	Piped Utilities Basic Materials And Methods
23 11 23 00	22 11 23 23	Water Supply Wells
23 11 23 00	22 05 76 00	Sanitary Sewerage
23 11 23 00	07 63 00 00	Common Work Results for Fire Suppression
23 11 23 00	07 63 00 00a	Common Work Results for Plumbing
23 11 23 00	07 63 00 00b	Common Work Results for HVAC
23 11 26 00	23 11 23 00	Relief Wells
23 11 26 00	22 05 76 00	Sanitary Sewerage
23 11 26 00	22 12 23 26	Underground Storage Tanks
23 11 26 00	07 63 00 00	Common Work Results for Fire Suppression
23 11 26 00	07 63 00 00a	Common Work Results for Plumbing
23 11 26 00	07 63 00 00b	Common Work Results for HVAC
23 11 26 00	22 11 16 00a	Sanitary Waste And Vent Piping
23 12 13 00	21 05 23 00	Piped Utilities Basic Materials And Methods
23 12 23 00	21 05 23 00	Piped Utilities Basic Materials And Methods
23 13 13 13	21 05 23 00	Piped Utilities Basic Materials And Methods
23 13 13 13	22 12 23 26	Underground Storage Tanks
23 13 13 23	21 05 23 00	Piped Utilities Basic Materials And Methods
23 13 13 23	22 12 23 26	Underground Storage Tanks
23 13 23 16	21 05 23 00	Piped Utilities Basic Materials And Methods
23 13 23 19	21 05 23 00	Piped Utilities Basic Materials And Methods
23 13 23 26	21 05 23 00	Piped Utilities Basic Materials And Methods
23 13 33 00	21 05 23 00	Piped Utilities Basic Materials And Methods
23 13 33 00	22 12 23 26	Underground Storage Tanks

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SECTION 23 21 13 23 - FACILITY FUEL-OIL PIPING

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for facility fuel-oil piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes fuel-oil, fuel-oil and diesel-fuel-oil, and diesel-fuel-oil distribution systems and the following:
   a. Pipes, tubes, and fittings.
   b. Piping and tubing joining materials.
   c. Piping specialties.
   d. Valves.
   e. Vertical, steel, fuel-oil ASTs.
   f. Horizontal, steel, fuel-oil ASTs.
   g. Containment-dike, steel, fuel-oil ASTs.
   h. Insulated, steel, fuel-oil ASTs.
   i. Concrete-vaulted, steel, fuel-oil ASTs.
   j. Steel, fuel-oil USTs with STI-P3.
   k. Composite, steel, fuel-oil USTs.
   l. Jacketed, steel, fuel-oil USTs.
   m. FRP fuel-oil USTs.
   n. Fuel-oil AST accessories.
   o. Fuel-oil UST accessories.
   p. Fuel-oil storage tank piping specialties.
   q. Fuel-oil storage tank pumps.
   r. Fuel-transfer pumps.
   s. Fuel maintenance system.
   t. Liquid-level gage system.
   u. Leak-detection and monitoring system.
   v. Mechanical sleeve seals.
   w. Grout.
   x. Concrete bases.

C. Definitions

1. AST: Aboveground storage tank.
2. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
3. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
4. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
5. FPM: Vinylidene fluoride-hexafluoropropylene copolymer rubber.
6. FRP: Glass-fiber-reinforced plastic.
7. UST: Underground storage tank.

D. Performance Requirements

1. Maximum Operating-Pressure Ratings: 3-psig (21-kPa) fuel-oil supply pressure at oil-fired appliances.

2. Delegated Design: Design restraint and anchors for fuel-oil piping, ASTs, and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
3. Seismic Performance: Factory-installed support attachments for AST shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event, **as directed**."

E. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: For facility fuel-oil piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
3. Delegated-Design Submittal: For fuel-oil piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   a. Detail fabrication and assembly of anchors and seismic restraints.
   b. Design Calculations: Calculate requirements for selecting seismic restraints.
   c. Detail fabrication and assembly of pipe anchors, hangers, supports for multiple pipes, and attachments of the same to building structure.
4. Seismic Qualification Certificates: For ASTs, accessories, and components, from manufacturer.
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
5. Brazing certificates.
6. Welding certificates.
7. Field quality-control reports.
8. Operation and Maintenance Data.
9. Warranty: Sample of special warranty.

F. Quality Assurance
1. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
2. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
3. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. Comply with ASME B31.9, "Building Services Piping," for fuel-oil piping materials, installation, testing, and inspecting.
6. Comply with requirements of the EPA and of state and local authorities having jurisdiction. Include recording of fuel-oil storage tanks and monitoring of tanks and piping.

G. Delivery, Storage, And Handling
1. Lift and support fuel-oil storage tanks only at designated lifting or supporting points, as shown on Shop Drawings. Do not move or lift tanks unless empty.
2. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

3. Store pipes and tubes with protective PE coating to avoid damaging the coating and to protect from direct sunlight.
4. Store PE pipes and valves protected from direct sunlight.

H. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-oil storage tanks and flexible, double-containment piping and related equipment that fail in materials or workmanship within specified warranty period.
   a. Storage Tanks:
      1) Failures include, but are not limited to, the following when used for storage of fuel oil at temperatures not exceeding 150 deg F (66 deg C):
         a) Structural failures including cracking, breakup, and collapse.
         b) Corrosion failure including external and internal corrosion of steel tanks.
      2) Warranty Period: 30 years from date of Final Completion.
   b. Flexible, Double-Containment Piping and Related Equipment:
      1) Failures due to defective materials or workmanship for materials installed together, including piping, dispenser sumps, entry boots, and sump mounting adapters.
      2) Warranty Period: 10 **OR** 30, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Pipes, Tubes, And Fittings
1. See Part 1.3 piping schedule articles for where pipes, tubes, fittings, and joining materials are applied in various services.
2. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
   a. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
   b. Wrought-Steel Welding Fittings: ASTM A 234/A 234M, for butt and socket welding.
   c. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
   d. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
      1) Material Group: 1.1.
      2) End Connections: Threaded or butt welding to match pipe.
      3) Lapped Face: Not permitted underground.
      4) Gasket Materials: Asbestos free, ASME B16.20 metallic, or ASME B16.21 nonmetallic, gaskets compatible with fuel oil.
      5) Bolts and Nuts: ASME B18.2.1, cadmium-plated steel.
   e. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
      1) Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
3. Drawn-Temper Copper Tube: Comply with ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**.
   a. Copper Fittings: ASME B16.22, wrought copper, streamlined pattern.
   b. Bronze Flanges and Flanged Fittings: ASME B16.24, Class 150.
      1) Gasket Material: Asbestos free, ASME B16.20, metallic, or ASME B16.21 nonmetallic, gaskets compatible with fuel oil.
      2) Bolts and Nuts: ASME B18.2.1, cadmium-plated steel.
4. Annealed-Temper Copper Tube: Comply with ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**.
   a. Copper Fittings: ASME B16.22, wrought copper, streamlined pattern.
   b. Flare Fittings: Comply with ASME B16.26 and SAE J513.
      1) Copper fittings with long nuts.
      2) Metal-to-metal compression seal without gasket.
      3) Dryseal threads complying with ASME B1.20.3.

B. Double-Containment Pipe And Fittings
1. Flexible, Double-Containment Piping: Comply with UL 971.
a. Pipe Materials: PVDF complying with ASTM D 3222 for carrier pipe with mechanical couplings to seal carrier, and PE pipe complying with ASTM D 4976 for containment piping.
b. Fiberglass **OR** PE, **as directed**, sumps.
c. Watertight sump entry boots, pipe adapters with test ports and tubes, coaxial fittings, and couplings.
d. Minimum Operating Pressure Rating: 10 psig (69 kPa).
e. Plastic to Steel Pipe Transition Fittings: Factory-fabricated fittings with plastic end matching or compatible with carrier piping, and steel pipe end complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
f. Include design and fabrication of double-containment pipe and fitting assemblies with provision for field installation of cable leak-detection system in annular space between carrier and containment piping.
2. Rigid, Double-Containment Piping: Comply with UL 971.
a. RTRP: ASTM D 2996 or ASTM D 2997 carrier and containment piping and mechanical couplings to seal carrier and containment piping or individually bonded joints.
1) Minimum Operating-Pressure Rating for RTRP NPS 2 and NPS 3 (DN 50 and DN 80): 150 psig (1035 kPa).
2) Minimum Operating-Pressure Rating for RTRP NPS 4 and NPS 6 (DN 100 and DN 150): 125 psig (860 kPa). Compliance with UL 971 is not required for NPS 6 (DN 150) and larger piping.
3) Fittings: RTRF complying with ASTM D 2996 or ASTM D 2997, and made by RTRP manufacturer; watertight sump entry boots, termination, or other end fittings.
b. Include design and fabrication of double-containment pipe and fitting assemblies with provision for field installation of cable leak-detection system in annular space between carrier and containment piping.

C. Piping Specialties
1. Flexible Connectors: Comply with UL 567.
a. Metallic Connectors:
1) Listed and labeled for aboveground and underground applications by an NRTL acceptable to authorities having jurisdiction.
2) Stainless-steel bellows with woven, flexible, bronze or stainless-steel, wire-reinforcing protective jacket.
3) Minimum Operating Pressure: 150 psig (1035 kPa).
4) End Connections: Socket, flanged, or threaded end to match connected piping.
5) Maximum Length: 30 inches (762 mm).
6) Swivel end, 50-psig (345-kPa) maximum operating pressure.
7) Factory-furnished anode.
b. Nonmetallic Connectors:
1) Listed and labeled for underground applications by an NRTL acceptable to authorities having jurisdiction.
2) PFTE bellows with woven, flexible, bronze or stainless-steel, wire-reinforcing protective jacket.
3) Minimum Operating Pressure: 150 psig (1035 kPa).
4) End Connections: Socket, flanged, or threaded end to match connected piping.
5) Maximum Length: 30 inches (762 mm).
6) Swivel end, 50-psig (345-kPa) maximum operating pressure.
7) Factory-furnished anode.
2. Y-Pattern Strainers:
a. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
b. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.

c. Strainer Screen: 60 **OR** 80, **as directed**,-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
d. CWP Rating: 125 psig (860 kPa).

3. Basket Strainers:
   a. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
   b. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
   c. Strainer Screen: 60 **OR** 80, **as directed**,-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
   d. CWP Rating: 125 psig (860 kPa).
4. T-Pattern Strainers:
   a. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
   b. End Connections: Grooved ends.
   c. Strainer Screen: 60 **OR** 80, **as directed**,-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
   d. CWP Rating: 750 psig (5170 kPa).
5. Manual Air Vents:
   a. Body: Bronze.
   b. Internal Parts: Nonferrous.
   c. Operator: Screwdriver or thumbscrew.
   d. Inlet Connection: NPS 1/2 (DN 15).
   e. Discharge Connection: NPS 1/8 (DN 6).
   f. CWP Rating: 150 psig (1035 kPa).
   g. Maximum Operating Temperature: 225 deg F (107 deg C).

D. Joining Materials
1. Joint Compound and Tape: Suitable for fuel oil.
2. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
3. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F (540 deg C) complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.
4. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.

E. Manual Fuel-Oil Shutoff Valves
1. See valve schedule in Part 1.3 for where each valve type is applied in various services.
2. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller for Liquid Service: Comply with UL 842.
   a. CWP Rating: 125 psig (860 kPa).
   b. Threaded Ends: Comply with ASME B1.20.1.
   c. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
   d. Tamperproof Feature: Locking feature for valves indicated in the valve schedule.
   e. Service Mark: Initials "WOG" shall be permanently marked on valve body.
3. General Requirements for Metallic Valves, NPS 2-1/2 (DN 65) and Larger: Comply with UL 842.
   a. CWP Rating: 125 psig (860 kPa).
   b. Flanged Ends: Comply with ASME B16.5 for steel flanges.
   c. Tamperproof Feature: Locking feature for valves indicated in the valve schedule.
   d. Service Mark: Initials "WOG" shall be permanently marked on valve body.
4. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
   a. Body: Bronze, complying with ASTM B 584.
   b. Ball: Chrome-plated brass.
   c. Stem: Bronze; blowout proof.
   d. Seats: Reinforced TFE; blowout proof.
   e. Packing: Separate packnut with adjustable-stem packing threaded ends.

f. Ends: Threaded, flared, or socket as indicated in the valve schedule.
g. CWP Rating: 600 psig (4140 kPa).
h. Service Mark: Initials "WOG" shall be permanently marked on valve body.

5. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
   a. Body: Bronze, complying with ASTM B 584.
   b. Ball: Chrome-plated bronze.
   c. Stem: Bronze; blowout proof.
   d. Seats: Reinforced TFE; blowout proof.
   e. Packing: Threaded-body packnut design with adjustable-stem packing.
   f. Ends: Threaded, flared, or socket as indicated in the valve schedule.
   g. CWP Rating: 600 psig (4140 kPa).
   h. Service Mark: Initials "WOG" shall be permanently marked on valve body.
6. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.
   a. Body: Bronze, complying with ASTM B 584.
   b. Ball: Chrome-plated bronze.
   c. Stem: Bronze; blowout proof.
   d. Seats: Reinforced TFE.
   e. Packing: Threaded-body packnut design with adjustable-stem packing.
   f. Ends: Threaded, flared, or socket as indicated in the valve schedule.
   g. CWP Rating: 600 psig (4140 kPa).
   h. Service Mark: Initials "WOG" shall be permanently marked on valve body.

F. Specialty Valves
1. Pressure Relief Valves: Comply with UL 842.
   a. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
   b. Body: Brass, bronze, or cast steel.
   c. Springs: Stainless steel, interchangeable.
   d. Seat and Seal: Nitrile rubber.
   e. Orifice: Stainless steel, interchangeable.
   f. Factory-Applied Finish: Baked enamel.
   g. Maximum Inlet Pressure: 150 psig (1035 kPa).
   h. Relief Pressure Setting: 60 psig (414 kPa).
2. Oil Safety Valves: Comply with UL 842.
   a. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
   b. Body: Brass, bronze, or cast steel.
   c. Springs: Stainless steel.
   d. Seat and Diaphragm: Nitrile rubber.
   e. Orifice: Stainless steel, interchangeable.
   f. Factory-Applied Finish: Baked enamel.
   g. Manual override port.
   h. Maximum Inlet Pressure: 60 psig (414 kPa).
   i. Maximum Outlet Pressure: 3 psig (21 kPa).
3. Emergency Shutoff Valves: Comply with UL 842.
   a. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
   b. Single **OR** Double, **as directed**, poppet valve.
   c. Body: ASTM A 126, cast iron.
   d. Disk: FPM.
   e. Poppet Spring: Stainless steel.
   f. Stem: Plated brass.
   g. O-Ring: FPM.
   h. Packing Nut: PTFE-coated brass.
   i. Fusible link to close valve at 165 deg F (74 deg C).

j. Thermal relief to vent line pressure buildup due to fire.
k. Air test port.
l. Maximum Operating Pressure: 0.5 psig (3.45 kPa).

4. Mechanical Leak Detector: Comply with UL 842.
   a. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
   b. Body: ASTM A 126, cast iron.
   c. O-Rings: Elastomeric compatible with fuel oil.
   d. Piston and Stem Seals: PTFE.
   e. Stem and Spring: Stainless steel.
   f. Piston Cylinder: Burnished brass.
   g. Indicated Leak Rate: Maximum 3 gph (3 mL/s) at 10 psig (69 kPa).
   h. Leak Indication: Reduced flow.

G. Vertical, Steel, Fuel-Oil AST
1. Description:
   a. UL 142, single-wall, vertical, steel tank.
   b. UL 142 and STI F921, **as directed**, double-wall, vertical, steel tank; with primary- and secondary-containment walls and interstitial space.
2. Construction: Fabricated with welded, carbon steel suitable for operation at atmospheric pressure and for storing fuel oil with specific gravity up to 1.1 and maintained temperature up to 150 deg F (66 deg C).

H. Horizontal, Steel, Fuel-Oil AST
1. Description:
   a. UL 142, single-wall, horizontal, steel tank.
   b. UL 142 and STI F921, **as directed**, double-wall, horizontal, steel tank; with primary- and secondary-containment walls and interstitial space.
2. Construction: Fabricated with welded, carbon steel; suitable for operation at atmospheric pressure and for storing fuel oil with specific gravity up to 1.1 and with maintained temperature up to 150 deg F (66 deg C).
3. Supports:
   a. Manufacturer's standard structural steel welded to tank.
   b. Manufacturer's standard type and number, steel or cast-iron cradles, for field installation.

I. Containment-Dike, Steel, Fuel-Oil AST
1. Description: UL 142 and STI F911, single-wall, horizontal, steel tank; with open or enclosed **OR** enclosed, **as directed**, secondary-containment dike with capacity greater than tank capacity.
2. Construction: Fabricated with welded, carbon steel; suitable for operation at atmospheric pressure and for storing fuel oil with specific gravity up to 1.1 and with maintained temperature up to 150 deg F (66 deg C).

J. Insulated, Steel, Fuel-Oil AST
1. Description: UL 142 and UL 2085 **OR** UL 142, UL 2085, and STI F941, **as directed**, thermally insulated and fire-resistant, double-wall, horizontal, steel tank; with primary- and secondary-containment walls and insulation and with interstitial space.
2. Construction: Fabricated with welded, carbon steel and insulation; suitable for operation at atmospheric pressure and for storing fuel oil with specific gravity up to 1.1 and with test temperature according to UL 2085.

K. Concrete-Vaulted, Steel, Fuel-Oil AST
1. Description: UL 142 and UL 2085 **OR** UL 142, UL 2085, and STI F941, **as directed**; thermally insulated, fire-resistant and protected, double-wall, horizontal, steel tank; with primary- and secondary-containment walls and insulation and with interstitial space.

2. Construction: Fabricated with welded, carbon steel and insulation and encased in concrete that will protect from bullets; suitable for operation at atmospheric pressure and for storing fuel oil with specific gravity up to 1.1 and with test temperature according to UL 2085.

L. Steel, Fuel-Oil UST With STI-P3
1. Description: UL 58 and STI P3, double-wall, horizontal, steel tank; with cathodic protection and electrical isolation.
   a. Containment Method: STI-P3, Type I, with primary and secondary walls in contact **OR** Type II, with interstitial space, **as directed**.
2. Construction: Fabricated with welded steel; suitable for operation at atmospheric pressure and for storing liquids with specific gravity up to 1.1; fabricated for the following loads:
   a. Depth of Bury: 3 feet (1 m) from top of tank to finished surface.
   b. External Hydrostatic Pressure: To withstand general buckling with safety factor of 2:1 if hole is fully flooded.
   c. Surface Loads: AASHTO's "Specifications for Highway Bridges," H-20 axle loads of 32,000 lb (14 515 kg).
3. Corrosion-Protection System: Protect tank and factory-installed piping by engineered and installed corrosion-protection system according to STI P3, with means of monitoring cathodic protection.

M. Composite, Steel, Fuel-Oil UST
1. Description: UL 58, double-wall, horizontal, composite tank; with coating complying with UL 1746 and STI F894.
   a. Containment Method: STI F894, Type I, with primary and secondary walls in contact **OR** Type II, with interstitial space, **as directed**.
2. Construction: Fabricated with welded steel and factory coating according to UL 1746 and STI F894; suitable for operation at atmospheric pressure and for storing liquids with specific gravity up to 1.1; fabricated for the following loads:
   a. Depth of Bury: 3 feet (1 m) from top of tank to finished surface.
   b. External Hydrostatic Pressure: To withstand general buckling with safety factor of 2:1 if hole is fully flooded.
   c. Surface Loads: AASHTO's "Specifications for Highway Bridges," H-20 axle loads of 32,000 lb (14 515 kg).

N. Jacketed, Steel, Fuel-Oil UST
1. Description: Jacketed, horizontal, steel tank; complying with UL 58, and with plastic or fiberglass jacket and corrosion-protection system according to UL 1746 and STI F922, **as directed**.
2. Construction: Tank fabricated with welded carbon steel, and jacket fabricated with plastic or fiberglass and vacuum-sealed interstitial space; suitable for operation at atmospheric pressure and with integral leak-detection device. Tank fabricated for the following loads:
   a. Depth of Bury: 3 feet (1 m) from top of tank to finished surface.
   b. External Hydrostatic Pressure: To withstand general buckling with safety factor of 2:1 if hole is fully flooded.
   c. Surface Loads: AASHTO's "Specifications for Highway Bridges," H-20 axle loads of 32,000 lb (14 515 kg).

O. FRP Fuel-Oil UST
1. Description: Horizontal, FRP UST; UL 1316, double wall, with interstitial space and integral, hydrostatic, leak-detection and monitoring system, **as directed**.
2. Construction: Fabricated with fiberglass-reinforced polyester resins; suitable for operation at atmospheric pressure; fabricated for the following loads:
   a. Depth of Bury: 3 feet (1 m) from top of tank to finished surface.
   b. External Hydrostatic Pressure: To withstand general buckling with safety factor of 2:1 if hole is fully flooded.

c. Surface Loads: AASHTO's "Specifications for Highway Bridges," H-20 axle loads of 32,000 lb (14 515 kg).

P. Shop Painting Of AST
1. Apply manufacturer's standard prime coat to exterior steel surface of AST and supports.
2. Prepare exterior steel surface of AST and tank supports.
3. Shop Cleaning: After fabrication, blast clean according to SSPC-SP 6/NACE No. 3 **OR** SSPC-SP 10/NACE No. 2, **as directed**.
4. After cleaning, remove dust or residue from cleaned surfaces.
5. If surface develops rust before prime coat is applied, repeat surface preparation.
6. Apply manufacturer's standard prime coat to shop-cleaned, dry surface same day as surface preparation.
7. Apply manufacturer's standard two-component, epoxy finish coats.

Q. Fuel-Oil AST Accessories
1. Tank Manholes (for horizontal tanks and some vertical tanks): 22-inch- (560-mm-) minimum diameter; bolted, flanged, and gasketed; centered on top of tank.
2. Tank Manholes (for vertical tanks): 22-inch- (560-mm-) minimum diameter; bolted, flanged, and gasketed; on top and at side of tank.
3. For Horizontal Tanks: Threaded pipe connection fittings on top of tank, for fill, supply, return, vent, sounding, and gaging. Include cast-iron plugs for shipping.
4. For Vertical Tanks: Threaded pipe connection fittings on top or sides of tank as indicated, for fill, supply, return, vent, sounding, and gaging. Include cast-iron plugs for shipping.
5. Striker Plates: Inside tank, on bottom below fill, vent, sounding, gage, and other tube openings.
6. Lifting Lugs: For handling and installation.
7. Ladders (for horizontal tanks and some vertical tanks): Carbon-steel ladder inside tank, anchored to top and bottom, and located as indicated. Include reinforcement of tank at bottom of ladder.
8. Ladders (for vertical tanks): Carbon-steel ladder outside tank, anchored to top and side wall. Comply with requirements in Division 05 Section "Metal Fabrications" for exterior steel ladder.
   a. Cage: Include welded steel cage around ladders for tanks 20 feet (6 m) high or higher.
9. Supply Tube: Extension of supply piping fitting into tank, terminating 6 inches (150 mm) above tank bottom and cut at a 45-degree angle (1:1 slope).
10. Sounding and Gage Tubes: Extension of fitting into tank, terminating 6 inches (150 mm) above tank bottom and cut at a 45-degree angle (1:1 slope).

R. Fuel-Oil UST Accessories
1. Tank Manholes: 22-inch- (560-mm-) minimum diameter; bolted, flanged, and gasketed, with extension collar; for access to inside of tank.
2. Steel Tank Masonry Supports: Two 6-by-6-by-3/8-inch (150-by-150-by-10-mm) steel angles, 72 inches (1800 mm) long, located longitudinally on tank on each side of manholes and continuously welded in place.
3. Threaded pipe connection fittings on top of tank for fill, supply, return, vent, sounding, and gaging, in locations and of sizes indicated. Include cast-iron plugs for shipping.
4. Striker Plates: Inside tank, on bottom below fill, vent, sounding, gage, and other tube openings.
5. Lifting Lugs: For handling and installation.
6. Ladders: Carbon-steel ladder inside tank, anchored to top and bottom. Include reinforcement of tank at bottom of ladder.
7. Supply Tube: Extension of supply piping fitting into tank, terminating 6 inches (150 mm) above tank bottom and cut at a 45-degree angle (1:1 slope).
8. Sounding and Gage Tubes: Extension of fitting into tank, terminating 6 inches (150 mm) above tank bottom and cut at a 45-degree angle (1:1 slope).
9. Containment Sumps: Fiberglass **OR** PE, **as directed**, with sump base, add-on extension pieces as required, sump top, lid, and gasket-seal joints. Include sump entry boots for pipe penetrations through sidewalls.

10. Sump Entry Boots: Two-part pipe fitting for field assembly and of size required to fit over pipe. Include gaskets shaped to fit sump sidewall, sleeves, seals, and clamps as required for liquid-tight pipe penetrations.
11. Anchor Straps: Storage tank manufacturer's standard anchoring system, with straps, strap-insulating material, cables and turnbuckles, of strength at least one and one-half times maximum uplift force of empty tank without backfill in place.
12. Filter Mat: Geotextile woven or spun filter fabric, in 1 or more layers, for minimum total weight of 3 oz./sq. yd. (101.7 g/sq. m).
13. Overfill Prevention Valves: Factory fabricated or shop or field assembled from manufacturer's standard components. Include drop tube, cap, fill nozzle adaptor, check valve mechanism or other devices, and vent if required to restrict flow at 95 percent of tank capacity and to provide complete shutoff of filling at 98 **OR** 99, **as directed**, percent of tank capacity.

S. Fuel-Oil Storage Tank Piping Specialties
1. Fitting Materials: Cast iron, malleable iron, brass, or corrosion-resistant metal; suitable for fuel-oil service.
   a. Surface, Flush-Mounted Fittings: Waterproof and suitable for truck traffic.
   b. Aboveground-Mounted Fittings: Weatherproof.
2. Spill-Containment Fill Boxes: Flush mounting, with drainage feature to drain oil into tank, threaded fill-pipe connection, and wrench operation.
3. Fill Boxes: Flush mounting, with threaded fill-pipe connection and wrench operation.
4. Locking Fill Boxes: Flush mounting, with locking-type inner fill cap for standard padlock and threaded fill-pipe connection.
5. Supply and Sounding Drop Tubes: Fuel-oil supply piping or fitting, inside tank, terminating 6 inches (150 mm) above bottom of tank, and with end cut at a 45-degree angle (1:1 slope).
6. Pipe Adapters and Extensions: Compatible with piping and fittings.
7. Suction Strainers and Check Valves: Bronze or corrosion-resistant metal components.
8. Foot Valves and Antisiphon Valves: Poppet-type, bronze or corrosion-resistant metal components.
9. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.
10. Metal Manholes: 22-inch- (560-mm-) minimum diameter frame and cover. Furnish manhole units of adequate size for access to fittings if size is not indicated.
11. Monitoring Well Caps: Locking pipe plug and manhole.

T. Submersible Fuel-Oil Pumps
1. Description: Comply with UL 79, UL 87, and UL 343.
   a. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
   b. Impeller: Turbine.
   c. Housing and Volute: Cast iron.
   d. Bearings: Bronze, self-lubricating.
   e. Seals: Mechanical.
   f. Shaft: Polished steel.
   g. Suspension Piping: Telescoping to accommodate tank diameter and depth of bury.
   h. Base: Steel.
   i. Pressure Relief: Built in.
   j. Discharge Check Valve: Built in.
   k. Drive: Direct, close coupled.
2. Controls: Pump controller panel complying with UL 353 and UL 508C and with interlock and terminals for connections to fuel-oil-burning equipment **OR** diesel-driven fire pumps **OR** diesel-driven emergency generators **OR** diesel-fuel-oil dispenser, **as directed**.
   a. Run pumps to maintain minimum manifold pressure with outdoor-air temperature less than 60 deg F (16 deg C).

b. Run pumps on seven-day schedule.
c. Stage pumps on pressure at a common supply manifold.
d. Alternate pumps to equalize run time.
e. Alarm motor failure.
f. Manual reset dry-run protection. Stop pumps if fuel level falls below pump suction.
g. Deenergize and alarm pump locked rotor condition.
h. Alarm open circuit, high and low voltage.
i. Indicating lights for power on, run, and off normal conditions.
j. Interface with automatic control system is specified in Division 23 Section "Instrumentation And Control For Hvac" to control and indicate the following:
    1) Start/stop pump set when required by schedule, fuel-fired appliance operation, day tank level control, or weather conditions.
    2) Operating status.
    3) Alarm off-normal status.

3. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
    a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
    b. Thermal-Overload Protection: Motor-winding temperature sensor.
    c. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 22.

U. Simplex Fuel-Oil Transfer Pumps
1. Description: Comply with UL 343, and HI M109.
    a. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
    b. Type: Positive-displacement, rotary type.
    c. Impeller: Steel gear with crescent **OR** Carbon vane, **as directed**.
    d. Housing: Cast-iron foot mounted.
    e. Bearings: Bronze, self-lubricating.
    f. Shaft: Polished steel.
    g. Seals: Mechanical.
    h. Base: Steel.
    i. Pressure Relief: Built in.
    j. Discharge Check Valve: Built in.
2. Drive: V-belt with guard; gear reducer; or direct, close coupled **OR** V-belt with guard **OR** Gear reducer **OR** Direct, close coupled, **as directed**.
3. Controls:
    a. Run pump to maintain minimum manifold pressure with outdoor-air temperature less than 60 deg F (16 deg C).
    b. Run pump on seven-day schedule.
    c. Alarm motor failure.
    d. Manual reset dry-run protection. Stop pump if fuel level falls below pump suction.
    e. Deenergize and alarm pump locked rotor condition.
    f. Alarm open circuit, high and low voltage.
    g. Indicating lights for power on, run, and off normal conditions.
    h. Interface with automatic control system is specified in Division 23 Section "Instrumentation And Control For Hvac" to control and indicate the following:
        1) Start/stop pump set when required by schedule, fuel-fired appliance operation, day tank level control, or weather conditions.
        2) Operating status.
        3) Alarm off-normal status.
4. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".

a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 22.

V. Duplex **OR** Triplex, **as directed**, Fuel-Oil Transfer Pump Sets
1. Description: Comply with HI M109.
   a. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
   b. Type: Positive-displacement, rotary type.
   c. Impeller: Steel gear with crescent **OR** Carbon vane, **as directed**.
   d. Housing: Cast-iron foot mounted.
   e. Bearings: Bronze, self-lubricating.
   f. Shaft: Polished steel.
   g. Seals: Mechanical.
   h. Base: Steel.
   i. Pressure Relief: Built in.
   j. Discharge Check Valve: Built in.
2. Drive: V-belt with guard, gear reducer, or direct close coupled **OR** V-belt with guard **OR** Gear reducer **OR** Direct close coupled, **as directed**.
3. Controls:
   a. Run pumps to maintain minimum manifold pressure with outdoor-air temperature less than 60 deg F (16 deg C).
   b. Run pumps on seven-day schedule.
   c. Stage pumps on pressure at a common supply manifold.
   d. Alternate pumps to equalize run time.
   e. Alarm motor failure.
   f. Manual reset dry-run protection. Stop pumps if fuel level falls below pump suction.
   g. Deenergize and alarm pump locked rotor condition.
   h. Alarm open circuit, high and low voltage.
   i. Indicating lights for power on, run, and off normal conditions.
   j. Interface with automatic control system is specified in Division 23 Section "Instrumentation And Control For Hvac" to control and indicate the following:
      1) Start/stop pump set when required by schedule, fuel-fired appliance operation, day tank level control, or weather conditions.
      2) Operating status.
      3) Alarm off-normal status.
4. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
   a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 22.
5. Piping Furnished with Pumps: Steel with ferrous fittings and threaded or welded joints.
6. Strainers Furnished with Pumps: Duplex, basket type with corrosion-resistant-metal-screen baskets.

W. Fuel Maintenance System
1. Description: Factory fabricated and wired fuel maintenance system for fuel-oil filtration; with enclosure, filter, fuel-oil pump, and controls; FMG approved, listed, and labeled by an NRTL acceptable to authorities having jurisdiction.
   a. Enclosure: NEMA 250, Type 3R, painted steel containing pumps, filters, accessories, and controls. Hinged door on the front of enclosure.

b. Pump: Comply with HI M109, steel-gear-with-crescent, positive-displacement, direct-coupled, rotary-type.
c. Materials: Cast-iron housing; bronze bearings; steel shaft; mechanical seals; and built-in, pressure relief bypass valve.
d. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
   1) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2) Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 22.
e. Piping: Steel with malleable-iron fittings and threaded joints or wrought-steel fittings and welded joints.
f. Multistage Filter: Spin-on, replaceable types.
   1) Stage 1: 100-mesh strainer.
   2) Stage 2: Centrifuge to separate particulates and water from oil.
   3) Stage 3: Coalescing water and particulate filter.
   4) Stage 4: 30-micron particulate removal.
   5) Stage 5: 10-micron particulate removal.
   6) Stage 6: Minimum 99.5 percent water removal with see-through bowl and water-sensor probe.
   7) Stage 7: 1.5 **OR** 3, **as directed**,-micron particulate removal.
g. Multiple-Tank Manifolds:
   1) Manifold fabricated of Schedule 80, black steel pipe and threaded nipples for two **OR** three **OR** four, **as directed**, tanks.
   2) Solenoid valves for supply and return piping to each tank.
   3) Strainers for each tank supply connection.
h. Programmable Logic Controller:
   1) Alarm on maximum 15-in. Hg (51-kPa) vacuum at pump suction indicating plugged filter.
   2) Alarm on high water level in filter.
   3) Alarm leak in enclosure.
   4) Touch screen; with minimum 2-line, 20-character, backlit, LCD display.
   5) Controller strip heater with thermostat.
i. Interface with automatic control system is specified in Division 23 Section "Instrumentation And Control For Hvac" to control and indicate the following:
   1) Start/stop system when required by schedule.
   2) Operating status.
   3) Alarm off-normal status.

X. Liquid-Level Gage System
1. Description: Calibrated, liquid-level gage system complying with UL 180 with floats **OR** UL 1238 with probes, **as directed**, or other sensors and remote annunciator panel.
2. Annunciator Panel: With visual and audible, high-tank-level and low-tank-level alarms, fuel indicator with registration in gallons (liters), and overfill alarm. Include gage volume range that covers fuel-oil storage capacity.
3. Controls: Electrical, operating on 120-V ac.

Y. Leak-Detection And Monitoring System
1. Cable and Sensor System: Comply with UL 1238.
   a. Calibrated, leak-detection and monitoring system with probes and other sensors and remote alarm panel for fuel-oil storage tanks and fuel-oil piping.
   b. Include fittings and devices required for testing.
   c. Controls: Electrical, operating on 120-V ac.
   d. Calibrated, liquid-level gage complying with UL 180 with floats **OR** UL 1238 with probes, **as directed,** or other sensors and remote annunciator panel.

e. Remote Annunciator Panel: With visual and audible, high-tank-level and low-tank-level alarms, fuel indicator with registration in gallons (liters), and overfill alarm. Include gage volume range that covers fuel-oil storage capacity.
f. Controls: Electrical, operating on 120-V ac.

2. Hydrostatic System: Comply with UL 1238.
a. Calibrated, leak-detection and monitoring system with brine antifreeze solution, reservoir sensor, and electronic control panel to monitor leaks in inner and outer tank walls.
b. Include fittings and devices required for testing.
c. Controls: Electrical, operating on 120-V ac.
d. Calibrated, liquid-level gage complying with UL 180 with floats **OR** UL 1238 with probes, **as directed**, or other sensors and remote annunciator panel.
e. Remote Annunciator Panel: With visual and audible, high-tank-level and low-tank-level alarms, fuel indicator with registration in gallons (liters), and overfill alarm. Include gage volume range that covers fuel-oil storage capacity.
f. Controls: Electrical, operating on 120-V ac.

Z. Fuel Oil
1. Fuel Oil: ASTM D 396, Grade No. 1 **OR** No. 2, **as directed**.
2. Diesel Fuel Oil: ASTM D 975, Grade Low Sulfur **OR** No. 1-D, special-purpose **OR** No. 2-D, general-purpose, **as directed**, high volatility.

AA. Sleeves
1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

BB. Mechanical Sleeve Seals
1. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
a. Sealing Elements: EPDM **OR** NBR, **as directed**, interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
b. Pressure Plates: Plastic **OR** Carbon steel **OR** Stainless steel, **as directed**.
c. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating **OR** Stainless steel, **as directed**, of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

CC. Escutcheons
1. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to fit around pipe or tube and with OD that completely covers opening.
2. One-Piece, Deep-Pattern Escutcheons: Deep-drawn brass with polished chrome-plated finish.
3. One-Piece, Cast-Brass Escutcheons: With set screw.
a. Finish: Polished chrome-plated **OR** Rough brass, **as directed**.
4. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
a. Finish: Polished chrome-plated **OR** Rough brass, **as directed**.
5. One-Piece, Stamped-Steel Escutcheons: With set screw **OR** spring clips, **as directed**, and chrome-plated finish.
6. Split-Plate, Stamped-Steel Escutcheons: With concealed **OR** exposed-rivet, **as directed**, hinge, set screw **OR** spring clips, **as directed**, and chrome-plated finish.
7. One-Piece, Floor-Plate Escutcheons: Cast-iron floor plate.
8. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

DD. Grout
1. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

a. Characteristics: Posthardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
b. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
c. Packaging: Premixed and factory packaged.

EE. Labeling And Identifying
1. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (152 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (762 mm) deep; colored yellow.

FF. Concrete Manholes
1. Precast Concrete Manhole Sections: ASTM C 478 (ASTM C 478M), base and concentric-cone sections with integral ladder or steps.
2. Cast-Iron Frame and Cover: Heavy-duty, water-resistant, cast-iron manhole frame, gasket, and bolted cover; 24-inch- (609-mm-) diameter, inside opening dimension; 8-inch (203-mm) frame riser height.

GG. Source Quality Control
1. Pressure test and inspect fuel-oil storage tanks, after fabrication and before shipment, according to ASME and the following:
a. Vertical **OR** Horizontal, **as directed**, Single-Wall Steel ASTs: UL 142.
b. Vertical **OR** Horizontal, **as directed**, Double-Wall Steel ASTs: UL 142, STI F921, and STI R931.
c. Horizontal, Containment-Dike, Steel ASTs: UL 142 and STI F911.
d. Horizontal, Concrete-Vaulted **OR** Concrete-Vaulted and Insulated **OR** Insulated, **as directed**, Steel ASTs: UL 142 and UL 2085.
e. Horizontal, Steel USTs with the STI-P3 Corrosion-Protection System: UL 58 and STI P3.
f. Composite **OR** Composite and Jacketed **OR** Jacketed, **as directed**, Steel USTs: UL 58.
g. FRP USTs: UL 1316.
2. Affix standards organization's code stamp.

1.3 EXECUTION

A. Earthwork
1. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

B. Preparation
1. Close equipment shutoff valves before turning off fuel oil to premises or piping section.
2. Comply with NFPA 30 and NFPA 31 requirements for prevention of accidental ignition.

C. Outdoor Piping Installation
1. Install underground fuel-oil piping buried at least 18 inches (457 mm) below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.
a. If fuel-oil piping is installed with less than 12 inches (305 mm) of cover to finished grade, install in containment piping.
2. Steel Piping with Protective Coating:
a. Apply joint cover kits to pipe after joining, to cover, seal, and protect joints.
b. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer. Review protective coating damage prior to repair.
OR
Replace pipe having damaged PE coating with new pipe.

3. Install double-containment, fuel-oil pipe at a minimum slope of 1 percent downward toward fuel-oil storage tank sump.
4. Install vent pipe at a minimum slope of 2 percent downward toward fuel-oil storage tank sump.
5. Assemble and install entry boots for pipe penetrations through sump sidewalls for liquid-tight joints.
6. Install metal pipes and tubes, fittings, valves, and flexible connectors at piping connections to AST and UST.
7. Install fittings for changes in direction in rigid pipe.
8. Install system components with pressure rating equal to or greater than system operating pressure.
9. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Install sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
10. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
11. Mechanical Sleeve Seal Installation: Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
12. Install pressure gage on suction **OR** suction and discharge, **as directed**, from each pump. Pressure gages are specified in Division 23 Section "Meters And Gages For Hvac Piping".

D. Indoor Piping Installation
1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
2. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
3. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
4. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
6. Install piping free of sags and bends.
7. Install fittings for changes in direction and branch connections.
8. Install escutcheons for penetrations of walls, ceilings, and floors.
   a. New Piping:
      1) Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      2) Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
         OR
         Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
      3) Piping at Ceiling Penetrations in Finished Spaces: One-piece **OR** Split-casting, **as directed**, cast-brass type with polished chrome-plated finish.
         OR
         Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type **OR** Split-plate, stamped-steel type with concealed hinge, **as directed**, and set screw.
      4) Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated **OR** rough-brass, **as directed**, finish.
         OR

Piping in Unfinished Service Spaces: One-piece, stamped-steel type with set screw **OR** spring clips, **as directed**.

5) Piping in Equipment Rooms: One-piece, cast-brass type.
OR
Piping in Equipment Rooms: One-piece, stamped-steel type with set screw **OR** spring clips, **as directed**.
6) Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

9. Existing Piping:
   1) Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
   OR
   Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.
   2) Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
   OR
   Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
   3) Piping in Unfinished Service Spaces: Split-casting, cast-brass type with polished chrome-plated **OR** rough-brass, **as directed**, finish.
   OR
   Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and set screw or spring clips.
   4) Piping in Equipment Rooms: Split-casting, cast-brass type.
   OR
   Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
   5) Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.
10. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping".
11. Verify final equipment locations for roughing-in.
12. Comply with requirements for equipment specifications in Division 14 AND Division 21 for roughing-in requirements.
13. Conceal pipe installations in walls, pipe spaces, or utility spaces; above ceilings; below grade or floors; and in floor channels unless indicated to be exposed to view.
14. Prohibited Locations:
    a. Do not install fuel-oil piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
    b. Do not install fuel-oil piping in solid walls or partitions.
15. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
16. Connect branch piping from top or side of horizontal piping.
17. Install unions in pipes NPS 2 (DN 50) and smaller at final connection to each piece of equipment and elsewhere as indicated. Unions are not required on flanged devices.
18. Do not use fuel-oil piping as grounding electrode.
19. Install Y-pattern **OR** basket **OR** T-pattern, **as directed**, strainer on inlet side of fuel-oil pump.

E. Valve Installation
1. Install manual fuel-oil shutoff valves on branch connections to fuel-oil appliance.
2. Install valves in accessible locations.
3. Protect valves from physical damage.
4. Install metal tag attached with metal chain indicating fuel-oil piping systems.
5. Identify valves as specified in Division 23 Section "Identification For Hvac Piping And Equipment".
6. Install oil safety valves at inlet of each oil-fired appliance.

7. Install pressure relief valves in distribution piping between the supply and return lines.
8. Install one-piece, bronze ball valve with hose end connection at low points in fuel-oil piping.
9. Install manual air vents at high points in fuel-oil piping.
10. Install emergency shutoff valves at dispensers (for systems with fuel-oil or diesel-fuel-oil dispensers).

F. Piping Joint Construction
1. Ream ends of pipes and tubes and remove burrs.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
4. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to "Quality Assurance" Article.
   a. Bevel plain ends of steel pipe.
   b. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
5. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
6. Flanged Joints: Install gasket material, size, type, and thickness for service application. Install gasket concentrically positioned.
7. Flared Joints: Comply with SAE J513. Tighten finger tight, then use wrench according to fitting manufacturer's written recommendations. Do not overtighten.
8. Fiberglass-Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

G. Fuel-Oil AST Installation
1. Install tank bases and supports.
2. Connect piping and vent fittings.
3. Install ground connections.
4. Install tank leak-detection and monitoring devices.
5. Install steel ASTs according to STI R912.
6. Install insulated and concrete-vaulted, steel ASTs according to STI R942.
7. Fill storage tanks with fuel oil.

H. Fuel-Oil UST Installation
1. Excavate to sufficient depth for a minimum of 3 feet (1 m) of earth cover from top of tank to finished grade. Allow for cast-in-place, concrete-ballast base plus 6 inches (150 mm) of sand or pea gravel between ballast base and tank. Extend excavation at least 12 inches (300 mm) around perimeter of tank.
2. Set tie-down eyelets for hold-down straps in concrete-ballast base and tie to reinforcing steel.
3. Place 6 inches (152 mm) of clean sand or pea gravel on top of concrete-ballast base.
4. Set tank on fill materials and install hold-down straps.
5. Connect piping.
6. Install tank leak-detection and monitoring devices.
7. Install containment sumps.
8. Backfill excavation with clean sand or pea gravel in 12-inch (305-mm) lifts and tamp backfill lift to consolidate.
9. Install filter mat between top of backfill material and earth fill.
10. Install steel USTs with the STI-P3 corrosion-protection system according to STI R821 and STI R891. Protect anodes during tank placement and backfilling operations.

11. Install composite, steel USTs according to STI R913 and STI R891.
12. Install jacketed, steel USTs according to STI R923 and STI R891.
13. Install FRP USTs with FRP hold-down straps, manhole extensions, and manhole risers.
14. Fill storage tanks with fuel oil.

I. Hanger And Support Installation
1. Pipe hanger and support and equipment support materials and installation requirements are specified in Division 23 Section "Hangers And Supports For Hvac Piping And Equipment".
2. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
   a. NPS 1-1/4 (DN 32) and Smaller: Maximum span, 84 inches (2130 mm); minimum rod size, 3/8 inch (10 mm).
   b. NPS 1-1/2 (DN 40): Maximum span, 108 inches (2740 mm); minimum rod size, 3/8 inch (10 mm).
   c. NPS 2 (DN 50): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (10 mm).
   d. NPS 2-1/2 (DN 65): Maximum span, 11 feet (3.4 m); minimum rod size, 1/2 inch (13 mm).
   e. NPS 3 (DN 80): Maximum span, 12 feet (3.7 m); minimum rod size, 1/2 inch (13 mm).
   f. NPS 4 (DN 100): Maximum span, 13 feet (4 m); minimum rod size, 5/8 inch (16 mm).
3. Support vertical steel pipe at each floor and at spacing not greater than 15 feet (4.5 m).
4. Install hangers for horizontal, drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:
   a. NPS 3/4 (DN 20) and Smaller: Maximum span, 60 inches (1524 mm); minimum rod size, 3/8 inch (10 mm).
   b. NPS 1 (DN 25): Maximum span, 72 inches (1830 mm); minimum rod size, 3/8 inch (10 mm).
   c. NPS 1-1/4 (DN 32): Maximum span, 84 inches (2130 mm); minimum rod size, 3/8 inch (10 mm).
   d. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): Maximum span, 96 inches (2440 mm); minimum rod size, 3/8 inch (10 mm).
   e. NPS 2-1/2 (DN 65): Maximum span, 108 inches (2740 mm); minimum rod size, 1/2 inch (13 mm).
   f. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod size, 1/2 inch (13 mm).
   g. NPS 4 (DN 100): Maximum span, 11 feet (3.4 m); minimum rod size, 5/8 inch (16 mm).
5. Support vertical copper tube at each floor and at spacing not greater than 10 feet (3 m).

J. Fuel-Oil Pump Installation
1. Submersible Pumps:
   a. Suspend pumps from supply piping and anchored to bottom of tank.
2. Transfer Pumps:
   a. Install pumps with access space for periodic maintenance including removal of motors, impellers, and accessories.
   b. Set pumps on and anchor to concrete base.
3. Install two-piece, full-port ball valves at suction and discharge of pumps.
4. Install mechanical leak-detector valves at pump discharge.
5. Install Y-pattern **OR** basket **OR** T-pattern, **as directed**, strainer on inlet side of simplex fuel-oil pumps.
6. Install check valve on discharge of simplex fuel-oil pumps.
7. Install suction piping with minimum fittings and change of direction.
8. Install vacuum and pressure gage, upstream and downstream respectively, at each pump to measure the differential pressure across the pump. Pressure gages are specified in Division 23 Section "Meters And Gages For Hvac Piping".

K. Fuel Maintenance System Installation
1. Install suction line, with foot valve, at one end of storage tank, 1 inch (25 mm) from the bottom of tank.
2. Install return line at the opposite end of storage tank from suction line.

L. Liquid-Level Gage System Installation
   1. Install liquid-level gage system. Locate panel inside building where indicated.

M. Leak-Detection And Monitoring System Installation
   1. Install leak-detection and monitoring system. Install alarm panel inside building where indicated.
      a. Double-Wall, Fuel-Oil Storage Tanks: Install probes **OR** Install probes or use factory-installed integral probes **OR** Use factory-installed integral probes, **as directed**, in interstitial space.
      b. Single-Wall, Fuel-Oil Storage Tanks: Install probes as indicated.
      c. Double-Containment, Fuel-Oil Piping: Install leak-detection sensor probes in fuel-oil storage tank containment sumps and at low points in piping **OR** cable probes in interstitial space of double-containment piping, **as directed**.
      d. Install liquid-level gage.

N. Connections
   1. Install piping adjacent to equipment to allow service and maintenance.
   2. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment having threaded pipe connection.
   3. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
   4. Connect piping to equipment with ball valve and union. Install union between valve and equipment.
   5. Install flexible piping connectors at final connection to burners or oil-fired appliances that must be moved for maintenance access.

O. Labeling And Identifying
   1. Nameplates, pipe identification, and signs are specified in Division 23 Section "Identification For Hvac Piping And Equipment".
      OR
      Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplates and signs on or near each service regulator, service meter, and earthquake valve.
      a. Text: In addition to identifying unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
   2. Install detectable warning tape directly above fuel-oil piping, 12 inches (304 mm) below finished grade, except 6 inches (152 mm) below subgrade under pavements and slabs. Terminate tracer wire in an accessible area, and identify as "tracer wire" for future use with plastic-laminate sign.
      a. Piping: Over underground fuel-oil distribution piping.
      b. Fuel-Oil Storage Tanks: Over edges of each UST.

P. Field Painting Of AST
   1. If shop painting AST, prepare and touch up damaged exterior surface of AST and supports, **as directed**, as specified in "Shop Painting of AST" Article.
   2. If field painting AST, prepare exterior steel surface of AST and tank supports, **as directed**.
   3. Field Cleaning: After fabrication, blast clean according to SSPC-SP 6/NACE No. 3 **OR** SSPC-SP 10/NACE No. 2, **as directed**.
   4. After cleaning, remove dust or residue from cleaned surfaces.
   5. If surfaces develop rust before prime coat is applied, repeat surface preparation.
   6. Prepare surface of AST and supports, **as directed**, and apply painting systems according to specifications in Division 09 Section "High-performance Coatings" for severe **OR** moderate **OR** mild, **as directed**, environment high-gloss **OR** semigloss, **as directed**, finish for ferrous metal.

Q. Field Painting Of Aboveground Piping
   1. Comply with requirements in Division 07 for painting interior and exterior fuel-oil piping.

2. Paint exposed, exterior metal piping, valves, and piping specialties, except components with factory-applied paint or protective coating.
   a. Alkyd System: MPI EXT 5.1D.
      1) Prime Coat: Alkyd anticorrosive metal primer.
      2) Intermediate Coat (for a Premium Grade system): Exterior alkyd enamel matching topcoat.
      3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
      4) Color: Gray, **as directed**.
3. Paint exposed, interior metal piping, valves, and piping specialties, except components with factory-applied paint or protective coating.
   a. Latex Over Alkyd Primer System: MPI INT 5.1Q.
      1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
      2) Intermediate Coat (for a Premium Grade system): Interior latex matching topcoat.
      3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
      4) Color: Gray, **as directed**.
   b. Alkyd System: MPI INT 5.1E.
      1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
      2) Intermediate Coat (for a Premium Grade system): Interior alkyd matching topcoat.
      3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
      4) Color: Gray, **as directed**.
4. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

R. Concrete Bases
1. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
   a. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
   b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (457-mm) centers around the full perimeter of the base.
   c. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   d. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   e. Install anchor bolts to elevations required for proper attachment to supported equipment.
   f. Use 3000-psig (20.7-MPa), **unless directed otherwise**, 28-day, compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-place Concrete".

S. Field Quality Control
1. Perform tests and inspections.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Tests and Inspections:
   a. Tanks: Minimum hydrostatic or compressed-air test pressures for fuel-oil storage tanks that have not been factory tested and do not bear the ASME code stamp or a listing mark acceptable to authorities having jurisdiction:
      1) Single-Wall Tanks: Minimum 3 psig (20.7 kPa) and maximum 5 psig (34.5 kPa).
      2) Double-Wall Tanks:
         a) Inner Tanks: Minimum 3 psig (20.7 kPa) and maximum 5 psig (34.5 kPa).
         b) Interstitial Space: Minimum 3 psig (20.7 kPa) and maximum 5 psig (34.5 kPa), or 5.3-in. Hg (18-kPa) vacuum.

3) Where vertical height of fill and vent pipes is such that the static head imposed on the bottom of the tank is greater than 10 psig (69 kPa), hydrostatically test the tank and fill and vent pipes to a pressure equal to the static head thus imposed.
4) Maintain the test pressure for one hour.

b. Piping: Minimum hydrostatic or pneumatic test-pressures measured at highest point in system:
1) Fuel-Oil Distribution Piping: Minimum 5 psig (34.5 kPa) for minimum 30 minutes.
2) Fuel-Oil, Double-Containment Piping:
a) Carrier Pipe: Minimum 5 psig (34.5 kPa) for minimum 30 minutes.
b) Containment Conduit: Minimum 5 psig (34.5 kPa) for minimum 60 minutes.
3) Suction Piping: Minimum 20-in. Hg (68 kPa) for minimum 30 minutes.
4) Isolate storage tanks if test pressure in piping will cause pressure in storage tanks to exceed 10 psig (69 kPa).

c. Inspect and test fuel-oil piping according to NFPA 31, "Tests of Piping" Paragraph; and according to requirements of authorities having jurisdiction.
d. Test liquid-level gage for accuracy by manually measuring fuel-oil levels at not less than three **OR** four **OR** five, **as directed**, different depths while filling tank and checking against gage indication.
e. Test leak-detection and monitoring system for accuracy by manually operating sensors and checking against alarm panel indication.
f. Start fuel-oil transfer pumps to verify for proper operation of pump and check for leaks.
g. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
h. Bleed air from fuel-oil piping using manual air vents.

3. Fuel-oil piping and equipment will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

T. Outdoor Piping Schedule
1. Underground fuel-oil piping shall be one of the following. Size indicated is carrier-pipe size.
a. Flexible, double-containment piping.
b. Rigid, double-containment piping.
2. Underground fuel-oil-tank fill and vent piping shall be one of the following:
a. NPS 2 (DN 50) and Smaller: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints. Coat pipe and fittings with protective coating for steel piping.
b. NPS 2-1/2 (DN 65) and Larger: Steel pipe, steel welding fittings, and welded joints. Coat pipe and fittings with protective coating for steel piping.
3. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
4. Aboveground fuel-oil piping shall be one of the following:
a. NPS 2 (DN 50) and Smaller: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints.
b. NPS 2-1/2 (DN 65) and Larger: Steel pipe, steel welding fittings, and welded joints.
c. Annealed **OR** Drawn, **as directed**,-temper copper tube with wrought-copper fittings and brazed joints.

U. Indoor Piping Schedule
1. Aboveground fuel-oil piping shall be one of the following:
a. NPS 1/2 (DN 15) and Smaller: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints **OR** Annealed-temper copper pipe, wrought copper fittings, and brazed or flared joints, **as directed**.
b. NPS 5/8 to NPS 2 (DN 18 to DN 50): Steel pipe, steel or malleable-iron threaded fittings, and threaded joints **OR** Drawn temper copper pipe, wrought copper fittings, and brazed joints, **as directed**.

c. NPS 2-1/2 (DN 65) and Larger: Steel pipe, steel fittings, and welded or flanged joints **OR** Drawn temper copper pipe, wrought copper fittings, and brazed or flanged joints, **as directed**.
d. Steel pipe with malleable-iron fittings and threaded joints.
e. Steel pipe with wrought-steel fittings and welded joints.
f. Annealed-temper copper tube, brass fittings, and flared joints.
g. Drawn-temper copper tubing, copper fittings, and brazed joints.

V. Aboveground Manual Fuel-Oil Shutoff Valve Schedule
1. Distribution piping valves for pipe NPS 2 (DN 50) and smaller shall be one of the following:
   a. One-piece, bronze ball valve with bronze trim.
   b. Two-piece, full **OR** regular, **as directed**,-port, bronze ball valves with bronze trim.
2. Distribution piping valves for pipe NPS 2-1/2 (DN 65) and larger shall be one of the following:
   a. Two-piece, full **OR** regular, **as directed**,-port, bronze ball valves with bronze trim.
   b. Bronze, nonlubricated **OR** lubricated, **as directed**, plug valve.
3. Valves in branch piping for single appliance shall be one of the following:
   a. One-piece, bronze ball valve with bronze trim.
   b. Two-piece, full **OR** regular, **as directed**,-port, bronze ball valves with bronze trim.

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SECTION 23 21 13 23a - RADIANT HEATING PIPING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for radiant heating piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes radiant heating piping, including pipes, fittings, and piping specialties.

C. Definitions
1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. PEX: Crosslinked polyethylene.
3. PEX/AL/PEX: Crosslinked polyethylene/aluminum/crosslinked polyethylene.

D. Submittals
1. Product Data: For each type of radiant heating pipe, fitting, manifold, specialty, and control.
   a. For radiant heating piping and manifolds, include pressure and temperature rating, oxygen-barrier performance, fire-performance characteristics, and water flow and pressure drop characteristics.
2. Shop Drawings: Show piping layout and details drawn to scale, including valves, manifolds, controls, and support assemblies, and their attachments to building structure.
3. Operation and Maintenance Data.

1.2 PRODUCTS

A. PEX Pipe And Fittings
1. Pipe Material: PEX plastic according to ASTM F 876.
2. Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.10 mg per cu. m/day at 104 deg F (40 deg C) according to DIN 4726.
3. Fittings: ASTM F 1807, metal insert and copper crimp rings.
4. Pressure/Temperature Rating: Minimum 100 psig (690 kPa) and 180 deg F (82 deg C).

B. PEX/AL/PEX Pipe And Fittings
1. Pipe Material: PEX plastic bonded to the inside and outside of a welded aluminum tube according to ASTM F 1281.
2. Oxygen Barrier: Limit oxygen diffusion through the pipe to maximum 0.10 mg per cu. m/day at 104 deg F (40 deg C) according to DIN 4726.
3. Fittings: ASTM F 1974, metal insert fittings with split ring and compression nut (compression joint) or metal insert fittings with copper crimp rings (crimp joint).
4. Flame-Spread and Smoke-Developed Indexes: 25 and 50 or less, respectively, tested according to ASTM E 84.
5. Pressure/Temperature Rating: Minimum 100 psig (690 kPa) and 210 deg F (99 deg C).

C. EPDM Pipe And Fittings
1. Pipe Material: Crosslinked EPDM inner and outer tubes.
2. Wall Thickness: Minimum 0.125 inch (3.2 mm).
3. Oxygen Barrier: Ductile aluminum foil layer applied to the inner tube to limit oxygen diffusion through the pipe to maximum 0.10 mg per cu. m/day at 104 deg F (40 deg C) according to DIN 4726.

4. Reinforcing Braid: Braided-aluminum wire between the inner and outer tube.
5. Fittings: ASTM F 1807, copper with stainless-steel crimps or clamps.
6. Pressure/Temperature Rating: Minimum 100 psig (690 kPa) and 210 deg F (99 deg C).

D. Distribution Manifolds
1. Manifold: Minimum NPS 1 (DN 25), brass **OR** copper **OR** modular plastic **OR** stainless steel, **as directed**.
2. Main Shutoff Valves:
   a. Factory installed on supply and return connections.
   b. Two **OR** Three, **as directed**,-piece body.
   c. Body: Brass or bronze.
   d. Ball: Chrome-plated bronze.
   e. Seals: PTFE.
   f. CWP Rating: 150 psig (1035 kPa).
   g. Maximum Operating Temperature: 225 deg F (107 deg C).
3. Manual Air Vents:
   a. Body: Bronze.
   b. Internal Parts: Nonferrous.
   c. Operator: Key furnished with valve, or screwdriver bit.
   d. Inlet Connection: NPS 1/2 (DN 15).
   e. Discharge Connection: NPS 1/8 (DN 6).
   f. CWP Rating: 150 psig (1035 kPa).
   g. Maximum Operating Temperature: 225 deg F (107 deg C).
4. Balancing Valves:
   a. Body: Plastic or bronze, ball or plug, or globe cartridge type.
   b. Ball or Plug: Brass or stainless steel.
   c. Globe Cartridge and Washer: Brass with EPDM composition washer.
   d. Seat: PTFE.
   e. Visual Flow Indicator: Flowmeter with visible indication in a clear plastic cap at top of valve.
      OR
      Differential Pressure Gage Connections: Integral seals for portable meter to measure loss across calibrated orifice.
   f. Handle Style: Lever or knob, with memory stop to retain set position if used for shutoff.
   g. CWP Rating: Minimum 125 psig (860 kPa).
   h. Maximum Operating Temperature: 250 deg F (121 deg C).
5. Zone Control Valves:
   a. Body: Plastic or bronze, ball or plug, or globe cartridge type.
   b. Ball or Plug: Brass or stainless steel.
   c. Globe Cartridge and Washer: Brass with EPDM composition washer.
   d. Seat: PTFE.
   e. Actuator: Replaceable electric motor.
   f. CWP Rating: Minimum 125 psig (860 kPa).
   g. Maximum Operating Temperature: 250 deg F (121 deg C).
6. Thermometers:
   a. Mount on supply and return connections.
   b. Case: Dry type, metal or plastic, 2-inch (50-mm) diameter.
   c. Element: Bourdon tube or other type of pressure element.
   d. Movement: Mechanical, connecting element and pointer.
   e. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
   f. Pointer: Black metal.
   g. Window: Plastic.
   h. Connector: Rigid, back type.
   i. Thermal System: Liquid- or mercury-filled bulb in copper-plated steel, aluminum, or brass stem.

j. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.
7. Mounting Brackets: Copper, or plastic or copper-clad steel, where in contact with manifold.

E. Piping Specialties
1. Cable Ties:
a. Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
b. Minimum Width: 1/8 inch (3 mm).
c. Tensile Strength: 20 lb (9 kg), minimum.
d. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
2. Floor-Mounting Staples:
a. Steel, with corrosion-resistant coating and smooth finish without sharp edges.
b. Minimum Thickness: 3/32 inch (2.4 mm).
c. Width: Minimum, wider than tubing.
3. Floor-Mounting Clamps:
a. Two bolt, steel, with corrosion-resistant coating and smooth finish without sharp edges.
b. Minimum Thickness: 3/32 inch (2.4 mm).
c. Width: Minimum, wider than tubing.
4. Floor Mounting Tracks:
a. Aluminum or plastic channel track with smooth finish, no sharp edges.
b. Minimum Thickness: 1/16 inch (1.6 mm).
c. Slot Width: Snap fit to hold tubing.
d. Slot Spacing: 2-inch (50-mm) **OR** 3-inch (75-mm), **as directed**, intervals.
5. Channeled Subfloor:
a. Plywood, APA-rated subfloor panel, composed of premium, tongue-and-groove, 7-layer, Douglas fir structural subfloor panels.
b. Particleboard manufactured to meet Federal Housing Authority standards of less than 0.3-ppm formaldehyde.
c. Clad panel with minimum 0.025-inch- (0.635-mm-) thick aluminum recessed in the grooves sized to maintain contact with radiant piping.
6. Modular Interlocking Blocks:
a. Polypropylene snap-together blocks with grooves to support piping.
b. Galvanized sheet metal or aluminum emission plates.
c. Natural mineralboard cover panel.
7. Heat-Emission Plates:
a. Formed aluminum suitable for radiant heating piping.
b. Minimum Thickness: 1/16 inch (1.6 mm).
c. Slot Width: Snap fit to maintain pressure fit on tubing.

F. Controls
1. Temperature-control devices and sequence of operations are specified in Division 23 Section(s) "Instrumentation And Control For Hvac" AND "Sequence Of Operations For Hvac Controls".
2. Wall-Mounting Thermostat:
a. Minimum temperature range from 50 to 90 deg F (10 to 32 deg C).
b. Manually operated with on-off switch.
c. Day and night setback and clock program with minimum four periods per day.
d. Operate pumps or open zone control valves if room temperature falls below the thermostat setting, and stop pumps or close zone control valves when room temperature rises above the thermostat setting.
3. Heated-Panel Thermostat:
a. Remote bulb unit with adjustable temperature range from 50 to 90 deg F (10 to 32 deg C).
b. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected pump or zone control valve.
c. Remote bulb on capillary tube, resistance temperature device, or thermistor for directly sensing radiant panel temperature.
d. Stop pump or close zone control valves if heated-panel thermostat setting is exceeded.

e. Corrosion-resistant, waterproof control enclosure.

4. Heated-Panel Thermostat with Outdoor Temperature Reset:
   a. Remote bulb unit with adjustable temperature range from 50 to 90 deg F (10 to 32 deg C).
   b. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected pump and zone control valve.
   c. Remote bulb on capillary tube, resistance temperature device, or thermistor for directly sensing radiant panel temperature.
   d. Remote bulb on capillary tube, resistance temperature device, or thermistor for directly sensing outdoor-air temperature.
   e. Operate zone control valves to reset supply-water temperature inversely with outdoor-air temperature as follows:
      1) Low outdoor-air temperature, zero deg F (minus 18 deg C) with high supply-water temperature 110 deg F (43 deg C).
      2) High outdoor-air temperature, 60 deg F (16 deg C) with low supply-water temperature 70 deg F (21 deg C).
   f. Corrosion-resistant, waterproof control enclosure.
5. Precipitation and Temperature Sensor:
   a. Microprocessor-based **OR** Automatic, **as directed**, control with manual on, automatic, and standby/reset switch.
   b. Precipitation and temperature sensors shall sense the surface conditions of pavement and shall be programmed to operate pump and zone control valves as follows:
      1) Temperature Span: 34 to 44 deg F (1 to 7 deg C).
      2) Adjustable Delay Off Span: 30 to 90 minutes.
      3) Start Pump or Open Zone Control Valves: Following two-minute delay if ambient temperature is below set point and precipitation is detected.
      4) Stop Pump or Close Zone Control Valves: On detection of a dry surface plus time delay.
   c. Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and precipitation and temperature sensors.
   d. Minimum 30-A contactor to start pump and open valves.
   e. Precipitation sensor shall be mounted in pavement.
   f. Provide relay with contacts to indicate operational status, on or off, for interface with central HVAC control system workstation.

1.3 EXECUTION

A. Applications
1. Install the following types of radiant heating piping for the applications described:
   a. Piping in Exterior Pavement: EPDM **OR** PEX **OR** PEX/AL/PEX, **as directed**.
   b. Piping in Interior Reinforced-Concrete Floors: EPDM **OR** PEX **OR** PEX/AL/PEX, **as directed**.
   c. Piping in Level Fill Concrete Floors (Not Reinforced): EPDM **OR** PEX **OR** PEX/AL/PEX, **as directed**.
   d. Piping in Ceilings: EPDM **OR** PEX **OR** PEX/AL/PEX, **as directed**.
   e. Piping in Subfloors: EPDM **OR** PEX **OR** PEX/AL/PEX, **as directed**.
   f. Piping below Wood Floors: EPDM **OR** PEX **OR** PEX/AL/PEX, **as directed**.

B. Installation
1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop or Coordination Drawings.
2. Install radiant heating piping continuous from the manifold through the heated panel and back to the manifold without piping joints in heated panels.

3. Connect radiant piping to manifold in a reverse-return arrangement.
4. Do not bend pipes in radii smaller than manufacturer's minimum bend radius dimensions.
5. Install manifolds in accessible locations, or install access panels to provide maintenance access as required in Division 08 Section "Access Doors And Frames".
6. Refer to Division 23 Section "Hydronic Piping" for pipes and connections to hydronic systems and for glycol-solution fill requirements.
7. Fire- and Smoke-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials according to Division 07 Section "Penetration Firestopping".
8. Piping in Exterior Pavement:
   a. Secure piping in concrete floors by attaching pipes to reinforcement using cable ties.
   b. Space cable ties a maximum of 18 inches (457 mm) o.c., and at center of turns or bends.
   c. Maintain 3-inch (75-mm) minimum cover.
   d. Install a sleeve of 3/8-inch- (9.5-mm-) thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches (250 mm) on each side of slab joints to protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.
   e. Maintain minimum 40-psig (275-kPa) pressure in piping during concrete placement and continue for 24 hours after placement.
9. Piping in Interior Reinforced-Concrete Floors:
   a. Secure piping in concrete floors by attaching pipes to reinforcement using cable ties.
   b. Space cable ties a maximum of 18 inches (457 mm) o.c., and at center of turns or bends.
   c. Maintain 2-inch (50-mm) minimum cover.
   d. Install a sleeve of 3/8-inch- (9.5-mm-) thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches (250 mm) on each side of slab joints to protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.
   e. Maintain minimum 40-psig (275-kPa) pressure in piping during concrete placement and continue for 24 hours after placement.
10. Piping in Level Fill Concrete Floors (Not Reinforced):
    a. Secure piping in concrete floors by attaching pipes to subfloor using tracks, clamps, or staples.
    b. Space tracks, clamps, or staples a maximum of 18 inches (457 mm) o.c., and at center of turns or bends.
    c. Maintain 3/4-inch (19-mm) minimum cover.
    d. Install a sleeve of 3/8-inch- (9.5-mm-) thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches (250 mm) on each side of slab joints to protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.
    e. Maintain minimum 40-psig (275-kPa) pressure in piping during the concrete pour and continue for 24 hours during curing.
11. Piping in Ceiling:
    a. Secure piping by attaching pipes to ceiling substrate using clamps or staples.
    b. Space clamps or staples a maximum of 18 inches (457 mm) o.c., and at center of turns or bends.
    c. Maintain 1-1/2-inch (38-mm) minimum plaster cover.
    d. Maintain minimum 40-psig (275-kPa) pressure in piping during the plaster application and continue for 24 hours during curing.
12. Piping in Subfloor:
    a. Secure piping by laying piping in subfloor channels or modular interlocking blocks.
    b. Use straight channel panels or blocks in the center, and curved channel panels or blocks at the ends.
    c. Finish floor with mineralboard panel cover or finished floor surface.
13. Piping below Wood Floor:
    a. Secure piping by attaching pipes to subfloor using heat-emission plates, clamps, or staples.

b. Space heat-emission plates, clamps, or staples a maximum of 4 inches (100 mm) o.c., and at center of turns or bends.
c. Install heat-emission plates on underside of wood subfloor with maximum space between plates, as noted above, to maintain pipe contact with floor.

14. Revise locations and elevations from those indicated as required to suit field conditions and ensure integrity of piping and as approved.
15. After system balancing has been completed, mark balancing valves to permanently indicate final position.
16. Perform the following adjustments before operating the system:
    a. Open valves to fully open position.
    b. Check operation of automatic valves.
    c. Set temperature controls so all zones call for full flow.
    d. Purge air from piping.
17. After the concrete or plaster heating panel has cured as recommended by concrete or plaster supplier, operate radiant heating system as follows:
    a. Start system heating at a maximum of 10 deg F (6 deg C) above the ambient radiant panel temperature, and increase 10 deg F (6 deg C) each following day until design temperature is achieved.
    b. For freeze protection, operate at a maximum of 60 deg F (16 deg C) supply-water temperature.

C. Field Quality Control
1. Prepare radiant heating piping for testing as follows:
    a. Open all isolation valves and close bypass valves.
    b. Open and verify operation of zone control valves.
    c. Flush with clean water, and clean strainers.
2. Tests and Inspections:
    a. Leak Test: After installation, charge system and test for leaks. Subject piping to hydrostatic test pressure that is not less than 1.5 times the design pressure but not more than 100 psig (690 kPa). Repair leaks and retest until no leaks exist.
    b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Remove and replace malfunctioning radiant heating piping components that do not pass tests, and retest as specified above.
4. Prepare a written report of testing.

END OF SECTION 23 21 13 23a

Task	Specification	Specification Description
23 21 13 23	21 05 23 00	Piped Utilities Basic Materials And Methods
23 21 13 23	23 11 23 00	Relief Wells
23 21 13 23	13 12 13 00	Water Distribution
23 21 13 23	23 11 23 00a	Monitoring Wells
23 21 13 23	22 11 23 23	Water Supply Wells
23 21 13 23	22 05 76 00	Sanitary Sewerage
23 21 13 23	23 05 29 00	Steam Distribution
23 21 13 23	07 63 00 00	Common Work Results for Fire Suppression
23 21 13 23	07 63 00 00a	Common Work Results for Plumbing
23 21 13 23	07 63 00 00b	Common Work Results for HVAC
23 21 13 23	22 11 16 00	Domestic Water Piping
23 21 13 23	22 11 16 00a	Sanitary Waste And Vent Piping
23 21 13 23	22 11 16 00b	Storm Drainage Piping
23 21 13 23	22 11 16 00c	Hydronic Piping
23 21 13 23	22 11 16 00d	Steam And Condensate Piping
23 21 13 23	22 11 16 00e	Refrigerant Piping
23 21 13 23	23 11 23 00b	Facility Natural-Gas Piping
23 21 13 23	23 11 23 00c	Facility Liquefied-Petroleum Gas Piping
23 21 13 23	22 11 16 00f	General-Service Compressed-Air Piping
23 21 13 23	22 11 16 00g	Compressed-Air Piping For Laboratory And Healthcare Facilities
23 21 13 23	22 11 16 00h	Vacuum Piping For Laboratory And Healthcare Facilities
23 21 13 23	22 11 16 00i	Gas Piping For Laboratory And Healthcare Facilities
23 21 16 00	01 22 16 00	No Specification Required
23 21 16 00	21 05 23 00	Piped Utilities Basic Materials And Methods
23 21 16 00	13 12 13 00	Water Distribution
23 21 16 00	23 05 29 00	Steam Distribution
23 21 16 00	22 12 23 26	Underground Storage Tanks
23 21 16 00	07 63 00 00	Common Work Results for Fire Suppression
23 21 16 00	07 63 00 00a	Common Work Results for Plumbing
23 21 16 00	07 63 00 00b	Common Work Results for HVAC
23 21 16 00	22 11 16 00c	Hydronic Piping
23 21 16 00	22 11 16 00d	Steam And Condensate Piping
23 21 16 00	22 11 16 00e	Refrigerant Piping
23 21 16 00	22 11 23 23a	Hydronic Pumps
23 21 16 00	23 21 13 23	Facility Fuel-Oil Piping
23 21 16 00	22 11 16 00f	General-Service Compressed-Air Piping
23 21 16 00	22 11 19 00	Electronic Air Cleaners
23 21 23 13	21 05 23 00	Piped Utilities Basic Materials And Methods
23 21 23 13	22 11 23 23	Water Supply Wells
23 21 23 13	22 11 23 23a	Hydronic Pumps
23 21 23 16	21 05 23 00	Piped Utilities Basic Materials And Methods
23 21 23 16	22 11 23 23	Water Supply Wells
23 21 23 16	22 11 23 23a	Hydronic Pumps

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SECTION 23 21 23 23 - ELECTRIC-DRIVE, VERTICAL-TURBINE FIRE PUMPS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for electric-drive, vertical-turbine fire pumps. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Vertical-turbine fire pumps.
      b. Fire-pump accessories and specialties.
      c. Flowmeter systems.

C. Performance Requirements
   1. Seismic Performance: Fire pumps shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   2. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig (1200 kPa) minimum unless higher pressure rating is indicated.

D. Submittals
   1. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, performance curves, electrical characteristics, and furnished specialties and accessories.
   2. Shop Drawings: For fire pumps, motor drivers, and fire-pump accessories and specialties. Include plans, elevations, sections, details, and attachments to other work.
      a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      b. Wiring Diagrams: For power, signal, and control wiring.
   3. Seismic Qualification Certificates: For fire pumps, accessories, and components, from manufacturer.
      a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
      c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
   4. Product Certificates: For each fire pump, from manufacturer.
   5. Source quality-control reports.
   6. Field quality-control reports.
   7. Operation and maintenance data.

E. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. NFPA Compliance: Comply with NFPA 20, "Installation of Stationary Pumps for Fire Protection."

1.2 PRODUCTS

A. General Requirements For Vertical-Turbine Fire Pumps
   1. Description: Factory-assembled and -tested fire-pump and driver unit.
   2. Base: Fabricated and attached to fire-pump and driver unit with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.
   3. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

B. Vertical-Turbine Fire Pumps
   1. Pump Head: Cast iron, for surface discharge.
      a. Discharge Outlet: With flange according to ASME B16.1 except connections may be threaded according to ASME B1.20.1, in sizes where flanges are not available.
      b. Pump Head Seal: Stuffing box and packing.
      c. Base: Cast iron or steel with hole for electrical cable.
   2. Pump:
      a. Standard: UL 448, for vertical-turbine pumps for fire service.
      b. Line Shaft: Stainless steel or steel, with corrosion-resistant shaft sleeves.
      c. Line Shaft Bearings: Rubber sleeve, water lubricated.
      d. Line Shaft: Steel.
      e. Line Shaft Bearings: Corrosion resistant, oil lubricated.
      f. Impeller Shaft: Monel metal or stainless steel.
      g. Bowl Section: Multiple cast-iron bowls with closed-type bronze or stainless-steel impellers.
      h. Column Pipe: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with threaded ends and cast-iron or steel fittings, in sections 10 feet (3 m) or less.
      i. Suction Strainer: Cast or fabricated, bronze or stainless steel, and sized to restrict passage of 0.5-inch (12.7-mm) spheres.
   3. Driver:
      a. Standard: UL 1004A.
      b. Type: Electric motor; NEMA MG 1, polyphase Design B.
      c. Mounting: On pump head above pump.

C. Fire-Pump Accessories And Specialties
   1. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump discharge piping.
   2. Relief Valves:
      a. Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.
   3. Outlet Fitting: Concentric tapered reducer at pump-head discharge outlet.
   4. Discharge Cone: Closed **OR** Open, **as directed**, type.
   5. Hose Valve Manifold Assembly:
      a. Standard: Comply with requirements in NFPA 20.
      b. Header Pipe: ASTM A 53/A 53M, Schedule 40, galvanized steel with ends threaded according to ASME B1.20.1.
      c. Header Pipe Fittings: ASME B16.4, galvanized cast-iron threaded fittings.
      d. Automatic Drain Valve: UL 1726.
      e. Manifold:
         1) Test Connections: Comply with UL 405 except provide outlets without clappers instead of inlets.
         2) Body: Flush type, brass or ductile iron, with number of outlets required by NFPA 20.
         3) Nipples: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with ends threaded according to ASME B1.20.1.
         4) Adapters and Caps with Chain: Brass or bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
         5) Escutcheon Plate: Brass or bronze; rectangular.
         6) Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.

7) Exposed Parts Finish: Polished **OR** Rough, **as directed**, brass, **as directed**, chrome plated, **as directed**.
8) Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

OR

Manifold:
1) Test Connections: Comply with UL 405 except provide outlets without clappers instead of inlets.
2) Body: Exposed type, brass, with number of outlets required by NFPA 20.
3) Escutcheon Plate: Brass or bronze; round.
4) Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads. Include caps and chains.
5) Exposed Parts Finish: Polished **OR** Rough, **as directed**, brass, **as directed**, chrome plated, **as directed**.
6) Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

D. Flowmeter Systems
1. Description: UL-listed or FM-Approved, fire-pump flowmeter system with capability to indicate flow to not less than 175 percent of fire-pump rated capacity.
2. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 250 psig (1725 kPa), **as directed**.
3. Sensor: Annubar probe, orifice plate, or venturi unless otherwise indicated. Sensor size shall match pipe, tubing, flowmeter, and fittings.
4. Permanently Mounted Flowmeter: Compatible with flow sensor; with dial not less than 4-1/2 inches (115 mm) in diameter. Include bracket or device for wall mounting.
   a. Tubing Package: NPS 1/8 or NPS 1/4 (DN 6 or DN 10) soft copper **OR** plastic, **as directed**, tubing with copper or brass fittings and valves.

   OR

   Portable Flowmeter: Compatible with flow sensor; with dial not less than 4-1/2 inches (115 mm) in diameter and with two 12-foot- (3.7-m-) long hoses in carrying case.

E. Grout
1. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
2. Characteristics: Nonshrink and recommended for interior and exterior applications.
3. Design Mix: 5000-psi (34-MPa), 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

F. Source Quality Control
1. Testing: Test and inspect fire pumps according to UL 448 requirements for "Operation Test" and "Manufacturing and Protection Tests."
   a. Verification of Performance: Rate fire pumps according to UL 448.
2. Fire pumps will be considered defective if they do not pass tests and inspections.
3. Prepare test and inspection reports.

1.3 EXECUTION

A. Installation
1. Fire-Pump Installation Standard: Comply with NFPA 20 for installation of fire pumps, relief valves, and related components.
2. Equipment Mounting: Install fire pumps on concrete bases. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-place Concrete".
   a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
d. Install anchor bolts to elevations required for proper attachment to supported equipment.

3. Install fire-pump discharge piping equal to or larger than size required by NFPA 20.
4. Support piping and pumps separately so weight of piping does not rest on pumps.
5. Install valves that are same size as connecting piping. Comply with requirements for fire-protection valves specified in Division 21 Section(s) "Fire-suppression Standpipes" OR "Wet-pipe Sprinkler Systems", **as directed**.
6. Install pressure gage on pump head discharge flange pressure-gage tapping. Comply with requirements for pressure gages specified in Division 21 Section(s) "Fire-suppression Standpipes" OR "Wet-pipe Sprinkler Systems", **as directed**.
7. Install flowmeters and sensors. Install flowmeter-system components and make connections according to NFPA 20 and manufacturer's written instructions.
8. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.
9. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

B. Alignment
1. Align pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.
2. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.
3. Align piping connection.
4. Align pump and driver shafts for angular and parallel alignment according to HI 2.4 and to tolerances specified by manufacturer.

C. Connections
1. Comply with requirements for piping and valves specified in Division 21 Section(s) "Fire-suppression Standpipes" OR "Wet-pipe Sprinkler Systems", **as directed**. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to pumps and equipment to allow service and maintenance.
3. Connect relief-valve discharge to drainage piping or point of discharge.
4. Connect flowmeter-system meters, sensors, and valves to tubing.
5. Connect fire pumps to their controllers.

D. Identification
1. Identify system components. Comply with requirements for fire-pump marking according to NFPA 20.

E. Field Quality Control
1. Test each fire pump with its controller as a unit. Comply with requirements for electric-motor-driver fire-pump controllers specified in Division 21 Section(s) "Electric-drive, Centrifugal Fire Pumps" OR "Diesel-drive, Centrifugal Fire Pumps" OR "Electric-drive, Vertical-turbine Fire Pumps" OR "Diesel-drive, Vertical-turbine Fire Pumps"
2. Perform tests and inspections.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
3. Tests and Inspections:
   a. After installing components, assemblies, and equipment including controller, test for compliance with requirements.
   b. Test according to NFPA 20 for acceptance and performance testing.

c. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
d. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
e. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

4. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.
5. Prepare test and inspection reports.
6. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to the Owner.

F. Startup Service
1. Perform startup service.
a. Complete installation and startup checks according to manufacturer's written instructions.

G. Demonstration
1. Train the Owner's maintenance personnel to adjust, operate, and maintain fire pumps.

END OF SECTION 23 21 23 23

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SECTION 23 21 23 23a - DIESEL-DRIVE, VERTICAL-TURBINE FIRE PUMPS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for diesel-drive, vertical-turbine fire pumps. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Vertical-turbine fire pumps.
      b. Fire-pump accessories and specialties.
      c. Flowmeter systems.

C. Performance Requirements
   1. Seismic Performance: Fire pumps shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   2. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig (1200 kPa) minimum unless higher pressure rating is indicated.

D. Submittals
   1. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, performance curves, electrical characteristics, and furnished specialties and accessories.
   2. Shop Drawings: For fire pumps, right-angle gear drives, engine drivers, and fire-pump accessories and specialties. Include plans, elevations, sections, details, and attachments to other work.
      a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      b. Wiring Diagrams: For power, signal, and control wiring.
   3. Seismic Qualification Certificates: For fire pumps, accessories, and components, from manufacturer.
      a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
      c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
   4. Product Certificates: For each fire pump, from manufacturer.
   5. Source quality-control reports.
   6. Field quality-control reports.
   7. Operation and maintenance data

E. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for location and application.
   2. NFPA Compliance: Comply with NFPA 20, "Installation of Stationary Pumps for Fire Protection."

1.2 PRODUCTS

A. General Requirements For Vertical-Turbine Fire Pumps
   1. Description: Factory-assembled and -tested fire pump, right-angle gear drive, and driver.
   2. Base: Fabricated and attached to fire pump, right-angle gear drive, and driver with reinforcement to resist movement of pump, gear drive, and driver during seismic events when base is anchored to building substrate.
   3. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

B. Vertical-Turbine Fire Pumps
   1. Pump Head: Cast iron, for surface discharge.
      a. Discharge Outlet: With flange according to ASME B16.1 except connections may be threaded according to ASME B1.20.1, in sizes where flanges are not available.
      b. Pump Head Seal: Stuffing box and packing.
      c. Base: Cast iron or steel with hole for electrical cable.
   2. Pump:
      a. Standard: UL 448, for vertical-turbine pumps for fire service.
      b. For static water levels of 50 feet (15 m) or less and for water-lubricated bearings.
         1) Line Shaft: Stainless steel or steel, with corrosion-resistant shaft sleeves.
         2) Line Shaft Bearings: Rubber sleeve, water lubricated.
      c. For static water levels between 50 and 200 feet (15 and 61 m) and for oil-lubricated bearings.
         1) Line Shaft: Steel.
         2) Line Shaft Bearings: Corrosion resistant, oil lubricated.
      d. Impeller Shaft: Monel metal or stainless steel.
      e. Bowl Section: Multiple cast-iron bowls with closed-type bronze or stainless-steel impellers.
      f. Column Pipe: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with threaded ends and cast-iron or steel fittings, in sections 10 feet (3 m) or less.
      g. Suction Strainer: Cast or fabricated, bronze or stainless steel, and sized to restrict passage of 0.5-inch (12.7-mm) spheres.
   3. Right-Angle Gear Drive:
      a. Description: FM-Approved, speed-reduction gear drive for pump speed control. Provide ratio for outlet speed of approximately 1760 rpm.
   4. Engine-to-Gear Drive Shaft: FM-Approved, telescoping, steel drive shaft with universal joint and grease fitting at each end. Include metal shaft guard.
   5. Driver:
      a. Standard: UL 1247.
      b. Type: Diesel engine.
      c. Emergency Manual Operator: Factory wired for starting and operating standby engine in case of malfunction in main controller or wiring.
      d. Engine Cooling System: Factory-installed radiator.
         1) Coolant: Type recommended by driver manufacturer.

         OR

         Engine Cooling System: Factory-installed water piping, valves, strainer, pressure regulator, heat exchanger, coolant pump, bypass piping, and fittings.
         1) Piping: ASTM B 88, Type L (ASTM B 88M, Type B), copper water tube; ASME B16.22, wrought-copper, solder-joint pressure fittings; AWS A5.8/A5.8M, BCuP Series brazing filler metal; and brazed joints.
      e. Engine-Jacket Water Heater: Factory-installed electric elements.
      f. Dual Batteries: Lead-acid-storage type with 100 percent standby reserve capacity.
      g. Fuel System: According to NFPA 20.
         1) Fuel Storage Tank: Size indicated but not less than required by NFPA 20. Include floor legs, direct-reading level gage, and secondary containment tank with capacity at least equal to fuel storage tank.

h. Exhaust System: ASTM A 53/A 53M, Type E or S, Schedule 40, black steel pipe; ASME B16.9, weld-type pipe fittings; ASME B16.5, steel flanges; and ASME B16.21, nonmetallic gaskets. Fabricate double-wall, ventilated thimble from steel pipe.
1) Exhaust Connector: Flexible type.
2) Exhaust Silencer: Industrial **OR** Residential, **as directed**, type.

C. Fire-Pump Accessories And Specialties
1. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump discharge piping.
2. Relief Valves:
a. Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.
3. Outlet Fitting: Concentric tapered reducer at pump-head discharge outlet.
4. Discharge Cone: Closed **OR** Open, **as directed**, type.
5. Hose Valve Manifold Assembly:
a. Standard: Comply with requirements in NFPA 20.
b. Header Pipe: ASTM A 53/A 53M, Schedule 40, galvanized steel with ends threaded according to ASME B1.20.1.
c. Header Pipe Fittings: ASME B16.4, galvanized cast-iron threaded fittings.
d. Automatic Drain Valve: UL 1726.
e. Manifold:
1) Test Connections: Comply with UL 405 except provide outlets without clappers instead of inlets.
2) Body: Flush type, brass or ductile iron, with number of outlets required by NFPA 20.
3) Nipples: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with ends threaded according to ASME B1.20.1.
4) Adapters and Caps with Chain: Brass or bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
5) Escutcheon Plate: Brass or bronze; rectangular.
6) Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
7) Exposed Parts Finish: Polished **OR** Rough, **as directed**, brass, **as directed**, chrome plated, **as directed**.
8) Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

OR

Manifold:
1) Test Connections: Comply with UL 405 except provide outlets without clappers instead of inlets.
2) Body: Exposed type, brass, with number of outlets required by NFPA 20.
3) Escutcheon Plate: Brass or bronze; round.
4) Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads. Include caps and chains.
5) Exposed Parts Finish: Polished **OR** Rough, **as directed**, brass, **as directed**, chrome plated, **as directed**.
6) Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

D. Flowmeter Systems
1. Description: UL-listed or FM-Approved, fire-pump flowmeter system with capability to indicate flow to not less than 175 percent of fire-pump rated capacity.
2. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 250 psig (1725 kPa), **as directed**.
3. Sensor: Annubar probe, orifice plate, or venturi unless otherwise indicated. Sensor size shall match pipe, tubing, flowmeter, and fittings.
4. Permanently Mounted Flowmeter: Compatible with flow sensor; with dial not less than 4-1/2 inches (115 mm) in diameter. Include bracket or device for wall mounting.
a. Tubing Package: NPS 1/8 or NPS 1/4 (DN 6 or DN 10) soft copper **OR** plastic, **as directed**, tubing with copper or brass fittings and valves.

OR
Portable Flowmeter: Compatible with flow sensor; with dial not less than 4-1/2 inches (115 mm) in diameter and with two 12-foot- (3.7-m-) long hoses in carrying case.

E. Grout
1. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
2. Characteristics: Nonshrink and recommended for interior and exterior applications.
3. Design Mix: 5000-psi (34-MPa), 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

F. Source Quality Control
1. Testing: Test and inspect fire pumps according to UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."
   a. Verification of Performance: Rate fire pumps according to UL 448.
2. Fire pumps will be considered defective if they do not pass tests and inspections.
3. Prepare test and inspection reports.

1.3 EXECUTION

A. Installation
1. Fire-Pump Installation Standard: Comply with NFPA 20 for installation of fire pumps, relief valves, and related components.
2. Equipment Mounting: Install fire pumps on concrete bases. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-place Concrete".
   a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   d. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install fire-pump discharge piping equal to or larger than size required by NFPA 20.
4. Support piping and pumps separately so weight of piping does not rest on pumps.
5. Install valves that are same size as connecting piping. Comply with requirements for fire-protection valves specified in Division 21 Section(s) "Fire-suppression Standpipes" OR "Wet-pipe Sprinkler Systems", **as directed**.
6. Install pressure gage on pump head discharge flange pressure-gage tapping. Comply with requirements for pressure gages specified in Division 21 Section(s) "Fire-suppression Standpipes" OR "Wet-pipe Sprinkler Systems", **as directed**.
7. Install piping hangers and supports, anchors, valves, gages, and equipment supports according to NFPA 20.
8. Install fuel system according to NFPA 20.
9. Install water supply and drain piping for diesel-engine heat exchangers. Extend drain piping from heat exchangers to point of disposal.
10. Install exhaust system piping for diesel engines. Extend to point of termination outside structure. Install pipe and fittings with welded joints; install components having flanged connections with gasketed joints.
11. Install condensate drain piping for diesel-engine exhaust system. Extend drain piping from low points of exhaust system to condensate traps and to point of disposal.
12. Install flowmeters and sensors. Install flowmeter-system components and make connections according to NFPA 20 and manufacturer's written instructions.
13. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.

14. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

B. Alignment
1. Align fire-pump-driver, right-angle gear-drive, and fire-pump shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.
2. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.
3. Align piping connections.
4. Align pump and driver shafts for angular and parallel alignment according to HI 2.4 and to tolerances specified by manufacturer.

C. Connections
1. Comply with requirements for piping and valves specified in Division 21 Section(s) "Fire-suppression Standpipes" OR "Wet-pipe Sprinkler Systems", **as directed**. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to pumps and equipment to allow service and maintenance.
3. Connect relief-valve discharge to drainage piping or point of discharge.
4. Connect flowmeter-system meters, sensors, and valves to tubing.
5. Connect fire pumps to their controllers.

D. Identification
1. Identify system components. Comply with requirements for fire-pump marking according to NFPA 20.

E. Field Quality Control
1. Test each fire pump with its right-angle gear drive and controller as a unit. Comply with requirements for electric-motor-driver fire-pump controllers specified in Division 21 Section(s) "Electric-drive, Centrifugal Fire Pumps" OR "Diesel-drive, Centrifugal Fire Pumps" OR "Electric-drive, Vertical-turbine Fire Pumps" OR "Diesel-drive, Vertical-turbine Fire Pumps".
2. Perform tests and inspections.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
3. Tests and Inspections:
   a. After installing components, assemblies, and equipment including controller, test for compliance with requirements.
   b. Test according to NFPA 20 for acceptance and performance testing.
   c. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   d. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   e. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.
5. Prepare test and inspection reports.
6. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to the Owner.

F. Startup Service
1. Perform startup service.
   a. Complete installation and startup checks according to manufacturer's written instructions.

G. Demonstration

1. Train the Owner's maintenance personnel to adjust, operate, and maintain fire pumps, right-angle gear drives, and fire-pump controllers.

END OF SECTION 23 21 23 23a

Task	Specification	Specification Description
23 21 23 23	21 05 23 00	Piped Utilities Basic Materials And Methods
23 21 23 23	22 11 23 23	Water Supply Wells
23 21 29 00	21 05 23 00	Piped Utilities Basic Materials And Methods
23 21 29 00	22 11 23 23a	Hydronic Pumps
23 22 16 00	21 05 23 00	Piped Utilities Basic Materials And Methods
23 22 16 00	13 12 13 00	Water Distribution
23 22 16 00	23 05 29 00	Steam Distribution
23 22 16 00	21 05 19 00	Meters and Gages for Plumbing Piping
23 22 16 00	21 05 19 00a	Meters and Gages for HVAC Piping
23 22 16 00	22 11 16 00d	Steam And Condensate Piping
23 22 16 00	22 11 16 00e	Refrigerant Piping
23 22 16 00	22 11 16 00f	General-Service Compressed-Air Piping

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SECTION 23 22 23 13 - STEAM CONDENSATE PUMPS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for steam condensate pumps. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes electric-driven and pressure-powered steam condensate pumps.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. Shop Drawings: Include details of installation.
      a. Include wiring diagrams.
   3. Operation and maintenance data.

D. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   2. ASME Compliance: Fabricate and label steam condensate pumps to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

E. Delivery, Storage, and Handling
   1. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
   2. Store steam condensate pumps in dry location.
   3. Retain protective covers for flanges and protective coatings during storage.
   4. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
   5. Comply with pump manufacturer's written rigging instructions.

1.2 PRODUCTS

A. Electric-Driven Steam Condensate Pumps
   1. Description: Factory-fabricated, packaged, electric-driven pumps; with receiver, pump(s), controls, and accessories suitable for operation with steam condensate.
   2. Configuration: Simplex **OR** Duplex, **as directed**, floor-mounting pump with receiver and float switch(es); rated to pump 200 deg F (93 deg C) steam condensate.
      a. Receiver: Floor-mounting, close-grained cast iron **OR** welded steel, **as directed**; with externally adjustable float switch(es), and flange(s) for pump mounting.
      b. Pump(s): Centrifugal, close coupled, vertical design, permanently aligned, and bronze fitted; with replaceable bronze case ring and mechanical seal; mounted on receiver flange.
      c. Factory Wiring: Between pump(s) and float switch(es), for single external electrical connection. Fused control power transformer if voltage exceeds 230 V.
      d. Electrical **OR** Mechanical, **as directed**, pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate if the normal start level for a single pump is exceeded.
   3. Configuration: Duplex floor-mounting pump with receiver and float switches; rated to pump 210 deg F (99 deg C) steam condensate.

a. Receiver: Floor-mounting, close-grained cast iron **OR** welded steel, **as directed**; with externally adjustable float switches and flanges for pump mounting.
b. Pumps: Regenerative turbine, close coupled, permanently aligned, and bronze fitted; with mechanical seals and an independent pump control circuit for each pump; mounted on base or receiver flange; rated to operate with a minimum of 2 feet (6 kPa) of NPSH.
c. Factory Wiring: Between pumps and float switches, for single external electrical connection. Fused control power transformer if voltage exceeds 230 V.
d. Electrical **OR** Mechanical, **as directed**, pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate if the normal start level for a single pump is exceeded.

4. Configuration: Duplex floor-mounting pumps with receiver and float switches; rated to pump minimum 200 deg F (93 deg C) **OR** 210 deg F (99 deg C), **as directed**, steam condensate.
   a. Receiver: Floor-mounting, close-grained cast iron **OR** welded steel, **as directed**; externally adjustable float switches; with water-level gage, steam condensate thermometer, discharge-pressure gage for each pump, bronze gate valves between receiver and pumps, flanges for pump mounting, and lifting eyebolts.
   b. Inlet Strainer: Cast iron with self-cleaning bronze screen, dirt pocket, and cleanout plug on receiver inlet.
   c. Pumps: Centrifugal, close coupled, vertical design, permanently aligned, and bronze fitted; with replaceable bronze case rings, stainless-steel shafts, and mechanical seals; mounted on receiver flanges; rated to operate with a minimum of 2 feet (6 kPa) of NPSH.
   d. Control Panel: NEMA 250, Type 1 **OR** 2 **OR** 12, **as directed**, enclosure with hinged door and grounding lug, mounted on pump; factory wired for single external electrical connection; and with the following components within cabinet:
      1) Motor controller for each pump.
      2) Electrical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate on receiver high level.
      3) Manual lead-lag control to override electrical pump alternator to manually select the lead pump.
      4) Momentary contact "TEST" push button on cover for each pump.
      5) Numbered terminal strip.
      6) Disconnect switch.
      7) Fused transformer for control circuit.
5. Configuration: Duplex floor-mounting pump with elevated receiver, float switches, and connecting piping; rated to pump 212 deg F (100 deg C) steam condensate.
   a. Receiver: Close-grained cast iron **OR** Welded steel, **as directed**, mounted on fabricated-steel supports; externally adjustable float switches; with water-level gage, steam condensate thermometer, pump discharge pressure gages, bronze isolation valves between receiver and pumps, and lifting eyebolts.
   b. Inlet Strainer: Cast iron with self-cleaning bronze screen, dirt pocket, and cleanout plug on receiver inlet.
   c. Pumps: Centrifugal, close coupled, permanently aligned, and bronze fitted; with replaceable bronze case rings, stainless-steel shafts, and mechanical seals; mounted on base below receiver; rated to operate with a minimum of 2 feet (6 kPa) of NPSH.
   d. Pipe: ASTM A 53/A 53M, Type S, Grade B or ASTM A 106; Schedule 80; seamless steel.
   e. Fittings NPS 2 (DN 50) and Smaller: ASME B16.1, Class 125 cast iron, threaded.
   f. Fittings NPS 2-1/2 (DN 65) and Larger: ASTM A 234/A 234M, steel, for welded connections.
   g. Control Panel: NEMA 250, Type 1 **OR** 2 **OR** 12, **as directed**, enclosure with hinged door and grounding lug; mounted on pump; factory wired for single external electrical connection; and with the following components within cabinet:
      1) Motor controller for each pump.
      2) Electrical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate on receiver high level.

3) Manual lead-lag control to override electrical alternator to manually select the lead pump.
4) Momentary contact "TEST" push button on cover for each pump.
5) Numbered terminal strip.
6) Disconnect switch.
7) Fused transformer for control circuit.

6. Configuration: Underground duplex pump with basin and float switches; rated to pump 200 deg F (93 deg C) steam condensate.
   a. Basin: Cast iron, with hub-type inlets.
   b. Basin Cover: Cast iron or steel with gasketed openings for access, pumps, pump shafts, control rods, discharge piping, and vent connections.
      1) Anchor Flange: Cast iron, attached to basin, in location and of size required to anchor basin to concrete slab.
   c. Pumps: Wet-pit mounted, vertical, flexible coupled, and suspended.
      1) Casing: Cast iron with open inlet.
      2) Shaft and Bearings: Stainless-steel shaft with oil-lubricated, bronze, intermediate sleeve bearings; 48-inch (1200-mm) maximum intervals where basin depth is more than 48 inches (1200 mm); and grease-lubricated, ball-type, thrust bearings.
      3) Shaft Couplings: Flexible, capable of absorbing vibration.
      4) Seals: Mechanical; with carbon rotating ring, bearing on a ceramic seat held by a stainless-steel spring, and enclosed by a flexible bellows and gasket.
      5) Motors: Vertically mounted on cast-iron pedestal.
      6) Pump Discharge Piping: Manufacturer's standard steel or bronze pipe, unless otherwise indicated.
   d. Control Panel: NEMA 250, Type 1 **OR** 2 **OR** 12, **as directed**, enclosure with hinged door and grounding lug; mounted on pump; factory wired for single external electrical connection; and with the following components within cabinet:
      1) Motor controller for each pump.
      2) Electrical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate on receiver high level.
      3) Manual lead-lag control to override electrical alternator to manually select the lead pump.
      4) Momentary contact "TEST" push button on cover for each pump.
      5) Numbered terminal strip.
      6) Disconnect switch.
      7) Fused transformer for control circuit.

B. Pressure-Powered Steam Condensate Pumps
1. Description: Factory-fabricated, pressure-powered pumps with mechanical controls, valves, piping connections, and accessories suitable for pumping steam condensate using steam **OR** compressed air, **as directed**.
2. Configuration: Simplex **OR** Duplex, **as directed**, pump with float-operated valve control.
   a. Pump Body: Cast iron **OR** Welded steel, **as directed**.
   b. Piping Connections: Threaded; for steam condensate, operating medium, vent, and indicated accessories.
   c. Level Gage: Glass site gage with shutoff cocks.
   d. Valves: Manufacturer's standard check valves on inlet and outlet.
   e. Internal Parts: Stainless-steel float, springs, and actuating mechanism.
   f. Valve Seals: Replaceable from exterior.
   g. Receiver: Cast iron **OR** Welded steel, **as directed**, factory mounted on steel supports; with water-level site glass and threaded piping connections.
   h. Pipe: ASTM A 53/A 53M, Type S, Grade B or ASTM A 106; Schedule 80; seamless steel.
   i. Fittings: ASME B16.1, Class 125 cast iron, threaded.

C. Motors

1. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".

1.3 EXECUTION

A. Installation
1. Install pumps according to HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."
2. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
3. Support pumps and piping separately so piping is not supported by pumps.
4. Install pumps on concrete bases. Anchor pumps to bases using inserts or anchor bolts.
5. Install thermometers and pressure gages.

B. Connections
1. Install piping adjacent to machine to allow service and maintenance.
2. Install steam supply for pressure-powered pumps as required by Division 23 Section "Steam And Condensate Heating Piping".
3. Install compressed-air supply for pressure-powered pumps as required by Division 22 Section "General-service Compressed-air Piping".
4. Install gate and check valves on inlet and outlet of pressure-powered pumps.
5. Install check valve, gate valve, and globe valve at pump discharge connections for each electric-driven pump.
6. Pipe drain to nearest floor drain for overflow and drain piping connections.
7. Install full-size vent piping to outdoors, terminating in 180-degree elbow at point above highest steam system connection or as indicated.
8. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
9. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

END OF SECTION 23 22 23 13

Task	Specification	Specification Description
23 23 13 00	21 05 23 00	Piped Utilities Basic Materials And Methods
23 23 13 00	22 11 16 00e	Refrigerant Piping
23 23 16 00	07 63 00 00	Common Work Results for Fire Suppression
23 23 16 00	07 63 00 00a	Common Work Results for Plumbing
23 23 16 00	07 63 00 00b	Common Work Results for HVAC
23 23 16 00	22 11 16 00a	Sanitary Waste And Vent Piping
23 23 16 00	22 11 16 00b	Storm Drainage Piping
23 23 16 00	22 11 16 00c	Hydronic Piping
23 23 16 00	22 11 16 00e	Refrigerant Piping
23 23 16 00	23 01 60 71	Condensing Units
23 23 23 00	23 01 60 71	Condensing Units

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SECTION 23 25 13 00 - HVAC WATER TREATMENT

A. Description Of Work
1. This specification covers the furnishing and installation of materials for HVAC water treatment. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work

B. Summary
1. This Section includes the following HVAC water-treatment systems:
   a. Bypass chemical-feed equipment and controls.
   b. Biocide chemical-feed equipment and controls.
   c. Ozone-generator biocide equipment and controls.
   d. UV-irradiation unit, biocide equipment, and controls.
   e. Chemical treatment test equipment.
   f. HVAC water-treatment chemicals.
   g. Makeup water softeners.
   h. RO equipment for HVAC makeup water.
   i. Water filtration units for HVAC makeup water.

C. Definitions
1. EEPROM: Electrically erasable, programmable read-only memory.
2. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
3. RO: Reverse osmosis.
4. TDS: Total dissolved solids.
5. UV: Ultraviolet.

D. Performance Requirements
1. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.
2. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
3. Closed hydronic systems, including hot-water heating, chilled water, dual-temperature water, and glycol cooling, shall have the following water qualities:
   a. pH: Maintain a value within 9.0 to 10.5.
   b. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
   c. Boron: Maintain a value within 100 to 200 ppm.
   d. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
   e. Soluble Copper: Maintain a maximum value of 0.20 ppm.
   f. TDS: Maintain a maximum value of 10 ppm.
   g. Ammonia: Maintain a maximum value of 20 ppm.
   h. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
   i. Microbiological Limits:
      1) Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
      2) Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.
      3) Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
      4) Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
      5) Iron Bacteria: Maintain a maximum value of 0 organisms/ml.
4. Steam Boiler and Steam Condensate:
   a. Steam Condensate:
      1) pH: Maintain a value within 7.8 to 8.4.
      2) Total Alkalinity: Maintain a value within 5 to 50 ppm.

3) Chemical Oxygen Demand: Maintain a maximum value of 15 ppm.
4) Soluble Copper: Maintain a maximum value of 0.20 ppm.
5) TDS: Maintain a maximum value of 10 ppm.
6) Ammonia: Maintain a maximum value of 20 ppm.
7) Total Hardness: Maintain a maximum value of 2 ppm.

b. Steam boiler operating at 15 psig (104 kPa) and less shall have the following water qualities:
1) "OH" Alkalinity: Maintain a value within 200 to 400 ppm.
2) TDS: Maintain a value within 600 to 3000 ppm.

c. Steam boiler operating at more than 15 psig (104 kPa) shall have the following water qualities:
1) "OH" Alkalinity: 200 to 400 ppm.
2) TDS: Maintain a value within 600 to 1200 ppm to maximum 30 times RO water TDS.

5. Open hydronic systems, including condenser **OR** fluid-cooler spray, **as directed**, water, shall have the following water qualities:
a. pH: Maintain a value within 8.0 to 9.1.
b. "P" Alkalinity: Maintain a maximum value of 100 ppm.
c. Chemical Oxygen Demand: Maintain a maximum value of 100ppm.
d. Soluble Copper: Maintain a maximum value of 0.20 ppm.
e. TDS: Maintain a maximum value of 10 ppm.
f. Ammonia: Maintain a maximum value of 20 ppm.
g. Free "OH" Alkalinity: Maintain a maximum value of 0 ppm.
h. Microbiological Limits:
1) Total Aerobic Plate Count: Maintain a maximum value of 10,000 organisms/ml.
2) Total Anaerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
3) Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
4) Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
5) Iron Bacteria: Maintain a maximum value of 0 organisms/ml.
i. Polymer Testable: Maintain a minimum value within 10 to 40.

6. Passivation for Galvanized Steel: For the first 60 days of operation.
a. pH: Maintain a value within 7 to 8.
b. Calcium Carbonate Hardness: Maintain a value within 100 to 300 ppm.
c. Calcium Carbonate Alkalinity: Maintain a value within 100 to 300 ppm.

E. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems. Include plans, elevations, sections, details, and attachments to other work.
a. Wiring Diagrams: Power and control wiring.
3. Field quality-control test reports.
4. Manufacturer Seismic Qualification Certification
5. Other Informational Submittals:
a. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.
b. Water Analysis: Illustrate water quality available at Project site.
c. Passivation Confirmation Report: Verify passivation of galvanized-steel surfaces, and confirm this observation in a letter to the Owner.

F. Quality Assurance
1. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.2 PRODUCTS

A. Manual Chemical-Feed Equipment
1. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch (89-mm) fill opening in the top, and NPS 3/4 (DN 20) bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
a. Capacity: 2 gal. (7.6 L) **OR** 5 gal. (19 L), **as directed**.
b. Minimum Working Pressure: 125 psig (860 kPa) **OR** 175 psig (1210 kPa), **as directed**.

B. Automatic Chemical-Feed Equipment
1. Water Meter:
a. AWWA C700, oscillating-piston, magnetic-drive, totalization meter.
b. Body: Bronze.
c. Maximum Pressure Loss at Design Flow: 3 psig (20 kPa).
d. Registration: Gallons (Liters) or cubic feet (cubic meters).
e. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250-V ac; and that will close at adjustable increments of total flow.
2. Water Meter:
a. AWWA C701, turbine-type, totalization meter.
b. Body: Bronze.
c. Minimum Working-Pressure Rating: 100 psig (690 kPa).
d. Maximum Pressure Loss at Design Flow: 3 psig (20 kPa).
e. Registration: Gallons (Liters) or cubic feet (cubic meters).
f. End Connections: Threaded.
g. Control: Low-voltage signal capable of transmitting 1000 feet (305 m).
3. Water Meter:

4. AWWA C701, turbine-type, totalization meter.
a. Body: Bronze **OR** Epoxy-coated cast iron, **as directed**.
b. Minimum Working-Pressure Rating: 150 psig (1035 kPa).
c. Maximum Pressure Loss at Design Flow: 3 psig (20 kPa).
d. Registration: Gallons (Liters) or cubic feet (cubic meters).
e. End Connections: Flanged.
f. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250-V ac; and that will close at adjustable increments of total flow.
5. Inhibitor Injection Timers:
a. Microprocessor-based controller with LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Division 23 Section "Instrumentation And Control For Hvac".
b. Programmable timers with infinite adjustment over full range, and mounted in cabinet with hand-off-auto switches and status lights.
c. Test switch.
d. Hand-off-auto switch for chemical pump.
e. Illuminated legend to indicate feed when pump is activated.
f. Programmable lockout timer with indicator light. Lockout timer to deactivate the pump and activate alarm circuits.
g. LCD makeup totalizer to measure amount of makeup and bleed-off water from two water meter inputs.
6. pH Controller:

a. Microprocessor-based controller, 1 percent accuracy in a range from zero to 14 units. Incorporate solid-state integrated circuits and digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Division 23 Section "Instrumentation And Control For Hvac".
b. Digital display and touch pad for input.
c. Sensor probe adaptable to sample stream manifold.
d. High, low, and normal pH indication.
e. High or low pH alarm light, trip points field adjustable; with silence switch.
f. Hand-off-auto switch for acid pump.
g. Internal adjustable hysteresis or deadband.

7. TDS Controller:
a. Microprocessor-based controller, 1 percent accuracy in a range from zero to 5000 micromhos. Incorporate solid-state integrated circuits and digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Division 23 Section "Instrumentation And Control For Hvac".
b. Digital display and touch pad for input.
c. Sensor probe adaptable to sample stream manifold.
d. High, low, and normal conductance indication.
e. High or low conductance alarm light, trip points field adjustable; with silence switch.
f. Hand-off-auto switch for solenoid bleed-off valve.
g. Bleed-off valve activated indication.
h. Internal adjustable hysteresis or deadband.
i. Bleed Valves:
1) Cooling Systems: Forged-brass body, globe pattern, general-purpose solenoid with continuous-duty coil, or motorized valve.
2) Steam Boilers: Motorized ball valve, steel body, and TFE seats and seals.

8. Biocide Feeder Timer:
a. Microprocessor-based controller with digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Division 23 Section "Instrumentation And Control For Hvac".
b. 24-hour timer with 14-day skip feature to permit activation any hour of day.
c. Precision, solid-state, bleed-off lockout timer and clock-controlled biocide pump timer. Prebleed and bleed lockout timers.
d. Solid-state alternator to enable use of two different formulations.
e. 24-hour display of time of day.
f. 14-day display of day of week.
g. Battery backup so clock is not disturbed by power outages.
h. Hand-off-auto switches for biocide pumps.
i. Biocide A and Biocide B pump running indication.

9. Chemical Solution Tanks:
a. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
b. Molded cover with recess for mounting pump.
c. Capacity: 30 gal. (114 L) **OR** 50 gal. (189 L) **OR** 120 gal. (454 L), **as directed**.

10. Chemical Solution Injection Pumps:
a. Self-priming, positive-displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
b. Adjustable flow rate.
c. Metal and thermoplastic construction.
d. Built-in relief valve.
e. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".

11. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A 269, Type 304, stainless steel for steam boiler injection assemblies.
12. Injection Assembly:
    a. Quill: Minimum NPS 1/2 (DN 15) with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
    b. Ball Valve: Three **OR** Two, **as directed**,-piece, stainless steel; selected to fit quill.
    c. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
    d. Assembly Pressure/Temperature Rating: Minimum 600 psig (4137 kPa) at 200 deg F (93 deg C).

C. Ozone-Generator Biocide Equipment
1. Corona discharge generator with stainless-steel generating cells, and transformer housed in a NEMA 250, Type 4 enclosure. Assembly shall be suitable for continuous duty. Provide site glasses to verify proper operation of generator.
2. Water-cooled generators shall be provided with cooling water at maximum 70 deg F (21 deg C) and 35 psig (241 kPa).
3. Generator vessels exposed to system pressure shall be constructed according to ASME Boiler and Pressure Vessel Code and be equipped with pressure relief valve.
4. External air compressor or induced airflow through a cleanable prefilter supplies concentrated oxygen through a molecular sieve with minus 62 deg F (minus 52 deg C) dew point to avoid the formation of nitric acid.
5. Microprocessor-based control with software in EEPROM, surge protection, high-temperature cutout, and operational status lights. Interface for start/stop and status indication at central workstation as described in Division 23 Section "Instrumentation And Control For Hvac".
6. Ozone Contactors:
    a. Bubble diffusers.
    b. Induction injection nozzle.
    c. Injectors with static mixers.
7. Ozone Detector and Alarm Devices:
    a. Detector:
        1) Sensor: Metal dioxide semiconductor.
        2) Concentration Range: 0.01 to 0.14 ppm.
        3) Accuracy: Plus or minus 20 percent of range.
        4) Sensitivity: 0.01 ppm.
        5) Response Time: Maximum 10 seconds.
        6) Operating Temperature: 50 to 100 deg F (10 to 38 deg C).
        7) Relatively Humidity: 20 to 95 percent, noncondensing over the operating temperature range.
    b. Horns:
        1) Electric-vibrating-polarized type.
        2) 24-V dc; with provision for housing the operating mechanism behind a grille.
        3) Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn.
    c. Visible Alarm Devices:
        1) Xenon strobe lights listed in UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate.
        2) Rated Light Output: 75 **OR** 110, **as directed**, candela.
        3) Strobe Leads: Factory connected to screw terminals.
8. Self-Contained Breathing Apparatus: Open-circuit, pressure-demand, compressed air includes completely assembled, portable, self-contained devices designed for hazardous breathing environment application.
    a. Face Piece: EPDM or silicone rubber construction material, one-size-fits-all with double-sealing edge, stainless-steel speaking diaphragm and lens retainer, five adjustable straps to hold face piece to head (two straps on each side and one on top), exhalation valve in

mask, close-fitting nose piece to ensure no CO_2 buildup, and perspiration drain to avoid skin irritation and to prevent eyepiece, spectacle, and lens fogging.

b. Backplate: Orthopedically designed of chemical and impact-resistant, glass-fiber composite **OR** aluminum, **as directed**.

c. Harness and Carrier Assembly: Large triangular back pad, backplate, and adjustable waist and shoulder straps. Modular in design, detachable components, and easy to clean and maintain. Shoulder straps padded with flame-resistant material, reinforced with stainless-steel cable, and attached with T-nuts, washers, and screws.

d. Air Cylinder: 30 **OR** 45 **OR** 60, **as directed**,-minute, low-pressure, air-supply-loaded fiberglass **OR** aluminum **OR** steel, **as directed**, cylinders fitted with quick-fill assembly for refilling and air transfer.

e. Wall-Mounting Cabinet: Leakproof, corrosion-resistant, clear, plastic case.

f. Tested and Certified: By the National Institute for Occupational Safety and Health and by the Mine Safety and Health Administration, according to 42 CFR 84, Subpart H.

D. Stainless-Steel Pipes And Fittings

1. Stainless-Steel Tubing: Comply with ASTM A 269, Type 316.
2. Stainless-Steel Fittings: Complying with ASTM A 815/A 815M, Type 316, Grade WP-S.
3. Two-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, carbon-filled TFE seats, threaded body design with adjustable stem packing, threaded ends, and 250-psig (1725-kPa) SWP and 600-psig (4140-kPa) CWP ratings.
4. Three-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, threaded body design with adjustable stem packing, threaded ends, and 150-psig (1035-kPa) SWP and 600-psig (4140-kPa) CWP rating.

E. UV Biocide Equipment

1. Target Irradiation: Minimum 30,000 microwatts x s/sq. cm.
2. Light Source Vessels:
   a. ASTM A 666, Type 304 stainless steel.
   b. Construct for minimum 150 psig (1035 kPa) at 150 deg F (65 deg C) according to ASME Boiler and Pressure Vessel Code, and equipped with pressure relief valve.
   c. Light Source Sleeve: Quartz, with EPDM O-ring seals.
   d. Light Source: Replaceable UV lamp producing minimum target irradiation of 254-nm wavelength light.
3. Controls: Interlock with pumps to operate when water is circulating.

F. Chemical Treatment Test Equipment

1. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounting cabinet for testing pH, TDS, inhibitor, chloride, alkalinity, and hardness; sulfite and testable polymer tests for high-pressure boilers, and oxidizing biocide test for open cooling systems.
2. Sample Cooler:
   a. Tube: Sample.
      1) Size: NPS 1/4 (DN 8) tubing.
      2) Material: ASTM A 666, Type 316 stainless steel.
      3) Pressure Rating: Minimum 2000 psig (13 790 kPa).
      4) Temperature Rating: Minimum 850 deg F (454 deg C).
   b. Shell: Cooling water.
      1) Material: ASTM A 666, Type 304 stainless steel.
      2) Pressure Rating: Minimum 250 psig (1725 kPa).
      3) Temperature Rating: Minimum 450 deg F (232 deg C).
   c. Capacities and Characteristics:
      1) Tube: Sample.
         a) Flow Rate: 0.25 gpm (0.016 L/s).

b) Entering Temperature: 400 deg F (204 deg C).
c) Leaving Temperature: 88 deg F (31 deg C).
d) Pressure Loss: 6.5 psig (44.8 kPa).
2) Shell: Cooling water.
a) Flow Rate: 3 gpm (0.19 L/s).
b) Entering Temperature: 70 deg F (21 deg C).
c) Pressure Loss: 1.0 psig (6.89 kPa).
3. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.
a. Two-station rack for closed-loop systems.
b. Four-station rack for open systems.

G. Chemicals
1. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1.1 "Performance Requirements" Article.
2. Water Softener Chemicals:
a. Mineral: High-capacity, sulfonated-polystyrene ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock. Resin exchange capacity minimum 30,000 grains/cu. ft. (69 kg/cu. m) of calcium carbonate of resin when regenerated with 15 lb (6.8 kg) of salt.
b. Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are not acceptable.

H. HVAC Makeup Water Softener
1. Description: Twin mineral tanks and one brine tank, factory mounted on skid.
2. Fabricate supports and attachments to tanks with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure as recommended in writing by manufacturer.
3. Mineral Tanks:
a. Fabricate and label steel filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
b. Fabricate and label FRP filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section X, if indicated.
c. Pressure Rating: 100 psig (690 kPa) **OR** 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, minimum.
d. Wetted Components: Suitable for water temperatures from 40 to at least 100 deg F (5 to at least 38 deg C).
e. Freeboard: 50 percent, minimum, for backwash expansion above the normal resin bed level.
f. Support Legs or Skirt: Constructed of structural steel, welded or bonded to tank before testing and labeling.
g. Finish: Hot-dip galvanized on exterior and interior of tank after fabrication.
h. Upper Distribution System: Single-point type, fabricated from galvanized-steel pipe and fittings.
i. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from PVC pipe and fittings with individual, fine-slotted, nonclogging PE strainers; arranged for even-flow distribution through resin bed.
4. Controls: Automatic; factory mounted on mineral tanks and factory wired.
a. Adjustable duration of regeneration steps.
b. Push-button start and complete manual operation override.
c. Pointer on pilot-control valve shall indicate cycle of operation.
d. Means of manual operation of pilot-control valve if power fails.
e. Main Operating Valves: Industrial, automatic, multiport, diaphragm type with the following features:

1) Slow opening and closing, nonslam operation.
2) Diaphragm guiding on full perimeter from fully open to fully closed.
3) Isolated dissimilar metals within valve.
4) Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.
5) Float-operated brine valve to automatically measure the correct amount of brine to the softener and refill with fresh water.
6) Sampling cocks for soft water.

f. Flow Control: Automatic control of backwash and flush rates over variations in operating pressures that do not require field adjustments. Equip mineral tanks with automatic-reset-head water meter that electrically activates cycle controller to initiate regeneration at preset total in gallons (liters), and automatically resets after regeneration to preset total in gallons (liters) for next service run. Include alternator to regenerate one mineral tank with the other in service.

5. Brine Tank: Combination measuring and wet-salt storing system.
   a. Tank and Cover Material: Fiberglass a minimum of 3/16 inch (4.8 mm) thick; or molded PE a minimum of 3/8 inch (9.5 mm) thick.
   b. Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawn and freshwater refill.
   c. Size: Large enough for at least four regenerations at full salting.
6. Factory-Installed Accessories:
   a. Piping, valves, tubing, and drains.
   b. Sampling cocks.
   c. Main-operating-valve position indicators.
   d. Water meters.
7. Water Test Kit: Include water test kit in wall-mounting enclosure for water softener.

I. RO Equipment For HVAC Makeup Water
1. Description: Factory fabricated and tested with RO membrane elements in housings, high-pressure pumps and motors, controls, valves, and prefilter; mounted on skid.
2. Fabricate supports and attachments to tanks with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure as recommended in writing by manufacturer.
3. Skid Assembly: Welded-steel frame coated with epoxy protective finish.
4. RO Membrane and Housing:
   a. Element: Thin-film composite with U-cup brine seal with minimum 98 percent salt rejection based on 2000-ppm water supplied at 225 psig (1551 kPa) and 77 deg F (25 deg C).
   b. Housing: ASTM A 666, Type 304 stainless steel with PVC end caps held in place with stainless-steel straps.
5. High-Pressure Pumps and Motors:
   a. Pump:
      1) Vertical, multistage centrifugal operating at 3500 rpm with ASTM A 666, Type 304 stainless-steel casing, shaft, impellers, and inlet and discharge casting.
      2) Bearings shall be tungsten carbide and ceramic.
      3) Cast-iron frame and flanged suction and discharge connections.
   b. Motor: NEMA-standard, C-faced TEFC motor supported on the pump-bearing frame. General requirements for motors are specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
6. Controls:
   a. Microprocessor-based controller with LCD display.
   b. Interlock for remote start/stop control.
   c. Membrane flush sequence when pumps shut down.
   d. Run time indicator.
   e. Low-pressure safety cutoff.
   f. Panel-mounted gages as follows:

1) Product and concentrate.
2) Inlet, cartridge filter outlet, RO feed, RO concentrate, and RO product pressures.
3) Product conductivity monitor.

7. Valves:
   a. Stainless-steel pump, concentrate, and recycle throttling valves rated for minimum 300 psig (2068 kPa).
   b. Automatic inlet shutoff valve, diaphragm type; solenoid actuated, normally closed, and constructed of glass-reinforced noryl thermoplastic.
   c. PVC valves with EPDM seats and seals for isolation at inlet, and check and sample valves at product and concentrate. Sample valves at cartridge filter outlet, concentrate, and product outlet.
8. Prefilter:
   a. Housing: Polypropylene with built-in relief or vent valve.
   b. Element: Spun-wound polypropylene.
9. Inlet Water Tempering Valve: Thermostatic water-tempering valve to maintain 77 deg F (25 deg C), **as directed**, inlet water temperature to RO unit.
10. Activated Carbon Filter:
   a. Media Tank: Fiberglass-reinforced polyester rated for minimum 150 psig (1035 kPa) with internal backwash distributor and filtered water collector.
   b. Media: 12 x 40-mesh, bituminous coal-based activated carbon.
   c. Backwash Valve: Piston-operated control valve with drain-line, flow-control orifice.
   d. Backwash Control: Seven-day time clock.
11. Atmospheric Storage Tank:
   a. Tank: Polyethylene single piece with closed top and flat bottom with manway in top, 0.2-micron filter vent, inlet, discharge, and drain piping connections, and bulkhead fittings for level controls.
   b. Control: Level switches start and stop RO unit. Low-level limit shall stop repressurization pumps, and signal an alarm.
12. Repressurization Pumps:
   a. Pumps: Two close-coupled, single-stage centrifugal pumps, with mechanical seals. Wetted components ASTM A 666, Type 316 stainless steel.
   b. Controls: NEMA-4X pump control panel constructed of fiberglass to control pumps, one operating, one standby, with automatic alternator and fail-over control.
   c. Motor: ODP motor supported on the pump-bearing frame. General requirements for motors are specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
13. Water Test Kit: Include water test kit in wall-mounting cabinet for RO unit.

J. Filtration Equipment
1. Multimedia Filters:
   a. Description: Factory-fabricated and -tested, simplex, multimedia filter system of filter tank, media, strainer, circulating pump, piping, and controls for removing particles from water.
      1) Filter Tank: Corrosion resistant with distribution system and media.
         a) Fabricate and label steel filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
         b) Fabricate and label FRP filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section X, if indicated.
         c) Pipe Connections NPS 2 (DN 50) and Smaller: Threaded according to ASME B1.20.1.
         d) Steel Tank Pipe Connections NPS 2-1/2 (DN 65) and Larger: Steel, Class 150 flanges according to ASME B16.5 or grooved according to AWWA C606.
         e) FRP Tank Pipe Connections NPS 2-1/2 (DN 65) and Larger: Type A, integral; Designation E, 125-psig (0.862-MPa) or F, 150-psig (1.034-MPa) pressure category flanges of grade same as tank material according to ASTM D 5421.

2) Motorized Valves: Flanged or grooved-end, ductile-iron butterfly type with EPDM valve seat and stem seal; with ASTM B 148 aluminum bronze disc.
3) Strainer: Basket type mounted on pump suction.
4) Piping: ASTM A 53/A 53M, Type S, F, or E; Grade B, Schedule 40 black steel, with flanged, grooved, or threaded joints and malleable, steel welding, or ductile-iron fittings.
5) Piping: ASTM B 88, Type L (ASTM B 88M, Type B) copper water tube, copper-alloy solder-joint fittings, and brazed, flanged, or grooved joints.
6) Safety Valves: Automatic pressure relief.
7) Circulating Pump: Overhung impeller, close coupled, single stage, end suction, centrifugal. Comply with UL 778 and with HI 1.1-1.2 and HI 1.3.
   a) Casing: Radially split, cast iron.
   b) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, minimum.
   c) Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
   d) Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
   e) Seal: Mechanical.
   f) Motor: ODP motor supported on the pump-bearing frame. General requirements for motors are specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
8) Controls: Automatic control of circulating pump and tank backwash; factory wired for single electrical connection.
   a) Panel: NEMA 250, Type 4 enclosure with time clock and pressure gages.
   b) Pump: Automatic and manual switching; manual switch position bypasses safeties and controls.
   c) Backwash: Automatic; with time clock and differential pressure switch.
   d) Backwash Valve: Tank mounted with valves interlocked to single actuator.
9) Support: Skid mounting. Fabricate supports and base and attachment to tank with reinforcement strong enough to resist filter movement during a seismic event when filter base is anchored to building structure.

2. Self-Cleaning Strainers:
   a. Description: Factory-fabricated and -tested, ASTM A 126, Class B, cast-iron or steel, self-cleaning strainer system of tank, strainer, backwash arm or cleaning spiral, drive and motor, piping, and controls for removing particles from water.
      1) Fabricate and label ASTM A 126, Class B, cast-iron or steel strainer tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
      2) Pipe Connections:
         a) NPS 2 (DN 50) and Smaller: Threaded according to ASME B1.20.1.
         b) NPS 2-1/2 (DN 65) and Larger: Steel, Class 150 flanges according to ASME B16.5 or grooved according to AWWA C606.
   b. Motorized Valves: Flanged or grooved-end, ductile-iron angle type with EPDM valve seat and stem seal; with ASTM B 148 aluminum bronze disc.
   c. Strainer: ASTM A 666, Type 316 stainless steel.
   d. Piping: ASTM A 53/A 53M, Type S, F, or E; Grade B, Schedule 40 black steel, with flanged, grooved, or threaded joints and malleable, steel welding, or ductile-iron fittings.
   e. Safety Valves: Automatic pressure relief.
   f. Backwash Arm Drive:
      1) Drive Casing: Cast iron.
      2) Worm Gears: Immersed in oil.
      3) Motor: ODP motor supported on the strainer-bearing frame. General requirements for motors are specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
   g. Controls: Automatic control of backwash; factory wired for single electrical connection.
      1) Panel: NEMA 250, Type 4 enclosure with time clock and pressure gages.

2) Backwash Arm Drive: Automatic and manual switching; manual switch position bypasses safeties and controls.
3) Backwash: Automatic; with time clock and differential pressure switch.
4) Backwash Valve: Electric actuator.

h. Support: Skid mounting. Fabricate supports and base and attachment to tank with reinforcement strong enough to resist strainer movement during a seismic event when strainer base is anchored to building structure.

3. Bag **OR** Cartridge, **as directed**,-Type Filters:
   a. Description: Floor-mounting housing with filter bags **OR** cartridges, **as directed**, for removing particles from water.
      1) Housing: Corrosion resistant; designed to separate inlet from outlet and to direct inlet through bag **OR** cartridge, **as directed**,-type water filter; with bag support and base, feet, or skirt.
         a) Pipe Connections NPS 2 (DN 50) and Smaller: Threaded according to ASME B1.20.1.
         b) Steel Housing Pipe Connections NPS 2-1/2 (DN 65) and Larger: Steel, Class 150 flanges according to ASME B16.5 or grooved according to AWWA C606.
         c) Plastic Housing Pipe Connections NPS 2-1/2 (DN 65) and Larger: 150-psig (1035-kPa) plastic flanges.
      2) Bag **OR** Cartridge, **as directed**: Replaceable; of shape to fit housing.
4. Centrifugal Separators:
   a. Description: Simplex separator housing with baffles and chambers for removing particles from water by centrifugal action and gravity.
   b. Housing: With manufacturer's proprietary system of baffles and chambers.
      1) Construction: Fabricate and label steel separator housing to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
      2) Inlet: Designed with tangential entry to produce centrifugal flow of feedwater.
      3) Vortex Chamber: Designed for downward vortex flow and gravity separation of particles.
      4) Collection Chamber: Designed to hold separated particles.
      5) Outlet: Near top of unit.
      6) Purge: At bottom of collection chamber.
      7) Pipe Connections NPS 2 (DN 50) and Smaller: Threaded according to ASME B1.20.1.
      8) Pipe Connections NPS 2-1/2 (DN 65) and Larger: Steel, Class 150 flanges according to ASME B16.5 or grooved according to AWWA C606. Provide stainless-steel flanges if tank is stainless steel.
   c. Motorized Purge Valve: Gate or plug pattern valve.
      1) Motorized Valves: Butterfly-type, flanged or grooved-end, ductile-iron body, with EPDM valve seat and stem seal; with ASTM B 148 aluminum bronze disc.
   d. Strainer: Stainless-steel basket type mounted on pump suction.
   e. Piping: ASTM A 53/A 53M, Type S, F, or E; Grade B, Schedule 40 black steel, with flanged, grooved, or threaded joints and malleable, steel welding, or ductile-iron fittings.
   f. Piping: ASTM B 88, Type L (ASTM B 88M, Type B) copper water tube, copper-alloy solder-joint fittings, and brazed, flanged, or grooved joints.
   g. Circulating Pump: Overhung impeller, close coupled, single stage, end suction, centrifugal. Comply with UL 778 and with HI 1.1-1.2 and HI 1.3.
      1) Casing: Radially split, cast iron.
      2) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, minimum.
      3) Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
      4) Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
      5) Seal: Mechanical.

6) Motor: ODP motor supported on the pump-bearing frame. General requirements for motors are specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".

h. Controls: Automatic control of circulating pump and separator purge; factory wired for single electrical connection.
   1) Panel: NEMA 250, Type 4 enclosure.
   2) Pump: Automatic and manual switching; manual switch position bypasses safeties and controls.
   3) Separator Purge: Automatic and manual.
   4) TDS Controller Interlock: Open separator purge valve with bleed-off control.

i. Support: Skid mounting. Fabricate supports and base and attachment to separator housing with reinforcement strong enough to resist separator movement during a seismic event when separator base is anchored to building structure.

1.3 EXECUTION

A. Water Analysis
   1. Perform an analysis of supply water to determine quality of water available at Project site.

B. Installation
   1. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.
   2. Install seismic restraints for equipment and floor-mounting accessories and anchor to building structure. Refer to Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment" for seismic restraints.
   3. Install water testing equipment on wall near water chemical application equipment.
   4. Install interconnecting control wiring for chemical treatment controls and sensors.
   5. Mount sensors and injectors in piping circuits.
   6. Bypass Feeders: Install in closed hydronic systems, including hot-water heating, chilled water, dual-temperature water, and glycol cooling, and equipped with the following:
      a. Install bypass feeder in a bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
      b. Install water meter in makeup water supply.
      c. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
      d. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
      e. Install a swing check on inlet after the isolation valve.
   7. Install automatic chemical-feed equipment for steam boiler and steam condensate systems and include the following:
      a. Install makeup water softener.
      b. Install water meter in makeup water supply.
      c. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.
         1) Pumps shall operate for timed interval when contacts close at water meter in makeup water supply connection. Injection pump shall discharge into boiler feedwater tank or feedwater supply connection at boiler.
      d. Install test equipment and furnish test-kit to the Owner.
      e. Install RO unit for makeup water.
      f. Install TDS controller with sensor and bleed valves.
         1) Bleed valves shall cycle to maintain maximum TDS concentration.
      g. Install inhibitor injection timer with injection pumps and solution tanks.

1) Pumps shall operate for timed interval on contact closure at water meter in makeup water supply connection. Injection pump shall discharge into main steam supply header.

8. Install automatic chemical-feed equipment for condenser **OR** fluid-cooler spray, **as directed**, water and include the following:
   a. Install makeup water softener.
   b. Install water meter in makeup water supply.
   c. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.
      1) Pumps shall operate for timed interval on contact closure at water meter in makeup water supply connection. Injection pump shall discharge into boiler feedwater tank or feedwater supply connection at boiler.
   d. Install test equipment and provide test-kit to the Owner. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
   e. Install TDS controller with sensor and bleed valves.
      1) Bleed valves shall cycle to maintain maximum TDS concentration.
   f. Install pH sensor and controller with injection pumps and solution tanks.
      1) Injector pumps shall operate to maintain required pH.
   g. Install biocide feeder alternating timer with two sets of injection pumps and solution tanks.
      1) Injection pumps shall operate to feed biocide on an alternating basis.
   h. Install ozone generator with diffusers in condenser-water piping.
   i. Ozone generator shall operate continuously with condenser-water flow.
   j. Install UV-irradiation lamps in condenser-water piping.
      1) UV lights shall operate continuously with condenser-water flow.

C. Ozone-Generator Installation
   1. Install ozone generator and equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.
   2. Install seismic restraints for equipment and floor-mounting accessories and anchor to building structure. Refer to Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment" for seismic restraints.
   3. Pipe ozone from ozone generator to condenser water with stainless-steel pipe and fittings with welded joints.
   4. Install two **OR** three, **as directed**,-piece, stainless-steel ball valve in ozone supply to condenser water.
   5. Pipe cooling water to ozone generator, and to air-gap drain fitting with stainless-steel pipe and fittings with welded joints where enclosed in ozone-generator room.
   6. Install two **OR** three, **as directed**,-piece, stainless-steel ball valve in cooling water supply to ozone generator.
   7. Mounting supports for ozone generator shall be ASTM A 666, Type 316 stainless steel.
   8. Mount breathing apparatus outside ozone-generator room.
   9. Mount and install ozone detector, warning lights, and audible alarm inside ozone-generator room. Mount another set of warning lights and audible alarm just outside the main entrance to ozone-generator room.

D. UV-Irradiation Unit Installation
   1. Install UV-irradiation units on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.
   2. Install seismic restraints for UV-irradiation units and floor-mounting accessories and anchor to building structure. Refer to Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment" for seismic restraints.

E. Water Softener Installation

1. Install water softener equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.
2. Install seismic restraints for tanks and floor-mounting accessories and anchor to building structure. Refer to Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment" for seismic restraints.
3. Install brine lines and fittings furnished by equipment manufacturer but not factory installed.
4. Prepare mineral-tank distribution system and underbed for minerals and place specified mineral into mineral tanks.
5. Install water-testing sets on wall adjacent to water softeners.

F. RO Unit Installation
1. Install RO unit and storage tank on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor RO unit and storage tank with pumps to substrate.
2. Install seismic restraints for tanks and floor-mounting accessories and anchor to building structure. Refer to Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment" for seismic restraints.
3. Install interconnecting piping and controls furnished by equipment manufacturer but not factory installed.
4. Install water testing sets on wall adjacent to RO unit.

G. Connections
1. Piping installation requirements are specified in other Division 21. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to equipment to allow service and maintenance.
3. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Division 23 Section "Common Work Results For Hvac".
4. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Division 23 Section "General-duty Valves For Hvac Piping".
5. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers required in makeup water connections to potable-water systems.
6. Confirm applicable electrical requirements in Division 22 for connecting electrical equipment.
7. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
8. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

H. Field Quality Control
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
2. Perform tests and inspections and prepare test reports.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
3. Tests and Inspections:
   a. Inspect field-assembled components and equipment installation, including piping and electrical connections.
   b. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
   c. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.

d. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
e. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
f. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
g. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
h. Repair leaks and defects with new materials and retest piping until no leaks exist.

4. Remove and replace malfunctioning units and retest as specified above.
5. Sample boiler water at one-week intervals after boiler startup for a period of five weeks, and prepare test report advising the Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article for each required characteristic. Sample boiler water at four **OR** six **OR** eight, **as directed**,-week intervals following the testing noted above to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section.
6. At four **OR** six **OR** eight, **as directed**,-week intervals following Final Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising the Owner of changes necessary to adhere to Part 1.1 "Performance Requirements" Article.
7. Comply with ASTM D 3370 and with the following standards:
   a. Silica: ASTM D 859.
   b. Steam System: ASTM D 1066.
   c. Acidity and Alkalinity: ASTM D 1067.
   d. Iron: ASTM D 1068.
   e. Water Hardness: ASTM D 1126.

I. Demonstration
1. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

END OF SECTION 23 25 13 00

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Task	Specification	Specification Description
23 25 13 00	21 05 23 00	Piped Utilities Basic Materials And Methods
23 25 13 00	22 12 23 26	Underground Storage Tanks
23 25 13 00	22 11 16 00c	Hydronic Piping

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SECTION 23 31 13 13 - HVAC CASINGS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for HVAC casings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Factory- and Shop-fabricated, field-assembled, single- and double-wall casings for HVAC equipment.

C. Performance Requirements

1. Static-Pressure Classes:
   a. Upstream from Fan(s): 2-inch wg (500 Pa).
   b. Downstream from Fan(s): 2-inch wg (500 Pa) **OR** 3-inch wg (750 Pa) **OR** 4-inch wg (1000 Pa) **OR** 6-inch wg (1500 Pa) **OR** 10-inch wg (2500 Pa), **as directed**.
2. Acoustical Performance:
   a. NRC: 1.09 **OR** 0.94, **as directed**, according to ASTM C 423.
   b. STC: 40 **OR** 34, **as directed**, according to ASTM E 90.
3. Structural Performance:
   a. Casings shall be fabricated to withstand 133 percent of the indicated static pressure without structural failure. Wall and roof deflection at the indicated static pressure shall not exceed 1/8 inch per foot (0.97 mm per meter) of width.
      1) Fabricate outdoor casings to withstand wind load of 15 lbf/sq. ft. (720 N/sq. m) and snow load of 30 lbf/sq. ft. (1440 N/sq. m).
4. Seismic Performance: HVAC casings shall withstand the effects of earthquake motions determined according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

D. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Product Data for Prerequisite EQ 1: Documentation indicating that duct systems comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
   b. Product Data for Prerequisite EA 2: Documentation indicating that duct systems comply with ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
   c. Leakage Test Report for Prerequisite EA 2: Documentation of work performed for compliance with ASHRAE/IESNA 90.1, Section 6.4.4.2.2 - "Duct Leakage Tests."
   d. Duct-Cleaning Test Report for Prerequisite EQ 1: Documentation of work performed for compliance with ASHRAE 62.1, Section 7.2.4 - "Ventilation System Start-Up."
   e. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: For HVAC casings. Include plans, elevations, sections, components, and attachments to other work.
4. Welding certificates.
5. Field quality-control reports.

E. Quality Assurance
1. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports **OR** AWS D9.1M/D9.1, "Sheet Metal Welding Code," for casing joint and seam welding, **as directed**.
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."
3. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

1.2 PRODUCTS

A. General Casing Fabrication Requirements
1. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 6, "Equipment and Casings," for acceptable materials, material thicknesses, and casing construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
   a. Fabricate casings with more than 3-inch wg (750-Pa) negative static pressure according to SMACNA's "Rectangular Industrial Duct Construction Standards."
   b. Casings with more than 2-inch wg (500-Pa) positive static pressure may be fabricated according to SMACNA's "Rectangular Industrial Duct Construction Standards."
2. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   a. Exterior Surface Galvanized Coating Designation: G60 (Z180) **OR** G90 (Z275), **as directed**.
   b. Interior Surface Galvanized Coating Designation:
      1) Sections Not Exposed to Moisture: G60 (Z180) **OR** G90 (Z275), **as directed**.
      2) Sections Housing and Downstream from Cooling Coil and Humidifiers: G90 (Z275).
3. Stainless Steel: ASTM A 480/A 480M, Type 304 **OR** Type 316, **as directed**, and having a No. 2D, **as directed**, finish.
4. Factory- or Shop-Applied Antimicrobial Coating:
   a. Apply to the interior sheet metal surfaces of casing in contact with the airstream. Apply untreated clear coating to the exterior surface.
   b. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
   c. Coating containing the antimicrobial compound shall have a hardness of 2H minimum when tested according to ASTM D 3363.
   d. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 according to UL 723; certified by an NRTL.
   e. Applied Coating Color: Standard **OR** Black **OR** White, **as directed**.
5. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
6. Sealing Requirement: SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Seal Class A. Seal all seams, joints, connections, and abutments to building.
7. Penetrations: Seal all penetrations airtight. Cover with escutcheons and gaskets, or fill with suitable compound so there is no exposed insulation. Provide shaft seals where fan shafts penetrate casing.
8. Access Doors: Fabricate access doors according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 6-11, "Casing Access Doors - 2-inch wg (500 Pa)," and Figure 6.12, "Casing Access Doors - 3-10-inch wg (750-2500 Pa)"; and according to pressure class of the plenum or casing section in which access doors are to be installed.
   a. Size: 20 by 54 inches (500 by 1370 mm).
   b. Vision Panel: Double-glazed, wire-reinforced safety glass with an airspace between panes and sealed with interior and exterior rubber seals.
   c. Hinges: Piano or butt hinges and latches, number and size according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

d. Latches: Minimum of two wedge-lever-type latches, operable from inside and outside.
e. Neoprene gaskets around entire perimeters of door frames.
f. Doors shall open against air pressure.

9. Condensate Drain Pans: Formed sections of Type 304, stainless-steel sheet **OR** G90 (Z275) coated, galvanized sheet steel, **as directed**, complying with requirements in ASHRAE 62.1. Pans shall extend a minimum of 12 inches (300 mm) past coil.
   a. Double-wall construction shall have space between walls filled with foam insulation and sealed moisture tight.
   b. Intermediate drain pan or drain trough shall collect condensate from top coil for units with stacked coils or stacked eliminators.
   c. Insulation: Polystyrene or polyurethane.
   d. Slopes shall be in a minimum of two planes to collect condensate from cooling coils (including coil piping connections and return bends), eliminators, and humidifiers when units are operating at maximum catalogued face velocity across cooling coil.
   e. Each drain pan connection shall have a trap. Drain traps with depth and height differential between inlet and outlet equal or greater to the design static pressure plus 2-inch wg (500 Pa), **as directed**. Include slab height in trap calculation.

B. Shop-Fabricated Casings
1. Single- and Double-Wall Casings: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for sheet metal thickness based on indicated static-pressure class unless otherwise indicated.
2. Double-Wall Casing Inner Panel: Perforated, galvanized sheet steel having 3/32-inch- (2.4-mm-) diameter perforations, with overall open area of 23 percent. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for sheet metal thickness based on indicated static-pressure class unless otherwise indicated.
   OR
   Double-Wall Casing Inner Panel: Solid sheet steel. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for sheet metal thickness based on indicated static-pressure class unless otherwise indicated.
3. Interstitial Insulation: Polyurethane foam complying with NFPA 90A or NFPA 90B.
   OR
   Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
   a. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) mean temperature.
   b. Coat insulation with antimicrobial coating.
   c. Cover insulation with polyester film complying with UL 181, Class 1.
   OR
   Interstitial Insulation: Flexible-elastomeric duct liner complying with ASTM C 534, Type II for sheet materials and with NFPA 90A or NFPA 90B.
   a. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F (0.034 W/m x K) at 75 deg F (24 deg C) mean temperature.
4. Fabricate casings with standing seams and angle-iron reinforcements unless otherwise indicated.
5. Fabricate close-off sheets from casing to dampers, filter frames, and coils and between stacked coils. Use galvanized sheet steel of same thickness as casing and with a galvanized coating designation of G90 (Z275).
6. Bolt close-off sheets to frame flanges and housings. Support coils on stands fabricated from galvanized-steel angles or channels.
7. Reinforce casings with galvanized-steel angles.

C. Manufactured Casings
1. Description: Double-wall, insulated, pressurized equipment casing.
2. Double-Wall Panel Fabrication: Solid, galvanized sheet steel exterior wall and solid **OR** perforated, **as directed**, galvanized sheet steel interior wall; with space between wall filled with insulation.

a. Wall Thickness: 2 inches (50 mm) **OR** 4 inches (100 mm), **as directed**.
b. Fabricate with a minimum number of joints.
c. Weld exterior and interior walls to perimeter; to interior, longitudinal, galvanized-steel channels; and to box-end internal closures. Paint welds.
d. Sheet metal thickness shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for static-pressure class indicated for casing.
OR
Sheet Metal Thicknesses:
1) Exterior Wall Thickness: 0.040 inch (1.0 mm) minimum.
2) Interior Wall Thickness: 0.034 inch (0.85 mm) minimum.
e. Double-Wall Casing Inner Panel: Perforated, galvanized sheet steel having 3/32-inch- (2.4-mm-) diameter perforations, with overall open area of 23 percent.
OR
Double-Wall Casing Inner Panel: Solid sheet steel.
f. Fill each panel assembly with insulating material that is noncombustible, inert, mildew resistant and vermin proof and that complies with NFPA 90A.
g. Fabricate panels with continuous tongue-and-groove **OR** self-locking, **as directed**, joints effective inside and outside each panel.

3. Trim Items: Fabricate from a minimum of 0.052-inch (1.3-mm) galvanized sheet steel, furnished in standard lengths for field cutting.

D. Casing Liner
1. Fibrous-Glass Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
a. Maximum Thermal Conductivity:
1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) mean temperature.
2) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F (0.033 W/m x K) at 75 deg F (24 deg C) mean temperature.
b. Antimicrobial Erosion-Resistant Coating: Apply to surface of the liner that will form the interior surface of casing to act as a moisture repellent and an erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
c. Solvent **OR** Water, **as directed**,-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
1) For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Flexible-Elastomeric Casing Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1, and with NFPA 90A or NFPA 90B.
a. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
b. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
1) For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Natural-Fiber Casing Liner: 85 percent cotton, 10 percent borate, and 5 percent polybinding fibers, treated with a microbial growth inhibitor, and complying with NFPA 90A or NFPA 90B.
a. Maximum Thermal Conductivity: 0.24 Btu x in./h x sq. ft. x deg F (0.034 W/m x K) at 75 deg F (24 deg C) mean temperature when tested according to ASTM C 518.
b. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
c. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
1) For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

4. Insulation Pins and Washers:
   a. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) **OR** 0.135-inch- (3.5-mm-), **as directed**, diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
   b. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, galvanized **OR** stainless, **as directed**, steel, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
5. Shop or Factory Application of Casing Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."
   a. Adhere a single layer of indicated thickness of casing liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of casing liner is prohibited.
   b. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
   c. Butt transverse joints without gaps, and coat joint with adhesive.
   d. Fold and compress liner in corners of casings or cut and fit to ensure butted-edge overlapping.
   e. Apply adhesive coating on longitudinal seams in casings with air velocity of 2500 fpm (12.7 m/s).
   f. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) longitudinally.
   g. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from casing wall. Fabricate edge facings at the following locations:
      1) Fan discharges.
      2) Intervals of lined casing preceding unlined duct.
      3) Upstream edges of transverse joints in casings where air velocities are higher than 2500 fpm (12.7 m/s) or where indicated.
   h. Secure insulation between perforated sheet metal inner wall of same thickness as specified for outer wall. Use mechanical fasteners that maintain inner wall at uniform distance from outer wall without compressing insulation.

E. Sealant Materials
1. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
2. Water-Based Joint and Seam Sealant:
   a. Application Method: Brush on.
   b. Solids Content: Minimum 65 percent.
   c. Shore A Hardness: Minimum 20.
   d. Water resistant.
   e. Mold and mildew resistant.
   f. VOC: Maximum 75 g/L (less water).
      OR
      For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   g. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive or negative.
   h. Service: Indoor or outdoor.
   i. Substrate: Compatible with galvanized sheet steel or stainless steel.
3. Solvent-Based Joint and Seam Sealant:
   a. Application Method: Brush on.
   b. Base: Synthetic rubber resin.
   c. Solvent: Toluene and heptane.
   d. Solids Content: Minimum 60 percent.

e. Shore A Hardness: Minimum 60.
f. Water resistant.
g. Mold and mildew resistant.
h. VOC: Maximum 395 g/L.
OR
For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
i. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive or negative.
j. Service: Indoor or outdoor.
k. Substrate: Compatible with galvanized sheet steel or stainless steel.

4. Flanged Joint Sealant: Comply with ASTM C 920.
a. General: Single component, acid curing, silicone, elastomeric.
b. Type: S.
c. Grade: NS.
d. Class: 25.
e. Use: O.
f. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

5. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

1.3 EXECUTION

A. Installation
1. Install casings according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Equipment Mounting: Install HVAC casings on concrete base. Comply with requirements for concrete base specified in Division 07 Section "Manufactured Roof Expansion Joints".
a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
b. For supported casings, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
d. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install seismic restraints on casings. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment"
4. Apply sealant to joints, connections, and mountings.
5. Field-cut openings for pipe and conduit penetrations; insulate and seal according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
6. Support casings on floor or foundation system. Secure and seal to base.
7. Support components rigidly with ties, braces, brackets, seismic restraints, **as directed**, and anchors of types that will maintain housing shape and prevent buckling.
8. Align casings accurately at connections, with 1/8-inch (3-mm) misalignment tolerance and with smooth interior surfaces.

B. Field Quality Control
1. Tests and Inspections:
a. Perform field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual."
b. Test the following systems:
1) Systems required by ASHRAE/IESNA 90.1.
2) Supply Air: 100 **OR** 50, **as directed**, percent of total installed duct area with a pressure class of 3-inch wg (750 Pa) **OR** 4-inch wg (1000 Pa), **as directed**, or higher.

c. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.

d. Determine leakage from entire system or section of system by relating leakage to surface area of test section. Comply with requirements for leakage classification of ducts connected to casings.

e. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

2. HVAC casings will be considered defective if they do not pass tests and inspections.
3. Prepare test and inspection reports.

C. Cleaning

1. Comply with requirements for cleaning in Division 23 Section "Metal Ducts".

END OF SECTION 23 31 13 13

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Task	Specification	Specification Description
23 31 13 13	23 01 30 61	Metal Ducts

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SECTION 23 31 13 16 - TAILPIPE EXHAUST EQUIPMENT

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of tailpipe exhaust equipment. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Capacity and Performance
1. Based on standard air density (0.075 pound per cubic foot). Fans shall have a peak static efficiency of not less than 60 percent.

B. Blowers and Accessories
1. Comply with AMCA 210, 300, and 301. Fan impellers shall be constructed of heavy gauge steel and accurately balanced both statically and dynamically when installed in the assembled fan unit. Impeller and housing in the air stream shall be coated with neoprene, epoxy, phenolic resins, or other material suitable to resist the corrosive gases and temperatures encountered. Fans to be mounted on exterior of building shall be provided with weatherproof covers.

C. Exhaust Duct and Fittings for Vehicle Tailpipe Exhaust Systems
1. Constructed of galvanized sheet steel, conforming to ASTM A 525. Ductwork shall be constructed with minimum metal gauge thickness and reinforced as required in the SMACNA Duct Construction Standards - Metal and Flexible.
   a. Tailpipe Adapter shall be not less than 20-gauge corrosion-resisting steel. The adapter shall be of the tapered cone type with spring clip or other suitable device for exhaust pipe attachment.
   b. Flexible Exhaust Tubing shall be 0.012 minimum thickness galvanized sheet steel or heat-resistant, reinforced wire, fiberglass, and neoprene tubing.
   c. Dampers shall be of the circular disk type with quadrant locking device or blast gate type.
   d. A Flexible Tubing Suspension System shall be furnished and installed for repaired tailpipe exhaust systems where no such suspension system exists. The flexible tubing suspension system shall suspend the flexible tubing overhead when not in use, allowing it to be lowered to the operating level, when required. The suspension system installed shall be complete with cable, pulleys, and operating mechanism.

1.3 EXECUTION

A. Ductwork joints in galvanized sheet steel ductwork shall be soldered or otherwise sealed. The lock seam in straight sections shall be located on top of the duct. Seams shall be suitable for 10-inch water gauge static pressure. Ductwork shall be constructed with minimum metal gauge thickness and reinforced as required in the SMACNA Duct Construction Standards - Metal and Flexible.

B. Weather-Resistant Finishes of items located outdoors shall meet the requirements of ASTM B 117.

END OF SECTION 23 31 13 16

Task	Specification	Specification Description
23 31 13 16	23 01 30 61	Metal Ducts
23 31 13 16	23 31 13 13	HVAC Casings

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SECTION 23 31 13 19 - DUCT ACCESSORIES

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for duct accessories. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Backdraft and pressure relief dampers.
   b. Barometric relief dampers.
   c. Manual volume dampers.
   d. Control dampers.
   e. Fire dampers.
   f. Ceiling dampers.
   g. Smoke dampers.
   h. Combination fire and smoke dampers.
   i. Corridor dampers.
   j. Flange connectors.
   k. Duct silencers.
   l. Turning vanes.
   m. Remote damper operators.
   n. Duct-mounted access doors.
   o. Flexible connectors.
   p. Flexible ducts.
   q. Duct security bars.
   r. Duct accessory hardware.

C. Submittals

1. Product Data: For each type of product indicated.
   a. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
2. LEED Submittal:
   a. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
3. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
   a. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
      1) Special fittings.
      2) Manual volume damper installations.
      3) Control damper installations.
      4) Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
      5) Duct security bars.
      6) Wiring Diagrams: For power, signal, and control wiring.
4. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

5. Source quality-control reports.
6. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

D. Quality Assurance
1. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
2. Comply with AMCA 500-D testing for damper rating.

1.2 PRODUCTS

A. Materials
1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
2. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   a. Galvanized Coating Designation: G60 (Z180) **OR** G90 (Z275),**as directed**.
   b. Exposed-Surface Finish: Mill phosphatized.
3. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and <**Insert finish designation**> finish for exposed ducts.
4. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
5. Extruded Aluminum: Comply with ASTM B 221 (ASTM B 221M), Alloy 6063, Temper T6.
6. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
7. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

B. Backdraft And Pressure Relief Dampers
1. Description: Gravity balanced.
2. Maximum Air Velocity: 2000 fpm (10 m/s) **OR** 3000 fpm (15 m/s), **as directed**.
3. Maximum System Pressure: 1-inch wg (0.25 kPa) **OR** 2-inch wg (0.5 kPa), **as directed**.
4. Frame: 0.052-inch- (1.3-mm-) thick, galvanized sheet steel **OR** 0.063-inch- (1.6-mm-) thick extruded aluminum **OR** 0.052-inch- (1.3-mm-) thick stainless steel, **as directed**, with welded corners and mounting flange, **as directed**.
5. Blades: Multiple single-piece blades, center-pivoted, **as directed**, maximum 6-inch (150-mm) width, 0.025-inch- (0.6-mm-) thick, roll-formed aluminum **OR** 0.050-inch- (1.2-mm-) thick aluminum sheet **OR** noncombustible, tear-resistant, neoprene-coated fiberglass, **as directed**, with sealed edges.
6. Blade Action: Parallel.
7. Blade Seals: Felt **OR** Vinyl foam **OR** Extruded vinyl, mechanically locked **OR** Neoprene, mechanically locked, **as directed**.
8. Blade Axles:
   a. Material: Nonferrous metal **OR** Galvanized steel **OR** Plated steel **OR** Stainless steel **OR** Non-metallic **OR** Aluminum, **as directed**.
   b. Diameter: 0.20 inch (5 mm).
9. Tie Bars and Brackets: Aluminum **OR** Galvanized steel, **as directed**.
10. Return Spring: Adjustable tension.
11. Bearings: Steel ball **OR** Synthetic pivot bushings **OR** Steel ball or synthetic pivot bushings, **as directed**.
12. Accessories:
    a. Adjustment device to permit setting for varying differential static pressure.
    b. Counterweights and spring-assist kits for vertical airflow installations.

c. Electric actuators.
d. Chain pulls.
e. Screen Mounting: Front mounted in sleeve.
   1) Sleeve Thickness: 20-gage (1.0-mm) minimum.
   2) Sleeve Length: 6 inches (152 mm) minimum.
   OR
   Screen Mounting: Rear mounted.
f. Screen Material: Galvanized steel **OR** Aluminum, **as directed**.
g. Screen Type: Bird **OR** Insect, **as directed**.
h. 90-degree stops.

C. Barometric Relief Dampers
1. Suitable for horizontal or vertical mounting.
2. Maximum Air Velocity: 2000 fpm (10 m/s) **OR** 2500 fpm (13 m/s), **as directed**.
3. Maximum System Pressure: 2-inch wg (0.5 kPa).
4. Frame: 0.064-inch- (1.6-mm-) thick, galvanized sheet steel **OR** 0.063-inch- (1.6-mm-) thick extruded aluminum, **as directed**, with welded corners and mounting flange, **as directed**.
5. Blades:
   a. Multiple, 0.025-inch- (0.6-mm-) thick, roll-formed aluminum **OR** 0.050-inch- (1.2-mm-) thick aluminum sheet, **as directed**.
   b. Maximum Width: 6 inches (150 mm).
   c. Action: Parallel.
   d. Balance: Gravity.
   e. Eccentrically pivoted.
6. Blade Seals: Vinyl **OR** Neoprene, **as directed**.
7. Blade Axles: Galvanized steel **OR** Nonferrous metal, **as directed**.
8. Tie Bars and Brackets:
   a. Material: Aluminum **OR** Galvanized steel, **as directed**.
   b. Rattle free with 90-degree stop.
9. Return Spring: Adjustable tension.
10. Bearings: Synthetic **OR** Stainless steel **OR** Bronze, **as directed**.
11. Accessories:
   a. Flange on intake.
   b. Adjustment device to permit setting for varying differential static pressures.

D. Manual Volume Dampers
1. Standard, Steel, Manual Volume Dampers:
   a. Standard leakage rating, with linkage outside airstream, **as directed**.
   b. Suitable for horizontal or vertical applications.
   c. Frames:
      1) Hat-shaped, galvanized-steel **OR** stainless-steel, **as directed**, channels, 0.064-inch (1.62-mm) minimum thickness.
      2) Mitered and welded corners.
      3) Flanges for attaching to walls and flangeless frames for installing in ducts.
   d. Blades:
      1) Multiple or single blade.
      2) Parallel- or opposed-blade design.
      3) Stiffen damper blades for stability.
      4) Galvanized-steel **OR** Stainless-steel, **as directed**, 0.064 inch (1.62 mm) thick.
   e. Blade Axles: Galvanized steel **OR** Stainless steel **OR** Nonferrous metal, **as directed**.
   f. Bearings:
      1) Oil-impregnated bronze **OR** Molded synthetic **OR** Stainless-steel sleeve, **as directed**.
      2) Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
   g. Tie Bars and Brackets: Galvanized steel.

2. Standard, Aluminum, Manual Volume Dampers:
    a. Standard leakage rating, with linkage outside airstream, **as directed**.
    b. Suitable for horizontal or vertical applications.
    c. Frames: Hat-shaped, 0.10-inch- (2.5-mm-) thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
    d. Blades:
        1) Multiple or single blade.
        2) Parallel- or opposed-blade design.
        3) Stiffen damper blades for stability.
        4) Roll-Formed Aluminum Blades: 0.10-inch- (2.5-mm-) thick aluminum sheet.
           OR
           Extruded-Aluminum Blades: 0.050-inch- (1.2-mm-) thick extruded aluminum.
    e. Blade Axles: Galvanized steel **OR** Stainless steel **OR** Nonferrous metal, **as directed**.
    f. Bearings:
        1) Oil-impregnated bronze **OR** Molded synthetic **OR** Stainless-steel sleeve, **as directed**.
        2) Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
    g. Tie Bars and Brackets: Aluminum.
3. Low-Leakage, Steel, Manual Volume Dampers:
    a. Low-leakage rating, with linkage outside airstream, **as directed**, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
    b. Suitable for horizontal or vertical applications.
    c. Frames:
        1) Hat **OR** U **OR** Angle, **as directed**, shaped.
        2) Galvanized-steel **OR** Stainless-steel, **as directed**, channels, 0.064 inch (1.62 mm) thick.
        3) Mitered and welded corners.
        4) Flanges for attaching to walls and flangeless frames for installing in ducts.
    d. Blades:
        1) Multiple or single blade.
        2) Parallel- or opposed-blade design.
        3) Stiffen damper blades for stability.
        4) Galvanized **OR** Stainless, **as directed**, roll-formed steel, 0.064 inch (1.62 mm) thick.
    e. Blade Axles: Galvanized steel **OR** Stainless steel **OR** Nonferrous metal, **as directed**.
    f. Bearings:
        1) Oil-impregnated bronze **OR** Molded synthetic **OR** Stainless-steel sleeve, **as directed**.
        2) Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
    g. Blade Seals: Felt **OR** Vinyl **OR** Neoprene, **as directed**.
    h. Jamb Seals: Cambered stainless steel **OR** aluminum, **as directed**.
    i. Tie Bars and Brackets: Galvanized steel **OR** Aluminum, **as directed**.
    j. Accessories:
        1) Include locking device to hold single-blade dampers in a fixed position without vibration.
4. Low-Leakage, Aluminum, Manual Volume Dampers:
    a. Low-leakage rating, with linkage outside airstream, **as directed**, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
    b. Suitable for horizontal or vertical applications.
    c. Frames: Hat **OR** U **OR** Angle, **as directed**,-shaped, 0.10-inch- (2.5-mm-) thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
    d. Blades:
        1) Multiple or single blade.

2) Parallel- or opposed-blade design.
3) Roll-Formed Aluminum Blades: 0.10-inch- (2.5-mm-) thick aluminum sheet.
OR
Extruded-Aluminum Blades: 0.050-inch- (1.2-mm-) thick extruded aluminum.

e. Blade Axles: Galvanized steel **OR** Stainless steel **OR** Nonferrous metal, **as directed**.
f. Bearings:
1) Oil-impregnated bronze **OR** Molded synthetic **OR** Stainless-steel sleeve, **as directed**.
2) Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

g. Blade Seals: Felt **OR** Vinyl **OR** Neoprene, **as directed**.
h. Jamb Seals: Cambered stainless steel **OR** aluminum, **as directed**.
i. Tie Bars and Brackets: Galvanized steel **OR** Aluminum, **as directed**.
j. Accessories:
1) Include locking device to hold single-blade dampers in a fixed position without vibration.

5. Jackshaft:
a. Size: 1-inch (25-mm) diameter.
b. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
c. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

6. Damper Hardware:
a. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- (2.4-mm-) thick zinc-plated steel, and a 3/4-inch (19-mm) hexagon locking nut.
b. Include center hole to suit damper operating-rod size.
c. Include elevated platform for insulated duct mounting.

E. Control Dampers

1. Low-leakage rating, with linkage outside airstream, **as directed**, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
2. Frames:
a. Hat **OR** U **OR** Angle, **as directed**, shaped.
b. Galvanized-steel **OR** Stainless-steel, **as directed**, channels, 0.064 inch (1.62 mm) thick.
c. Mitered and welded corners.

3. Blades:
a. Multiple blade with maximum blade width of 8 inches (200 mm).
b. Parallel **OR** Parallel- and opposed **OR** Opposed, **as directed**,-blade design.
c. Galvanized **OR** Stainless, **as directed**, steel.
d. 0.064 inch (1.62 mm) thick.
e. Blade Edging: Closed-cell neoprene edging.
OR
Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

4. Blade Axles: 1/2-inch- (13-mm-) diameter; galvanized steel **OR** stainless steel **OR** nonferrous metal, **as directed**; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
a. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).

5. Bearings:
a. Oil-impregnated bronze **OR** Molded synthetic **OR** Stainless-steel sleeve, **as directed**.
b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
c. Thrust bearings at each end of every blade.

F. Fire Dampers

1. Type: Static **OR** Dynamic **OR** Static and dynamic, **as directed**; rated and labeled according to UL 555 by an NRTL.
2. Closing rating in ducts up to 4-inch wg (1-kPa) static pressure class and minimum 4000-fpm (20-m/s) velocity.
3. Fire Rating: 1-1/2 **OR** 3, **as directed**, hours.
4. Frame: Curtain type with blades inside airstream **OR** Curtain type with blades outside airstream **OR** Multiple-blade type **OR** Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream, **as directed**; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.
5. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
   a. Minimum Thickness: 0.052 or 0.138 inch (1.3 or 3.5 mm) thick, as indicated, and of length to suit application.
   b. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
6. Mounting Orientation: Vertical or horizontal as indicated.
7. Blades: Roll-formed, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.
8. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
9. Heat-Responsive Device: Replaceable, 165 deg F (74 deg C) **OR** 212 deg F (100 deg C), **as directed**, rated, fusible links.
   OR
   Heat-Responsive Device: Electric **OR** Pneumatic, **as directed**, resettable link and switch package, factory installed, 165 deg F (74 deg C) **OR** 212 deg F (100 deg C), **as directed**, rated.

G. Ceiling Dampers
1. General Requirements:
   a. Labeled according to UL 555C by an NRTL.
   b. Comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."
2. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.
3. Blades: Galvanized sheet steel with refractory insulation.
4. Heat-Responsive Device: Replaceable, 165 deg F (74 deg C) **OR** 212 deg F (100 deg C), **as directed**, rated, fusible links.
5. Fire Rating: 2 **OR** 3, **as directed**, hours.

H. Smoke Dampers
1. General Requirements: Label according to UL 555S by an NRTL.
2. Smoke Detector: Integral, factory wired for single-point connection.
3. Frame: Curtain type with blades inside airstream **OR** Curtain type with blades outside airstream **OR** Multiple-blade type **OR** Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream, **as directed**; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.
4. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.
5. Leakage: Class I **OR** Class II, **as directed**.
6. Rated pressure and velocity to exceed design airflow conditions.
7. Mounting Sleeve: Factory-installed, 0.052-inch- (1.3-mm-) thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking, **as directed**.
8. Damper Motors: Modulating **OR** Two-position, **as directed**, action.
9. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".

a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section(s) "Instrumentation And Control For Hvac" OR Division 22, **as directed**.
c. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
d. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m).
e. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F (minus 40 deg C).
f. Nonspring-Return Motors: For dampers larger than 25 sq. ft. (2.3 sq. m), size motor for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 300 in. x lbf (34 N x m).
g. Electrical Connection: 115 V, single phase, 60 Hz.

10. Accessories:
    a. Auxiliary switches for signaling **OR** fan control **OR** position indication, **as directed**.
    b. Momentary test switch **OR** Test and reset switches, **as directed**, damper **OR** remote, **as directed**, mounted.

I. Combination Fire And Smoke Dampers
1. Type: Static **OR** Dynamic **OR** Static and dynamic, **as directed**; rated and labeled according to UL 555 and UL 555S by an NRTL.
2. Closing rating in ducts up to 4-inch wg (1-kPa) static pressure class and minimum 4000-fpm (20-m/s) velocity.
3. Fire Rating: 1-1/2 **OR** 3, **as directed**, hours.
4. Frame: Curtain type with blades inside airstream **OR** Curtain type with blades outside airstream **OR** Multiple-blade type **OR** Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream, **as directed**; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.
5. Heat-Responsive Device: Replaceable, 165 deg F (74 deg C) **OR** 212 deg F (100 deg C), **as directed**, rated, fusible links.
   OR
   Heat-Responsive Device: Electric **OR** Pneumatic, **as directed**, resettable link and switch package, factory installed, rated.
6. Smoke Detector: Integral, factory wired for single-point connection.
7. Frame: Curtain type with blades inside airstream **OR** Curtain type with blades outside airstream **OR** Multiple-blade type **OR** Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream, **as directed**; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.
8. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.
9. Leakage: Class I **OR** Class II, **as directed**.
10. Rated pressure and velocity to exceed design airflow conditions.
11. Mounting Sleeve: Factory-installed, 0.052-inch- (1.3-mm-) thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking, **as directed**.
12. Master control panel for use in dynamic smoke-management systems.
13. Damper Motors: Modulating **OR** Two-position, **as directed**, action.
14. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".

a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section(s) "Instrumentation And Control For Hvac" OR Division 22, **as directed**.
c. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
d. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m).
e. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F (minus 40 deg C).
f. Nonspring-Return Motors: For dampers larger than 25 sq. ft. (2.3 sq. m), size motor for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 300 in. x lbf (34 N x m).
g. Electrical Connection: 115 V, single phase, 60 Hz.

15. Accessories:
    a. Auxiliary switches for signaling **OR** fan control **OR** position indication, **as directed**.
    b. Momentary test switch **OR** Test and reset switches, **as directed**, damper **OR** remote, **as directed**, mounted.

J. Corridor Dampers
1. General Requirements: Label combination fire and smoke dampers according to UL 555 for 1-1/2-hour rating by an NRTL.
2. Heat-Responsive Device: Replaceable, 165 deg F (74 deg C) **OR** 212 deg F (100 deg C), **as directed**, rated, fusible links.
   OR
   Heat-Responsive Device: Electric **OR** Pneumatic, **as directed**, resettable link and switch package, factory installed, rated.
3. Frame: Curtain type with blades inside airstream **OR** Curtain type with blades outside airstream **OR** Multiple-blade type **OR** Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream, **as directed**; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.
4. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.
5. Mounting Sleeve: Factory-installed, 0.052-inch- (1.3-mm-) thick, galvanized sheet steel; length to suit wall or floor application.
6. Damper Motors: Modulating **OR** Two-position, **as directed**, action.
7. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
   a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section(s) "Instrumentation And Control For Hvac" OR Division 22, **as directed**.
   c. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
   d. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m).

e. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F (minus 40 deg C).
f. Nonspring-Return Motors: For dampers larger than 25 sq. ft. (2.3 sq. m), size motor for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 300 in. x lbf (34 N x m).
g. Electrical Connection: 115 V, single phase, 60 Hz.

K. Flange Connectors
1. Description: Add-on **OR** Roll-formed, **as directed**, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
2. Material: Galvanized steel.
3. Gage and Shape: Match connecting ductwork.

L. Duct Silencers
1. General Requirements:
a. Factory fabricated.
b. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.
c. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
2. Shape:
a. Rectangular straight with splitters or baffles.
b. Round straight with center bodies or pods.
c. Rectangular elbow with splitters or baffles.
d. Round elbow with center bodies or pods.
e. Rectangular transitional with splitters or baffles.
3. Rectangular Silencer Outer Casing: ASTM A 653/A 653M, G90 (Z275) **OR** G60 (Z180), **as directed**, galvanized sheet steel, 0.034 inch (0.85 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
4. Round Silencer Outer Casing: ASTM A 653/A 653M, G90 (Z275) **OR** G60 (Z180), **as directed**, galvanized sheet steel.
a. Sheet Metal Thickness for Units up to 24 Inches (600 mm) in Diameter: 0.034 inch (0.85 mm) thick.
b. Sheet Metal Thickness for Units 26 through 40 Inches (660 through 1000 mm) in Diameter: 0.040 inch (1.02 mm) thick.
c. Sheet Metal Thickness for Units 42 through 52 Inches (1060 through 1300 mm) in Diameter: 0.052 inch (1.3 mm) thick.
d. Sheet Metal Thickness for Units 54 through 60 Inches (1370 through 1500 mm) in Diameter: 0.064 inch (1.62 mm) thick.
5. Inner Casing and Baffles: ASTM A 653/A 653M, G90 (Z275) **OR** G60 (Z180), **as directed**, galvanized sheet metal, 0.034 inch (0.85 mm) thick, and with 1/8-inch- (3-mm-) diameter perforations.
6. Special Construction:
a. Suitable for outdoor use.
b. High transmission loss to achieve STC 45, **as directed**.
7. Connection Sizes: Match connecting ductwork unless otherwise indicated.
8. Principal Sound-Absorbing Mechanism:
a. Controlled impedance membranes and broadly tuned resonators without absorptive media.
b. Dissipative **OR** Film-lined, **as directed**, type with fill material.
1) Fill Material: Inert and vermin-proof fibrous material, packed under not less than 5 percent compression **OR** Inert and vermin-proof fibrous material, packed under not less than 15 percent compression **OR** Moisture-proof nonfibrous material, **as directed**.
2) Erosion Barrier: Polymer bag enclosing fill, and heat sealed before assembly.

c. Lining: None **OR** Mylar **OR** Tedlar **OR** Fiberglas cloth, **as directed**.

9. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.
   a. Lock form and seal or continuously weld joints **OR** Flange connections, **as directed**.
   b. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
   c. Reinforcement: Cross or trapeze angles for rigid suspension.
10. Accessories:
   a. Integral 1-1/2 **OR** 3, **as directed**,-hour fire damper with access door. Access door to be high transmission loss to match silencer, **as directed**.
   b. Factory-installed end caps to prevent contamination during shipping.
   c. Removable splitters.
   d. Airflow measuring devices.
   e. Source Quality Control: Test according to ASTM E 477.
   f. Testing to be witnessed by the Owner.
   g. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000-fpm (10-m/s) face velocity.
   h. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg (1500-Pa) static pressure, whichever is greater.

M. Turning Vanes
1. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
   a. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
2. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
3. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."
4. Vane Construction: Single **OR** Double, **as directed**, wall.
   OR
   Vane Construction: Single wall for ducts up to 48 inches (1200 mm) wide and double wall for larger dimensions.

N. Remote Damper Operators
1. Description: Cable system designed for remote manual damper adjustment.
2. Tubing: Brass.
3. Cable: Stainless steel.
4. Wall-Box Mounting: Recessed, 3/4 inches (19 mm) deep **OR** Recessed, 2 inches (50 mm) deep **OR** Surface, **as directed**.
5. Wall-Box Cover-Plate Material: Steel **OR** Stainless steel, **as directed**.

O. Duct-Mounted Access Doors
1. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
   a. Door:
      1) Double wall, rectangular.
      2) Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
      3) Vision panel.
      4) Hinges and Latches: 1-by-1-inch (25-by-25-mm) butt or piano hinge and cam latches.
      5) Fabricate doors airtight and suitable for duct pressure class.

b. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
c. Number of Hinges and Locks:
   1) Access Doors Less Than 12 Inches (300 mm) Square: No hinges and two sash locks.
   2) Access Doors up to 18 Inches (460 mm) Square: Two hinges and two sash locks.
   3) Access Doors up to 24 by 48 Inches (600 by 1200 mm): Three hinges and two compression latches with outside and inside handles, **as directed**.
   4) Access Doors Larger Than 24 by 48 Inches (600 by 1200 mm): Four hinges and two compression latches with outside and inside handles.

2. Pressure Relief Access Door:
   a. Door and Frame Material: Galvanized sheet steel.
   b. Door: Single wall **OR** Double wall with insulation fill, **as directed**, with metal thickness applicable for duct pressure class.
   c. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
   d. Factory set at 10-inch wg (2500 Pa).
   e. Doors close when pressures are within set-point range.
   f. Hinge: Continuous piano.
   g. Latches: Cam.
   h. Seal: Neoprene or foam rubber.
   i. Insulation Fill: 1-inch- (25-mm-) thick, fibrous-glass or polystyrene-foam board.

P. Duct Access Panel Assemblies
1. Labeled according to UL 1978 by an NRTL.
2. Panel and Frame: Minimum thickness 0.0528-inch (1.3-mm) carbon **OR** 0.0428-inch (1.1-mm) stainless, **as directed**, steel.
3. Fasteners: Carbon **OR** Stainless, **as directed**, steel. Panel fasteners shall not penetrate duct wall.
4. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F (1093 deg C).
5. Minimum Pressure Rating: 10-inch wg (2500 Pa), positive or negative.

Q. Flexible Connectors
1. Materials: Flame-retardant or noncombustible fabrics.
2. Coatings and Adhesives: Comply with UL 181, Class 1.
3. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches (89 mm) **OR** 5-3/4 inches (146 mm), **as directed**, wide attached to 2 strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Provide metal compatible with connected ducts.
4. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
   a. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
   b. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
   c. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
5. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
   a. Minimum Weight: 24 oz./sq. yd. (810 g/sq. m).
   b. Minimum Tensile Strength: 500 lbf/inch (88 N/mm) in the warp and 440 lbf/inch (77 N/mm) in the filling.
   c. Service Temperature: Minus 50 to plus 250 deg F (Minus 45 to plus 121 deg C).
6. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
   a. Minimum Weight: 16 oz./sq. yd. (542 g/sq. m).
   b. Tensile Strength: 285 lbf/inch (50 N/mm) in the warp and 185 lbf/inch (32 N/mm) in the filling.
   c. Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C).

7. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
   a. Minimum Weight: 14 oz./sq. yd. (474 g/sq. m).
   b. Tensile Strength: 450 lbf/inch (79 N/mm) in the warp and 340 lbf/inch (60 N/mm) in the filling.
   c. Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C).
8. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
   a. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
   b. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   f. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
   g. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch (6-mm) movement at start and stop.

R. Flexible Ducts
1. Noninsulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire.
   a. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
   b. Maximum Air Velocity: 4000 fpm (20 m/s).
   c. Temperature Range: Minus 10 to plus 160 deg F (Minus 23 to plus 71 deg C).
2. Noninsulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire.
   a. Pressure Rating: 4-inch wg (1000 Pa) positive and 0.5-inch wg (125 Pa) negative.
   b. Maximum Air Velocity: 4000 fpm (20 m/s).
   c. Temperature Range: Minus 20 to plus 175 deg F (Minus 29 to plus 79 deg C).
3. Noninsulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire.
   a. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
   b. Maximum Air Velocity: 4000 fpm (20 m/s).
   c. Temperature Range: Minus 20 to plus 210 deg F (Minus 29 to plus 99 deg C).
4. Noninsulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire.
   a. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
   b. Maximum Air Velocity: 4000 fpm (20 m/s).
   c. Temperature Range: Minus 20 to plus 210 deg F (Minus 29 to plus 99 deg C).
5. Noninsulated, Flexible Duct: UL 181, Class 0, interlocking spiral of aluminum foil.
   a. Pressure Rating: 8-inch wg (2280 Pa) positive or negative.
   b. Maximum Air Velocity: 5000 fpm (25 m/s).
   c. Temperature Range: Minus 100 to plus 435 deg F (Minus 73 to plus 224 deg C).
6. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene **OR** aluminized, **as directed**, vapor-barrier film.
   a. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
   b. Maximum Air Velocity: 4000 fpm (20 m/s).
   c. Temperature Range: Minus 10 to plus 160 deg F (Minus 23 to plus 71 deg C).
   d. Insulation R-value: Comply with ASHRAE/IESNA 90.1.
7. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene **OR** aluminized, **as directed**, vapor-barrier film.

a. Pressure Rating: 4-inch wg (1000 Pa) positive and 0.5-inch wg (125 Pa) negative.
b. Maximum Air Velocity: 4000 fpm (20 m/s).
c. Temperature Range: Minus 20 to plus 175 deg F (Minus 29 to plus 79 deg C).
d. Insulation R-Value: Comply with ASHRAE/IESNA 90.1.

8. Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene **OR** aluminized, **as directed**, vapor-barrier film.
   a. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
   b. Maximum Air Velocity: 4000 fpm (20 m/s).
   c. Temperature Range: Minus 20 to plus 210 deg F (Minus 29 to plus 99 deg C).
   d. Insulation R-value: Comply with ASHRAE/IESNA 90.1.
9. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene **OR** aluminized, **as directed**, vapor-barrier film.
   a. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
   b. Maximum Air Velocity: 4000 fpm (20 m/s).
   c. Temperature Range: Minus 20 to plus 210 deg F (Minus 29 to plus 99 deg C).
   d. Insulation R-value: Comply with ASHRAE/IESNA 90.1.
10. Insulated, Flexible Duct: UL 181, Class 0, interlocking spiral of aluminum foil; fibrous-glass insulation; polyethylene **OR** aluminized, **as directed**, vapor-barrier film.
   a. Pressure Rating: 8-inch wg (2280 Pa) positive or negative.
   b. Maximum Air Velocity: 5000 fpm (25 m/s).
   c. Temperature Range: Minus 20 to plus 250 deg F (Minus 29 to plus 121 deg C).
   d. Insulation R-value: Comply with ASHRAE/IESNA 90.1.
11. Flexible Duct Connectors:
   a. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action **OR** Nylon strap, **as directed**, in sizes 3 through 18 inches (75 through 460 mm), to suit duct size.
   b. Non-Clamp Connectors: Adhesive **OR** Liquid adhesive plus tape **OR** Adhesive plus sheet metal screws, **as directed**.

S. Duct Security Bars
1. Description: Field-fabricated **OR** Factory-fabricated and field-installed **OR** Field- or factory-fabricated and field-installed, **as directed**, duct security bars.
2. Configuration:
   a. Frame: 10 gage by 2 inches (3.57 mm by 50 mm).
   b. Sleeve: 3/16-inch (4.8-mm), continuously welded **OR** bent, **as directed**, steel frames with 1-by-1-by-3/16-inch (25-by-25-by-4.8-mm) angle frame factory welded to 1 end **OR** furnished loose for field welding on other end, **as directed**. To be poured in place or set with concrete block or welded or bolted to wall, one side only. Duct connections on both sides.
   c. Horizontal Bars: 1/2 inch (13 mm) **OR** 2 by 1/4 inch (50 by 6 mm), **as directed**.
   d. Vertical Bars: 1/2 inch (13 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**.
   e. Bar Spacing: 6 inches (150 mm).
   f. Mounting: Metal deck or roofing **OR** Bolted or welded **OR** Bolted or welded with masonry anchors **OR** Ductwork or other framing **OR** Poured in place or set with concrete block **OR** Welded or bolted to one wall (one side only) **OR** Bar extends 6 inches (150 mm) into wall, **as directed**.

T. Duct Accessory Hardware
1. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
2. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

1.3 EXECUTION

A. Installation

1. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
2. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
3. Install backdraft **OR** control, **as directed**, dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
4. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
    a. Install steel volume dampers in steel ducts.
    b. Install aluminum volume dampers in aluminum ducts.
5. Set dampers to fully open position before testing, adjusting, and balancing.
6. Install test holes at fan inlets and outlets and elsewhere as indicated.
7. Install fire and smoke, **as directed**, dampers according to UL listing.
8. Install duct security bars. Construct duct security bars from 0.164-inch (4.18-mm) steel sleeve, continuously welded at all joints and 1/2-inch- (13-mm-) diameter steel bars, 6 inches (150 mm) o.c. in each direction in center of sleeve. Weld each bar to steel sleeve and each crossing bar. Weld 2-1/2-by-2-1/2-by-1/4-inch (63-by-63-by-6-mm) steel angle to 4 sides and both ends of sleeve. Connect duct security bars to ducts with flexible connections. Provide 12-by-12-inch (300-by-300-mm) hinged access panel with cam lock in duct in each side of sleeve.
9. Connect ducts to duct silencers with flexible duct connectors **OR** rigidly, **as directed**.
10. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
    a. On both sides of duct coils.
    b. Upstream **OR** Upstream and downstream, **as directed**, from duct filters.
    c. At outdoor-air intakes and mixed-air plenums.
    d. At drain pans and seals.
    e. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
    f. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
    g. At each change in direction and at maximum 50-foot (15-m) spacing.
    h. Upstream **OR** Upstream and downstream, **as directed**, from turning vanes.
    i. Upstream or downstream from duct silencers.
    j. Control devices requiring inspection.
    k. Elsewhere as indicated.
11. Install access doors with swing against duct static pressure.
12. Access Door Sizes:
    a. One-Hand or Inspection Access: 8 by 5 inches (200 by 125 mm).
    b. Two-Hand Access: 12 by 6 inches (300 by 150 mm).
    c. Head and Hand Access: 18 by 10 inches (460 by 250 mm).
    d. Head and Shoulders Access: 21 by 14 inches (530 by 355 mm).
    e. Body Access: 25 by 14 inches (635 by 355 mm).
    f. Body plus Ladder Access: 25 by 17 inches (635 by 430 mm).
13. Label access doors according to Division 21 Section "Fire-suppression Systems Insulation" to indicate the purpose of access door.
14. Install flexible connectors to connect ducts to equipment.

15. For fans developing static pressures of 5-inch wg (1250 Pa) and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
16. Connect terminal units to supply ducts directly or, **as directed**, with maximum 12-inch (300-mm) lengths of flexible duct. Do not use flexible ducts to change directions.
17. Connect diffusers or light troffer boots to ducts directly or, **as directed**, with maximum 60-inch (1500-mm) lengths of flexible duct clamped or strapped in place.
18. Connect flexible ducts to metal ducts with adhesive **OR** liquid adhesive plus tape **OR** draw bands **OR** adhesive plus sheet metal screws, **as directed**.
19. Install duct test holes where required for testing and balancing purposes.
20. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch (6-mm) movement during start and stop of fans.

B. Field Quality Control
1. Tests and Inspections:
    a. Operate dampers to verify full range of movement.
    b. Inspect locations of access doors and verify that purpose of access door can be performed.
    c. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
    d. Inspect turning vanes for proper and secure installation.
    e. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 23 31 13 19

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Task	Specification	Specification Description
23 31 13 19	23 01 30 61	Metal Ducts
23 31 13 19	23 31 13 13	HVAC Casings
23 31 13 23	23 01 30 61	Metal Ducts
23 31 13 23	23 31 13 13	HVAC Casings

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SECTION 23 31 16 13 - NONMETAL DUCTS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for nonmetal ducts. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Fibrous-glass ducts and fittings.
      b. Phenolic-foam ducts and fittings.
      c. Thermoset FRP ducts and fittings.
      d. PVC ducts and fittings.

C. Performance Requirements
   1. Delegated Duct Design: Duct construction, including duct closure, reinforcements, and hangers and supports, shall comply with SMACNA's "Fibrous Glass Duct Construction Standards" and performance requirements and design criteria indicated.
      a. Static-Pressure Classes:
         1) Supply Ducts (except in Mechanical Rooms): 1-inch wg (250 Pa).
         2) Supply Ducts (Upstream from Air Terminal Units): 2-inch wg (500 Pa).
         3) Supply Ducts (Downstream from Air Terminal Units): 1-inch wg (250 Pa).
         4) Supply Ducts (in Mechanical Equipment Rooms): 2-inch wg (500 Pa).
         5) Return Ducts (Negative Pressure): 1-inch wg (250 Pa).
         6) Exhaust Ducts (Negative Pressure): 1-inch wg (250 Pa).
   2. Structural Performance: Duct hangers and supports and seismic restraints, **as directed**, shall withstand the effects of gravity and seismic, **as directed**, loads and stresses within limits and under conditions to comply with ASCE/SEI 7 **OR** SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems", **as directed**.
      a. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
         OR
         Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
         OR
         Seismic Hazard Level C: Seismic force to weight ratio, 0.15.
   3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittals:
      a. Product Data for Prerequisite EQ 1: Documentation indicating that duct systems comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
      b. Product Data for Prerequisite EA 2: Documentation indicating that duct systems comply with ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
      c. Leakage Test Report for Prerequisite EA 2: Documentation of work performed for compliance with ASHRAE/IESNA 90.1, Section 6.4.4.2.2 - "Duct Leakage Tests."
      d. Duct-Cleaning Test Report for Prerequisite EQ 1: Documentation of work performed for compliance with ASHRAE 62.1, Section 7.2.4 - "Ventilation System Start-Up."
      e. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
   3. Shop Drawings:

a. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
b. Duct layout indicating sizes and pressure classes.
c. Elevation of top of ducts.
d. Dimensions of main duct runs from building grid lines.
e. Fittings.
f. Reinforcement and spacing.
g. Seam and joint construction.
h. Penetrations through fire-rated and other partitions.
i. Equipment installation based on equipment being used on Project.
j. Hangers and supports, including methods for duct and building attachment, seismic restraints, **as directed**, and vibration isolation.

4. Delegated-Design Submittal:
   a. Duct materials and thicknesses.
   b. Joint and seam construction and sealing.
   c. Reinforcement details and spacing.
   d. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation, **as directed**, for selecting hangers and supports and seismic restraints, **as directed**.
5. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   a. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
   b. Suspended ceiling components.
   c. Structural members to which duct will be attached.
   d. Size and location of initial access modules for acoustical tile.
   e. Penetrations of smoke barriers and fire-rated construction.
   f. Items penetrating finished ceiling including the following:
      1) Lighting fixtures.
      2) Air outlets and inlets.
      3) Speakers.
      4) Sprinklers.
      5) Access panels.
      6) Perimeter moldings.
6. Welding certificates.
7. Field quality-control reports.

E. Quality Assurance
1. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports **OR** AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports, **as directed**.
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."
3. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
4. NFPA Compliance:
   a. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
   b. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.2 PRODUCTS

A. Fibrous-Glass Ducts And Fittings

1. Fibrous-Glass Duct Materials: Resin-bonded fiberglass, faced on the outside surface with fire-resistive FSK vapor retarder and with a smooth fiberglass mat finish on the air-side surface.
   a. Duct Board: Factory molded into rectangular boards.
   b. Round Duct: Factory molded into straight round duct and smooth fittings.
   c. Temperature Limits: 40 to 250 deg F (5 to 121 deg C) inside ducts; 150 deg F (66 deg C) ambient temperature surrounding ducts.
   d. Maximum Thermal Conductivity: 0.24 Btu x in./h x sq. ft. x deg F (0.035 W/m x K) at 75 deg F (24 deg C) mean temperature.
   e. Moisture Absorption: Not exceeding 5 percent by weight at 120 deg F (49 deg C) and 95 percent relative humidity for 96 hours when tested according to ASTM C 1104/C 1104M.
   f. Permeability: 0.02 perms (1.15 ng/Pa x s x sq. m) maximum when tested according to ASTM E 96/E 96M, Procedure A.
   g. Antimicrobial Agent: Compound shall be tested for efficacy by an NRTL, and registered by the EPA for use in HVAC systems.
   h. Noise-Reduction Coefficient: 0.65 minimum when tested according to ASTM C 423, Mounting A.
   i. Required Markings: EI rating, UL label, and other markings required by UL 181 on each full sheet of duct board.
2. Closure Materials:
   a. Pressure-Sensitive Tape: Comply with UL 181A; imprinted by the manufacturer with the coding "181A-P," the manufacturer's name, and a date code.
      1) Tape: Aluminum foil-scrim tape imprinted with listing information.
      2) Minimum Tape Width: 2-1/2 inches (64 mm); 3 inches (76 mm) for duct board thicker than 1 inch (25 mm).
      3) Staples: 1/2-inch (13-mm) outward clinching, 2 inches (51 mm) o.c. in tabs, one tab per joint.
      4) Water resistant.
      5) Mold and mildew resistant.
   b. Heat-Activated Tape: Comply with UL 181A; imprinted by the manufacturer with the coding "181A-H," the manufacturer's name, and a date code.
      1) Tape: Aluminum foil-scrim tape imprinted with listing information.
      2) Minimum Tape Width: 3 inches (76 mm).
      3) Heat-Sensitive Imprint: Printed indicator on tape to show proper heating during application has been achieved.
      4) Water resistant.
      5) Mold and mildew resistant.
   c. Two-Part Tape Sealing System: Comply with UL 181A; imprinted by the manufacturer with the coding "181A-M," the manufacturer's name, and a date code.
      1) Tape: Woven glass fiber impregnated with mineral gypsum.
      2) Minimum Tape Width: 3 inches (76 mm).
      3) Sealant: Modified styrene acrylic.
      4) Water resistant.
      5) Mold and mildew resistant.
      6) For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Fabrication:
   a. Select joints, seams, transitions, elbows, and branch connections and fabricate according to SMACNA's "Fibrous Glass Duct Construction Standards," Chapter 2, "Specifications and Closure," and Chapter 4, "Fittings and Connections" **OR** NAIMA AH116, "Fibrous Glass Duct Construction Standards," Section II, "Fabrication of Straight Duct Modules," Section III, "Fabrication of Fittings from Modules or Flat Board," and Section IV, "Closure", **as directed**.
   b. Fabricate 90-degree mitered elbows to include turning vanes.
   c. Reinforcements: Comply with requirements in SMACNA's "Fibrous Glass Duct Construction Standards," Chapter 5, "Reinforcement" **OR** NAIMA AH116, "Fibrous Glass

Duct Construction Standards," Section V, "Reinforcement", **as directed**, for channel- and tie-rod reinforcement materials, spacing, and fabrication.
d. Preformed Round Duct: Comply with NAIMA AH116, "Fibrous Glass Duct Construction Standards," Section VII, "Preformed Round Duct."

B. Phenolic-Foam Ducts And Fittings
1. Duct Panel: CFC-free phenolic-foam bonded on both sides with factory-applied 0.001-inch- (0.025-mm-) thick, aluminum foil reinforced with fiberglass scrim.
a. Maximum Temperature: 158 deg F (70 deg C) inside ducts or ambient temperature surrounding ducts.
b. Maximum Thermal Conductivity: 0.13 Btu x in./h x sq. ft. x deg F (0.019 W/m x K) at 75 deg F (24 deg C) mean temperature.
c. Permeability: 0.0002 perms (0.0115 ng/Pa x s x sq. m) maximum when tested according to ASTM E 96/E 96M, Procedure A.
d. Antimicrobial Agent: Compound shall be tested for efficacy by an NRTL, and registered by the EPA for use in HVAC systems.
e. Noise-Reduction Coefficient: 0.65 minimum when tested according to ASTM C 423, Mounting A.
f. Required Markings: UL label and other markings required by UL 181 on each full sheet of duct panel; UL ratings for closure materials.
2. Closure Materials:
a. V-Groove Adhesive: Silicone.
1) For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
b. Pressure-Sensitive Tape: Comply with UL 181A, imprinted by the manufacturer with the coding "181A-P," the manufacturer's name, and a date code.
1) Tape: Aluminum foil tape imprinted with listing information.
2) Minimum Tape Width: 3 inches (76 mm).
3) Water resistant.
4) Mold and mildew resistant.
c. Polymeric Sealing System:
1) Structural Membrane: Woven glass fiber.
2) Minimum Tape Width: 3 inches (76 mm).
3) Sealant: Water based.
4) Color: White.
5) Water resistant.
6) Mold and mildew resistant.
7) For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Fabrication:
a. Fabricate joints, seams, transitions, reinforcement, elbows, branch connections, access doors and panels, and damage repairs according to Knauf Insulation's "Knauf KoolDuct System Design Guide," Section 4, "Duct Construction," and Section 5, "Ductwork System General."
b. Fabricate 90-degree mitered elbows to include turning vanes.

C. Thermoset FRP Ducts And Fittings
1. Duct and Fittings:
a. Thermoset FRP Resin: Manufacture duct with resin that complies with UL 181, Class 1, maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL according to ASTM E 84.
b. Inner Liner: FSK liner rated by an NRTL to comply with UL 181, Class 1.
c. Round Duct: ASTM D 2996, Type I, Grade 2, Class E, filament-wound duct, minimum 0.125-inch (3.2-mm) wall thickness, with tapered bell and spigot ends for adhesive joints, or plain ends with couplings.

d. Round Fittings: Compression or spray-up/contact, molded of same material, pressure class, and joining method as duct.
e. Rectangular Fittings: Minimum 0.125-inch- (3.2-mm-) thick flat sheet with fiberglass roving and resin-reinforced joints and seams.
f. Double-Wall Insulated Duct: Inner and outer duct complying with requirements for "Round Duct" description above. Polyurethane foam or isocyanurate insulation with maximum thermal conductivity of 0.14 Btu x in./h x sq. ft. x deg F (0.020 W/m x K) at 75 deg F (24 deg C) mean temperature.

2. Joining Materials: Roving and polyester resin.
   a. Use fiberglass adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Fabrication:
   a. Fabricate joints, seams, transitions, reinforcement, elbows, branch connections, and access doors and panels according to SMACNA's "Thermoset FRP Duct Construction Manual," Chapter 7, "Requirements."
   b. Fabricate 90-degree rectangular mitered elbows to include turning vanes, 90-degree round elbows with a minimum of three segments for 12 inches (300 mm) and smaller and a minimum of five segments for 14 inches (350 mm) and larger.
4. Drains: Formed drain pockets with a minimum of NPS 1 (DN 25) threaded pipe connections.

D. PVC Ducts And Fittings
1. Duct and Fittings:
   a. Round Duct: Comply with cell Classification 12454-B in ASTM D 1784, with external loading properties of ASTM D 2412.
   b. Round Fittings: Socket end molded of same material, pressure class, and joining method as duct.
   c. Rectangular Fittings: Minimum 0.125-inch- (3.2-mm-) thick flat sheet with heat-formed corners and continuous welded butt joints.
2. Joining Materials: PVC solvent cement complying with ASTM D 2564.
   a. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Fabrication:
   a. Fabricate joints, seams, transitions, reinforcement, elbows, branch connections, and access doors and panels according to SMACNA's "Thermoplastic Duct (PVC) Construction Manual," Chapter 3, "Standards of Construction for PVC Duct Systems."
   b. Fabricate 90-degree rectangular mitered elbows to include turning vanes, 90-degree round elbows with a minimum of three segments for 12 inches (300 mm) and smaller and a minimum of five segments for 14 inches (350 mm) and larger.
4. Drains: PVC drain pockets with a minimum of NPS 1 (DN 25) threaded PVC pipe connections.

E. Hangers And Supports
1. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
2. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
3. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1 (Table 4-1M), "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
4. Steel Cables: ASTM A 603, galvanized **OR** ASTM A 492, stainless, **as directed**, steel with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
5. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
6. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.

F. Seismic-Restraint Devices
1. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of the ICC Evaluation Service **OR** the Office of Statewide Health Planning and Development for the State of California **OR** an agency acceptable to authorities having jurisdiction, **as directed**.
    a. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
2. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.
3. Restraint Cables: ASTM A 603, galvanized **OR** ASTM A 492, stainless, **as directed**,-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.
4. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections **OR** Reinforcing steel angle clamped, **as directed**, to hanger rod.
5. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

1.3 EXECUTION

A. Duct Installation
1. Install ducts with fewest possible joints.
2. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
3. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
4. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.
5. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges. Overlap openings on four sides by at least 1-1/2 inches (38 mm).
6. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
7. Protect duct interiors from the moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines", **as directed**.
8. Install fibrous-glass ducts and fittings to comply with NAIMA AH116, "Fibrous Glass Duct Construction Standards **OR** SMACNA's "Fibrous Glass Duct Construction Standards", **as directed**.
9. Install foam ducts and fittings to comply with Knauf Insulation's "Knauf KoolDuct System Design Guide."
10. Install thermoset FRP ducts and fittings to comply with SMACNA's "Thermoset FRP Duct Construction Manual."
11. Install PVC ducts and fittings to comply with SMACNA's "Thermoplastic Duct (PVC) Construction Manual."

B. Hanger And Support Installation
1. Install hangers and supports for fibrous-glass ducts and fittings to comply with SMACNA's "Fibrous Glass Duct Construction Standards," Chapter 6, "Hangers and Supports" **OR** NAIMA AH116, "Fibrous Glass Duct Construction Standards," Section VI, "Hangers and Supports", **as directed**.
2. Install hangers and supports for phenolic-foam ducts and fittings to comply with Knauf Insulation's "Knauf KoolDuct System Design Guide," Section 5, "Ductwork System General."

3. Install hangers and supports for thermoset FRP ducts and fittings to comply with SMACNA's "Thermoset FRP Duct Construction Manual," Chapter 7, "Requirements."
4. Install hangers and supports for PVC ducts and fittings to comply with SMACNA's "Thermoplastic Duct (PVC) Construction Manual," Chapter 3, "Standards of Construction for PVC Duct Systems."
5. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   a. Install concrete inserts before placing concrete.
   b. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   c. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
   d. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
   e. Do not use powder-actuated concrete fasteners for seismic restraints.
6. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

C. Seismic-Restraint-Device Installation
1. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems" **OR** ASCE/SEI 7, **as directed**.
   a. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
   b. Brace a change of direction longer than 12 feet (3.7 m).
2. Select sizes of components so strength will be adequate to carry present and future static and seismic loads within restraint device capacity.
3. Install cables so they do not bend across edges of adjacent equipment or building structure.
4. Install cable restraints where ducts are suspended with vibration isolators.
5. Install seismic-restraint devices using methods approved by an evaluation service member of the ICC Evaluation Service **OR** the Office of Statewide Health Planning and Development for the State of California **OR** an agency acceptable to authorities having jurisdiction, **as directeed**.
6. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure to flanges of beams, to upper truss chords of bar joists, or to concrete members.
7. Drilling for and Setting Anchors:
   a. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the the Owner if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
   b. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   c. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
   d. Set anchors to manufacturer's recommended torque, using a torque wrench.
   e. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

D. Painting
1. Paint interior of thermoset FRP and PVC ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 07.

E. Field Quality Control
1. Perform tests and inspections.
2. Leakage Tests:

a. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
b. Test the following systems:
1) Ducts with a Pressure Class Higher Than 3-Inch wg (750 Pa): Test representative duct sections, selected by the Owner from sections installed, **as directed**, totaling no less than 25 percent of total installed duct area for each designated pressure class.
2) Supply Ducts with a Pressure Class of 2-Inch wg (500 Pa) **OR** 3-Inch wg (750 Pa) **OR** 4-Inch wg (1000 Pa), **as directed**, or Higher: Test representative duct sections, selected by the Owner from sections installed, **as directed**, totaling no less than 50 **OR** 100, **as directed**, percent of total installed duct area for each designated pressure class.
3) Return Ducts with a Pressure Class of 2-Inch wg (500 Pa) **OR** 3-Inch wg (750 Pa) **OR** 4-Inch wg (1000 Pa), **as directed**, or Higher: Test representative duct sections, selected by the Owner from sections installed, **as directed**, totaling no less than 50 **OR** 100, **as directed**, percent of total installed duct area for each designated pressure class.
4) Exhaust Ducts with a Pressure Class of 2-Inch wg (500 Pa) **OR** 3-Inch wg (750 Pa) **OR** 4-Inch wg (1000 Pa), **as directed**, or Higher: Test representative duct sections, selected by the Owner from sections installed, **as directed**, totaling no less than 50 **OR** 100, **as directed**, percent of total installed duct area for each designated pressure class.
5) Outdoor Air Ducts with a Pressure Class of 2-Inch wg (500 Pa) **OR** 3-Inch wg (750 Pa) **OR** 4-Inch wg (1000 Pa), **as directed**, or Higher: Test representative duct sections, selected by the Owner from sections installed, **as directed**, totaling no less than 50 **OR** 100, **as directed**, percent of total installed duct area for each designated pressure class.
c. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
d. Test for leaks before applying external insulation.
e. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
3. Duct System Cleanliness Tests:
a. Visually inspect duct system to ensure that no visible contaminants are present.
b. Test sections of nonmetal duct system, chosen randomly by the Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
1) Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
4. Duct system will be considered defective if it does not pass tests and inspections.
5. Prepare test and inspection reports.

F. Duct Cleaning
1. Clean new **OR** existing **OR** new and existing, **as directed**, duct system(s) before testing, adjusting, and balancing.
2. Use service openings for entry and inspection.
a. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch duct as recommended by duct manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.
b. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
c. Remove and reinstall ceiling to gain access during the cleaning process.
3. Particulate Collection and Odor Control:

a. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
b. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

4. Clean the following components by removing surface contaminants and deposits:
   a. Air outlets and inlets (registers, grilles, and diffusers).
   b. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
   c. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
   d. Coils and related components.
   e. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
   f. Supply-air ducts, dampers, actuators, and turning vanes.
   g. Dedicated exhaust and ventilation components and makeup air systems.
5. Mechanical Cleaning Methodology:
   a. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
   b. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of ducts or duct accessories.
   c. Clean fibrous-glass duct with HEPA vacuuming equipment; do not permit duct to get wet. Replace fibrous-glass duct that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
   d. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
   e. Provide drainage and cleanup for wash-down procedures.
   f. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

G. Start Up
1. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, And Balancing For Hvac".

H. Duct Schedule
1. Indoor Ducts and Fittings:
   a. Fibrous-Glass Rectangular Ducts and Fittings:
      1) Minimum Flexural Rigidity: EI-475 **OR** 800 **OR** 1400, **as directed**.
      2) Minimum Board Thickness: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (51 mm), **as directed**.
   b. Fibrous-Glass Round Ducts and Fittings:
      1) Minimum Thickness: 1 inch (25 mm).
   c. Phenolic-Foam Rectangular Ducts and Fittings:
      1) Minimum Panel Thickness: 7/8 inch (22 mm) **OR** 1-3/32 inches (28 mm), **as directed**.
      2) Aluminum Cladding: Minimum 0.025 inch (0.635 mm) thick.
2. Outdoor Ducts and Fittings:
   a. Phenolic-Foam Rectangular Ducts and Fittings:
      1) Minimum Panel Thickness: 7/8 inch (22 mm) **OR** 1-3/32 inches (28 mm), **as directed**.
      2) Aluminum Cladding: Minimum 0.032 inch (0.813 mm) thick.

3) Polymeric Sealing System: Coat ducts, including gang-nail couplings, grip flanges, and couplings.

b. Thermoset FRP Round Ducts and Fittings:

1) Double-Wall Insulated Ducts: Minimum 5/8-inch (15.9-mm) **OR** 7/8-inch (22.2-mm), **as directed**, insulation thickness.

c. PVC Round Ducts and Fittings:

3. Underground Ducts:

a. Thermoset FRP Round Ducts and Fittings:

1) Insulation Thickness: 1 inch (25 mm).

2) Drain: Minimum NPS 1 (DN 25) PVC pipe with P-trap to air-gap drain.

b. PVC Round Ducts and Fittings:

1) Drain: Minimum NPS 1 (DN 25) PVC pipe with P-trap to air-gap drain.

END OF SECTION 23 31 16 13

Task	Specification	Specification Description
23 31 16 13	23 01 30 61	Metal Ducts
23 31 16 16	23 01 30 61	Metal Ducts
23 31 16 16	23 31 16 13	Nonmetal Ducts

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SECTION 23 33 13 13 - DRAFT CONTROL DEVICES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for draft control devices. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Draft inducer fans.
   b. Venturi-draft inducer fans.
   c. Mechanical-draft vent fans.
   d. Vent exhaust fans.
   e. Barometric dampers.
   f. Vent dampers.
   g. Combustion-air fans.

C. Submittals
1. Product Data: For each type of product indicated.
2. Wiring Diagrams: Power, signal, and control wiring.
3. Operation and Maintenance Data.
4. Warranty: Warranty specified in this Section.

D. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Warranty
1. Manufacturer's standard form in which manufacturer agrees to repair or replace components of draft inducer fans, venturi-draft inducer fans, mechanical-draft vent fans, vent exhaust fans, barometric dampers, vent dampers, and/or combustion-air fans that fail in materials or workmanship within two **OR** 10, **as directed**, years from date of Final Completion.
   a. Failures include failure of the fan due to corrosion.

1.2 PRODUCTS

A. Draft Inducer Fans
1. Fan Construction: Galvanized **OR** Aluminized, **as directed**,-steel housing and radial-blade centrifugal fan.
   a. Fan Motor: Permanent split-capacitor type.
2. Controls:
   a. Draft proving switch.
   b. Control kit to cycle fan with gas flow to a single burner.

B. Venturi-Draft Inducer Fans
1. Fan Construction: Enameled-steel venturi tube for vents 20 inches (508 mm) in diameter and smaller, and ASTM A 666, Type 304, stainless-steel venturi tube for vents 22 to 48 inches (559 to 1219 mm) in diameter. Galvanized **OR** Enameled, **as directed**,-steel fan housing with radial-blade centrifugal wheel.

a. Fan Motor: Permanent split-capacitor type.
2. Controls:
a. Draft proving switch.
b. Control kit to cycle fan with gas flow to a single burner.

C. Mechanical-Draft Vent Fans
1. Fan Construction: Forward-curved centrifugal fan and scroll fabricated of aluminized **OR** galvanized, **as directed**, steel; direct-drive, ball-bearing motor lubricated with synthetic oil; internal cooling fan; stainless-steel shaft; and integral pressure-sensing switch.
a. Fan Motor: Permanent split-capacitor type.
2. Controls:
a. Draft proving switch.
b. Control kit to cycle fan with gas flow to single **OR** multiple, **as directed**, burner(s).
3. Accessories:
a. Aluminized **OR** Stainless, **as directed**,-steel, wall-vent hood.

D. Vent Exhaust Fans
1. General: Centrifugal fan with variable **OR** constant, **as directed**,-speed control mounted at end of sidewall **OR** vertical, **as directed**, vent.
2. Test Standard: UL 378, for fans exposed to flue gases up to 640 deg F (337 deg C).
3. Fan Construction: Cast-aluminum **OR** Galvanized-steel **OR** Stainless-steel, **as directed**, housing painted manufacturer's standard color of baked enamel, **as directed**. Galvanized **OR** Stainless, **as directed**,-steel vent. Cast-aluminum **OR** Stainless-steel, **as directed**, wheel. Backward-inclined centrifugal or axial fan wheel statically and dynamically balanced. Provide access to clean the discharge area. Concentric makeup air inlet duct surrounding the vent to allow zero clearance to combustibles, **as directed**.
4. Motor: Fully enclosed, variable-speed duty, **as directed**, permanent split capacitor, out of the airstream, with prelubricated and sealed ball bearings.
5. Constant-Speed Controls: Boiler interlock relay starts fan when burner control cycles on. Pressure switch permits burner operation via interlock with boiler. Fan proving switch is adjustable between minus 0.07- and minus 0.15-inch wg (minus 17 and minus 37 Pa).
6. Variable-Speed Controls: Boiler interlock relay starts fan when burner control cycles on. Pressure controller, control transformer, and miscellaneous controls for automatic modulation of fan speed to maintain preset negative pressure between 0- and minus 1.0-inch wg (0 and minus 249 Pa). Include controller with indicator lights, pressure differential transmitter, chimney pressure sensor probe, and fan proving switch adjustable between minus 0.07- and minus 0.15-inch wg (minus 17 and minus 37 Pa). Include tubing.

E. Barometric Dampers
1. Damper Construction: High-temperature-enamel-painted steel damper and housing with galvanized-steel breeching connection. Adjustable counterweight with lock. Include knife-edge bearings that do not require lubrication.

F. Vent Dampers
1. Damper Construction: Stainless-steel damper blade, shaft, and vent pipe with metal, prelubricated bearings.
a. Electric motor sized to power damper open and closed in approximately 15 seconds in each direction. Power is off when damper is at rest.
b. Comply with ANSI Z21.66.
2. Controls:
a. Control transformer.
b. Keyed wiring harness.
c. Damper end-switch to prove damper is open.
d. Interlock with boiler to permit burner operation when damper is open.
e. Hold-open switch for troubleshooting boiler controls.

G. Combustion-Air Fans
1. Fan Construction: Galvanized **OR** Aluminized, **as directed**,-steel housing; steel forward-curved fan and scroll; direct-drive, totally enclosed, fan-cooled motor with ball bearings; stainless-steel shaft; and integral pressure-sensing switch.
 a. Internal bypass to temper supply-air temperature to room.
2. Controls:
 a. Fan proving switch to permit burner operation when combustion-air fan is operating.
 b. Multiple appliance control starts fan with operation of any one of three **OR** four, **as directed**, appliances.
 c. Modulating combustion-air fan speed to control pressure differential in room with respect to outdoors.
 d. Manual-reset, high-limit switch stops operation with 160 deg F (71 deg C) room temperature.
 e. Optional Controls:
  1) Alarm circuit.
  2) Excessive negative pressure limit.
  3) Interface relay for vent exhaust fan, draft inducer fan, or mechanical-draft vent fan.
  4) Galvanized-steel **OR** Aluminum, **as directed**, intake hood.

H. Motors
1. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".

1.3 EXECUTION

A. Installation
1. Install listed components in a manner complying with the listing.
2. Secure barometric dampers to breechings with hardware compatible with connected materials.
3. Locate barometric and motorized vent dampers as close to draft hood collar as possible.
4. Secure barometric and motorized vent dampers to appliances, breechings, or chimneys with hardware compatible with connected materials.
5. Install draft inducer fans in single-wall vent section that is designed to couple with other vent materials.
6. Secure draft inducer fans to appliances, breechings, or stacks with hardware compatible with connected materials.
7. Install draft inducer fans with clearances for service and maintenance.
8. Install PVC, **as directed**, intake duct that is sized according to manufacturer's written instructions.

B. Connections
1. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
2. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Startup Service
1. Engage a factory-authorized service representative to perform startup service.
 a. Complete installation and startup checks according to manufacturer's written instructions.
2. Remove and replace malfunctioning components and recheck.

D. Adjusting
1. Set field-adjustable switches and controls as indicated.

E. Demonstration
1. Engage a factory-authorized service representative to train **OR** Train, **as directed**, Owner's maintenance personnel to adjust, operate, and maintain draft control devices.

END OF SECTION 23 33 13 13

Task	Specification	Specification Description
23 33 13 13	23 31 13 19	Duct Accessories
23 33 13 16	23 31 13 19	Duct Accessories
23 33 13 33	23 31 13 19	Duct Accessories
23 33 13 43	23 31 13 19	Duct Accessories
23 33 23 00	23 31 13 19	Duct Accessories
23 33 33 00	23 31 13 19	Duct Accessories
23 33 43 00	23 31 13 19	Duct Accessories
23 33 46 00	23 01 30 61	Metal Ducts
23 33 46 00	23 31 13 19	Duct Accessories
23 33 53 00	01 22 16 00	No Specification Required
23 33 53 00	23 01 30 61	Metal Ducts
23 33 53 00	23 31 13 13	HVAC Casings
23 33 56 00	23 01 30 61	Metal Ducts
23 33 56 00	23 31 13 19	Duct Accessories
23 33 59 00	23 31 13 19	Duct Accessories

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SECTION 23 34 13 00 - AXIAL FANS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for axial fans. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Tubeaxial fans.
      b. Vaneaxial fans.
      c. Mixed-flow fans.

C. Performance Requirements
   1. Project Altitude: Base fan performance ratings on actual Project site elevations above sea level.
   2. Operating Limits: Classify according to AMCA 99.

D. Submittals
   1. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
      a. Certified fan performance curves with system operating conditions indicated.
      b. Certified fan sound-power ratings.
      c. Motor ratings and electrical characteristics, plus motor and electrical accessories.
      d. Material thickness and finishes, including color charts.
      e. Dampers, including housings, linkages, and operators.
      f. Fan speed controllers.
   2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      a. Wiring Diagrams: Power, signal, and control wiring.
      b. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
      c. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.
   3. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.
   4. Field quality-control test reports.
   5. Operation and Maintenance Data: For axial fans to include in emergency, operation, and maintenance manuals.

E. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   2. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
   3. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

F. Delivery, Storage, And Handling

1. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.
2. Disassemble and reassemble units, as required for moving to final locations, according to manufacturer's written instructions.
3. Lift and support units with manufacturer's designated lifting or supporting points.

G. Coordination
1. Coordinate size and location of structural-steel support members.
2. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 31..
3. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories".

1.2 PRODUCTS

A. Tubeaxial Fans
1. Description: Fan wheel and housing, factory-mounted motor with belt drive or direct drive, an inlet cone section, and accessories.
2. Housings: Steel **OR** Galvanized steel **OR** Aluminum **OR** Fiberglass-reinforced plastic **OR** Stainless steel, **as directed,** with flanged inlet and outlet connections.
3. Wheel Assemblies: Cast or extruded aluminum with airfoil-shaped blades mounted on cast-iron wheel plate keyed to shaft with solid-steel key **OR** Fiberglass-reinforced plastic cured under pressure with airfoil-shaped blades keyed to stainless steel shaft **OR** Cast aluminum, machined and fitted to shaft, **as directed**.
4. Drives: Factory mounted, with final alignment and belt adjustment made after installation.
   a. Service Factor Based on Fan Motor Size: 1.2 **OR** 1.3 **OR** 1.4 **OR** 1.5, **as directed**.
   b. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
   c. Fan Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
   d. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
   e. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
   f. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.
   g. Motor Mount: Adjustable base.
   h. Shaft Bearings: Radial, self-aligning ball or roller bearings.
      1) Ball-Bearing Rating Life: ABMA 9, L10 of 100,000 hours.
         OR
         Roller-Bearing Rating Life: ABMA 11, L10 of 100,000 hours.
      2) Extend lubrication lines to outside of casing and terminate with grease fittings.
5. Accessories:
   a. Companion Flanges: Rolled flanges of same material as housing.
   b. Inspection Door: Bolted door allowing limited access to internal parts of fan, of same material as housing.
   c. Propeller Access Section Door: Short duct section bolted to fan inlet **OR** outlet **OR** inlet and outlet, **as directed,** allowing access to internal parts of fan for inspection and cleaning, of same material as housing.
   d. Swingout Construction: Assembly allowing entire fan section to swing out from duct for cleaning and servicing, of same material as housing.
   e. Mounting Clips: Horizontal ceiling **OR** Vertical mounting, **as directed,** clips welded to fan housing, of same material as housing.
   f. Horizontal Support: Pair of supports bolted to fan housing, of same material as housing.
   g. Vertical Support: Short duct section with welded brackets bolted to fan housing, of same material as housing.

h. Inlet and Outlet Screens: Wire-mesh screen on fans not connected to ductwork, of same material as housing.
i. Backdraft Dampers: Butterfly style, for bolting to the discharge of fan or outlet cone, of same material as housing.
j. Shaft Seal: Elastomeric seal and Teflon wear plate, suitable for up to 300 deg F (149 deg C).
k. Motor Cover: Cover with side vents to dissipate motor heat, of same material as housing.
l. Inlet Vanes: Adjustable; with peripheral control linkage operated from outside of airstream, bronze sleeve bearings on each end of vane support, and provision for manual or automatic operation of same material as housing.
m. Inlet Bell: Curved inlet for when fan is not attached to duct, of same material as housing **OR** aluminum, **as directed**.
n. Inlet Cones: Round-to-round transition of same material as housing.
o. Outlet Cones: Round-to-round transition of same material as housing.
p. Stack Cap: Vertical discharge assembly with backdraft dampers, of same material as housing.

6. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
a. Enclosure Type: Totally enclosed, fan cooled **OR** Totally enclosed, nonventilated, **as directed**.
b. Direct-Driven Units: Encase motor in housing outside of airstream, factory wired to disconnect switch located on outside of fan housing, **as directed**.

7. Factory Finishes:
a. Sheet Metal Parts: Prime coat before final assembly.
b. Exterior Surfaces: Baked-enamel finish coat after assembly.
c. Coatings: Thermoplastic vinyl **OR** Epoxy **OR** Zinc **OR** Synthetic resin **OR** Phenolic **OR** Color-match enamel **OR** Polytetrafluoroethylene **OR** Vinyl ester **OR** Hot-dip galvanized **OR** Powder-baked enamel, **as directed**.
1) Apply to finished housings.
2) Apply to fan wheels.

B. Vaneaxial Fans
1. Description: Fan wheel and housing, straightening vane section**,** factory-mounted motor with belt drive or direct drive, an inlet cone section, and accessories.
a. Variable-Pitch Fans: Internally mounted pneumatic **OR** electric **OR** electronic, **as directed,** actuator, externally mounted positive positioner, and mechanical-blade-pitch indicator.
2. Housings: Steel **OR** Galvanized steel **OR** Aluminum **OR** Fiberglass-reinforced plastic **OR** Stainless steel, **as directed**.
a. Inlet and Outlet Connections: Flanges.
b. Guide Vane Section: Integral guide vanes downstream from fan wheel designed to straighten airflow.
3. Wheel Assemblies: Cast aluminum with airfoil-shaped blades mounted on cast-iron wheel plate keyed to shaft with solid-steel key **OR** Fiberglass-reinforced plastic cured under pressure with airfoil-shaped blades keyed to stainless steel shaft **OR** Cast-aluminum hub assembly, machined and fitted with threaded bearing wells to receive blade-bearing assemblies with replaceable, cast-aluminum blades; factory mounted and balanced, **as directed**.
4. Drives: Factory mounted, with final alignment and belt adjustment made after installation.
a. Service Factor Based on Fan Motor Size: 1.2 **OR** 1.3 **OR** 1.4 **OR** 1.5, **as directed**.
b. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
c. Fan Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
d. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
e. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

f. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.
g. Motor Mount: Adjustable base.
h. Shaft Bearings: Radial, self-aligning ball or roller bearings.
   1) Ball-Bearing Rating Life: ABMA 9, L10 of 100,000 hours.
      OR
      Roller-Bearing Rating Life: ABMA 11, L10 of 100,000 hours.
   2) Extend lubrication lines to outside of casing and terminate with grease fittings.

5. Accessories:
   a. Companion Flanges: Rolled flanges of same material as housing.
   b. Inspection Door: Bolted door allowing limited access to internal parts of fan, of same material as housing.
   c. Propeller Access Section Door: Short duct section bolted to fan inlet **OR** outlet **OR** inlet and outlet, **as directed,** allowing access to internal parts of fan for inspection and cleaning, of same material as housing.
   d. Swingout Construction: Assembly allowing entire fan section to swing out from duct for cleaning and servicing, of same material as housing.
   e. Mounting Clips: Horizontal ceiling **OR** Vertical mounting, **as directed**, clips welded to fan housing, of same material as housing.
   f. Horizontal Support: Pair of supports bolted to fan housing, of same material as housing.
   g. Vertical Support: Short duct section with welded brackets bolted to fan housing, of same material as housing.
   h. Inlet and Outlet Screens: Wire-mesh screen on fans not connected to ductwork of same material as housing.
   i. Backdraft Dampers: Butterfly style, for mounting with flexible connection to the discharge of fan or direct mounted to the discharge diffuser section of same material as housing.
   j. Stall Alarm Probe: Sensing probe capable of detecting fan operation in stall and signaling control devices. Control devices and sequence of operation are specified in Division 23 Section(s) "Instrumentation And Control For Hvac" AND "Sequence Of Operations For Hvac Controls".
   k. Flow Measurement Port: Pressure measurement taps installed in the inlet of fan to detect and signal airflow readings to temperature-control systems. Control devices and sequence of operation are specified in Division 23 Section(s) "Instrumentation And Control For Hvac" AND "Sequence Of Operations For Hvac Controls".
   l. Shaft Seal: Elastomeric seal and Teflon wear plate, suitable for up to300 deg F (148 deg C).
   m. Motor Cover: Cover with side vents to dissipate motor heat, of same material as housing.
   n. Inlet Vanes: Adjustable; with peripheral control linkage operated from outside of airstream, bronze sleeve bearings on each end of vane support, and provision for manual or automatic operation of same material as housing.
   o. Inlet Bell: Curved inlet for when fan is not attached to duct, of same material as housing.
   p. Inlet Cones: Round-to-round transition of same material as housing.
   q. Outlet Cones: Round-to-round transition of same material as housing.
   r. Stack Cap: Vertical discharge assembly with backdraft dampers, of same material as housing.

6. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
   a. Enclosure Type: Totally enclosed, fan cooled **OR** Totally enclosed, nonventilated, **as directed**.
   b. Direct-Driven Units: Encase motor in housing outside of airstream, factory wired to disconnect switch located on outside of fan housing, **as directed**.

7. Factory Finishes:
   a. Sheet Metal Parts: Prime coat before final assembly.
   b. Exterior Surfaces: Baked-enamel finish coat after assembly.

c. Coatings: Thermoplastic vinyl **OR** Epoxy **OR** Zinc **OR** Synthetic resin **OR** Phenolic **OR** Color-match enamel **OR** Polytetrafluoroethylene **OR** Vinyl ester **OR** Hot-dip galvanized **OR** Powder-baked enamel, **as directed**.
   1) Apply to finished housings.
   2) Apply to fan wheels.

C. Mixed-Flow Fans
1. Description: Fan wheel and housing, straightening vane section, **as directed**, factory-mounted motor with belt drive, and accessories.
2. Housings: Steel **OR** Galvanized steel **OR** Aluminum, **as directed**.
   a. Inlet and Outlet Connections: Outer mounting frame and companion flanges.
   b. Guide Vane Section: Integral guide vanes downstream from fan wheel designed to straighten airflow.
   c. Mixed-Flow Outlet Connection: One **OR** Two, **as directed,** flanged discharge(s) perpendicular to fan inlet.
3. Wheel Assemblies: Cast aluminum with airfoil-shaped blades mounted on cast-iron wheel plate keyed to shaft with solid-steel key.
4. Drives: Factory mounted, with final alignment and belt adjustment made after installation.
   a. Service Factor Based on Fan Motor Size: 1.2 **OR** 1.3 **OR** 1.4 **OR** 1.5, **as directed**.
   b. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
   c. Fan Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
   d. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
   e. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
   f. Motor Mount: Adjustable base.
   g. Shaft Bearings: Radial, self-aligning ball or roller bearings.
      1) Ball-Bearing Rating Life: ABMA 9, L10 of 100,000 hours.
         OR
         Roller-Bearing Rating Life: ABMA 11, L10 of 100,000 hours.
      2) Extend lubrication lines to outside of casing and terminate with grease fittings.
5. Accessories:
   a. Mounting Clips: Horizontal ceiling **OR** Vertical mounting, **as directed,** clips welded to fan housing, of same material as housing.
   b. Inlet and Outlet Screens: Wire-mesh screen on fans not connected to ductwork of same material as housing.
   c. Backdraft Dampers: Butterfly style, for mounting with flexible connection to the discharge of fan or direct mounted to the discharge diffuser section of same material as housing.
   d. Motor Cover: Cover with side vents to dissipate motor heat, of same material as housing.
   e. Inlet Bell: Curved inlet for when fan is not attached to duct, of same material as housing.
   f. Inlet Cones: Round-to-round transition of same material as housing.
   g. Outlet Cones: Round-to-round transition of same material as housing.
   h. Stack Cap: Vertical discharge assembly with backdraft dampers, of same material as housing.
6. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
   a. Enclosure Type: Totally enclosed, fan cooled **OR** Totally enclosed, nonventilated, **as directed**.
   b. Direct-Driven Units: Encase motor in housing outside of airstream, factory wired to disconnect switch located on outside of fan housing.
7. Factory Finishes:
   a. Sheet Metal Parts: Prime coat before final assembly.
   b. Exterior Surfaces: Baked-enamel finish coat after assembly.

c. Coatings: Thermoplastic vinyl **OR** Epoxy **OR** Zinc **OR** Synthetic resin **OR** Phenolic **OR** Color-match enamel **OR** Polytetrafluoroethylene **OR** Vinyl ester **OR** Hot-dip galvanized **OR** Powder-baked enamel, **as directed**.
   1) Apply to finished housings.
   2) Apply to fan wheels.

D. Source Quality Control
   1. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
   2. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

1.3 EXECUTION

A. Installation
   1. Install axial fans level and plumb.
   2. Support floor-mounting units using spring isolators **OR** restrained spring isolators, **as directed,** having a static deflection of 1 inch (25 mm). Vibration- and seismic-control devices are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
      a. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.
   3. Install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-place Concrete".
   4. Install floor-mounting units on concrete bases designed to withstand, without damage to equipment, the seismic force required by authorities having jurisdiction. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-place Concrete".
   5. Support suspended units from structure using threaded steel rods and elastomeric hangers **OR** spring hangers **OR** spring hangers with vertical-limit stops, **as directed,** having a static deflection of 1 inch (25 mm). Vibration-control devices are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
   6. Install units with clearances for service and maintenance.
   7. Label fans according to requirements specified in Division 23 Section "Identification For Hvac Piping And Equipment".

B. Connections
   1. Duct installation and connection requirements are specified in other Division 21. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories".
   2. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
   3. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Field Quality Control
   1. Perform the following field tests and inspections and prepare test reports:
      a. Verify that shipping, blocking, and bracing are removed.
      b. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
      c. Verify that cleaning and adjusting are complete.

d. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
e. Adjust belt tension.
f. Adjust damper linkages for proper damper operation.
g. Verify lubrication for bearings and other moving parts.
h. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
i. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
j. Shut unit down and reconnect automatic temperature-control operators.
k. Remove and replace malfunctioning units and retest as specified above.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Adjusting
1. Adjust damper linkages for proper damper operation.
2. Adjust belt tension.
3. Lubricate bearings.

END OF SECTION 23 34 13 00

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SECTION 23 34 16 00 - CENTRIFUGAL FANS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for centrifugal fans. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Airfoil centrifugal fans.
b. Backward-inclined centrifugal fans.
c. Forward-curved centrifugal fans.
d. Plenum fans.
e. Plug fans.

C. Performance Requirements
1. Project Altitude: Base fan performance ratings on actual Project site elevations above sea level.
2. Operating Limits: Classify according to AMCA 99.

D. Submittals
1. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated.
2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Field quality-control test reports.
4. Operation and maintenance data.

E. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
3. NEMA Compliance: Motors and electrical accessories shall comply with NEMA 1.

F. Delivery, Storage, And Handling
1. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.
2. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.
3. Lift and support units with manufacturer's designated lifting or supporting points.

1.2 PRODUCTS

A. Airfoil Centrifugal Fans
1. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, **as directed,**, drive assembly, and support structure.

2. Housings: Formed panels to make curved-scroll housings with shaped cutoff, with doors or panels to allow access to internal parts and components.
   a. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
   b. Horizontally split, bolted-flange housing.
   c. Spun inlet cone with flange.
   d. Outlet flange.
3. Airfoil Wheels: Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange; heavy backplate; hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate; and cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws; and special coating, **as directed**.
4. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
   a. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
   b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
5. Prelubricated and Sealed Shaft Bearings: Self-aligning, pillow-block-type ball bearings.
   a. Ball-Bearing Rating Life: ABMA 9, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
   b. Roller-Bearing Rating Life: ABMA 11, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
6. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
   a. Ball-Bearing Rating Life: ABMA 9, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
   b. Roller-Bearing Rating Life: ABMA 11, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
7. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
   a. Ball-Bearing Rating Life: ABMA 9, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
   b. Roller-Bearing Rating Life: ABMA 11, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
8. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
   a. Service Factor Based on Fan Motor Size: 1.5 **OR** 1.4 **OR** 1.3 **OR** 1.2, **as directed**.
   b. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
   c. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
   d. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
   e. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
   f. Motor Mount: Adjustable for belt tensioning.
9. Accessories:
   a. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
   b. Cleanout Door: Bolted **OR** Quick-opening, latch-type, **as directed,** gasketed door allowing access to fan scroll, of same material as housing.
   c. Scroll Drain Connection: NPS 1 (DN 25) steel pipe coupling welded to low point of fan scroll.
   d. Companion Flanges: Rolled flanges for duct connections of same material as housing.
   e. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
   f. Discharge Dampers: Assembly with parallel **OR** opposed, **as directed,** blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.

g. Inlet Screens: Grid screen of same material as housing.
h. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
i. Spark-Resistant Construction: AMCA 99.
j. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
k. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

10. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
    a. Enclosure Type: Totally enclosed, fan cooled.

B. Backward-Inclined Centrifugal Fans
1. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure.
2. Housings: Formed panels to make curved-scroll housings with shaped cutoff; with doors or panels to allow access to internal parts and components.
    a. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
    b. Spun inlet cone with flange.
    c. Outlet flange.
3. Backward-Inclined Wheels: Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate, **as directed**, and fastened to shaft with set screws.
4. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
    a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
    b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
5. Prelubricated and Sealed Shaft Bearings: Self-aligning, pillow-block-type ball bearings.
    a. Ball-Bearing Rating Life: ABMA 9, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
    b. Roller-Bearing Rating Life: ABMA 11, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
6. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
    a. Ball-Bearing Rating Life: ABMA 9, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
    b. Roller-Bearing Rating Life: ABMA 11, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
7. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
    a. Ball-Bearing Rating Life: ABMA 9, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
    b. Roller-Bearing Rating Life: ABMA 11, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
8. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
    a. Service Factor Based on Fan Motor Size: 1.5 **OR** 1.4 **OR** 1.3 **OR** 1.2, **as directed**].
    b. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
    c. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
    d. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
    e. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
    f. Motor Mount: Adjustable for belt tensioning.
9. Accessories:

a. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
b. Cleanout Door: Bolted **OR** Quick-opening, latch-type, **as directed,** gasketed door allowing access to fan scroll, of same material as housing.
c. Scroll Drain Connection: NPS 1 (DN 25) steel pipe coupling welded to low point of fan scroll.
d. Companion Flanges: Rolled flanges for duct connections of same material as housing.
e. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
f. Discharge Dampers: Assembly with parallel **OR** opposed, **as directed,** blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
g. Inlet Screens: Grid screen of same material as housing.
h. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
i. Spark-Resistant Construction: AMCA 99.
j. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
k. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

10. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
    a. Enclosure Type: Totally enclosed, fan cooled.

C. Forward-Curved Centrifugal Fans

1. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, **as directed**, drive assembly, and support structure.
2. Housings: Formed panels to make curved-scroll housings with shaped cutoff; with doors or panels to allow access to internal parts and components.
   a. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
   b. Horizontally split, bolted-flange housing.
   c. Spun inlet cone with flange.
   d. Outlet flange.
3. Forward-Curved Wheels: Black-enameled or galvanized steel construction with inlet flange, backplate, shallow blades with inlet and tip curved forward in direction of airflow, mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.
4. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
   a. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
   b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
5. Prelubricated and Sealed Shaft Bearings: Self-aligning, pillow-block-type ball bearings.
   a. Ball-Bearing Rating Life: ABMA 9, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
   b. Roller-Bearing Rating Life: ABMA 11, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
6. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
   a. Ball-Bearing Rating Life: ABMA 9, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
   b. Roller-Bearing Rating Life: ABMA 11, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
7. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
   a. Ball-Bearing Rating Life: ABMA 9, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
   b. Roller-Bearing Rating Life: ABMA 11, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.

8. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
   a. Service Factor Based on Fan Motor Size: 1.5.
   b. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
   c. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
   d. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
   e. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
   f. Motor Mount: Adjustable for belt tensioning.
9. Accessories:
   a. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
   b. Cleanout Door: Bolted **OR** Quick-opening, latch-type, **as directed,** gasketed door allowing access to fan scroll, of same material as housing.
   c. Scroll Drain Connection: NPS 1 (DN 25) steel pipe coupling welded to low point of fan scroll.
   d. Companion Flanges: Rolled flanges for duct connections of same material as housing.
   e. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
   f. Discharge Dampers: Assembly with parallel **OR** opposed, **as directed,** blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
   g. Inlet Screens: Grid screen of same material as housing.
   h. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
   i. Spark-Resistant Construction: AMCA 99.
   j. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
   k. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.
10. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
   a. Enclosure Type: Totally enclosed, fan cooled.

D. Plenum Fans
1. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of wheel, fan shaft, bearings, motor and disconnect switch, **as directed**, drive assembly, and support structure.
2. Airfoil Wheels: Single-width-single-inlet construction with smooth-curved inlet flange; heavy backplate; hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate; and cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws; and special coating.
3. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
   a. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
   b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
4. Prelubricated and Sealed Shaft Bearings: Self-aligning, pillow-block-type ball bearings.
   a. Ball-Bearing Rating Life: ABMA 9, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
   b. Roller-Bearing Rating Life: ABMA 11, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
5. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.

a. Ball-Bearing Rating Life: ABMA 9, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
b. Roller-Bearing Rating Life: ABMA 11, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
6. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
a. Ball-Bearing Rating Life: ABMA 9, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
b. Roller-Bearing Rating Life: ABMA 11, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
7. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
a. Service Factor Based on Fan Motor Size: 1.5 **OR** 1.4 **OR** 1.3 **OR** 1.2, **as directed**.
b. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
c. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
d. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
e. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
f. Motor Mount: Adjustable for belt tensioning.
8. Accessories:
a. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
b. Spark-Resistant Construction: AMCA 99.
c. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
9. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
a. Enclosure Type: Totally enclosed, fan cooled.

E. Plug Fans
1. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of wheel, fan shaft, bearings, motor and disconnect switch, **as directed**, drive assembly, and support structure.
2. Airfoil Wheels: Single-width-single-inlet construction with smooth-curved inlet flange; heavy backplate; hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate; and cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws; and special coating, **as directed**.
3. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
a. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
4. Prelubricated and Sealed Shaft Bearings: Self-aligning, pillow-block-type ball bearings.
a. Ball-Bearing Rating Life: ABMA 9, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
b. Roller-Bearing Rating Life: ABMA 11, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
5. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
a. Ball-Bearing Rating Life: ABMA 9, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
b. Roller-Bearing Rating Life: ABMA 11, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
6. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
a. Ball-Bearing Rating Life: ABMA 9, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
b. Roller-Bearing Rating Life: ABMA 11, Ll0 at 50,000 hours **OR** 120,000 hours, **as directed**.
7. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

a. Service Factor Based on Fan Motor Size: 1.5 **OR** 1.4 **OR** 1.3 **OR** 1.2, **as directed**.
b. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
c. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
d. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
e. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
f. Motor Mount: Adjustable for belt tensioning.

8. Accessories:
   a. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
   b. Spark-Resistant Construction: AMCA 99.
   c. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
9. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
   a. Enclosure Type: Totally enclosed, fan cooled.

F. Source Quality Control
1. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
2. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

1.3 EXECUTION

A. Installation
1. Install centrifugal fans level and plumb.
2. Support floor-mounting units using spring isolators **OR** restrained spring isolators, **as directed,** having a static deflection of 1 inch (25 mm). Vibration- and seismic-control devices are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
   a. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.
3. Install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-place Concrete".
4. Install floor-mounting units on concrete bases designed to withstand, without damage to equipment, the seismic force required by authorities having jurisdiction. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-place Concrete".
5. Support suspended units from structure using threaded steel rods and elastomeric hangers **OR** spring hangers **OR** spring hangers with vertical-limit stops, **as directed,** having a static deflection of 1 inch (25 mm). Vibration-control devices are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
6. Install units with clearances for service and maintenance.
7. Label fans according to requirements specified in Division 23 Section "Identification For Hvac Piping And Equipment".

B. Connections
1. Duct installation and connection requirements are specified in other Division 21. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with

flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories".
2. Install ducts adjacent to fans to allow service and maintenance.
3. Install line-sized piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain.
4. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
5. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Field Quality Control
1. Perform the following field tests and inspections and prepare test reports:
    a. Verify that shipping, blocking, and bracing are removed.
    b. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
    c. Verify that cleaning and adjusting are complete.
    d. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
    e. Adjust belt tension.
    f. Adjust damper linkages for proper damper operation.
    g. Verify lubrication for bearings and other moving parts.
    h. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
    i. Refer to Division 23 Section "Testing, Adjusting, And Balancing For Hvac" for testing, adjusting, and balancing procedures.
    j. Remove and replace malfunctioning units and retest as specified above.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 23 34 16 00

SECTION 23 34 16 00a - POWER VENTILATORS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for power ventilators. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Utility set fans.
   b. Centrifugal roof ventilators.
   c. Axial roof ventilators.
   d. Upblast propeller roof exhaust fans.
   e. Centrifugal wall ventilators.
   f. Ceiling-mounting ventilators.
   g. In-line centrifugal fans.
   h. Propeller fans.

C. Performance Requirements
1. Project Altitude: Base fan-performance ratings on actual Project site elevations **OR** sea level, **as directed**.
2. Operating Limits: Classify according to AMCA 99.

D. Submittals
1. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
   a. Certified fan performance curves with system operating conditions indicated.
   b. Certified fan sound-power ratings.
   c. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   d. Material thickness and finishes, including color charts.
   e. Dampers, including housings, linkages, and operators.
   f. Roof curbs.
   g. Fan speed controllers.
2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   b. Wiring Diagrams: For power, signal, and control wiring.
3. Delegated-Design Submittal: For unit hangars and supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   a. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
   b. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
4. Field quality-control reports.
   a. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

E. Quality Assurance

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended use.
2. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.
3. UL Standard: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.2 PRODUCTS

A. Utility Set Fans
1. Description: Direct **OR** Belt, **as directed,**-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.
2. Housing: Fabricated of galvanized, **as directed**, steel with side sheets fastened with a deep lock seam or welded to scroll sheets.
   a. Housing Discharge Arrangement: Adjustable to eight standard positions.
3. Fan Wheels: Single-width, single inlet; welded to cast-iron or cast-steel hub and spun-steel inlet cone, with hub keyed to shaft.
   a. Blade Materials: Steel **OR** Aluminum, **as directed**.
   b. Blade Type: Backward inclined **OR** Forward curved **OR** Airfoil, **as directed**.
   c. Spark-Resistant Construction: AMCA 99, Type A **OR** B **OR** C, **as directed**.
4. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
5. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings with ABMA 9, L_{50} of 200,000 hours **OR** L_{10} of 80,000 hours, **as directed**.
6. Belt Drives:
   a. Factory mounted, with final alignment and belt adjustment made after installation.
   b. Service Factor Based on Fan Motor Size: 1.5 **OR** 1.4 **OR** 1.3 **OR** 1.2, **as directed**.
   c. Motor Pulleys: Adjustable pitch for use with motors through 5, **as directed**, hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
   d. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
   e. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.
7. Accessories:
   a. Inlet and Outlet: Flanged.
   b. Companion Flanges: Rolled flanges for duct connections of same material as housing.
   c. Backdraft Dampers: Gravity actuated with counterweight and interlocking aluminum blades with felt edges in steel frame installed on fan discharge.
   d. Access Door: Gasketed door in scroll with latch-type handles.
   e. Scroll Dampers: Single-blade damper installed at fan scroll top with adjustable linkage.
   f. Inlet Screens: Removable wire mesh.
   g. Drain Connections: NPS 3/4 (DN 20) threaded coupling drain connection installed at lowest point of housing.
   h. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.
   i. Discharge Dampers: Assembly with parallel **OR** opposed, **as directed,** blades constructed of two plates formed around and to shaft, channel frame, sealed ball bearings, with blades linked outside of airstream to single control lever of same material as housing.
   j. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
   k. Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

B. Centrifugal Roof Ventilators
1. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

2. Housing: Removable, spun-aluminum, dome top and outlet baffle **OR** extruded-aluminum, rectangular top **OR** galvanized steel, mushroom-domed top, **as directed**; square, one-piece, aluminum base with venturi inlet cone.
    a. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains and grease collector, **as directed**.
    b. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
3. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
4. Belt-Driven Drive:
    a. Resiliently mounted to housing.
    b. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
    c. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
    d. Pulleys: Cast-iron, adjustable-pitch motor pulley.
    e. Fan and motor isolated from exhaust airstream.
5. Accessories:
    a. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
    b. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside **OR** outside, **as directed,** fan housing, factory wired through an internal aluminum conduit.
    c. Bird Screens: Removable, 1/2-inch (13-mm) mesh, aluminum or brass wire.
    d. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
    e. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
6. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- (40-mm-) thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to suit roof opening and fan base.
    a. Configuration: Self-flashing without a cant strip, with mounting flange **OR** Built-in cant and mounting flange **OR** Built-in raised cant and mounting flange, **as directed**.
    b. Overall Height: 8 inches (200 mm) **OR** 9-1/2 inches (240 mm) **OR** 12 inches (300 mm) **OR** 16 inches (400 mm) **OR** 18 inches (450 mm), **as directed**.
    c. Sound Curb: Curb with sound-absorbing insulation matrix.
    d. Pitch Mounting: Manufacture curb for roof slope.
    e. Metal Liner: Galvanized steel.
    f. Burglar Bars: 1/2-inch- (13-mm-) **OR** 5/8-inch- (16-mm-) **OR** 3/4-inch- (19-mm-), **as directed,** thick steel bars welded in place to form 6-inch (150-mm) squares.
    g. Mounting Pedestal: Galvanized steel with removable access panel.
    h. Vented Curb: Unlined with louvered vents in vertical sides.

C. Axial Roof Ventilators
1. Description: Direct- or belt-driven axial fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
2. Housing: Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; square, one-piece, hinged, aluminum base.
    a. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
3. Fan Wheel: Aluminum **OR** Steel, **as directed,** hub and blades.
4. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
    a. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
    b. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
    c. Pulleys: Cast-iron, adjustable-pitch motor pulley.
5. Accessories:
    a. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside **OR** outside, **as directed,** fan housing, factory wired through an internal aluminum conduit.
    b. Bird Screens: Removable, 1/2-inch (13-mm) mesh, aluminum or brass wire.

c. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
d. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

6. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- (40-mm-) thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to suit roof opening and fan base.
   a. Configuration: Self-flashing without a cant strip, with mounting flange **OR** Built-in cant and mounting flange **OR** Built-in raised cant and mounting flange, **as directed**.
   b. Overall Height: 8 inches (200 mm) **OR** 9-1/2 inches (240 mm) **OR** 12 inches (300 mm) **OR** 16 inches (400 mm) **OR** 18 inches (450 mm), **as directed**.
   c. Sound Curb: Curb with sound-absorbing insulation matrix.
   d. Pitch Mounting: Manufacture curb for roof slope.
   e. Metal Liner: Galvanized steel.
   f. Burglar Bars: 1/2-inch- (13-mm-) **OR** 5/8-inch- (16-mm-) **OR** 3/4-inch- (19-mm-), **as directed,** thick steel bars welded in place to form 6-inch (150-mm) squares.
   g. Mounting Pedestal: Galvanized steel with removable access panel.

D. Upblast Propeller Roof Exhaust Fans
1. Description: Direct- or belt-driven propeller fans consisting of housing, wheel, butterfly-type discharge damper, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
2. Wind Band, Fan Housing, and Base: Reinforced and braced galvanized steel **OR** aluminum, **as directed**, containing galvanized-steel **OR** aluminum, **as directed,** butterfly dampers and rain trough, motor and drive assembly, and fan wheel.
   a. Damper Rods: Steel with bronze **OR** nylon, **as directed,** bearings.
   b. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
3. Fan Wheel: Replaceable, cast **OR** extruded, **as directed,**-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.
4. Belt-Driven Drive Assembly: Resiliently mounted to housing; weatherproof housing of same material as fan housing with the following features:
   a. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   b. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings.
   c. Pulleys: Cast-iron, adjustable-pitch motor pulley.
   d. Motor Mount: On outside of fan cabinet, adjustable base for belt tensioning.
5. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- (40-mm-) thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to suit roof opening and fan base.
   a. Configuration: Self-flashing without a cant strip, with mounting flange **OR** Built-in cant and mounting flange **OR** Built-in raised cant and mounting flange, **as directed**.
   b. Overall Height: 8 inches (200 mm) **OR** 9-1/2 inches (240 mm) **OR** 12 inches (300 mm) **OR** 16 inches (400 mm) **OR** 18 inches (450 mm), **as directed**.
   c. Sound Curb: Curb with sound-absorbing insulation matrix.
   d. Pitch Mounting: Manufacture curb for roof slope.
   e. Metal Liner: Galvanized steel.
   f. Burglar Bars: 1/2-inch- (13-mm-) **OR** 5/8-inch- (16-mm-) **OR** 3/4-inch- (19-mm-), **as directed,** thick steel bars welded in place to form 6-inch (150-mm) squares.
   g. Mounting Pedestal: Galvanized steel with removable access panel.

E. Centrifugal Wall Ventilators
1. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.
2. Housing: Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; venturi inlet cone.
3. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.

4. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
   a. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   b. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
   c. Pulleys: Cast-iron, adjustable-pitch motor pulley.
   d. Fan and motor isolated from exhaust airstream.
5. Accessories:
   a. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   b. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through internal aluminum conduit.
   c. Bird Screens: Removable, 1/2-inch (13-mm) mesh, aluminum or brass wire.
   d. Wall Grille: Ring type for flush mounting.
   e. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in wall sleeve; factory set to close when fan stops.
   f. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

F. Ceiling-Mounting Ventilators
1. Description: Centrifugal fans designed for installing in ceiling or wall or for concealed in-line applications.
2. Housing: Steel, lined with acoustical insulation.
3. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
4. Grille: Plastic **OR** Stainless steel **OR** Aluminum **OR** Painted aluminum, **as directed**, louvered grille with flange on intake and thumbscrew attachment to fan housing.
5. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
6. Accessories:
   a. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   b. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
   c. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
   d. Motion Sensor: Motion detector with adjustable shutoff timer.
   e. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless-steel springs, and fusible link.
   f. Filter: Washable aluminum to fit between fan and grille.
   g. Isolation: Rubber-in-shear vibration isolators.
   h. Manufacturer's standard roof jack or wall cap, and transition fittings.

G. In-Line Centrifugal Fans
1. Description: In-line, direct **OR** belt, **as directed,**-driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.
2. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
3. Direct-Driven Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel, inlet cone, and motor on swing-out service door, **as directed**.
4. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
5. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.
6. Accessories:
   a. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   b. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
   c. Companion Flanges: For inlet and outlet duct connections.

d. Fan Guards: 1/2- by 1-inch (13- by 25-mm) mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
e. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

H. Propeller Fans
1. Description: Direct- or belt-driven propeller fans consisting of fan blades, hub, housing, orifice ring, motor, drive assembly, and accessories.
2. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.
3. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.
4. Fan Wheel: Replaceable, cast **OR** extruded, **as directed,**-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.
5. Belt-Driven Drive Assembly: Resiliently mounted to housing, statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
a. Service Factor Based on Fan Motor Size: 1.4.
b. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
c. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
1) Ball-Bearing Rating Life: ABMA 9, L_{10} of 100,000 hours.
d. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
e. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
f. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
g. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.
6. Accessories:
a. Gravity Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings.
b. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
c. Wall Sleeve: Galvanized steel to match fan and accessory size.
d. Weathershield Hood: Galvanized steel to match fan and accessory size.
e. Weathershield Front Guard: Galvanized steel with expanded metal screen.
f. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
g. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

I. Motors
1. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
2. Enclosure Type: Open dripproof **OR** Totally enclosed, fan cooled, **as directed**.

J. Source Quality Control
1. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
2. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

1.3 EXECUTION

A. Installation
1. Install power ventilators level and plumb.
2. Support units using elastomeric mounts **OR** restrained elastomeric mounts **OR** spring isolators **OR** restrained spring isolators, **as directed,** having a static deflection of 1 inch (25 mm). Vibration- and seismic-control devices are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
   a. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.
3. For projects not in seismic areas, install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-place Concrete".
4. For projects in seismic areas, install floor-mounting units on concrete bases designed to withstand, without damage to equipment, the seismic force required by code. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-place Concrete".
5. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 07 Section "Roof Accessories" for installation of roof curbs.
6. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
7. Support suspended units from structure using threaded steel rods and elastomeric hangers **OR** spring hangers **OR** spring hangers with vertical-limit stops, **as directed,** having a static deflection of 1 inch (25 mm). Vibration-control devices are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
8. Install units with clearances for service and maintenance.
9. Label units according to requirements specified in Division 23 Section "Identification For Hvac Piping And Equipment".
10. Duct installation and connection requirements are specified in other Division 21. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories".
11. Install ducts adjacent to power ventilators to allow service and maintenance.
12. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
13. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

B. Field Quality Control
1. Perform the following field tests and inspections and prepare test reports:
   a. Verify that shipping, blocking, and bracing are removed.
   b. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   c. Verify that cleaning and adjusting are complete.
   d. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
   e. Adjust belt tension.
   f. Adjust damper linkages for proper damper operation.
   g. Verify lubrication for bearings and other moving parts.
   h. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
   i. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
   j. Shut unit down and reconnect automatic temperature-control operators.
   k. Remove and replace malfunctioning units and retest as specified above.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 23 34 16 00a

Task	Specification	Specification Description
23 34 16 00	01 22 16 00	No Specification Required
23 34 23 00	23 34 16 00a	Power Ventilators

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SECTION 23 34 33 00 - AIR CURTAINS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for air curtains. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes air curtains with hot-water heat, steam heat, electric heat, and gas-fired heater.

C. Submittals
1. Product Data: Include rated capacities, furnished specialties, and accessories for each unit indicated.
2. Shop Drawings: For air curtains. Include plans, elevations, sections, details, and attachments to other work.
   a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   b. Wiring Diagrams: Power, signal, and control wiring.
3. Delegated-Design Submittal: For air curtains indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   a. Detail fabrication and assembly of air-curtain mounting assemblies.
   b. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints.
4. Operation and maintenance data: For air curtains to include in maintenance manuals.
5. Warranties: Sample of special warranties.

D. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified and marked for intended location and application.
2. Comply with AMCA 220, "Laboratory Methods of Testing Air Curtains for Aerodynamic Performance Ratings," for airflow, outlet velocity, and power consumption.
3. Comply with ARI 410, "Forced-Circulation Air-Cooling and Air-Heating Coils," for components, construction, and rating.
   a. Certify coils according to ARI 410.
4. Comply with NSF 37, "Air Curtains for Entranceways in Food and Food Service Establishments."

E. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of air curtains that fail in materials or workmanship within specified warranty period.
   a. Warranty Period (Nonheating Units): 24 months.
   b. Warranty Period (Water or Steam Heating Units): 18 **OR** 24 months, **as directed**.
   c. Warranty Period (Gas Heating Units): 18 **OR** 24 months, **as directed**.

1.2 PRODUCTS

A. Air-Curtain Unit
1. Housing:

a. Materials: Galvanized steel with electrostatically applied epoxy enamel finish over powdered mirror
b. Materials: One-piece, molded, high-impact, white polymer material
c. Materials: Heavy-gage, electroplated-zinc steel with welded construction and polyester-coated finish.
d. Materials: Heavy-gage, aluminum construction.
   1) Anodized Finish: Match finish and color of adjacent architectural metals. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   2) Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
      a) Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: Nonspecular as fabricated; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.
      b) Class II, Color Anodic Finish: AA-M12C22A32/A34 (Mechanical Finish: Nonspecular as fabricated; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class II, integrally colored or electrolytically deposited color coating 0.010 mm or thicker).
e. Materials: Stainless steel.
f. Discharge Nozzle: Integral part of the housing, containing fixed air-directional vanes.
g. Discharge Nozzle: Integral part of the housing, containing adjustable air-directional vanes with 40 **OR** 20 **OR** 15-degree sweep front to back, **as directed**.
h. Discharge Nozzle: Integral part of the housing, containing air-directional vanes adjustable in 5-degree increments through a 45-degree sweep front to back.

2. Mounting Brackets: Steel, for wall **OR** ceiling mounting, **as directed**.
3. Air-Intake Louvers: Comply with requirements in Division 08 Section "Louvers And Vents".
4. Air-Intake Louvers **OR** Grille**, as directed.**
   a. Louvers: Integral part of the housing, mechanically field adjustable and capable of reducing air-outlet velocity by 60 percent with louver in totally closed position.
   b. Grille: Integral part of and same material as the housing.
   c. Insect Scrren: Aluminum **OR** Stainless steel**, as directed**, removable.
5. Fans
   a. Centrifugal, forward curved, double width, double inlet **OR** Vane axial, **as directed**.
   b. Galvanized steel **OR** Painted steel **OR** Aluminum, **as directed.**
   c. Statically and dynamically balanced.
   d. Direct drive **OR** Belt drive and equipped with belt guards and adjustable sheaves and pulleys for adjusting air-outlet velocity, **as directed**.
6. Motors: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
   a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   b. Single speed **OR** Two speed Multispeed, **as directed**.
   c. Resiliently mounted.
   d. Continuous duty.
   e. Totally enclosed, air over **OR** totally enclosed, fan cooled, **OR**, open, dripproof **OR** explosion proof, **as directed.**
   f. Integral thermal-overload protection.
   g.
   h. Bearings: Permanently sealed, lifetime, prelubricated, ball bearings.
   i. Disconnect: Internal power cord with plug and receptacle.
7. Water Coils
   a. Type: Continuous-circuit **OR** Self-draining **OR** Cleanable, **as directed**.
   b. Piping Connections: Threaded on same end **OR** opposite ends, **as directed**.

c. Tubes: Copper, complying with ASTM B 75 (ASTM B 75M).
   1) Tube Diameter: 0.625 inch (15.9 mm).
d. Fins: Aluminum **OR** Copper, **as directed** with fin spacing 0.167 inch (4.23 mm) **OR** 0.125 inch (3.18 mm) **OR** 0.091 inch (2.31 mm) **OR** 0.071 inch (1.80 mm) **OR** 0.067 inch (1.70 mm) **OR** 0.056 inch (1.42 mm) **OR** 0.0075 inch (0.19 mm), **as directed**.
e. Fin and Tube Joint: Mechanical bond **OR** Silver brazed, **as directed**.
f. Headers: Cast iron with drain and air vent tappings **OR** Cast iron with cleaning plugs, and drain and air vent tappings **OR** Seamless copper tube with brazed joints, prime coated **OR** Fabricated steel with brazed joints, prime coated, **as directed**.
g. Frames: Galvanized-steel channel frame 0.052 inch (1.3 mm) **OR** 0.064 inch (1.6 mm) **OR** 0.079 inch (2.0 mm) **OR** 0.0625 inch (1.59 mm), **as directed**.
h. Ratings: According to ASHRAE 33.
i. Working-Pressure Ratings: 200 psig (1380 kPa), 325 deg F (163 deg C).

8. Steam Coils Distribution header coil **OR** Single-tube coil, **as directed** with threaded steam supply and condensate connections.
   a. Piping Connections: Same end **OR** Opposite ends **OR** Steam supply on both ends; condensate on one end, **as directed**.
   b. Tube Material: Copper, complying with ASTM B 75 (ASTM B 75M).
   c. Tube Diameter: 0.625 inch (15.9 mm).
   d. Fins: Aluminum **OR** Copper, **as directed** 0.167 inch (4.23 mm) **OR** 0.125 inch (3.18 mm) **OR** 0.091 inch (2.31 mm) **OR** 0.071 inch (1.80 mm) **OR** 0.067 inch (1.70 mm) **OR** 0.056 inch (1.42 mm) **OR** 0.0075 inch (0.19 mm), **as directed**.
   e. Fin and Tube Joint: Mechanical bond **OR** Silver brazed, **as directed**.
   f. Headers: Cast iron with drain and air vent tappings **OR** Cast iron with cleaning plugs, and drain and air vent tappings **OR** Seamless copper tube with brazed joints, prime coated **OR** Fabricated steel with brazed joints, prime coated, **as directed**.
   g. Frames: Galvanized-steel channel frame, 0.052 inch (1.3 mm) **OR** 0.064 inch (1.6 mm) **OR** 0.079 inch (2.0 mm) **OR** 0.0625 inch (1.59 mm) , **as directed**.
   h. Pressure and Temperature Ratings: 100 psig (690 kPa), 400 deg F (205 deg C) according to ASHRAE 33.
9. Electric-Resistance Coils:
   a. Coil Assembly: Comply with UL 1995.
   b. Frame: Galvanized-steel frame.
   c. Heating Elements: Coiled resistance wire of 80 percent nickel and 20 percent chromium; surrounded by compacted magnesium-oxide powder in tubular-steel sheath; with spiral-wound, copper-plated, steel fins continuously brazed to sheath.
   d. Heating Elements: Open-coil resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
   e. Overtemperature Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box without removing heater from duct or unit.
      1) Secondary Protection: Load-carrying, manually reset or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
   f. Control Panel: Unit **OR** Remote, **as directed**, mounted with disconnecting means and overcurrent protection. Include the following controls:
      1) Magnetic contactor.
      2) Mercury contactor.
      3) Solid-state stepless pulse controller.
      4) Toggle switches; one per step.
      5) Step controller.
      6) Time-delay relay.
      7) Pilot lights; one per step.
      8) Airflow proving switch.
10. Gas-Fired Heaters:
   a. Comply with ANSI Z83.8/CSA, "Gas Unit Heaters and Gas-Fired Duct Furnaces."
      1) CSA Approval: Bear AGA label.

2) Type of Gas: Natural **OR** LP, **as directed**.

b. Assembly and Wiring: Heaters factory assembled, piped, wired, and tested for 120-V ac.

c. Housing: Steel, with integral draft hood and inserts for suspension-mounting rods.

d. External Casings and Cabinets: Baked enamel over corrosion-resistant-treated surface.

e. Heat Exchanger: Aluminized **OR** Stainless, **as directed**, steel.

f. Burners: Cast iron or aluminized steel with stainless-steel inserts.

g. Gravity vent.

h. Power Venter: 120-V ac, with stainless-steel shaft.

i. Automatic Gas Control: Single **OR** 2-stage, **as directed**, 24-V ac valve.

j. Ignition: Standing pilot **OR** Electronically controlled spark with flame sensor, **as directed**.

11. Filters:
    a. Disposable Panel Filters: Factory-fabricated, viscous-coated, flat-panel-type, disposable air filters with glass-fiber media sprayed with nonflammable adhesive in cardboard **OR** galvanized-steel, **as directed**, frame.
    b. Washable Panel Filters: Removable, stainless-steel, baffle-type filters with spring-loaded fastening; with minimum 0.0781-inch- (1.984-mm-) thick, stainless-steel filter frame.
    c. Mounting Frames: Welded, galvanized steel with gaskets and fasteners and suitable for bolting together into built-up filter banks.
12. Controls:
    a. Built-in **OR** Field-Installed, **as directed**, Thermostat: Line voltage, factory installed and wired to the junction box on air curtain **OR** motor-control panel**, as directed.**
    b. Automatic Door Switch: Plunger type installed in door area to activate air curtain when door opens and to deactivate air curtain when door closes.
    c. Start-Stop, Push-Button Switch: Manually activates and deactivates air curtain.
    d. Three-Speed Switch: Manually activates, deactivates, and controls air-curtain fan speed.
    e. Time-Delay Relay: Factory installed and adjustable to allow air curtain to operate from 0.5 seconds to 10 hours.
    f. Motor-Control Panel: Complete with motor starter, 115-V ac transformer with primary and secondary fuses, terminal strip, and NEMA 250, Type 1 **OR** 12, **as directed**, enclosure.
13. Accessories:
    a. Mounting Brackets: Adjustable mounting brackets for drum-type roll-up doors.
    b. Discharge Extension Neck: For ceiling-recessed installation.

B. Source Quality Control
1. Source Quality Control: Test to 300 psig (2070 kPa) and to 200 psig (1380 kPa) underwater.
2. Testing: Test and inspect steam coils according to ASHRAE 33.
3. Steam coils will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

1.3 EXECUTION

A. Examination
1. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
2. Examine roughing-in for hot-water **OR** steam **OR** gas, **as directed**, piping systems to verify actual locations of piping connections before air-curtain installation.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation
1. Install air curtains with clearance for equipment service and maintenance.
2. Equipment Installation: Install air curtains with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".

3. Comply with requirements for hangers and supports specified in Division 23 Section "Hangers And Supports For Hvac Piping And Equipment".

C. Connections
1. Comply with requirements for piping specified in Division 26 Section "Grounding And Bonding For Electrical Systems" and Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
2. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
3. Breaching: Comply with applicable requirements in Division 23 Section "Breechings, Chimneys, And Stacks". Connect breaching to full size at flue outlet.

D. Field Quality Control
1. Perform tests ad inspections.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Tests and Inspections:
   a. After installing air curtains completely, perform visual and mechanical check of individual components.
   b. After electrical circuitry has been energized, start unit to confirm motor rotation and unit operation. Certify compliance with test parameters.
   c. Inspect for water leaks.
   d. Test gas train and verify that there are no gas leaks.
   e. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Air-curtain unit will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

E. Adjusting
1. Adjust belt tension.
2. Adjust motor and fan speed to achieve specified airflow.
3. Adjust discharge louver and dampers to regulate airflow.
4. Adjust air-directional vanes.

END OF SECTION 23 34 33 00

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Task	Specification	Specification Description
23 35 13 13	01 22 16 00	No Specification Required
23 35 16 16	23 31 13 16	Tailpipe Exhaust Equipment

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SECTION 23 36 13 00 - DIFFUSERS, REGISTERS, AND GRILLES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for diffusers, registers and grilles. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Round ceiling diffusers.
b. Rectangular and square ceiling diffusers.
c. Perforated diffusers.
d. Louver face diffusers.
e. Linear bar diffusers.
f. Linear slot diffusers.
g. Ceiling-integral continuous diffusers.
h. Light troffer diffusers.
i. Round induction diffusers.
j. Linear floor diffuser plenums.
k. Drum louvers.
l. Modular core supply grilles.
m. Continuous tubular diffusers.
n. Adjustable bar registers and grilles.
o. Security registers and grilles.
p. Fixed face registers and grilles.
q. Linear bar grilles.

C. Submittals
1. Product Data: For each type of product indicated, include the following:
a. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
b. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
2. Samples: For each exposed product and for each color and texture specified.

1.2 PRODUCTS

A. Ceiling Diffusers
1. Round Ceiling Diffuser:
a. Devices shall be specifically designed for variable-air-volume flows.
b. Material: Steel **OR** Aluminum, **as directed**.
c. Finish: Baked enamel, white **OR** Baked enamel, color selected **OR** Anodized aluminum, **as directed**.
d. Face Style: Four **OR** Three **OR** Two, **as directed**, cone.
e. Mounting: Duct connection.
f. Pattern: Fully adjustable **OR** Two-position horizontal, **as directed**.
g. Dampers: Radial opposed blade **OR** Butterfly **OR** Combination damper and grid, **as directed**.
h. Accessories:
1) Equalizing grid.

2) Plaster ring.
3) Safety chain.
4) Wire guard.
5) Sectorizing baffles.
6) Operating rod extension.

2. Rectangular and Square Ceiling Diffusers:
   a. Devices shall be specifically designed for variable-air-volume flows.
   b. Material: Steel **OR** Aluminum, **as directed**.
   c. Finish: Baked enamel, white **OR** Baked enamel, color selected **OR** Anodized aluminum, **as directed**.
   d. Face Size: 24 by 24 inches (600 by 600 mm) **OR** 20 by 20 inches (500 by 500 mm) **OR** 12 by 12 inches (300 by 300 mm), **as directed**.
   e. Face Style: Three cone **OR** Four cone **OR** Plaque, **as directed**.
   f. Mounting: Surface **OR** T-bar **OR** Snap in **OR** Spline **OR** Mounting panel, **as directed**.
   g. Pattern: Fixed **OR** Two position **OR** Adjustable, **as directed**.
   h. Dampers: Radial opposed blade **OR** Butterfly **OR** Combination damper and grid, **as directed**.
   i. Accessories:
      1) Equalizing grid.
      2) Plaster ring.
      3) Safety chain.
      4) Wire guard.
      5) Sectorizing baffles.
      6) Operating rod extension.

3. Perforated Diffuser:
   a. Devices shall be specifically designed for variable-air-volume flows.
   b. Material: Steel backpan and pattern controllers, with steel **OR** aluminum, **as directed**, face.
   c. Finish: Baked enamel, white **OR** Baked enamel, color selected **OR** Anodized aluminum, **as directed**.
   d. Face Size: 12 by 12 inches (300 by 300 mm) **OR** 24 by 12 inches (600 by 300 mm) **OR** 36 by 12 inches (900 by 300 mm) **OR** 48 by 12 inches (1200 by 300 mm) **OR** 16 by 16 inches (400 by 400 mm) **OR** 20 by 20 inches (500 by 500 mm) **OR** 24 by 24 inches (600 by 600 mm) **OR** 36 by 24 inches (900 by 600 mm) **OR** 48 by 24 inches (1200 by 600 mm), **as directed**.
   e. Duct Inlet: Round **OR** Square, **as directed**.
   f. Face Style: Flush **OR** Drop extended, **as directed**.
   g. Mounting: Surface **OR** T-bar **OR** Snap in **OR** Spline **OR** Mounting panel, **as directed**.
   h. Pattern Controller: Four louvered deflector patches **OR** Fixed with curved blades at inlet **OR** Adjustable with louvered pattern modules at inlet **OR** None, **as directed**.
   i. Dampers: Opposed blade **OR** Radial opposed blade **OR** Butterfly **OR** Combination damper and grid **OR** Combination volume and fire, **as directed**.
   j. Accessories:
      1) Equalizing grid.
      2) Plaster ring.
      3) Safety chain.
      4) Wire guard.
      5) Sectorizing baffles.
      6) Operating rod extension.

4. Louver Face Diffuser:
   a. Devices shall be specifically designed for variable-air-volume flows.
   b. Material: Steel **OR** Aluminum, **as directed**.
   c. Finish: Baked enamel, white **OR** Baked enamel, color selected **OR** Anodized aluminum, **as directed**.
   d. Face Size: as directed by the Owner.

e. Mounting: Surface **OR** Surface with beveled frame **OR** T-bar **OR** Snap in **OR** Spline **OR** Mounting panel, **as directed**.
f. Pattern: One-way **OR** Two-way **OR** Two-way corner **OR** Three-way **OR** Four-way **OR** Adjustable, **as directed**, core style.
g. Dampers: Radial opposed blade **OR** Butterfly **OR** Combination damper and grid, **as directed**.
h. Accessories:
1) Square to round neck adaptor.
2) Adjustable pattern vanes.
3) Throw reducing vanes.
4) Equalizing grid.
5) Plaster ring.
6) Safety chain.
7) Wire guard.
8) Sectorizing baffles.
9) Operating rod extension.

B. Ceiling Linear Slot Outlets
1. Linear Bar Diffuser:
a. Devices shall be specifically designed for variable-air-volume flows.
b. Material: Steel **OR** Aluminum **OR** Stainless steel, **as directed**.
c. Finish: Baked enamel, white **OR** Baked enamel, color selected, **as directed**.
d. Narrow Core Spacing Arrangement: 1/8-inch- (3-mm-) thick blades spaced 1/4 inch (6 mm) apart, zero **OR** 15, **as directed**,-degree deflection.
e. Wide Core Spacing Arrangement: 1/8-inch- (3-mm-) thick blades spaced 1/2 inch (13 mm) apart, zero **OR** 15, **as directed**,-degree deflection.
f. Wide Core Spacing Arrangement: 3/16-inch- (5-mm-) thick blades spaced 1/2 inch (13 mm) apart, zero **OR** 15 **OR** 30, **as directed**,-degree deflection.
g. Pencil-Proof Core Spacing Arrangement: 3/16-inch- (5-mm-) thick blades spaced 7/16 inch (11 mm) apart, zero **OR** 15 **OR** 30, **as directed**,-degree deflection.
h. One **OR** Two, **as directed**,-Way Deflection Vanes: Extruded construction fixed louvers with removable core.
i. Frame: 1-1/4 inches (32 mm) **OR** 1 inch (25 mm) **OR** 3/4 inch (19 mm) **OR** 1/2 inch (13 mm) **OR** 3/16 inch (5 mm), **as directed**, wide.
j. Mounting Frame: Filter.
k. Mounting: Countersunk screw **OR** Concealed bracket **OR** Spring clip, **as directed**.
l. Damper Type: Adjustable opposed-blade assembly **OR** Hinged single blade, **as directed**.
m. Accessories: Plaster frame **OR** Directional vanes **OR** Alignment pins **OR** Core clips **OR** Blank-off strips, **as directed**.
2. Linear Slot Diffuser:
a. Devices shall be specifically designed for variable-air-volume flows.
b. Material - Shell: Steel **OR** Aluminum, **as directed**, insulated **OR** noninsulated, **as directed**.
c. Material - Pattern Controller and Tees: Aluminum.
d. Finish - Face and Shell: Baked enamel, black.
e. Finish - Pattern Controller: Baked enamel, black.
f. Finish - Tees: Baked enamel, white **OR** Baked enamel, color selected, **as directed**.
g. Slot Width: 1/2 inch (13 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
h. Number of Slots: One **OR** Two **OR** Three **OR** Four, **as directed**.
i. Length: 24 inches (600 mm) **OR** 30 inches (750 mm) **OR** 36 inches (900 mm) **OR** 48 inches (1200 mm) **OR** 60 inches (1500 mm), **as directed**.
j. Accessories: Plaster frame **OR** T-bar slot **OR** Center notch **OR** T-bar on inlet side **OR** T-bar on both sides **OR** T-bar clip on one side **OR** T-bar clips on both sides, **as directed**.
3. Ceiling-Integral Continuous Diffuser:

a. Slot Width: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 2-1/2 inches (63 mm) **OR** 3 inches (76 mm), **as directed**.
b. Section Length: 12 feet (3.7 m).
c. Straight and curved sections as required to accommodate layout.
d. Mitered tees and corners.
e. Pattern Controllers: 24 inches (600 mm) o.c.
f. Material: Aluminum, extruded, heavy wall.
g. Finishes:
1) Exterior: Standard white.
2) Interior: Standard black.
h. Throw: Standard **OR** High, **as directed**.
i. Mounting: Ceiling **OR** Sidewall, **as directed**.
j. Plenum: Noninsulated **OR** Insulated, **as directed**.
k. Other Features:
1) Painted interior.
2) Blank-offs.

4. Light Troffer Diffuser:
a. Devices shall be specifically designed for variable-air-volume flows.
b. Material: Steel with external insulation, **as directed**.
c. Finish: None **OR** Black enamel on visible surfaces, **as directed**.
d. Slot Width: 1/2 inch (13 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
e. Number of Sides: One **OR** Two, **as directed**.
f. Length: 24 inches (600 mm) **OR** 36 inches (900 mm) **OR** 48 inches (1200 mm), **as directed**.
g. Pattern: Fixed **OR** Adjustable, **as directed**.
h. Inlet: Top **OR** Side, **as directed**.
i. Inlet Size: 5 inches (125 mm) **OR** 6 inches (150 mm) **OR** 8 inches (200 mm), **as directed**.

C. Underfloor Air Distribution Diffusers
1. Round Induction Diffusers:
a. Airflow Principle: Swirl-pattern induction.
b. Material: Plastic, high impact, and resistant to cart and foot traffic.
c. Color: Gray **OR** Black, **as directed**.
d. Components:
1) Diffuser core.
2) Flow regulator.
3) Dirt and liquid catch pan.
4) Spacer flange.
5) Gasketed, underfloor compression ring.

2. Linear Floor Diffuser Plenums:
a. Material: Steel.
b. Finish: White baked acrylic.
c. Deflection: Zero **OR** 15, **as directed**, degrees.
d. Components:
1) Aluminum diffuser core.
2) Diffuser frame.
3) Plenum, 0.034-inch (0.85-mm) steel.

D. High-Capacity Diffusers
1. Drum Louver:
a. Airflow Principle: Extended distance for high airflow rates.
b. Material: Aluminum, heavy gage extruded.
c. Finish: White baked acrylic.
d. Border: 1-1/4-inch (32-mm) width with countersunk screw holes.

e. Gasket between drum and border.
f. Body: Drum shaped; adjustable vertically.
g. Blades: Individually adjustable horizontally.
h. Mounting: Surface to duct **OR** wall, **as directed**.
i. Inlet Width: 6 inches (150 mm) **OR** 10 inches (250 mm) **OR** 12 inches (300 mm) **OR** 15 inches (380 mm), **as directed**.
j. Inlet Length: 12 inches (300 mm) **OR** 24 inches (600 mm) **OR** 36 inches (900 mm) **OR** 60 inches (1500 mm), **as directed**.
k. Accessories:
   1) Opposed-blade steel damper.
   2) Duct-mounting collars with countersunk screw holes.

2. Modular Core Supply Grilles:
   a. Throw: Extended distance for airflow rates.
   b. Material: Steel.
   c. Grilles per Unit: One **OR** Two **OR** Three **OR** Four, **as directed**.
   d. Finish: White baked acrylic.
   e. Border: 1-1/2-inch (38-mm) width with countersunk screw holes.
   f. Blades:
      1) Airfoil, individually adjustable horizontally.
      2) Double deflection.
      3) Set in modules.
   g. Modules: Removable; rotatable.
   h. Mounting: Surface.
   i. Accessory: Opposed-blade steel damper.

E. Flexible Diffusion Outlets
1. Continuous Tubular Diffuser:
   a. Material: Flame-retardant, woven polyethylene fabric **OR** Flame-retardant, coated polyester and fiberglass fabric **OR** Flame-retardant, permeable polyester and fiberglass fabric **OR** Polyethylene, **as directed**.
   b. Duct Connection: Round.
   c. Duct Connection Size: as directed by the Owner.
   d. Diffusion Hole Size: as directed by the Owner.
   e. Diffusion Hole Frequency - Number per 100 Feet (30 m): <**Insert number**>.
   f. Accessories:
      1) Quick-connect joint.
      2) Snap hooks.
      3) Cleanout zipper.
      4) Condensate drain.

F. Registers And Grilles
1. Adjustable Bar Register:
   a. Material: Steel **OR** Aluminum **OR** Stainless steel, **as directed**.
   b. Finish: Baked enamel, white **OR** Baked enamel, color selected, **as directed**.
   c. Face Blade Arrangement: Horizontal **OR** Vertical, **as directed**, spaced 3 inches (76 mm) **OR** 1-1/2 inches (38 mm) **OR** 3/4 inch (19 mm) **OR** 1/2 inch (13 mm), **as directed**, apart.
   d. Core Construction: Integral **OR** Removable, **as directed**.
   e. Rear-Blade Arrangement: Horizontal **OR** Vertical, **as directed**, spaced 3/4 inch (19 mm) **OR** 1/2 inch (13 mm), **as directed**, apart.
   f. Frame: 1-1/4 inches (32 mm) **OR** 1 inch (25 mm), **as directed**, wide.
   g. Mounting Frame: Filter.
   h. Mounting: Countersunk screw **OR** Concealed **OR** Lay in, **as directed**.
   i. Damper Type: Adjustable opposed blade **OR** NRTL listed, opposed blade, spring closing, and with fusible link for 160 deg F (71 deg C), **as directed**.
   j. Accessories:
      1) Front **OR** Rear, **as directed**,-blade gang operator.

2) Filter.

2. Adjustable Bar Grille:
   a. Material: Steel **OR** Aluminum **OR** Stainless steel, **as directed**.
   b. Finish: Baked enamel, white **OR** Baked enamel, color selected, **as directed**.
   c. Face Blade Arrangement: Horizontal **OR** Vertical, **as directed**, spaced 3 inches (76 mm) **OR** 1-1/2 inches (38 mm) **OR** 3/4 inch (19 mm) **OR** 1/2 inch (13 mm), **as directed**, apart.
   d. Core Construction: Integral **OR** Removable, **as directed**.
   e. Rear-Blade Arrangement: Horizontal **OR** Vertical, **as directed**, spaced 3/4 inch (19 mm) **OR** 1/2 inch (13 mm), **as directed**, apart.
   f. Frame: 1-1/4 inches (32 mm) **OR** 1 inch (25 mm), **as directed**, wide.
   g. Mounting Frame: Filter.
   h. Mounting: Countersunk screw **OR** Concealed **OR** Lay in, **as directed**.
3. Security Register:
   a. Security Level: Maximum **OR** Medium **OR** Minimum, **as directed**, and suicide deterrent, **as directed**.
   b. Application: Ducted return **OR** Air transfer **OR** Barrier, **as directed**.
   c. Material: Steel **OR** Aluminum, **as directed**.
   d. Material Thickness: 0.19 inch (4.8 mm).
   e. Finish: Baked enamel, white **OR** Baked enamel, color selected, **as directed**.
   f. Face Arrangement:
      1) Shape: Square **OR** Rectangular **OR** Round, **as directed**.
      2) Design: Fixed bar **OR** Perforated **OR** Lattice, **as directed**.
      3) Frame: Yes **OR** No, **as directed**.
      4) Deflection: Zero **OR** 38, **as directed**, degrees.
      5) Core: None **OR** Louvered, **as directed**.
      6) 3/16-inch- (5-mm-) thick, front lattice plate with 2-by-2-inch- (50-by-50-mm-) square holes and 1-inch (25-mm) frets, 0.135-inch (3.43-mm) wire mesh, and 1/4-inch- (6-mm-) thick backer plate.
      7) 3/16-inch- (5-mm-) thick, perforated faceplate with 5/16-inch- (8-mm-) diameter holes spaced 7/16 inch (11 mm) o.c., staggered at 60 degrees.
      8) 1-1/2-inch (38-mm) bars and mandrel tubes and rods with zero **OR** 15, **as directed**,-degree deflection in 1-1/4-by-1-1/4-by-3/16-inch (32-by-32-by-5-mm) angle border.
      9) 1-3/8-inch (35-mm) bars and double mandrel tubes with zero **OR** 15, **as directed**,-degree deflection in 1-3/4-inch (45-mm) angle border.
   g. Damper Operation: None **OR** Face operated **OR** Rear operated, **as directed**.
   h. Damper Type: Adjustable opposed blade **OR** NRTL listed, opposed blade, spring closing, and with fusible link for 160 deg F (71 deg C), **as directed**.
   i. Wall Sleeve: 3/16 inch (5 mm) welded to face **OR** 1/8 inch (3 mm) welded to face **OR** Mechanically fastened to border, **as directed**.
   j. Mounting: 1-by-1-by-3/16-inch (25-by-25-by-5-mm) retaining angle frame **OR** 1-1/4-by-1-1/4-by-3/16-inch (32-by-32-by-5-mm) retaining angle frame **OR** 1-1/4-by-1-1/4-by-3/16-inch (32-by-32-by-5-mm) cast-in-place frame and tamperproof machine screws, **as directed**.
4. Security Grille:
   a. Security Level: Maximum **OR** Medium **OR** Minimum, **as directed**, and suicide deterrent, **as directed**.
   b. Application: Ducted return **OR** Air transfer **OR** Barrier, **as directed**.
   c. Material: Steel **OR** Aluminum, **as directed**.
   d. Material Thickness: 0.19 inch (4.8 mm).
   e. Finish: Baked enamel, white **OR** Baked enamel, color selected, **as directed**.
   f. Face Arrangement:
      1) Shape: Square **OR** Rectangular **OR** Round, **as directed**.
      2) Design: Fixed bar **OR** Perforated **OR** Lattice, **as directed**.
      3) Frame: Yes **OR** No, **as directed**.
      4) Deflection: Zero **OR** 38, **as directed**, degrees.
      5) Core: None **OR** Louvered, **as directed**.

6) 3/16-inch- (5-mm-) thick, front lattice plate with 2-by-2-inch- (50-by-50-mm-) square holes and 1-inch (25-mm) frets, 0.135-inch (3.43-mm) wire mesh, and 1/4-inch- (6-mm-) thick backer plate.
7) 3/16-inch- (5-mm-) thick perforated faceplate with 5/16-inch- (8-mm-) diameter holes spaced 7/16 inch (11 mm) o.c., staggered at 60 degrees.
8) 1-1/2-inch (38-mm) bars and mandrel tubes and rods with zero **OR** 15, **as directed**,-degree deflection in 1-1/4-by-1-1/4-by-3/16-inch (32-by-32-by-5-mm) angle border.
9) 1-3/8-inch (35-mm) bars and double mandrel tubes with zero **OR** 15, **as directed**,-degree deflection in 1-3/4-inch (45-mm) angle border.

g. Wall Sleeve: 3/16 inch (5 mm) welded to face **OR** 1/8 inch (3 mm) welded to face **OR** Mechanically fastened to border, **as directed**.
h. Mounting: 1-by-1-by-3/16-inch (25-by-25-by-5-mm) retaining angle frame **OR** 1-1/4-by-1-1/4-by-3/16-inch (32-by-32-by-5-mm) retaining angle frame **OR** 1-1/4-by-1-1/4-by-3/16-inch (32-by-32-by-5-mm) cast-in-place frame and tamperproof machine screws, **as directed**.

5. Fixed Face Register:
   a. Material: Steel **OR** Aluminum, **as directed**.
   b. Finish: Baked enamel, white **OR** Baked enamel, color selected, **as directed**.
   c. Face Arrangement: 1/2-by-1/2-by-1/2-inch (13-by-13-by-13-mm) grid **OR** Perforated, **as directed**, core.
   d. Core Construction: Integral **OR** Removable, **as directed**.
   e. Frame: 1-1/4 inches (32 mm) **OR** 1 inch (25 mm), **as directed**, wide.
   f. Mounting Frame: Filter.
   g. Mounting: Countersunk screw **OR** Concealed **OR** Lay in, **as directed**.
   h. Damper Type: Adjustable opposed blade **OR** NRTL listed, opposed blade, spring closing, and with fusible link for 160 deg F (71 deg C), **as directed**.
   i. Accessory: Filter.
6. Fixed Face Grille:
   a. Material: Steel **OR** Aluminum, **as directed**.
   b. Finish: Baked enamel, white **OR** Baked enamel, color selected.
   c. Face Arrangement: 1/2-by-1/2-by-1/2-inch (13-by-13-by-13-mm) grid **OR** Perforated, **as directed**, core.
   d. Core Construction: Integral **OR** Removable, **as directed**.
   e. Frame: 1-1/4 inches (32 mm) **OR** 1 inch (25 mm), **as directed**, wide.
   f. Mounting Frame: Filter.
   g. Mounting: Countersunk screw **OR** Concealed **OR** Lay in, **as directed**.
   h. Accessory: Filter.
7. Linear Bar Grille:
   a. Material: Steel **OR** Aluminum, **as directed**.
   b. Finish: Baked enamel, white **OR** Baked enamel, color selected, **as directed**.
   c. Face Arrangement: 1/2-by-1/2-by-1/2-inch (13-by-13-by-13-mm) grid **OR** Perforated, **as directed**, core.
   d. Distribution plenum.
      1) Internal insulation.
      2) Inlet damper.
   e. Frame: 1-1/4 inches (32 mm) **OR** 1 inch (25 mm), **as directed**, wide.
   f. Mounting Frame: Filter.
   g. Mounting: Countersunk screw **OR** Concealed **OR** Lay in, **as directed**.
   h. Damper Type: Adjustable opposed blade **OR** NRTL listed, opposed blade, spring closing, and with fusible link for 160 deg F (71 deg C), **as directed**.

G. Source Quality Control
1. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

1.3 EXECUTION

A. Installation
   1. Install diffusers, registers, and grilles level and plumb.
   2. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify the Owner for a determination of final location.
   3. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

B. Adjusting
   1. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 36 13 00

SECTION 23 36 16 00 - AIR TERMINAL UNITS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for air terminal units. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Bypass, single-duct air terminal units.
   b. Dual-duct air terminal units.
   c. Fan-powered air terminal units.
   d. Induction air terminal units.
   e. Shutoff, single-duct air terminal units.
   f. Diffuser-type air terminal units.

C. Performance Requirements
1. Structural Performance: Hangers and supports and seismic restraints, **as directed**, shall withstand the effects of gravity and seismic, **as directed**, loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7 **OR** SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems", **as directed**.
   a. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
   b. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
   c. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.

D. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
   a. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1-2004, Section 5 - "Systems and Equipment."
3. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.
   a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   b. Wiring Diagrams: For power, signal, and control wiring.
   c. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
4. Delegated-Design Submittal:
   a. Materials, fabrication, assembly, and spacing of hangers and supports.
   b. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation, **as directed**, for selecting hangers and supports and seismic restraints, **as directed**.
5. Field quality-control reports.
6. Operation and maintenance data.

E. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

1.2 PRODUCTS

A. Bypass, Single-Duct Air Terminal Units
1. Configuration: Diverting-damper assembly inside unit casing with control components inside a protective metal shroud.
2. Casing: 0.034-inch (0.85-mm) steel **OR** 0.032-inch (0.8-mm) aluminum, **as directed**, single **OR** double, **as directed**, wall.
   a. Casing Lining: Adhesive attached, 1/2-inch- (13-mm-) **OR** 3/4-inch- (19-mm-) **OR** 1-inch- (25-mm-), **as directed**, thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
      1) Cover liner with nonporous foil.
      OR
      Cover liner with nonporous foil and perforated metal.
   OR
   Casing Lining: Adhesive attached, 1/2-inch- (13-mm-) **OR** 3/4-inch- (19-mm-) **OR** 1-inch- (25-mm-), **as directed**, thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
   b. Air Inlet: Round stub connection for duct attachment.
   c. Air Outlet: S-slip and drive connections.
   d. Access: Removable panels for access to diverting damper and other parts requiring service, adjustment, or maintenance; with airtight gasket.
   e. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
3. Diverter Assembly: Galvanized-steel gate, with polyethylene linear bearings **OR** Aluminum blade, with nylon-fitted pivot points, **as directed**.
4. Multioutlet Attenuator Section: With two **OR** three **OR** four, **as directed**, 6-inch- (150-mm-) **OR** 8-inch- (200-mm-) **OR** 10-inch- (250-mm-), **as directed**, diameter collars, each with locking butterfly balancing damper.
5. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), and rated for a minimum working pressure of 200 psig (1380 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain valve.
   OR
   Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.
   a. Access door interlocked disconnect switch.
   b. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable.)
   c. Nickel chrome 80/20 heating elements.
   d. Airflow switch for proof of airflow.
   e. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
   f. Mercury contactors.
   g. Pneumatic-electric switches and relays.
   h. Magnetic contactor for each step of control (for three-phase coils).
6. Electric Controls: Damper actuator and thermostat.
   a. Damper Actuator: 24 V, powered closed, powered open with microswitch to energize heating control circuit, **as directed**.
   b. Thermostat: Wall-mounted electric type with temperature display in Fahrenheit and Celsius, and space temperature set point.

c. Changeover Thermostat: Duct-mounted, field-adjustable, electric type reverses action of zone thermostat when air temperature reaches 70 deg F (21 deg C).

OR

Electronic Controls: Bidirectional damper operator and microprocessor-based thermostat. Control devices shall be compatible with temperature controls specified in Division 23 Section "Instrumentation And Control For Hvac" and shall have the following features:

d. Damper Actuator: 24 V, powered closed, powered open.

e. Thermostat: Wall-mounted electronic type with the following features:
   1) Temperature set-point display in Fahrenheit and Celsius.
   2) Auxiliary switch to energize heating control circuit.
   3) Changeover thermistor to reverse action.

B. Dual-Duct Air Terminal Units

1. Configuration: Two volume dampers inside unit casing with mixing attenuator section and control components inside a protective metal shroud with a third primary air inlet with volume damper, **as directed**.
2. Casing: 0.034-inch (0.85-mm) steel **OR** 0.032-inch (0.8-mm) aluminum, **as directed**, single **OR** double, **as directed**, wall.
   a. Casing Lining: Adhesive attached, 1/2-inch- (13-mm-) **OR** 3/4-inch- (19-mm-) **OR** 1-inch- (25-mm-), **as directed**, thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
      1) Cover liner with nonporous foil.

         OR

         Cover liner with nonporous foil and perforated metal.

      OR

      Casing Lining: Adhesive attached, 1/2-inch- (13-mm-) **OR** 3/4-inch- (19-mm-) **OR** 1-inch- (25-mm-), **as directed**, thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
   b. Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
   c. Air Outlet: S-slip and drive connections.
   d. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
   e. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
3. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
   a. Maximum Damper Leakage: ARI 880 rated, 3 percent of nominal airflow at 3-inch wg (750-Pa) **OR** 6-inch wg (1500-Pa), **as directed**, inlet static pressure.
4. Velocity Sensors: Multipoint array with velocity sensors in cold- and hot-deck air inlets and air outlets.
5. Attenuator Section: 0.034-inch (0.85-mm) steel **OR** 0.032-inch (0.8-mm) aluminum, **as directed**, sheet.
   a. Lining: Adhesive attached, 1/2-inch- (13-mm-) **OR** 3/4-inch- (19-mm-) **OR** 1-inch- (25-mm-), **as directed**, thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
      1) Cover liner with nonporous foil.

         OR

         Cover liner with nonporous foil and perforated metal.

      OR

      Lining: Adhesive attached, 3/4-inch- (19-mm-) thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.

b. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

6. Multioutlet Attenuator Section: With two **OR** three **OR** four, **as directed**, 6-inch- (150-mm-) **OR** 8-inch- (200-mm-) **OR** 10-inch- (250-mm-) **OR** 12-inch- (300-mm-), **as directed**, diameter collars, each with locking butterfly balancing damper.

7. Pneumatic Controls: Damper operator, velocity controllers, and thermostat. Control devices shall be compatible with temperature controls specified in Division 23 Section "Instrumentation And Control For Hvac" and shall have the following features:

a. Pneumatic Damper Operator: 0- to 13-psig (0- to 90-kPa) spring range.

b. Velocity Controllers: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg (1000 Pa); and shall have a multipoint velocity sensor. Locate velocity sensors in cold- and hot-deck **OR** cold-, hot-, and ventilation- deck **OR** cold-deck, **as directed**, air inlets and supply air outlets.

c. Thermostat: Wall-mounted pneumatic type with appropriate mounting hardware.

OR

Electronic Controls: Bidirectional damper operator and microprocessor-based thermostat with integral airflow transducer and room sensor. Control devices shall be compatible with temperature controls specified in Division 23 Section "Instrumentation And Control For Hvac" and shall have the following features:

a. Damper Actuator: 24 V, powered closed, spring return open **OR** powered open, **as directed**.

b. Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg (1000 Pa); and shall have a multipoint velocity sensor. Locate velocity sensors in cold-deck air inlets and air outlets.

c. Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius, **as directed**.

OR

Direct Digital Controls: Single-package unitary controller and actuator specified in Division 23 Section "Instrumentation And Control For Hvac"

OR

Direct Digital Controls: Bidirectional damper operators and microprocessor-based controller and room sensor. Control devices shall be compatible with controls specified in Division 23 Section "Instrumentation And Control For Hvac" and shall have the following features:

d. Damper Actuators: 24 V, powered closed, spring return open **OR** powered open, **as directed**.

e. Terminal Unit Controller: Pressure-independent, variable-air **OR** constant, **as directed**,-volume controller with electronic airflow transducers factory calibrated to minimum and maximum air volumes, and having the following features:

1) Occupied and unoccupied operating mode.
2) Remote reset of airflow or temperature set points.
3) Adjusting and monitoring with portable terminal.
4) Communication with temperature-control system specified in Division 23 Section "Instrumentation And Control For Hvac".

f. Room Sensor: Wall mounted with temperature set-point adjustment and access for connection of portable operator terminal.

8. Control Sequence:

a. Modulate cold-air damper to maintain room temperature.

b. Modulate warm-air damper to maintain constant airflow.

C. Parallel Fan-Powered Air Terminal Units

1. Configuration: Volume-damper assembly and fan in parallel arrangement inside unit casing with control components inside a protective metal shroud.
2. Casing: 0.034-inch (0.85-mm) steel **OR** 0.032-inch (0.8-mm) aluminum, **as directed**, single **OR** double, **as directed**, wall.
   a. Casing Lining: Adhesive attached, 1/2-inch- (13-mm-) **OR** 3/4-inch- (19-mm-) **OR** 1-inch- (25-mm-), **as directed**, thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
      1) Cover liner with nonporous foil.
         OR
         Cover liner with nonporous foil and perforated metal.

      OR
      Casing Lining: Adhesive attached, 1/2-inch- (13-mm-) **OR** 3/4-inch- (19-mm-) **OR** 1-inch- (25-mm-), **as directed**, thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
   b. Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
   c. Air Outlet: S-slip and drive connections.
   d. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
   e. Fan: Forward-curved centrifugal, located at plenum air inlet.
   f. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
3. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.
   a. Maximum Damper Leakage: ARI 880 rated, 2 **OR** 3, **as directed**, percent of nominal airflow at 3-inch wg (750-Pa) **OR** 6-inch wg (1500-Pa), **as directed**, inlet static pressure.
   b. Damper Position: Normally open **OR** closed, **as directed**.
4. Velocity Sensors: Multipoint array with velocity sensors in cold- and hot-deck air inlets and air outlets.
5. Motor:
   a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
   b. Type: Permanent-split capacitor with SCR for speed adjustment **OR** Electronically commutated motor, **as directed**.
   c. Fan-Motor Assembly Isolation: Rubber isolators.
   d. Enclosure: Open dripproof **OR** Totally enclosed, fan cooled **OR** Totally enclosed, air over **OR** Open, externally ventilated **OR** Totally enclosed, nonventilated **OR** Severe duty **OR** Explosion proof **OR** Dust-ignition-proof machine, **as directed**.
   e. Enclosure Materials: Cast iron **OR** Cast aluminum **OR** Rolled steel, **as directed**.
6. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
   a. Material: Polyurethane foam having 70 percent arrestance and 3 MERV.
      OR
      Material: Glass fiber treated with adhesive; having 80 percent arrestance and 5 MERV.
      OR
      Material: Pleated cotton-polyester media having 90 percent arrestance and 7 MERV.
   b. Thickness: 2 inches (50 mm) **OR** 1 inch (25 mm), **as directed**.
7. Attenuator Section: 0.034-inch (0.85-mm) steel **OR** 0.032-inch (0.8-mm) aluminum, **as directed**, sheet.
   a. Lining: Adhesive attached, 1/2-inch- (13-mm-) **OR** 3/4-inch- (19-mm-) **OR** 1-inch- (25-mm-), **as directed**, thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and

having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.

1) Cover liner with nonporous foil.

OR

Cover liner with nonporous foil and perforated metal.

b. Lining: Adhesive attached, 3/4-inch- (19-mm-) thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.

c. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

8. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), and rated for a minimum working pressure of 200 psig (1380 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain valve.

a. Location: Plenum air inlet.

OR

Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.

a. Location: Plenum air inlet.
b. Stage(s): 1 **OR** 2 **OR** 3, **as directed**.
c. Access door interlocked disconnect switch.
d. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable.)
e. Nickel chrome 80/20 heating elements.
f. Airflow switch for proof of airflow.
g. Fan interlock contacts.
h. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
i. Mercury contactors.
j. Pneumatic-electric switches and relays.
k. Magnetic contactor for each step of control (for three-phase coils).

9. Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.

a. Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.
b. Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
c. Disconnect Switch: Factory-mounted, fuse type.

10. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

11. Electric Controls: 24-V damper actuator with wall-mounted electric thermostat and appropriate mounting hardware.

OR

Pneumatic Controls: Damper operator, velocity controller, and thermostat. Control devices shall be compatible with temperature controls specified in Division 23 Section "Instrumentation And Control For Hvac" and shall have the following features:

a. Pneumatic Damper Operator: 0- to 13-psig (0- to 90-kPa) spring range.
b. Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while pressure independent up to 4-inch wg (1000 Pa); and shall have a multipoint velocity sensor at air inlet.
c. Thermostat: Wall-mounted pneumatic type with appropriate mounting hardware.

OR

Electronic Controls: Bidirectional damper operator and microprocessor-based controller with integral airflow transducer and room sensor. Control devices shall be compatible with temperature controls specified in Division 23 Section "Instrumentation And Control For Hvac" and shall have the following features:

a. Occupied and unoccupied operating mode.
b. Remote reset of airflow or temperature set points.
c. Adjusting and monitoring with portable terminal.
d. Communication with temperature-control system specified in Division 23 Section "Instrumentation And Control For Hvac".

12. Control Sequence:
    a. Occupied (Primary Airflow On):
        1) Operate as throttling control for cooling.
        2) As cooling requirement decreases, control valve throttles toward minimum airflow.
        3) As heating requirement increases, fan energizes to draw in warm plenum air and electric heat is energized in steps, **as directed**.
    b. Unoccupied (Primary Airflow Off):
        1) When pressure at primary inlet is zero or less, fan is de-energized.
        2) As heating requirement increases, fan energizes to draw in warm plenum air and electric heat is energized in steps, **as directed**.

D. Series Fan-Powered Air Terminal Units

1. Configuration: Volume-damper assembly and fan in series arrangement inside unit casing with control components inside a protective metal shroud for installation above a ceiling and within a raised access floor, **as directed**.
2. Casing: 0.034-inch (0.85-mm) steel **OR** 0.032-inch (0.8-mm) aluminum, **as directed**, single **OR** double, **as directed**, wall.
    a. Casing Lining: Adhesive attached, 1/2-inch- (13-mm-) **OR** 3/4-inch- (19-mm-) **OR** 1-inch- (25-mm-), **as directed**, thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
        1) Cover liner with nonporous foil.
           OR
           Cover liner with nonporous foil and perforated metal.

       OR
       Casing Lining: Adhesive attached, 1/2-inch- (13-mm-) **OR** 3/4-inch- (19-mm-) **OR** 1-inch- (25-mm-), **as directed**, thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
    b. Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
    c. Air Outlet: S-slip and drive connections.
    d. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
    e. Fan: Forward-curved centrifugal.
    f. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
3. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.
    a. Maximum Damper Leakage: ARI 880 rated, 2 **OR** 3, **as directed**, percent of nominal airflow at 3-inch wg (750-Pa) **OR** 6-inch wg (1500-Pa), **as directed**, inlet static pressure.
    b. Damper Position: Normally open **OR** closed, **as directed**.
4. Velocity Sensors: Multipoint array with velocity sensors in cold- and hot-deck air inlets and air outlets.
5. Motor:

a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
b. Type: Permanent-split capacitor with SCR for speed adjustment **OR** Electronically commutated motor, **as directed**.
c. Fan-Motor Assembly Isolation: Rubber isolators.
d. Enclosure: Open dripproof **OR** Totally enclosed, fan cooled **OR** Totally enclosed, air over **OR** Open, externally ventilated **OR** Totally enclosed, nonventilated **OR** Severe duty **OR** Explosion proof **OR** Dust-ignition-proof machine, **as directed**.
e. Enclosure Materials: Cast iron **OR** Cast aluminum **OR** Rolled steel, **as directed**.

6. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
a. Material: Polyurethane foam having 70 percent arrestance and 3 MERV.
OR
Material: Glass fiber treated with adhesive; having 80 percent arrestance and 5 MERV.
OR
Material: Pleated cotton-polyester media having 90 percent arrestance and 7 MERV.
b. Thickness: 2 inches (50 mm) **OR** 1 inch (25 mm), **as directed**.

7. Attenuator Section: 0.034-inch (0.85-mm) steel **OR** 0.032-inch (0.8-mm) aluminum, **as directed**, sheet.
a. Lining: Adhesive attached, 1/2-inch- (13-mm-) **OR** 3/4-inch- (19-mm-) **OR** 1-inch- (25-mm-), **as directed**, thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
1) Cover liner with nonporous foil.
OR
Cover liner with nonporous foil and perforated metal.
OR
Lining: Adhesive attached, 3/4-inch- (19-mm-) thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
b. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

8. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), and rated for a minimum working pressure of 200 psig (1380 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain valve.
OR
Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.
a. Stage(s): 1 **OR** 2 **OR** 3, **as directed**.
b. Access door interlocked disconnect switch.
c. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable.)
d. Nickel chrome 80/20 heating elements.
e. Airflow switch for proof of airflow.
f. Fan interlock contacts.
g. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
h. Mercury contactors.
i. Pneumatic-electric switches and relays.
j. Magnetic contactor for each step of control (for three-phase coils).

9. Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.

a. Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.
b. Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
c. Disconnect Switch: Factory-mounted, fuse type.

10. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.
11. Electric Controls: 24-V damper actuator with wall-mounted electric thermostat and appropriate mounting hardware.
OR
Pneumatic Controls: Damper operator, velocity controller, and thermostat. Control devices shall be compatible with temperature controls specified in Division 23 Section "Instrumentation And Control For Hvac" and shall have the following features:
a. Pneumatic Damper Operator: 0- to 13-psig (0- to 90-kPa) spring range.
b. Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while pressure independent up to 4-inch wg (1000 Pa); and shall have a multipoint velocity sensor at air inlet.
c. Thermostat: Wall-mounted pneumatic type with appropriate mounting hardware.
OR
Electronic Controls: Bidirectional damper operator and microprocessor-based controller with integral airflow transducer and room sensor. Control devices shall be compatible with temperature controls specified in Division 23 Section "Instrumentation And Control For Hvac" and shall have the following features:
a. Occupied and unoccupied operating mode.
b. Remote reset of airflow or temperature set points.
c. Adjusting and monitoring with portable terminal.
d. Communication with temperature-control system specified in Division 23 Section "Instrumentation And Control For Hvac".
12. Control Sequence:
a. Occupied (Primary Airflow On):
1) When pressure at inlet is at least 1.2-inch wg (300 Pa).
2) As cooling requirement decreases, control valve throttles toward minimum airflow.
b. Unoccupied (Primary Airflow Off):
1) When pressure at primary inlet is zero or less, fan is de-energized.

E. Induction Air Terminal Units
1. Configuration: Volume-damper assembly inside unit casing with mechanical induction damper mounted on casing and control components inside a protective metal shroud.
2. Casing: 0.034-inch (0.85-mm) steel **OR** 0.032-inch (0.8-mm) aluminum, **as directed**, single **OR** double, **as directed**, wall.
a. Casing Lining: Adhesive attached, 1/2-inch- (13-mm-) **OR** 3/4-inch- (19-mm-) **OR** 1-inch- (25-mm-), **as directed**, thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
1) Cover liner with nonporous foil.
OR
Cover liner with nonporous foil and perforated metal.
OR
Casing Lining: Adhesive attached, 1/2-inch- (13-mm-) **OR** 3/4-inch- (19-mm-) **OR** 1-inch- (25-mm-), **as directed**, thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.

b. Air Inlet: Round stub connection for duct attachment.
c. Air Outlet: S-slip and drive connections, size matching inlet size, **as directed**.
d. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
e. Fan: Forward-curved centrifugal.
f. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

3. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
   a. Maximum Damper Leakage: ARI 880 rated, 2 **OR** 3, **as directed**, percent of nominal airflow at 3-inch wg (750-Pa) **OR** 6-inch wg (1500-Pa), **as directed**, inlet static pressure.
   b. Damper Position: Normally open **OR** closed, **as directed**.
4. Induction Damper: Galvanized-steel, multiblade assembly with self-lubricating bearings.
5. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), and rated for a minimum working pressure of 200 psig (1380 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain valve.
   OR
   Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.
   a. Access door interlocked disconnect switch.
   b. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable.)
   c. Nickel chrome 80/20 heating elements.
   d. Airflow switch for proof of airflow.
   e. Fan interlock contacts.
   f. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
   g. Mercury contactors.
   h. Pneumatic-electric switches and relays.
   i. Magnetic contactor for each step of control (for three-phase coils).
6. Pneumatic Controls: Damper operator, velocity controller, and induction damper operator. Control devices shall be compatible with temperature controls specified in Division 23 Section "Instrumentation And Control For Hvac" and shall have the following features:
   a. Damper Operator: Pneumatic, 0- to 13-psig (0- to 90-kPa) spring range.
   b. Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg (1000 Pa); and shall have a multipoint velocity sensor at air inlet.
   c. Induction Damper Operator: Pneumatic, spring range matching reset range of controller.
   d. Thermostat: Wall-mounted pneumatic type with appropriate mounting hardware.
   OR
   Electronic Controls: Pneumatic damper operators, electronic controller integral airflow transducer, and electronic thermostat. Control devices shall be compatible with temperature controls specified in Division 23 Section "Instrumentation And Control For Hvac" and shall have the following features:
   a. Damper Actuator: Pneumatic, 0- to 13-psig (0- to 90-kPa) spring range.
   b. Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg (1000 Pa); and shall have a multipoint velocity sensor at air inlet.
   c. Induction Damper Operator: Pneumatic, spring range matching reset range of controller.
   d. Thermostat: Wall-mounted electronic type with the following features:
      1) Proportional, plus integral control of room temperature.
      2) Time-proportional reheat-coil control.
      3) Temperature set-point display in Fahrenheit and Celsius.

F. Shutoff, Single-Duct Air Terminal Units
1. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
2. Casing: 0.034-inch (0.85-mm) steel **OR** 0.032-inch (0.8-mm) aluminum, **as directed**, single **OR** double, **as directed**, wall.
a. Casing Lining: Adhesive attached, 1/2-inch- (13-mm-) **OR** 3/4-inch- (19-mm-) **OR** 1-inch- (25-mm-), **as directed**, thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
1) Cover liner with nonporous foil.
OR
Cover liner with nonporous foil and perforated metal.
OR
Casing Lining: Adhesive attached, 1/2-inch- (13-mm-) **OR** 3/4-inch- (19-mm-) **OR** 1-inch- (25-mm-), **as directed**, thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
b. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
c. Air Outlet: S-slip and drive connections, size matching inlet size, **as directed**.
d. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
e. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
3. Regulator Assembly: System-air-powered bellows section incorporating polypropylene bellows for volume regulation and thermostatic control. Bellows shall operate at temperatures from 0 to 140 deg F (minus 18 to plus 60 deg C), shall be impervious to moisture and fungus, shall be suitable for 10-inch wg (2500-Pa) static pressure, and shall be factory tested for leaks.
4. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
a. Maximum Damper Leakage: ARI 880 rated, 2 **OR** 3, **as directed**, percent of nominal airflow at 3-inch wg (750-Pa) **OR** 6-inch wg (1500-Pa), **as directed**, inlet static pressure.
b. Damper Position: Normally open **OR** closed, **as directed**.
5. Attenuator Section: 0.034-inch (0.85-mm) steel **OR** 0.032-inch (0.8-mm) aluminum, **as directed**, sheet.
a. Lining: Adhesive attached, 1/2-inch- (13-mm-) **OR** 3/4-inch- (19-mm-) **OR** 1-inch- (25-mm-), **as directed**, thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
1) Cover liner with nonporous foil.
OR
Cover liner with nonporous foil and perforated metal.
OR
Lining: Adhesive attached, 3/4-inch- (19-mm-) thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
b. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
6. Multioutlet Attenuator Section: With two **OR** three **OR** four, **as directed**, 6-inch- (150-mm-) **OR** 8-inch- (200-mm-) **OR** 10-inch- (250-mm-), **as directed**, diameter collars, each with locking butterfly balancing damper.
7. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), and rated for a minimum working pressure of 200 psig (1380 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain valve.
OR

Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.

a. Access door interlocked disconnect switch.
b. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable.)
c. Nickel chrome 80/20 heating elements.
d. Airflow switch for proof of airflow.
e. Fan interlock contacts.
f. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
g. Mercury contactors.
h. Pneumatic-electric switches and relays.
i. Magnetic contactor for each step of control (for three-phase coils).

8. Electric Controls: Damper actuator and thermostat.
   a. Damper Actuator: 24 V, powered closed, spring return open **OR** powered open, **as directed**.
   b. Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius, and space temperature set point.

OR

Pneumatic Controls: Damper operator and velocity controller. Control devices shall be compatible with temperature controls specified in Division 23 Section "Instrumentation And Control For Hvac" and shall have the following features:

a. Pneumatic Damper Operator: 0- to 13-psig (0- to 90-kPa) spring range.
b. Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg (1000 Pa); and shall have a multipoint velocity sensor at air inlet.
c. Thermostat: Wall-mounted pneumatic type with appropriate mounting hardware.

OR

Electronic Controls: Bidirectional damper operator and microprocessor-based thermostat with integral airflow transducer and room sensor. Control devices shall be compatible with temperature controls specified in Division 23 Section "Instrumentation And Control For Hvac" and shall have the following features:

a. Damper Actuator: 24 V, powered closed, spring return open **OR** powered open, **as directed**.
b. Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg (1000 Pa); and shall have a multipoint velocity sensor at air inlet.
c. Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.

OR

Direct Digital Controls: Single-package unitary controller and actuator specified in Division 23 Section "Instrumentation And Control For Hvac".

OR

Direct Digital Controls: Bidirectional damper operators and microprocessor-based controller and room sensor. Control devices shall be compatible with temperature controls specified in Division 23 Section "Instrumentation And Control For Hvac" and shall have the following features:

a. Damper Actuator: 24 V, powered closed, spring return open **OR** powered open, **as directed**.
b. Terminal Unit Controller: Pressure-independent, variable-air-volume controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
   1) Occupied and unoccupied operating mode.

2) Remote reset of airflow or temperature set points.
3) Adjusting and monitoring with portable terminal.
4) Communication with temperature-control system specified in Division 23 Section "Instrumentation And Control For Hvac".

c. Room Sensor: Wall mounted with temperature set-point adjustment and access for connection of portable operator terminal.

9. Control Sequence:
   a. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg (60- and 750-Pa) inlet static pressure.
   b. System-powered, wall-mounted thermostat.

G. Diffuser-Type Air Terminal Units

1. Configuration: Volume-damper, diffuser, controller assembly and electric heater, **as directed**, and wall-mounted thermostat with master-slave capability, **as directed**.
2. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
   a. Damper Position: Normally open **OR** closed, **as directed**.
3. Diffuser: Galvanized steel with white baked-enamel finish.
4. Electronic Controls: Bidirectional damper operator and microprocessor-based thermostat with integral airflow transducer and room sensor. Control devices shall be compatible with temperature controls specified in Division 23 Section "Instrumentation And Control For Hvac" and shall have the following features:
   a. Damper Actuator: 24 V, powered closed, spring return open **OR** powered open, **as directed**.
   b. Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg (1000 Pa); and shall have a multipoint velocity sensor at air inlet.
   c. Thermostat: Wall-mounted electronic type with the following features:
      1) Proportional, plus integral control of room temperature.
      2) Temperature set-point display in Fahrenheit and Celsius.
5. Integral thermally powered actuators control diffusion dampers based on duct and room temperature.

H. Hangers And Supports

1. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
2. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
3. Steel Cables: Galvanized steel complying with ASTM A 603 **OR** Stainless steel complying with ASTM A 492, **as directed**.
4. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
5. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
6. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

I. Seismic-Restraint Devices

1. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of the ICC Evaluation Service **OR** the Office of Statewide Health Planning and Development for the State of California **OR** an agency acceptable to authorities having jurisdiction, **as directed**.
   a. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
2. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to

braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

3. Restraint Cables: ASTM A 603, galvanized **OR** ASTM A 492, stainless, **as directed**,-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; with an automatic-locking and clamping device or double-cable clips.
4. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections **OR** Reinforcing steel angle clamped, **as directed**, to hanger rod.
5. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

J. Source Quality Control
1. Factory Tests, as directed: Test factory-assembled air terminal units according to ARI 880.
   a. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, **as directed**, and ARI certification seal.

1.3 EXECUTION

A. Installation
1. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
2. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.
3. Install wall-mounted thermostats.

B. Hanger And Support Installation
1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
2. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   a. Where practical, install concrete inserts before placing concrete.
   b. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   c. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches (100 mm) thick.
   d. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches (100 mm) thick.
   e. Do not use powder-actuated concrete fasteners for seismic restraints.
3. Hangers Exposed to View: Threaded rod and angle or channel supports.
4. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

C. Seismic-Restraint-Device Installation
1. Install hangers and braces designed to support the air terminal units and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems" **OR** ASCE/SEI 7, **as directed**.
2. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
3. Install cables so they do not bend across edges of adjacent equipment or building structure.
4. Install cable restraints on air terminal units that are suspended with vibration isolators.
5. Install seismic-restraint devices using methods approved by an evaluation service member of the ICC Evaluation Service **OR** the Office of Statewide Health Planning and Development for the State of California **OR** an agency acceptable to authorities having jurisdiction, **as directed**.
6. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

7. Drilling for and Setting Anchors:

8. Identify position of reinforcing steel and other embedded items before drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the the Owner if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
9. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
10. Wedge Anchors: Protect threads from damage during anchor installation. Install heavy-duty sleeve anchors with sleeve fully engaged in the structural element to which anchor is to be fastened.
11. Set anchors to manufacturer's recommended torque, using a torque wrench.
12. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

D. Connections
1. Install piping adjacent to air terminal unit to allow service and maintenance.
2. Hot-Water Piping: In addition to requirements in Division 23 Section "Hydronic Piping", connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.
3. Connect ducts to air terminal units according to Division 23 Section(s) "Metal Ducts" OR "Nonmetal Ducts", **as directed**.
4. Make connections to air terminal units with flexible connectors complying with requirements in Division 23 Section "Air Duct Accessories".

E. Identification
1. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Division 23 Section "Identification For Hvac Piping And Equipment" for equipment labels and warning signs and labels.

F. Field Quality Control
1. Perform tests and inspections.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Tests and Inspections:
   a. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
   b. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
   c. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Air terminal unit will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

G. Startup Service
1. Perform startup service.
   a. Complete installation and startup checks according to manufacturer's written instructions.
   b. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
   c. Verify that controls and control enclosure are accessible.
   d. Verify that control connections are complete.
   e. Verify that nameplate and identification tag are visible.
   f. Verify that controls respond to inputs as specified.

H. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 23 36 16 00

Task	Specification	Specification Description
23 37 13 13	23 31 13 19	Duct Accessories
23 37 13 13	23 36 13 00	Diffusers, Registers, And Grilles
23 37 13 43	23 31 13 19	Duct Accessories
23 37 13 43	23 36 13 00	Diffusers, Registers, And Grilles
23 37 23 13	07 72 13 00a	Intake and Relief Ventilators
23 38 13 16	01 22 16 00	No Specification Required
23 38 13 16	11 21 63 00	Food Service Equipment
23 38 13 16	23 01 30 61	Metal Ducts
23 38 13 16	07 72 13 00a	Intake and Relief Ventilators

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SECTION 23 41 13 00 - AIR FILTERS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for particulate air infiltration. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Metal panel filters.
   b. Flat panel filters.
   c. Pleated panel filters.
   d. Ring panel filters.
   e. Nonsupported bag filters.
   f. Supported bag filters.
   g. Rigid cell box filters.
   h. V-bank cell filters.
   i. Self-supported pocket filters.
   j. Automatic roll filters.
   k. Bulk media.
   l. Front- and rear-access filter frames.
   m. Side-service housings.
   n. Filter gages.

C. Submittals

1. Product Data: For each type of product indicated. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.
2. LEED Submittals:
   a. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
   b. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: For air filters. Include plans, elevations, sections, details, and attachments to other work.
   a. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
   b. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.
   c. Wiring Diagrams: For power, signal, and control wiring.
4. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.

D. Quality Assurance

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. ASHRAE Compliance:
   a. Comply with applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality"; Section 5 - "Systems and Equipment"; and Section 7 - "Construction and Startup."

b. Comply with ASHRAE 52.1 for arrestance and ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.

3. Comply with NFPA 90A and NFPA 90B.

E. Coordination

1. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases.

1.2 PRODUCTS

A. Metal Panel Filters

1. Description: Factory-fabricated, self-supported, cleanable, all-metal, impingement-type, panel-type, permanent air filters with holding frames.
2. Media: Four **OR** Six, **as directed**, alternate layers of galvanized-steel **OR** aluminum **OR** stainless-steel, **as directed**, flat and herringbone-crimp screen.
   a. Nonoiled for grease removal application.
   b. Adhesive coating.
      1) Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Filter-Media Frame: Galvanized steel **OR** Hot-dip galvanized steel **OR** Aluminum **OR** Stainless steel, **as directed**, hinged, and with pull and retaining handles fastened to the media.
   a. Drain holes.

B. Flat Panel Filters

1. Description: Factory-fabricated, self-supported, flat, nonpleated, panel-type, disposable air filters with holding frames.
2. Filter Unit Class: UL 900, Class 1 **OR** Class 2, **as directed**.
3. Media: Interlaced glass or synthetic fibers **OR** Cotton and synthetic fibers, **as directed**, coated with nonflammable adhesive.
   a. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. Media shall be coated with an antimicrobial agent.
   c. Metal Retainer: Upstream side and downstream side.
4. Filter-Media Frame: Cardboard with perforated metal retainer **OR** Galvanized steel with metal grid on outlet side and steel rod grid on inlet side, hinged, with pull and retaining handles, **as directed**, sealed or bonded to the media.
5. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

C. Pleated Panel Filters

1. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters with holding frames.
2. Filter Unit Class: UL 900, Class 1 **OR** Class 2, **as directed**.
3. Media: Interlaced glass or synthetic fibers **OR** Cotton and synthetic fibers, **as directed**, coated with nonflammable adhesive.
   a. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. Media shall be coated with an antimicrobial agent.
   c. Separators shall be bonded to the media to maintain pleat configuration.
   d. Welded wire grid shall be on downstream side to maintain pleat.
   e. Media shall be bonded to frame to prevent air bypass.
   f. Support members on upstream and downstream sides to maintain pleat spacing.
4. Filter-Media Frame: Cardboard frame with perforated metal retainer **OR** Galvanized steel **OR** Aluminized steel, **as directed**, with metal grid on outlet side and steel rod grid on inlet side, hinged, with pull and retaining handles, **as directed**, sealed or bonded to the media.

5. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

D. Ring Panel Filters
1. Description: Internally supported, flat panel filters for installation in a filter track.
2. Filter Unit Class: UL 900, Class 1 **OR** Class 2, **as directed**.
3. Media: Two **OR** Three **OR** Four, **as directed**,-ply polyester with sealed edges.
   a. Panel Construction: Single with one edge unsealed for support removal, **as directed**, **OR** Linked, **as directed**.
   b. Media shall be coated with an antimicrobial agent.
4. Internal Support: 9-gage steel wire frame.

E. Nonsupported Bag Filters
1. Description: Factory-fabricated, dry, extended-surface, nonsupported filters with header frames.
2. Filter Unit Class: UL 900, Class 1 **OR** Class 2, **as directed**.
3. Media: Glass-fiber **OR** Synthetic, **as directed**, material constructed so individual pockets are maintained in tapered form under rated-airflow conditions by flexible internal supports.
   a. Media shall be coated with an antimicrobial agent.
4. Filter-Media Frame: Galvanized steel **OR** Hard polyurethane foam, **as directed**.
5. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

F. Supported Bag Filters
1. Description: Factory-fabricated, dry, extended-surface, self-supported filters with holding frames in steel, basket-type retainers.
2. Filter Unit Class: UL 900, Class 1 **OR** Class 2, **as directed**.
3. Media: Fibrous material constructed so individual pleats are maintained in tapered form under rated-airflow conditions by flexible internal supports.
   a. Media shall be coated with an antimicrobial agent.
4. Filter-Media Frame: Galvanized steel **OR** Hard polyurethane foam, **as directed**.
5. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

G. Rigid Cell Box Filters
1. Description: Factory-fabricated, adhesive-coated, **as directed**, disposable, packaged air filters with media perpendicular to airflow, and with holding frames.
2. Filter Unit Class: UL 900, Class 1 **OR** Class 2, **as directed**.
3. Media: Fibrous material constructed so individual pleats are maintained in tapered form under rated-airflow conditions by flexible internal supports.
   a. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. Media shall be coated with an antimicrobial agent.
4. Filter-Media Frames: Galvanized steel **OR** Hard polyurethane foam, **as directed**.
5. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

H. V-Bank Cell Filters
1. Description: Factory-fabricated, adhesive-coated, **as directed**, disposable, packaged air filters with media angled to airflow, and with holding frames.
2. Filter Unit Class: UL 900, Class 1 **OR** Class 2, **as directed**.
3. Media: Fibrous material constructed so individual pleats are maintained in tapered form under rated-airflow conditions by flexible internal supports.
   a. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. Media shall be coated with an antimicrobial agent.
4. Filter-Media Frames: Galvanized steel **OR** Hard polyurethane foam, **as directed**.

5. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

I. Self-Supported Pocket Filters
1. Description: Factory-fabricated, panel-type, disposable air filters with contoured media for extended surface.
2. Filter Unit Class: UL 900, Class 1 **OR** Class 2, **as directed**.
3. Media: Fibrous material constructed so individual pleats are maintained in tapered form under rated-airflow conditions by flexible internal supports.
   a. Media shall be coated with an antimicrobial agent.
4. Configuration: Single-pocket cube **OR** Multipocket, **as directed**.
5. Filter-Media Frame: Galvanized steel **OR** Hard polyurethane foam, **as directed**.
6. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

J. Automatic Roll Filters
1. Description: Factory-fabricated, automatic, motor-driven, roll-type filters with holding casing.
2. Arrangement: Horizontal **OR** Vertical, **as directed**.
3. Filter Unit Class: UL 900, Class 1 **OR** Class 2, **as directed**.
4. Media: Compressed and rolled, fibrous-glass material; viscous coated.
   a. Media shall be coated with an antimicrobial agent.
5. Holding Frame: Galvanized steel with enclosed, clean media roll arranged to allow upstream replacement of filter media.
   a. Auxiliary Frame: Locate on downstream side of unit with downstream **OR** side, **as directed**, access.
   b. Final Filter: Extended-surface, retained **OR** nonsupported, **as directed**, media.
6. Control and Drive: Electric, gear-reducer, motor-driven, feed-control mechanism equipped with manual media advance and runout switches for stopping media movement of filter bank and operating remote warning signal lights.
   a. Manual Control: Manual switch to advance media, and wired to override automatic controls.
   b. Automatic Control: Prewired control package to advance media when filter resistance exceeds preselected high limit **OR** after preselected operating time, **as directed**.

K. Bulk Media
1. Description: Air-filter media, factory custom cut or rolled.
2. Filter Unit Class: UL 900, Class 1 **OR** Class 2, **as directed**.
3. Media: Spun glass **OR** Synthetic **OR** Polyester, **as directed**, in a roll **OR** cut into pads, **as directed**.

L. Front- And Rear-Access Filter Frames
1. Framing System: Galvanized-steel **OR** Aluminum, **as directed**, framing members with access for either upstream (front) or downstream (rear) filter servicing, cut to size and prepunched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation or operation.
2. Prefilters: Incorporate a separate track with spring clips, **as directed**, removable from front or back, **as directed**.
3. Sealing: Factory-installed, positive-sealing device for each row of filters, to ensure seal between gasketed filter elements and to prevent bypass of unfiltered air.

M. Side-Service Housings
1. Description: Factory-assembled, side-service housings, constructed of galvanized steel **OR** aluminum, **as directed**, with flanges to connect to duct or casing system.
2. Prefilters: Integral tracks to accommodate 2-inch- (50-mm-) deep, disposable or washable, **as directed**, filters.

3. Access Doors: Hinged, with continuous **OR** Continuous, **as directed**, gaskets on perimeter and positive-locking devices, and arranged so filter cartridges can be loaded from either access door.
4. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames and to prevent bypass of unfiltered air.

N. Filter Gages
1. Diaphragm-type gage with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.
   a. Diameter: 4-1/2 inches (115 mm) **OR** 2 inches (50 mm), **as directed**.
   b. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5-Inch wg (125 Pa) or Less: 0- to 0.5-inch wg (0 to 125 Pa).
   c. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5- to 1.0-Inch wg (125 to 250 Pa) or Less: 0- to 1.0-inch wg (0 to 250 Pa).
   d. Scale Range for Filter Media Having a Recommended Final Resistance of 1.0- to 2.0-Inch wg (250 to 500 Pa) or Less: 0- to 2.0-inch wg (0 to 500 Pa).
   e. Scale Range for Filter Media Having a Recommended Final Resistance of 2.0- to 3.0-Inch wg (500 to 750 Pa) or Less: 0- to 3.0-inch wg (0 to 750 Pa).
   f. Scale Range for Filter Media Having a Recommended Final Resistance of 3.0- to 4.0-Inch wg (750 to 1000 Pa) or Less: 0- to 4.0-inch wg (0 to 1000 Pa).
2. Manometer-Type Filter Gage: Molded plastic, with epoxy-coated aluminum scale and logarithmic-curve tube gage with integral leveling gage, graduated to read from 0- to 3.0-inch wg (0 to 750 Pa), and accurate within 3 percent of the full scale range.
3. Accessories: Static-pressure tips, tubing, gage connections, and mounting bracket.

1.3 EXECUTION

A. Installation
1. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.
2. Install filters in position to prevent passage of unfiltered air.
3. Install filter gage for each filter bank.
4. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.
5. Install filter-gage, static-pressure taps upstream and downstream from filters. Install filter gages on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.
6. Coordinate filter installations with duct and air-handling-unit installations.

B. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
   a. Operate automatic roll filters to demonstrate compliance with requirements.
   b. Test for leakage of unfiltered air while system is operating.
3. Air filter will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

C. Cleaning
1. After completing system installation and testing, adjusting, and balancing of air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION 23 41 13 00

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SECTION 23 41 13 00a - GAS-PHASE AIR FILTRATION

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for gas-phase air infiltration. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Activated-carbon panel filters.
   b. Activated-carbon, deep-V filters.
   c. Activated carbon, V-cell filters.
   d. Cylindrical-canister filters.
   e. Permanganate filters.
   f. Supported adsorber bag filters.
   g. Front-access filter housings.
   h. Side-service housings.
   i. Filter gages.

C. Submittals

1. Product Data: For each type of product indicated. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.
2. LEED Submittal:
   a. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with applicable requirements in ASHRAE 62.1, Section 5, "Systems and Equipment."
3. Shop Drawings: For air filters. Include plans, elevations, sections, details, and attachments to other work.
   a. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
   b. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.
4. Field quality-control reports.
5. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.

D. Quality Assurance

1. ASHRAE Compliance:
   a. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
2. Comply with NFPA 90A and NFPA 90B.

1.2 PRODUCTS

A. Activated-Carbon Panel Filters

1. Description: Factory-fabricated unit with activated-carbon media.
2. Media: Flat-panel, disposable multilayer filter with an inlet layer of polyester fibers, a layer of activated-carbon granules bonded to fibers, and a layer of polyurethane foam; housed in a cardboard frame.

3. Media: Flat-panel, disposable honeycombed cellulose with cells filled with activated-carbon granules and a perforated mesh grid; housed in a cardboard frame.
4. Media: Pleated, multilayer filter with an inlet layer of cotton and synthetic fibers and a layer of activated-carbon granules bonded to synthetic fibers; media formed into deep-V-shaped pleats, held by self-wire grid, and housed in a cardboard frame.
5. Mounting Frames: Welded, galvanized, sheet-steel frame and galvanized-steel fasteners with polyurethane, **as directed**, gaskets; capable of bolting together into built-up filter banks.

B. Activated-Carbon, Deep-V Filters

1. Description: Factory-fabricated unit with activated-carbon trays in deep-V arrangement with disposable panel prefilter, **as directed**, and final filter, **as directed**.
2. Module Housing: 0.064-inch- (1.6-mm-) thick, galvanized steel **OR** stainless steel **OR** double-wall casing with 1-inch- (25-mm-) thick insulation, **as directed**, to hold media-filled panels; with side servicing through gasketed access doors on both sides and able to connect to other housings. Equip housings with metal slide channel tracks to hold activated-carbon trays and particulate prefilter, **as directed**, and final filter, **as directed**.
   a. Finish: Factory primed **OR** primed and painted, **as directed**, outside **OR** inside and outside **OR** inside, **as directed**.
   b. Pressure tap and fitting.
3. Media-Holding Panels: 1-inch- (25-mm-) thick, perforated polystyrene to allow airflow through contained loose-fill media; with removable service cap for recharging.
   OR
   Media-Holding Panels: 1 inch (25 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, deep and containing granular carbon bonded into a briquette form with a galvanized **OR** stainless, **as directed**,-steel frame.
4. Media: 45 lb (20.3 kg) per 1000 cfm (470 L/s) of loose-fill **OR** loose-fill or bonded-briquette **OR** bonded-briquette, **as directed**, coconut-shell activated carbon.
   a. Ash Content: 2 to 3 percent.
   b. Percent Carbon Tetrachloride Activity: 35 to 70 percent when tested according to ASTM D 3467.
   c. Bulk Density: 32 lb/cu. ft. (510 kg/cu. m).
   d. Mesh Size: 4 by 6 inches (100 by 150 mm), 90 percent minimum.
   e. Hardness Factor: 95 when tested according to ASTM D 3802.
5. Media: loose-fill **OR** loose-fill or bonded-briquette **OR** bonded-briquette, **as directed**, activated alumina impregnated with potassium permanganate.
   a. Ash Content: 2 to 3 percent.
   b. Percent Carbon Tetrachloride Activity: 35 to 70 percent when tested according to ASTM D 3467.
   c. Bulk Density: 32 lb/cu. ft. (510 kg/cu. m).
   d. Mesh Size: 4 by 6 inches (100 by 150 mm), 90 percent minimum.
   e. Hardness Factor: 95 when tested according to ASTM D 3802.
6. Media: loose-fill **OR** loose-fill or bonded-briquette **OR** bonded-briquette, **as directed**, impregnated carbon.
   a. Ash Content: 2 to 3 percent.
   b. Percent Carbon Tetrachloride Activity: 35 to 70 percent when tested according to ASTM D 3467.
   c. Bulk Density: 32 lb/cu. ft. (510 kg/cu. m).
   d. Mesh Size: 4 by 6 inches (100 by 150 mm), 90 percent minimum.
   e. Hardness Factor: 95 when tested according to ASTM D 3802.
7. Media: loose-fill **OR** loose-fill or bonded-briquette **OR** bonded-briquette, **as directed**, blended carbon and alumina impregnated with potassium permanganate.
   a. Ash Content: 2 to 3 percent.
   b. Percent Carbon Tetrachloride Activity: 35 to 70 percent when tested according to ASTM D 3467.
   c. Bulk Density: 32 lb/cu. ft. (510 kg/cu. m).

d. Mesh Size: 4 by 6 inches (100 by 150 mm), 90 percent minimum.
e. Hardness Factor: 95 when tested according to ASTM D 3802.

C. Activated-Carbon, V-Cell Filters
1. Description: Factory-fabricated, dry, V-shaped cartridges containing loose-fill media with holding frames.
2. Cartridges: V-cell configuration, plastic enclosure caps, galvanized-steel frame with vertical galvanized-steel channel supports. Integral, 1-inch- (25-mm-) deep panels constructed of honeycombed paper and nylon mesh.
3. Fill Media: Coconut-shell activated carbon; 45 lb (20.3 kg) of activated carbon per 1000 cfm (470 L/s) of airflow.
a. Ash Content: 2 to 3 percent.
b. Percent Carbon Tetrachloride Activity: 35 to 70 percent when tested according to ASTM D 3467.
c. Bulk Density: 32 lb/cu. ft. (510 kg/cu. m).
d. Mesh Size: 4 by 6 inches (100 by 150 mm), 90 percent minimum.
e. Hardness Factor: 95 when tested according to ASTM D 3802.
4. Fill Media: Activated alumina impregnated with potassium permanganate; 10.5 lb (4.8 kg) of adsorbent per 500 cfm (236 L/s) of airflow.
a. Ash Content: 2 to 3 percent.
b. Percent Carbon Tetrachloride Activity: 35 to 70 percent when tested according to ASTM D 3467.
c. Bulk Density: 32 lb/cu. ft. (510 kg/cu. m).
d. Mesh Size: 4 by 6 inches (100 by 150 mm), 90 percent minimum.
e. Hardness Factor: 95 when tested according to ASTM D 3802.
5. Fill Media: Impregnated carbon; 8.0 lb (3.6 kg) of adsorbent per 500 cfm (236 L/s) of airflow.
a. Ash Content: 2 to 3 percent.
b. Percent Carbon Tetrachloride Activity: 35 to 70 percent when tested according to ASTM D 3467.
c. Bulk Density: 32 lb/cu. ft. (510 kg/cu. m).
d. Mesh Size: 4 by 6 inches (100 by 150 mm), 90 percent minimum.
e. Hardness Factor: 95 when tested according to ASTM D 3802.
6. Fill Media: Blended carbon and alumina impregnated with potassium permanganate; 7.0 lb (3.1 kg) of adsorbent per 500 cfm (236 L/s) of airflow.
a. Ash Content: 2 to 3 percent.
b. Percent Carbon Tetrachloride Activity: 35 to 70 percent when tested according to ASTM D 3467.
c. Bulk Density: 32 lb/cu. ft. (510 kg/cu. m).
d. Mesh Size: 4 by 6 inches (100 by 150 mm), 90 percent minimum.
e. Hardness Factor: 95 when tested according to ASTM D 3802.
7. Mounting Frames: Welded, galvanized, sheet-steel frame and galvanized-steel fasteners with gaskets; capable of bolting together into built-up filter banks.

D. Cylindrical-Canister Filters
1. Description: Factory-fabricated, dry, cylindrical canisters containing loose-fill adsorbent with holding frames.
2. Cylinders: 0.0455-inch- (1.2-mm-) thick, perforated, electroplated **OR** stainless, **as directed**, steel, with end plate.
3. Fill Media: 5.0 lb (2.3 kg) **OR** 6.7 lb (3.0 kg), **as directed**, of coconut-shell activated carbon **OR** activated alumina impregnated with potassium permanganate **OR** impregnated carbon **OR** blended carbon and alumina impregnated with potassium permanganate, **as directed**, per canister.
a. Ash Content: 2 to 3 percent.
b. Percent Carbon Tetrachloride Activity: 35 to 70 percent when tested according to ASTM D 3467.
c. Bulk Density: 32 lb/cu. ft. (510 kg/cu. m).

d. Mesh Size: 4 by 6 inches (100 by 150 mm), 90 percent minimum.
e. Hardness Factor: 95 when tested according to ASTM D 3802.
4. Mounting Frames: Welded galvanized, sheet steel with galvanized-steel fasteners **OR** stainless steel with stainless-steel fasteners, **as directed**, with gaskets; designed for bolting together into built-up filter banks.

E. Permanganate Filters
1. Description: Factory-fabricated modules containing loose-fill adsorbent with holding frames.
2. Modules: Permanent type, 24 inches wide by 24 inches high by 24 inches deep (600 mm wide by 600 mm high by 600 mm deep); shall hold both potassium permanganate and activated carbon. Manufactured in two pieces, each 12 inches (300 mm) wide for ease of installation.
3. Media: Porous spherical pellets formed from a combination of powdered, activated carbon and other binders, impregnated with potassium permanganate.
a. Leach Test: 180 minutes.
b. Potassium Permanganate Content: 4 percent minimum.
c. Moisture Content: 20 percent maximum.
d. Bulk Density: 34 lb/cu. ft. (0.54 g/mL) **OR** 50 lb/cu. ft. (0.8 g/mL), **as directed**.
e. Crush Strength: 40 **OR** 50 **OR** 60, **as directed**, percent maximum.
f. Abrasion: 4 percent maximum.
g. Nominal Pellet Diameter: 0.125 inch (3.175 mm).
h. Percent of Pellet Sizes: 80 to 85 percent after screening.
4. Media: High-grade carbon, manufactured from coconut shells, bituminous coal, or a combination of both.
a. Ash Content: 2 to 3 percent.
b. Percent Carbon Tetrachloride Activity: 35 to 70 percent when tested according to ASTM D 3467.
c. Bulk Density: 32 lb/cu. ft. (510 kg/cu. m).
d. Mesh Size: 4 by 6 inches (100 by 150 mm), 90 percent minimum.
e. Hardness Factor: 95 when tested according to ASTM D 3802.
5. Frame: Galvanized steel **OR** Hot-dip galvanized steel **OR** Aluminum **OR** Stainless steel, **as directed**, hinged, and with pull and retaining handles fastened to the media.

F. Supported Adsorber Bag Filters
1. Description: Factory-fabricated, dry, extended-surface, self-supporting filters with holding frames.
2. Media: Carbon-filled fibrous material constructed so individual pleats are maintained under rated-airflow conditions in tapered form by flexible internal supports.
3. Filter-Media Frame: Galvanized steel.
4. Mounting Frames: Welded, galvanized, sheet-steel frame and galvanized-steel fasteners with gaskets; capable of bolting together into built-up filter banks.

G. Front-Access Filter Frames
1. Framing System: Galvanized-steel **OR** Aluminum, **as directed**, framing members with access for upstream (front) filter servicing, cut to size and prepunched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation or operation.
2. Prefilters: Incorporate a separate track with spring clips, **as directed**, removable from front or back, **as directed**.
3. Sealing: Factory-installed, positive-sealing device for each row of filters to ensure seal between gasketed filter elements to prevent bypass of unfiltered air.

H. Side-Service Housings
1. Description: Factory-assembled, side-service housings constructed of galvanized steel **OR** aluminum, **as directed**, with flanges to connect to duct or casing system.
2. Prefilters: Integral tracks to accommodate 2-inch- (50-mm-) thick, disposable or washable, **as directed**, filters.

3. Access Doors: Hinged with continuous **OR** Continuous, **as directed**, gaskets on perimeter and with positive-locking devices. Arrange so filter cartridges can be loaded from either access door.
4. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

I. Filter Gages
1. Diaphragm type, with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.
   a. Diameter: 4-1/2 inches (115 mm) **OR** 2 inches (50 mm),**as directed** .
   b. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5-Inch wg (125 Pa) or Less: 0- to 0.5-inch wg (0 to 125 Pa).
   c. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5- to 1.0-Inch wg (125 to 250 Pa) or Less: 0- to 1.0-inch wg (0 to 250 Pa).
   d. Scale Range for Filter Media Having a Recommended Final Resistance of 1.0- to 2.0-Inch wg (250 to 500 Pa) or Less: 0- to 2.0-inch wg (0 to 500 Pa).
   e. Scale Range for Filter Media Having a Recommended Final Resistance of 2.0- to 3.0-Inch wg (500 to 750 Pa) or Less: 0- to 3.0-inch wg (0 to 750 Pa).
   f. Scale Range for Filter Media Having a Recommended Final Resistance of 3.0- to 4.0-Inch wg (750 to 1000 Pa) or Less: 0- to 4.0-inch wg (0 to 1000 Pa).
2. Manometer-Type Filter Gage: Molded plastic, with epoxy-coated aluminum scale, logarithmic-curve tube gage with integral leveling gage; graduated to read from 0- to 3.0-inch wg (0 to 750 Pa) and accurate within 3 percent of full-scale range.
3. Accessories: Static-pressure tips, tubing, gage connections, and mounting bracket.

1.3 EXECUTION

A. Installation
1. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.
2. Install filters in position to prevent passage of unfiltered air.
3. Install filter gage for each filter bank.
4. Do not operate fan system until particulate filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.
5. Do not install gas-phase filters until fan system is clean and there is no risk of construction debris loading the filter.
6. Install filter-gage, static-pressure taps upstream and downstream from filters. Install filter gages on filter banks with separate static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.
7. Coordinate filter installations with duct and air-handling unit installations.

B. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
   a. Test for leakage of unfiltered air while system is operating.
3. Air filter will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

C. Cleaning
1. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems, clean filter housings and install new particulate filter media.

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Task	Specification	Specification Description
23 41 13 00	22 11 19 00	Electronic Air Cleaners
23 41 16 00	23 41 13 00	Air Filters
23 41 16 00	22 11 19 00	Electronic Air Cleaners
23 41 19 00	23 41 13 00	Air Filters
23 41 19 00	22 11 19 00	Electronic Air Cleaners
23 41 33 00	23 41 13 00	Air Filters
23 41 33 00	22 13 19 00	High-Efficiency Particulate Filtration
23 42 13 00	23 41 13 00	Air Filters
23 42 13 00	23 41 13 00a	Gas-Phase Air Filtration

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SECTION 23 51 13 13 - BREECHINGS, CHIMNEYS, AND STACKS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for breechings, chimneys, and stacks. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Listed chimney liners.
b. Listed single-wall and double-wall vents and chimneys.
c. Listed, refractory-lined breechings and stacks.
d. Field-fabricated metal breechings and chimneys.
e. Listed grease and dishwasher ducts.

C. Submittals
1. Product Data: For the following:
a. Chimney liners.
b. Type B and BW vents.
c. Type L vents.
d. Special gas vents.
e. Building-heating-appliance chimneys.
f. Grease ducts.
g. Refractory-lined metal breechings and chimneys.
h. Guy wires and connectors.
2. Shop Drawings: For vents, breechings, chimneys, and stacks. Include plans, elevations, sections, details, and attachments to other work.
3. Welding certificates.
4. Manufacturer Seismic Qualification Certification: Submit certification that factory-fabricated breeching, chimneys, and stacks; accessories; and components will withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
5. Warranty: Warranty specified in this Section.

D. Quality Assurance
1. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code--Steel," for hangers and supports and AWS D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in vents, breechings, and stacks.

E. Warranty
1. Manufacturer's standard form in which manufacturer agrees to repair or replace components of venting system that fail in materials or workmanship within 10 **OR** 15 **OR** 25, **as directed**, years from date of Final Completion. Failures include, but are not limited to, structural failures caused by expansion and contraction.

1.2 PRODUCTS

A. Listed Chimney Liners
1. Description: Straight **OR** Corrugated, **as directed**, single-wall chimney liner tested according to UL 1777 and rated for 1000 deg F (538 deg C) continuously, or 2100 deg F (1150 deg C) for 10 minutes; with negative or positive flue pressure complying with NFPA 211.

2. Straight Liner Materials: ASTM A 666, Type 304 **OR** Type 316, **as directed**, stainless steel.
3. Corrugated Liner Materials: ASTM A 240/A 240M, Type 321 **OR** ASTM A 240/A 240M, Type 430 **OR** ASTM A 959, Type 29-4C, **as directed**, stainless steel.
4. Accessories:
   a. Fittings: Tees, elbows, increasers, draft-hood connectors, metal caps with bird barriers, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar or compatible materials and designs.
   b. Sealant: Manufacturer's standard high-temperature sealant.
   c. Insulating Fill: Manufacturer's standard high-temperature insulation fill material in annular space surrounding chimney liner including high-temperature, ceramic-fiber insulation required to seal chimney at top and bottom.

B. Listed Type B And BW Vents
1. Description: Double-wall metal vents tested according to UL 441 and rated for 480 deg F (248 deg C) continuously for Type B, or 550 deg F (288 deg C) continuously for Type BW; with neutral or negative flue pressure complying with NFPA 211.
2. Construction: Inner shell and outer jacket separated by at least a 1/4-inch (6-mm) airspace.
3. Inner Shell: ASTM B 209 (ASTM B 209M), Type 1100 aluminum **OR** ASTM B 209 (ASTM B 209M), Type 3003 aluminum **OR** ASTM B 209 (ASTM B 209M), Type 3105 aluminum **OR** ASTM A 666, Type 430 stainless steel, **as directed**.
4. Outer Jacket: Galvanized **OR** Aluminized, **as directed**, steel.
5. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
   a. Termination:
      1) Stack cap designed to exclude minimum 90 percent of rainfall.
         OR
         Round chimney top designed to exclude minimum 98 percent of rainfall.
         OR
         Exit cone with drain section incorporated into riser.
         OR
         Antibackdraft.

C. Listed Type L Vents
1. Description: Double-wall metal vents tested according to UL 641 and rated for 570 deg F (300 deg C) continuously, or 1700 deg F (926 deg C) for 10 minutes; with neutral or negative flue pressure complying with NFPA 211.
2. Construction: Inner shell and outer jacket separated by at least a 1/4-inch (6-mm) **OR** 1-inch (25-mm) **OR** 2-inch (50-mm) **OR** 4-inch (100-mm), **as directed**, airspace filled with high-temperature, ceramic-fiber **OR** mineral-wool, **as directed**, insulation.
3. Inner Shell: ASTM A 666, Type 304 **OR** Type 316, **as directed**, stainless steel.
4. Outer Jacket: Galvanized **OR** Aluminized **OR** Stainless, **as directed**, steel.
5. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
   a. Termination:
      1) Stack cap designed to exclude 90 percent of rainfall.
         OR
         Round chimney top designed to exclude 98 percent of rainfall.
         OR
         Exit cone with drain section incorporated into riser.

D. Listed Special Gas Vents
1. Description: Double-wall metal vents tested according to UL 1738 and rated for 480 deg F (248 deg C) continuously, with positive or negative flue pressure complying with NFPA 211.

2. Construction: Inner shell and outer jacket separated by at least a 1/2-inch (13-mm) airspace.
3. Inner Shell: ASTM A 959, Type 29-4C stainless steel.
4. Outer Jacket: Aluminized **OR** Stainless, **as directed**, steel.
5. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
   a. Termination:
      1) Stack cap designed to exclude minimum 90 percent of rainfall.
         OR
         Round chimney top designed to exclude minimum 98 percent of rainfall.
         OR
         Exit cone with drain section incorporated into riser.

E. Listed Building-Heating-Appliance Chimneys
1. Description for building-heating-appliance chimneys suitable for dual-fuel boilers, oven vents, water heaters, or exhaust for engines: Double-wall metal vents tested according to UL 103 and rated for 1000 deg F (538 deg C) continuously, or 1700 deg F (926 deg C) for 10 minutes; with neutral or negative flue pressure complying with NFPA 211.
   a. Construction: Inner shell and outer jacket separated by at least a 1/2-inch (25-mm) **OR** 1-inch (50-mm) **OR** 2-inch (50-mm) **OR** 3-inch (75-mm) **OR** 4-inch (100-mm), **as directed**, annular space filled with high-temperature, ceramic-fiber insulation, **as directed**.
   b. Inner Shell: ASTM A 666, Type 304 **OR** Type 316, **as directed**, stainless steel.
2. Description for 1400 deg F (760 deg C) chimneys suitable for dual-fuel boilers, oven vents, water heaters, or exhaust for engines: Double-wall metal vents tested according to UL 103 and UL 959 and rated for 1400 deg F (760 deg C) continuously, or 1800 deg F (982 deg C) for 10 minutes; with positive or negative flue pressure complying with NFPA 211.
   a. Construction: Inner shell and outer jacket separated by at least a 1-inch (25-mm) **OR** 2-inch (50-mm) **OR** 3-inch (75-mm) **OR** 4-inch (100-mm), **as directed**, annular space filled with high-temperature, ceramic-fiber insulation.
   b. Inner Shell: ASTM A 666, Type 304 **OR** Type 316, **as directed**, stainless steel.
3. Description for Type HT chimneys suitable for fireplaces and other solid-fuel-burning appliances: Double-wall metal vents tested according to UL 103 and rated for 1000 deg F (538 deg C) continuously, or 2100 deg F (1150 deg C) for 10 minutes; with neutral or negative flue pressure complying with NFPA 211.
   a. Construction: Inner shell and outer jacket separated by at least a 1-inch (25-mm) **OR** 1-1/2-inch (38-mm) **OR** 2-inch (50-mm) **OR** 4-inch (100-mm), **as directed**, annular space filled with high-temperature, ceramic-fiber insulation.
   b. Inner Shell: ASTM A 666, Type 304 **OR** ASTM A 666, Type 316 **OR** ASTM A 240/A 240M, Type 430, **as directed**, stainless steel.
4. Outer Jacket: Galvanized **OR** Aluminized **OR** Stainless, **as directed**, steel.
5. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
   a. Termination:
      1) Stack cap designed to exclude minimum 90 percent of rainfall.
         OR
         Round chimney top designed to exclude minimum 98 percent of rainfall.
         OR
         Exit cone with drain section incorporated into riser.

F. Listed Grease Ducts
1. Description: Double-wall metal vents tested according to UL 1978 and rated for 500 deg F (260 deg C) continuously, or 2000 deg F (1093 deg C) for 30 minutes; with positive or negative duct pressure and complying with NFPA 211.

2. Construction: Inner shell and outer jacket separated by at least a 1-inch (25-mm) **OR** 2-inch (50-mm) **OR** 3-inch (75-mm) **OR** 4-inch (100-mm), **as directed**, annular space filled with high-temperature, ceramic-fiber insulation.
3. Inner Shell: ASTM A 666, Type 304 **OR** Type 316, **as directed**, stainless steel.
4. Outer Jacket: Aluminized **OR** Stainless, **as directed**, steel where concealed. Stainless steel where exposed.
5. Accessories: Tees, elbows, increasers, hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly. Include unique components required to comply with NFPA 96 including cleanouts, transitions, adapters and drain fittings.

G. Listed, Refractory-Lined Metal Breechings And Chimneys
1. Comply with ASME STS-1.
2. Design Wind Loads: 150 mph (241 km/h), **as directed**.
3. Design for seismic conditions at Project site.
4. Chimney Outer Jacket: Aluminized **OR** Galvanized, **as directed**, steel with riveted **OR** welded, **as directed**, seams.
5. Refractory Lining: Tested according to UL 959 for temperature and acid resistance, and bearing the testing laboratory label.
    a. Temperature Rating: 1800 deg F (982 deg C) continuously, and 2000 deg F (1093 deg C) intermittently.
    b. Acid Extraction: Maximum of 0.2 percent.
    c. Cold Crushing Strength: Minimum of 3200 psig (22 MPa).
    d. Thickness: Minimum of 2 inches (50 mm).
6. Finish: Factory-applied, high-heat-resistant paint; color as selected.
7. Base Section: Acid-resistant-coated, cast-iron anchor lugs for securing stack to foundation with anchorage designed by manufacturer, **as directed**.
8. Reinforced Cleanout Section: Smoke-tight connection, with gasketed and bolt-tightened inspection plate; neck shall be welded to stack section.
9. T or Y Sections: Smoke-tight connection, with welded joints and refractory lining; finished with smooth transition and with no exposed metal on inside.
10. Spark Screen: ASTM A 666, Type 316 stainless steel, 0.0625 inch (1.6 mm) thick, maximum 1/2-by-1/2-inch (13-by-13-mm) mesh, with ASTM A 666, Type 304 stainless-steel rolled angle and drawband.
11. Guy Bands: 8-inch- (200-mm-) wide bands of same material as jacket, with bolted fasteners.
12. Roof Penetration: Factory-fabricated thimbles, flashings, and counterflashings.
13. Fabricate sections, fittings, and accessories as individual pieces or in combination lengths for field handling.
14. Fabricate components with centrifugally cast refractory lining in lengths suitable for connection with drawbands.
15. Bond refractory to steel jacket with calcium aluminate cement to prevent separation in finished product during shipping, handling, and installation.
16. Fabricate stacks with anchor lugs; cleanout; T sections; flashings and counterflashings; and provisions for support, expansion, and contraction.

H. Field-Fabricated Metal Breechings And Chimneys
1. Fabricate freestanding chimneys according to SMACNA's "Guide for Steel Stack Design and Construction."
2. Fabricate breechings and chimneys from ASTM A 1011/A 1011M hot-rolled steel with continuously welded joints, complying with NFPA 211 for minimum metal thickness.
    a. Equal to or Less Than 1.069 Sq. Ft. (0.099 Sq. m.) or 14 Inches (356 mm) in Diameter: 0.053 inch (1.35 mm).
    b. Up to 1.396 Sq. Ft. (0.129 Sq. m) or 16 Inches (406 mm) in Diameter: 0.067 inch (1.7 mm).

c. Up to 1.764 Sq. Ft. (0.164 Sq. m.) or 18 Inches (457 mm) in Diameter: 0.093 inch (2.36 mm).
d. Larger Than Above: 0.123 inch (3.12 mm).

3. Fabricate chimneys and vent connectors from galvanized steel, complying with NFPA 211 for minimum metal thickness.
   a. Equal to or Less Than 6 Inches (152 mm) in Diameter: 0.019 inch (0.48 mm).
   b. Up to 10 Inches (254 mm) in Diameter: 0.024 inch (0.61 mm).
   c. Up to 16 Inches (406 mm) in Diameter: 0.029 inch (0.74 mm).
   d. Larger Than Above: 0.056 inch (1.42 mm).
4. Fabricate chimneys and vent connectors from ASTM B 209 (ASTM B 209M), Type 1100 or 3003, aluminum or stainless steel, complying with NFPA 211 for the following minimum metal thicknesses:
   a. Aluminum: 0.027 inch (0.69 mm).
   b. Stainless Steel: 0.012 inch (0.31 mm).
5. Fabricate cleanout doors from compatible material, same thickness as breeching, bolted and gasketed.
6. Fabricate engine exhaust from ASTM A 53/A 53M, Type E (electric-resistance welded), Grade B; or ASTM A 106, Type S, Grade B, Schedule 40 **OR** Schedule 80, **as directed**, pipe; with welded joints and carbon-steel fittings and flanges.
   a. Wrought-Steel Fittings: ASME B16.9, wall thickness to match adjoining pipe.
   b. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, Class 150, including bolts, nuts, and gaskets.

I. Guying And Bracing Materials
1. Cable: Three **OR** Four, **as directed**, galvanized, stranded wires of the following thickness:
   a. Minimum Size: 1/4 inch (6 mm) in diameter.
   b. For ID Sizes 4 to 15 Inches (100 to 381 mm): 5/16 inch (8 mm).
   c. For ID Sizes 18 to 24 Inches (457 to 610 mm): 3/8 inch (9.5 mm).
   d. For ID Sizes 27 to 30 Inches (685 to 762 mm): 7/16 inch (11 mm).
   e. For ID Sizes 33 to 36 Inches (838 to 915 mm): 1/2 inch (13 mm).
   f. For ID Sizes 39 to 48 Inches (990 to 1220 mm): 9/16 inch (14.3 mm).
   g. For ID Sizes 51 to 60 Inches (1295 to 1524 mm): 5/8 inch (16 mm).
2. Pipe: Two **OR** Three, **as directed**, galvanized steel, NPS 1-1/4 (DN 32).
3. Angle Iron: Two **OR** Three, **as directed**, galvanized steel, 2 by 2 by 0.25 inch (50 by 50 by 6 mm).

1.3 EXECUTION

A. Application
1. Listed Chimney Liners: High-efficiency boiler or furnace vents in masonry chimney, dishwasher exhaust, or Type II commercial kitchen hood.
2. Listed Type B and BW Vents: Vents for certified gas appliances.
3. Listed Type L Vents: Vents for low-heat appliances.
4. Listed Special Gas Vents: Condensing gas appliances.
5. Listed Building-Heating-Appliance Chimneys: Dual-fuel boilers, oven vents, water heaters, and exhaust for engines. Fireplaces and other solid-fuel-burning appliances.
6. Listed Grease Ducts: Type I commercial kitchen grease duct.
7. Listed, Refractory-Lined Metal Breechings and Chimneys: Freestanding dual-fuel boiler vents, oven vents, water heaters, exhaust for engines, fireplaces, and other solid-fuel-burning appliances.
8. Field-Fabricated Metal Breechings and Chimneys: Dual-fuel boilers, oven vents, water heaters, exhaust for engines, fireplaces, and other solid-fuel-burning appliances.
9. Field-Fabricated Metal Breechings and Chimneys: Steel pipe for use with engine exhaust.

B. Installation Of Listed Vents And Chimneys

1. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
2. Seal between sections of positive-pressure vents and grease exhaust ducts according to manufacturer's written installation instructions, using sealants recommended by manufacturer.
3. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.
4. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.
5. Lap joints in direction of flow.
6. Connect base section to foundation using anchor lugs of size and number recommended by manufacturer.
7. Join sections with acid-resistant joint cement to provide continuous joint and smooth interior finish.
8. Erect stacks plumb to finished tolerance of no more than 1 inch (25 mm) out of plumb from top to bottom.

C. Installation Of Unlisted, Field-Fabricated Breechings And Chimneys
1. Suspend breechings and chimneys independent of their appliance connections.
2. Install, support, and restrain according to seismic requirements.
3. Align breechings at connections, with smooth internal surface and a maximum 1/8-inch (3-mm) misalignment tolerance.
4. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.
5. Lap joints in direction of flow.
6. Support breechings and chimneys from building structure with bolts, concrete inserts, steel expansion anchors, welded studs, C-clamps, or beam clamps according to manufacturer's written instructions.

D. Cleaning
1. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.
2. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.
3. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

END OF SECTION 23 51 13 13

Task	Specification	Specification Description
23 51 13 16	23 51 13 13	Breechings, Chimneys, And Stacks
23 51 13 19	23 33 13 13	Draft Control Devices
23 51 13 19	23 31 13 19	Duct Accessories
23 51 16 00	23 51 13 13	Breechings, Chimneys, And Stacks

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SECTION 23 52 13 00 - ELECTRIC BOILERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for electric boilers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes packaged, factory-fabricated and -assembled electric boilers, trim, and accessories for generating hot water or steam.

C. Submittals
1. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
2. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.
   a. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.
      1) Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
   b. Wiring Diagrams: Power, signal, and control wiring.
3. Manufacturer Seismic Qualification Certification: Submit certification that boiler, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
4. Source quality-control test reports.
5. Field quality-control test reports.
6. Operation and maintenance data.
7. Warranty: Special warranty specified in this Section.

D. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
3. NFPA Compliance: Design and fabricate boilers to comply with NFPA 70, "National Electrical Code," Article 424, Paragraphs G and H.
4. UL Compliance: Test boilers for compliance with UL 834, "Heating, Water Supply, and Power Boilers--Electric." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

E. Warranty
1. Manufacturer's standard form in which manufacturer agrees to repair or replace pressure vessels of boilers that fail in materials or workmanship within five years from date of Final Completion.

1.2 PRODUCTS

A. Manufactured Units
1. Description: Factory-fabricated, -assembled, and -tested electric boilers with trim and controls necessary to generate hot water **OR** steam, **as directed**.

2. Pressure Vessel: Carbon-steel **OR** Cast-iron, **as directed**, pressure vessel mounted on structural-steel base.
3. Nozzles: Flanges for water inlet and **OR** steam, **as directed**, outlet and heating element inserts; threaded connections for trim and controls.
4. Insulation: One layer **OR** Two layers, **as directed**, of minimum 1-inch- (25-mm-) **OR** 2-inch- (50-mm-), **as directed**, thick, glass-fiber insulation.
5. Jacket: Galvanized, **as directed**, sheet metal casing with baked-enamel **OR** powder-coated, **as directed**, protective finish and removable panels with snap-in or interlocking closures for access to pressure vessel.
6. Lifting Lugs: Welded to pressure vessel, extending above jacket.
7. Heating Elements: Copper **OR** Incoloy, **as directed**,-sheathed, replaceable electric-resistance element, rated 20 kW maximum, with maximum 50 W/sq. in. (7.7 W/sq. cm) **OR** 75 W/sq. in. (11.5 W/sq. cm), **as directed**, over heat-transfer length.
8. Mounting base to secure boiler to concrete base.
   a. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment" when mounting base is anchored to building structure.

B. Trim For Hot-Water Boilers
1. Include devices sized to comply with ANSI B31.1, "Power Piping" **OR** ANSI B31.9, Building Services Piping," **as directed**.
2. Aquastat Controllers: Operating auto-reset high limit.
3. Safety Relief Valve: ASME rated.
4. Pressure and Temperature Gage: Minimum 3-1/2-inch- (89-mm-) diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.
5. Boiler Air Vent: Automatic **OR** Manual, **as directed**.
6. Dip-tube in water outlet.
7. Drain Valve: Minimum NPS 3/4 (DN 20) hose-end ball valve sized per requirements of authorities having jurisdiction.
8. Tankless Heater: Carbon-steel header with copper-tube heat exchanger, mounted in an upper port of pressure vessel and sealed with fiber gasket.
   a. Tappings NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
   b. Tappings NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

C. Trim For Steam Boilers
1. Include devices sized to comply with ANSI B31.1, "Power Piping" **OR** ANSI B31.9, "Building Services Piping," **as directed**.
2. Pressure Controllers: Operating auto-reset high limit.
3. Safety Relief Valve:
   a. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.
   b. Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.
      1) Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
4. Pressure Gage: Minimum 3-1/2-inch (89-mm) diameter. Gage shall have normal operating pressure about 50 percent of full range.
5. Water Column: Minimum 12-inch (300-mm) glass gage with shutoff cocks.
6. Drain Valves: Minimum NPS 3/4 (DN 20) or nozzle size with hose-end connection.

7. Blowdown Valves: Factory-installed bottom and surface, slow-acting blowdown valves same size as boiler nozzle. Blowdown valves shall be combination of slow and quick acting as required by ANSI B31.1, **as directed**.
8. Stop Valves: Boiler inlets and outlets, except safety relief valves or preheater inlet and outlet, shall be equipped with stop valve in an accessible location as near as practical to boiler nozzle and same size or larger than nozzle. Valves larger than NPS 2 (DN 50) shall have rising stem.
9. Stop-Check Valves: Factory-installed, stop-check valve and stop valve at boiler outlet with free-blow drain valve factory installed between the two valves and visible when operating stop-check valve.
10. Tankless Heater: Carbon-steel header with copper-tube heat exchanger, mounted in an upper port of pressure vessel and sealed with fiber gasket.
    a. Tappings NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
    b. Tappings NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

D. Controls
1. Boiler operating controls shall include the following devices and features:
    a. Control transformer.
    b. Step controller.
    c. Recycling relay returns controller to off position after power failure.
    d. Multistage thermostat.
    e. Control circuit switch.
    f. Visual indication for each step.
    g. Supply-voltage indicator.
    h. Set-Point Adjust: Set points shall be adjustable.
    i. Operating Level Control: Factory wired and mounted to cycle feedwater pump(s) for makeup water control.
    j. Sequence of Operation for hot-water boilers: Electric, factory-fabricated and field-installed panel to control element sequence controller to maintain space temperature in response to thermostat with heat anticipator located in heated space.
    k. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control element sequence controller to reset supply-water temperature inversely with outside-air temperature. At 0 deg F (minus 17 deg C) outside-air temperature, set supply-water temperature at 200 deg F (93 deg C); at 60 deg F (15 deg C) outside-air temperature, set supply-water temperature at 140 deg F (60 deg C).
    l. Sequence of Operation for steam boilers: Electric, factory-fabricated and field-installed panel to control element sequence controller to maintain a constant steam pressure. Maintain pressure set point plus or minus 10 percent.
        1) Include automatic, alternating-operation sequence for multiple boilers to provide equal runtime for boilers.
2. Safety Controls: To maintain safe operating conditions, safety controls limit boiler operation.
    a. High Cutoff: Manual **OR** Automatic, **as directed**, reset stops boiler if operating conditions rise above set point or maximum boiler design temperature **OR** pressure, **as directed**.
    b. Low-Water Cutoff Switch: Electronic **OR** Float and electronic, **as directed**, probe shall prevent boiler operation on low water. Cutoff switch shall be manual **OR** automatic, **as directed**,-reset type.
    c. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.
3. Building Management System Interface: Factory install hardware and software to enable building management system to monitor, control, and display boiler status and alarms.
    a. Hardwired Points:
        1) Monitoring: On/off status, common trouble alarm **OR** low water level alarm, **as directed**.

2) Control: On/off operation, hot water supply temperature set-point adjustment **OR** steam pressure adjustment, **as directed**.

b. A communication interface with building management system shall enable building management system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building management system.

E. Electrical Power

1. Single-Point Field Power Connection: Factory-installed and -wired switches, transformers, and electrical devices necessary shall provide a single-point field power connection to boiler.
   a. Field power interface shall be to fused disconnect switch **OR** nonfused disconnect switch **OR** circuit breaker, **as directed**.
   b. Interlock with door to de-energize power with door open.
2. Electrical Enclosures: NEMA 250, Type 1, **as directed**, enclosure with hinged door and key-locking handle.
3. Install factory wiring outside of an enclosure in a metal, **as directed**, raceway.
4. Comply with NFPA 70.
   a. Electrical Circuits: 48 A, maximum.
5. Connectors: Mechanical lugs bolted to copper bus bars or distribution blocks with pressure connectors.
6. Fuses: NEMA FU 1, Class J or K5; 60 A, maximum.
7. Contactors: 3-pole magnetic contactors, listed for 500,000 cycles at full load.
8. Factory-wired internal control devices and heating elements.
   a. Wiring shall be numbered and color coded to match the wiring diagram.

F. Source Quality Control

1. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
2. Hydrostatic Test: Factory test assembled boiler including hydrostatic test.

1.3 EXECUTION

A. Boiler Installation

1. Install boilers level on concrete base. Concrete base is specified in Division 23 Section "Common Work Results For Hvac", and concrete materials and installation requirements are specified in Division 31..
2. Vibration Isolation: Elastomeric isolator pads **OR** mounts, **as directed**, with a minimum static deflection of 0.25 inch (6.35 mm), **as directed**. Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
3. Install electrical devices furnished with boiler but not specified to be factory mounted.

B. Connections

1. Piping installation requirements are specified in other Division 21. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to boiler to allow service and maintenance.
3. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.
4. Connect steam and condensate piping to supply-, return-, and blowdown-boiler tappings with shutoff valve and union or flange at each connection.
5. Install piping from safety relief valves to nearest floor drain.
6. Install piping from safety valves to drip-pan elbow and to nearest floor drain.
7. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

8. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
9. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Field Quality Control
1. Perform tests and inspections and prepare test reports.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Tests and Inspections:
   a. Perform installation and startup checks according to manufacturer's written instructions.
   b. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
   c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
      1) Check and adjust initial operating set points and high- and low-limit safety set points of water level and water temperature **OR** steam pressure, **as directed**.
      2) Set field-adjustable switches and circuit-breaker trip ranges as indicated.
3. Remove and replace malfunctioning units and retest as specified above.
4. Occupancy Adjustments: When requested within 12 months of date of Final Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

D. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain boilers. Video training sessions, **as directed**.

END OF SECTION 23 52 13 00

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SECTION 23 52 16 13 - CONDENSING BOILERS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for condensing boilers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes packaged, factory-fabricated and -assembled, gas-fired, pulse-combustion, fire-tube, water-tube, and water-jacketed condensing boilers, trim, and accessories for generating hot water or steam.

C. Submittals

1. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
2. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.
   a. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.
      1) Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
      2) Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and equipment mounting frames.
   b. Wiring Diagrams: Power, signal, and control wiring.
3. Manufacturer Seismic Qualification Certification: Submit certification that boiler, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment". Include the following:
4. Source quality-control test reports.
5. Field quality-control test reports.
6. Operation and maintenance data.
7. Warranty: Special warranty specified in this Section.
8. Other Informational Submittals:
   a. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

D. Quality Assurance

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
3. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
4. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."
5. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

E. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
    a. Warranty Period for Pulse-Combustion Boilers:
        1) Heat Exchanger Damaged by Thermal Shock: 10 years from date of Final Completion.
        2) Heat-Exchanger Corrosion: Prorated **OR** Nonprorated, **as directed**, for five years from date of Final Completion.
    b. Warranty Period for Fire-Tube Condensing Boilers:
        1) Leakage and Materials: 10 years from date of Final Completion.
        2) Heat Exchanger Damaged by Thermal Stress and Corrosion: Prorated **OR** Nonprorated for five years from date of Final Completion.
    c. Warranty Period for Water-Tube Condensing Boilers: 20 years from date of Final Completion.
    d. Warranty Period for Water-Jacketed Condensing Boilers:
        1) Leakage and Materials: Eight years from date of Final Completion.
        2) Heat Exchanger Damaged by Thermal Stress and Corrosion: Prorated **OR** Nonprorated, **as directed**, for five years from date of Final Completion.

1.2 PRODUCTS

A. Manufactured Units: Pulse-Combustion Condensing Boilers.
1. Description: Factory-fabricated, -assembled, and -tested, pulse-combustion condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.
2. Heat Exchanger: Type 316L, stainless-steel **OR** Carbon-steel, **as directed**, primary and secondary combustion chamber.
3. Pressure Vessel: Carbon steel with welded heads and tube connections.
4. Exhaust Decoupler: Fiberglass composite material in a corrosion-resistant steel box.
5. Burner: Natural **OR** Propane, **as directed**, gas, self-aspirating and self-venting after initial start.
6. Blower: Centrifugal fan to operate only during start of each burner sequence.
    a. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
        1) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
7. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
8. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
9. Casing:
    a. Jacket: Sheet metal, with snap-in or interlocking closures.
    b. Control Compartment Enclosure: NEMA 250, Type 1A.
    c. Finish: Baked-enamel **OR** Powder-coated, **as directed**, protective finish.
    d. Insulation: Minimum 2-inch- (50-mm-) thick, mineral-fiber insulation surrounding the heat exchanger.
    e. Draft Hood: Integral **OR** External, **as directed**.
    f. Combustion-Air Connection: Inlet duct collar and sheet metal closure over burner compartment.
    g. Mounting base to secure boiler to concrete base.
        1) Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment" when mounting base is anchored to building structure.

10. Mufflers: Carbon-steel intake muffler and stainless-steel exhaust.
11. Condensate Trap: Cast-iron body with stainless-steel internal parts.

B. Manufactured Units: Fire-Tube Condensing Boilers.
1. Description: Factory-fabricated, -assembled, and -tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.
2. Heat Exchanger: Nonferrous, corrosion-resistant combustion chamber.
3. Pressure Vessel: Carbon steel with welded heads and tube connections.
4. Burner: Natural **OR** Propane, **as directed**, gas, forced draft.
5. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.
   a. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
      1) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
6. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
7. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
8. Casing:
   a. Jacket: Sheet metal **OR** Plastic, **as directed**, with snap-in or interlocking closures.
   b. Control Compartment Enclosures: NEMA 250, Type 1A.
   c. Finish: Baked-enamel **OR** Powder-coated, **as directed**, protective finish for sheet metal jacket.
   d. Insulation: Minimum 2-inch- (50-mm-) thick, mineral-fiber **OR** polyurethane-foam, **as directed**, insulation surrounding the heat exchanger.
   e. Combustion-Air Connections: Inlet and vent duct collars.
   f. Mounting base to secure boiler.
      1) Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment" when mounting base is anchored to building structure.

C. Manufactured Units: Water-Tube Condensing Boilers.
1. Description: Factory-fabricated, -assembled, and -tested, water-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.
2. Heat Exchanger: Finned-copper primary and stainless-steel secondary heat exchangers.
3. Combustion Chamber: Stainless steel, sealed.
4. Burner: Natural **OR** Propane, **as directed**, gas, forced draft drawing from gas premixing valve.
5. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.
   a. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
      1) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
6. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
7. Ignition: Silicone carbide hot-surface ignition that includes flame safety supervision and 100 percent main-valve shutoff.
8. Integral Circulator: Cast-iron body and stainless-steel impeller sized for minimum flow required in heat exchanger.
9. Casing:
   a. Jacket: Sheet metal, with snap-in or interlocking closures.
   b. Control Compartment Enclosures: NEMA 250, Type 1A.

c. Finish: Textured epoxy.
d. Insulation: Minimum 1-inch- (25-mm-) **OR** 2-inch- (50-mm-), **as directed**, thick, mineral-fiber insulation surrounding the heat exchanger.
e. Combustion-Air Connections: Inlet and vent duct collars.
f. Mounting base to secure boiler.
   1) Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment" when mounting base is anchored to building structure.

D. Manufactured Units: Water-Jacketed Condensing Boilers.
1. Description: Factory-fabricated, -assembled, and -tested, water-jacketed condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; water supply, return, and condensate drain connections; and controls. Water heating service only.
2. Heat Exchanger: Stainless-steel primary and secondary combustion chamber.
3. Pressure Vessel: Carbon steel with welded heads and tube connections where not in contact with combustion or flue gases.
4. Burner: Natural **OR** Propane, **as directed**, gas, forced draft; swing-open front and burner observation port.
5. Blower: Centrifugal fan, forced draft. Include prepurge and postpurge of the combustion chamber.
   a. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
      1) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
6. Gas Train: Combination gas valve with manual shutoff and pressure regulator. Include 100 percent safety shutoff with electronic flame supervision.
7. Ignition: Electric-spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
8. Casing:
   a. Jacket: Sheet metal, with snap-in or interlocking closures.
   b. Control Compartment Enclosures: NEMA 250, Type 1A.
   c. Finish: Powder-coated protective finish.
   d. Insulation: Minimum 4-inch- (100-mm-) thick, mineral-fiber insulation surrounding the heat exchanger.
   e. Combustion-Air Connections: Inlet and vent duct collars.
   f. Mounting base to secure boiler.
      1) Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment" when mounting base is anchored to building structure.

E. Trim: For Hot-Water Boilers.
1. Include devices sized to comply with ANSI B31.1, "Power Piping **OR** ANSI B31.9, "Building Services Piping", **as directed**.
2. Aquastat Controllers: Operating, firing rate, **as directed**, and high limit.
3. Safety Relief Valve: ASME rated.
4. Pressure and Temperature Gage: Minimum 3-1/2-inch- (89-mm-) diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.
5. Boiler Air Vent: Automatic **OR** Manual, **as directed**.
6. Drain Valve: Minimum NPS 3/4 (DN 20) hose-end gate valve.

7. Circulation Pump: Non-overloading, in-line pump with split-capacitor motor having thermal-overload protection and lubricated bearings; designed to operate at specified boiler pressures and temperatures.

F. Trim: For Steam Boilers.
   1. Include devices sized to comply with ANSI B31.1, "Power Piping **OR** ANSI B31.9, "Building Services Piping", **as directed**.
   2. Pressure Controllers: Operating, firing rate, **as directed**, and high limit.
   3. Safety Relief Valve:
      a. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.
      b. Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.
         1) Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
   4. Pressure Gage: Minimum 3-1/2-inch (89-mm) diameter. Gage shall have normal operating pressure about 50 percent of full range.
   5. Water Column: Minimum 12-inch (300-mm) glass gage with shutoff cocks.
   6. Drain Valves: Minimum NPS 3/4 (DN 20) or nozzle size with hose-end connection.
   7. Blowdown Valves: Factory-installed bottom and surface, slow-acting blowdown valves same size as boiler nozzle. Blowdown valves shall be combination of slow and quick acting as required by ANSI B31.1, **as directed**.
   8. Stop Valves: Boiler inlets and outlets, except safety relief valves or preheater inlet and outlet, shall be equipped with stop valve in an accessible location as near as practical to boiler nozzle and same size or larger than nozzle. Valves larger than NPS 2 (DN 50) shall have rising stem.
   9. Stop-Check Valves: Factory-installed, stop-check valve and stop valve at boiler outlet with free-blow drain valve factory installed between the two valves and visible when operating stop-check valve.

G. Controls
   1. Refer to Division 23 Section "Instrumentation And Control For Hvac".
      OR
      Boiler operating controls shall include the following devices and features:
      a. Operating Pressure Control for Steam Boilers: Factory wired and mounted to cycle burner.
      b. Low-Water Cutoff and Pump Control for Steam Boilers: Cycle feedwater pump(s) for makeup water control.
      c. Sequence of Operation for Hot-Water Boilers: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain space temperature in response to thermostat with heat anticipator located in heated space.
         OR
         Sequence of Operation for Hot-Water Boilers: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 0 deg F (minus 17 deg C) outside-air temperature, set supply-water temperature at 200 deg F (93 deg C); at 60 deg F (15 deg C) outside-air temperature, set supply-water temperature at 140 deg F (60 deg C).
      d. Sequence of Operation for Steam Boilers: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain a constant steam pressure. Maintain pressure set point plus or minus 10 percent.
         1) Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.
   2. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
      a. High Cutoff: Manual **OR** Automatic, **as directed**, reset stops burner if operating conditions rise above maximum boiler design temperature for hot-water boiler or pressure for steam boiler.

b. Low-Water Cutoff Switch: Electronic for hot-water boilers or Float and electronic for steam boilers probe shall prevent burner operation on low water. Cutoff switch shall be manual **OR** automatic, **as directed**,-reset type.

c. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.

d. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

3. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
   a. Hardwired Points:
      1) Monitoring: On/off status, common trouble alarm **OR** low water level alarm, **as directed**.
      2) Control: On/off operation, hot water supply temperature set-point adjustment **OR** steam pressure adjustment, **as directed**.
   b. A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

H. Electrical Power

1. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 22.

   OR

   Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
   a. House in NEMA 250, Type 1 enclosure.
   b. Wiring shall be numbered and color-coded to match wiring diagram.
   c. Install factory wiring outside of an enclosure in a metal raceway.
   d. Field power interface shall be to wire lugs **OR** fused disconnect switch **OR** nonfused disconnect switch **OR** circuit breaker, **as directed**.
   e. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker, **as directed**.
   f. Provide each motor with overcurrent protection.

I. Venting Kits

1. Kit: Complete system, ASTM A 959, Type 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.
2. Combustion-Air Intake: Complete system, stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

J. Source Quality Control

1. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
2. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
3. Allow the Owner access to source quality-control testing of boilers. Notify the Owner 14 days in advance of testing.

1.3 EXECUTION

A. Boiler Installation

1. Install boilers level on concrete base. Concrete base is specified in Division 23 Section "Common Work Results For Hvac", and concrete materials and installation requirements are specified in Division 31..
2. Vibration Isolation for Equipment Supported on Slabs-On -Grade: Elastomeric isolation pads **OR** mounts, **as directed**, with a minimum static deflection of 0.25 inch (6.35 mm). Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
3. Install gas-fired boilers according to NFPA 54.
4. Assemble and install boiler trim.
5. Install electrical devices furnished with boiler but not specified to be factory mounted.
6. Install control wiring to field-mounted electrical devices.

B. Connections
1. Piping installation requirements are specified in other Division 21. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to boiler to allow service and maintenance.
3. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
4. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Division 23 Section "Common Work Results For Hvac".
5. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
6. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.
7. Connect steam and condensate piping to supply-, return-, and blowdown-boiler tappings with shutoff valve and union or flange at each connection.
8. Install piping from safety relief valves to nearest floor drain.
9. Install piping from safety valves to drip-pan elbow and to nearest floor drain.
10. Boiler Venting:
    a. Install flue venting kit and combustion-air intake.
    b. Connect full size to boiler connections. Comply with requirements in Division 23 Section "Breechings, Chimneys, And Stacks".
11. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
12. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Field Quality Control
1. Perform tests and inspections and prepare test reports.
    a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Tests and Inspections:
    a. Perform installation and startup checks according to manufacturer's written instructions.
    b. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
    c. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
    d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
        1) Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature **OR** steam pressure, **as directed**.
        2) Set field-adjustable switches and circuit-breaker trip ranges as indicated.
3. Remove and replace malfunctioning units and retest as specified above.

4. Occupancy Adjustments: When requested within 12 months of date of Final Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.
5. Performance Tests, **as directed**:
   a. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
   b. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
   c. Perform field performance tests to determine capacity and efficiency of boilers.
      1) Test for full capacity.
      2) Test for boiler efficiency at low fire 20, 40, 60, 80, 100, 80, 60, 40, and 20 percent of full capacity. Determine efficiency at each test point.
   d. Repeat tests until results comply with requirements indicated.
   e. Provide analysis equipment required to determine performance.
   f. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
   g. Notify the Owner in advance of test dates.
   h. Document test results in a report and submit to the Owner.

D. Demonstration
   1. Train the Owner's maintenance personnel to adjust, operate, and maintain boilers.

END OF SECTION 23 52 16 13

SECTION 23 52 33 13 - WATER-TUBE BOILERS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for water-tube boilers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes packaged, factory-fabricated and -assembled, gas-fired, finned water-tube boilers, trim, and accessories for generating hot water.
2. This Section includes packaged, water-tube boilers, trim, and accessories for generating hot water or steam with the following configurations, burners, and outputs:
    a. Factory and Field assembled.
    b. Atmospheric gas, Forced-draft gas, Oil, and Combination gas and oil burner.

C. Submittals

1. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
2. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.
    a. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.
        1) Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
        2) Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and equipment mounting frames.
    b. Wiring Diagrams: Power, signal, and control wiring.
3. Manufacturer Seismic Qualification Certification: Submit certification that boiler, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment". Include the following:
4. Source quality-control test reports.
5. Field quality-control test reports.
6. Operation and maintenance data.
7. Warranty: Special warranty specified in this Section.
8. Other Informational Submittals:
    a. ASME "A" Stamp Certification and Report: Submit "A" stamp certificate of authorization as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.
    b. Startup service reports.

D. Quality Assurance

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
3. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
4. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."

5. I=B=R Compliance: Boilers shall be tested and rated according to HI's "Rating Procedure for Heating Boilers" and "Testing Standard for Commercial Boilers," with I=B=R emblem on a nameplate affixed to boiler.
6. UL Compliance: Test boilers for compliance with UL 726, "Oil-Fired Boiler Assemblies" **OR** UL 726, "Oil-Fired Boiler Assemblies" and UL 795, "Commercial-Industrial Gas Heating Equipment" **OR** UL 795, "Commercial-Industrial Gas Heating Equipment", **as directed**. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

E. Warranty
1. Special Warranty for Finned Water-Tube Boilers: Manufacturer's standard form in which manufacturer agrees to repair or replace heat exchangers damaged by thermal shock and vent dampers of boilers that fail in materials or workmanship within specified warranty period.
    a. Warranty Period for Heat Exchangers: 20 years from date of Final Completion.
    b. Warranty Period for Vent Dampers: Five years from date of Final Completion.
2. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace drums, tubes, headers, cabinets, atmospheric gas burners, and pressure vessels of boilers that fail in materials or workmanship within specified warranty period.
    a. Warranty Period for Drums, Tubes, Headers, Cabinets, and Atmospheric Gas Burner: Five years from date of Final Completion, pro rata.
    b. Warranty Period for Pressure Vessel: 20 years from date of Final Completion, for thermal shock.

1.2 PRODUCTS

A. Finned Water-Tube Boilers
1. Description: Factory-fabricated, -assembled, and -tested boiler with tubes sealed into headers pressure tight, and set on a steel base; including insulated jacket, flue-gas vent, combustion-air intake connections, water supply and return connections, and controls.
2. Heat Exchanger:
    a. Finned copper **OR** steel **OR** copper-nickel, **as directed**, tubing with stainless-steel baffles.
    b. Bronze **OR** Cast-iron **OR** Steel, **as directed**, headers.
    c. Single-pass **OR** Two-pass, **as directed**, horizontal **OR** vertical **OR** coil, **as directed**, configuration.
    d. Tubes shall be sealed in header with silicone O-ring gaskets **OR** by welding **OR** by mechanically rolling tubes in header, **as directed**.
3. Combustion Chamber Internal Insulation: Interlocking panels of refractory insulation, high-temperature cements, mineral fiber, and ceramic refractory tile for service temperatures to 2000 deg F (1100 deg C).
4. Casing:
    a. Jacket: Sheet metal **OR** Stainless steel, **as directed**, with snap-in or interlocking closures.
    b. Control Compartment Enclosure: NEMA 250, Type 1A.
    c. Finish: Baked enamel over primer **OR** Baked enamel over galvanizing **OR** Powder coated, **as directed**.
    d. Insulation: Minimum 1-inch- (25-mm-) **OR** 2-inch- (50-mm-), **as directed**, thick, mineral-fiber insulation surrounding the heat exchanger.
    e. Draft Hood: Integral **OR** External, **as directed**.
    f. Combustion-Air Connection: Inlet duct collar and sheet metal closure over burner compartment.
    g. Mounting base to secure boiler with accessory for mounting on combustible surface, **as directed**.
        1) Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration And

Seismic Controls For Hvac Piping And Equipment" when mounting base is anchored to building structure.

5. Burner:
   a. Burner Tubes and Orifices: Stainless steel, for natural **OR** propane, **as directed**, gas. Mount burner tubes in a slide-out burner drawer for ease of inspection, **as directed**.
      1) Sealed Combustion: Factory-mounted centrifugal fan to draw outside air into boiler and discharge into burner compartment.
      2) Direct Vent: Factory-mounted centrifugal fan to draw flue gas out of boiler and discharge into boiler vent.
   b. Vertical Burner:
      1) High-temperature stainless steel **OR** Ceramic, **as directed**, to fire in a 360-degree pattern.
      2) Burner shall have a viewing port for observation of burner operation and a factory-mounted centrifugal fan to supply room **OR** outside, **as directed**, air through a replaceable 99 percent efficient (1-micrometer particles) filter, **as directed**, to boiler burner.
      3) Fan shall be controlled to prepurge and postpurge the combustion chamber before firing.
   c. Gas Train for Commercial Boilers: Control devices and full-modulation **OR** on-off **OR** low-high-low **OR** proportional, **as directed**, control sequence shall comply with requirements in AGA **OR** ASME CSD-1 **OR** FMG **OR** IRI **OR** UL, **as directed**. In addition to these requirements, include shutoff cock, pressure regulator, and control valve.
   d. Gas Train for Residential Boilers: Combination gas valve with manual shutoff, pressure regulator, and pilot adjustment.
   e. Pilot: Standing **OR** Intermittent-electric-spark **OR** Hot-surface, **as directed**, pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.
   f. Flue-Gas Recirculation Fans: Centrifugal fans on burner assembly to recirculate flue gas to decrease oxides of nitrogen emissions to less than 30 ppm.

   g. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
6. Trim:
   a. Aquastat Controllers: Operating, firing rate, **as directed**, and high limit.
   b. Safety Relief Valve: ASME rated.
   c. Pressure and Temperature Gage: Minimum 3-1/2-inch- (89-mm-) diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.
   d. Boiler Air Vent: Automatic **OR** Manual, **as directed**.
   e. Drain Valve: Minimum NPS 3/4 (DN 20) hose-end gate valve.
   f. Circulation Pump: Non-overloading, in-line pump with split-capacitor motor having thermal-overload protection and lubricated bearings; designed to operate at specified boiler pressures and temperatures.
7. Controls:
   a. Refer to Division 23 Section "Instrumentation And Control For Hvac".
      OR
      Boiler operating controls shall include the following devices and features:
      1) Control transformer.
      2) Motorized Vent Damper: Interlocked with burner to open before burner starts. If damper fails to open, stop burner operation.
      3) Set-Point Adjust: Set points shall be adjustable.
      4) Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain space temperature in response to thermostat with heat anticipator located in heated space.
         OR

Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 0 deg F (minus 17 deg C) outside-air temperature, set supply-water temperature at 200 deg F (93 deg C); at 60 deg F (15 deg C) outside-air temperature, set supply-water temperature at 140 deg F (60 deg C).

5) Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

b. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
   1) High Cutoff: Manual **OR** Automatic, **as directed**, reset stops burner if operating conditions rise above maximum boiler design temperature.
   2) Water Flow Switch: Automatic-reset paddle-switch shall prevent burner operation on low water flow.
   3) Blocked Vent Safety Switch: Manual-reset switch factory mounted on draft diverter.
   4) Rollout Safety Switch: Factory mounted on boiler combustion chamber.
   5) Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

c. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
   1) Monitoring: On/off status, common trouble alarm **OR** low water level alarm, **as directed**.
   2) Control: On/off operation, hot water supply temperature set-point adjustment, **as directed**.
   3) A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

B. Steel **OR** Flexible, **as directed**, Water-Tube Boilers

1. Description: Factory-fabricated and assembled **OR** Field-assembled, **as directed**, water-tube boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket, flue-gas vent, supply and return connections, and controls.
2. Heat-Exchanger Design: Straight steel tubes rolled into steel headers.
   a. Accessible head plates at both ends.
   b. Handholes or couplings, **as directed**, in headers for water-side inspections.
   c. Accessible drain and blowdown tappings, both high and low, for surface and mud removal.
   d. Lifting lugs on top of boiler.
   e. Built-in air separator.
3. Heat-Exchanger Design: Bent steel tubes swaged **OR** welded, **as directed**, into steel headers with membrane waterwall design, **as directed**.
   a. Limit tube configurations to two **OR** four, **as directed**.
   b. Accessible drain and blowdown tappings, both high and low, for surface and mud removal.
   c. Accessible inspection ports in drum, mud legs, and tube manifolds.
   d. Lifting lugs on top of boiler.
   e. Built-in air separator.
4. Combustion Chamber: Equipped with minimum 2-1/2-inch (64-mm) **OR** 3-inch (75-mm) **OR** 4-inch (100-mm), **as directed**, 2700 deg F (1482 deg C) poured refractory on floor and minimum 2-inch (50-mm) **OR** 3-1/2-inch (89-mm), **as directed**, lap-jointed cast refractory with fiber-blanket joint seals on side walls. Combustion chamber shall have flame observation ports in front and back **OR** back, **as directed**.
5. Casing:
   a. Insulation: Minimum 2-inch (50-mm) thick, lightweight refractory; 1-inch (25-mm) thick insulating board; galvanized-steel membrane, and 2-inch (50-mm) thick, mineral-fiber insulation surrounding the heat exchanger and combustion chamber **OR** 2-inch (50-mm)

thick, mineral-fiber insulation surrounding the heat exchanger and combustion chamber, **as directed**.

b. Top Flue Connection: Constructed of aluminized steel **OR** stainless steel, **as directed**.

c. Jacket: Mirror-finish stainless steel, with screw-fastened closures.
OR
Jacket: Sheet metal **OR** Galvanized sheet metal, **as directed**, with screw-fastened closures and baked-enamel **OR** powder-coated, **as directed**, protective finish.

d. Mounting base to secure boiler to concrete base.
   1) Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment" when mounting base is anchored to building structure.

e. Control Compartment Enclosure: NEMA 250, Type 1A.

6. Draft Diverter **OR** Barometric Damper, **as directed**: Galvanized-steel assembly with flue-gas thermometer.

7. Burner - Atmospheric Gas Burners:
   a. Burner and Orifices: Stainless steel **OR** Cast iron, **as directed**, for natural **OR** propane, **as directed**, gas.
   b. Gas Train for Commercial Boilers: Control devices and full-modulation **OR** on-off **OR** low-high-low, **as directed**, control sequence shall comply with requirements in AGA **OR** ASME CSD-1 **OR** FMG **OR** IRI **OR** UL, **as directed**.
   c. Gas Train for Residential Boilers: Combination gas valve with manual shutoff, pressure regulator, and pilot adjustment.
   d. Pilot: Standing **OR** Intermittent-electric-spark, **as directed**, pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

8. Burner - Forced-Draft Gas Burners:
   a. Burner: Welded construction with multivane, stainless-steel, flame-retention diffuser for natural **OR** propane, **as directed**, gas. Mount burner on hinged access door to permit access to combustion chamber, **as directed**.
   b. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.
      1) Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
         a) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   c. Gas Train: Control devices and modulating **OR** on-off **OR** low-high-low, **as directed**, control sequence shall comply with requirements in AGA **OR** ASME CSD-1 **OR** FMG **OR** IRI **OR** UL, **as directed**.
   d. Pilot: Intermittent **OR** Interrupted, **as directed**,-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.
   e. Flue-Gas Recirculation: Burner connections shall be equipped for recirculating flue gas.
      1) Maximum Oxides of Nitrogen Emissions: 20 **OR** 30, **as directed**, ppm.

9. Burner - Oil Burners:
   a. Burner: Welded construction with multivane, stainless-steel, flame-retention diffuser for fuel oil. Mount burner on hinged access door to permit access to combustion chamber, **as directed**.
   b. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.
      1) Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
         a) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   c. Oil Supply: Control devices and modulating **OR** on-off **OR** low-high-low, **as directed**, control sequence shall comply with requirements in ASME CSD-1 **OR** FMG **OR** IRI **OR** UL, **as directed**.

1) Oil Pump: Two-stage, gear-type oil pump integral to and directly driven by blower, **as directed**, shall be capable of producing 300-psig (2070-kPa) discharge pressure and 15-inch Hg (50.7-kPa) vacuum.
2) Oil Piping Specialties:
a) Suction-line, manual, gate valve.
b) Removable-mesh oil strainer.
c) 0- to 30-inch Hg (0- to 101.3-kPa) vacuum; 0- to 30-psig (0- to 207-kPa) vacuum-pressure gage.
d) 0- to 300-psig (0- to 2070-kPa) oil-nozzle pressure gage.
e) Nozzle-line, solenoid-safety-shutoff oil valve.

d. Pilot: Intermittent **OR** Interrupted, **as directed**,-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff solenoid using cadmium sulfide **OR** UV scanner, **as directed**, flame-safety control.

e. Flue-Gas Recirculation: Burner connections shall be equipped for recirculating flue gas.
1) Maximum Oxides of Nitrogen Emissions: 30 ppm.

10. Burner - Combination Gas and Oil Burners:
a. Burner: Welded construction with multivane, stainless-steel, flame-retention diffuser for fuel oil and natural **OR** propane, **as directed** gas. Mount burner on hinged access door to permit access to combustion chamber, **as directed**.
b. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.
1) Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
a) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
c. Oil Supply: Control devices and modulating **OR** on-off **OR** low-high-low, **as directed**, control sequence shall comply with requirements in ASME CSD-1 **OR** FMG **OR** IRI, **as directed**.
1) Oil Pump: Two-stage, gear-type oil pump integral to and directly driven by blower, **as directed**, shall be capable of producing 300-psig (2070-kPa) discharge pressure and 15-inch Hg (50.7-kPa) vacuum.
2) Oil Piping Specialties:
a) Suction-line, manual, gate valve.
b) Removable-mesh oil strainer.
c) 0- to 30-inch Hg (0- to 101.3-kPa) vacuum; 0- to 30-psig (0- to 207-kPa) vacuum-pressure gage.
d) 0- to 300-psig (0- to 2070-kPa) oil-nozzle pressure gage.
e) Nozzle-line, solenoid-safety-shutoff oil valve.
d. Gas Train: Control devices and modulating **OR** on-off **OR** low-high-low, **as directed**, control sequence shall comply with requirements in ASME CSD-1 **OR** FMG **OR** IRI **OR** UL, **as directed**.
e. Gas Pilot: Intermittent **OR** Interrupted, **as directed**,-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.
f. Oil Pilot: Intermittent **OR** Interrupted, **as directed**,-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff solenoid with cadmium sulfide **OR** UV scanner, **as directed**, flame-safety control.
g. Flue-Gas Recirculation: Burner connections shall be equipped for recirculating flue gas.
1) Maximum Oxides of Nitrogen Emissions: 20 **OR** 30, **as directed**, ppm.

11. Trim for Hot-Water Boilers:
a. Include devices sized to comply with ANSI B31.1, "Power Piping **OR** ANSI B31.9, "Building Services Piping", **as directed**.
b. Aquastat Controllers: Operating, firing rate, **as directed**, and high limit.
c. Safety Relief Valve: ASME rated.

d. Pressure and Temperature Gage: Minimum 3-1/2-inch- (89-mm-) diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.
e. Boiler Air Vent: Automatic **OR** Manual, **as directed**.
f. Drain Valve: Minimum NPS 3/4 (DN 20) hose-end gate valve.
g. Tankless Heater: Carbon-steel **OR** Bronze, **as directed**, header with copper-tube heat exchanger, mounted in a port of upper drum and sealed with fiber gasket.
    1) Tappings NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
    2) Tappings NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

12. Trim for Steam Boilers:
    a. Include devices sized to comply with ANSI B31.1, "Power Piping **OR** ANSI B31.9, "Building Services Piping", **as directed**.
    b. Pressure Controllers: Operating, firing rate, **as directed**, and high limit.
    c. Safety Relief Valve:
        1) Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.
        2) Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.
            a) Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
    d. Pressure Gage: Minimum 3-1/2-inch (89-mm) diameter. Gage shall have normal operating pressure about 50 percent of full range.
    e. Water Column: Minimum 12-inch (300-mm) glass gage with shutoff cocks.
    f. Drain Valves: Minimum NPS 3/4 (DN 20) or nozzle size with hose-end connection.
    g. Blowdown Valves: Factory-installed bottom and surface, slow-acting blowdown valves same size as boiler nozzle. Blowdown valves shall be combination of slow and quick acting as required by ANSI B31.1, **as directed**.
    h. Stop Valves: Boiler inlets and outlets, except safety relief valves or preheater inlet and outlet, shall be equipped with stop valve in an accessible location as near as practical to boiler nozzle and same size or larger than nozzle. Valves larger than NPS 2 (DN 50) shall have rising stem.
    i. Stop-Check Valves: Factory-installed, stop-check valve and stop valve at boiler outlet with free-blow drain valve factory installed between the two valves and visible when operating stop-check valve.
    j. Tankless Heater: Carbon-steel header with copper-tube heat exchanger, mounted in a port of upper manifold and sealed with fiber gasket.
        1) Tappings NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
        2) Tappings NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

13. Controls:
    a. Refer to Division 23 Section "Instrumentation And Control For Hvac".
       OR
       Boiler operating controls shall include the following devices and features:
        1) Control transformer.
        2) Set-Point Adjust: Set points shall be adjustable.
        3) Operating Pressure Control for Steam Boilers: Factory wired and mounted to cycle burner.
        4) Low-Water Cutoff and Pump Control for Steam Boilers: Cycle feedwater pump(s) for makeup water control.

5) Sequence of Operation for Hot-Water Boilers: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain space temperature in response to thermostat with heat anticipator located in heated space.
OR
Sequence of Operation for Hot-Water Boilers: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 0 deg F (minus 17 deg C) outside-air temperature, set supply-water temperature at 200 deg F (93 deg C); at 60 deg F (15 deg C) outside-air temperature, set supply-water temperature at 140 deg F (60 deg C).
6) Sequence of Operation for Steam Boilers: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain a constant steam pressure. Maintain pressure set point plus or minus 10 percent.
7) Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

b. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
1) High Cutoff: Manual **OR** Automatic, **as directed**, reset stops burner if operating conditions rise above maximum boiler design temperature for hot-water boiler or design pressure for steam boiler.
2) Low-Water Cutoff Switch: Electronic (for hot-water boilers) or Float and electronic (for steam boilers) probe shall prevent burner operation on low water. Cutoff switch shall be manual **OR** automatic, **as directed**,-reset type.
3) Blocked Vent Safety Switch (Atmospheric Boilers): Manual-reset switch factory mounted on draft diverter.
4) Rollout Safety Switch (Atmospheric Boilers): Factory mounted on boiler combustion chamber.
5) Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

c. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
1) Monitoring: On/off status, common trouble alarm **OR** low water level alarm, **as directed**.
2) Control: On/off operation, hot water supply temperature set-point adjustment **OR** steam pressure adjustment, **as directed**.
3) A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

C. Electrical Power
1. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 22.
OR
Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
a. House in NEMA 250, Type 1 enclosure.
b. Wiring shall be numbered and color-coded to match wiring diagram.
c. Install factory wiring outside of an enclosure in a metal, **as directed**, raceway.
d. Field power interface shall be to wire lugs **OR** fused disconnect switch **OR** nonfused disconnect switch **OR** circuit breaker, **as directed**.
e. Provide branch power circuit to each motor and to controls with disconnect switch or circuit breaker, **as directed**.

f. Provide each motor with overcurrent protection.

D. Venting Kits

1. Vent Damper (for Finned Water-Tube Boilers): Motorized, UL listed for use on atmospheric burner boiler equipped with draft hood; motor to open and close damper; stainless-steel vent coupling and damper blade; keyed wiring harness connector plug; and dual-position switches to permit burner operation.
2. Kit: Complete system, ASTM A 959, Type 29-4C, **as directed**, stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap, and sealant.
3. Combustion-Air Intake: Stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

E. Source Quality Control

1. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
2. Burner and Hydrostatic Test (for Factory-Assembled Boilers): Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
3. Allow the Owner access to source quality-control testing of boilers. Notify the Owner 14 days in advance of testing.

1.3 EXECUTION

A. Boiler Installation

1. Install boilers level on concrete base. Concrete base is specified in Division 23 Section "Common Work Results For Hvac", and concrete materials and installation requirements are specified in Division 31.
2. Vibration Isolation: Elastomeric isolator pads **OR** mounts, **as directed**, with a minimum static deflection of 0.25 inch (6.35 mm). Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
3. Install gas-fired boilers according to NFPA 54.
4. Install oil-fired boilers according to NFPA 31.
5. Assemble boiler tubes in sequence and seal each tube joint.
6. Assemble and install boiler trim.
7. Install electrical devices furnished with boiler but not specified to be factory mounted.
8. Install control wiring to field-mounted electrical devices.

B. Connections

1. Piping installation requirements are specified in other Division 21. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to boiler to allow service and maintenance.
3. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
4. Connect oil piping full size to burner inlet with shutoff valve and union.
5. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.
6. Connect steam and condensate piping to supply-, return-, and blowdown-boiler tappings with shutoff valve and union or flange at each connection.
7. Install piping from safety relief valves to nearest floor drain (for hot-water boilers).
8. Install piping from safety valves to drip-pan elbow and to nearest floor drain (for steam boilers).
9. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
10. Boiler Flue Venting (for Finned Water-Tube Boilers):
    a. Install venting kit and combustion-air intake.

b. Connect full size to boiler connections. Comply with requirements in Division 23 Section "Breechings, Chimneys, And Stacks".

11. Connect breeching to full size of boiler outlet. Comply with requirements in Division 23 Section "Breechings, Chimneys, And Stacks" for venting materials.
12. Install flue-gas recirculation duct from vent to burner. Comply with requirements in Division 23 Section "Breechings, Chimneys, And Stacks" for recirculation duct materials.
13. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
14. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Field Quality Control

1. Perform tests and inspections and prepare test reports.
    a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Tests and Inspections:
    a. Perform installation and startup checks according to manufacturer's written instructions.
    b. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
    c. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
    d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
        1) Burner Test (for Field-Assembled Boilers): Adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency.
        2) Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature **OR** steam pressure, **as directed**.
        3) Set field-adjustable switches and circuit-breaker trip ranges as indicated.
3. Remove and replace malfunctioning units and retest as specified above.
4. Occupancy Adjustments: When requested within 12 months of date of Final Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.
5. Performance Tests, as directed:
    a. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
    b. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment in order to comply.
    c. Perform field performance tests to determine the capacity and efficiency of the boilers.
        1) For dual-fuel boilers, perform tests for each fuel.
        2) Test for full capacity.
        3) Test for boiler efficiency at low fire 20, 40, 60, 80, 100, 80, 60, 40 and 20, **as directed**, percent of full capacity. Determine efficiency at each test point.
    d. Repeat tests until results comply with requirements indicated.
    e. Provide analysis equipment required to determine performance.
    f. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
    g. Notify the Owner in advance of test dates.
    h. Document test results in a report and submit to the Owner.

D. Demonstration

1. Train the Owner's maintenance personnel to adjust, operate, and maintain boilers.

END OF SECTION 23 52 33 13

Task	Specification	Specification Description
23 52 33 16	23 52 33 13	Water-Tube Boilers

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SECTION 23 52 36 00 - FIRE-TUBE BOILERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for fire-tube boilers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes packaged, factory-fabricated and -assembled boilers, trim, and accessories for generating hot water **OR** steam, **as directed**, with the following configurations and burners:
   a. Horizontal, fire-tube, Vertical, fire-tube, and Fire-box boiler.
   b. Gas, Oil, and Combination gas and oil burner.

C. Submittals
1. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
2. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.
   a. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.
      1) Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
      2) Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and equipment mounting frames.
   b. Wiring Diagrams: Power, signal, and control wiring.
3. Manufacturer Seismic Qualification Certification: Submit certification that boiler, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment". Include the following:
4. Source quality-control test reports.
5. Field quality-control test reports.
6. Operation and maintenance data.
7. Warranty: Special warranty specified in this Section.
8. Other Informational Submittals:
   a. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.
   b. Startup service reports.

D. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
3. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
4. UL Compliance: Test Boilers for compliance with UL 726, "Oil-Fired Boiler Assemblies" **OR** UL 726, "Oil-Fired Boiler Assemblies" and UL 795, "Commercial-Industrial Gas Heating Equipment" **OR** UL 795, "Commercial-Industrial Gas Heating Equipment", **as directed**. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

E. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace front- and rear-door refractories and heat exchangers of boilers that fail in materials or workmanship within specified warranty period.
a. Horizontal, Fire-Tube and Fire-Box Boilers: Refractory in front and rear doors, 10 years from date of startup by factory-authorized personnel.
b. Vertical, Fire-Tube Boilers and Heat Exchanger: Five years from date of Final Completion, if following water-treatment program recommended by manufacturer.

1.2 PRODUCTS

A. Manufactured Units - Horizontal, Fire-Tube Boilers
1. Description: Factory-fabricated, -assembled, and -tested, horizontal, fire-tube boilers with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket, flue-gas vent, water supply and return connections, and controls.
2. Pressure Vessel Design: Straight, steel tubes rolled **OR** welded, **as directed**, into steel headers. Three **OR** Four, **as directed**, passes with dry-back **OR** wet-back, **as directed**, design. Minimum heat-exchanger surface of 5 sq. ft./bhp (2.1 sq. m/10 kW). Include the following accessories:
a. Handholes for water-side inspections.
b. Lifting lugs on top of boiler.
c. Minimum NPS 1 (DN 25) hose-end drain valves at shell low point.
d. For hot-water boilers only:
1) Tappings or flanges for supply- and return-water piping.
2) Built-in air separator.
e. For steam boilers only:
1) Accessible drain and blowdown tappings, both high and low, for surface and mud removal.
2) Tappings for steam supply, makeup, level controls, and chemical treatment.
3. Front and Rear Doors:
a. Bolted **OR** Hinged **OR** Davited, **as directed**, sealed with heat-resistant gaskets and fastened with lugs and cap screws.
b. Designed so tube sheets and flues are fully accessible for inspection or cleaning when doors are open.
c. Include observation ports in doors at both ends of boiler for inspection of flame conditions.
d. Door refractory **OR** insulation, **as directed**, shall be accessible for inspection and maintenance.
4. Casing:
a. Insulation: Minimum 2-inch- (50-mm-) thick, mineral-fiber insulation surrounding the boiler shell.
b. Flue Connection: Flange at top of boiler.
c. Jacket: Galvanized sheet **OR** Sheet, **as directed**, metal, with screw-fastened closures and baked-enamel **OR** powder-coated, **as directed**, protective finish.
d. Mounting base to secure boiler to concrete base.
1) Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment" when mounting base is anchored to building structure.
e. Control Compartment Enclosure: NEMA 250, Type 1 **OR** 4 **OR** 4X **OR** 12, **as directed**.
5. Barometric Damper: Galvanized-steel assembly with flue-gas thermometer having a minimum 3-1/2-inch- (89-mm-) diameter dial.

B. Manufactured Units - Vertical, Fire-Tube Boilers

1. Description: Factory-fabricated, -assembled, and -tested, vertical, fire-tube boilers with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket, flue-gas vent, water supply and return connections, and controls.
2. Pressure Vessel Design: Straight, steel pipe welded in a concentric pattern to separate flue-gas and heating media to form two **OR** four, **as directed**, passes with welded fins to improve heat transfer in secondary flue-gas passages. Include the following accessories:
   a. Handholes for water-side inspections.
   b. Lifting lugs on top of boiler.
   c. Minimum NPS 1 (DN 25) hose-end drain valves at water passage low point.
   d. For hot-water boilers only:
      1) Tappings or flanges for supply- and return-water piping.
      2) Built-in air separator.
   e. For steam boilers only:
      1) Accessible drain and blowdown tappings, both high and low, for surface and mud removal.
      2) Tappings for steam supply, makeup, level controls, and chemical treatment.
3. Combustion Chamber: Equipped with flame retainer to lengthen flame-residence time.
4. Casing:
   a. Insulation: Minimum 4-inch- (100-mm-) thick, mineral-fiber insulation surrounding the heat exchanger and combustion chamber.
   b. Flue Connection: Top connection, constructed of aluminized **OR** stainless, **as directed**, steel.
   c. Jacket: Mirror-finish stainless steel with screw-fastened closures.
      OR
      Jacket: Galvanized sheet **OR** Sheet, **as directed**, metal, with screw-fastened closures and baked-enamel **OR** powder-coated, **as directed**, protective finish.
   d. Mounting base to secure boiler to concrete base.
      1) Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 22 Section "Identification For Plumbing Piping And Equipment" when mounting base is anchored to building structure.
   e. Control Compartment Enclosure: NEMA 250, Type 1 **OR** 4 **OR** 4X **OR** 12, **as directed**.
5. Barometric Damper: Galvanized-steel assembly with flue-gas thermometer having a minimum 3-1/2-inch- (89-mm-) diameter dial.

C. Manufactured Units - Fire-Box Boilers
1. Description: Factory-fabricated, -assembled, and -tested, fire-box boilers with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket, flue-gas vent, water supply and return connections, and controls.
2. Pressure Vessel Design: Straight, steel tubes rolled **OR** welded, **as directed**, into steel headers. Three passes with wet-back design. Minimum heat-exchanger surface of 5 sq. ft./bhp (2.1 sq. m/10 kW). Include the following features and accessories:
   a. Tube Size and Thickness: Minimum NPS 2 (DN 50), minimum 0.105 inch (2.667 mm) thick.
   b. Brass washout plugs.
   c. Steel turbulators.
   d. Lifting lugs on top of boiler.
   e. Minimum NPS 1 (DN 25) hose-end drain valves at shell low point.
   f. For hot-water boilers only:
      1) Tappings or flanges for supply- and return-water piping.
      2) Built-in air separator.
   g. For steam boilers only:
      1) Accessible drain and blowdown tappings, both high and low, for surface and mud removal.
      2) Tappings for steam supply, makeup, level controls, and chemical treatment.

3. Combustion Chamber: Welded steel, waterwall and -floor design **OR** water-leg design with refractory insulation poured in the floor, **as directed**. Flame observation port.
4. Casing:
    a. Insulation: Minimum 2-inch- (50-mm-) thick, foil-backed, **as directed**, mineral-fiber insulation surrounding the boiler shell.
    b. Insulated removable smoke boxes and reversing chamber cover.
    c. Flue Connection: Steel top **OR** rear, **as directed**.
    d. Jacket: Sheet metal, with screw-fastened closures and baked-enamel **OR** powder-coated, **as directed**, protective finish.
    e. Control Compartment Enclosure: NEMA 250, Type 1 **OR** 1A **OR** 4 **OR** 4X **OR** 12, **as directed**.
    f. Mounting base to secure boiler to concrete base.
        1) Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment" when mounting base is anchored to building structure.
5. Barometric Damper: Galvanized-steel assembly with flue-gas thermometer having a minimum 3-1/2-inch- (89-mm-) diameter dial.

D. Burner For Forced-Draft Gas Burners
1. Burner: Welded construction with multivane, stainless-steel, flame-retention diffuser for natural **OR** propane, **as directed**, gas. Mount burner on hinged access door to permit access to combustion chamber, **as directed**.
2. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.
    a. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
        1) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
3. Gas Train: Control devices and modulating **OR** on-off **OR** low-high-low, **as directed**, control sequence shall comply with requirements in ASME CSD-1 **OR** FMG **OR** IRI **OR** UL, **as directed**.
4. Pilot: Intermittent **OR** Interrupted, **as directed**,-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.
5. Flue-Gas Recirculation: Burner connections shall be equipped for recirculating flue gas.
    a. Maximum Oxides of Nitrogen Emissions: 20 **OR** 30, **as directed**, ppm.

E. Burner For Oil Burners
1. Burner: Welded construction with multivane, stainless-steel, flame-retention diffuser for fuel oil. Mount burner on hinged access door to permit access to combustion chamber, **as directed**.
2. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.
    a. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
        1) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
3. Oil Supply: Control devices and modulating **OR** on-off **OR** low-high-low, **as directed**, control sequence shall comply with requirements in ASME CSD-1 **OR** FMG **OR** IRI **OR** UL, **as directed**.
    a. Oil Pump: Two-stage, gear-type oil pump integral to and directly driven by blower, **as directed**, shall be capable of producing 300-psig (2070-kPa) discharge pressure and 15-inch Hg (50.7-kPa) vacuum.
    b. Oil Piping Specialties:
        1) Suction-line, manual, gate valve.
        2) Removable-mesh oil strainer.
        3) 0- to 30-inch Hg (0- to 101.3-kPa) vacuum; 0- to 30-psig (0- to 207-kPa) vacuum-pressure gage.

4) 0- to 300-psig (0- to 2070-kPa) oil-nozzle pressure gage.
5) Nozzle-line, solenoid-safety-shutoff oil valve.

4. Pilot: Intermittent **OR** Interrupted, **as directed**,-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff solenoid with cadmium sulfide **OR** UV scanner, **as directed**, flame-safety control.
5. Flue-Gas Recirculation: Burner connections shall be equipped for recirculating flue gas.
   a. Maximum Oxides of Nitrogen Emissions: 30 ppm.

F. Burner For Combination Gas And Oil Burners
1. Burner: Welded construction with multivane, stainless-steel, flame-retention diffuser for fuel oil and natural **OR** propane, **as directed**, gas. Mount burner on hinged access door to permit access to combustion chamber, **as directed**.
2. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.
   a. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
      1) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
3. Oil Supply: Control devices and modulating **OR** on-off **OR** low-high-low, **as directed**, control sequence shall comply with requirements in ASME CSD-1 **OR** FMG **OR** IRI **OR** UL, **as directed**.
   a. Oil Pump: Two-stage, gear-type oil pump integral to and directly driven by blower, **as directed**, shall be capable of producing 300-psig (2070-kPa) discharge pressure and 15-inch Hg (50.7-kPa) vacuum.
   b. Oil Piping Specialties:
      1) Suction-line, manual, gate valve.
      2) Removable-mesh oil strainer.
      3) 0- to 30-inch Hg (0- to 101.3-kPa) vacuum; 0- to 30-psig (0- to 207-kPa) vacuum-pressure gage.
      4) 0- to 300-psig (0- to 2070-kPa) oil-nozzle pressure gage.
      5) Nozzle-line, solenoid-safety-shutoff oil valve.
4. Gas Train: Control devices and modulating **OR** on-off **OR** low-high-low, **as directed**, control sequence shall comply with requirements in ASME CSD-1 **OR** FMG **OR** IRI **OR** UL, **as directed**.
5. Gas Pilot: Intermittent **OR** Interrupted, **as directed**,-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.
6. Oil Pilot: Intermittent **OR** Interrupted, **as directed**,-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff solenoid with cadmium sulfide **OR** UV scanner, **as directed**, flame-safety control.
7. Flue-Gas Recirculation: Burner connections shall be equipped for recirculating flue gas.
   a. Maximum Oxides of Nitrogen Emissions: 20 **OR** 30, **as directed**, ppm.

G. Trim For Hot-Water Boilers
1. Include devices sized to comply with ANSI B31.1, "Power Piping **OR** ANSI B31.9, "Building Services Piping", **as directed**.
2. Aquastat Controllers: Operating, firing rate, **as directed**, and high limit.
3. Safety Relief Valve: ASME rated.
4. Pressure and Temperature Gage: Minimum 3-1/2-inch- (89-mm-) diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.
5. Boiler Air Vent: Automatic **OR** Manual, **as directed**.
6. Drain Valve: Minimum NPS 3/4 (DN 20) hose-end gate valve.
7. Tankless Heater: Carbon-steel **OR** Bronze, **as directed**, header with copper-tube heat exchanger, mounted in a port of upper drum and sealed with fiber gasket.
   a. Tappings NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.

b. Tappings NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

H. Trim For Steam Boilers
1. Include devices sized to comply with ANSI B31.1, "Power Piping **OR** ANSI B31.9, "Building Services Piping", **as directed**.
2. Pressure Controllers: Operating, firing rate, **as directed**, and high limit.
3. Safety Relief Valve:
a. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.
b. Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.
1) Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
4. Pressure Gage: Minimum 3-1/2-inch (89-mm) diameter. Gage shall have normal operating pressure about 50 percent of full range.
5. Water Column: Minimum 12-inch (300-mm) glass gage with shutoff cocks.
6. Drain Valves: Minimum NPS 3/4 (DN 20) or nozzle size with hose-end connection.
7. Blowdown Valves: Factory-installed bottom and surface, slow-acting blowdown valves same size as boiler nozzle. Blowdown valves shall be combination of slow and quick acting as required by ANSI B31.1, **as directed.**
8. Stop Valves: Boiler inlets and outlets, except safety relief valves or preheater inlet and outlet, shall be equipped with stop valve in an accessible location as near as practical to boiler nozzle and same size or larger than nozzle. Valves larger than NPS 2 (DN 50) shall have rising stem.
9. Stop-Check Valves: Factory-installed, stop-check valve and stop valve for field installation at boiler outlet with free-blow drain valve for field installation between the two valves and visible when operating stop-check valve.
10. Tankless Heater: Carbon-steel header with copper-tube heat exchanger, mounted in a port of upper manifold and sealed with fiber gasket.
a. Tappings NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
b. Tappings NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

I. Controls
1. Refer to Division 23 Section "Instrumentation And Control For Hvac".
OR
Boiler operating controls shall include the following devices and features:
a. Control transformer.
b. Set-Point Adjust: Set points shall be adjustable.
c. Operating Pressure Control for steam boilers: Factory wired and mounted to cycle burner.
d. Low-Water Cutoff and Pump Control for steam boilers: Cycle feedwater pump(s) **OR** Operate feedwater pump(s) continuously and modulate valve, **as directed**, for makeup water control.
e. Sequence Of Operation For Hot-Water Boilers: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain space temperature in response to thermostat with heat anticipator located in heated space.
OR
Sequence Of Operation For Hot-Water Boilers: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 0 deg F (minus 17 deg C) outside-air temperature, set supply-water temperature at 200 deg F (93 deg C); at 60 deg F (15 deg C) outside-air temperature, set supply-water temperature at 140 deg F (60 deg C).

f. Sequence Of Operation For Steam Boilers: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain a constant steam pressure. Maintain pressure set point plus or minus 10 percent.
   1) Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

2. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
   a. High Cutoff: Manual **OR** Automatic, **as directed**, reset stops burner if operating conditions rise above maximum boiler design temperature for hot-water boiler **OR** design pressure for steam boiler, **as directed**.
   b. Low-Water Cutoff Switch: Electronic for hot-water boilers **OR** Float and electronic for steam boilers, **as directed**, probe shall prevent burner operation on low water. Cutoff switch shall be manual **OR** automatic, **as directed**,-reset type.
   c. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

3. Building Automation System Interface: Factory-install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
   a. Hardwired Points:
      1) Monitoring: On/off status, common trouble alarm **OR** low water level alarm, **as directed**.
      2) Control: On/off operation, hot water supply temperature set-point adjustment **OR** steam pressure adjustment, **as directed**.
   b. A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

J. Electrical Power
1. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 22..
   OR
   Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
   a. House in NEMA 250, Type 1 **OR** 4 **OR** 4X **OR** 12, **as directed**, enclosure.
   b. Wiring shall be numbered and color-coded to match wiring diagram.
   c. Install wiring outside of an enclosure in a metal, **as directed**, raceway.
   d. Field power interface shall be to wire lugs **OR** fused disconnect switch **OR** nonfused disconnect switch **OR** circuit breaker, **as directed**.
   e. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker, **as directed**.
   f. Provide each motor with overcurrent protection.

K. Source Quality Control
1. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
2. Burner and Hydrostatic Test for factory-assembled boilers: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
3. Allow the Owner access to source quality-control testing of boilers. Notify the Owner 14 days in advance of testing.

1.3 EXECUTION

A. Boiler Installation
1. Install boilers level on concrete base. Concrete base is specified in Division 23 Section "Common Work Results For Hvac", and concrete materials and installation requirements are specified in Division 31.
2. Vibration Isolation: Elastomeric isolator pads **OR** mounts, **as directed**, with a minimum static deflection of 0.25 inch (6.35 mm). Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
3. Install gas-fired boilers according to NFPA 54.
4. Install oil-fired boilers according to NFPA 31.
5. Assemble and install boiler trim.
6. Install electrical devices furnished with boiler but not specified to be factory mounted.
7. Install control wiring to field-mounted electrical devices.

B. Connections
1. Piping installation requirements are specified in other Division 21. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to boiler to allow service and maintenance.
3. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
4. Connect oil piping full size to burner inlet with shutoff valve and union.
5. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.
6. Connect steam and condensate piping to supply-, return-, and blowdown-boiler tappings with shutoff valve and union or flange at each connection.
7. Install piping from safety relief valves to nearest floor drain, for hot-water boilers.
8. Install piping from safety valves to drip-pan elbow and to nearest floor drain, for steam boilers.
9. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
10. Connect breeching full size to boiler outlet. Comply with requirements in Division 23 Section "Breechings, Chimneys, And Stacks" for venting materials.
11. Install flue-gas recirculation duct from vent to burner. Comply with requirements in Division 23 Section "Breechings, Chimneys, And Stacks" for recirculation duct materials.
12. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
13. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Field Quality Control
1. Perform tests and inspections and prepare test reports.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Tests and Inspections:
   a. Perform installation and startup checks according to manufacturer's written instructions.
   b. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
   c. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
   d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
      1) Burner Test for field-assembled boilers: Adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency.

2) Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature **OR** steam pressure, **as directed**.
3) Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3. Remove and replace malfunctioning units and retest as specified above.
4. Occupancy Adjustments: When requested within 12 months of date of Final Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.
5. Performance Tests, **as directed**:
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
   b. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment in order to comply.
   c. Perform field performance tests to determine the capacity and efficiency of boilers.
      1) For dual-fuel boilers, perform tests for each fuel.
      2) Test for full capacity.
      3) Test for boiler efficiency at low fire, 20, 40, 60, 80, 100, 80, 60, 40 and 20, **as directed**, percent of full capacity. Determine efficiency at each test point.
   d. Repeat tests until results comply with requirements indicated.
   e. Provide analysis equipment required to determine performance.
   f. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
   g. Notify the Owner in advance of test dates.
   h. Document test results in a report and submit to the Owner.

D. Demonstration
   1. Train the Owner's maintenance personnel to adjust, operate, and maintain boilers.

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Task	Specification	Specification Description
23 52 39 13	23 52 36 00	Fire-Tube Boilers

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SECTION 23 53 16 00 - FEEDWATER EQUIPMENT

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for feedwater equipment. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Feedwater pumps and receivers.
      b. Vacuum-type feedwater pumps and receivers.

C. Definition
   1. NPSH: Net-positive suction head.

D. Submittals
   1. Product Data: For each type of product indicated. Include rated capacity, temperature and NPSH required, pump performance curves with selection points clearly indicated, and furnished specialties and accessories.
   2. Shop Drawings: Include plans, elevations, sections, details, dimensions, weights, loadings, required clearances, method of field assembly, and attachments to other work.
      a. Wiring Diagrams: Power, signal, and control wiring.
   3. Manufacturer Seismic Qualification Certification: Submit certification that feedwater equipment, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
   4. Field quality-control test reports.
   5. Operation and Maintenance Data.

E. Quality Assurance
   1. Regulatory Requirements: Fabricate and test unit according to ASME PTC 12.1, "Closed Feedwater Heaters."
   2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   3. ASME Compliance: ASME B31.1, "Power Piping," for systems more than 15 psig (104 kPa); ASME B31.9, "Building Services Piping," for systems equal to or less than 15 psig (104 kPa). Safety valves and pressure vessels shall bear the appropriate ASME label.

F. Delivery, Storage, And Handling
   1. Preparation for Shipping: Clean flanges and exposed-metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
   2. Store units in dry location.
   3. Retain protective flange covers and machined-surface protective coatings during storage.
   4. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
   5. Comply with manufacturer's written rigging instructions.

1.2 PRODUCTS

A. Feedwater Units

1. Description: Factory-assembled and -tested unit consisting of a receiver, simplex **OR** duplex, **as directed**, feedwater pumps, controls, and the following features and accessories:
   a. Liquid-filled industrial **OR** Bimetal dial-type, **as directed**, thermometer graduated in Fahrenheit **OR** Celsius **OR** both Fahrenheit and Celsius, **as directed**.
   b. Level gage glass, reflex flat type, **as directed**, with stops at top and bottom.
   c. Lifting eyes.
   d. Companion flanges.
   e. Pump, suction and discharge isolation valve, inlet strainer, discharge check valve, and liquid-filled pressure gage.
   f. Makeup Water Assembly: Float operated with integral valve **OR** Electric level controller and valve, **as directed**; with inlet strainer and three-valve bypass.
   g. Feedwater Heater: Sparge tube, thermostat, and control valve.
   h. Factory-Installed Pipe, NPS 2-1/2 (DN 65) and Smaller: ASTM A 53/A 53M, Type S (seamless), Grade B; or ASTM A 106, Type S, Grade B, Schedule 40 **OR** 80, **as directed**; with threaded joints and fittings.
      1) Cast-Iron Threaded Fittings: ASME B16.4; Class 125 **OR** 250, **as directed**.
      2) Malleable-Iron Threaded Fittings: ASME B16.3, Class 150 **OR** 300, **as directed**.
      3) Forged-Steel Fittings: ASME B16.11, Class 3000.
      4) Malleable-Iron Unions: ASME B16.39; Class 150 **OR** 300, **as directed**.
      5) Forged-Steel Unions: MSS SP-83, Class 3000.
   i. Factory-Installed Pipe, NPS 3 (DN 80) and Larger: ASTM A 53/A 53M, Type E (electric-resistance welded), Grade B; or ASTM A 106, Type S, Grade B, Schedule 40 **OR** 80, **as directed**; with welded joints and carbon-steel fittings and flanges.
      1) Wrought-Steel Fittings: ASME B16.9, wall thickness to match adjoining pipe.
      2) Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, Class 150 **OR** 300, **as directed**, including bolts, nuts, and gaskets.
2. Receiver:
   a. Material: Close-grain cast iron **OR** Welded carbon steel **OR** Welded carbon steel galvanized after fabrication **OR** Stainless steel, **as directed**.
   b. Additional corrosion protection:
      1) 0.07-inch (1.8-mm) **OR** 0.13-inch (3.3-mm) **OR** 0.19-inch (4.8-mm), **as directed,** thickness allowance.
      2) Electrolytic corrosion-inhibitor anode.
   c. Finish: Primer **OR** Primer under enamel topcoat **OR** Primer under epoxy topcoat, **as directed**.
   d. Factory-Applied Insulation and Jacket: Minimum thickness of 2 inches (50 mm) for mineral-fiber pipe and tank insulation. Cover insulation with painted steel **OR** stucco-embossed aluminum **OR** stainless-steel, **as directed**, jacket.
   e. Mounting Arrangement: Recessed below floor **OR** Floor mounted, **as directed**.
   f. Mounting Frame: Structural-steel stand to support receiver and pumps. Fabricate stand with bracing adequate for seismic forces according to authorities having jurisdiction and to allow anchoring mounting frame to floor, **as directed**.
3. Vertical Feedwater Pump: Flange-mounted, close-coupled, single-stage, **OR** multistage, **as directed**, radially split-case-design centrifugal pump; rated for 175-psig (1205-kPa) minimum working pressure and a continuous water temperature of at least 225 deg F (107 deg C); with the following features:
   a. Impeller: Bronze **OR** Stainless steel, **as directed**.
   b. Seals: Mechanical.
   c. Motor: Open dripproof **OR** Totally enclosed **OR** Totally enclosed fan-cooled, **as directed**, enclosure. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
4. Horizontal Feedwater Pump: Base-mounted, single-stage, **OR** multistage, **as directed**, radially split-case-design centrifugal pump; rated for 175-psig (1205-kPa) minimum working pressure and a continuous water temperature of at least 225 deg F (107 deg C); with the following features:
   a. Impeller: Bronze **OR** Stainless steel, **as directed**.

b. Coupling: Close **OR** Flexible, **as directed**.
c. Seals: Mechanical.
d. Motor: Open dripproof **OR** Totally enclosed **OR** Totally enclosed fan-cooled, **as directed**, enclosure. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".

5. Control panel shall be unit mounted and factory wired and include the following:
a. NEMA 250, Type 1 **OR** 4 **OR** 4X **OR** 12, **as directed**, enclosure.
b. Single-point field power interface to fused disconnect switch **OR** nonfused disconnect switch **OR** circuit breaker, **as directed**.
1) Branch power circuit to each motor and to controls with a disconnect switch or circuit breaker, **as directed**.
c. NEMA-rated motor controller for each motor, and include a hand-off-auto switch and overcurrent protection.
1) Alternating controls for duplex units with intermittent operation as indicated by control sequence.
d. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
e. Wiring outside of an enclosure in a metal, **as directed**, raceway. Make connections to motor with liquidtight conduit.
f. Removable control mounting plate.
g. Visual indication of status and alarm with momentary test push button, **as directed**.
h. Audible alarm and silence switch.
i. Visual indication of elapsed run time, graduated in hours.
j. Fused control-circuit transformer.
k. Microprocessor-based controller.

6. Feedwater Simplex-Pump Control Sequence:
a. Boiler water-level controller starts and stops pump to maintain boiler water-level set point.
b. Visual indication of pump on and off, **as directed**, status.
c. Visual and audible, **as directed**, alarm indication of pump failure.

7. Feedwater Duplex-Pump Control Sequence (for duplex-pump units with operating and standby pump):
a. Boiler water-level controller starts and stops lead pump to maintain boiler water-level set point.
b. Lead and lag pumps alternate after each start **OR** to equalize run time, **as directed**.
c. Lead pump failure, lag pump automatically starts if lead pump cannot maintain set point **OR** is started manually, **as directed**.
d. Visual indication of pump on and off, **as directed**, status.
e. Visual indication of pump lead/lag status.
f. Visual and audible, **as directed**, alarm indication of pump failure.

8. Feedwater Duplex-Pump Control Sequence (for duplex-pump units with continuous pump operation and modulating control valve):
a. Pump runs continuously while boiler operates. Electric interlock with boiler control starts lead pump when boiler starts.
b. Boiler water-level controller modulates feedwater control valve to maintain boiler water-level set point. Valve closes when boiler is off.
c. Lead and lag pumps alternate after each start **OR** to equalize run time, **as directed**.
d. Lead pump failure automatically starts lag pump.
OR
Feedwater pressure controller starts and stops lag pump to maintain feedwater pressure set point.
e. Visual indication of pump on and off, **as directed**, status.
f. Visual indication of pump lead/lag status.
g. Visual and audible, **as directed**, alarm indication of pump failure.

9. Receiver Makeup Water Control Sequence:
a. Electric level controller operates electric control valve to maintain receiver water-level set point.
OR

Mechanical float operates integral valve to maintain water-level set point.
b. Visual and audible, **as directed**, alarm indication of low and high, **as directed**, receiver-water level.
10. Building Management System Interface: Factory install hardware to enable building management system to monitor and display points.
a. Hardwired Monitoring Points: On/off status for each pump, failure alarm for each pump, receiver low-water-level alarm, receiver high-water-level alarm, feedwater temperature, **as directed**.

B. Feedwater Unit With Vacuum Producer
1. Description: Receiver mounted, consisting of multijet vacuum producer, centrifugal pump and motor assembly mounted on separation chamber, and automatic pressure and water temperature controls. Include the following accessories:
a. Liquid-filled industrial **OR** Bimetal dial-type, **as directed**, thermometer graduated in Fahrenheit **OR** Celsius **OR** both Fahrenheit and Celsius, **as directed**.
b. Vacuum Gage: Dial-type register in inches of mercury (kPa).
c. Level Gage Glass: Stops top and bottom.
d. Air-suction check valve.
e. Lifting eyes.
f. Companion flanges.
g. Low-water cutoff switch.
h. Cooling-Water Control: Aquastat, inlet strainer, and electric valve.
i. Air vent.
j. Overflow drain from vacuum-producer receiver.
k. Factory-Installed Pipe, NPS 2-1/2 (DN 65) and Smaller: ASTM A 53/A 53M, Type S (seamless), Grade B; or ASTM A 106, Type S, Grade B, Schedule 40 **OR** 80, **as directed**; with threaded joints and fittings.
1) Cast-Iron Threaded Fittings: ASME B16.4; Class 125 **OR** 250, **as directed**.
2) Malleable-Iron Threaded Fittings: ASME B16.3, Class 150 **OR** 300, **as directed**.
3) Forged-Steel Fittings: ASME B16.11, Class 3000.
4) Malleable-Iron Unions: ASME B16.39; Class 150 **OR** 300, **as directed**.
5) Forged-Steel Unions: MSS SP-83, Class 3000.
l. Factory-Installed Pipe, NPS 3 (DN 80) and Larger: ASTM A 53/A 53M, Type E (electric-resistance welded), Grade B; or ASTM A 106, Type S, Grade B, Schedule 40 **OR** 80, **as directed**; with welded joints and carbon-steel fittings and flanges.
1) Wrought-Steel Fittings: ASME B16.9, wall thickness to match adjoining pipe.
2) Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, Class 150 **OR** 300, **as directed**, including bolts, nuts, and gaskets.
2. Vacuum-Producer Reservoir and Vacuum Receiver:
a. Material: Close-grain cast iron **OR** Welded carbon steel **OR** Welded carbon steel galvanized after fabrication **OR** Stainless steel, **as directed**.
b. Additional corrosion protection:
1) 0.07-inch (1.8-mm) **OR** 0.13-inch (3.3-mm) **OR** 0.19-inch (4.8-mm), **as directed,** thickness allowance.
2) Electrolytic corrosion-inhibitor anode.
c. Finish: Primer **OR** Primer under enamel topcoat **OR** Primer under epoxy topcoat, **as directed**.
d. Factory-Applied Insulation and Jacket: Minimum thickness of 2 inches (50 mm) for mineral-fiber pipe and tank insulation. Cover insulation with painted steel **OR** stucco-embossed aluminum **OR** stainless-steel, **as directed**, jacket.
e. Mounting Arrangement: Recessed below floor **OR** Floor mounted, **as directed**.
f. Mounting Frame: Structural-steel stand to support receiver and pumps. Fabricate stand with bracing adequate for seismic forces according to authorities having jurisdiction and to allow anchoring mounting frame to floor, **as directed**.

3. Vertical Vacuum-Producer Pump: Flange-mounted, close-coupled, single-stage, radially split-case-design centrifugal pump; rated for 175-psig (1205-kPa) minimum working pressure and a continuous water temperature of at least 225 deg F (107 deg C); with the following features:
   a. Impeller: Bronze.
   b. Shaft: Stainless steel.
   c. Seals: Mechanical.
   d. Motor: Open dripproof **OR** Totally enclosed **OR** Totally enclosed fan-cooled, **as directed**, enclosure. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
4. Horizontal Vacuum-Producer Pump: Base-mounted, single-stage, radially split-case-design centrifugal pump; rated for 175-psig (1205-kPa) minimum working pressure and a continuous water temperature of at least 225 deg F (107 deg C); with the following features:
   a. Impeller: Bronze.
   b. Shaft: Stainless steel.
   c. Coupling: Close **OR** Flexible, **as directed**.
   d. Seals: Mechanical.
   e. Motor: Open dripproof **OR** Totally enclosed **OR** Totally enclosed fan-cooled, **as directed**, enclosure. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
5. Vertical Feedwater Pump: Flange-mounted, close-coupled, single-stage, **OR** multistage, **as directed**, radially split-case-design centrifugal pump; rated for 175-psig (1205-kPa) minimum working pressure and a continuous water temperature of at least 225 deg F (107 deg C); with the following features:
   a. Impeller: Bronze **OR** Stainless steel, **as directed**.
   b. Seals: Mechanical.
   c. Motor: Open dripproof **OR** Totally enclosed **OR** Totally enclosed fan-cooled, **as directed**, enclosure. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
6. Horizontal Feedwater Pump: Base-mounted, single-stage, **OR** multistage, **as directed**, radially split-case-design centrifugal pump; rated for 175-psig (1205-kPa) minimum working pressure and a continuous water temperature of at least 225 deg F (107 deg C); with the following features:
   a. Impeller: Bronze **OR** Stainless steel, **as directed**.
   b. Coupling: Close **OR** Flexible, **as directed**.
   c. Seals: Mechanical.
   d. Motor: Open dripproof **OR** Totally enclosed **OR** Totally enclosed fan-cooled, **as directed**, enclosure. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
7. Control panel shall be unit mounted and factory wired and include the following:
   a. Vacuum Switches for Simplex Vacuum-Producer Pumps: Include pressure adjustment, and test push button. Factory set to operate pump between 3 and 6 inches of mercury (10.1 and 20.2 kPa).
      OR
      Vacuum Switches for Duplex Vacuum-Producer Pumps: Include pressure adjustment, and test push button. Factory set so one pump operates for 3 to 5 inches of mercury (10.1 to 16.9 kPa) and both pumps operate for 4 to 6 inches of mercury (13.5 to 20.2 kPa).
   b. NEMA 250, Type 1 **OR** 4 **OR** 4X **OR** 12, **as directed**, enclosure.
   c. Single-point field power interface to fused disconnect switch **OR** nonfused disconnect switch **OR** circuit breaker, **as directed**.
      1) Branch power circuit to each motor and to controls with a disconnect switch or circuit breaker, **as directed**.
   d. NEMA-rated motor controller for each motor and include a hand-off-auto switch and overcurrent protection.
      1) Alternating control for units with intermittent operation as indicated by control sequence.
   e. Terminal blocks with numbered and color-coded wiring to match wiring diagram.

f. Wiring outside of an enclosure in a metal, **as directed**, raceway. Make connections to motor with liquidtight conduit.
g. Removable control mounting plate.
h. Visual indication of status and alarm with momentary test push button, **as directed**.
i. Audible alarm and silence switch.
j. Visual indication of elapsed run time, graduated in hours.
k. Fused control-circuit transformer.

8. Vacuum-Producer Control Sequence:
   a. Cycle pumps to maintain vacuum-pressure set point.
   b. Visual indication of pump on and off, **as directed**, status.
   c. Visual and audible, **as directed**, alarm indication of pump failure.
9. Feedwater Simplex-Pump Control Sequence:
   a. Boiler water-level controller starts and stops pump to maintain boiler water-level set point.
   b. Visual indication of pump on and off, **as directed**, status.
   c. Visual and audible, **as directed**, alarm indication of pump failure.
10. Feedwater Duplex-Pump Control Sequence (for duplex-pump units with operating and standby pump):
   a. Boiler water-level controller starts and stops lead pump to maintain boiler water-level set point.
   b. Lead and lag pumps alternate after each start **OR** to equalize run time, **as directed**.
   c. Lead pump failure, lag pump automatically starts if lead pump cannot maintain set point **OR** is started manually, **as directed**.
   d. Visual indication of pump on and off, **as directed**, status.
   e. Visual indication of pump lead/lag status.
   f. Visual and audible, **as directed**, alarm indication of pump failure.
11. Feedwater Duplex-Pump Control Sequence (for duplex-pump units with continuous pump operation and modulating control valve):
   a. Pump runs continuously while boiler operates. Electric interlock with boiler control starts lead pump when boiler starts.
   b. Boiler water-level controller modulates feedwater control valve to maintain boiler water-level set point. Valve closes when boiler is off.
   c. Lead and lag pumps alternate after each start **OR** to equalize run time, **as directed**.
   d. Lead pump failure automatically starts lag pump.
      OR
      Feedwater pressure controller starts and stops lag pump to maintain feedwater pressure set point.
   e. Visual indication of pump on and off, **as directed**, status.
   f. Visual indication of pump lead/lag status.
   g. Visual and audible, **as directed**, alarm indication of pump failure.
12. Makeup Water Control Sequence:
   a. Electric level controller operates electric control valve to maintain water temperature set point.
   b. Visual and audible, **as directed**, alarm indication of low and high, **as directed**, water level.
13. Building Management System Interface: Factory install hardware to enable building management system to monitor and display points.
   a. Hardwired Monitoring Points: On/off status for each pump, failure alarm for each pump, receiver low-water-level alarm, receiver high-water-level alarm, feedwater temperature, **as directed**.

1.3 EXECUTION

A. Installation

1. Install feedwater unit level on concrete base. Concrete base is specified in Division 23 Section "Common Work Results For Hvac", and concrete materials and installation requirements are specified in Division 31.
2. Vibration Isolation: Elastomeric isolator pads **OR** mounts, **as directed**, with a minimum static deflection of 0.25 inch (6.35 mm). Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
3. Install unit to permit access for maintenance.
4. Support piping independent of pumps.
5. Install base-mounted pumps on concrete bases with grouted base frames.
6. Install parts and accessories shipped loose.
7. Piping installation requirements are specified in other Division 21. Drawings indicate general arrangement of piping, fittings, and specialties.
8. Install piping adjacent to machine to allow service and maintenance.
9. Connect makeup water piping and cooling-water piping with reduced-pressure backflow preventers.
10. Install overflow drain piping to nearest floor drain.
11. Install vents and extend to outdoors; terminate with elbow turned down and an insect screen.
12. Adjust boiler water-level controls to properly stage unit.
13. Set field-adjustable, makeup water and cooling-water controls.
14. Clean equipment internally; remove coatings applied for protection during shipping and storage, foreign material, and oily residue according to manufacturer's written instructions.
15. Clean strainers.

B. Field Quality Control
1. Perform tests and inspections and prepare test reports.
    a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Tests and Inspections:
    a. Inspect field-assembled components, equipment installation, and piping and electrical connections for compliance with manufacturer's written instructions.
    b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
    c. Check bearing lubrication.
    d. Verify proper motor rotation.
    e. Start up service.
    f. Report results in writing.
3. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 23 53 16 00

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SECTION 23 53 16 00a - DEAERATORS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for deaerators. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes packaged, factory-assembled deaerators.

C. Definitions

1. Feedwater Pump: Pump that moves feedwater from the deaerator to the boiler.
2. Transfer Pump: Pump that moves feedwater from the surge tank to the deaerator.
3. NPSH: Net-positive suction head.

D. Submittals

1. Product Data: For each type of product indicated. Include rated makeup water, feedwater, and steam flow rates; working pressure; tank capacities; storage capacity in minutes; temperature and NPSH required; pump performance curves with selection points clearly indicated; furnished specialties; and accessories.
2. Shop Drawings: For deaerators, signed and sealed by a qualified professional engineer; include plans, elevations, sections, details, dimensions, weights, loadings, required clearances, and attachments to other work.
   a. For installed products indicated to comply with design loads, include structural analysis data.
   b. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing deaerator bases.
   c. Wiring Diagrams: Power, signal, and control wiring.
3. Manufacturer Seismic Qualification Certification: Submit certification that deaerators, accessories, and components will withstand seismic forces as indicated in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
4. Field quality-control test reports.
5. Operation and Maintenance Data: For deaerators to include in emergency, operation, and maintenance manuals.

E. Quality Assurance

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. ASME Compliance: ASME B31.1, "Power Piping," for systems more than 15 psig (104 kPa); ASME B31.9, "Building Services Piping," for systems equal to or less than 15 psig (104 kPa). Safety valves and pressure vessels shall bear the appropriate ASME label.

F. Delivery, Storage, And Handling

1. Protect flanges, pipe openings, nozzles, bearings, and couplings from damage during shipping and storage.
2. Comply with manufacturer's written rigging instructions.
3. Deliver deaerators as factory-assembled units with protective crating and covering.

1.2 PRODUCTS

A. Manufactured Units
1. Horizontal **OR** Vertical, **as directed**, packed-column **OR** spray **OR** tray, **as directed**, single-compartment deaerator, and a separate packaged surge tank with transfer and feedwater pumps and controls to supply feedwater to deaerator, **as directed**.
OR
Horizontal **OR** Vertical, **as directed**, packed-column **OR** spray **OR** tray, **as directed**, two-compartment deaerator. One compartment for deaeration and one for surge volume, each with its own transfer and feedwater pumps and controls.
OR
Horizontal **OR** Vertical, **as directed**, packed-column **OR** spray **OR** tray, **as directed**, single-compartment deaerator and separate surge tank, both mounted on same factory-fabricated stand with necessary transfer and feedwater pumps and controls.
2. Material for Wetted Components: Components in contact with water that has not been deaerated shall be made of Type 304 **OR** 316, **as directed**, stainless steel.
3. Adjustable Spray Valves: Type 316 stainless steel. Arrange spray valves for counterflow of steam and condensate and so corrosive gases being vented do not contact deaerator's head or shell.
4. Vent Condenser: Stainless steel, with automatic and manual vent valves.
5. Deaerator and Storage Tank:
    a. Material: Welded carbon steel **OR** Welded carbon steel galvanized after fabrication **OR** Stainless steel, **as directed**.
    b. Additional Corrosion Protection:
        1) 0.07-inch (1.8-mm) **OR** 0.13-inch (3.3-mm) **OR** 0.19-inch (4.8-mm), **as directed**, thickness allowance.
        2) Electrolytic corrosion-inhibitor anode.
    c. Access: Manhole in deaerator and storage tank for access to internal components for inspection and service.
    d. Factory-Applied Insulation and Jacket: Minimum thickness of 2 inches (50 mm), **as directed,** for mineral-fiber pipe and tank insulation. Cover insulation with painted steel **OR** stucco-embossed aluminum **OR** stainless-steel, **as directed**, jacket.
    e. Factory-Installed Pipe, NPS 2-1/2 (DN 65) and Smaller: ASTM A 53/A 53M, Type S (seamless), Grade B; or ASTM A 106, Type S, Grade B, Schedule 40 **OR** 80, **as directed**; with threaded joints and fittings.
        1) Cast-Iron Threaded Fittings: ASME B16.4, Class 125 **OR** 250, **as directed**.
        2) Malleable-Iron Threaded Fittings: ASME B16.3, Class 150 **OR** 300, **as directed**.
        3) Forged-Steel Fittings: ASME B16.11, Class 3000.
        4) Malleable-Iron Unions: ASME B16.39, Class 150 **OR** 300, **as directed**.
        5) Forged-Steel Unions: MSS SP-83, Class 3000.
    f. Factory-Installed Pipe, NPS 3 (DN 80) and Larger: ASTM A 53/A 53M, Type E (electric-resistance welded), Grade B; or ASTM A 106, Type S, Grade B, Schedule 40 **OR** 80, **as directed**; with welded joints and carbon-steel fittings and flanges.
        1) Wrought-Steel Fittings: ASME B16.9, wall thickness to match adjoining pipe.
        2) Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, Class 150 **OR** 300, **as directed**, including bolts, nuts, and gaskets.
6. Accessories:
    a. Lifting eyes.
    b. Companion flanges.
    c. Pump suction piping with vortex breaker, isolation valve, strainer, and flexible connector.
    d. Pump discharge piping with check valve, isolation valve, and liquid-filled pressure gage graduated in pounds force per square inch **OR** kilopascals **OR** both pounds force per square inch and kilopascals, **as directed**.
    e. Pump-discharge bypass relief valve **OR** orifice plate **OR** relief valve with orifice plate, **as directed**.

f. Makeup Water Assembly:
   1) Factory-mounted modulating valve with mechanical level control, external float cage, and stainless-steel float.
      OR
      Factory **OR** Field, **as directed**,-mounted, electric, pilot-operated, solenoid **OR** modulating, **as directed**, valve with factory-mounted, probe-type, **as directed**, water-level controller.
      OR
      Factory **OR** Field, **as directed**,-mounted, pneumatic modulating valve with factory-mounted water-level controller.
   2) Factory **OR** Field, **as directed**,-mounted, three-valve bypass and inlet strainer.
g. Steam Pressure-Reducing Valve(s): Steam **OR** Electric **OR** Pneumatic, **as directed**, operated with three-valve bypass, **as directed**, and sized to reduce boiler outlet pressure to the deaerator design pressure.
h. Tank Overflow Drain: Sized to relieve full capacity at operating pressure.
i. Safety Valve(s): ASME labeled and sized to relieve full capacity of pressure-reducing valve.
j. Vents: Manual and automatic vent valves.
k. Vacuum breaker.
l. Meters and Gages:
   1) Full-height, water-level gage glass, reflex flat type, **as directed**, and stop valve set.
   2) Liquid-filled industrial **OR** Bimetal dial-type, **as directed**, thermometer graduated in Fahrenheit **OR** Celsius **OR** both Fahrenheit and Celsius, **as directed**, mounted to measure temperature in storage and steam, **as directed**, section of tank.
   3) Pressure gage graduated in pounds force per square inch **OR** kilopascals **OR** both pounds force per square inch and kilopascals, **as directed**, mounted to measure pressure in steam section of tank.
m. Provision for chemical injection quill.
n. Chemical injection quill.
o. Sampling connection with valve.
p. Tank drain connection with valve.
q. Oxygen test kit.

7. Support Frame: Structural-steel frame for supporting tank and pumps. Weld or bolt to tank.
   a. Fabricate support frame with bracing adequate for seismic forces according to authorities having jurisdiction and to allow installation by anchoring deaerators to floor only, as directed.
8. Feedwater Pump: Cast-iron, flange **OR** base, **as directed**,-mounted volute; with bronze **OR** stainless-steel, **as directed**, multistage centrifugal **OR** turbine, **as directed**, impeller, renewable bronze case ring, and stainless-steel shaft.
   a. Seals: Mechanical, suitable for 250 deg F (121 deg C).
   b. Pump Motor: Vertical **OR** Horizontal, **as directed**, open dripproof **OR** totally enclosed **OR** totally enclosed fan-cooled, **as directed**, enclosure, close **OR** flexible, **as directed**, coupled to pump. Comply with requirements in Division 15 Section "Motors."
9. Feedwater Pump Control Panel: Factory mounted and wired and including the following:
   a. NEMA 250, Type 1 **OR** 4 **OR** 4X **OR** 12, **as directed**, enclosure.
   b. Single-point, field power connection to fused disconnect switch **OR** nonfused disconnect switch **OR** circuit breaker, **as directed**.
      1) Branch power circuit to each motor and to controls with a disconnect switch or circuit breaker, **as directed**.
   c. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor.
      1) Alternating control as indicated by control sequence for each pump.
   d. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
   e. Metal raceway **OR** Raceway, **as directed**, for factory-installed wiring outside of enclosures. Make connections to motor with liquidtight conduit.
   f. Removable control mounting plate.

g. Visual indication of status and alarm with momentary test push button, **as directed**.
h. Audible alarm and silence switch.
i. Visual indication of elapsed run time, graduated in hours.
j. Fusible, control-circuit transformer.
k. Microprocessor-based controller.

10. Feedwater Pump Start-Stop Control Sequence (for intermittent pump operation):
    a. Boiler water-level controller starts and stops lead pump to maintain boiler water-level set point.
    b. Lead and lag pumps alternate after each start **OR** to equalize run time, **as directed**.
    c. Lead pump failure, lag pump automatically starts if lead pump cannot maintain set point **OR** is started manually, **as directed**.
    d. Visual indication of pump on **OR** on and off, **as directed**, status.
    e. Visual indication of pump lead/lag status.
    f. Visual **OR** Visual and audible, **as directed**, alarm indication of pump failure.
11. Feedwater Pump Continuous Control Sequence (for continuous pump operation and modulating control valve):
    a. Pump runs continuously while boiler operates. Electric interlock with boiler control starts lead pump when boiler starts.
    b. Boiler water-level controller modulates feedwater control valve to maintain boiler water-level set point. Valve closes when boiler is off.
    c. Lead and lag pumps alternate after each start **OR** to equalize run time, **as directed**.
    d. Lead pump failure automatically starts lag pump.
       OR
       Feedwater pressure controller starts and stops lag pump to maintain feedwater pressure set point.
    e. Visual indication of pump on **OR** on and off, **as directed**, status.
    f. Visual indication of pump lead/lag status.
    g. Visual **OR** Visual and audible, **as directed**, alarm indication of pump failure.
12. Makeup Water Control Sequence:
    a. Electric level controller operates electric control valve to maintain tank water-level set point.
       OR
       Pneumatic level controller operates pneumatic control valve to maintain tank water-level set point.
       OR
       Mechanical float operates valve to maintain water-level set point.
    b. Visual **OR** Visual and audible, **as directed**, alarm indication of low **OR** low and high, **as directed**, tank water level.
13. Building Management System Interface: Factory install hardware to enable building management system to monitor and display points.
    a. Hardwired Monitoring Points: On/off status for each pump, failure alarm for each pump, low-water level alarm, high-water level alarm, feedwater temperature, **as directed**.

B. Surge Tank
1. Description: Factory-assembled and -tested unit consisting of a condensate receiver, transfer pumps, and controls.
2. Accessories:
    a. Liquid-filled industrial **OR** Bimetal dial-type, **as directed**, thermometer graduated in Fahrenheit **OR** Celsius **OR** both Fahrenheit and Celsius, **as directed**.
    b. Level gage glass, reflex flat type, **as directed**, with stops at top and bottom.
    c. Lifting eyes.
    d. Companion flanges.
    e. Pump suction piping with vortex breaker, isolation valve, strainer, and flexible connector.
    f. Pump discharge piping with check valve, isolation valve, and liquid-filled pressure gage graduated in pounds force per square inch **OR** kilopascals **OR** both pounds force per square inch and kilopascals, **as directed**.

g. Pump-discharge bypass relief valve **OR** orifice plate **OR** relief valve with orifice plate, **as directed**.

3. Factory-Installed Pipe, NPS 2-1/2 (DN 65) and Smaller: ASTM A 53/A 53M, Type S (seamless), Grade B; or ASTM A 106, Type S, Grade B, Schedule 40 **OR** 80, **as directed**; with threaded joints and fittings.
   a. Cast-Iron Threaded Fittings: ASME B16.4, Class 125 **OR** 250, **as directed**.
   b. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150 **OR** 300, **as directed**.
   c. Forged-Steel Fittings: ASME B16.11, Class 3000.
   d. Malleable-Iron Unions: ASME B16.39, Class 150 **OR** 300, **as directed**.
   e. Forged-Steel Unions: MSS SP-83, Class 3000.
4. Factory-Installed Pipe, NPS 3 (DN 80) and Larger: ASTM A 53/A 53M, Type E (electric-resistance welded), Grade B; or ASTM A 106, Type S, Grade B, Schedule 40 **OR** 80, **as directed**; with welded joints and carbon-steel fittings and flanges.
   a. Wrought-Steel Fittings: ASME B16.9, wall thickness to match adjoining pipe.
   b. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, Class 150 **OR** 300, **as directed**, including bolts, nuts, and gaskets.
5. Tank:
   a. Material: Welded carbon steel **OR** Welded carbon steel galvanized after fabrication **OR** Stainless steel, **as directed**.
   b. Additional Corrosion Protection:
      1) 0.07-inch (1.8-mm) **OR** 0.13-inch (3.3-mm) **OR** 0.19-inch (4.8-mm), **as directed**, thickness allowance.
      2) Electrolytic corrosion-inhibitor anode.
   c. Access: Manhole in tank for access to internal components for inspection and service.
   d. Factory-Applied Insulation and Jacket: Minimum thickness of 2 inches (50 mm) for mineral-fiber pipe and tank insulation. Cover insulation with painted steel **OR** stucco-embossed aluminum **OR** stainless-steel, **as directed**, jacket.
6. Support Frame: Structural-steel frame for supporting tank. Weld or bolt to tank.
   a. Fabricate support frame with bracing adequate for seismic forces according to authorities having jurisdiction and to allow installation by anchoring deaerators to floor only.
7. Transfer Pump: Vertical, flange-mounted, close-coupled, single-stage **OR** multistage, **as directed**, radially split-case centrifugal pump; rated for 175-psig (1205-kPa) minimum working pressure and a continuous water temperature of 225 deg F (107 deg C); with the following features:
   a. Impeller: Bronze **OR** Stainless steel, **as directed**.
   b. Seals: Mechanical.
   c. Motor: Open dripproof **OR** Totally enclosed **OR** Totally enclosed fan-cooled, **as directed**, enclosure. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
8. Transfer Pump: Horizontal, base-mounted, single-stage **OR** multistage, **as directed**, radially split-case centrifugal pump; rated for 175-psig (1205-kPa) minimum working pressure and a continuous water temperature of 225 deg F (107 deg C); with the following features:
   a. Impeller: Bronze **OR** Stainless steel, **as directed**.
   b. Coupling: Close **OR** Flexible, **as directed**.
   c. Seals: Mechanical.
   d. Motor: Open dripproof **OR** Totally enclosed **OR** Totally enclosed fan-cooled, **as directed**, enclosure. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
9. Transfer Pump Control Panel: Factory mounted and wired and including the following:
   a. NEMA 250, Type 1 **OR** 4 **OR** 4X **OR** 12, **as directed**, enclosure.
   b. Single-point, field power connection to fused disconnect switch **OR** nonfused disconnect switch **OR** circuit breaker, **as directed**.
      1) Branch power circuit to each motor and to controls with a disconnect switch or circuit breaker, **as directed**.
   c. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor.

1) Alternating control indicated by control sequence for each pump.

d. Terminal blocks with numbered and color-coded wiring to match wiring diagram.

e. Metal raceway **OR** Raceway, **as directed**, for factory-installed wiring outside of enclosures. Make connections to motor with liquidtight conduit.

f. Removable control mounting plate.

g. Visual indication of on/off status and pump failure alarm with momentary test push button, **as directed**.

h. Audible alarm and silence switch.

i. Visual indication of elapsed run time, graduated in hours.

j. Fusible, control-circuit transformer.

k. Microprocessor-based controller.

10. Transfer Pump Start-Stop Control Sequence: Deaerator water-level controller controls lead pump; alternator switches lead and lag pump(s) after each start **OR** to equalize run time, **as directed**; failure of lead pump switches to lag pump and sounds audible alarm, **as directed**.
11. Transfer Pump Continuous-Run Control Sequence: Lead pump runs continuously while deaerator is operating; deaerator water-level controller modulates water-level-control valve; lead and lag pump(s) switch to equalize run time; lag pump operates if lead pump fails; pump failure sounds audible alarm, **as directed**.
12. Building Management System Interface: Factory install hardware to enable building management system to monitor and display points.

a. Hardwired Monitoring Points: On/off status for each pump, failure alarm for each pump, low-water level alarm, high-water level alarm, **as directed**.

C. Factory Finishes

1. Manufacturer's standard prime-coat finish ready for field painting.
2. Manufacturer's standard paint in standard colors, applied to factory-assembled and -tested unit before shipping.
3. Do not paint aluminum, galvanized-steel, and stainless-steel surfaces.

D. Source Quality Control

1. Fabricate and label deaerator tanks according to ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.
2. Factory install and test piping that connects pumps to tanks according to ASME B31.1, "Power Piping" **OR** ASME B31.9, "Building Services Piping," **as directed**.
3. Factory test performance and certify test results on packaged deaerator units, according to ASME PTC 12.3, before shipping to Project.

1.3 EXECUTION

A. Examination

1. Before deaerator installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting performance, maintenance, and operations.

a. Final deaerator locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

b. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation

1. Install deaerators level on concrete base. Concrete base is specified in Division 23 Section "Common Work Results For Hvac", and concrete materials and installation requirements are specified in Division 31.
2. Vibration Isolation: Elastomeric isolator pads **OR** mounts, **as directed**, with a minimum static deflection of 0.25 inch (6.35 mm). Vibration isolation devices and installation requirements are

specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
3. Install deaerators to permit access for service and maintenance.
4. Support piping independent of pumps.
5. Install base-mounted pumps on concrete base with grouted base frame.
6. Install all parts and materials not factory installed.
7. Extend overflow drains to floor drains.
8. Extend vent piping to outside and terminate with manufacturer-approved cap furnished with deaerator.
9. Install piping adjacent to machine to allow service and maintenance.

C. Connections
1. Steam and condensate piping installation requirements are specified in other Division 21. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Connect steam and condensate piping to tank tappings with shutoff valves and unions or flanges at each connection.
3. Connect condensate drains, pump-discharge piping, vents, overflow drains, makeup water, steam supply, and cooling water piping.

D. Field Quality Control
1. Perform tests and inspections and prepare test reports.
2. Tests and Inspections:
    a. Inspect field-assembled components and equipment installation, including piping and electrical connections, for compliance with requirements.
    b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
    c. Verify bearing lubrication.
    d. Verify proper motor rotation.
    e. Test Reports: Prepare a written report to record the following:
        1) Test procedures used.
        2) Test results that comply with requirements.
        3) Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
3. Remove and replace malfunctioning equipment and retest as specified above.

E. Startup Service
1. Engage a factory-authorized service representative to perform startup service.
2. Complete installation and startup checks according to manufacturer's written instructions and do the following:
    a. Set deaerator makeup water-level controls.
    b. Verify bearing lubrication.
    c. Verify proper motor rotation.
    d. Start pumps according to manufacturer's written instructions.

F. Adjusting And Cleaning
1. Adjust initial temperature and pressure set points.
2. Set field-adjustable switches and circuit-breaker trip ranges.
3. Clean strainers.

G. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain deaerators.

END OF SECTION 23 53 16 00a

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SECTION 23 54 16 13 - FURNACES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for furnaces. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Gas-fired, noncondensing, Gas-fired, condensing, Oil-fired, and Electric furnaces and accessories complete with controls.
      b. Air filters.
      c. Air cleaners.
      d. Ultraviolet germicidal lights.
      e. Humidifiers.
      f. Ventilation heat exchangers.
      g. Refrigeration components.

C. Submittals
   1. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each of the following:
      a. Furnace.
      b. Thermostat.
      c. Humidistat.
      d. Air filter.
      e. Air cleaner.
      f. Ultraviolet germicidal light.
      g. Humidifier.
      h. Ventilation heat exchanger.
      i. Refrigeration components.
   2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      a. Wiring Diagrams: Power, signal, and control wiring.
   3. Operation and maintenance data.
   4. LEED Submittals:
      a. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.
      b. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
      c. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.
   5. Warranty: Special warranty specified in this Section.

D. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

3. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
4. Comply with NFPA 70.

E. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace the following components of furnaces that fail in materials or workmanship within specified warranty period:
   a. Warranty Period, Commencing on Date of Final Completion:
      1) Furnace Heat Exchanger: 10 years **OR** 20 years **OR** Lifetime, **as directed**.
      2) Integrated Ignition and Blower Control Circuit Board: Five years.
      3) Draft-Inducer Motor: Five years.
      4) High-Efficiency Oil Furnace Burner: Three years.
      5) Refrigeration Compressors: 10 years **OR** Lifetime, **as directed**.
      6) Evaporator and Condenser Coils: Five years.

1.2 PRODUCTS

A. Gas-Fired Furnaces, Noncondensing
1. General Requirements for Gas-Fired, Noncondensing Furnaces: Factory assembled, piped, wired, and tested; complying with ANSI Z21.47/CSA 2.3, "Gas-Fired Central Furnaces," and with NFPA 54.
2. Cabinet: Steel **OR** Galvanized steel, **as directed**.
   a. Cabinet interior around heat exchanger shall be factory-installed insulation.
   b. Lift-out panels shall expose burners and all other items requiring access for maintenance.
   c. Factory paint external cabinets in manufacturer's standard color.
   d. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
3. Fan: Centrifugal, factory balanced, resilient mounted, direct drive **OR** belt drive **OR** direct or belt drive **OR** drive type indicated on Drawings, **as directed**.
   a. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
   b. Special Motor Features: Single speed, Premium (TM) efficiency, as defined in Division 23 Section "Common Motor Requirements For Hvac Equipment", and with internal thermal protection and permanent lubrication.
      OR
      Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
      OR
      Special Motor Features: Electronically controlled motor (ECM) controlled by integrated furnace/blower control.
4. Type of Gas: Natural **OR** Propane, **as directed**.
5. Heat Exchanger: Aluminized **OR** Stainless, **as directed**, steel.
6. Burner:
   a. Gas Valve: 100 percent safety two-stage **OR** modulating, **as directed**, main gas valve, main shutoff valve, pressure regulator, safety pilot with electronic flame sensor, limit control, transformer, and combination ignition/fan timer control board.
   b. Ignition: Electric pilot ignition, with hot-surface igniter or electric spark ignition.
7. Gas-Burner Safety Controls:
   a. Electronic Flame Sensor: Prevents gas valve from opening until pilot flame is proven; stops gas flow on ignition failure.
   b. Flame Rollout Switch: Installed on burner box; prevents burner operation.
   c. Limit Control: Fixed stop at maximum permissible setting; de-energizes burner on excessive bonnet temperature; automatic reset.

8. Combustion-Air Inducer: Centrifugal fan with thermally protected motor and sleeve bearings prepurges heat exchanger and vents combustion products; pressure switch prevents furnace operation if combustion-air inlet or flue outlet is blocked.
9. Furnace Controls: Solid-state board integrates ignition, heat, cooling, and fan speeds; and adjustable fan-on and fan-off timing; terminals for connection to accessories.
10. Vent Materials: Comply with requirements in Division 23 Section "Breechings, Chimneys, And Stacks", for Type B metal vents.

B. Gas-Fired Furnaces, Condensing
1. General Requirements for Gas-Fired, Condensing Furnaces: Factory assembled, piped, wired, and tested; complying with ANSI Z21.47/CSA 2.3, "Gas-Fired Central Furnaces," and with NFPA 54.
2. Cabinet: Steel **OR** Galvanized steel, **as directed**.
   a. Cabinet interior around heat exchanger shall be factory-installed insulation.
   b. Lift-out panels shall expose burners and all other items requiring access for maintenance.
   c. Factory paint external cabinets in manufacturer's standard color.
   d. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
3. Fan: Centrifugal, factory balanced, resilient mounted, direct drive.
   a. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
   b. Special Motor Features: Single speed, Premium (TM) efficiency, as defined in Division 23 Section "Common Motor Requirements For Hvac Equipment", and with internal thermal protection and permanent lubrication.
      OR
      Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
      OR
      Special Motor Features: Electronically controlled motor (ECM) controlled by integrated furnace/blower control.
4. Type of Gas: Natural **OR** Propane, **as directed**.
5. Heat Exchanger:
   a. Primary: Aluminized **OR** Stainless, **as directed**, steel.
   b. Secondary: Polyethylene-coated **OR** Stainless, **as directed**, steel.
6. Burner:
   a. Gas Valve: 100 percent safety two-stage **OR** modulating, **as directed**, main gas valve, main shutoff valve, pressure regulator, safety pilot with electronic flame sensor, limit control, transformer, and combination ignition/fan timer control board.
   b. Ignition: Electric pilot ignition, with hot-surface igniter or electric spark ignition.
7. Gas-Burner Safety Controls:
   a. Electronic Flame Sensor: Prevents gas valve from opening until pilot flame is proven; stops gas flow on ignition failure.
   b. Flame Rollout Switch: Installed on burner box; prevents burner operation.
   c. Limit Control: Fixed stop at maximum permissible setting; de-energizes burner on excessive bonnet temperature; automatic reset.
8. Combustion-Air Inducer: Centrifugal fan with thermally protected motor and sleeve bearings prepurges heat exchanger and vents combustion products; pressure switch prevents furnace operation if combustion-air inlet or flue outlet is blocked.
9. Furnace Controls: Solid-state board integrates ignition, heat, cooling, and fan speeds; adjustable fan-on and fan-off timing; terminals for connection to accessories; diagnostic light with viewport, **as directed**.
10. Accessories:
   a. Combination Combustion-Air Intake and Vent: PVC plastic fitting to combine combustion-air inlet and vent through outside wall **OR** roof, **as directed**.
   b. CPVC Plastic Vent Materials.
      1) CPVC Plastic Pipe: Schedule 40, complying with ASTM F 441/F 441M.

2) CPVC Plastic Fittings: Schedule 40, complying with ASTM F 438, socket type.
3) CPVC Solvent Cement: ASTM F 493.
   a) Use CPVC solvent cement that has a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b) Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

c. PVC Plastic Vent Materials:
1) PVC Plastic Pipe: Schedule 40, complying with ASTM D 1785.
2) PVC Plastic Fittings: Schedule 40, complying with ASTM D 2466, socket type.
3) PVC Solvent Cement: ASTM D 2564.
   a) Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b) Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Oil-Fired Furnaces
1. General Requirements for Oil-Fired Furnaces: Factory assembled, piped, wired, and tested; complying with UL 727 and with NFPA 31.
2. Cabinet: Steel **OR** Galvanized steel, **as directed**.
   a. Cabinet interior around heat exchanger shall be factory-installed insulation.
   b. Lift-out panels shall expose burners and all other items requiring access for maintenance.
   c. Factory paint external cabinets in manufacturer's standard color.
   d. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
3. Fan: Centrifugal, factory balanced, resilient mounted, direct drive **OR** belt drive **OR** drive type indicated on Drawings, **as directed**.
   a. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
4. Special Motor Features: Single speed, Premium (TM) efficiency, as defined in Division 23 Section "Common Motor Requirements For Hvac Equipment", and with internal thermal protection and permanent lubrication.
   OR
   Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
5. Heat Exchanger: Welded steel with ceramic-fiber liner **OR** refractory insert, **as directed**, at the burner in the combustion chamber. Minimum 2-inch- (50-mm-) diameter access ports in heat exchanger to permit access for cleaning.
6. Burner: High-pressure atomizing type, with rubber-mounted, adjustable, combustion-air blower; integrated fuel pump; hinged, flame-inspection port; cadmium-sulfide flame sensor; electrodes; ignition transformer; and oil nozzle.
   a. Time-Delay Relay: Limits time for establishing main flame.
   b. Flame Sensor: Monitors flame and stops burner on flame failure.
   c. Limit Control: Fixed stop at maximum permissible setting; de-energizes burner on excessive bonnet temperature; automatic reset.
7. Barometric Draft Regulator: Match furnace; for mounting in flue.
8. Furnace Controls: Solid-state board integrates ignition, heat, cooling, and fan speeds; and adjustable fan-on and fan-off timing; terminals for connection to accessories.
9. Vent Materials: Comply with requirements in Division 23 Section "Breechings, Chimneys, And Stacks" for Type B metal vents.

D. Electric Furnaces
1. General Requirements for Electric Furnaces: Factory assembled, piped, wired, and tested.
2. Cabinet: Steel, with duct liner downstream from cooling coil, **as directed**.
   a. Duct Liner: Fiberglass, minimum 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, thick, complying with ASTM C 1071 and having a coated surface exposed to airstream

complying with NFPA 90A or NFPA 90B and with NAIMA's "Fibrous Glass Duct Liner Standard."
1) Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
b. Factory paint external cabinets in manufacturer's standard color.
3. Fan: Centrifugal, factory balanced, resilient mounted, direct drive.
a. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
b. Special Motor Features: Single speed, Premium (TM) efficiency, as defined in Division 23 Section "Common Motor Requirements For Hvac Equipment", and with internal thermal protection and permanent lubrication.
OR
Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
OR
Special Motor Features: Electronically controlled motor (ECM) controlled by integrated furnace/blower control.
4. Electric-Resistant Heating Elements: Helix-wound, nickel-chromium wire-heating elements in ceramic insulators mounted on steel supports.
5. Heating-Element Control: Sequencer relay with relay for each element; switches elements on and off, with delay between each increment; initiates, stops, or changes fan speed.
6. Summer Fan Switch: Connected to permit independent on-off switch of unit fan.

E. Thermostats And Humidistats
1. Solid-State Thermostat: Wall-mounting **OR** Freestanding **OR** Wireless, **as directed**, programmable, microprocessor-based unit with automatic **OR** manual, **as directed**, switching from heating to cooling, preferential rate control, seven-day programmability with minimum of four temperature presets per day, vacation mode, **as directed**, and battery backup protection against power failure for program settings.
OR
Single-Stage, Heating-Cooling Thermostat: Adjustable, heating-cooling, wall-mounting unit with fan on-automatic selector.
OR
Two-Stage, Heating-Cooling Thermostat: Adjustable, heating-cooling, wall-mounting unit with fan on-automatic selector.
OR
Single-Stage **OR** Two-Stage, **as directed**, Heating-Only Thermostat: Wall-mounting unit with fan on-automatic selector.
OR
Solid-State, Combination Thermostat and Humidistat: Wall-mounting **OR** Freestanding **OR** Wireless, **as directed**, programmable, microprocessor-based unit with automatic switching from heating to cooling and humidifying to dehumidifying, preferential rate control, seven-day programmability with minimum of four temperature presets per day, vacation mode, **as directed**, and battery backup protection against power failure for program settings.
2. Humidistat: Adjustable, wall-mounting **OR** duct-mounting, **as directed**, unit.
3. Control Wiring: Unshielded twisted-pair cabling.
a. No. 24 AWG, 100 ohm, four pair.
b. Cable Jacket Color: Blue.
4. Controls shall comply with requirements in ASHRAE/IESNA 90.1, "Controls."

F. Air Filters
1. Washable Filters: 1-inch- (25-mm-) thick, urethane pad.
2. Disposable Filters: 1-inch- (25-mm-) thick fiberglass media with ASHRAE 52.2 MERV rating of 6 or higher, **as directed**, in sheet metal frame.
3. Charged Media Air Filters: Sheet metal housing arranged to be ducted in return-air duct connection to furnace, generates electrostatic charge; MERV 10 rating.

4. HEPA Air Filter Units: Sheet metal housing with fan arranged to be ducted to return-air duct connection to furnace, with activated carbon prefilter, high-efficiency particulate air (HEPA) disposable filter, and carbon VOC, **as directed**. HEPA shall be as follows:
   a. Standard: UL 586, "High-Efficiency, Particulate, Air Filter Units."
   b. Rating: ASHRAE 52.1, dust-spot efficiency of 65 percent; ASHRAE 52.2, 99.97 percent efficiency to 0.03-micrometer particle size.

G. Air Cleaners
1. Electronic Air Cleaners: Packaged system, including sheet metal housing, prefilter, power supply, and automatic control device, arranged for mounting in return-air duct at furnace; equip with on-off and test switches and pilot light.
   a. Standard: UL 586, "High-Efficiency, Particulate, Air Filter Units."
   b. Rating: ASHRAE 52.2, particle size to 0.01 micrometer.
   c. Static Pressure Drop: Maximum 0.14-inch wg (35 Pa) at 300-fpm (1.52-m/s) air velocity.

H. Ultraviolet Germicidal Lights
1. Description: Lighting unit in metal housing arranged for installation in supply-air duct and controlled to cycle on and off with furnace fan, with one **OR** two, **as directed**, 75-W ultraviolet-light bulb(s).

I. Humidifiers
1. Minimum capacity rating indicated according to ARI 610, "Central System Humidifiers for Residential Applications."
2. Media-wheel bypass type with bypass damper and motor-driven media wheel in reservoir with float-valve level control; arranged for mounting on return duct or plenum with bypass connection to supply duct.
   OR
   Wetted-pad, continuous-drain, bypass type with bypass damper and water-flow control orifice; arranged for mounting on return duct or plenum with bypass connection to supply duct.
   OR
   Fan-powered, wetted-pad, continuous-drain type with water-flow control orifice and motor; arranged for mounting on duct or plenum.
   OR
   Pumped, fan-powered, wetted-pad type with reservoir-level control and pump and fan motors; arranged for mounting on duct or plenum.
   OR
   Steam type with electric heating element in stainless-steel reservoir with float-valve level control; arranged for attachment to duct or plenum and for control by humidistat.
3. Comply with applicable requirements in ASHRAE 62.1.

J. Ventilation Air Heat Exchanger
1. Cabinet: Steel, with factory-installed interior insulation and manufacturer's standard factory finish. Fabricate with space for piping and electrical conduits.
2. Heat-Recovery Device: Fixed-plate, polypropylene copolymer (high-density plastic) heat-exchanger plates evenly spaced and sealed and arranged for counter airflow.
3. Supply and Exhaust Fans: Forward curved centrifugal with direct drive. Motors comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
4. Filters: 1-inch- (25-mm-) thick disposable type with ASHRAE 52.2 MERV rating of 6 or higher, **as directed**, in galvanized-steel frame, mounted upstream of unit in both supply and exhaust airstreams.
5. Wiring: Wire motors and controls so only external connections are required during installation.

K. Refrigeration Components
1. General Refrigeration Component Requirements:

a. Refrigeration compressor, coils, and specialties shall be designed to operate with CFC-free refrigerants.
b. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Standard for Buildings except Low-Rise Residential Buildings."

2. Refrigerant Coil: Copper tubes mechanically expanded into aluminum fins. Comply with ARI 210/240, "Unitary Air-Conditioning and Air-Source Heat Pump Equipment." Match size with furnace. Include condensate drain pan with accessible drain outlet complying with ASHRAE 62.1, **as directed**.
   a. Refrigerant Coil Enclosure: Steel, matching furnace and evaporator coil, with access panel and flanges for integral mounting at or on furnace cabinet and galvanized sheet metal drain pan coated with black asphaltic base paint.
3. Refrigerant Line Kits: Annealed-copper suction and liquid lines factory cleaned, dried, pressurized with nitrogen, sealed, and with suction line insulated. Provide in standard lengths for installation without joints, except at equipment connections.
   a. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I, 1/2 inch (13 mm) **OR** 1 inch (25 mm), **as directed**, thick.
4. Refrigerant Piping: Comply with requirements in Division 23 Section "Refrigerant Piping".
5. Air-Cooled, Compressor-Condenser Unit:
   a. Casing: Steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
   b. Compressor: Hermetically sealed reciprocating **OR** scroll, **as directed**, type.
      1) Crankcase heater.
      2) Restrained vibration **OR** Vibration, **as directed**, isolation mounts for compressor.
      3) Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
      4) Two-speed compressor motors shall have manual-reset high-pressure switch and automatic-reset low-pressure switch.
      5) Refrigerant Charge: R-407C **OR** R-410A, **as directed**.
   c. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.
   d. Heat-Pump Components: Reversing valve and low-temperature air cut-off thermostat.
   e. Fan: Aluminum-propeller type, directly connected to motor.
   f. Motor: Permanently lubricated, with integral thermal-overload protection.
   g. Low Ambient Kit: Permits operation down to 45 deg F (7 deg C).
   h. Mounting Base: Polyethylene.

1.3 EXECUTION

A. Installation
1. Install gas-fired furnaces and associated fuel and vent features and systems according to NFPA 54.
2. Install oil-fired furnaces and associated fuel and vent piping according to NFPA 31.
3. Suspended Units: Suspend from structure using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.
   a. Install seismic restraints to limit movement of furnace by resisting code-required seismic acceleration.
4. Base-Mounted Units: Secure units to substrate. Provide optional bottom closure base if required by installation conditions.
   a. Anchor furnace to substrate to resist code-required seismic acceleration.
5. Controls: Install thermostats and humidistats at mounting height of 60 inches (1500 mm) above floor.
6. Wiring Method: Install control wiring in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal control wiring except in unfinished spaces.

7. Install ground-mounted, compressor-condenser components on 4-inch- (100-mm-) thick, reinforced concrete base; 4 inches (100 mm) larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-place Concrete". Coordinate anchor installation with concrete base.
   OR
   Install ground-mounted, compressor-condenser components on polyethylene mounting base.
8. Install roof-mounted, compressor-condenser components on equipment supports specified in Division 07 Section "Roof Accessories". Anchor units to supports with removable, cadmium-plated fasteners.

B. Connections
1. Gas piping installation requirements are specified in Division 23 Section(s) "Facility Natural-gas Piping" OR "Facility Liquefied-petroleum Gas Piping", **as directed**. Drawings indicate general arrangement of piping, fittings, and specialties. Connect gas piping with union or flange and appliance connector valve.
2. Oil piping installation requirements are specified in Division 23 Section "Facility Fuel-oil Piping". Drawings indicate general arrangement of piping, fittings, and specialties. Connect oil piping with union or flange and ball **OR** gate, **as directed**, valve.
3. Install piping adjacent to equipment to allow service and maintenance.
4. Water piping installation requirements for furnaces with humidifiers are specified in Division 22 Section "Domestic Water Piping". Drawings indicate general arrangement of piping, fittings, and specialties. Connect water piping with union and ball valve.
5. Vent Connection, Noncondensing, Gas-Fired Furnaces: Connect Type B vents to furnace vent connection and extend outdoors. Type B vents and their installation requirements are specified in Division 23 Section "Breechings, Chimneys, And Stacks".
6. Vent and Outside-Air Connection, Condensing, Gas-Fired Furnaces: Connect plastic piping vent material to furnace connections and extend outdoors. Terminate vent outdoors with a cap and in an arrangement that will protect against entry of birds, insects, and dirt.
   a. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
   b. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
   c. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
      1) Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
      2) CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
      3) PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
      4) Requirements for Low-Emitting Materials:
         a) Use CPVC solvent cement that has a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
         b) Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
         c) Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   d. Slope pipe vent back to furnace or to outside terminal.
7. Vent Connections, Oil-Fired Furnaces: Connect Type L vents to furnace vent connection and extend outdoors. Type L vents and their installation requirements are specified in Division 23 Section "Breechings, Chimneys, And Stacks".
8. Connect ducts to furnace with flexible connector. Comply with requirements in Division 23 Section "Air Duct Accessories".
9. Connect refrigerant tubing kits to refrigerant coil in furnace and to air-cooled, compressor-condenser unit.

a. Flared Joints: Use ASME B16.26 fitting and flared ends, following procedures in CDA's "Copper Tube Handbook."
OR
Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
OR
Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

10. Comply with requirements in Division 23 Section "Refrigerant Piping" for installation and joint construction of refrigerant piping.

C. Field Quality Control
1. Perform the following field tests and inspections and prepare test reports:
   a. Perform electrical test and visual and mechanical inspection.
   b. Leak Test: After installation, charge systems with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
   c. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.
   d. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
   e. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

D. Startup Service
1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
   a. Inspect for physical damage to unit casings.
   b. Verify that access doors move freely and are weathertight.
   c. Clean units and inspect for construction debris.
   d. Verify that all bolts and screws are tight.
   e. Adjust vibration isolation and flexible connections.
   f. Verify that controls are connected and operational.
2. Adjust fan belts to proper alignment and tension.
3. Start unit according to manufacturer's written instructions and complete manufacturer's operational checklist.
4. Measure and record airflows.
5. Verify proper operation of capacity control device.
6. After startup and performance test, lubricate bearings and adjust belt tension, **as directed**.

E. Adjusting
1. Adjust initial temperature and humidity set points.
2. Set controls, burner, and other adjustments for optimum heating performance and efficiency. Adjust heat-distribution features, including shutters, dampers, and relays, to provide optimum heating performance and system efficiency.

F. Cleaning
1. After completing installation, clean furnaces internally according to manufacturer's written instructions.
2. Install new filters in each furnace within 14 days after Final Completion.

G. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain condensing units.

END OF SECTION 23 54 16 13

Task	Specification	Specification Description
23 54 19 00	23 54 16 13	Furnaces

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SECTION 23 55 23 13 - RADIANT HEATING AND COOLING UNITS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for radiant heating and cooling units. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Electric radiant heaters.
      b. Prefabricated electric radiant heating panels.
      c. Hydronic heating and cooling panels.

C. Definitions
   1. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.

D. Submittals
   1. Product Data: Include rated capacities, specialties, and accessories for each product indicated.
   2. Manufacturer Seismic Qualification Certification.
   3. Field quality-control test reports.
   4. Operation and maintenance data.

E. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.2 PRODUCTS

A. Electric Radiant Heaters
   1. Quartz Lamp Heating Elements: Coiled tungsten-wire heating element enclosed in clear quartz tube.
   2. Quartz Tube Heating Elements: Nickel-chromium-wire heating element enclosed in quartz tube.
   3. Metal-Sheathed Heating Elements: Nickel-chromium-wire heating element embedded in magnesium oxide powder and enclosed in metal sheath. Comply with UL 1030.
   4. Comply with UL 499 and UL 2021, **as directed**.
   5. Enclosures: Aluminized **OR** Stainless **OR** Painted, **as directed,**-steel housing with anodized-aluminum reflector.
      a. Finish: Baked-enamel finish in manufacturer's standard **OR** custom, **as directed,** paint color as selected.
   6. Unit Controls:
      a. Line-voltage thermostat.
      b. Enclosed contactor for remote thermostat.
      c. Snow and ice detector with moisture sensor and integral temperature sensor.

B. Prefabricated Electric Radiant Heating Panels
   1. Description: Sheet-metal-enclosed panel with heating element suitable for lay-in installation flush with T-bar ceiling grid **OR** surface mounting **OR** recessed mounting, **as directed**. Comply with UL 2021.

a. Panel: Minimum 0.0276-inch- (0.7-mm-) thick, galvanized-steel sheet back panel riveted to minimum 0.0396-inch- (1.0-mm-) thick, galvanized-steel sheet front panel with fused-on crystalline surface.
b. Heating Element: Powdered graphite sandwiched between sheets of electric insulation **OR** Insulated resistive wires, **as directed**.
c. Electrical Connections: Nonheating, high-temperature, insulated-copper leads, factory connected to heating element.
d. Exposed-Side Panel Finish:
    1) Apply silk-screened finish to match appearance of Architect-selected acoustical ceiling tiles.
    OR
    Factory prime coated, ready for field painting.
    OR
    Baked-enamel finish in manufacturer's standard **OR** custom, **as directed,** paint color as selected.
e. Surface-Mounting Trim: Sheet metal with baked-enamel finish in manufacturer's standard **OR** custom, **as directed,** paint color as selected.

2. Wall Thermostat: Bimetal, sensing elements calibrated from 55 to 90 deg F (13 to 32 deg C); with contacts suitable for low **OR** line, **as directed,**-voltage circuit, and manually operated on-off switch with contactors, relays, and control transformers.
3. Capacities and Characteristics:
    a. Nominal Panel Size: 24 by 24 inches (600 by 600 mm) **OR** 24 by 36 inches (600 by 900 mm) **OR** 24 by 48 inches (600 by 1200 mm) **OR** 24 by 60 inches (600 by 1500 mm), **as directed**.
    b. Heating Capacity: 250 **OR** 375 **OR** 500 **OR** 570 **OR** 625 **OR** 750 **OR** 950, **as directed**, kW.

C. Hydronic Heating And Cooling, **as directed**, Panels
1. Description: Modular **OR** Linear, **as directed,** sheet metal panel with serpentine water piping, suitable for lay-in installation flush with T-bar ceiling grid **OR** surface mounting **OR** recessed mounting, **as directed**.
    a. Panels: Minimum 0.0336-inch- (0.86-mm-) thick, galvanized-steel **OR** 0.0396-inch- (1.0-mm-) thick, aluminum, **as directed,** sheet.
    b. Backing Insulation: Minimum 1-inch- (25-mm-) **OR** 2-inch- (50-mm-), **as directed,** thick, mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB with factory-applied jacket.
    c. Exposed-Side Panel Finish:
        1) Apply silk-screened finish to match appearance of selected acoustical ceiling tiles.
        OR
        Factory prime coated, ready for field painting.
        OR
        Baked-enamel finish in manufacturer's standard **OR** custom, **as directed,** paint color as selected.
    d. Factory Piping: ASTM B 88, Type L (ASTM B 88M, Type B) **OR** ASTM B 88, Type M (ASTM B 88M, Type C), **as directed,** copper tube with ASME B16.22 wrought-copper fittings and brazed joints. Piping shall be mechanically bonded to panel.
    e. Surface-Mounting Trim: Sheet metal with baked-enamel finish in manufacturer's standard **OR** custom, **as directed,** paint color as selected.
    f. Accessories:
        1) 5-inch (127-mm) **OR** 6-inch (152-mm) **OR** 8-inch (203-mm), **as directed,** panel with drape track recess.
        2) 5-inch (127-mm) male bullnose panel.
        3) 5-inch (127-mm) female bullnose panel.
        4) 4-inch (102-mm) male corner panel.
        5) 4-inch (102-mm) female corner panel.

6) Inside corner panel.
7) 1/2-inch (13-mm) filler panel.

2. Capacities and Characteristics:
   a. Nominal Panel Size: 24 by 24 inches (600 by 600 mm) **OR** 24 by 36 inches (600 by 900 mm) **OR** 24 by 48 inches (600 by 1200 mm) **OR** 24 by 60 inches (600 by 1500 mm), **as directed**.
   b. Piping Inlet and Outlet: NPS 1/2 (DN 15).

1.3 EXECUTION

A. Installation
1. Install radiant heating and cooling units level and plumb.
2. Suspend radiant heaters from structure.
3. Support for Radiant Heating and Cooling Panels in or on Grid-Type Suspended Ceilings: Use grid as a support element.
   a. Install a minimum of four ceiling support system rods or wires for each panel. Locate not more than 6 inches (150 mm) from panel corners.
   b. Support Clips: Fasten to panel and to ceiling grid members at or near each panel corner with clips designed for the application.
   c. Panels of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support panels independently with at least two 3/4-inch (19-mm) metal channels spanning and secured to ceiling tees.
   d. Install at least one independent support rod or wire from structure to a tab on panel. Wire or rod shall have breaking strength of the weight of panel at a safety factor of 3.
4. Verify locations of thermostats with Drawings and room details before installation. Install devices 48 inches (1220 mm) **OR** 60 inches (1525 mm), **as directed,** above finished floor.
5. Piping installation requirements are specified in Division 23 Section "Hydronic Piping". Drawings indicate general arrangement of piping, fittings, and specialties.
6. Unless otherwise indicated, install shutoff valve and union or flange at each connection.
7. Install piping adjacent to unit to allow service and maintenance.
8. Ground electric units according to Division 26 Section "Grounding And Bonding For Electrical Systems".
9. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

B. Field Quality Control
1. Testing: Perform the following field tests and inspections and prepare test reports:
   a. Operate electric heating elements through each stage to verify proper operation and electrical connections.
   b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and units.
2. Remove and replace malfunctioning units and retest as specified above.
3. After installing panels, inspect unit cabinet for damage to finish. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

END OF SECTION 23 55 23 13

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SECTION 23 55 23 13a - RADIANT-HEATING ELECTRIC PANELS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for radiant-heating electric panels. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes prefabricated radiant-heating electric panels.

C. Submittals
   1. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.
   2. Shop Drawings: For electric heating panels. Include plans, sections, details, and attachments to other work.
      a. Wiring Diagrams: Power, signal, and control wiring.
   3. Field quality-control test reports.
   4. Operation and Maintenance Data: For electric heating panels to include in operation and maintenance manuals.
   5. Warranty: Special warranty specified in this Section.

D. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.2 PRODUCTS

A. Prefabricated Radiant-Heating Electric Panels
   1. Description: Sheet-metal-enclosed panel with heating element suitable for lay-in installation flush with T-bar ceiling grid **OR** surface mounting **OR** recessed mounting, **as directed**. Comply with UL 2021.
      a. Panel: Minimum 0.0276-inch- (0.7-mm-) thick, galvanized-steel sheet back panel riveted to minimum 0.0396-inch- (1.0-mm-) thick, galvanized-steel sheet front panel with fused-on crystalline surface.
      b. Heating Element:
         1) Powdered graphite sandwiched between sheets of electric insulation.
            OR
            Insulated resistive wires.
      c. Electrical Connections: Nonheating, high-temperature, insulated-copper leads, factory connected to heating element.
      d. Exposed-Side Panel Finish:
         1) Apply silk-screened finish to match appearance of selected acoustical ceiling tiles.
         2) Factory prime coated, ready for field painting.
         3) Baked-enamel finish in manufacturer's standard **OR** custom, **as directed**, paint color as selected.
      e. Surface-Mounting Trim: Sheet metal with baked-enamel finish in manufacturer's standard **OR** custom, **as directed**, paint color as selected.

2. Wall Thermostat: Bimetal, sensing elements calibrated from 55 to 90 deg F (13 to 32 deg C); with contacts suitable for low **OR** line, **as directed**,-voltage circuit, and manually operated on-off switch with contactors, relays, and control transformers.

1.3 EXECUTION

A. Installation
1. Install radiant-heating panels level and plumb.
2. Support for Radiant-Heating Panels in or on Grid-Type Suspended Ceilings: Use grid as a support element.
   a. Install a minimum of four ceiling support system rods or wires for each panel. Locate not more than 6 inches (150 mm) from panel corners.
   b. Support Clips: Fasten to panel and to ceiling grid members at or near each panel corner with clips designed for the application.
   c. Panels of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support panels independently with at least two 3/4-inch (19-mm) metal channels spanning and secured to ceiling tees.
   d. Install at least one independent support rod or wire from structure to a tab on panel. Wire or rod shall have breaking strength of the weight of panel at a safety factor of 3.
3. Verify locations of thermostats with Drawings and room details before installation. Install devices 48 inches (1220 mm) **OR** 60 inches (1525 mm), **as directed**, above finished floor.

B. Connections
1. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
2. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Field Quality Control
1. Testing: Perform the following field tests and inspections and prepare test reports:
   a. Operate electric heating elements through each stage to verify proper operation and electrical connections.
   b. Test and adjust controls and safeties.
2. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 23 55 23 13a

SECTION 23 55 33 00 - FUEL-FIRED UNIT HEATERS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for fuel-fired unit heaters. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes gas and oil-fired unit heaters.

C. Submittals
   1. Product Data: For each type of fuel-fired unit heater indicated. Include rated capacities, operating characteristics, and accessories.
   2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      a. Wiring Diagrams: Power, signal, and control wiring.
   3. Manufacturer Seismic Qualification Certification: Submit certification that fuel-fired unit heaters, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
   4. Field quality-control test reports.
   5. Operation and maintenance data.
   6. Warranty: Special warranty specified in this Section.

D. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   2. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Warranty
   1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace heat exchanger of fuel-fired unit heater that fails in materials or workmanship within Two **OR** Five, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Gas-Fired Unit Heaters
   1. Description: Factory assembled, piped, and wired, and complying with ANSI Z83.8/CSA 2.6.
   2. Fuel Type: Design burner for natural **OR** propane, **as directed**, gas having characteristics same as those of gas available at Project site.
   3. Type of Venting: Gravity **OR** Powered **OR** Indoor, separated combustion, power, **as directed**, vented.
   4. Housing: Steel, with integral draft hood and inserts for suspension mounting rods.
      a. External Casings and Cabinets: Baked enamel **OR** Powder coating, **as directed**, over corrosion-resistant-treated surface.
      b. Suspension Attachments: Reinforce suspension attachments at connection to fuel-fired unit heaters.

1) Seismic Fabrication Requirements: Fabricate suspension attachments of fuel-fired unit heaters, accessories mountings, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment" when fuel-fired unit heater is anchored to building structure.

5. Heat Exchanger: Aluminized **OR** Stainless, **as directed**, steel.
6. Burner Material: Aluminized steel with stainless-steel inserts **OR** Stainless steel, **as directed**.
7. Unit Fan: Formed-steel **OR** Aluminum, **as directed**, propeller blades riveted to heavy-gage steel spider bolted to cast-iron hub, dynamically balanced, and resiliently mounted.
   a. Fan-Blade Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
   b. General requirements for motors are specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
      1) Motors: Totally enclosed with internal thermal-overload protection and complying with Division 23 Section "Common Motor Requirements For Hvac Equipment".
      2) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
      3) Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 22.
8. Unit Fan: Steel, centrifugal fan dynamically balanced and resiliently mounted.
   a. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
      1) Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
      2) Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
      3) Pulleys: Cast-iron, adjustable-pitch motor pulley.
   b. General requirements for motors are specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
      1) Motors: Totally enclosed with internal thermal-overload protection and complying with Division 23 Section "Common Motor Requirements For Hvac Equipment".
      2) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
      3) Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 22.
9. Controls: Regulated redundant gas valve containing pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
   a. Gas Control Valve: Single stage **OR** Two stage **OR** Modulating, **as directed**.
   b. Ignition: Standing pilot **OR** Electronically controlled electric spark with flame sensor, **as directed**.
   c. Fan Thermal Switch: Operates fan on heat-exchanger temperature.
   d. Vent Flow Verification: Flame rollout switch **OR** Differential pressure switch to verify open vent, **as directed**.
   e. Control transformer.
   f. High Limit: Thermal switch or fuse to stop burner.
   g. Thermostats: Devices and wiring are specified in Division 23 Section "Instrumentation And Control For Hvac".

      OR

      Thermostat: Single-stage, wall-mounting type with 50 to 90 deg F (10 to 32 deg C) operating range and fan on switch.

      OR

      Thermostat: 2-stage, wall-mounting type with 50 to 90 deg F (10 to 32 deg C) operating range and fan on switch.

      OR

      Thermostat: Single-stage type with duct-mounting sensor and 50 to 90 deg F (10 to 32 deg C) operating range.

      OR

Thermostat: 2-stage type with duct-mounting sensor and 50 to 90 deg F (10 to 32 deg C) operating range.

10. Discharge Louvers: Independently adjustable horizontal blades.
11. Accessories:
    a. Vertical discharge louvers.
    b. Discharge Nozzle: Discharge at 25 to 65 degrees (0.44 to 1.13 radians) **OR** 50 to 90 degrees (0.87 to 1.57 radians), **as directed**, from horizontal.
    c. Four-point suspension kit.
    d. Summer fan switch.
    e. Unit-mounted thermostat bracket.
    f. Power Venter: Centrifugal aluminized-steel fan, with stainless-steel shaft; 120-V ac motor.
    g. Concentric, Terminal Vent Assembly: Combined combustion-air inlet and power-vent outlet with wall or roof caps. Include adapter assembly for connection to inlet and outlet pipes, and flashing for wall or roof penetration.

B. Oil-Fired Unit Heaters
1. Description: Factory assembled, piped, and wired, and complying with UL 731.
2. Housing: Steel, with inserts for suspension mounting rods.
    a. External Casings and Cabinets: Baked enamel **OR** Powder coating, **as directed**, over corrosion-resistant-treated surface.
    b. Suspension Attachments: Reinforce suspension attachments at connection to fuel-fired unit heaters.
        1) Seismic Fabrication Requirements: Fabricate suspension attachments of fuel-fired unit heaters, accessories mountings, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment" when fuel-fired unit heater is anchored to building structure.
3. Heat Exchanger: Minimum 0.09-inch (2.2-mm) steel.
4. Burners: Flame-retention, pressure-atomizing, forced-draft, gun type; with integral fuel pump and electronic spark ignition and flame safety.
    a. Safety Device: Oil-pressure switch.
5. Unit Fan: Propeller fan with aluminum blades dynamically balanced and resiliently mounted.
    a. Steel fan-blade guard.
    b. General requirements for motors are specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
        1) Motors: Totally enclosed with internal thermal-overload protection and complying with Division 23 Section "Common Motor Requirements For Hvac Equipment".
        2) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
        3) Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 22.
6. Unit Fan: Steel, centrifugal fan dynamically balanced and resiliently mounted.
    a. Belt driven with adjustable-pitch motor sheave.
    b. General requirements for motors are specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
        1) Motors: Totally enclosed with internal thermal-overload protection and complying with Division 23 Section "Common Motor Requirements For Hvac Equipment".
        2) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
        3) Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 22.
7. Controls: Factory piped and prewired to electrical junction box mounted on unit, including the following:
    a. Control Transformer: Integrally mounted, 120 to 24 V ac.
    b. Cad-cell safety system.
    c. Manual reset safety.

d. Thermostat: Devices and wiring are specified in Division 23 Section "Instrumentation And Control For Hvac".
OR
Thermostat: Single-stage, 24-V ac, wall-mounting type with 50 to 90 deg F (10 to 32 deg C) operating range and fan on switch.
OR
Thermostat: 2-stage, 24-V ac, wall-mounting type with 50 to 90 deg F (10 to 32 deg C) operating range and fan on switch.
OR
Thermostat: Single-stage, 24-V ac type with duct-mounting sensor and 50 to 90 deg F (10 to 32 deg C) operating range.
OR
Thermostat: 2-stage, 24-V ac type with duct-mounting sensor and 50 to 90 deg F (10 to 32 deg C) operating range.

8. Automatic Fan Thermal Switch: Fan operates with heat-exchanger temperature more than 135 deg F (58 deg C).
9. Discharge Louvers: Independently adjustable horizontal blades.
10. Accessories:
    a. Vertical discharge louvers.
    b. Discharge Nozzle: Discharge at 25 to 65 degrees (0.44 to 1.13 radians) **OR** 50 to 90 degrees (0.87 to 1.57 radians), **as directed**, from horizontal.
    c. Summer fan switch.
    d. Unit-mounted thermostat bracket.
    e. Oil Booster Pump: 30-gph (108-L/h) **OR** 70-gph (252-L/h), **as directed**, capacity; motor and 2-stage fuel unit with pressure-regulating valve and strainer.
    f. Oil safety valve.
    g. Outdoor Combustion-Air Adapter: Sealed to housing and fitted with quick access cover or door and fitting for terminating outdoor-air duct.

1.3 EXECUTION

A. Installation
1. Install and connect gas-fired unit heaters and associated fuel and vent features and systems according to NFPA 54 **OR** CAN/CSA B149.1, **as directed**, applicable local codes and regulations, and manufacturer's written installation instructions.
2. Install and connect oil-fired unit heaters and associated fuel and vent piping according to NFPA 31 **OR** CAN/CSA B139, **as directed**, applicable local codes and regulations, and manufacturer's written installation instructions.
3. Suspended Units: Suspend from substrate using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.
    a. Restrain the unit to resist code-required horizontal acceleration.
4. Substrate-Mounted Units: Provide supports connected to substrate. Secure units to supports.
    a. Spring hangers and seismic restraints are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
    b. Anchor the unit to resist code-required horizontal acceleration.

B. Connections
1. Piping installation requirements are specified in other Division 21. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to fuel-fired unit heater to allow service and maintenance.
3. Gas Piping: Comply with Division 23 Section(s) "Facility Natural-gas Piping" OR "Facility Liquefied-petroleum Gas Piping", **as directed**. Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.

4. Fuel Oil Piping: Comply Division 23 Section "Facility Fuel-oil Piping". Connect to fuel oil supply and return piping with shutoff valve and union at each connection.
5. Vent Connections: Comply with Division 23 Section "Breechings, Chimneys, And Stacks".
6. Electrical Connections: Comply with applicable requirements in Division 22.
   a. Install electrical devices furnished with heaters but not specified to be factory mounted.

C. Field Quality Control
1. Perform tests and inspections and prepare test reports.
2. Tests and Inspections:
   a. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   b. Verify bearing lubrication.
   c. Verify proper motor rotation.
   d. Test Reports: Prepare a written report to record the following:
      1) Test procedures used.
      2) Test results that comply with requirements.
      3) Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
3. Remove and replace malfunctioning units and retest as specified above.

D. Adjusting
1. Adjust initial temperature set points.
2. Adjust burner and other unit components for optimum heating performance and efficiency.

E. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain fuel-fired unit heaters.

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SECTION 23 55 33 00a - UNIT HEATERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for unit heaters. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Cabinet unit heaters with centrifugal fans and hot-water, steam, and electric-resistance heating coils.
b. Propeller unit heaters with hot-water, steam, and electric-resistance heating coils.
c. Wall and ceiling heaters with propeller fans and electric-resistance heating coils.

C. Definitions
1. BAS: Building automation system.
2. CWP: Cold working pressure.
3. PTFE: Polytetrafluoroethylene plastic.
4. TFE: Tetrafluoroethylene plastic.

D. Submittals
1. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
2. LEED Submittal:
a. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1-2004, Section 5 - "Systems and Equipment."
3. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
a. Plans, elevations, sections, and details.
b. Location and size of each field connection.
c. Details of anchorages and attachments to structure and to supported equipment.
d. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
e. Location and arrangement of piping valves and specialties.
f. Location and arrangement of integral controls.
g. Wiring Diagrams: Power, signal, and control wiring.
4. Manufacturer Seismic Qualification Certification: Submit certification that cabinet unit heaters, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
5. Field quality-control test reports.
6. Operation and maintenance data.

E. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
3. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.2 PRODUCTS

A. Cabinet Unit Heaters
1. Description: A factory-assembled and -tested unit complying with ARI 440.
   a. Comply with UL 2021.
2. Coil Section Insulation (for duct-liner-type, glass-fiber insulation): ASTM C 1071; surfaces exposed to airstream shall be aluminum-foil facing **OR** erosion-resistant coating, **as directed**, to prevent erosion of glass fibers.
   a. Thickness: 1/2 inch (13 mm) **OR** 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
   b. Thermal Conductivity (k-Value): 0.26 Btu x in./h x sq. ft. at 75 deg F (0.037 W/m x K at 24 deg C) mean temperature.
   c. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
   d. Adhesive: Comply with ASTM C 916 and with NFPA 90A or NFPA 90B.
   e. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
3. Coil Section Insulation (for flexible elastomeric insulation): Comply with NFPA 90A or NFPA 90B. Unicellular polyethylene thermal plastic, preformed sheet insulation complying with ASTM C 534, Type II, except for density.
   a. Thickness: 3/8 inch (9 mm) **OR** 1/2 inch (13 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**.
   b. Thermal Conductivity (k-Value): 0.24 Btu x in./h x sq. ft. at 75 deg F (0.034 W/m x K at 24 deg C) mean temperature.
   c. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM C 411.
   d. Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
   e. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
4. Cabinet (for surface, semi-recessed, and fully recessed units): Steel with factory prime coating, ready for field painting **OR** baked-enamel finish with manufacturer's standard paint, in color selected by the Owner **OR** baked-enamel finish with manufacturer's custom paint, in color selected by the Owner, **as directed**.
   a. Vertical Unit, Exposed Front Panels: Minimum 0.0528-inch- (1.35-mm-) **OR** 0.0677-inch- (1.7-mm-), **as directed**, thick, galvanized, **as directed**, sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
   b. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0528-inch- (1.35-mm-) **OR** 0.0677-inch- (1.7-mm-), **as directed**, thick, galvanized, **as directed**, sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
   c. Recessing Flanges (for units that are semirecessed or fully recessed in walls or ceilings): Steel, finished to match cabinet.
   d. Control Access Door: Key operated.
   e. Base (for surface, vertical, wall-mounting units): Minimum 0.0528-inch- (1.35-mm-) thick steel, finished to match cabinet, 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, high with leveling bolts.
   f. Extended Piping Compartment: 8-inch- (200-mm-), **as directed**, wide piping end pocket.
   g. False Back (for vertical, wall-mounting units only): Minimum 0.0428-inch- (1.1-mm-) thick steel, finished to match cabinet.
   h. Outdoor-Air Wall Box (for vertical, wall-mounting units only): Minimum 0.1265-inch- (3.2-mm-) thick, aluminum, rain-resistant louver and box with integral eliminators and bird screen. Aluminum louver with anodized **OR** baked-enamel, **as directed**, finish in color selected by the Owner from manufacturer's standard **OR** custom, **as directed**, colors.
      1) Outdoor-Air Damper: Galvanized-steel blades with edge and end seals and nylon bearings; with manual **OR** electronic **OR** pneumatic, **as directed**, two-position actuators.

5. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
   a. Washable Foam: 70 percent arrestance and 3 MERV.
   b. Glass Fiber Treated with Adhesive: 80 percent arrestance and 5 MERV.
   c. Pleated: 90 percent arrestance and 7 MERV.
6. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm) and rated for a minimum working pressure of 200 psig (1378 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain.
   OR
   Steam Coil: Copper distributing, **as directed**, tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm) and rated for a minimum working pressure of 75 psig (517 kPa).
   OR
   Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
7. Fan and Motor Board: Removable.
   a. Fan: Forward curved, high static, **as directed**, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
   b. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
   c. Wiring Terminations: Connect motor to chassis wiring with plug connection.
8. Factory, Hot-Water Piping Package: ASTM B 88, Type L (ASTM B 88M, Type B) **OR** ASTM B 88, Type M (ASTM B 88M Type C), **as directed**, copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet and outlet.
   a. Two **OR** Three, **as directed**,-way, two-position **OR** modulating, **as directed**, control valve. Three-way valve packages shall include bypass line with manually adjustable balance device, **as directed**.
   b. Hose Kits: Minimum 400-psig (2758-kPa) working pressure, and operating temperatures from 33 to 211 deg F (0.5 to 99 deg C). Tag hose kits to equipment designations.
      1) Length: 24 inches (600 mm) **OR** 36 inches (900 mm), **as directed**,.
      2) Minimum Diameter: Equal to cabinet unit heater connection size.
   c. Two-Piece, Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig (4140-kPa) minimum CWP rating and blowout-proof stem.
   d. Calibrated-Orifice Balancing Valves: Bronze body, ball type, 125-psig (860-kPa) working pressure, 250 deg F (121 deg C) maximum operating temperature; with calibrated orifice or venture, connection for portable differential pressure meter with integral seals, threaded ends, and equipped with a memory stop to retain set position.
   e. Automatic Flow-Control Valve: Brass or ferrous-metal body, 300-psig (2068-kPa) working pressure at 250 deg F (121 deg C), with removable, corrosion-resistant, tamperproof, self-cleaning, piston-spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of 2 to 80 psig (13.8 to 552 kPa).
   f. Y-Pattern, Hot-Water Strainers: Cast-iron body (ASTM A 126, Class B); 125-psig (860-kPa) minimum working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 (DN 15) threaded pipe and full-port ball valve in strainer drain connection.
   g. Wrought-Copper Unions: ASME B16.22.
9. Control devices and operational sequences are specified in Division 23 Section(s) "Instrumentation And Control For Hvac" AND "Sequence Of Operations For Hvac Controls".
10. Basic Unit Controls:
    a. Control voltage transformer.
    b. Wall-mounting **OR** Unit-mounted, **as directed**, thermostat with the following features.
       1) Heat-off switch.

2) Fan on-auto switch.
3) Manual fan speed switch (for use with multispeed motors).
4) Adjustable deadband.
5) Concealed **OR** Exposed, **as directed**, set point.
6) Concealed **OR** Exposed, **as directed**, indication.
7) Deg F (Deg C) indication.

c. Wall-mounting **OR** Unit-mounted, **as directed**, temperature sensor.
d. Unoccupied period override push button.
e. Data entry and access port.
1) Input data includes room temperature, and occupied and unoccupied periods.
2) Output data includes room temperature, supply-air temperature, entering-water temperature, operating mode, and status.

11. DDC, **as directed**, Terminal Controller:
a. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
b. Unoccupied Period Override: Two, **as directed**, hours.
c. Unit Supply-Air Fan Operations:
1) Occupied Periods: Fan runs continuously.
2) Unoccupied Periods: Fan cycles to maintain setback room temperature.

d. Heating Coil Operations:
1) Occupied Periods: Open control valve **OR** Modulate control valve **OR** Energize electric-resistance coil, **as directed**, to provide heating if room temperature falls below thermostat set point.
2) Unoccupied Periods: Start fan and open control valve **OR** modulate control valve **OR** energize electric-resistance coil, **as directed**, if room temperature falls below setback temperature.

e. Outdoor-Air Damper Operation:
1) Occupied Periods: Open dampers. Delay damper opening if room temperature is more than three degrees below set point.
2) Unoccupied Periods: Close damper.

f. Controller shall have volatile-memory backup.

12. BAS Interface Requirements:
a. Interface relay for scheduled operation.
b. Interface relay to provide indication of fault at central workstation.
c. Interface shall be BAC-net **OR** LonWorks, **as directed**, compatible for central BAS workstation and include the following functions:
1) Adjust set points.
2) Cabinet unit heater start, stop, and operating status.
3) Data inquiry, including outdoor-air damper position, **as directed**, supply-air and room-air temperature.
4) Occupied and unoccupied schedules.

13. Electrical Connection: Factory wire motors and controls for a single field connection.

B. Propeller Unit Heaters
1. Description: An assembly including casing, coil, fan, and motor in vertical **OR** horizontal **OR** vertical and horizontal, **as directed**, discharge configuration with adjustable discharge louvers.
2. Comply with UL 2021, for electric unit heaters.
3. Comply with UL 823, for explosion-proof electric unit heaters.
4. Cabinet: Removable panels for maintenance access to controls.
5. Cabinet Finish: Manufacturer's standard **OR** custom, **as directed**, baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
7. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

8. General Coil Requirements: Test and rate hot-water **OR** steam, **as directed**, propeller unit heater coils according to ASHRAE 33.
9. Hot-Water Coil: Copper tube, minimum 0.025-inch (0.635-mm) wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm) and rated for a minimum working pressure of 200 psig (1380 kPa) and a maximum entering-water temperature of 325 deg F (163 deg C), with manual air vent. Test for leaks to 350 psig (2413 kPa) underwater.
   OR
   Hot-Water Coil: Cupronickel tube, minimum 0.031-inch (0.78-mm) wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm) and rated for a minimum working pressure of 400 psig (2760 kPa) and a maximum entering-water temperature of 450 deg F (232 deg C), with manual air vent. Test for leaks to 600 psig (4137 kPa) underwater.
   OR
   Hot-Water Coil: Red brass tube, minimum 0.049-inch (1.24-mm) wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm) and rated for a minimum working pressure of 260 psig (1793 kPa) and a maximum entering-water temperature of 390 deg F (199 deg C), with manual air vent. Test for leaks to 390 psig (2689 kPa) underwater.
   OR
   Hot-Water Coil: Steel tube, minimum 0.049-inch (1.24-mm) wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm) and rated for a minimum working pressure of 400 psig (2760 kPa) and a maximum entering-water temperature of 450 deg F (232 deg C), with manual air vent. Test for leaks to 600 psig (4137 kPa) underwater.
   OR
   Hot-Water Coil: Vertical steel tube, minimum 0.065-inch (1.65-mm) wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm) and rated for a minimum working pressure of 400 psig (2760 kPa) and a maximum entering-water temperature of 450 deg F (232 deg C), with steel headers at top and bottom. Test for leaks to 600 psig (4137 kPa) underwater.
   OR
   Steam Coil: Copper tube, minimum 0.025-inch (0.635-mm) wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm) and rated for a minimum working pressure of 75 psig (520 kPa).
   OR
   Steam Coil: Red brass tube, minimum 0.049-inch (1.24-mm) wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm) and rated for a minimum working pressure of 75 psig (520 kPa).
   OR
   Steam Coil: Vertical steel tube, minimum 0.065-inch (1.65-mm) wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm) and rated for a minimum working pressure of 100 psig (690 kPa) **OR** 200 psig (1380 kPa), **as directed**, with steel headers at top and bottom.
10. Electric-Resistance Heating Elements: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch (4 mm). Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F (288 deg C) at any point during normal operation.
    a. Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters.
    b. Wiring Terminations: Stainless-steel or corrosion-resistant material.
11. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.
12. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
    a. Motor Type: Permanently lubricated, explosion proof **OR** multispeed **OR** variable speed, **as directed**.
13. Control Devices:
    a. Unit-mounted **OR** Wall-mounting, **as directed**, variable, **as directed**, fan-speed switch.
    b. Unit-mounted **OR** Wall-mounting, **as directed**, thermostat.

C. Wall And Ceiling Heaters
1. Description: An assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.
2. Cabinet:
   a. Front Panel: Stamped-steel louver **OR** Extruded-aluminum bar grille, **as directed**, with removable panels fastened with tamperproof fasteners.
   b. Finish: Baked enamel over baked-on primer with manufacturer's standard **OR** custom, **as directed**, color selected by the Owner, applied to factory-assembled and -tested wall and ceiling heaters before shipping.
   c. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
3. Surface-Mounting Cabinet Enclosure: Steel with finish to match cabinet.
4. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high temperature protection. Provide integral circuit breaker for overcurrent protection, **as directed**.
5. Fan: Aluminum propeller directly connected to motor.
   a. Motor: Permanently lubricated, multispeed, **as directed**. Comply with requirements inDivision 23 Section "Common Motor Requirements For Hvac Equipment".
6. Controls: Unit-mounted thermostat. Low-voltage relay with transformer kit, **as directed**.
7. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch, **as directed**.

1.3 EXECUTION

A. Installation
1. Install wall boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Division 07 Section "Joint Sealants".
2. Install cabinet unit heaters to comply with NFPA 90A.
3. Install propeller unit heaters level and plumb.
4. Suspend cabinet unit heaters from structure with elastomeric hangers and seismic restraints, **as directed**. Vibration isolators and seismic restraints, **as directed**, are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
5. Suspend propeller unit heaters from structure with all-thread hanger rods and elastomeric hangers **OR** spring hangers **OR** spring hangers with vertical-limit stop, **as directed**. Hanger rods and attachments to structure are specified in Division 23 Section "Hangers And Supports For Hvac Piping And Equipment". Vibration hangers are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
6. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.
7. Install new filters in each fan-coil unit within two weeks of Final Completion.

B. Connections
1. Piping installation requirements are specified in other Division 21. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to machine to allow service and maintenance.
3. Connect piping to cabinet unit heater's factory, hot-water piping package. Install the piping package if shipped loose.
4. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Division 23 Section "Air Duct Accessories".
5. Comply with safety requirements in UL 1995.

6. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of unit heater. Hydronic specialties are specified in Division 23 Section "Hydronic Piping".
7. Unless otherwise indicated, install union and gate or ball valve on steam-supply connection and union, strainer, steam trap, and gate or ball valve on condensate-return connection of unit heater. Steam specialties are specified in Division 23 Section "Steam And Condensate Heating Piping".
8. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
9. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Field Quality Control
1. Perform the following field tests and inspections and prepare test reports:
    a. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
    b. Operate electric heating elements through each stage to verify proper operation and electrical connections.
    c. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
2. Remove and replace malfunctioning units and retest as specified above.

D. Adjusting
1. Adjust initial temperature set points.
2. Occupancy Adjustments: When requested within 12 months of date of Final Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

E. Demonstration
1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters.

END OF SECTION 23 55 33 00a

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Task	Specification	Specification Description
23 55 33 00	01 22 16 00	No Specification Required

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SECTION 23 57 13 00 - HEAT EXCHANGERS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for hydronic and steam heat exchangers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes shell-and-tube and plate heat exchangers.

C. Submittals
   1. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
   2. Coordination Drawings: Equipment room, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
      a. Tube-removal space.
      b. Structural members to which heat exchangers will be attached.
   3. Manufacturer Seismic Qualification Certification: Submit certification that heat exchanger, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".

D. Quality Assurance
   1. ASME Compliance: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

1.2 PRODUCTS

A. Shell-And-Tube Heat Exchangers
   1. Configuration: U-tube with removable bundle.
   2. Shell Materials: Steel.
   3. Head:
      a. Materials: Cast iron **OR** Cast stainless steel **OR** Fabricated steel **OR** Fabricated steel with removable cover **OR** Fabricated stainless steel **OR** Fabricated stainless steel with removable cover, **as directed**.
      b. Flanged and bolted to shell.
   4. Tube:
      a. Seamless copper **OR** Steel **OR** Stainless-steel **OR** Cupronickel **OR** Admiralty-metal, **as directed,** tubes.
      b. Tube diameter is determined by manufacturer based on service.
   5. Tubesheet Materials: Steel **OR** Stainless-steel, **as directed,** tubesheets.
   6. Baffles: Steel **OR** Stainless steel, **as directed**.
   7. Piping Connections:
      a. Shell: Flanged inlet and threaded **OR** Threaded inlet and **OR** Flanged inlet and, **as directed,** outlet fluid connections, threaded drain, and vent connections.
      b. Head: Threaded **OR** Flanged, **as directed,** inlet and outlet fluid connections.
   8. Support Saddles:
      a. Fabricated of material similar to shell.
      b. Foot mount with provision for anchoring to support.

c. Fabricate attachment of saddle supports to pressure vessel with reinforcement strong enough to resist heat-exchanger movement during a seismic event when heat-exchanger saddles are anchored to building structure.

B. Gasketed Plate Heat Exchangers
1. Configuration: Freestanding assembly consisting of frame support, top and bottom carrying and guide bars, fixed and movable end plates, tie rods, individually removable plates, and one-piece gaskets.
2. Frame:
a. Capacity to accommodate 20 percent additional plates.
b. Painted carbon steel with provisions for anchoring to support.
3. Top and Bottom Carrying and Guide Bars: Painted carbon steel, aluminum, or stainless steel.
a. Fabricate attachment of heat-exchanger carrying and guide bars with reinforcement strong enough to resist heat-exchanger movement during a seismic event when heat-exchanger carrying and guide bars are anchored to building structure.
4. End-Plate Material: Painted carbon steel.
5. Tie Rods and Nuts: Steel or stainless steel.
6. Plate Material: 0.024 inch (0.6 mm) **OR** 0.031 inch (0.8 mm) **OR** 0.039 inch (1 mm), **as directed,** thick before stamping; Type 304 **OR** 304L **OR** 316 **OR** 316L, **as directed,** stainless steel.
7. Gasket Material: Nitrile rubber **OR** EPDM, **as directed**.
8. Piping Connections:
a. Threaded port for NPS 2 (DN 50) and smaller. For larger sizes, furnish end-plate port with threaded studs suitable for flanged connection.
b. End plate with welded carbon-steel nozzles. Threaded pipe connection for NPS 2 (DN 50) and smaller; carbon-steel flanged pipe connection for larger sizes.
c. Line wetted surfaces with same material as plates.
9. Enclose plates in a solid aluminum **OR** stainless-steel, **as directed,** removable shroud.

C. Brazed Plate Heat Exchangers
1. Configuration: Brazed assembly consisting of two end plates, one with threaded nozzles and pattern-embossed plates.
2. End-Plate Material: Type 316 stainless steel.
3. Threaded Nozzles: Type 316 stainless steel.
4. Plate Material: Type 316 stainless steel.
5. Brazing Material: Copper or nickel.

1.3 EXECUTION

A. Heat-Exchanger Installation
1. Install shell-and-tube heat exchangers on saddle supports.
2. Install shell-and-tube heat exchangers on, and anchor to, concrete base.

B. Connections
1. Install shutoff valves at heat-exchanger inlet and outlet connections.
2. Install relief valves on heat-exchanger heated-fluid connection and install pipe relief valves, full size of valve connection, to floor drain.
3. Install vacuum breaker at heat-exchanger steam inlet connection.
4. Install hose end valve to drain shell.

END OF SECTION 23 57 13 00

Task	Specification	Specification Description
23 57 16 00	23 57 13 00	Heat Exchangers
23 57 19 13	23 57 13 00	Heat Exchangers
23 57 19 19	23 57 13 00	Heat Exchangers
23 57 19 23	23 57 13 00	Heat Exchangers

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SECTION 23 61 16 00 - CENTRIFUGAL WATER CHILLERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for centrifugal water chillers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Packaged, water-cooled, electric-motor-driven centrifugal chillers.
b. Packaged, portable refrigerant recovery units.
c. Heat-exchanger, brush-cleaning system.

C. Definitions
1. BAS: Building automation system.
2. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.
3. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.
4. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and referenced to ARI standard rating conditions.
5. kW/Ton (kW/kW): The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons (kW) at any given set of rating conditions.
6. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and intended for operating conditions other than the ARI standard rating conditions.

D. Performance Requirements
1. Seismic Performance: Centrifugal chillers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Condenser-Fluid Temperature Performance:
a. Startup Condenser-Fluid Temperature: Chiller shall be capable of starting with an entering condenser-fluid temperature of 60 deg F (16 deg C) **OR** 55 deg F (13 deg C) **OR** 40 deg F (4 deg C), **as directed**, and providing stable operation until the system temperature is elevated to the minimum operating entering condenser-fluid temperature.
b. Minimum Operating Condenser-Fluid Temperature: Chiller shall be capable of continuous operation over the entire capacity range indicated with an entering condenser-fluid temperature of 65 deg F (18 deg C) **OR** 60 deg F (16 deg C) **OR** 55 deg F (13 deg C), **as directed**.
c. Make factory modifications to standard chiller design if necessary to comply with performance indicated.
3. Site Altitude: Chiller shall be suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.
4. Performance Tolerance: Comply with the following in lieu of ARI 550/590, **as directed**:
a. Allowable Capacity Tolerance: Zero percent.
b. Allowable IPLV/NPLV Performance Tolerance: Zero percent.

E. Submittals

1. Product Data: For each type of product indicated. Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
2. LEED Submittal:
   a. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.
3. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   a. Detail equipment assemblies and indicate dimensions, weights, load distribution, required clearances, method of field assembly, components, and location and size of each field connection.
   b. Wiring Diagrams: For power, signal, and control wiring.
4. Certificates: For certification required in "Quality Assurance" Article.
5. Seismic Qualification Certificates: For chillers, accessories, and components, from manufacturer.
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
6. Startup service reports.
7. Operation and maintenance data.
8. Warranty: Sample of special warranty.

F. Quality Assurance
1. ARI Certification: Certify chiller according to ARI 550 certification program.
2. ARI Rating: Rate chiller performance according to requirements in ARI 550/590.
3. ASHRAE Compliance:
   a. ASHRAE 15 for safety code for mechanical refrigeration.
   b. ASHRAE 147 for refrigerant leaks, recovery, and handling and storage requirements.
4. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
5. ASME Compliance: Fabricate and label chillers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, as applicable to chiller design. For chillers charged with R-134a refrigerant, include an ASME U-stamp and nameplate certifying compliance.
6. Comply with NFPA 70.
7. Comply with requirements of UL and UL Canada, and include label by a qualified testing agency showing compliance.
8. Green Seal Compliance: Signed by manufacturer **OR** Green Seal, **as directed**, certifying compliance with GS-31.

G. Delivery, Storage, And Handling
1. Ship chillers from the factory fully charged with refrigerant.
   OR
   Ship each chiller with a full charge of refrigerant. Charge each chiller with nitrogen if refrigerant is shipped in containers separate from chiller.
2. Ship each oil-lubricated chiller with a full charge of oil.
   a. Ship oil factory installed in chiller **OR** in containers separate from chiller, **as directed**.
3. Package chiller for export shipping in totally enclosed bagging **OR** crate **OR** crate with bagging, **as directed**.

H. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chillers that fail in materials or workmanship within specified warranty period.
   a. Extended warranties include, but are not limited to, the following:
      1) Complete chiller including refrigerant and oil charge.
         OR

Complete compressor and drive assembly including refrigerant and oil charge.
OR
Refrigerant **OR** Refrigerant and oil, **as directed**, charge.
2) Parts only **OR** Parts and labor, **as directed**.
3) Loss of refrigerant charge for any reason.
b. Warranty Period: Two **OR** Three **OR** Four **OR** Five, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Manufactured Unit
1. Description: Factory-assembled and -tested chiller complete with compressor, compressor motor, compressor motor controller, evaporator **OR** lubrication system evaporator, **as directed**, condenser, heat-reclaim condenser as indicated, controls, interconnecting unit piping and wiring, and indicated accessories.
a. Disassemble chiller into major assemblies as required by the installation after factory testing and before packaging for shipment.
b. For chillers with dual compressors, provide each compressor with a dedicated motor and motor controller, and provide for continued operation when either compressor-drive assembly fails or is being serviced.
2. Fabricate chiller mounting base with reinforcement strong enough to resist chiller movement during a seismic event when chiller is anchored to field support structure.

B. Compressor-Drive Assembly
1. Description: Single-stage or multistage, variable-displacement, centrifugal-type compressor driven by an electric motor.
a. Where indicated, provide oil-free compressor technology using a permanent magnet synchronous motor, magnetic bearings, integral variable frequency controller, and digital electronic controls.
2. Compressor:
a. Casing: Cast iron, precision ground.
b. Impeller: High-strength cast aluminum or cast-aluminum alloy on carbon- or alloy-steel shaft.
3. Drive: Direct-drive, hermetic **OR** Gear-drive, hermetic **OR** Gear-drive, open **OR** Direct- or gear-drive, hermetic **OR** Direct- or gear-drive, open or hermetic, **as directed**, design using an electric motor as the driver.
a. Gear Drives: For chillers with gear drives, provide single- or double-helical gear design continuously coated with oil while chiller is operating. Gears shall comply with American Gear Manufacturer Association standards.
b. Drive Coupling: For chillers with open drives, provide flexible disc with all-metal construction and no wearing parts to ensure long life without the need for lubrication.
c. Seals: Seal drive assembly to prevent refrigerant leakage.
4. Compressor Motor:
a. Continuous-duty, squirrel-cage, induction-type, two-pole motor with energy efficiency required to suit chiller energy efficiency indicated.
b. Factory mounted, aligned, and balanced as part of compressor assembly before shipping.
c. Motor shall be of sufficient capacity to drive compressor throughout entire operating range without overload and with sufficient capacity to start and accelerate compressor without damage.
d. For chillers with open drives, provide motor with open-dripproof **OR** weather-protected, Type I **OR** weather-protected, Type II **OR** totally enclosed, **as directed**, enclosure.
e. Provide motor with thermistor or RTD in single motor winding **OR** each of three-phase motor windings, **as directed**, to monitor temperature and report information to chiller control panel.

f. Provide motor with thermistor or RTD to monitor bearing temperature and report information to chiller control panel.
g. Provide open-drive motor with internal electric heater, internally powered from chiller power supply.

5. Vibration Balance: Balance chiller compressor and drive assembly to provide a precision balance that is free of noticeable vibration over the entire operating range.
   a. Overspeed Test: 25 percent above design operating speed.
6. Service: Easily accessible for inspection and service.
   a. Compressor's internal components shall be accessible without having to remove compressor-drive assembly from chiller.
   b. Provide lifting lugs or eyebolts attached to casing.
7. Economizers: For multistage chillers, provide interstage economizers.
8. Capacity Control: Modulating, variable-inlet, guide-vane assembly combined with hot-gas bypass, if necessary, to achieve performance indicated.
   a. Maintain stable operation that is free of surge, cavitation, and vibration throughout range of operation. Configure to achieve most energy-efficient operation possible.
   b. Operating Range: From 100 to 15 **OR** 10 **OR** 5 **OR** zero, **as directed**, percent of design capacity.
   c. Condenser-Fluid Unloading Requirements over Operating Range: Constant-design entering condenser-fluid temperature **OR** Drop-in entering condenser-fluid temperature of 2.5 deg F (1.4 deg C) for each 10 percent in capacity reduction, **as directed**.
   d. Chillers with variable frequency controllers shall modulate compressor speed with variable-inlet, guide-vane control to achieve optimum energy efficiency.
9. Oil Lubrication System: Consisting of pump, filtration, heater, **as directed**, cooler, factory-wired power connection, and controls.
   a. Provide lubrication to bearings, gears, and other rotating surfaces at all operating, startup, coastdown, and standby conditions including power failure.
   b. Manufacturer's standard method **OR** Thermostatically controlled oil heater properly sized, **as directed**, to remove refrigerant from oil.
   c. Oil filter **OR** Dual oil filers, one redundant, **as directed**, shall be the easily replaceable cartridge type, minimum 0.5-micron efficiency, with means of positive isolation while servicing.
   d. Refrigerant **OR** Water, **as directed**,-cooled oil cooler.
   e. Factory-installed and pressure-tested piping with isolation valves and accessories.
   f. Oil compatible with refrigerant and chiller components.
   g. Positive visual indication of oil level.

C. Refrigeration

1. Refrigerant:
   a. Type: R-123; ASHRAE 34, Class B1 **OR** R-134a; ASHRAE 34, Class A1**,** as directed.
   b. Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
2. Refrigerant Flow Control: Manufacturer's standard refrigerant flow-control device satisfying performance requirements indicated.
3. Pressure Relief Device:
   a. Comply with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   b. For Chillers Using R-123: Rupture disc constructed of frangible carbon **OR** Spring-loaded, pressure relief valve; single- or multiple-reseating type, **as directed**.
   c. For Chillers Using R-134a: ASME-rated, spring-loaded, pressure relief valve; single- or multiple-reseating type. Pressure relief valve(s) shall be provided for each heat exchanger. Condenser shall have dual valves with one being redundant and configured to allow either valve to be replaced without loss of refrigerant.

4. Refrigeration Transfer: Provide service valves and other factory-installed accessories required to facilitate transfer of refrigerant from chiller to a remote refrigerant storage and recycling system. Comply with requirements in ASHRAE 15 and ASHRAE 147.
5. Refrigerant Isolation for Chillers Using R-134a: Factory install positive shutoff, manual, **as directed**, isolation valves in the compressor discharge line to the condenser and the refrigerant liquid line leaving the condenser to allow for isolation and storage of full refrigerant charge in the chiller condenser shell. In addition, provide isolation valve on suction side of compressor from evaporator to allow for isolation and storage of full refrigerant charge in the chiller evaporator shell, **as directed**.
6. Purge System:
    a. For chillers operating at subatmospheric pressures (using R-123 refrigerant), factory install an automatic purge system for collection and return of refrigerant and lubricating oil and for removal of noncondensables including, but not limited to, water, water vapor, and noncondensable gases.
    b. System shall be a thermal purge design, refrigerant or air cooled, equipped with a carbon filter that includes an automatic regeneration cycle.
    c. Factory wire to chiller's main power supply and system complete with controls, piping, and refrigerant valves to isolate the purge system from the chiller.
    d. Construct components of noncorrodible materials.
    e. Controls shall interface with chiller control panel to indicate modes of operation, set points, data reports, diagnostics, and alarms.
    f. Efficiency of not more than 0.02 lb of refrigerant per pound of air (9 g of refrigerant per gram of air) when rated according to ARI 580.
    g. Operation independent of chiller per ASHRAE 147.
7. Positive-Pressure System:
    a. For chillers operating at subatmospheric pressures (using R-123 refrigerant), factory install an automatic positive-pressure system.
    b. During nonoperational periods, positive-pressure system shall automatically maintain a positive pressure for atmosphere in the refrigerant pressure vessel of not less than 0.5 psig (3 kPa) (adjustable) up to a pressure that remains within the vessel design pressure limits.
    c. System shall be factory wired and include controller, electric heat, pressure transmitter, or switch.

D. Evaporator
1. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from condenser.
2. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.
3. Designed to prevent liquid refrigerant carryover from entering compressor.
4. Provide evaporator with sight glass or other form of positive visual verification of liquid-refrigerant level.
5. Tubes:
    a. Individually replaceable from either end and without damage to tube sheets and other tubes.
    b. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
    c. Material: Copper **OR** Copper-nickel alloy **OR** Stainless steel **OR** Titanium, **as directed**.
    d. Nominal OD: Manufacturer's choice **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**.
    e. Minimum Wall Thickness: Manufacturer's choice **OR** 0.025 inch (0.6 mm) **OR** 0.028 inch (0.7 mm) **OR** 0.035 inch (0.9 mm), **as directed**.
    f. External Finish: Manufacturer's standard.
    g. Internal Finish: Enhanced **OR** Smooth, **as directed**.
6. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.
7. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.

8. Water Box:
   a. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
   b. Standard **OR** Marine, **as directed**, type for water box with piping connections. Standard type for water box without piping connections.
   c. Provide water boxes and marine water-box covers, **as directed**, with lifting lugs or eyebolts.
   d. Hinged **OR** Davited, **as directed**, water boxes.
   OR
   Hinged **OR** Davited, **as directed**, marine water-box covers.
   e. Nozzle Pipe Connections: Welded, ASME B16.5, flat-face flange **OR** Welded, ASME B16.5, raised-face flange **OR** Grooved for mechanical-joint coupling **OR** Grooved with mechanical-joint coupling and flange adapter, **as directed**.
   f. Thermistor or RTD temperature sensor factory installed in each nozzle.
   g. Fit each water box with 3/4-inch (19-mm) **OR** 1-inch (25-mm), **as directed**, drain connection at low point and vent connection at high point, each with threaded plug.
9. Additional Corrosion Protection:
   a. Electrolytic corrosion-inhibitor anode.
   b. Coat wetted surfaces with a corrosion-resistant finish.
   OR
   Using same material as tubes, clad surfaces of end tube sheets in contact with fluid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.

E. Condenser
1. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from evaporator.
2. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.
3. Designed to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes.
4. Provide condenser with sight glass or other form of positive visual verification of refrigerant charge and condition.
5. Tubes:
   a. Individually replaceable from either end and without damage to tube sheets and other tubes.
   b. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
   c. Material: Copper **OR** Copper-nickel alloy **OR** Stainless steel **OR** Titanium, **as directed**.
   d. Nominal OD: Manufacturer's choice **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**
   e. Minimum Wall Thickness: Manufacturer's choice **OR** 0.025 inch (0.6 mm) **OR** 0.028 inch (0.7 mm) **OR** 0.035 inch (0.9 mm), **as directed**.
   f. External Finish: Manufacturer's standard.
   g. Internal Finish: Enhanced **OR** Smooth, **as directed**.
6. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.
7. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.
8. Water Box:
   a. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
   b. Standard **OR** Marine, **as directed**, type for water box with piping connections. Standard type for water box without piping connections.
   c. Provide water boxes and marine water-box covers, **as directed**, with lifting lugs or eyebolts.
   d. Hinged **OR** Davited, **as directed**, water boxes.
   OR

Hinged **OR** Davited, **as directed**, marine water-box covers.

e. Nozzle Pipe Connections: Welded, ASME B16.5, flat-face flange **OR** Welded, ASME B16.5, raised-face flange **OR** Grooved for mechanical-joint coupling **OR** Grooved with mechanical-joint coupling and flange adapter, **as directed**.

f. Thermistor or RTD temperature sensor factory installed in each nozzle.

g. Fit each water box with 3/4-inch (19-mm) **OR** 1-inch (25-mm), **as directed**, drain connection at low point and vent connection at high point, each with threaded plug.

9. Additional Corrosion Protection:

a. Electrolytic corrosion-inhibitor anode.

b. Coat wetted surfaces with a corrosion-resistant finish.
OR
Using same material as tubes, clad surfaces of end tube sheets in contact with fluid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.

F. Heat-Reclaim Condenser

1. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from evaporator and condenser.
2. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.
3. Designed to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes.
4. Tubes:

a. Individually replaceable from either end and without damage to tube sheets and other tubes.

b. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.

c. Material: Copper **OR** Copper-nickel alloy **OR** Stainless steel **OR** Titanium, **as directed**.

d. Nominal OD: Manufacturer's choice **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**.

e. Minimum Wall Thickness: Manufacturer's choice **OR** 0.025 inch (0.6 mm) **OR** 0.028 inch (0.7 mm) **OR** 0.035 inch (0.9 mm), **as directed**.

f. External Finish: Manufacturer's standard.

g. Internal Finish: Enhanced **OR** Smooth, **as directed**.

5. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.
6. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.
7. Water Box:

a. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.

b. Standard **OR** Marine, **as directed**, type for water box with piping connections. Standard type for water box without piping connections.

c. Provide water boxes and marine water-box covers, **as directed**, with lifting lugs or eyebolts.

d. Hinged **OR** Davited, **as directed**, water boxes.
OR
Hinged **OR** Davited, **as directed**, marine water-box covers.

e. Nozzle Pipe Connections: Welded, ASME B16.5, flat-face flange **OR** Welded, ASME B16.5, raised-face flange **OR** Grooved for mechanical-joint coupling **OR** Grooved with mechanical-joint coupling and flange adapter, **as directed**.

f. Thermistor or RTD temperature sensor factory installed in each nozzle.

g. Fit each water box with 3/4-inch (19-mm) **OR** 1-inch (25-mm), **as directed**, drain connection at low point and vent connection at high point, each with threaded plug.

8. Additional Corrosion Protection:

a. Electrolytic corrosion-inhibitor anode.

b. Coat wetted surfaces with a corrosion-resistant finish.
OR

Using same material as tubes, clad surfaces of end tube sheets in contact with fluid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.

G. Insulation
1. Closed-cell, flexible elastomeric thermal insulation complying with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
   a. Thickness: 3/4 inch (19 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
2. Adhesive: As recommended by insulation manufacturer.
3. Factory-applied insulation over all cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator shell and end tube sheets, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.
   a. Apply adhesive to 100 percent of insulation contact surface.
   b. Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
   c. Seal seams and joints to provide a vapor barrier.
   d. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.

H. Electrical
1. Factory installed and wired, and functionally tested at factory before shipment.
2. Single-point, field-power connection to fused disconnect switch **OR** nonfused disconnect switch **OR** circuit breaker, **as directed**. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 42,000 **OR** 65,000, **as directed**, A.
   a. Branch power circuit to each motor, electric heater, dedicated electrical load, and controls with disconnect switch or circuit breaker, **as directed**.
      1) NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
      2) NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit-trip set point.
   b. NEMA ICS 2-rated motor controller for auxiliary motors, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller for each variable-speed motor furnished.
   c. Control-circuit transformer with primary and secondary side fuses.
3. Terminal blocks with numbered and color-coded, **as directed**, wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
4. Factory-installed wiring outside of enclosures shall be in metal raceway except make terminal connections with not more than a 24-inch (610-mm) length of liquidtight **OR** flexible metallic, **as directed**, conduit.
5. Factory install and wire capacitor bank for the purpose of power factor correction to 0.95 at all operating conditions.
   a. If capacitors are mounted in a dedicated enclosure, use same NEMA enclosure type as motor controller. Provide enclosure with service entrance knockouts and bushings for conduit.
   b. Capacitors shall be non-PCB dielectric fluid, metallized electrode design, low loss with low-temperature rise. The kVAr ratings shall be indicated and shall not exceed the maximum limitations set by NFPA 70. Provide individual cells as required.
   c. Provide each cell with current-limiting replaceable fuses and carbon-film discharge resistors to reduce residual voltage to less than 50 V within one minute after de-energizing.
   d. Provide a ground terminal and a terminal block or individual connectors for phase connection.

I. Motor Controller

1. Enclosure: Factory installed, unit mounted **OR** Factory furnished, field mounted, **as directed**, NEMA 250 **OR** NEMA ICS 6, **as directed**, Type 1 **OR** Type 4 **OR** Type 4X **OR** Type 12, **as directed**, with hinged full-front access door with lock and key or padlock and key, **as directed**.
2. Control Circuit: Obtained from integral control power transformer, **as directed**, with a control power transformer **OR** source, **as directed**, of enough capacity to operate connected control devices.
3. Overload Relay: Shall be sized according to UL 1995 or shall be an integral component of chiller control microprocessor.
4. Across-the-Line Controller: NEMA ICS 2, Class A, full voltage, nonreversing; include isolation switch and current-limiting fuses.
5. Star-Delta, Reduced-Voltage Controller: NEMA ICS 2, closed transition.
6. Autotransformer Reduced-Voltage Controller: NEMA ICS 2, closed transition; include isolation switch and current-limiting fuses.
7. Solid-State, Reduced-Voltage Controller: NEMA ICS 2.
   a. Surge suppressor in solid-state power circuits providing three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
   b. Visual indication of motor and control status, including the following conditions:
      1) Controller on.
      2) Overload trip.
      3) Loss of phase.
      4) Starter fault.
8. Accessories: Devices shall be factory installed in controller enclosure unless otherwise indicated.
   a. Externally Operated, Door-Interlocked, **as directed**, Disconnect: Fused disconnect switch **OR** Nonfused disconnect switch **OR** Circuit breaker, **as directed**. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 42,000 **OR** 65,000, **as directed**, A.
   b. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
   c. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
   d. Control Relays: Time-delay relays.
   e. Elapsed-Time Meters: Numerical readout in hours on face of enclosure.
   f. Number-of-Starts Counter: Numerical readout on face of enclosure.
   g. Meters: Panel type, 2-1/2 inches (64 mm) **OR** 4-1/4 inches (108 mm), **as directed**, with 90 **OR** 120 **OR** 270, **as directed**,-degree scale and 1 **OR** 2, **as directed**, percent accuracy. Where indicated, provide transfer device with an off position. Meters shall indicate the following:
      1) Ammeter: Output current for each phase, with current sensors rated to suit application.
      2) Voltmeter: Output voltage for each phase.
      3) Frequency Meter, **as directed**: Output frequency.
      4) Real-time clock with current time and date.
      5) Total run time.

      OR

      Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
      1) Selectable, digital display of the following:
         a) Phase Currents, Each Phase: Plus or minus 1 percent.
         b) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
         c) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
         d) Three-Phase Real Power: Plus or minus 2 percent.
         e) Three-Phase Reactive Power: Plus or minus 2 percent.
         f) Power Factor: Plus or minus 2 percent.
         g) Frequency: Plus or minus 0.5 percent.
         h) Integrated Demand with Demand Interval Selectable from Five to 60 Minutes: Plus or minus 2 percent.

i) Accumulated energy, in megawatt hours (joules), plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.

2) Mounting: Display and control unit flush or semirecessed in instrument compartment door.

h. Phase-Failure, Phase-Reversal, Undervoltage Relays: Solid-state sensing circuit with adjustable undervoltage setting and isolated output contacts for hardwired connection.

i. Power Protection: Chiller shall shut down within six cycles of power interruption.

J. Variable Frequency Controller

1. Motor controller shall be factory mounted and wired on the chiller to provide a single-point, field-power termination to the chiller and its auxiliaries.
2. Description: NEMA ICS 2; listed and labeled as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.
3. Enclosure: Unit mounted, NEMA 250, Type 1 **OR** Type 4 **OR** Type 4x **OR** Type 12, **as directed**, with hinged full-front access door with lock and key.
4. Integral Disconnecting Means: Door-interlocked, **as directed**, NEMA AB 1, instantaneous-trip circuit breaker with lockable handle. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 42,000 **OR** 65,000, **as directed**, A.
5. Technology: Pulse width modulated (PWM) output with insulated gate bipolar transistors (IGBT); suitable for variable torque loads.
6. Controller shall consist of a rectifier converter section, a digital/analog driver regulator section, and an inverter output section.
   a. Rectifier section shall be a full-wave diode bridge that changes fixed-voltage, fixed-frequency, ac line power to a fixed dc voltage. Silicon controller rectifiers, current source inverters, and paralleling of devices are unacceptable. Rectifier shall be insensitive to phase rotation of the ac line.
   b. Regulator shall provide full digital control of frequency and voltage.
   c. Inverter section shall change fixed dc voltage to variable-frequency, variable ac voltage, for application to a squirrel-cage motor. Inverter shall produce a sine-coded, pulse width modulated (PWM) output wave form and shall conduct no radio-frequency interference back to the input power supply.
7. Output Rating: Three phase; with voltage proportional to frequency throughout voltage range.
8. Operating Requirements:
   a. Input AC Voltage Tolerance: 460-V ac, plus 10 percent or 506 V maximum, **as directed**.
   b. Input frequency tolerance of 60 Hz, plus or minus 2 Hz.
   c. Capable of driving full load, without derating, under the following conditions:
      1) Ambient Temperature: 0 to 50 deg C.
      2) Relative Humidity: Up to 90 **OR** 95, **as directed**, percent (noncondensing).
      3) Altitude: 3300 feet (1005 m) **OR** 6600 feet (2010 m), **as directed**.
   d. Minimum Efficiency: 96 percent at 60 Hz, full load.
   e. Minimum Displacement Primary-Side Power Factor: 95 percent without harmonic filter, 98 percent with harmonic filter.
   f. Overload Capability: 1.05 times the full-load current for 7 seconds.
   g. Starting Torque: As required by compressor-drive assembly.
   h. Speed Regulation: Plus or minus 1 percent.
   i. Isolated control interface to allow controller to follow control signal over a 10:1 speed range.
   j. To avoid equipment resonant vibrations, provide critical speed lockout circuitry to allow bands of operating frequency at which controller shall not operate continuously.
   k. Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.
9. Internal Adjustability Capabilities:
   a. Minimum Output Frequency: 6 Hz.
   b. Maximum Output Frequency: 60 Hz.
   c. Acceleration: 2 seconds to a minimum of 60 seconds.

d. Deceleration: 2 seconds to a minimum of 60 seconds.
e. Current Limit: 30 percent to a minimum of 100 percent of maximum rating.

10. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions shall not result in component failure or the need for replacement:
    a. Overtemperature.
    b. Short circuit at controller output.
    c. Ground fault at controller output. Variable frequency controller shall be able to start a grounded motor.
    d. Open circuit at controller output.
    e. Input undervoltage.
    f. Input overvoltage.
    g. Loss of input phase.
    h. Reverse phase.
    i. AC line switching transients.
    j. Instantaneous overload, line to line or line to ground.
    k. Sustained overload exceeding 100 percent of controller rated current.
    l. Starting a rotating motor.
11. Motor Protection: Controller shall protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.
12. Automatic Reset and Restart: Capable of three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Controller shall be capable of automatic restart on phase-loss and overvoltage and undervoltage trips.
13. Visual Indication: On face of controller enclosure or chiller control enclosure; indicating the following conditions:
    a. Power on.
    b. Run.
    c. Overvoltage.
    d. Line fault.
    e. Overcurrent.
    f. External fault.
    g. Motor speed (percent).
    h. Fault or alarm status (code).
    i. DC-link voltage.
    j. Motor output voltage.
    k. Input kilovolt amperes.
    l. Total power factor.
    m. Input kilowatts.
    n. Input kilowatt-hours.
    o. Three-phase input voltage.
    p. Three-phase output voltage.
    q. Three-phase input current.
    r. Three-phase output current.
    s. Three-phase input voltage total harmonic distortion.
    t. Three-phase input current total harmonic distortion.
    u. Output frequency (Hertz).
    v. Elapsed operating time (hours).
    w. Diagnostic and service parameters.
14. Operator Interface: At controller or chiller control panel; with start-stop and auto-manual selector with manual-speed-control potentiometer.
15. Control Signal Interface:
    a. Electric Input Signal Interface: A minimum of two analog inputs (0 to 10 V or 0/4-20 mA) and six programmable digital inputs.
16. Active Harmonic Distortion Filter: Factory mounted and wired to limit total voltage and current distortion to 5 percent.
    OR
    Input Line Conditioning: <**Insert requirements**>.

17. Cooling: Air **OR** Refrigerant **OR** Water, **as directed**, cooled.
18. Accessories: Devices shall be factory installed in controller enclosure unless otherwise indicated.
    a. Control Relays: Auxiliary and adjustable time-delay relays.
19. Chiller Capacity Control Interface: Equip chiller with adaptive control logic to automatically adjust the compressor motor speed and the compressor pre-rotation inlet vane position independently to achieve maximum part-load efficiency in response to sensor inputs that are integral to the chiller controls.

K. Controls
1. Control: Standalone and microprocessor based, with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.
2. Enclosure: Unit mounted, NEMA 250, Type 1 **OR** Type 4 **OR** Type 4x **OR** Type 12, **as directed**, hinged or lockable; factory wired with a single-point, field-power connection and a separate control circuit.
3. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. In either imperial or metric units selectable through the interface, display the following information:
    a. Date and time.
    b. Operating or alarm status.
    c. Fault history with not less than last 10 faults displayed.
    d. Set points of controllable parameters.
    e. Trend data.
    f. Operating hours.
    g. Number of chiller starts.
    h. Outdoor-air temperature or space temperature if required for chilled-water reset.
    i. Entering- and leaving-fluid temperatures of evaporator and condenser.
    j. Difference in fluid temperatures of evaporator and condenser.
    k. Fluid flow of evaporator and condenser.
    l. Fluid pressure drop of evaporator and condenser.
    m. Refrigerant pressures in evaporator and condenser.
    n. Refrigerant saturation temperature in evaporator and condenser shell.
    o. Compressor refrigerant suction and discharge temperature.
    p. Compressor bearing temperature.
    q. Motor bearing temperature.
    r. Motor winding temperature.
    s. Oil temperature.
    t. Oil discharge pressure.
    u. Phase current.
    v. Percent of motor rated load amperage.
    w. Phase voltage.
    x. Demand power (kilowatts).
    y. Energy use (kilowatt-hours).
    z. Power factor.
    aa. For chillers equipped with variable frequency controllers and harmonic filters, include the following:
        1) Output voltage and frequency.
        2) Voltage total harmonic distortion for each phase.
        3) Supply current total demand distortion for each phase.
        4) Inlet vane position.
        5) Controller internal ambient temperature.
        6) Heatsink temperature.
    bb. Purge suction temperature if purge system is provided.
    cc. Purge elapsed time if purge system is provided.
4. Control Functions:
    a. Manual or automatic startup and shutdown time schedule.

b. Entering and leaving chilled-water temperatures, control set points, and motor load limits. Evaporator fluid temperature shall be reset based on return-water **OR** outdoor-air **OR** space, **as directed**, temperature.
c. Current limit and demand limit.
d. Condenser-fluid temperature.
e. External chiller emergency stop.
f. Variable evaporator flow.
g. Thermal storage.
h. Heat reclaim.

5. Manually Reset Safety Controls: The following conditions shall shut down chiller and require manual reset:
a. Low evaporator pressure **OR** temperature, **as directed**; high condenser pressure.
b. Low evaporator fluid temperature.
c. Low oil differential pressure.
d. High or low oil pressure.
e. High oil temperature.
f. High compressor-discharge temperature.
g. Loss of condenser-fluid flow.
h. Loss of evaporator fluid flow.
i. Motor overcurrent.
j. Motor overvoltage.
k. Motor undervoltage.
l. Motor phase reversal.
m. Motor phase failure.
n. Sensor- or detection-circuit fault.
o. Processor communication loss.
p. Motor controller fault.
q. Extended compressor surge.
r. Excessive air-leakage detection for chillers using R-123 refrigerant.

6. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.
7. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.
8. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.
9. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer, **as directed**.
10. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display chiller status and alarms.
a. Hardwired Points:
1) Monitoring: On-off status, common trouble alarm **OR** electrical power demand (kilowatts) **OR** electrical power consumption (kilowatt-hours) **OR** power factor, **as directed**.
2) Control: On-off operation, chilled-water, discharge temperature set-point adjustment **OR** electrical power demand limit, **as directed**.
b. ASHRAE 135 (BACnet) **OR** LonTalk **OR** Modbus **OR** Industry-accepted, open-protocol, **as directed**, communication interface with the BAS shall enable the BAS operator to remotely control and monitor the chiller from an operator workstation. Control features and monitoring points displayed locally at chiller control panel shall be available through the BAS.

L. Finish
1. Paint chiller, using manufacturer's standard procedures, except comply with the following minimum requirements:

a. Provide at least one coat of primer with a total dry film thickness of at least 2 mils (0.05 mm).
b. Provide at least two coats of alkyd-modified, vinyl enamel **OR** epoxy **OR** polyurethane, **as directed**, finish with a total dry film thickness of at least 4 mils (0.10 mm).
c. Paint surfaces that are to be insulated before applying the insulation.
d. Paint installed insulation to match adjacent uninsulated surfaces.
e. Color of finish coat to be manufacturer's standard **OR** custom color selected by the Owner, **as directed**.

2. Provide the Owner with quart container of paint used in application of topcoat to use in touchup applications after Project Closeout.

M. Accessories
1. Flow Switches:
a. Chiller manufacturer shall furnish a switch for each condenser **OR** evaporator and condenser, **as directed**, and verify field-mounting location before installation.
b. Paddle Flow Switches:
1) Vane operated to actuate a double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the BAS.
2) Contacts: Platinum alloy, silver alloy, or gold-plated switch contacts with a rating of 10 A at 120-V ac.
3) Pressure rating equal to pressure rating of heat exchanger.
4) Construct body and wetted parts of Type 316 stainless steel.
5) House switch in a NEMA 250, Type 4, **as directed**, enclosure constructed of die-cast aluminum.
6) Vane length to suit installation.

OR

Pressure Differential Switches:
1) Construction: Wetted parts of body and trim constructed of Type 316 stainless steel.
2) Performance: Switch shall withstand, without damage, the full-pressure rating of the heat exchanger applied to either port and exhibit zero set-point shift due to variation in working pressure.
3) Set Point: Screw type, field adjustable.
4) Electrical Connections: Internally mounted screw-type terminal blocks.
5) Switch Enclosure: NEMA 250, Type 4, **as directed**.
6) Switch Action: Double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the BAS.

2. Vibration Isolation:
a. Chiller manufacturer shall furnish vibration isolation for each chiller.
b. Neoprene Pad:
1) Two layers of 0.375-inch- (10-mm-) thick, ribbed- or waffle-pattern neoprene pads separated by a 16-gage, stainless-steel plate.
2) Fabricate pads from 40- to 50-durometer neoprene.
3) Provide stainless-steel square bearing plate to load the pad uniformly between 20 and 40 psig (138 and 276 kPa) with a 0.12- to 0.16-inch (3- to 4-mm) deflection.

OR

Spring Isolator:
1) Stable in operation and designed for not less than 30 percent reserve deflection beyond actual operating conditions. Isolators shall be designed so that the Kx/Ky ratio shall be 1.0 or more for stability.
2) Provide PVC or neoprene-coated springs and hot-dip, galvanized-steel components. Aluminum components shall be etched and painted. Nuts, bolts, and washers shall be zinc electroplated.
3) Isolators shall be adjustable and with an open spring, having one or more coil springs attached to a top compression plate and a baseplate. An elastomeric pad with a minimum thickness of 0.25 inch (6 mm) shall be bonded to the baseplate.

4) Spring assembly shall be removable and shall fit within a welded steel enclosure consisting of a top plate and rigid lower housing, which serves as a blocking device during installation. Isolated restraining bolts shall not be engaged during normal operation and shall connect the top plate and lower housing to prevent the isolated equipment from rising when drained of fluid.

5) Isolators shall be selected for a nominal 1-inch (25-mm) **OR** 2-inch (50-mm), **as directed**, deflection.

3. Sound Barrier:
   a. Furnish removable and reusable sound-barrier covers over the compressor housing, hermetic motor, compressor suction and discharge piping, and condenser shell.
   b. Provide for repeated installation and removal without use of tape or calk.
   c. Inner and outer cover shall consist of a PTFE-impregnated fiberglass cloth enclosing heavy-density, needled fiberglass insulation material with a mass-loaded vinyl acoustic barrier.
   d. Covers shall be double sewn and lock stitched with edges folded and sewn so no raw cut edges are exposed.
   e. Form covers around control devices, gages, conduit, piping, and supports without degrading sound-barrier performance.
   f. Continuously lap all exposed seams at least 2 inches (50 mm) for better sound containment.
   g. Permanently label each section of cover to indicate its location, description, size, and number sequence.
   h. Randomly place stainless-steel quilting pins to prevent covers from shifting and sagging.

N. Packaged Refrigerant Recovery Units
1. Packaged portable unit consisting of compressor, air-cooled condenser, recovery system, tank pressure gages, filter-dryer, and valving that allows for switching between liquid and vapor recovery mode. Refrigerant recovery unit shall be factory mounted on an ASME-constructed and -stamped refrigerant storage vessel that is sized to hold the full refrigerant charge of the largest chiller furnished.

O. Heat-Exchanger, Brush-Cleaning System
1. Furnish for field installation a brush-cleaning system on each chiller condenser, **as directed**, for tube cleaning and improved heat transfer.
2. System shall maintain tube fouling at or below design conditions without interrupting normal equipment operation.
3. System shall consist of a brush inserted in each tube and a catch basket attached to each end of the tube. A four-way valve shall operate to reverse the direction of water flow to push the brush through the tube while removing tube deposits. Four-way reversing valve's actuator shall be controlled by a preset time cycle that provides regular tube brushing during equipment operation. Frequency of the brushing cycle shall be set up to match Project requirements.
4. Components:
   a. Brush: Each brush shall have nylon bristles, titanium wires, and polypropylene tips. Brush interference fit with the ID of the tube shall not exceed 0.025 inch (0.6 mm).
   b. Basket: Single-piece polypropylene basket with neck OD to press fit inner diameter of tube. Design shall provide for insertion of eddy current probe or removal of brushes without removing baskets from the valve.
   c. Four-Way Valve:
      1) Construct valve body of carbon steel with internal sealing parts of hard rubber and Type 304 stainless steel.
      2) Configure valve with parallel flow connections to minimize field installation piping.
      3) Construct to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, at a system working pressure equal to condenser.
      4) Pipe connections shall be flanged.

5) Valve manufacturer to test and certify a maximum leakage rate of less than 0.05 percent of the design flow rate at operation conditions of maximum differential pressure.
6) Hydrostatically test to 1.5 times the design working pressure.
7) Design the valve to cause no more than 0.5-psig (3-kPa) pressure drop at design flow conditions.
8) Provide valve with valve-mounted indicating/warning light, which shall light before the valve begins rotation.
9) Valve Actuator: Mount electric actuator to operate valve.
OR
Valve Actuator: Mount pneumatic piston-type actuator to operate valve. Actuator shall be suitable for operation using field-supplied air pressure.
10) Position Switches: Factory mount microswitches on the valve to indicate the complete turn of valve in both normal and reverse flow.

d. Control Panel: Factory or field mount a control panel on chiller. Control panel shall include the following features:
1) NEMA 250, Type 1 **OR** Type 4 **OR** Type 4x **OR** Type 12, **as directed**, enclosure.
2) Timer to automatically initiate the cleaning cycle over a 24-hour period.
3) Manual override of preset cleaning cycle.
4) Visual indication of "Power On," "Diverter Position," "Normal Flow," "Reverse Flow," and "Valve Malfunction" indicating a slow turn or incomplete valve turn.
5) For pneumatic actuators, mount four-way solenoid valve for actuator operation in the control panel.
6) Flow switch bypass.
7) Unloading signal to chiller.

P. Source Quality Control
1. Perform functional **OR** functional run, **as directed**, tests of chillers before shipping.
2. Factory performance test chillers, before shipping, according to ARI 550/590.
a. Test the following conditions:
1) Design conditions indicated.
2) Reduction in capacity from design to minimum load in steps of 10 **OR** 25 **OR** 33, **as directed**, with condenser fluid at design conditions.
OR
Reduction in capacity from design to minimum load in steps of 10 **OR** 25 **OR** 33, **as directed**, with varying entering condenser-fluid temperature from design to minimum conditions in 5 deg F (3 deg C) increments.
OR
At one **OR** two **OR** three **OR** four **OR** five **OR** 10, **as directed**, point(s) of varying part-load performance to be selected by the Owner at time of test.
b. Allow the Owner access to place where chillers are being tested. Notify the Owner 14 days in advance of testing.
c. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.
3. Factory sound test chillers, before shipping, according to ARI 575, **s directed**.
a. Test the following conditions:
1) Design conditions indicated.
2) Chiller operating at calculated worst-case sound condition.
3) At one **OR** two **OR** three **OR** four **OR** five, **as directed**, point(s) of varying part-load performance to be selected by the Owner at time of test.
b. Allow the Owner access to place where chillers are being tested. Notify the Owner 14 days in advance of testing.
c. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

4. For chillers using R-134a refrigerant, factory test and inspect evaporator and condenser **OR** condenser, and heat-reclaim condenser, **as directed**, according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
5. For chillers using R-123 refrigerant, factory test and inspect evaporator and condenser **OR** condenser and heat-reclaim condenser, **as directed**, according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Pressure test fluid side of heat exchangers, including water boxes, to 1.5 times the rated pressure. Pressure proof test refrigerant side of heat exchangers to a minimum of 45 psig (310 kPa). Vacuum and pressure test for leaks.
6. For chillers located indoors, rate sound power level according to ARI 575.

1.3 EXECUTION

A. Chiller Installation
1. Install chillers on support structure indicated.
2. Equipment Mounting: Install chiller on concrete bases using elastomeric pads **OR** restrained spring isolators, **as directed**. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-place Concrete". Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
    a. Minimum Deflection: 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**.
    b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
    c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
    d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    e. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Equipment Mounting: Install chiller using elastomeric pads **OR** restrained spring isolators, **as directed**. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
    a. Minimum Deflection: 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**.
4. Equipment Mounting: Install chiller on concrete bases. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-place Concrete".
    a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
    b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
    c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    d. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Maintain manufacturer's recommended clearances for service and maintenance.
6. Charge chiller with refrigerant and fill with oil if not factory installed.
7. Install separate devices furnished by manufacturer and not factory installed.

B. Heat-Exchanger, Brush-Cleaning System Installation
1. Install brush-cleaning system control panel adjacent to chiller control panel.
2. Arrange piping to provide service access to four-way valve assembly without affecting access to chiller. Secure valve to prevent lateral movement and vibration during operation.
3. Provide field electric power, as required, to each system control panel and electric actuated valve.
4. Provide pneumatic piping with pressure regulator and isolation valve to each pneumatic supply connection. Coordinate field source of air with manufacturer to ensure that requirements are satisfied for proper valve operation.

5. Interconnect brush-cleaning system controls with chiller controls. Coordinate requirements to ensure safe, trouble-free operation.
6. Functionally test the entire brush-cleaning system, including the valve, actuator, position indicator, and control panel, with chiller in operation.

C. Connections
1. Comply with requirements for piping specified in Division 23 Section(s) "Hydronic Piping" AND "Refrigerant Piping". Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to chiller to allow service and maintenance.
3. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, strainer, **as directed**, flexible connector, **as directed**, thermometer, and plugged tee with pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, **as directed**, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, flow meter, **as directed**, and drain connection with valve. Make connections to chiller with a flange **OR** mechanical coupling, **as directed**.
4. Condenser-Fluid Connections: Connect to condenser inlet with shutoff valve, strainer, **as directed**, flexible connector, **as directed**, thermometer, and plugged tee with pressure gage. Connect to condenser outlet with shutoff valve, balancing valve, flexible connector, **as directed**, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, flow meter, **as directed**, and drain connection with valve. Make connections to chiller with a flange **OR** mechanical coupling, **as directed**.
5. Heat-Reclaim Condenser-Fluid Connections: Connect to condenser inlet with shutoff valve, strainer, **as directed**, flexible connector, **as directed**, thermometer, and plugged tee with pressure gage. Connect to condenser outlet with shutoff valve, balancing valve, flexible connector, **as directed**, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, flow meter, **as directed**, and drain connection with valve. Make connections to chiller with a flange **OR** mechanical coupling, **as directed**.
6. Refrigerant Pressure Relief Device Connections: For chillers installed indoors, extend vent piping **OR** separate vent piping for each chiller, **as directed** to the outdoors without valves or restrictions. Comply with ASHRAE 15. Connect to chiller pressure relief device with flexible connector and dirt leg with drain valve.
7. For chillers equipped with a purge system, extend purge vent piping **OR** separate purge vent piping for each chiller, **as directed**, to the outdoors. Comply with ASHRAE 15 and ASHRAE 147.
8. Connect each chiller drain connection with a union and drain pipe, and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection.

D. Startup Service
1. Engage a factory-authorized service representative to perform startup service.
   a. Complete installation and startup checks according to manufacturer's written instructions.
   b. Verify that refrigerant charge is sufficient and chiller has been leak tested.
   c. Verify that pumps are installed and functional.
   d. Verify that thermometers and gages are installed.
   e. Operate chiller for run-in period.
   f. Check bearing lubrication and oil levels.
   g. Verify that refrigerant pressure relief device is vented outside.
   h. Verify proper motor rotation.
   i. Verify static deflection of vibration isolators, including deflection during chiller startup and shutdown.
   j. Verify and record performance of fluid flow and low-temperature interlocks for evaporator and condenser **OR** condenser, and heat-reclaim condenser, **as directed**.
   k. Verify and record performance of chiller protection devices.
   l. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
2. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.

3. Prepare test and inspection startup reports.

END OF SECTION 23 61 16 00

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SECTION 23 61 16 00a - ROTARY-SCREW WATER CHILLERS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for rotary screw water chillers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Packaged, water-cooled, single-compressor chillers.
      b. Packaged, water-cooled, multiple-compressor chillers.
      c. Packaged, air-cooled chillers.
      d. Packaged, portable refrigerant recovery units.
      e. Heat-exchanger, brush-cleaning system.

C. Definitions
   1. BAS: Building automation system.
   2. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.
   3. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.
   4. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and referenced to ARI standard rating conditions.
   5. kW/Ton (kW/kW): The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons (kW)at any given set of rating conditions.
   6. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and intended for operating conditions other than ARI standard rating conditions.

D. Performance Requirements
   1. Seismic Performance: Chillers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   2. Condenser-Fluid Temperature Performance:
      a. Startup Condenser-Fluid Temperature: Chiller shall be capable of starting with an entering condenser-fluid temperature of 60 deg F (16 deg C) **OR** 55 deg F (13 deg C) **OR** 40 deg F (4 deg C), **as directed**, and providing stable operation until the system temperature is elevated to the minimum operating entering condenser-fluid temperature.
      b. Minimum Operating Condenser-Fluid Temperature: Chiller shall be capable of continuous operation over the entire capacity range indicated with an entering condenser-fluid temperature of 65 deg F (18 deg C) **OR** 60 deg F (16 deg C) **OR** 55 deg F (13 deg C), **as directed**.
      c. Make factory modifications to standard chiller design if necessary to comply with performance indicated.
   3. Site Altitude: Chiller shall be suitable for altitude in which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.
   4. Performance Tolerance: Comply with the following in lieu of ARI 550/590, **as directed**:
      a. Allowable Capacity Tolerance: Zero percent.
      b. Allowable IPLV/NPLV Performance Tolerance: Zero percent.

E. Submittals
1. Product Data: For each type of product indicated. Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
2. LEED Submittal:
    a. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.
3. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
    a. Detail equipment assemblies and indicate dimensions, weights, load distribution, required clearances, method of field assembly, components, and location and size of each field connection.
    b. Wiring Diagrams: For power, signal, and control wiring.
4. Certificates: For certification required in "Quality Assurance" Article.
5. Seismic Qualification Certificates: For chillers, accessories, and components, from manufacturer.
6. Startup service reports.
7. Operation and maintenance data.
8. Warranty: Sample of special warranty.

F. Quality Assurance
1. ARI Certification: Certify chiller according to ARI 550 and ARI 590, **as directed**, certification program(s).
2. ARI Rating: Rate chiller performance according to requirements in ARI 550/590.
3. ASHRAE Compliance:
    a. ASHRAE 15 for safety code for mechanical refrigeration.
    b. ASHRAE 147 for refrigerant leaks, recovery, and handling and storage requirements.
4. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
5. ASME Compliance: Fabricate and label chiller to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, and include an ASME U-stamp and nameplate certifying compliance.
6. Comply with NFPA 70.
7. Comply with requirements of UL and UL Canada and include label by a qualified testing agency showing compliance.

G. Delivery, Storage, And Handling
1. Ship chillers from the factory fully charged with refrigerant.
   OR
   Ship each chiller with a full charge of refrigerant. Charge each chiller with nitrogen if refrigerant is shipped in containers separate from chiller.
2. Ship each oil-lubricated chiller with a full charge of oil.
    a. Ship oil factory installed in chiller **OR** in containers separate from chiller, **as directed**.
3. Package chiller for export shipping in totally enclosed crate and bagging, **as directed**.

H. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chillers that fail in materials or workmanship within specified warranty period.
    a. Extended warranties include, but are not limited to, the following:
        1) Complete chiller including refrigerant and oil charge.
           OR
           Complete compressor and drive assembly including refrigerant and oil charge.
           OR
           Refrigerant **OR** Refrigerant and oil charge, **as directed**.
        2) Parts only **OR** Parts and labor, **as directed**.
        3) Loss of refrigerant charge for any reason.
    b. Warranty Period: Two **OR** Three **OR** Four **OR** Five, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Packaged, Water-Cooled, Single-Compressor Chillers
   1. Description: Factory-assembled and factory-tested **OR** run-tested, **as directed**, chiller with compressor, compressor motor, compressor motor controller, lubrication system, evaporator, condenser, heat-reclaim condenser as indicated, controls, interconnecting unit piping and wiring, and indicated accessories.
      a. Disassemble chiller into major assemblies as required by the installation after factory testing and before packaging for shipment.
   2. Fabricate chiller mounting base with reinforcement strong enough to resist chiller movement during a seismic event when chiller is anchored to field support structure.
   3. Compressor:
      a. Description: Hermetic **OR** Open, **as directed**, positive displacement, and oil lubricated.
      b. Casing: Cast iron, precision machined for minimum clearance about periphery of rotors.
      c. Rotors: Manufacturer's standard one-, two-, or three-rotor design.
      d. Drive Coupling: For chillers with open drives, provide flexible disc with all-metal construction and no wearing parts to ensure long life without the need for lubrication.
      e. Seals: Seal drive assembly to prevent refrigerant leakage.
   4. Compressor Motor:
      a. Continuous-duty, squirrel-cage, induction-type motor with energy efficiency required to suit chiller energy efficiency indicated.
      b. Factory mounted, aligned, and balanced as part of compressor assembly before shipping.
      c. Motor shall be of sufficient capacity to drive compressor throughout entire operating range without overload and with sufficient capacity to start and accelerate compressor without damage.
      d. For chillers with open drives, provide motor with open-dripproof **OR** weather-protected, Type I **OR** weather-protected, Type II **OR** totally enclosed, **as directed**, enclosure.
      e. Provide motor with thermistor or RTD in single motor winding **OR** each of three-phase motor windings, **as directed**, to monitor temperature and report information to chiller control panel.
      f. Provide motor with thermistor or RTD to monitor bearing temperature and report information to chiller control panel.
      g. Provide open-drive motor with internal electric heater, internally powered from chiller power supply.
   5. Vibration Balance: Balance chiller compressor and drive assembly to provide a precision balance that is free of noticeable vibration over the entire operating range.
      a. Overspeed Test: 25 percent above design operating speed.
   6. Service: Easily accessible for inspection and service.
      a. Compressor's internal components shall be accessible without having to remove compressor-drive assembly from chiller.
      b. Provide lifting lugs or eyebolts attached to casing.
   7. Capacity Control: Modulating slide-valve assembly or port unloaders combined with a variable frequency controller, if applicable, and hot-gas bypass, if necessary, to achieve performance indicated.
      a. Maintain stable operation throughout range of operation. Configure to achieve most energy-efficient operation possible.
      b. Operating Range: From 100 to 20 **OR** 15 **OR** 10 **OR** 5 **OR** zero, **as directed**, percent of design capacity.
      c. Condenser-Fluid Unloading Requirements over Operating Range: Constant-design entering condenser-fluid temperature **OR** Drop-in entering condenser-fluid temperature of 2.5 deg F1.4 deg C drop for each 10 percent in capacity reduction, **as directed**.
   8. Oil Lubrication System: Consisting of pump if required, filtration, heater, cooler, factory-wired power connection, and controls.
      a. Provide lubrication to bearings, gears, and other rotating surfaces at all operating, startup, shutdown, and standby conditions including power failure.
      b. Thermostatically controlled oil heater properly sized to remove refrigerant from oil.

c. Oil filter **OR** Dual oil filers, one redundant, **as directed**, shall be the easily replaceable cartridge type, minimum 0.5-micron efficiency, with means of positive isolation while servicing.
d. Refrigerant **OR** Water, **as directed**,-cooled oil cooler.
e. Factory-installed and pressure-tested piping with isolation valves and accessories.
f. Oil compatible with refrigerant and chiller components.
g. Positive visual indication of oil level.

9. Refrigerant Circuit:
   a. Refrigerant: Type as indicated on Drawings.
   OR
   Refrigerant Type: R-134a **OR** HFC, **as directed**. Classified as Safety Group A1 according to ASHRAE 34.
   b. Refrigerant Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
   c. Refrigerant Flow Control: Manufacturer's standard refrigerant flow-control device satisfying performance requirements indicated.
   d. Pressure Relief Device:
      1) Comply with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
      2) ASME-rated, spring-loaded pressure relief valve; single- or multiple-reseating type. Pressure relief valve(s) shall be provided for each heat exchanger. Condenser shall have dual valves with one being redundant and configured to allow either valve to be replaced without loss of refrigerant.
   e. Refrigeration Transfer: Provide service valves and other factory-installed accessories required to facilitate transfer of refrigerant from chiller to a remote refrigerant storage and recycling system. Comply with requirements in ASHRAE 15 and ASHRAE 147.
   f. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line to the condenser and the refrigerant liquid line leaving the condenser to allow for isolation and storage of full refrigerant charge in the chiller condenser shell. In addition, provide isolation valve on suction side of compressor from evaporator to allow for isolation and storage of full refrigerant charge in the chiller evaporator shell, **as directed**.
10. Evaporator:
   a. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from condenser.
   b. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.
   c. Designed to prevent liquid refrigerant carryover from entering compressor.
   d. Provide evaporator with sight glass or other form of positive visual verification of liquid-refrigerant level.
   e. Tubes:
      1) Individually replaceable from either end and without damage to tube sheets and other tubes.
      2) Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
      3) Material: Copper **OR** Copper-nickel alloy, **as directed**.
      4) Nominal OD: Manufacturer's choice **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**.
      5) Minimum Wall Thickness: Manufacturer's choice **OR** 0.025 inch (0.6 mm) **OR** 0.028 inch (0.7 mm) **OR** 0.035 inch (0.9 mm), **as directed**.
      6) External Finish: Manufacturer's standard.
      7) Internal Finish: Enhanced **OR** Smooth, **as directed**.
   f. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.
   g. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.

h. Water Box:
   1) Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
   2) Standard **OR** Marine, **as directed**, type for water box with piping connections. Standard type for water box without piping connections.
   3) Provide water boxes and marine water-box covers, **as directed**, with lifting lugs or eyebolts.
   4) Hinged **OR** Davited, **as directed**, water boxes.
      OR
      Hinged **OR** Davited, **as directed**, marine water-box covers.
   5) Nozzle Pipe Connections: Welded, ASME B16.5, flat-face flange **OR** Welded, ASME B16.5, raised-face flange **OR** Grooved for mechanical-joint coupling **OR** Grooved with mechanical-joint coupling and flange adapter, **as directed**.
   6) Thermistor or RTD temperature sensor factory installed in each nozzle.
   7) Fit each water box with 3/4-inch (19-mm) **OR** 1-inch (25-mm), **as directed**, drain connection at low point and vent connection at high point, each with threaded plug.
i. Additional Corrosion Protection:
   1) Electrolytic corrosion-inhibitor anode.
   2) Coat wetted surfaces with a corrosion-resistant finish.

11. Condenser:
   a. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from evaporator.
   b. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.
   c. Designed to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes.
   d. Provide condenser with sight glass or other form of positive visual verification of refrigerant charge and condition.
   e. Tubes:
      1) Individually replaceable from either end and without damage to tube sheets and other tubes.
      2) Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
      3) Material: Copper **OR** Copper-nickel alloy, **as directed**.
      4) Nominal OD: Manufacturer's choice **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**.
      5) Minimum Wall Thickness: Manufacturer's choice **OR** 0.025 inch (0.6 mm) **OR** 0.028 inch (0.7 mm) **OR** 0.035 inch (0.9 mm), **as directed**.
      6) External Finish: Manufacturer's standard.
      7) Internal Finish: Enhanced **OR** Smooth, **as directed**.
   f. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.
   g. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.
   h. Water Box:
      1) Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
      2) Standard **OR** Marine, **as directed**, type for water box with piping connections. Standard type for water box without piping connections.
      3) Provide water boxes and marine water-box covers, **as directed**, with lifting lugs or eyebolts.
      4) Hinged **OR** Davited, **as directed**, water boxes.
         OR
         Hinged **OR** Davited, **as directed**, marine water-box covers.

5) Nozzle Pipe Connections: Welded, ASME B16.5, flat-face flange **OR** Welded, ASME B16.5, raised-face flange **OR** Grooved for mechanical-joint coupling **OR** Grooved with mechanical-joint coupling and flange adapter, **as directed**.
6) Thermistor or RTD temperature sensor factory installed in each nozzle.
7) Fit each water box with 3/4-inch (19-mm) **OR** 1-inch (25-mm), **as directed**, drain connection at low point and vent connection at high point, each with threaded plug.

i. Additional Corrosion Protection:
1) Electrolytic corrosion-inhibitor anode.
2) Coat wetted surfaces with a corrosion-resistant finish.

12. Heat-Reclaim Condenser:
a. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from evaporator and condenser.
b. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.
c. Designed to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes.
d. Tubes:
1) Individually replaceable from either end and without damage to tube sheets and other tubes.
2) Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
3) Material: Copper **OR** Copper-nickel alloy, **as directed**.
4) Nominal OD: Manufacturer's choice **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**.
5) Minimum Wall Thickness: Manufacturer's choice **OR** 0.025 inch (0.6 mm) **OR** 0.028 inch (0.7 mm) **OR** 0.035 inch (0.9 mm), **as directed**.
6) External Finish: Manufacturer's standard.
7) Internal Finish: Enhanced **OR** Smooth, **as directed**.

e. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.
f. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.
g. Water Box:
1) Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
2) Standard **OR** Marine, **as directed**, type for water box with piping connections. Standard type for water box without piping connections.
3) Provide water boxes and marine water-box covers, **as directed**, with lifting lugs or eyebolts.
4) Hinged **OR** Davited, **as directed**, water boxes.
OR
Hinged **OR** Davited, **as directed**, marine water-box covers.
5) Nozzle Pipe Connections: Welded, ASME B16.5, flat-face flange **OR** Welded, ASME B16.5, raised-face flange **OR** Grooved for mechanical-joint coupling **OR** Grooved with mechanical-joint coupling and flange adapter, **as directed**.
6) Thermistor or RTD temperature sensor factory installed in each nozzle.
7) Fit each water box with 3/4-inch (19-mm) **OR** 1-inch (25-mm), **as directed**, drain connection at low point and vent connection at high point, each with threaded plug.

h. Additional Corrosion Protection:
1) Electrolytic corrosion-inhibitor anode.
2) Coat wetted surfaces with a corrosion-resistant finish.

13. Electrical Power:
a. Factory installed and wired, and functionally tested at factory before shipment.

b. Single-point, field-power connection to fused disconnect switch **OR** nonfused disconnect switch **OR** circuit breaker, **as directed**. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 42,000 **OR** 65,000, **as directed**, A.
   1) Provide branch power circuit to each motor, electric heater, dedicated electrical load, and controls with disconnect switch or circuit breaker, **as directed**.
   2) NEMA- and ICS 2-rated motor controller for auxiliary motors, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller for each variable-speed motor furnished.
   3) Control-circuit transformer with primary and secondary side fuses.
c. Terminal blocks with numbered and color-coded, **as directed**, wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
d. Factory-installed wiring outside of enclosures shall be in metal raceway except make connections to each motor and heater with not more than a 24-inch (610-mm) length of liquidtight conduit.
e. Factory install and wire capacitor bank for the purpose of power factor correction to 0.95 at all operating conditions.
   1) If capacitors are mounted in a dedicated enclosure, use same NEMA enclosure type as motor controller. Provide enclosure with service entrance knockouts and bushings for conduit.
   2) Capacitors shall be non-PCB dielectric fluid, metallized electrode design, low loss with low-temperature rise. The kVAr ratings shall be indicated and shall not exceed the maximum limitations set by NFPA 70. Provide individual cells as required.
   3) Provide each cell with current-limiting replaceable fuses and carbon-film discharge resistors to reduce residual voltage to less than 50 V within 1 minute after de-energizing.
   4) Provide a ground terminal and a terminal block or individual connectors for phase connection.

14. Motor Controller:
a. Enclosure: Factory installed, unit mounted **OR** Factory furnished, field mounted, **as directed**, NEMA 250 **OR** NEMA ICS 6, **as directed**, Type 1 **OR** Type 4 **OR** Type 4X **OR** Type 12, **as directed**, with hinged full-front access door with lock and key or padlock and key, **as directed**.
b. Control Circuit: Obtained from integral control power transformer, **as directed**, with a control power transformer **OR** source, **as directed**, of enough capacity to operate connected control devices.
c. Overload Relay: Shall be sized according to UL 1995 or shall be an integral component of chiller control microprocessor.
d. Across-the-Line Controller: NEMA ICS 2, Class A, full voltage, nonreversing; include isolation switch and current-limiting fuses.
e. Star-Delta, Reduced-Voltage Controller: NEMA ICS 2, closed transition.
f. Autotransformer Reduced-Voltage Controller: NEMA ICS 2, closed transition; include isolation switch and current-limiting fuses.
g. Solid-State, Reduced-Voltage Controller: NEMA ICS 2.
   1) Surge suppressor in solid-state power circuits providing three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
   2) Visual indication of motor and control status, including the following conditions:
      a) Controller on.
      b) Overload trip.
      c) Loss of phase.
      d) Starter fault.
h. Accessories: Devices shall be factory installed in controller enclosure unless otherwise indicated.
   1) Externally Operated, Door-Interlocked, **as directed**, Disconnect: Fused disconnect switch **OR** Nonfused disconnect switch **OR** Circuit breaker, **as directed**. Minimum

withstand rating shall be as required by electrical power distribution system, but not less than 42,000 **OR** 65,000, **as directed**, A.

2) Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
3) Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
4) Control Relays: Time-delay relays.
5) Elapsed-Time Meters: Numerical readout in hours on face of enclosure.
6) Number-of-Starts Counter: Numerical readout on face of enclosure.
7) Meters: Panel type, 2-1/2 inches (64 mm) **OR** 4-1/4 inches (108 mm), **as directed**, with 90 **OR** 120 **OR** 270, **as directed**,-degree scale and 1 **OR** 2, **as directed**, percent accuracy. Where indicated, provide transfer device with an off position. Meters shall indicate the following:
   a) Ammeter: Output current for each phase, with current sensors rated to suit application.
   b) Voltmeter: Output voltage for each phase.
   c) Frequency Meter: Output frequency.
   d) Real-time clock with current time and date.
   e) Total run time.

   OR

   Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
   a) Selectable, digital display of the following:
      i. Phase Currents, Each Phase: Plus or minus 1 percent.
      ii. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
      iii. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
      iv. Three-Phase Real Power: Plus or minus 2 percent.
      v. Three-Phase Reactive Power: Plus or minus 2 percent.
      vi. Power Factor: Plus or minus 2 percent.
      vii. Frequency: Plus or minus 0.5 percent.
      viii. Integrated Demand with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
      ix. Accumulated energy, in megawatt hours (joules), plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.
   b) Mounting: Display and control unit flush or semirecessed in instrument compartment door.
8) Phase-Failure, Phase-Reversal, Undervoltage Relays: Solid-state sensing circuit with adjustable undervoltage setting and isolated output contacts for hardwired connection.
9) Power Protection: Chiller shall shut down within six cycles of power interruption.

15. Variable Frequency Controller:
   a. Motor controller shall be factory mounted and wired on the chiller to provide a single-point, field-power termination to the chiller and its auxiliaries.
   b. Description: NEMA ICS 2; listed and labeled as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.
   c. Enclosure: Unit mounted, NEMA 250, Type 1, **as directed**, with hinged full-front access door with lock and key.
   d. Integral Disconnecting Means: Door-interlocked, **as directed**, NEMA AB 1, instantaneous-trip circuit breaker with lockable handle. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 42,000 **OR** 65,000 **OR** 100,000, **as directed**, A.
   e. Technology: Pulse width modulated (PWM) output suitable for constant or variable torque loads.

f. Output Rating: Three phase; with voltage proportional to frequency throughout voltage range.
g. Operating Requirements:
   1) Input AC Voltage Tolerance: 460-V ac, plus 10 percent or 506 V maximum, **as directed**.
   2) Input frequency tolerance of 60 Hz, plus or minus 2 Hz.
   3) Capable of driving full load, without derating, under the following conditions:
      a) Ambient Temperature: 0 to 40 deg C.
      b) Relative Humidity: Up to 90 **OR** 95, **as directed**, percent (noncondensing).
      c) Altitude: 3300 feet (1005 m) **OR** 6600 feet (2010 m), **as directed**.
   4) Minimum Efficiency: 96 percent at 60 Hz, full load.
   5) Minimum Displacement Primary-Side Power Factor: 98 percent.
   6) Overload Capability: 1.05 times the full-load current for 7 seconds.
   7) Starting Torque: As required by compressor-drive assembly.
   8) Speed Regulation: Plus or minus 1 percent.
   9) Isolated control interface to allow controller to follow control signal over a 10:1 speed range.
   10) To avoid equipment resonant vibrations, provide critical speed lockout circuitry to allow bands of operating frequency at which controller shall not operate continuously.
   11) Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.
h. Internal Adjustability Capabilities:
   1) Minimum Output Frequency: 6 Hz.
   2) Maximum Output Frequency: 60 Hz.
   3) Acceleration: 2 seconds to 60 seconds.
   4) Deceleration: Zero seconds to 60 seconds.
   5) Current Limit: 30 to a minimum of 100 percent of maximum rating.
i. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions shall not result in component failure or the need for replacement:
   1) Overtemperature.
   2) Short circuit at controller output.
   3) Ground fault at controller output. Variable frequency controller shall be able to start a grounded motor.
   4) Open circuit at controller output.
   5) Input undervoltage.
   6) Input overvoltage.
   7) Loss of input-phase.
   8) Reverse phase.
   9) AC line switching transients.
   10) Instantaneous overload, line to line or line to ground.
   11) Sustained overload exceeding 100 percent of controller rated current.
   12) Starting a rotating motor.
j. Motor Protection: Controller shall protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.
k. Automatic Reset and Restart: Capable of three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Controller shall be capable of automatic restart on phase-loss, and overvoltage and undervoltage trips.
l. Visual Indication: On face of controller enclosure or chiller control enclosure; indicating the following conditions:
   1) Power on.
   2) Run.
   3) Overvoltage.
   4) Line fault.
   5) Overcurrent.

6) External fault.
7) Motor speed (percent).
8) Fault or alarm status (code).
9) Motor output voltage.
10) Input kilovolt amperes.
11) Total power factor.
12) Input kilowatts.
13) Input kilowatt-hours.
14) Three-phase input voltage.
15) Three-phase output voltage.
16) Three-phase input current.
17) Three-phase output current.
18) Output frequency (Hertz).
19) Elapsed operating time (hours).
20) Diagnostic and service parameters.

m. Operator Interface: At controller or chiller control panel; with start-stop and auto-manual selector with manual-speed-control potentiometer.

n. Harmonic Distortion Filter: Factory mounted and wired to limit total voltage and current distortion to 5 percent.

16. Controls:

a. Standalone and microprocessor based with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.

b. Enclosure: Unit mounted, NEMA 250, Type 1 **OR** Type 4 **OR** Type 4x **OR** Type 12, **as directed**, hinged or lockable; factory wired with a single-point, field-power connection and a separate control circuit.

c. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. In either imperial or metric units, display the following information:

1) Date and time.
2) Operating or alarm status.
3) Fault history with not less than last 10 faults displayed.
4) Set points of controllable parameters.
5) Trend data.
6) Operating hours.
7) Number of chiller starts.
8) Outdoor-air temperature or space temperature if required for chilled-water reset.
9) Temperature and pressure of operating set points.
10) Entering- and leaving-fluid temperatures of evaporator and condenser.
11) Difference in fluid temperatures of evaporator and condenser.
12) Fluid flow of evaporator and condenser.
13) Fluid pressure drop of evaporator and condenser.
14) Refrigerant pressures in evaporator and condenser.
15) Refrigerant saturation temperature in evaporator and condenser.
16) Pump status.
17) Antirecycling timer status.
18) Percent of maximum motor amperage.
19) Current-limit set point.
20) Compressor bearing temperature.
21) Motor bearing temperature.
22) Motor winding temperature.
23) Oil temperature.
24) Oil discharge pressure.
25) Phase current.
26) Percent of motor rated load amperes.
27) Phase voltage.

28) Demand power (kilowatts).
29) Energy use (kilowatt-hours).
30) Power factor.

d. Control Functions:
1) Manual or automatic startup and shutdown time schedule.
2) Entering and leaving chilled-water temperatures, control set points, and motor load limits. Evaporator fluid temperature shall be reset based on return-water **OR** outdoor-air **OR** space, **as directed**, temperature.
3) Current limit and demand limit.
4) Condenser-fluid temperature.
5) External chiller emergency stop.
6) Antirecycling timer.
7) Variable evaporator flow.
8) Thermal storage.
9) Heat reclaim.

e. Manually Reset Safety Controls: The following conditions shall shut down chiller and require manual reset:
1) Low evaporator pressure or temperature; high condenser pressure.
2) Low evaporator fluid temperature.
3) Low oil differential pressure.
4) High or low oil pressure.
5) High oil temperature.
6) High compressor-discharge temperature.
7) Loss of condenser-fluid flow.
8) Loss of evaporator-fluid flow.
9) Motor overcurrent.
10) Motor overvoltage.
11) Motor undervoltage.
12) Motor phase reversal.
13) Motor phase failure.
14) Sensor- or detection-circuit fault.
15) Processor communication loss.
16) Motor controller fault.
17) Extended compressor surge.

f. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.

g. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.

h. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.

i. Communication Port: RS-232 port or equivalent connection capable of connecting a printer and a notebook computer, **as directed**.

j. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display chiller status and alarms.
1) Hardwired Points:
   a) Monitoring: On-off status, common trouble alarm **OR** electrical power demand (kilowatts) **OR** electrical power consumption (kilowatt-hours) **OR** power factor, **as directed**.
   b) Control: On-off operation, chilled-water, discharge temperature set-point adjustment **OR** electrical power demand limit, **as directed**.
2) ASHRAE 135 (BACnet) **OR** LonTalk **OR** Modbus **OR** Industry-accepted, open-protocol, **as directed**, communication interface with the BAS shall enable the BAS operator to remotely control and monitor the chiller from an operator workstation. Control features and monitoring points displayed locally at chiller control panel shall be available through the BAS.

17. Insulation:
    a. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
    b. Thickness: 3/4 inch (19 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
    c. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.
    d. Factory-applied insulation over cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator shell and end tube sheets, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.
        1) Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
        2) Seal seams and joints to provide a vapor barrier.
        3) After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.
18. Finish:
    a. Paint chiller, using manufacturer's standard procedures, except comply with the following minimum requirements:
        1) Provide at least one coat of primer with a total dry film thickness of at least 2 mils (0.05 mm).
        2) Provide at least two coats of alkyd-modified, vinyl enamel **OR** epoxy **OR** polyurethane, **as directed**, finish with a total dry film thickness of at least 4 mils (0.10 mm).
        3) Paint surfaces that are to be insulated before applying the insulation.
        4) Paint installed insulation to match adjacent uninsulated surfaces.
        5) Color of finish coat to be manufacturer's standard **OR** custom color selected by the Owner, **as directed**.
    b. Provide the Owner with quart container of paint used in application of topcoat to use in touchup applications after Project Closeout.
19. Accessories:
    a. Flow Switches:
        1) If required and not factory installed, chiller manufacturer shall furnish a switch for each condenser **OR** evaporator and condenser, **as directed**, and verify field-mounting location before installation.
        2) Paddle Flow Switches:
            a) Vane operated to actuate a double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the BAS.
            b) Contacts: Platinum alloy, silver alloy, or gold-plated switch contacts with a rating of 10 A at 120-V ac.
            c) Pressure rating equal to pressure rating of heat exchanger.
            d) Construct body and wetted parts of Type 316 stainless steel.
            e) House switch in a NEMA 250, Type 4, **as directed**, enclosure constructed of die-cast aluminum.
            f) Vane length to suit installation.

            OR

            Pressure Differential Switches:
            g) Construction: Wetted parts of body and trim constructed of Type 316 stainless steel.
            h) Performance: Switch shall withstand, without damage, the full-pressure rating of the heat exchanger applied to either port and exhibit zero set-point shift due to variation in working pressure.
            i) Set Point: Screw type, field adjustable.
            j) Electrical Connections: Internally mounted screw-type terminal blocks.
            k) Switch Enclosure: NEMA 250, Type 4, **as directed**.

l) Switch Action: Double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the BAS.

b. Vibration Isolation:

c. Chiller manufacturer shall furnish vibration isolation for each chiller.
   1) Neoprene Pad:
      a) Two layers of 0.375-inch- (10-mm-) thick, ribbed- or waffle-pattern neoprene pads separated by a 16-gage, stainless-steel plate.
      b) Fabricate pads from 40- to 50-durometer neoprene.
      c) Provide stainless-steel square bearing plate to load the pad uniformly between 20 and 40 psig (138 and 276 kPa) with a 0.12- to 0.16-inch (3- to 4-mm) deflection.

   OR

   Spring Isolator:
      d) Stable in operation and designed for not less than 30 percent reserve deflection beyond actual operating conditions. Isolators shall be designed such that the Kx/Ky ratio shall be 1.0 or more for stability.
      e) Provide PVC or neoprene-coated springs and hot-dip, galvanized-steel components. Aluminum components shall be etched and painted. Nuts, bolts, and washers shall be zinc electroplated.
      f) Isolators shall be adjustable and with an open spring, having one or more coil springs attached to a top compression plate and a baseplate. An elastomeric pad with a minimum thickness of 0.25 inch (6 mm) shall be bonded to the baseplate.
      g) Spring assembly shall be removable and shall fit within a welded steel enclosure consisting of a top plate and rigid lower housing, which serves as a blocking device during installation. Isolated restraining bolts shall not be engaged during normal operation and shall connect the top plate and lower housing to prevent the isolated equipment from rising when drained of fluid.
      h) Isolators shall be selected for a nominal 1-inch (25-mm) **OR** 2-inch (50-mm), **as directed**, deflection.

d. Sound Barrier:
   1) Furnish removable and reusable sound-barrier covers over the compressor housing, hermetic motor, compressor suction and discharge piping, and condenser shell.
   2) Provide for repeated installation and removal without use of tape or calk.
   3) Inner and outer cover shall consist of a PTFE-impregnated fiberglass cloth enclosing heavy-density, needled fiberglass insulation material with a mass-loaded vinyl acoustic barrier.
   4) Covers shall be double sewn and lock stitched with edges folded and sewn so no raw cut edges are exposed.
   5) Form covers around control devices, gages, conduit, piping, and supports without degrading sound-barrier performance.
   6) Continuously lap all exposed seams at least 2 inches (50 mm) for better sound containment.
   7) Permanently label each section of cover to indicate its location, description, size, and number sequence.
   8) Randomly place stainless-steel quilting pins to prevent covers from shifting and sagging.

B. Packaged, Water-Cooled, Multiple-Compressor Chillers
   1. Description: Factory-assembled and -tested **OR** run-tested, **as directed**, chiller with compressor(s), compressor motors and motor controllers, evaporator, condenser where indicated, electrical power, controls, and indicated accessories.
      a. Disassemble chiller into major assemblies as required by the installation after factory testing and before packaging for shipment.

2. Fabricate chiller mounting base with reinforcement strong enough to resist chiller movement during a seismic event when chiller is anchored to field support structure.
3. Compressors:
   a. Description: Positive displacement, hermetically sealed.
   b. Casing: Cast iron, precision machined for minimum clearance about periphery of rotors.
   c. Rotors: Manufacturer's standard one- or two-rotor design.
4. Service: Easily accessible for inspection and service.
   a. Compressor's internal components shall be accessible without having to remove compressor-drive assembly from chiller.
   b. Provide lifting lugs or eyebolts attached to casing.
5. Capacity Control: On-off compressor cycling and modulating slide-valve assembly or port unloaders combined with hot-gas bypass, if necessary, to achieve performance indicated.
   a. Maintain stable operation throughout range of operation. Configure to achieve most energy-efficient operation possible.
   b. Operating Range: From 100 to 20 **OR** 15 **OR** 10 **OR** 5 **OR** zero, **as directed**, percent of design capacity.
   c. Condenser-Fluid Unloading Requirements over Operating Range: Constant-design entering condenser-fluid temperature **OR** Drop-in entering condenser-fluid temperature of 2.5 deg F (1.4 deg C) drop for each 10 percent in capacity reduction, **as directed**.
6. Oil Lubrication System: Consisting of pump if required, filtration, heater, cooler, factory-wired power connection, and controls.
   a. Provide lubrication to bearings, gears, and other rotating surfaces at all operating, startup, shutdown, and standby conditions including power failure.
   b. Thermostatically controlled oil heater properly sized to remove refrigerant from oil.
   c. Factory-installed and pressure-tested piping with isolation valves and accessories.
   d. Oil compatible with refrigerant and chiller components.
   e. Positive visual indication of oil level.
7. Vibration Control:
   a. Vibration Balance: Balance chiller compressor and drive assembly to provide a precision balance that is free of noticeable vibration over the entire operating range.
      1) Overspeed Test: 25 percent above design operating speed.
   b. Isolation: Mount individual compressors on vibration isolators.
8. Sound Control: Sound-reduction package shall consist of removable acoustic enclosures around the compressors and drive assemblies that are designed to reduce sound levels without affecting performance.
9. Compressor Motors:
   a. Hermetically sealed and cooled by refrigerant suction gas.
   b. High-torque, induction type with inherent thermal-overload protection on each phase.
10. Refrigerant Circuits:
   a. Refrigerant: Type as indicated on Drawings.
      OR
      Refrigerant Type: R-134a **OR** HFC, **as directed**. Classified as Safety Group A1 according to ASHRAE 34.
   b. Refrigerant Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
   c. Refrigerant Circuit: Each shall include a thermal- or electronic-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction, **as directed**, and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core, **as directed**, filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
   d. Pressure Relief Device:
      1) Comply with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
      2) ASME-rated, spring-loaded pressure relief valve; single- or multiple-reseating type.

e. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line to the condenser and the refrigerant liquid-line leaving the condenser to allow for isolation and storage of full refrigerant charge in the chiller condenser shell.

11. Evaporator:
    a. Description: Shell-and-tube design.
        1) Direct-expansion (DX) type with fluid flowing through the shell, and refrigerant flowing through the tubes within the shell.
        2) Flooded type with fluid flowing through tubes and refrigerant flowing around tubes within the shell.
    b. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
    c. Shell Material: Carbon steel.
    d. Shell Heads: Removable carbon-steel heads with multipass baffles, and located at each end of the tube bundle.
    e. Fluid Nozzles: Terminated with mechanical-coupling or flanged end connections for connection to field piping.
    f. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
12. Condenser:
    a. Shell and tube, or without integral condenser; as indicated.
       OR
       Shell and Tube:
        1) Description: Shell-and-tube design with refrigerant flowing through shell, and fluid flowing through tubes within shell.
        2) Provides positive subcooling of liquid refrigerant.
        3) Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
        4) Shell Material: Carbon steel.
        5) Water Boxes: Removable, of carbon-steel construction, located at each end of the tube bundle with fluid nozzles terminated with mechanical-coupling end connections for connection to field piping.
        6) Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
        7) Provide each condenser with a pressure relief device, purge cock, and liquid-line shutoff valve.
    b. Provide chiller without an integral condenser and design chiller for field connection to remote condenser. Coordinate requirements with Division 23 Section "Air-cooled Refrigerant Condensers".
13. Electrical Power:
    a. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a multipoint **OR** single-point, **as directed**, field-power connection to chiller.
    b. House in a unit-mounted, NEMA 250, Type 1, **as directed**, enclosure with hinged access door with lock and key or padlock and key, **as directed**.
    c. Wiring shall be numbered and color-coded, **as directed**, to match wiring diagram.
    d. Install factory wiring outside of an enclosure in a raceway.
    e. Field-power interface shall be to wire lugs **OR** NEMA KS 1, heavy-duty, nonfused disconnect switch **OR** NEMA AB 1, instantaneous-trip circuit breaker with lockable handle, **as directed**.
        1) Disconnect means shall be interlocked with door operation.
        2) Minimum withstand rating shall be as required by electrical power distribution system, but not less than 42,000 **OR** 65,000 **OR** 100,000, **as directed**, A.
    f. Provide branch power circuit to each motor and to controls with one of the following disconnecting means:
        1) NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.

2) NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit-trip set point.

g. Provide each motor with overcurrent protection.

h. Overload relay sized according to UL 1995 or an integral component of chiller control microprocessor.

i. Phase-Failure and Undervoltage Relays: Solid-state sensing with adjustable settings.

j. Control Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.

k. Control Relays: Auxiliary and adjustable time-delay relays.

l. For chiller electrical power supply, indicate the following:
   1) Current and phase to phase for all three phases.
   2) Voltage, phase to phase, and phase to neutral for all three phases.
   3) Three-phase real power (kilowatts).
   4) Three-phase reactive power (kilovolt amperes reactive).
   5) Power factor.
   6) Running log of total power versus time (kilowatt-hours).
   7) Fault log, with time and date of each.

14. Compressor Motor Controllers:
   a. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing, or solid state, **as directed**.
   b. Star-Delta, Reduced-Voltage Controller: NEMA ICS 2, closed or open transition, or solid state, **as directed**.

15. Controls:
   a. Standalone and microprocessor based.
   b. Enclosure: Share enclosure with electrical-power devices or provide a separate enclosure of matching construction.
   c. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. In either imperial or metric units, display the following information:
      1) Date and time.
      2) Operating or alarm status.
      3) Fault history with not less than last 10 faults displayed.
      4) Set points of controllable parameters.
      5) Trend data.
      6) Operating hours.
      7) Number of chiller starts.
      8) Outdoor-air temperature or space temperature if required for chilled-water reset.
      9) Temperature and pressure of operating set points.
      10) Entering- and leaving-fluid temperatures of evaporator and condenser.
      11) Difference in fluid temperatures of evaporator and condenser.
      12) Refrigerant pressures in evaporator and condenser.
      13) Refrigerant saturation temperature in evaporator and condenser.
      14) No cooling load condition.
      15) Elapsed time meter (compressor run status).
      16) Pump status.
      17) Antirecycling timer status.
      18) Percent of maximum motor amperage.
      19) Current-limit set point.
      20) Number of compressor starts.
      21) Compressor refrigerant suction and discharge temperature.
      22) Oil temperature.
      23) Oil discharge pressure.
      24) Phase current.
      25) Percent of motor rated load amperes.
      26) Phase voltage.

d. Control Functions:
   1) Manual or automatic startup and shutdown time schedule.
   2) Entering and leaving chilled-water temperatures, control set points, and motor load limits. Chilled-water leaving temperature shall be reset based on return-water **OR** outdoor-air **OR** space, **as directed**, temperature.
   3) Current limit and demand limit.
   4) Condenser-fluid temperature.
   5) External chiller emergency stop.
   6) Antirecycling timer.
   7) Automatic lead-lag switching.
   8) Variable evaporator flow.
   9) Thermal storage.
e. Manually Reset Safety Controls: The following conditions shall shut down chiller and require manual reset:
   1) Low evaporator pressure, or high condenser pressure.
   2) Low chilled-water temperature.
   3) Refrigerant high pressure.
   4) High or low oil pressure.
   5) High oil temperature.
   6) Loss of chilled-water flow.
   7) Loss of condenser-fluid flow.
   8) Control device failure.
f. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.
g. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.
h. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.
i. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display chiller status and alarms.
   1) Hardwired Points:
      a) Monitoring: On-off status, common trouble alarm **OR** electrical power demand (kilowatts) **OR** electrical power consumption (kilowatt-hours), **as directed**.
      b) Control: On-off operation, chilled-water, discharge temperature set-point adjustment **OR** electrical power demand limit, **as directed**.
   2) ASHRAE 135 (BACnet) **OR** LonTalk **OR** Modbus **OR** Industry-accepted, open-protocol, **as directed**, communication interface with the BAS shall enable the BAS operator to remotely control and monitor the chiller from an operator workstation. Control features and monitoring points displayed locally at chiller control panel shall be available through the BAS.

16. Insulation:
   a. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
   b. Thickness: 3/4 inch (19 mm).
   c. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.
   d. Factory-applied insulation over cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator shell and end tube sheets, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.
      1) Before insulating steel surfaces, prepare surfaces for paint, prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
      2) Seal seams and joints to provide a vapor barrier.

3) After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.

17. Finish:
    a. Paint chiller, using manufacturer's standard procedures, except comply with the following minimum requirements:
        1) Provide at least one coat of primer.
        2) Provide finish coat of alkyd-modified, vinyl enamel, **as directed**.
        3) Paint surfaces that are to be insulated before applying the insulation.
        4) Paint installed insulation to match adjacent uninsulated surfaces.
18. Accessories:
    a. Factory-furnished, chilled- and condenser-, **as directed**,water flow switches for field installation.
    b. Individual compressor suction and discharge pressure gages with shutoff valves for each refrigerant circuit.
    c. Factory-furnished neoprene **OR** spring, **as directed**, isolators for field installation.

C. Packaged, Air-Cooled Chillers
1. Description: Factory-assembled and run-tested chiller complete with base and frame, condenser casing, compressors, compressor motors and motor controllers, evaporator, condenser coils, condenser fans and motors, electrical power, controls, and accessories.
2. Fabricate base, frame, and attachment to chiller components strong enough to resist chiller movement during a seismic event when chiller base is anchored to field support structure.
3. Cabinet:
    a. Base: Galvanized-steel base extending the perimeter of chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
    b. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported by base.
    c. Casing: Galvanized steel.
    d. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 500 **OR** 1000, **as directed**,-hour salt-spray test according to ASTM B 117.
    e. Sound-reduction package designed to reduce sound level without affecting performance and consisting of the following:
        1) Acoustic enclosure around compressors.
        2) Reduced-speed fans with acoustic treatment.
    f. Security Package: Provide removable grilles **OR** louvered panels, **as directed**, with fasteners for additional protection of compressors, evaporator, and condenser coils without inhibiting service access. Finish to match cabinet.
4. Compressors:
    a. Description: Positive displacement, hermetically sealed.
    b. Casing: Cast iron, precision machined for minimum clearance about periphery of rotors.
    c. Rotors: Manufacturer's standard one- or two-rotor design.
    d. Each compressor provided with suction and, **as directed**, discharge shutoff valves, crankcase oil heater, and suction strainer.
5. Service: Easily accessible for inspection and service.
6. Capacity Control: On-off compressor cycling and modulating slide-valve assembly or port unloaders combined with hot-gas bypass, if necessary, to achieve performance indicated.

7. Maintain stable operation throughout range of operation. Configure to achieve most energy-efficient operation possible.
    a. Operating Range: From 100 to 20 **OR** 15 **OR** 10 **OR** 5 **OR** zero, **as directed**, percent of design capacity.
    b. Condenser-Air Unloading Requirements over Operating Range: Constant-design entering condenser-air temperature **OR** Drop-in entering condenser-air temperature of 5 deg F (3 deg C) drop for each 10 percent in capacity reduction, **as directed**.

c. For units equipped with a variable frequency controller, capacity control shall be both "valveless" and "stepless," requiring no slide valve or capacity-control valve(s) to operate at reduced capacity.

8. Oil Lubrication System: Consisting of pump if required, filtration, heater, cooler, factory-wired power connection, and controls.
   a. Provide lubrication to bearings, gears, and other rotating surfaces at all operating, startup, shutdown, and standby conditions including power failure.
   b. Thermostatically controlled oil heater properly sized to remove refrigerant from oil.
   c. Factory-installed and pressure-tested piping with isolation valves and accessories.
   d. Oil compatible with refrigerant and chiller components.
   e. Positive visual indication of oil level.
9. Vibration Control:
   a. Vibration Balance: Balance chiller compressors and drive assemblies to provide a precision balance that is free of noticeable vibration over the entire operating range.
      1) Overspeed Test: 25 percent above design operating speed.
   b. Isolation: Mount individual compressors on vibration isolators.
10. Compressor Motors:
    a. Hermetically sealed and cooled by refrigerant suction gas.
    b. High-torque, induction type with inherent thermal-overload protection on each phase.
11. Compressor Motor Controllers:
    a. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing, or solid state, **as directed**.
    b. Star-Delta, Reduced-Voltage Controller: NEMA ICS 2, closed transition, or solid state, **as directed**.
    c. Variable Frequency Controller:
       1) Motor controller shall be factory mounted and wired on the chiller to provide a single-point, field-power termination to the chiller and its auxiliaries.
       2) Description: NEMA ICS 2; listed and labeled as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.
       3) Enclosure: Unit mounted, NEMA 250, Type 3R, **as directed**, with hinged full-front access door with lock and key.
       4) Integral Disconnecting Means: Door-interlocked, **as directed**, NEMA AB 1, instantaneous-trip circuit breaker with lockable handle. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 42,000 **OR** 65,000 **OR** 100,000, **as directed**, A.
       5) Technology: Pulse width modulated (PWM) output suitable for constant or variable torque loads.
       6) Motor current at start shall not exceed the rated load amperes, providing no electrical inrush.
12. Refrigerant Circuits:
    a. Refrigerant: Type as indicated on Drawings.
       OR
       Refrigerant Type: R-134a **OR** R-407c **OR** HFC, **as directed**: Classified as Safety Group A1 according to ASHRAE 34.
    b. Refrigerant Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
    c. Refrigerant Circuit: Each shall include a thermal- or electronic-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction, **as directed**, and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core, **as directed**, filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
    d. Pressure Relief Device:
       1) Comply with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
       2) ASME-rated, spring-loaded pressure relief valve; single- or multiple-reseating type.
13. Evaporator:

a. Description: Shell-and-tube design.
   1) Direct-expansion (DX) type with fluid flowing through the shell, and refrigerant flowing through the tubes within the shell.
   2) Flooded type with fluid flowing through tubes and refrigerant flowing around tubes within the shell.
b. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
c. Shell Material: Carbon steel.
d. Shell Heads: Removable carbon-steel heads located at each end of the tube bundle.
e. Fluid Nozzles: Terminated with mechanical-coupling **OR** flanged, **as directed**, end connections for connection to field piping.
f. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
g. Heater: Factory-installed and -wired electric heater with integral controls designed to protect the evaporator to minus 20 deg F (minus 29 deg C).
h. Remote Mounting: Designed for remote field mounting where indicated. Provide kit for field installation.

14. Air-Cooled Condenser:
   a. Plate-fin coil with integral subcooling on each circuit, rated at 450 psig (3103 kPa).
      1) Construct coil casing of galvanized **OR** stainless, **as directed**, steel.
      2) Construct coils of copper tubes mechanically bonded to aluminum **OR** aluminum with precoated epoxy-phenolic **OR** copper, **as directed**, fins.
      3) Coat coils with a baked-epoxy, corrosion-resistant coating after fabrication.
      4) Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.
   b. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.
   c. Fan Motors: Totally enclosed nonventilating (TENV) or totally enclosed air over (TEAO) enclosure, with permanently lubricated bearings. Equip each motor with overload protection integral to either the motor or chiller controls.
   d. Fan Guards: Steel safety guards with corrosion-resistant coating.
15. Electrical Power:
   a. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a multipoint **OR** single-point, **as directed**, field-power connection to chiller.
   b. House in a unit-mounted, NEMA 250, Type 3R, **as directed**, enclosure with hinged access door with lock and key or padlock and key, **as directed**.
   c. Wiring shall be numbered and color-coded, **as directed**, to match wiring diagram.
   d. Install factory wiring outside of an enclosure in a raceway.
   e. Field-power interface shall be to wire lugs **OR** NEMA KS 1, heavy-duty, nonfused disconnect switch **OR** NEMA AB 1, instantaneous-trip circuit breaker with lockable handle, **as directed**.
      1) Disconnect means shall be interlocked with door operation.
      2) Minimum withstand rating shall be as required by electrical power distribution system, but not less than 42,000 **OR** 65,000 **OR** 100,000, **as directed**, A.
   f. Provide branch power circuit to each motor and to controls with one of the following disconnecting means:
      1) NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
      2) NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit-trip set point.
   g. Provide each motor with overcurrent protection.
   h. Overload relay sized according to UL 1995 or an integral component of chiller control microprocessor.
   i. Phase-Failure and Undervoltage Relays: Solid-state sensing with adjustable settings.

j. Provide power factor correction capacitors to correct power factor to 0.90 **OR** 0.95, **as directed**, at full load.
k. Control Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
   1) Power unit-mounted controls where indicated.
   2) Power unit-mounted, ground fault interrupt (GFI) duplex receptacle.
l. Control Relays: Auxiliary and adjustable time-delay relays.
m. For chiller electrical power supply, indicate the following:
   1) Current and phase to phase for all three phases.
   2) Voltage, phase to phase, and phase to neutral for all three phases.
   3) Three-phase real power (kilowatts).
   4) Three-phase reactive power (kilovolt amperes reactive).
   5) Power factor.
   6) Running log of total power versus time (kilowatt-hours).
   7) Fault log, with time and date of each.

16. Controls:
   a. Standalone and microprocessor based.
   b. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure for remote mounting in the field, **as directed**.
   c. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. In either imperial or metric units, display the following information:
      1) Date and time.
      2) Operating or alarm status.
      3) Operating hours.
      4) Outdoor-air temperature if required for chilled-water reset.
      5) Temperature and pressure of operating set points.
      6) Entering and leaving temperatures of chilled water.
      7) Refrigerant pressures in evaporator and condenser.
      8) Saturation temperature in evaporator and condenser.
      9) No cooling load condition.
      10) Elapsed time meter (compressor run status).
      11) Pump status.
      12) Antirecycling timer status.
      13) Percent of maximum motor amperage.
      14) Current-limit set point.
      15) Number of compressor starts.
   d. Control Functions:
      1) Manual or automatic startup and shutdown time schedule.
      2) Entering and leaving chilled-water temperatures, control set points, and motor load limits. Chilled-water leaving temperature shall be reset based on return-water **OR** outdoor-air **OR** space, **as directed**, temperature.
      3) Current limit and demand limit.
      4) External chiller emergency stop.
      5) Antirecycling timer.
      6) Automatic lead-lag switching.
      7) Variable evaporator flow.
      8) Thermal storage.
   e. Manually Reset Safety Controls: The following conditions shall shut down chiller and require manual reset:
      1) Low evaporator pressure or high condenser pressure.
      2) Low chilled-water temperature.
      3) Refrigerant high pressure.
      4) High or low oil pressure.
      5) High oil temperature.
      6) Loss of chilled-water flow.

7) Control device failure.

f. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.

g. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.

h. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.

i. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display chiller status and alarms.

1) Hardwired Points:

a) Monitoring: On-off status, common trouble alarm **OR** electrical power demand (kilowatts) **OR** electrical power consumption (kilowatt-hours), **as directed**.

b) Control: On-off operation, chilled-water, discharge temperature set-point adjustment **OR** electrical power demand limit, **as directed**.

2) ASHRAE 135 (BACnet) **OR** LonTalk **OR** Modbus **OR** Industry-accepted, open-protocol, **as directed**, communication interface with the BAS shall enable the BAS operator to remotely control and monitor the chiller from an operator workstation. Control features and monitoring points displayed locally at chiller control panel shall be available through the BAS.

17. Insulation:

a. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

b. Thickness: 3/4 inch (19 mm) **OR** 1-1/2 inches (38 mm), **as directed**.

c. Factory-applied insulation over cold surfaces of chiller components.

1) Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.

d. Apply protective coating to exposed surfaces of insulation to protect insulation from weather.

18. Accessories:

a. Factory-furnished, chilled-water flow switches for field installation.

b. Individual compressor suction and discharge pressure gages with shutoff valves for each refrigerant circuit.

c. Factory-furnished neoprene **OR** spring, **as directed**, isolators for field installation.

D. Packaged Refrigerant Recovery Units

1. Packaged portable unit consisting of compressor, air-cooled condenser, recovery system, tank pressure gages, filter-dryer, and valving that allows for switching between liquid and vapor recovery mode. Refrigerant recovery unit shall be factory mounted on an ASME-constructed and -stamped refrigerant storage vessel that is sized to hold the full refrigerant charge of the largest chiller furnished.

E. Heat-Exchanger, Brush-Cleaning System

1. Furnish for field installation a brush-cleaning system on each chiller condenser, **as directed**, for tube cleaning and improved heat transfer.

2. System shall maintain tube fouling at or below design conditions without interrupting normal equipment operation.

3. System shall consist of a brush inserted in each tube and a catch basket attached to each end of the tube. A four-way valve shall operate to reverse the direction of water flow to push the brush through the tube while removing tube deposits. Four-way reversing valve's actuator shall be controlled by a preset time cycle that provides regular tube brushing during equipment operation. Frequency of the brushing cycle shall be set up to match Project requirements.

4. Components:

a. Brush: Each brush shall have nylon bristles, titanium wires, and polypropylene tips. Brush interference fit with the ID of the tube shall not exceed 0.025 inch (0.6 mm).
b. Basket: Single-piece polypropylene basket with neck OD to press fit ID of tube. Design shall provide for insertion of eddy current probe or removal of brushes without removing baskets from the valve.
c. Four-Way Valve:
   1) Construct valve body of carbon steel with internal sealing parts of hard rubber and Type 304 stainless steel.
   2) Configure valve with parallel flow connections to minimize field installation piping.
   3) Construct to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, at a system working pressure equal to condenser.
   4) Pipe connections shall be flanged.
   5) Valve manufacturer to test and certify a maximum leakage rate of less than 0.05 percent of the design flow rate at operation conditions of maximum differential pressure.
   6) Hydrostatically test to 1.5 times the design working pressure.
   7) Design the valve to cause no more than 0.5-psig (3-kPa) pressure drop at design flow conditions.
   8) Provide valve with valve-mounted indicating/warning light, which shall light before valve begins rotation.
   9) Valve Actuator: Mount electric actuator to operate valve.
      OR
      Valve Actuator: Mount pneumatic piston-type actuator to operate valve. Actuator shall be suitable for operation using field-supplied air pressure.
   10) Position Switches: Factory mount microswitches on valve to indicate the complete turn of valve in both normal and reverse flow.
d. Control Panel: Factory or field mount a control panel on chiller. Control panel shall include the following features:
   1) NEMA 250, Type 1 **OR** Type 4 **OR** Type 4x **OR** Type 12, **as directed**, enclosure.
   2) Timer to automatically initiate the cleaning cycle over a 24-hour period.
   3) Manual override of preset cleaning cycle.
   4) Visual indication of "Power On," "Diverter Position," "Normal Flow," "Reverse Flow," and "Valve Malfunction" indicating a slow turn or incomplete valve turn.
   5) For pneumatic actuators, mount four-way solenoid valve for actuator operation in the control panel.
   6) Flow switch bypass.
   7) Unloading signal to chiller.

F. Source Quality Control
1. Perform functional tests of chillers before shipping.
2. Factory run test each air-cooled chiller with water flowing through evaporator.
3. Factory performance test water-cooled chillers, before shipping, according to ARI 550/590.
   a. Test the following conditions:
      1) Design conditions indicated.
      2) Reduction in capacity from design to minimum load in steps of 10 **OR** 25 **OR** 33, **as directed**, with condenser fluid at design conditions.
         OR
         Reduction in capacity from design to minimum load in steps of 10 **OR** 25 **OR** 33, **as directed**, with varying entering condenser-fluid temperature from design to minimum conditions in 5 deg F (3 deg C) increments.
         OR
         At one **OR** two **OR** three **OR** four **OR** five **OR** 10, **as directed**, point(s) of varying part-load performance to be selected by the Owner at time of test.
   b. Allow the Owner access to place where chillers are being tested. Notify the Owner 14 days in advance of testing.

c. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

4. Factory performance test air-cooled chillers, **as directed**, before shipping, according to ARI 550/590.
   a. Test the following conditions:
      1) Design conditions indicated.
      2) Reduction in capacity from design to minimum load in steps of 10 **OR** 25 **OR** 33, **as directed**, with condenser air at design conditions.
      OR
      At one **OR** two **OR** three **OR** four **OR** five, **as directed**, point(s) of varying part-load performance to be selected by the Owner at time of test.
   b. Allow the Owner access to place where chillers are being tested. Notify the Owner 14 days in advance of testing.
   c. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.
5. Factory sound test water-cooled chillers, **as directed**, before shipping, according to ARI 575 **OR** air-cooled chillers, before shipping, according to ARI 370, **as directed**.
   a. Test the following conditions:
      1) Design conditions indicated.
      2) Chiller operating at calculated worst-case sound condition.
      OR
      At one **OR** two **OR** three **OR** four **OR** five, **as directed**, point(s) of varying part-load performance to be selected by the Owner at time of test.
   b. Allow the Owner access to place where chillers are being tested. Notify the Owner 14 days in advance of testing.
   c. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.
6. Factory test and inspect evaporator and condenser **OR** condenser, and heat-reclaim condenser, **as directed**, according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
7. For chillers located indoors, rate sound power level according to ARI 575.
8. For chillers located outdoors, rate sound power level according to ARI 370.

1.3 EXECUTION

A. Chiller Installation
1. Install chillers on support structure indicated.
2. Equipment Mounting: Install chiller on concrete bases using elastomeric pads **OR** restrained spring isolators, **as directed**. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-place Concrete". Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
   a. Minimum Deflection: 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**.
   b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   e. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Equipment Mounting: Install chiller using elastomeric pads **OR** restrained spring isolators, **as directed**. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".

a. Minimum Deflection: 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**.

4. Equipment Mounting: Install chiller on concrete bases. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-place Concrete".
   a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   d. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Maintain manufacturer's recommended clearances for service and maintenance.
6. Charge chiller with refrigerant and fill with oil if not factory installed.
7. Install separate devices furnished by manufacturer and not factory installed.

B. Heat-Exchanger, Brush-Cleaning System Installation
1. Install brush-cleaning system control panel adjacent to chiller control panel.
2. Arrange piping to provide service access to four-way valve assembly without affecting access to chiller. Secure valve to prevent lateral movement and vibration during operation.
3. Provide field electric power, as required, to each system control panel and electric actuated valve.
4. Provide pneumatic piping with pressure regulator and isolation valve to each pneumatic supply connection. Coordinate field source of air with manufacturer to ensure that requirements are satisfied for proper valve operation.
5. Interconnect brush-cleaning system controls with chiller controls. Coordinate requirements to ensure safe, trouble-free operation.
6. Functionally test the entire brush-cleaning system, including the valve, actuator, position indicator, and control panel, with chiller in operation.

C. Connections
1. Comply with requirements for piping specified in Division 23 Section(s) "Hydronic Piping" AND "Refrigerant Piping". Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to chiller to allow service and maintenance.
3. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, strainer, **as directed**, flexible connector, **as directed**, thermometer, and plugged tee with pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, **as directed**, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, flow meter, **as directed**, and drain connection with valve. Make connections to chiller with a flange **OR** mechanical coupling, **as directed**.
4. Condenser Fluid Connections: Connect to condenser inlet with shutoff valve, strainer, **as directed**, flexible connector, **as directed**, thermometer, and plugged tee with pressure gage. Connect to condenser outlet with shutoff valve, balancing valve, flexible connector, **as directed**, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, flow meter, **as directed**, and drain connection with valve. Make connections to chiller with a flange **OR** mechanical coupling, **as directed**.
5. Heat-Reclaim Condenser Fluid Connections: Connect to condenser inlet with shutoff valve, strainer, **as directed**, flexible connector, **as directed**, thermometer, and plugged tee with pressure gage. Connect to condenser outlet with shutoff valve, balancing valve, flexible connector, **as directed**, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, flow meter, **as directed**, and drain connection with valve. Make connections to chiller with a flange **OR** mechanical coupling, **as directed**.
6. Refrigerant Pressure Relief Device Connections: For chillers installed indoors, extend vent piping **OR** separate vent piping for each chiller, **as directed**, to the outdoors without valves or restrictions. Comply with ASHRAE 15. Connect vent to chiller pressure relief device with flexible connector and dirt leg with drain valve.
7. Connect each chiller drain connection with a union and drain pipe, and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection.

D. Startup Service
1. Engage a factory-authorized service representative to perform startup service.
   a. Complete installation and startup checks according to manufacturer's written instructions.
   b. Verify that refrigerant charge is sufficient and chiller has been leak tested.
   c. Verify that pumps are installed and functional.
   d. Verify that thermometers and gages are installed.
   e. Operate chiller for run-in period.
   f. Check bearing lubrication and oil levels.
   g. For chillers installed indoors, verify that refrigerant pressure relief device is vented outdoors.
   h. Verify proper motor rotation.
   i. Verify static deflection of vibration isolators, including deflection during chiller startup and shutdown.
   j. Verify and record performance of fluid flow and low-temperature interlocks for evaporator and condenser **OR** condenser, and heat-reclaim condenser, **as directed**.
   k. Verify and record performance of chiller protection devices.
   l. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
2. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.
3. Prepare test and inspection startup reports.

END OF SECTION 23 61 16 00a

Task	Specification	Specification Description
23 61 23 00	23 61 16 00a	Rotary-Screw Water Chillers

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SECTION 23 62 13 00 - INDIRECT-FIRED ABSORPTION WATER CHILLERS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for indirect-fired absorption water chillers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Packaged, water-cooled, single-effect and double-effect absorption chillers.
      b. Heat-exchanger, brush-cleaning system.

C. Definitions
   1. BAS: Building automation system.
   2. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.
   3. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 560 and referenced to ARI standard rating conditions.
   4. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 560 and intended for operating conditions other than the ARI standard rating conditions.

D. Performance Requirements
   1. Seismic Performance: Indirect-fired absorption chillers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   2. Condenser-Fluid Temperature Performance:
      a. Startup Condenser-Fluid Temperature: Chiller shall be capable of starting with an entering condenser-fluid temperature of 60 deg F (16 deg C) **OR** 55 deg F (13 deg C) **OR** 40 deg F (4.4 deg C), **as directed**, and providing stable operation until the system temperature is elevated to the minimum operating entering condenser-fluid temperature.
      b. Minimum Operating Condenser-Fluid Temperature: Chiller shall be capable of continuous operation over the entire capacity range indicated with an entering condenser-fluid temperature of 65 deg F (18 deg C) **OR** 60 deg F (16 deg C) **OR** 55 deg F (13 deg C), **as directed**.
      c. Make factory modifications to standard chiller design if necessary to comply with performance indicated.
   3. Site Altitude: Chiller shall be suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.
   4. Performance Tolerance: Comply with the following in lieu of ARI 560, **as directed**:
      a. Allowable Capacity Tolerance: Zero percent.
      b. Allowable IPLV/NPLV Performance Tolerance: Zero percent.

E. Submittals
   1. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, furnished specialties and accessories.
   2. LEED Submittals:
      a. Product Data for LEED-NC Prerequisite EA 2: Documentation indicating that units comply with ASHRAE 90.1.

b. Product Data for LEED-NC Prerequisite EA 3: Documentation indicating that refrigerants comply.
c. Product Data for LEED-NC Credit EA 4: Documentation indicating that equipment and refrigerants comply.

3. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
4. Certificates: For certification required in "Quality Assurance" Article.
5. Seismic Qualification Certificates: For chillers, accessories, and components, from manufacturer.
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
6. Startup service reports.
7. Operation and maintenance data.
8. Warranty: Sample of special warranty.

F. Quality Assurance
1. ARI Rating: Rate chiller performance according to requirements in ARI 560.
2. ASHRAE Compliance:
   a. ASHRAE 15 for safety code for mechanical refrigeration.
   b. ASHRAE/IESNA 90.1.
3. ASME Compliance: Fabricate and label chiller pressure vessels to comply with applicable portions of ASME Boiler and Pressure Vessel Code.
4. Comply with NFPA 70.
5. Comply with requirements of UL and UL Canada, and include label by a qualified testing agency showing compliance.

G. Delivery, Storage, And Handling
1. Ship chillers factory charged with nitrogen.
2. Ship absorbent and refrigerant in chillers or in containers separate from chillers.
   OR
   Ship absorbent and refrigerant, **as directed**, in containers separate from chillers.
3. Package chiller for export shipping in totally enclosed bagging **OR** crate **OR** crate with bagging, **as directed**.

H. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chillers that fail in materials or workmanship within specified warranty period.
   a. Extended warranties include, but are not limited to, the following:
      1) Complete chiller.
         OR
         Pumps and motors **OR** Purge unit, **as directed**.
         OR
         Absorbent **OR** Absorbent and refrigerant, **as directed**, only.
      2) Parts only **OR** Parts and labor, **as directed**.
      3) Loss of absorbent and refrigerant for any reason.
2. Warranty Period: Two **OR** Three **OR** Four **OR** Five, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Manufactured Unit

1. Description: Factory-assembled and -tested, hermetic-design chiller complete with absorber, evaporator, condenser, generator, solution heat exchanger, controls, absorbent solution pump with motor, refrigerant pump with motor, purge unit with motor, motor controllers, rupture disk, interconnecting unit piping and wiring, indicated accessories, and mounting frame.
    a. Disassemble chiller into major assemblies as required by the installation after factory testing and before packaging for shipment.
2. Absorbent and Refrigerant:
    a. Absorbent: Lithium bromide solution with corrosion inhibitor.
    b. Refrigerant: Deionized or distilled, **as directed**, water.
    c. Performance Enhancer: Heat and mass transfer enhancer to improve performance.
3. Seismic Fabrication Requirements: Fabricate mounting base and attachment to chiller, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment" when mounting base is anchored to building structure.

B. Pumps
1. Hermetically sealed, self-lubricating, and fitted with self-adjusting, spring-loaded, wear-compensating tapered carbon bearings.
2. Pump motor assembly shall be designed to operate for not less than 25,000 **OR** 50,000, **as directed**, hours between inspections.
3. Pump motors cooled, and bearings lubricated, either by fluid being pumped or by a filtered supply of liquid refrigerant.
4. Pump suction and discharge equipped with isolation valves.
5. Separate and dedicated pumps for absorbent solution and refrigerant.
    a. Absorbent solution and refrigerant flow-control method shall be manufacturer's choice to comply with operating requirements indicated.
6. Purge System: Unit mounted and factory wired, equipped with controls and a pump to automatically remove noncondensable vapors.
    a. Purge Pump Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
        1) Enclosure: Open dripproof **OR** Totally enclosed, **as directed**.

C. Heat-Exchanger Shells
1. Configuration for Single-Effect Chillers: Two shells; one shell consists of the absorber/evaporator and the other shell consists of the condenser/generator.
2. Configuration for Double-Effect Chillers: Two shells; one shell consists of the absorber/evaporator, low-stage generator/condenser and the other shell consists of the high-stage generator.
3. Construction: Fabricated from continuously welded carbon-steel sheet or plate, or from seamless pipe.
4. Design Pressure and Temperature Rating: Comply with applicable requirements in ASME Boiler and Pressure Vessel Code.
5. End Tube Sheets: Carbon-steel plates continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.
6. Intermediate Tube Sheets: Carbon-steel plates installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.
7. Generator/Condenser Shell Pressure Relief Device: Manufacturers standard rupture disk complying with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. Absorber
1. Nozzle or Dispersion Trays: Designed to evenly distribute absorbent solution over tubes. Constructed of brass, stainless steel, or another material that will not corrode.
2. Tubes:

a. Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end and without damage to tube sheets and other tubes.
b. Material: Copper **OR** Copper-nickel alloy **OR** Stainless steel **OR** Titanium, **as directed**.
c. Minimum Wall Thickness: Manufacturer's choice **OR** 0.025 inch (0.6 mm) **OR** 0.028 inch (0.7 mm) **OR** 0.035 inch (0.9 mm), **as directed**.
d. External Finish: Manufacturer's standard.
e. Internal Finish: Enhanced **OR** Smooth, **as directed**.

3. Water Boxes:
   a. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
   b. Standard **OR** Marine, **as directed**, type for water box with piping connections.
      1) Water boxes and marine water-box covers, **as directed**, shall have lifting lugs or eyebolts.
      2) Hinged **OR** davited, **as directed**, water boxes.
         OR
         Hinged **OR** davited, **as directed**, marine water-box covers.

      OR
      Standard type for water box without piping connections.
      1) Water boxes shall have lifting lugs or eyebolts.
      2) Hinged **OR** davited, **as directed**, water boxes.
         OR
         Hinged **OR** davited, **as directed**, marine water-box covers.
   c. Nozzle Pipe Connections: Welded, ASME B16.5, flat-face flange **OR** Welded, ASME B16.5, raised-face flange **OR** Grooved for mechanical-joint coupling **OR** Grooved with mechanical-joint coupling and flange adapter, **as directed**.
   d. Thermistor or RTD temperature sensor factory installed in each nozzle.
   e. Fit each water box with 3/4-inch (19-mm) **OR** 1-inch (25-mm) **OR** 3/4- or 1-inch (19- or 25-mm), **as directed**, drain connection at low point and vent connection at high point, each with threaded plug.
4. Additional Corrosion Protection:
   a. Electrolytic corrosion-inhibitor anode.
   b. Coat wetted surfaces with a corrosion-resistant finish.
      OR
      Using same material as tubes, clad surfaces of end tube sheets in contact with fluid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.
5. Absorber/Condenser Crossover Piping: Factory furnished **OR** installed, **as directed**, piping connecting fluid connection of absorber discharge to condenser inlet.

E. Evaporator
1. Nozzle or Dispersion Trays: Designed to evenly distribute refrigerant over tubes. Constructed of brass, stainless steel, or another material that will not corrode.
2. Refrigerant Holding Pan: Steel **OR** Stainless steel, **as directed**.
3. Tubes:
   a. Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end and without damage to tube sheets and other tubes.
   b. Material: Copper **OR** Copper-nickel alloy **OR** Stainless steel **OR** Titanium, **as directed**.
   c. Minimum Wall Thickness: Manufacturer's choice **OR** 0.025 inch (0.6 mm) **OR** 0.028 inch (0.7 mm) **OR** 0.035 inch (0.9 mm), **as directed**.
   d. External Finish: Manufacturer's standard.
   e. Internal Finish: Enhanced **OR** Smooth, **as directed**.
4. Water Boxes:
   a. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
   b. Standard **OR** Marine, **as directed**, type for water box with piping connections.

1) Water boxes and marine water-box covers, **as directed**, shall have lifting lugs or eyebolts.
2) Hinged **OR** davited, **as directed**, water boxes.
OR
Hinged **OR** davited, **as directed**, marine water-box covers.

OR
Standard type for water box without piping connections.
1) Water boxes shall have lifting lugs or eyebolts.
2) Hinged **OR** davited, **as directed**, water boxes.
OR
Hinged **OR** davited, **as directed**, marine water-box covers.

c. Nozzle Pipe Connections: Welded, ASME B16.5, flat-face flange **OR** Welded, ASME B16.5, raised-face flange **OR** Grooved for mechanical-joint coupling **OR** Grooved with mechanical-joint coupling and flange adapter, **as directed**.
d. Thermistor or RTD temperature sensor factory installed in each nozzle.
e. Fit each water box with 3/4-inch (19-mm) **OR** 1-inch (25-mm) **OR** 3/4- or 1-inch (19- or 25-mm), **as directed**, drain connection at low point and vent connection at high point, each with threaded plug.

F. Condenser
1. Refrigerant Holding Pan: Steel **OR** Stainless steel, **as directed**.
2. Tubes:
a. Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end and without damage to tube sheets and other tubes.
b. Material: Copper **OR** Copper-nickel alloy **OR** Stainless steel **OR** Titanium, **as directed**.
c. Minimum Wall Thickness: Manufacturer's choice **OR** 0.025 inch (0.6 mm) **OR** 0.028 inch (0.7 mm) **OR** 0.035 inch (0.9 mm), **as directed**.
d. External Finish: Manufacturer's standard.
e. Internal Finish: Enhanced **OR** Smooth, **as directed**.
3. Water Boxes:
a. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
b. Standard **OR** Marine, **as directed**, type for water box with piping connections.
1) Water boxes and marine water-box covers, **as directed**, shall have lifting lugs or eyebolts.
2) Hinged **OR** davited, **as directed**, water boxes.
OR
Hinged **OR** davited, **as directed**, marine water-box covers.

OR
Standard type for water box without piping connections.
1) Water boxes shall have lifting lugs or eyebolts.
2) Hinged **OR** davited, **as directed**, water boxes.
OR
Hinged **OR** davited, **as directed**, marine water-box covers.

c. Nozzle Pipe Connections: Welded, ASME B16.5, flat-face flange **OR** Welded, ASME B16.5, raised-face flange **OR** Grooved for mechanical-joint coupling **OR** Grooved with mechanical-joint coupling and flange adapter, **as directed**.
d. Thermistor or RTD temperature sensor factory installed in each nozzle.
e. Fit each water box with 3/4-inch (19-mm) **OR** 1-inch (25-mm), **as directed**, drain connection at low point and vent connection at high point, each with threaded plug.
4. Additional Corrosion Protection:
a. Electrolytic corrosion-inhibitor anode.
b. Coat wetted surfaces with a corrosion-resistant finish.
OR
Using same material as tubes, clad surfaces of end tube sheets in contact with fluid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.

G. Generator For Single-Effect Chillers
1. Tubes:
a. Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end and without damage to tube sheets and other tubes.
b. Material: 90/10 copper-nickel alloy **OR** Stainless steel **OR** Titanium**,** as directed.
c. Minimum Wall Thickness: Manufacturer's choice **OR** 0.035 inch (0.9 mm), **as directed**.
d. External Finish: Manufacturer's standard.
e. Internal Finish: Smooth **OR** Enhanced, **as directed**
2. Water Boxes:
a. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
b. Standard type water box.
c. Water boxes shall have lifting lugs or eyebolts.
d. Nozzle Pipe Connections: Welded, ASME B16.5, flat-face flange **OR** Welded, ASME B16.5, raised-face flange **OR** Grooved for mechanical-joint coupling **OR** Grooved with mechanical-joint coupling and flange adapter, **as directed**.
e. Thermistor or RTD temperature sensor factory installed in each nozzle.
f. Fit each water box with 3/4-inch (19-mm) **OR** 1-inch (25-mm), **as directed**, drain connection at low point and vent connection at high point, each with threaded plug.
3. Additional Corrosion Protection:
a. Electrolytic corrosion-inhibitor anode.
b. Coat wetted surfaces with a corrosion-resistant finish.
OR
Using same material as tubes, clad surfaces of end tube sheets in contact with fluid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.

H. First-Stage Generator For Double-Effect Chillers
1. Tubes:
a. Replaceable, straight, or U tubes expanded into tube sheets.
b. Material: Manufacturer's standard **OR** 70/30 copper-nickel alloy **OR** Type 409 stainless steel **OR** Titanium, **as directed**.
c. Minimum Wall Thickness: Manufacturer's choice **OR** 0.028 inch (0.7 mm) **OR** 0.035 inch (0.9 mm), **as directed**.
d. External Finish: Manufacturer's standard.
e. Internal Finish: Smooth **OR** Enhanced, **as directed**.
2. Water Boxes:
a. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
b. Standard type water box.
c. Water boxes shall have lifting lugs or eyebolts.
d. Nozzle Pipe Connections: Welded, ASME B16.5, flat-face flange **OR** Welded, ASME B16.5, raised-face flange **OR** Grooved for mechanical-joint coupling **OR** Grooved with mechanical-joint coupling and flange adapter, **as directed**.
e. Thermistor or RTD temperature sensor factory installed in each nozzle.
f. Fit each water box with 3/4-inch (19-mm) **OR** 1-inch (25-mm), **as directed**, drain connection at low point and vent connection at high point, each with threaded plug.
3. Additional Corrosion Protection:
a. Electrolytic corrosion-inhibitor anode.
b. Coat wetted surfaces with a corrosion-resistant finish.
OR
Using same material as tubes, clad surfaces of end tube sheets in contact with fluid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.

I. Second-Stage Generator For Double-Effect Chillers
1. Tubes:

a. Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end and without damage to tube sheets and other tubes.
b. Material: Copper **OR** Copper-nickel alloy **OR** Stainless steel **OR** Titanium, **as directed**.
c. Minimum Wall Thickness: Manufacturer's choice **OR** 0.025 inch (0.6 mm) **OR** 0.028 inch (0.7 mm) **OR** 0.035 inch (0.9 mm), **as directed**.
d. External Finish: Manufacturer's standard.
e. Internal Finish: Smooth **OR** Enhanced, **as directed**.

2. Water Boxes:
   a. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
   b. Standard type water box.
   c. Water boxes shall have lifting lugs or eyebolts.
   d. Nozzle Pipe Connections: Welded, ASME B16.5, flat-face flange **OR** Welded, ASME B16.5, raised-face flange **OR** Grooved for mechanical-joint coupling **OR** Grooved with mechanical-joint coupling and flange adapter, **as directed**.
   e. Thermistor or RTD temperature sensor factory installed in each nozzle.
   f. Fit each water box with 3/4-inch (19-mm) **OR** 1-inch (25-mm), **as directed**, drain connection at low point and vent connection at high point, each with threaded plug.
3. Additional Corrosion Protection:
   a. Electrolytic corrosion-inhibitor anode.
   b. Coat wetted surfaces with a corrosion-resistant finish.
   OR
   Using same material as tubes, clad surfaces of end tube sheets in contact with fluid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.

J. Solution Heat Exchanger
   1. Description: Shell-and-tube or brazed-plate heat exchanger; integral part of chiller to increase cycle efficiency by preheating the weak solution on its way to the generator while precooling the strong solution returning from the generator.

K. Steam Condensate Drain Cooler
   1. Description: Shell-and-tube heat exchanger constructed of carbon-steel shell and copper-nickel-alloy or stainless-steel tubes.

L. Factory-Applied Insulation
   1. Factory-Applied Insulation on Cold Surfaces:
      a. Closed-cell, flexible elastomeric thermal insulation complying with ASTM C 534, Type I for tube and Type II for sheet materials.
         1) Thickness: 3/4 inch (19 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
      b. Adhesive: As recommended by insulation manufacturer.
      c. Factory apply insulation over all cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator shell and end tube sheets; evaporator water boxes including nozzles; refrigerant pump; cold surfaces of motor; and cold piping.
         1) Apply adhesive to 100 percent of insulation contact surface.
         2) Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
         3) Seal seams and joints to provide a vapor barrier.
         4) After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.
   2. Factory-Applied Insulation on Hot Surfaces:
      a. Mineral-fiber board, pipe or tank insulation complying with one of following:
         1) ASTM C 547, Type I or Type II, Grade A.
         2) ASTM C 612, Type IB.
         3) ASTM C 1393, Type II or Type IIIA, Category 2.
         4) Thickness: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**.

b. Adhesive: As recommended by insulation manufacturer.
c. Factory apply materials over all hot surfaces to provide smooth, straight, and even surfaces; free of voids.
   1) Apply adhesive to insulation contact surface as recommended by insulation manufacturer.
   2) Install insulation anchor pins and washers if required by insulation manufacturer to secure insulation to surfaces to be insulated.
   3) Completely encapsulate insulation with metal jacket, leaving no exposed insulation. Provide removable jacket on components requiring access for service and inspection.
   4) Paint exposed surfaces of metal jacket to match other painted parts unless jacket material is aluminum or stainless steel.

M. Electrical
1. Factory installed and wired, and functionally tested at factory before shipment.
2. Single-point, field-power connection to fused disconnect switch **OR** nonfused disconnect switch **OR** circuit breaker, **as directed**. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 42,000 **OR** 65,000, **as directed**, A.
   a. Branch power circuit to each motor, dedicated electrical load, and controls with disconnect switch or circuit breaker, **as directed**.
      1) NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
      2) NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit-trip set point.
   b. NEMA ICS 2, Class A, full-voltage, nonreversing motor controller, hand-off-auto switch, and overcurrent protection for each motor.
   c. Control-circuit transformer with primary and secondary side fuses.
3. Terminal blocks with numbered and color-coded, **as directed**, wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
4. Wiring Outside of Enclosures: Factory installed in metal raceway except make terminal connections with not more than a 24-inch (610-mm) length of liquidtight **OR** flexible metallic, **as directed**, conduit.

N. Controls
1. Control: Standalone and microprocessor based, with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.
2. Enclosure: Unit mounted, NEMA 250, Type 1 **OR** Type 4 **OR** Type 4x, **as directed**, hinged or lockable.
3. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. In either imperial or metric units selectable through the interface, display the following information:
   a. Date and time.
   b. Operating or alarm status.
   c. Operating hours.
   d. Outdoor-air temperature if required for chilled-water reset.
   e. Temperature and pressure of operating set points.
   f. Entering and leaving temperatures of chilled and condenser water.
   g. Refrigerant temperature.
   h. Solution concentration and temperature.
   i. Indication of solution and purge-pump operation.
   j. Generator shell pressure.
   k. Number of starts.
   l. Number of purge cycles.
   m. Hot-water valve actuator potentiometer position (percentage).
   n. Entering and leaving hot-water temperatures.

o. Steam demand limit.
p. Inlet steam pressure and temperature.
q. Steam valve actuator potentiometer position (percentage).
r. First-stage generator pressure and temperature.

4. Control Functions:
   a. Manual or automatic startup and shutdown time schedule.
   b. Automatic cycle to prevent crystallization.
   c. Entering and leaving chilled-water temperatures and control set points. Chilled-water temperature shall be reset based on return-water **OR** outdoor-air **OR** space, **as directed**, temperature.
   d. Condenser-fluid temperature.
   e. Cooling provided and heating energy used within programmable time periods, minimum monthly.
5. Capacity Control: Automatically controls input flow rate of heat source to maintain chilled-water temperature set point for cooling loads ranging from 10 to 100 percent.
6. Control Valve Package: Factory-furnished, for field installation, **OR** Factory-installed, **as directed**, control valve package suitable for energy source indicated.
   a. Body: Cast-iron, carbon-steel, or stainless-steel body with flanged connections.
   b. Type: Manufacturer's choice **OR** V-notch ball **OR** Butterfly **OR** Globe style with cage-guide plug, **as directed**, constructed of stainless steel.
   c. Rating: Pressure and temperature rating to match heat exchanger.
   d. Shutoff: Capable of bubble-tight shutoff against maximum system pressure.
   e. Size: Determined by chiller manufacturer.
   f. Modulation: Two-way **OR** Three-way, **as directed**.
   g. Turndown: As required to achieve stable control through the indicated operating range.
   h. Actuator: Electric powered from chiller control panel and installed on valve.
7. Safety Shutdowns:
   a. Crystallization.
   b. Low refrigerant temperature.
   c. Loss of chilled- or condenser-water flow.
   d. Low leaving chilled-water temperature, 2 deg F (1 deg C) below set point, **as directed**.
   e. First-stage generator low-solution level.
   f. First-stage generator high temperature or pressure.
   g. Power failure.
   h. Solution pump overloads.
   i. External auxiliary safety shutdown.
   j. High solution concentration.
   k. Incomplete dilution cycle.
   l. High entering-water temperature.
   m. High inlet steam pressure and temperature.
8. Warning Conditions: Control panel shall close warning contacts and generate a message when one of the following operating conditions is detected:
   a. Low refrigerant temperature.
   b. High generator temperature or pressure.
   c. High entering generator-water temperature (single-stage generator only).
   d. High or low entering condenser-water temperature.
   e. Solution temperature sensor failure.
   f. Low chilled-water flow.
9. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.
10. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.
11. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.

12. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer, **as directed**.
13. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display chiller status and alarms.
    a. Hardwired Points:
        1) Monitoring: On-off status, common trouble alarm.
        2) Control: On-off operation, chilled-water, discharge temperature set-point adjustment **OR** generator heat source capacity limiting, **as directed**.
    b. ASHRAE 135 (BACnet) **OR** LonTalk **OR** Modbus **OR** Industry-accepted, open-protocol, **as directed**, communication interface with the BAS shall enable the BAS operator to remotely control and monitor the chiller from an operator workstation. Control features and monitoring points displayed locally at chiller control panel shall be available through the BAS.

O. Finish
1. Paint chiller, using manufacturer's standard procedures, except comply with the following minimum requirements:
    a. Provide at least one coat of primer with a total dry film thickness of at least 2 mils (0.05 mm).
    b. Provide at least two coats of alkyd-modified, vinyl enamel **OR** epoxy **OR** polyurethane, **as directed**, finish with a total dry film thickness of at least 4 mils (0.10 mm).
    c. Paint surfaces that are to be insulated before applying the insulation.
    d. Paint installed insulation to match adjacent uninsulated surfaces.
    e. Color of finish coat to be manufacturer's standard **OR** custom color selected by the Owner.
2. Provide the Owner with quart container of paint used in application of topcoat to use in touchup applications after Project Closeout.

P. Accessories
1. Sight Glasses: Equip unit with sight glasses for visual inspection of absorbent solution and refrigerant levels. Provide at least one sight glass in absorber and evaporator sections.
2. Flow Switches:
    a. Chiller manufacturer shall furnish a switch for each condenser **OR** evaporator and condenser, **as directed**, and verify field-mounting location before installation.
    b. Paddle Flow Switches:
        1) Vane operated to actuate a double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the BAS.
        2) Contacts: Platinum alloy, silver alloy, or gold-plated switch contacts with a rating of 10 A at 120-V ac.
        3) Pressure rating equal to pressure rating of heat exchanger.
        4) Construct body and wetted parts of Type 316 stainless steel.
        5) House switch in a NEMA 250, Type 4 enclosure constructed of die-cast aluminum.
        6) Vane length to suit installation.

    OR

    Pressure Differential Switches:
        1) Construction: Wetted parts of body and trim constructed of Type 316 stainless steel.
        2) Performance: Switch shall withstand, without damage, the full-pressure rating of the heat exchanger applied to either port and exhibit zero set-point shift due to variation in working pressure.
        3) Set Point: Screw type, field adjustable.
        4) Electrical Connections: Internally mounted screw-type terminal blocks.
        5) Switch Enclosure: NEMA 250, Type 4.
        6) Switch Action: Double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the BAS.
3. Vibration Isolation:
    a. Chiller manufacturer shall furnish neoprene-pad vibration isolation for each chiller.

1) Two layers of 0.375-inch- (10-mm-) thick, ribbed- or waffle-pattern neoprene pads separated by a 16-gage, stainless-steel plate.
2) Fabricate pads from 40- to 50-durometer neoprene.
3) Provide stainless-steel square bearing plate to load the pad uniformly between 20 and 40 psig (138 and 276 kPa) with a 0.12- to 0.16-inch (3- to 4-mm) deflection.

4. Lithium Bromide Filter, **as directed**:
   a. Factory install a filter, isolation valves, and associated piping.
   b. Filter shall consist of a stainless-steel body, with removable and cleanable 150-micron, stainless-steel element.
   c. Isolation valves shall provide isolation for filter servicing without disturbing operation of chiller.

Q. Heat-Exchanger, Brush-Cleaning System
1. Furnish for field installation a brush-cleaning system on each chiller condenser, **as directed**, for tube cleaning and improved heat transfer.
2. System shall maintain tube fouling at or below design conditions without interrupting normal equipment operation.
3. System shall consist of a brush inserted in each tube and a catch basket attached to each end of the tube. A four-way valve shall operate to reverse the direction of water flow to push the brush through the tube while removing tube deposits. Four-way reversing valve's actuator shall be controlled by a preset time cycle that provides regular tube brushing during equipment operation. Frequency of the brushing cycle shall be set up to match Project requirements.
4. Components:
   a. Brush: Each brush shall have nylon bristles, titanium wires, and polypropylene tips. Brush interference fit with the ID of the tube shall not exceed 0.025 inch (0.6 mm).
   b. Basket: Single-piece polypropylene basket with neck OD to press fit inner diameter of tube. Design shall provide for insertion of eddy current probe or removal of brushes without removing baskets from the valve.
   c. Four-Way Valve:
      1) Construct valve body of carbon steel with internal sealing parts of hard rubber and Type 304 stainless steel.
      2) Configure valve with parallel flow connections to minimize field installation piping.
      3) Construct to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, at a system working pressure equal to condenser.
      4) Pipe connections shall be flanged.
      5) Valve manufacturer to test and certify a maximum leakage rate of less than 0.05 percent of the design flow rate at operation conditions of maximum differential pressure.
      6) Hydrostatically test to 1.5 times the design working pressure.
      7) Design the valve to cause no more than 0.5-psig (3-kPa) pressure drop at design flow conditions.
      8) Provide valve with valve-mounted indicating/warning light, which shall light before the valve begins rotation.
      9) Valve Actuator: Mount electric actuator to operate valve.
         OR
         Valve Actuator: Mount pneumatic piston-type actuator to operate valve. Actuator shall be suitable for operation using field-supplied air pressure.
      10) Position Switches: Factory mount microswitches on the valve to indicate the complete turn of valve in both normal and reverse flow.
   d. Control Panel: Factory or field mount a control panel on chiller. Control panel shall include the following features:
      1) NEMA 250, Type 1 **OR** Type 4 **OR** Type 4x **OR** Type 12, **as directed**, enclosure.
      2) Timer to automatically initiate the cleaning cycle over a 24-hour period.
      3) Manual override of preset cleaning cycle.
      4) Visual indication of "Power On," "Diverter Position," "Normal Flow," "Reverse Flow," and "Valve Malfunction" indicating a slow turn or incomplete valve turn.

5) For pneumatic actuators, mount four-way solenoid valve for actuator operation in the control panel.
6) Flow-switch bypass.
7) Unloading signal to chiller.

R. Source Quality Control
1. Perform functional tests **OR** run tests, **as directed**, of chillers before shipping.
2. Factory test and inspect absorber, generator, evaporator and condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Pressure test tube-side of heat exchangers, including water boxes, to 1.5 times the rated pressure. Vacuum and pressure test shells for leaks.
3. Rate sound power level according to ARI 575.
4. Factory performance test chillers, before shipping, according to ARI 560, **as directed**.
   a. Test the following conditions:
      1) Design conditions indicated.
      2) Reduction in capacity from design to minimum load in steps of 10 **OR** 25 **OR** 33, **as directed**, with condenser fluid at design conditions.
      OR
      Reduction in capacity from design to minimum load in steps of 10 **OR** 25 **OR** 33, **as directed**, with varying entering condenser-fluid temperature from design to minimum conditions in 5 deg F (3 deg C) increments.
      OR
      At one **OR** two **OR** three **OR** four **OR** five **OR** 10, **as directed**, point(s) of varying part-load performance to be selected by the Owner at time of test.
5. Factory sound test chillers, before shipping, according to ARI 575, **as directed**.
   a. Test the following conditions:
      1) Design conditions indicated.
      2) Chiller operating at calculated worst-case sound condition.
      3) At one **OR** two **OR** three **OR** four **OR** five, **as directed**, point(s) of varying part-load performance to be selected by the Owner at time of test.
6. Allow the Owner access to place where chillers are being tested. Notify the Owner 14 days in advance of testing.
7. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

1.3 EXECUTION

A. Chiller Installation
1. Install chillers on support structure indicated.
2. Equipment Mounting: Install chiller on concrete bases using elastomeric pads. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-place Concrete". Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
   a. Minimum Deflection: 1/4 inch (6 mm) **OR** 1/2 inch (13 mm), **as directed**.
   b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   e. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Equipment Mounting: Install chiller using elastomeric pads. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".

a. Minimum Deflection: 1/4 inch (6 mm) **OR** 1/2 inch (13 mm), **as directed**.

4. Equipment Mounting: Install chiller on concrete bases. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-place Concrete".
   a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   d. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Install chillers with seismic-restraint device. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
6. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
7. Maintain manufacturer's recommended clearances for service and maintenance.
8. Charge chiller with absorbent and refrigerant if not factory charged.
9. Install separate devices furnished by manufacturer and not factory installed.
10. Insulate hot and cold chiller surfaces that are recommended by chiller manufacturer to be insulated, and are not factory insulated. Comply with requirements in Division 23 Section "Hvac Insulation".

B. Heat-Exchanger, Brush-Cleaning System Installation
1. Install brush-cleaning system control panel adjacent to chiller control panel.
2. Arrange piping to provide service access to four-way valve assembly without affecting access to chiller. Secure valve to prevent lateral movement and vibration during operation.
3. Provide field electric power, as required, to each system control panel and electric actuated valve.
4. Provide pneumatic piping with pressure regulator and isolation valve to each pneumatic supply connection. Coordinate field source of air with manufacturer to ensure that requirements are satisfied for proper valve operation.
5. Interconnect brush-cleaning system controls with chiller controls. Coordinate requirements to ensure safe, trouble-free operation.
6. Functionally test the entire brush-cleaning system, including the valve, actuator, position indicator, and control panel, with chiller in operation.

C. Connections
1. Comply with requirements in Division 23 Section "Hydronic Piping" for hydronic piping. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Comply with requirements in Division 23 Section "Steam And Condensate Heating Piping" for steam and condensate piping. Drawings indicate general arrangement of piping, fittings, and specialties.
3. Install piping adjacent to chiller to allow service and maintenance.
4. Generator Steam Piping Connections:
   a. Connect steam piping with trapped drip leg, gate valve, strainer, control valve, and pressure gage. Install pressure reducing valve and safety relief valve upstream from steam-control valve to protect control valve from excessive steam pressure. Make connections to chiller with a flange **OR** union, **as directed**.
   b. Connect steam condensate piping with vacuum breaker, trapped drip leg, gate valve, strainer, float and thermostatic trap(s), condensate cooler, **as directed**, condensate receiver, **as directed**, condensate receiver and pump, **as directed**, and check valve. Make connections to chiller with a flange **OR** union, **as directed**.
5. Generator Hot-Water Connections: Connect to generator inlet with shutoff valve, strainer, **as directed**, flexible connector, **as directed**, control valve, thermometer, and plugged tee with shutoff valve and pressure gage. Connect to generator outlet with shutoff valve, check valve, balancing valve, flexible connector, **as directed**, flow switch, thermometer, plugged tee with

shutoff valve and pressure gage, flow meter, **as directed**, and drain connection with valve. Make connections to chiller with a flange **OR** mechanical coupling, **as directed**.

6. Evaporator-Fluid Connections: Connect to evaporator inlet with shutoff valve, strainer, **as directed**, flexible connector, **as directed**, thermometer, and plugged tee with shutoff valve and pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, **as directed**, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, flow meter, **as directed**, and drain connection with valve. Make connections to chiller with a flange **OR** mechanical coupling, **as directed**.
7. Absorber/Condenser-Fluid Connections: Connect to inlet with shutoff valve, strainer, **as directed**, flexible connector, **as directed**, thermometer, and plugged tee with shutoff valve and pressure gage. Connect to outlet with shutoff valve, balancing valve, flexible connector, **as directed**, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, flow meter, **as directed**, and drain connection with valve. Make connections to chiller with a flange **OR** mechanical coupling, **as directed**.
   a. If not factory furnished or installed, provide pipe connecting fluid connection of absorber discharge and condenser inlet.
8. Refrigerant Pressure Relief Device Connections: Extend vent piping **OR** separate vent piping for each chiller, **as directed**, to the outdoors without valves or restrictions. Comply with ASHRAE 15. Connect to chiller pressure relief device with flexible connector and dirt leg with drain valve.
9. Extend purge vent piping **OR** separate purge vent piping for each chiller, **as directed**, to the outdoors. Comply with ASHRAE 15.
10. Connect each chiller drain connection with a union and drain pipe, and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection.

D. Startup Service
1. Engage a factory-authorized service representative to perform startup service.
   a. Complete installation and startup checks according to manufacturer's written instructions.
   b. Operate chiller for run-in period.
   c. Verify that absorbent and refrigerant charge is sufficient and chiller has been leak tested.
   d. Verify that pumps are installed and functional.
   e. Verify that thermometers and gages are installed.
   f. Operate chiller for run-in period.
   g. Verify that refrigerant pressure relief device is vented outside.
   h. Verify proper motor rotation.
   i. Verify static deflection of vibration isolators including deflection during chiller startup and shutdown.
   j. Verify and record performance of fluid flow and low-temperature interlocks for evaporator and condenser.
   k. Verify and record performance of chiller protection devices.
   l. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
2. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.
3. Prepare test and inspection startup reports.

E. Demonstration
1. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain chillers.

END OF SECTION 23 62 13 00

Task	Specification	Specification Description
23 62 23 00	23 01 60 71	Condensing Units

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SECTION 23 63 13 00 - AIR-COOLED CONDENSERS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for air-cooled condensers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes packaged, air-cooled condensers for outdoor and indoor installation.

C. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings: Signed and sealed by a qualified professional engineer.
   a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints, **as directed**, and for designing vibration isolation bases.
   b. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and equipment mounting frames.
   c. Wiring Diagrams: Power, signal, and control wiring.
3. Manufacturer Seismic Qualification Certification: Submit certification that air-cooled condensers, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment". Include the following:
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
4. Field quality-control test reports.
5. Operation and maintenance data.
6. LEED Submittal:
   a. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.

D. Quality Assurance

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Code for Mechanical Refrigeration."
3. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.2 PRODUCTS

A. Manufactured Units

1. Description: Factory assembled and tested; consisting of casing, condenser coils, condenser fans and motors, and unit controls.
2. Condenser Coil: Seamless copper-tube, finned coil; factory tested at 425 psig (2930 kPa).
   a. Coil Fin: Aluminum **OR** Copper, **as directed**.
   b. Coil Coating: **As directed**.
   c. Circuit: To match compressors with liquid subcooling coil, **as directed**.
   d. Refrigerant Accessories, **as directed**: Provide receiver, pressure control, and solenoid valve for each circuit.

3. Condenser Fans and Drives: Propeller fans with aluminum or galvanized-steel **OR** galvanized-steel **OR** stainless-steel, **as directed**, fan blades, for vertical **OR** horizontal, **as directed**, air discharge; directly driven with permanently lubricated ballbearing motors with integral current- and thermal-overload protection.
OR
Condenser Fans and Drives: Forward-curved centrifugal fans for vertical **OR** horizontal, **as directed**, air discharge.
   a. Fan on steel shaft with self-aligning ball bearings.
   b. V-belt drive with minimum of two belts; variable pitch drive pulley.
   c. Motor mounted on adjustable slide base.
4. Operating and Safety Controls: Include condenser fan motor thermal and overload cutouts; 115-V control transformer, if required; magnetic contactors for condenser fan motors and a nonfused factory-mounted and -wired disconnect switch for single external electrical power connection.
5. Unit Casings: Galvanized or zinc-coated steel treated and finished with manufacturer's standard paint coating **OR** Stainless steel, **as directed**, designed for outdoor installation with weather protection for components and controls **OR** indoor installation, **as directed**, and with the following:
   a. Removable panels for access to controls, condenser fans, motors, and drives.
   b. Plated-steel **OR** Stainless-steel, **as directed**, fan guards.
   c. Lifting eyes.
   d. Removable legs.
   e. 1-inch- (25-mm-) thick inlet filter.

B. Motors
1. General requirements for motors are specified in Division 14 Section "Facility Chutes".
   a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   b. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 22.

C. Source Quality Control
1. Verification of Performance: Rate air-cooled condensers according to ARI 460.
2. Testing Requirements: Factory test sound-power-level ratings according to ARI 270.

1.3 EXECUTION

A. Installation
1. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.
2. Install air-cooled condensers on concrete base. Concrete base is specified in Division 23 Section "Common Work Results For Hvac" and concrete materials and installation requirements are specified in Division 31.
3. Concrete Bases:
   a. Install dowel rods to connect concrete base to concrete slab. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of the base.
   b. For equipment supported on structural slab, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   d. Install anchor bolts to elevations required for proper attachment to supported equipment.
   e. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
4. Install roof-mounting units on equipment supports specified in Division 07.

5. Vibration Isolation: Mount air-cooled condensers on rubber pads with a minimum deflection of 1/4 inch (6.35 mm). Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
   OR
   Vibration Isolation: Mount air-cooled condensers on restrained spring isolators with a minimum deflection of <**Insert measurement**>. Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
6. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch (25 mm). Vibration- and seismic-control devices are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
   a. Secure vibration and seismic controls, and suspended units to structure.
   OR
   Support suspended units from structure using threaded steel rods.
7. Maintain manufacturer's recommended clearances for service and maintenance.
8. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

B. Connections
1. Piping installation requirements are specified in other Division 21. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to machine to allow service and maintenance.
3. Refrigerant Piping: Connect piping to unit with pressure relief, service valve, filter-dryer, and moisture indicator on each refrigerant-circuit liquid line. Refrigerant piping and specialties are specified in Division 23 Section "Refrigerant Piping".

C. Field Quality Control
1. Perform the following field tests and inspections and prepare test reports:
   a. Perform electrical test and visual and mechanical inspection.
   b. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   c. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Complete manufacturer's starting checklist.
   d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   e. Verify proper airflow over coils.
2. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
3. Remove and replace malfunctioning air-cooled condensers and retest as specified above.

D. Startup Service
1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
   a. Inspect for physical damage to unit casing.
   b. Verify that access doors move freely and are weathertight.
   c. Clean units and inspect for construction debris.
   d. Verify that all bolts and screws are tight.
   e. Adjust vibration isolation and flexible connections.
   f. Verify that controls are connected and operational.
2. Lubricate bearings on fans.
3. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
4. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.
5. Measure and record airflow over coils.
6. Verify proper operation of capacity control device.

7. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
8. After startup and performance test, lubricate bearings.

E. Demonstration
   1. Train Owner's maintenance personnel to adjust, operate, and maintain air-cooled condensers.

END OF SECTION 23 63 13 00

SECTION 23 63 13 00a - SPLIT-SYSTEM AIR-CONDITIONING UNITS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for split-system air-conditioning units. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

C. Submittals
   1. Product Data: For each unit indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
   2. LEED Submittals:
      a. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.
      b. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
   3. Shop Drawings: Diagram power, signal, and control wiring.
   4. Field quality-control test reports.
   5. Operation and maintenance data.
   6. Warranty: Special warranty specified in this Section.

D. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
   3. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Warranty
   1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within five years from date of Final Completion.

1.2 PRODUCTS

A. Concealed Evaporator-Fan Components
   1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
      a. Insulation: Faced, glass-fiber duct liner.
      b. Drain Pans: Galvanized steel, with connection for drain; insulated and complying with ASHRAE 62.1, **as directed**.
      c. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.
3. Water **OR** Steam, **as directed**, Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm); leak tested to 300 psig (2070 kPa) underwater; and having a two-position control valve.
   OR
   Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.
4. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
5. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
   a. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
6. Disposable Filters: 1 inch (25 mm) thick, in fiberboard frames with ASHRAE 52.2 MERV rating of 6 or higher, **as directed**.
7. Wiring Terminations: Connect motor to chassis wiring with plug connection.

B. Floor-Mounting, Evaporator-Fan Components
1. Cabinet: Enameled steel with removable panels on front and ends in color selected by the Owner.
   a. Discharge Grille: Steel with surface-mounted frame **OR** Welded steel bars forming a linear grille and welded into supporting panel, **as directed**.
   b. Insulation: Faced, glass-fiber, duct liner.
   c. Drain Pans: Galvanized steel, with connection for drain; insulated and complying with ASHRAE 62.1, **as directed**.
   d. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.
3. Water **OR** Steam, **as directed**, Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm); leak tested to 300 psig (2070 kPa) underwater; and having a 2-position control valve.
   OR
   Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.
4. Fan: Direct drive, centrifugal, with power-induced outside air, **as directed**.
5. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
   a. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
6. Filters: Permanent, cleanable **OR** Disposable, with ASHRAE 52.2 MERV rating of 6 or higher, **as directed**.

C. Wall-Mounting, Evaporator-Fan Components
1. Cabinet: Enameled steel with removable panels on front and ends in color selected by the Owner, and discharge drain pans with drain connection.
   a. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
   b. Drain Pan and Drain Connection: Comply with ASHRAE 62.1.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

3. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.
4. Fan: Direct drive, centrifugal fan.
5. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
   a. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
6. Filters: Permanent, cleanable **OR** Disposable, with ASHRAE 52.2 MERV rating of 6 or higher, **as directed**.

D. Ceiling-Mounting, Evaporator-Fan Components
1. Cabinet: Enameled steel with removable panels on front and ends in color selected by the Owner, and discharge drain pans with drain connection.
   a. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
   b. Drain Pan and Drain Connection: Comply with ASHRAE 62.1.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.
3. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.
4. Fan: Direct drive, centrifugal fan, with power-induced outside air, **as directed**, and integral condensate pump.
5. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
   a. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
6. Filters: Permanent, cleanable **OR** Disposable, with ASHRAE 52.2 MERV rating of 6 or higher, **as directed**.

E. Air-Cooled, Compressor-Condenser Components
1. Casing: Steel, finished with baked enamel in color selected by the Owner, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
   a. Compressor Type: Reciprocating **OR** Scroll, **as directed**.
   b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
   c. Refrigerant: R-407C **OR** R-410A, **as directed**.
3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.
4. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.
5. Fan: Aluminum-propeller type, directly connected to motor.
6. Motor: Permanently lubricated, with integral thermal-overload protection.
7. Low Ambient Kit: Permits operation down to 45 deg F (7 deg C).
8. Mounting Base: Polyethylene.
9. Minimum Energy Efficiency: Comply with ASHRAE/IESNA 90.1, "Energy Standard for Buildings except Low-Rise Residential Buildings."

F. Water-Cooled, Compressor-Condenser Components

1. Casing: Steel, with baked-enamel finish in color selected by the Owner, removable panels for access to controls, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
    a. Compressor Type: Reciprocating **OR** Scroll, **as directed**.
    b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
    c. Refrigerant: R-407C **OR** R-410A, **as directed**.
3. Heat Pump Components: Reversing valve.
4. Heat Exchanger: Copper tubes in copper tube or in steel shell, with water-temperature-actuated, water-regulating valve.
5. Minimum Energy Efficiency: Comply with ASHRAE/IESNA 90.1, "Energy Standard for Buildings except Low-Rise Residential Buildings."

G. Accessories
1. Control equipment and sequence of operation are specified in Division 23 Section(s) "Instrumentation And Control For Hvac" AND "Sequence Of Operations For Hvac Controls".
2. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
3. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:
    a. Compressor time delay.
    b. 24-hour time control of system stop and start.
    c. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
    d. Fan-speed selection, including auto setting.
4. Automatic-reset timer to prevent rapid cycling of compressor.
5. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
    a. Minimum Insulation Thickness: 1/2 inch (13 mm) **OR** 1 inch (25 mm), **as directed**, thick.

1.3 EXECUTION

A. Installation
1. Install units level and plumb.
2. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
3. Install ground-mounting, compressor-condenser components on 4-inch- (100-mm-) thick, reinforced concrete base; 4 inches (100 mm) larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-place Concrete". Coordinate anchor installation with concrete base.
   OR
   Install ground-mounting, compressor-condenser components on polyethylene mounting base.
4. Install roof-mounting compressor-condenser components on equipment supports specified in Division 07 Section "Roof Accessories". Anchor units to supports with removable, cadmium-plated fasteners.
5. Install seismic restraints.
6. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch (25 mm). Refer to Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
7. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

B. Connections

1. Piping installation requirements are specified in other Division 21. Drawings indicate general arrangement of piping, fittings, and specialties.
   a. Water Coil Connections: Comply with requirements in Division 23 Section "Hydronic Piping". Connect to supply and return coil with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.
   b. Remote Water-Cooled Condenser Connections: Comply with requirements in Division 23 Section "Hydronic Piping". Connect to supply and return with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.
   c. Steam Coil Connections: Comply with requirements in Division 23 Section "Steam And Condensate Heating Piping". Connect to steam piping with shutoff valve and union or flange; for condensate piping, starting from the coil connection, connect with union or flange, strainer, trap, and shutoff valve.
2. Install piping adjacent to unit to allow service and maintenance.
3. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts". Drawings indicate the general arrangement of ducts. Connect supply and return, **as directed**, ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories".
4. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
5. Electrical Connections: Comply with requirements in Division 22 for power wiring, switches, and motor controls.

C. Field Quality Control

1. Perform the following field tests and inspections and prepare test reports:
   a. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   b. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Remove and replace malfunctioning units and retest as specified above.

D. Startup Service

1. Engage a factory-authorized service representative to perform startup service.
   a. Complete installation and startup checks according to manufacturer's written instructions.

E. Demonstration

1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

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Task	Specification	Specification Description
23 63 13 00	23 01 60 71	Condensing Units

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SECTION 23 64 13 16 - DIRECT-FIRED ABSORPTION WATER CHILLERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for direct-fired absorption water chillers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
 a. Packaged, water-cooled, direct-fired absorption chillers.
 b. Heat-exchanger, brush-cleaning system.

C. Definitions
1. BAS: Building automation system.
2. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.
3. IPLV: Integrated part-load value. A single-number, part-load efficiency figure of merit calculated per the method defined by ARI 560 and referenced to ARI standard rating conditions.
4. NPLV: Nonstandard part-load value. A single-number, part-load efficiency figure of merit calculated per the method defined by ARI 560 and intended for operating conditions other than the ARI standard rating conditions.

D. Performance Requirements
1. Seismic Performance: Direct-fired absorption chillers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Condenser-Fluid Temperature Performance:
 a. Startup Condenser-Fluid Temperature: Chiller shall be capable of starting with an entering condenser-fluid temperature of 60 deg F (16 deg C) and providing stable operation until the system temperature is elevated to the minimum operating entering condenser-fluid temperature.
 b. Minimum Operating Condenser-Fluid Temperature: Chiller shall be capable of continuous operation over the entire capacity range indicated with an entering condenser-fluid temperature of 70 deg F (21 deg C).
 c. Make factory modifications to standard chiller design if necessary to comply with performance indicated.
3. Site Altitude: Chiller shall be suitable for altitude at which it is installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.
4. Performance Tolerance: Comply with the following in lieu of ARI 560:
 a. Allowable Capacity Tolerance: Zero percent.
 b. Allowable IPLV/NPLV Performance Tolerance: Zero percent.

E. Submittals
1. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, furnished specialties and accessories, and the following:
 a. Performance at ARI standard conditions and at conditions indicated.
 b. Performance at ARI standard unloading conditions.
 c. Minimum evaporator flow rate.

d. Absorbent capacity of chiller.
e. Refrigerant capacity of chiller.
f. Fluid capacity of evaporator and condenser.
g. Fluid capacity of generator.
h. Characteristics of safety relief devices.
i. Minimum entering condenser-fluid temperature.
j. Performance at varying capacities with constant design condenser-fluid temperature. Repeat performance at varying capacities for different condenser-fluid temperatures from design to minimum in 5 deg F (3 deg C) increments.
k. If equipped, fluid capacity of dedicated hot-water heater exchanger.
l. Combustion-air flow.
m. Exhaust gas airflow.
n. Exhaust gas minimum and maximum operating temperature.

2. LEED Submittals:
a. Product Data for Prerequisite EA 2: Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1.
b. Product Data for Prerequisite EA 3: Documentation indicating that refrigerants comply.
c. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.

3. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
a. Detail equipment assemblies and indicate dimensions, weights, load distribution, required clearances, method of field assembly, components, and location and size of each field connection.
b. Wiring Diagrams: For power, signal, and control wiring.
c. Insulated Surface Diagrams: Indicating cold and hot surfaces requiring field-applied insulation with area tabulated for each.

4. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
a. Structural supports.
b. Piping roughing-in requirements.
c. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
d. Access requirements, including working clearances for mechanical controls and electrical equipment, and clearances for tube pull and service.

5. Certificates: For certification required in "Quality Assurance" Article.
6. Seismic Qualification Certificates: For chillers, accessories, and components, from manufacturer.
a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

7. Source quality-control reports.
8. Startup service reports.
9. Operation and Maintenance Data: For each chiller to include in emergency, operation, and maintenance manuals.
10. Warranty: Sample of special warranty.

F. Quality Assurance
1. ARI Rating: Rate chiller performance according to requirements in ARI 560.
2. ASHRAE Compliance:
a. ASHRAE 15 for safety code for mechanical refrigeration.
b. ASHRAE/IESNA 90.1.
3. ASME Compliance: Fabricate and label chiller pressure vessels to comply with applicable portions of ASME Boiler and Pressure Vessel Code.
4. Comply with NFPA 70.

5. Comply with requirements of UL and UL Canada, and include label by a qualified testing agency showing compliance.
   a. UL Compliance: UL 726, "Oil-Fired Boiler Assemblies" **OR** UL 726, "Oil-Fired Boiler Assemblies"; and UL 795, "Commercial-Industrial Gas Heating Equipment" **OR** UL 795, "Commercial-Industrial Gas Heating Equipment", **as directed**.

G. Delivery, Storage, And Handling
1. Ship chillers factory charged with nitrogen.
2. Ship absorbent and refrigerant in chillers or in containers separate from chillers.
   OR
   Ship absorbent and refrigerant in containers separate from chillers.
3. Package chiller for export shipping in totally enclosed bagging **OR** crate **OR** crate with bagging, **as directed**.

H. Coordination
1. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.
2. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

I. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chillers that fail in materials or workmanship within specified warranty period.
   a. Extended warranties include, but are not limited to, the following:
      1) Complete chiller.
         OR
         Pumps and motors **OR** Purge unit **OR** Burner assembly, **as directed**.
         OR
         Absorbent **OR** Absorbent and refrigerant, **as directed**, only.
      2) Parts only **OR** only and labor, **as directed**.
      3) Loss of absorbent and refrigerant for any reason.
   b. Warranty Period: Two **OR** Three **OR** Four **OR** Five, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Manufactured Unit
1. Description: Factory-assembled and -tested, hermetic-design chiller complete with absorber, evaporator, condenser, generator, solution heat exchanger, controls, absorbent solution pump with motor, refrigerant pump with motor, purge unit with motor, burner assembly, motor controllers, rupture disk, interconnecting unit piping and wiring, indicated accessories, and mounting frame.
   a. Disassemble chiller into major assemblies, as required by the installation, after factory testing and before packaging for shipment.
2. Absorbent and Refrigerant:
   a. Absorbent: Lithium bromide solution with corrosion inhibitor.
   b. Refrigerant: Deionized or distilled, **as directed**, water.
   c. Performance Enhancer: Heat and mass transfer enhancer to improve performance.
3. Seismic Fabrication Requirements: Fabricate mounting base and attachment to chiller, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment" when mounting base is anchored to building structure.

B. Pumps

1. Hermetically sealed, self-lubricating, and fitted with self-adjusting, spring-loaded, wear-compensating, tapered carbon bearings.
2. Pump motor assembly shall be designed to operate for not less than 50,000 hours between inspections.
3. Pump motors shall be cooled and bearings lubricated, either by fluid being pumped or by a filtered supply of liquid refrigerant.
4. Pump suction and discharge shall be equipped with isolation valves.
5. Absorbent solution and refrigerant shall have separate and dedicated pumps.
   a. Absorbent solution and refrigerant flow-control method shall be manufacturer's choice to comply with operating requirements indicated.
6. Purge System: Unit mounted and factory wired, equipped with controls and a pump to automatically remove noncondensable vapors.
   a. Purge Pump Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
      1) Enclosure: Open dripproof **OR** Totally enclosed, **as directed**.

C. Heat-Exchanger Shells
1. Configuration: Two shells; one shell consists of the absorber/evaporator, low-stage generator/condenser and the other shell consists of the high-stage generator. Where indicated, equip chiller with a dedicated hot-water heat exchanger.
2. Construction: Fabricated from continuously welded carbon-steel sheet or plate, or from seamless pipe.
3. Design Pressure and Temperature Rating: Comply with applicable requirements in ASME Boiler and Pressure Vessel Code.
4. End Tube Sheets: Carbon-steel plates continuously welded to each end of shell; drilled and reamed to accommodate tubes, with positive seal between fluid in tubes and refrigerant in shell.
5. Intermediate Tube Sheets: Carbon-steel plates installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid tube contact resulting in abrasion and wear.
6. Generator/Condenser Shell Pressure Relief Device: Manufacturer's standard rupture disk complying with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code.

D. Absorber
1. Nozzle or Dispersion Trays: Designed to evenly distribute absorbent solution over tubes; constructed of brass, stainless steel, or another material that will not corrode.
2. Tubes:
   a. Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end without damage to tube sheets and other tubes.
   b. Material: Copper **OR** Copper-nickel alloy, **as directed**.
   c. Minimum Wall Thickness: Manufacturer's choice **OR** 0.025 inch (0.6 mm) **OR** 0.028 inch (0.7 mm) **OR** 0.035 inch (0.9 mm), **as directed**.
   d. External Finish: Manufacturer's standard.
   e. Internal Finish: Enhanced **OR** Smooth, **as directed**.
3. Water Boxes:
   a. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
   b. Standard **OR** Marine-type, **as directed**, water box with piping connections.
      1) Water boxes and marine-type water-box covers, **as directed**, shall have lifting lugs or eyebolts.
      2) Hinged **OR** Davited, **as directed**, water boxes.
         OR
         Hinged **OR** Davited, **as directed**, marine-type water-box covers.
   c. Standard water box without piping connections.

1) Water boxes shall have lifting lugs or eyebolts.
2) Hinged **OR** Davited, **as directed**, water boxes.

d. Nozzle Pipe Connections: Welded, ASME B16.5, flat-face flange **OR** Welded, ASME B16.5, raised-face flange **OR** Grooved for mechanical-joint coupling **OR** Grooved with mechanical-joint coupling and flange adapter, **as directed**.
e. Thermistor or RTD temperature sensor factory installed in each nozzle.
f. Fit each water box with 3/4-inch (19-mm) **OR** 1-inch (25-mm), **as directed**, drain connection at low point and vent connection at high point, each with threaded plug.

4. Additional Corrosion Protection:
   a. Electrolytic corrosion-inhibitor anode.
   b. Coat wetted surfaces with a corrosion-resistant finish.
   OR
   Using same material as tubes, clad surfaces of end tube sheets in contact with fluid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.
5. Absorber/Condenser Crossover Piping: Factory-furnished and -installed piping connecting fluid connection of absorber discharge to condenser inlet.

E. Evaporator
1. Nozzle or Dispersion Trays: Designed to evenly distribute refrigerant over tubes; constructed of brass, stainless steel, or another material that will not corrode.
2. Refrigerant Holding Pan: Steel or stainless steel.
3. Tubes:
   a. Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end without damage to tube sheets and other tubes.
   b. Material: Copper **OR** Copper-nickel alloy, **as directed**.
   c. Minimum Wall Thickness: Manufacturer's choice **OR** 0.025 inch (0.6 mm) **OR** 0.028 inch (0.7 mm) **OR** 0.035 inch (0.9 mm), **as directed**.
   d. External Finish: Manufacturer's standard.
   e. Internal Finish: Enhanced **OR** Smooth, **as directed**.
4. Water Boxes:
   a. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
   b. Standard **OR** Marine-type, **as directed**, water box with piping connections.
      1) Water boxes and marine-type water-box covers, **as directed**, shall have lifting lugs or eyebolts.
      2) Hinged **OR** Davited, **as directed**, water boxes.
      OR
      Hinged **OR** Davited, **as directed**, marine-type water-box covers.
   c. Standard water box without piping connections.
      1) Water boxes shall have lifting lugs or eyebolts.
      2) Hinged **OR** Davited, **as directed**, water boxes.
   d. Nozzle Pipe Connections: Welded, ASME B16.5, flat-face flange **OR** Welded, ASME B16.5, raised-face flange **OR** Grooved for mechanical-joint coupling **OR** Grooved with mechanical-joint coupling and flange adapter, **as directed**.
   e. Thermistor or RTD temperature sensor factory installed in each nozzle.
   f. Fit each water box with 3/4-inch (19-mm) **OR** 1-inch (25-mm), **as directed**, drain connection at low point and vent connection at high point, each with threaded plug.

F. Condenser
1. Refrigerant Holding Pan: Steel or stainless steel.
2. Tubes:
   a. Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end without damage to tube sheets and other tubes.
   b. Material: Copper **OR** Copper-nickel alloy, **as directed**.
   c. Minimum Wall Thickness: Manufacturer's choice **OR** 0.025 inch (0.6 mm) **OR** 0.028 inch (0.7 mm) **OR** 0.035 inch (0.9 mm), **as directed**.

d. External Finish: Manufacturer's standard.
e. Internal Finish: Enhanced **OR** Smooth, **as directed**.

3. Water Boxes:
a. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
b. Standard **OR** Marine-type, **as directed**, water box with piping connections.
1) Water boxes and marine-type water-box covers, **as directed**, shall have lifting lugs or eyebolts.
2) Hinged **OR** Davited, **as directed**, water boxes.
OR
Hinged **OR** Davited, **as directed**, marine-type water-box covers.
c. Standard water box without piping connections.
1) Water boxes shall have lifting lugs or eyebolts.
2) Hinged **OR** Davited, **as directed**, water boxes.
d. Nozzle Pipe Connections: Welded, ASME B16.5, flat-face flange **OR** Welded, ASME B16.5, raised-face flange **OR** Grooved for mechanical-joint coupling **OR** Grooved with mechanical-joint coupling and flange adapter, **as directed**.
e. Thermistor or RTD temperature sensor factory installed in each nozzle.
f. Fit each water box with 3/4-inch (19-mm) **OR** 1-inch (25-mm), **as directed**, drain connection at low point and vent connection at high point, each with threaded plug.

4. Additional Corrosion Protection:
a. Electrolytic corrosion-inhibitor anode.
b. Coat wetted surfaces with a corrosion-resistant finish.
OR
Using same material as tubes, clad surfaces of end tube sheets in contact with fluid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.

G. First-Stage Generator
1. Tubes:
a. Replaceable, **as directed**, straight, or U tubes expanded into tube sheets.
b. Material: Manufacturer's standard **OR** Steel, **as directed**.
c. Minimum Wall Thickness: Manufacturer's choice.
d. External Finish: Manufacturer's standard.
e. Internal Finish: Manufacturer's choice; enhanced or smooth.
2. Water Boxes:
a. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
b. Standard water box.
c. Water boxes shall have lifting lugs or eyebolts.
d. Nozzle Pipe Connections: Welded, ASME B16.5, flat-face flange **OR** Welded, ASME B16.5, raised-face flange **OR** Grooved for mechanical-joint coupling **OR** Grooved with mechanical-joint coupling and flange adapter, **as directed**.
e. Thermistor or RTD temperature sensor factory installed in each nozzle.
f. Fit each water box with 3/4-inch (19-mm) **OR** 1-inch (25-mm), **as directed**, drain connection at low point and vent connection at high point, each with threaded plug.

H. Second-Stage Generator
1. Tubes:
a. Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end without damage to tube sheets and other tubes.
b. Material: Copper **OR** Copper-nickel alloy, **as directed**.
c. Minimum Wall Thickness: Manufacturer's choice **OR** 0.025 inch (0.6 mm) **OR** 0.028 inch (0.7 mm) **OR** 0.035 inch (0.9 mm), **as directed**.
d. External Finish: Manufacturer's standard.
e. Internal Finish: Manufacturer's standard.

2. Water Boxes:
   a. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
   b. Standard type.
   c. Water boxes shall have lifting lugs or eyebolts.
   d. Nozzle Pipe Connections: Welded, ASME B16.5, flat-face flange **OR** Welded, ASME B16.5, raised-face flange **OR** Grooved for mechanical-joint coupling **OR** Grooved with mechanical-joint coupling and flange adapter, **as directed**.
   e. Thermistor or RTD temperature sensor factory installed in each nozzle.
   f. Fit each water box with 3/4-inch (19-mm) **OR** 1-inch (25-mm), **as directed**, drain connection at low point and vent connection at high point, each with threaded plug.

I. Dedicated Hot-Water Heat Exchanger
1. Tubes:
   a. Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end without damage to tube sheets and other tubes.
   b. Material: Copper **OR** Copper-nickel alloy, **as directed**.
   c. Minimum Wall Thickness: Manufacturer's choice **OR** 0.025 inch (0.6 mm) **OR** 0.028 inch (0.7 mm) **OR** 0.035 inch (0.9 mm), **as directed**.
   d. External Finish: Manufacturer's standard.
   e. Internal Finish: Manufacturer's standard.
2. Water Boxes:
   a. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
   b. Standard type.
   c. Water boxes shall have lifting lugs or eyebolts.
   d. Nozzle Pipe Connections: Welded, ASME B16.5, flat-face flange **OR** Welded, ASME B16.5, raised-face flange **OR** Grooved for mechanical-joint coupling **OR** Grooved with mechanical-joint coupling and flange adapter, **as directed**.
   e. Thermistor or RTD temperature sensor factory installed in each nozzle.
   f. Fit each water box with 3/4-inch (19-mm) **OR** 1-inch (25-mm), **as directed**, drain connection at low point and vent connection at high point, each with threaded plug.

J. Solution Heat Exchanger
1. Description: Shell-and-tube or brazed-plate heat exchanger, an integral part of chiller, increases cycle efficiency by preheating the weak solution on its way to the generator while precooling the strong solution returning from the generator.

K. Burner Assembly
1. Burner: Welded construction with multivane, stainless-steel, flame-retention diffuser suitable for natural gas **OR** propane **OR** fuel oil, **as directed**. Mount burner on hinged access door to permit access to combustion chamber, **as directed**.
2. Blower: Centrifugal fan integral to burner, directly driven by motor; with adjustable damper assembly and locking quadrant to set air-fuel ratio.
   a. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
      1) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
3. Oil Supply: Control devices and modulating control sequence shall comply with requirements of ASME CSD-1 **OR** FMG **OR** IRI **OR** UL, **as directed**.
   a. Oil Pump: Two-stage, gear-type oil pump shall be capable of producing 300-psig (2070-kPa) discharge pressure and 15-in. Hg (50.7-kPa) vacuum.
   b. Oil Piping Specialties:
      1) Suction-line, manual, gate valve.
      2) Removable-mesh oil strainer.

3) 0- to 30-in. Hg (0- to 101.3-kPa) vacuum; 0- to 30-psig (0- to 207-kPa) vacuum-pressure gage.
4) 0- to 300-psig (0- to 2070-kPa) oil-nozzle pressure gage.
5) Nozzle-line, solenoid-safety-shutoff oil valve.

4. Oil Pilot: Intermittent-electric-spark **OR** Interrupted-electric-spark, **as directed**, pilot ignition with 100 percent main-valve and pilot-safety shutoff solenoid with cadmium sulfide **OR** UV scanner, **as directed**, flame-safety control.
5. Gas Train: Control devices and modulating control sequence shall comply with requirements of ASME CSD-1 **OR** FMG **OR** IRI **OR** UL, **as directed**.
6. Gas Pilot: Intermittent-electric-spark **OR** Interrupted-electric-spark, **as directed**, pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.
7. Burner assembly shall be equipped to limit nitrogen oxide emissions to 20 **OR** 30, **as directed**, ppm.

L. Electrical
1. Factory installed and wired, and functionally tested at factory before shipment.
2. Single-point, field-power connection to fused disconnect switch **OR** nonfused disconnect switch **OR** circuit breaker, **as directed**. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 42,000 **OR** 65,000, **as directed**, A.
   a. Branch power circuit to each motor, dedicated electrical load, and to controls with disconnect switch or circuit breaker, **as directed**.
      1) NEMA KS 1, heavy-duty fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
      2) NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit-trip set point.
   b. NEMA ICS 2, Class A, full-voltage, nonreversing motor controller, hand-off-auto switch, and overcurrent protection for each motor.
   c. Control-circuit transformer with primary and secondary side fuses.
3. Terminal blocks with numbered and color-coded, **as directed**, wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
4. Wiring Outside of Enclosures: Factory installed in metal raceway except make terminal connections with not more than a 24-inch (610-mm) length of liquidtight **OR** flexible metallic, **as directed**, conduit.

M. Controls
1. Chiller control panel shall be separate from burner control panel.
2. Burner Control Panel: Factory or field, **as directed**, mounted. Maintains safe operating conditions, burner safety limits, burner operation, and interface with chiller controls; include the following components:
   a. On-off switch.
   b. Flame safeguard.
   c. Contacts for remote monitoring of flame failure.
   d. Contacts for proof of combustion air.
   e. Exhaust gas temperature limit switch.
   f. Control-circuit transformer.
   g. Burner motor controls.
   h. Fuel-oil pump controls, if chiller is equipped with fuel-oil pump.
   i. Visual indication of on/off status of ignition, blower, and main fuel.
   j. Alarm bell.
3. Control: Standalone and microprocessor based, with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.
4. Enclosure: Unit mounted, NEMA 250, Type 1 **OR** Type 4 **OR** Type 4x, **as directed**, hinged or lockable.

5. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. Display the following information in either imperial or metric units selectable through the interface:
    a. Date and time.
    b. Operating or alarm status.
    c. Operating hours.
    d. Outdoor-air temperature if required for chilled-water reset.
    e. Temperature and pressure of operating set points.
    f. Entering and leaving temperatures of chilled and condenser water.
    g. Refrigerant temperature.
    h. Solution concentration and temperature.
    i. Indication of solution and purge-pump operation.
    j. Generator shell pressure.
    k. Number of starts.
    l. Number of purge cycles.
    m. Entering and leaving hot-water temperatures.
    n. Burner firing rate displayed in percent.
6. Control Functions:
    a. Manual or automatic startup and shutdown time schedule.
    b. Automatic cycle to prevent crystallization.
    c. Entering and leaving chilled-water temperatures and control set points. Chilled-water temperature shall be reset based on return-water **OR** outdoor-air **OR** space, **as directed**, temperature.
    d. Entering and leaving hot-water temperatures and control set points. Hot-water temperature shall be reset based on return-water **OR** outdoor-air **OR** space, **as directed**, temperature.
    e. Condenser-fluid temperature.
    f. Cooling provided and heating energy used within programmable time periods, minimum monthly.
    g. Heating provided and heating energy used within programmable time periods, minimum monthly.
7. Capacity Control: Automatically controls burner firing rate to maintain chilled-water temperature set point for cooling loads and heating-water temperature set point for heating loads ranging from 30 to 100 percent.
8. Safety Shutdowns: Chiller shall automatically shut down and require manual restart. Display a message following each safety shutdown.
    a. Crystallization.
    b. Low refrigerant temperature.
    c. Loss of chilled- or condenser-water flow.
    d. Low leaving chilled-water temperature, 2 deg F (1 deg C) below set point.
    e. First-stage generator low-solution level.
    f. First-stage generator high temperature or pressure.
    g. Burner alarm or control malfunction.
    h. Power failure.
    i. Solution pump overloads.
    j. External auxiliary safety shutdown.
    k. High solution concentration.
    l. Incomplete dilution cycle.
9. Warning Conditions: Chiller shall remain operational but inhibit burner firing rate to prevent safety shutdown. Control panel shall close warning contacts and generate a message when one of the following operating conditions is detected:
    a. Low refrigerant temperature.
    b. High generator temperature or pressure.
    c. High or low entering condenser-water temperature.
    d. Solution temperature sensor failure.
    e. Low chilled-water flow.

f. Purge-pump current overload.

10. Cycling Shutdowns: Permit automatic restart when preprogrammed limits are reached. Display a message following each cycle shutdown.
    a. Cooling Mode:
        1) Loss of condenser-water flow.
        2) Low leaving chilled-water temperature.
        3) Power failure.
    b. Heating Mode:
        1) Loss of hot-water flow.
        2) High leaving hot-water temperature.
        3) Power failure.
11. Trending: Capability to trend analog data up to five parameters simultaneously over an adjustable period and frequency of polling.
12. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.
13. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.
14. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.
15. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display chiller status and alarms.
    a. Hardwired Points:
        1) Monitoring: On-off status, common trouble alarm.
        2) Control: On-off operation, chilled-water, discharge temperature set-point adjustment **OR** hot-water, discharge temperature set-point adjustment, **as directed**.
    b. ASHRAE 135 (BACnet) **OR** LonTalk **OR** Modbus **OR** Industry-accepted, open-protocol, **as directed**, communication interface with the BAS shall enable the BAS operator to remotely control and monitor the chiller from an operator workstation. Control features and monitoring points displayed locally at chiller control panel shall be available through the BAS.

N. Finish
1. Paint chiller, using manufacturer's standard procedures, except comply with the following minimum requirements:
    a. Provide at least one coat of primer with a total dry film thickness of at least 2 mils (0.05 mm).
    b. Provide at least two coats of alkyd-modified, vinyl enamel **OR** epoxy **OR** polyurethane, **as directed**, finish with a total dry film thickness of at least 4 mils (0.10 mm).
    c. Paint surfaces that are to be insulated before applying the insulation.
    d. Paint installed insulation to match adjacent uninsulated surfaces.
    e. Color of finish coat to be manufacturer's standard **OR** custom color selected by the Owner.

O. Accessories
1. Sight Glasses: Equip unit with sight glasses for visual inspection of absorbent solution and refrigerant levels. Provide at least one sight glass in absorber and evaporator sections.
2. Flow Switches:
    a. Chiller manufacturer shall furnish a switch for each condenser **OR** evaporator and condenser, **as directed**, and shall verify field-mounting location before installation.
    b. Paddle Flow Switches:
        1) Vane operated to actuate a double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the BAS.
        2) Contacts: Platinum alloy, silver alloy, or gold-plated switch contacts with a rating of 10 A at 120-V ac.
        3) Pressure rating equal to pressure rating of heat exchanger.

4) Construct body and wetted parts of Type 316 stainless steel.
5) House switch in an NEMA 250, Type 4 enclosure constructed of die-cast aluminum.
6) Vane length to suit installation.

c. Pressure Differential Switches:
1) Construction: Wetted parts of body and trim constructed of Type 316 stainless steel.
2) Performance: Switch shall withstand, without damage, the full-pressure rating of the heat exchanger applied to either port and exhibit zero set point shift due to variation in working pressure.
3) Set Point: Screw type, field adjustable.
4) Electrical Connections: Internally mounted, screw-type terminal blocks.
5) Switch Enclosure: NEMA 250, Type 4.
6) Switch Action: Double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the BAS.

3. Vibration Isolation:
a. Chiller manufacturer shall furnish neoprene-pad vibration isolation for each chiller.
1) Two layers of 0.375-inch- (10-mm-) thick, ribbed- or waffle-pattern neoprene pads separated by a 16-gage, stainless-steel plate.
2) Fabricate pads from 40- to 50-durometer neoprene.
3) Provide stainless-steel square bearing plate to load the pad uniformly between 20 and 40 psig (138 and 276 kPa) with a 0.12- to 0.16-inch (3- to 4-mm) deflection.

P. Heat-Exchanger, Brush-Cleaning System
1. Furnish for field installation a brush-cleaning system on each chiller condenser for tube cleaning and improved heat transfer.
2. System shall maintain tube fouling at or below design conditions without interrupting normal equipment operation.
3. System shall consist of a brush inserted in each tube and a catch basket attached to each end of the tube. A four-way valve shall operate to reverse the direction of water flow to push the brush through the tube while removing tube deposits. Four-way reversing valve's actuator shall be controlled by a preset time cycle that provides regular tube brushing during equipment operation. Frequency of the brushing cycle shall be set up to match Project requirements.
4. Components:
a. Brush: Each brush shall have nylon bristles, titanium wires, and polypropylene tips. Brush interference fit with the ID of the tube shall not exceed 0.025 inch (0.6 mm).
b. Basket: Single-piece polypropylene basket with neck OD to press fit inner diameter of tube. Design shall provide for insertion of eddy current probe or removal of brushes without removing baskets from the valve.
c. Four-Way Valve:
1) Construct valve body of carbon steel with internal sealing parts of hard rubber and Type 304 stainless steel.
2) Configure valve with parallel flow connections to minimize field installation piping.
3) Construct valve to comply with ASME Boiler and Pressure Vessel Code , at a system working pressure equal to condenser.
4) Pipe connections shall be flanged.
5) Valve manufacturer to test and certify a maximum leakage rate of less than 0.05 percent of the design flow rate at operation conditions of maximum differential pressure.
6) Hydrostatically test valve to 1.5 times the design working pressure.
7) Design the valve to cause no more than 0.5-psig (3-kPa) pressure drop at design flow conditions.
8) Provide valve with valve-mounted indicating/warning light, which shall light before the valve begins rotation.
9) Valve Actuator: Mount electric actuator to operate valve.
OR
Valve Actuator: Mount pneumatic piston-type actuator to operate valve. Actuator shall be suitable for operation using field-supplied air pressure.

10) Position Switches: Factory mount microswitches on valve to indicate the complete turn of valve in both normal and reverse flow.

d. Control Panel: Factory or field mount a control panel on chiller. Control panel shall include the following features:
1) NEMA 250, Type 1 **OR** Type 4 **OR** Type 4x **OR** Type 12, **as directed**, enclosure.
2) Timer to automatically initiate the cleaning cycle over a 24-hour period.
3) Manual override of preset cleaning cycle.
4) Visual indication of "Power On," "Diverter Position," "Normal Flow," "Reverse Flow," and "Valve Malfunction" indicating a slow or incomplete valve turn.
5) For pneumatic actuators, mount four-way solenoid valve for actuator operation in the control panel.
6) Flow-switch bypass.
7) Unloading signal to chiller.

Q. Source Quality Control
1. Perform functional run tests of chillers before shipping.
2. Factory test and inspect absorber, generator, evaporator, and condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Pressure test tube-side of heat exchangers, including water boxes, to 1.5 times the rated pressure. Vacuum and pressure test shells for leaks.
3. Rate sound power level according to ARI 575.
4. Burner Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion requirements indicated.
5. Factory performance test chillers, before shipping, according to ARI 560.
a. Test the following conditions:
1) Design conditions indicated.
2) Reduction in capacity from design to minimum load in steps of 10 **OR** 25 **OR** 33, **as directed**, with condenser fluid at design conditions.
OR
Reduction in capacity from design to minimum load in steps of 10 **OR** 25 **OR** 33, **as directed**, with varying entering condenser-fluid temperature from design to minimum conditions in 5 deg F (3 deg C) increments.
OR
At one **OR** two **OR** three **OR** four **OR** five **OR** 10, **as directed**, point(s) of varying part-load performance to be selected by the Owner at time of test.
6. Factory sound test chillers, before shipping, according to ARI 575.
a. Test the following conditions:
1) Design conditions indicated.
2) Chiller operating at calculated worst-case sound condition.
3) At one **OR** two **OR** three **OR** four **OR** five, **as directed**, point(s) of varying part-load performance to be selected by the Owner at time of test.
7. Allow the Owner access to place where chillers are being tested. Notify the Owner 14 days in advance of testing.
8. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

1.3 EXECUTION

A. Examination
1. Examine chillers before installation. Reject chillers that are damaged.
2. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations before equipment installation.

a. Final chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Chiller Installation
1. Install chillers on support structure indicated.
2. Equipment Mounting (for equipment supported on concrete bases and vibration isolation devices): Install chiller on concrete bases using elastomeric pads. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-place Concrete". Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
a. Minimum Deflection: 1/4 inch (6 mm) **OR** 1/2 inch (13 mm), **as directed**.
b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
e. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Equipment Mounting (for equipment supported on vibration isolation devices without a concrete base): Install chiller using elastomeric pads. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
a. Minimum Deflection: 1/4 inch (6 mm) **OR** 1/2 inch (13 mm), **as directed**.
4. Equipment Mounting (for equipment installed on concrete bases without vibration isolation devices): Install chiller on concrete bases. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-place Concrete".
a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
d. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Install chillers with seismic-restraint device. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
6. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
7. Maintain manufacturer's recommended clearances for service and maintenance.
8. Charge chiller with absorbent and refrigerant if not factory charged.
9. Install separate devices furnished by manufacturer and not factory installed.
10. Insulate hot and cold chiller surfaces that are recommended by chiller manufacturer to be insulated. Comply with requirements in Division 23 Section "Hvac Insulation".
11. Install electrical devices furnished with chiller but not specified to be factory mounted.
12. Install control wiring to field-mounted electrical devices.

C. Heat-Exchanger, Brush-Cleaning System Installation
1. Install brush-cleaning system control panel adjacent to chiller control panel.
2. Arrange piping to provide service access to four-way valve assembly without affecting access to chiller. Secure valve to prevent lateral movement and vibration during operation.
3. Provide field electric power, as required, to each system control panel and electric-actuated valve.

4. Provide pneumatic piping with pressure regulator and an isolation valve to each pneumatic supply connection. Coordinate field source of air with manufacturer to ensure that requirements are satisfied for proper valve operation.
5. Interconnect brush-cleaning system controls with chiller controls. Coordinate requirements to ensure safe, trouble-free operation.
6. Functionally test the entire brush-cleaning system, including the valve, actuator, position indicator, and control panel, with chiller in operation.

D. Connections
1. Comply with requirements for hydronic piping in Division 23 Section "Hydronic Piping". Drawings indicate general arrangement of piping, fittings, and specialties.
2. Comply with requirements for gas piping in Division 23 Section(s) "Facility Natural-gas Piping" OR "Facility Liquefied-petroleum Gas Piping". Drawings indicate general arrangement of piping, fittings, and specialties.
3. Connect gas piping full size to gas-train inlet with shutoff valve and union.
4. Install gas-fired boilers according to NFPA 54.
5. Comply with requirements for fuel-oil piping in Division 23 Section "Facility Fuel-oil Piping". Drawings indicate general arrangement of piping, fittings, and specialties.
6. Connect oil piping full size to burner inlet with shutoff valve and union.
7. Install oil-fired boilers according to NFPA 31.
8. Install piping adjacent to chiller to allow service and maintenance.
9. Hot-Water Heat-Exchanger Connections: Connect to heat-exchanger inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with shutoff valve and pressure gage. Connect to heat-exchanger outlet with shutoff valve, check valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, flow meter, and drain connection with valve. Make connections to chiller with a flange or mechanical coupling.
10. Evaporator-Fluid Connections: Connect to evaporator inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with shutoff valve and pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, flow meter, and drain connection with valve. Make connections to chiller with a flange or mechanical coupling.
11. Absorber/Condenser-Fluid Connections: Connect to inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with shutoff valve and pressure gage. Connect to outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, flow meter, and drain connection with valve. Make connections to chiller with a flange or mechanical coupling.
    a. If not factory furnished or installed, provide pipe connecting fluid connection of absorber discharge and condenser inlet.
12. Refrigerant Pressure Relief Device Connections: Extend vent piping **OR** separate vent piping for each chiller, **as directed**, to the outdoors without valves or restrictions. Comply with ASHRAE 15. Connect to chiller pressure relief device with flexible connector and dirt leg with drain valve.
13. Extend purge vent piping **OR** separate purge vent piping for each chiller, **as directed**, to the outdoors. Comply with ASHRAE 15.
14. Connect each chiller drain connection with a union and drain pipe, and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection.
15. Comply with requirements for chimney system in Division 23 Section "Breechings, Chimneys, And Stacks". Drawings indicate general arrangement of pipe, fittings, and specialties. Connect chimney system to chiller burner outlet and extend to the outdoors.
16. Connect fuel-fired burner assembly and blower and associated damper for combustion air.

E. Startup Service
1. Perform startup service.
    a. Complete installation and startup checks according to manufacturer's written instructions.

b. Operate chiller for run-in period.
c. Verify that absorbent and refrigerant charge is sufficient and chiller has been leak tested.
d. Verify that pumps are installed and functional.
e. Verify that thermometers and gages are installed.
f. Operate chiller for run-in period.
g. Verify that refrigerant pressure relief device is vented to the outdoors.
h. Verify proper motor rotation.
i. Verify proper fuel supply. Adjust air-fuel ratio and combustion.
j. Verify proper combustion-air source.
k. Verify proper exhaust emissions.
l. Verify static deflection of vibration isolators including deflection during chiller startup and shutdown.
m. Verify and record performance of fluid flow and low-temperature interlocks for evaporator and condenser.
n. Verify and record performance of chiller protection devices.
o. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
p. Burner Test: Adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas.

2. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.
3. Prepare test and inspection startup reports.

F. Demonstration
1. Train the Owner's maintenance personnel to adjust, operate, and maintain chillers. Video record the training sessions, **as directed**.

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Task	Specification	Specification Description
23 64 13 16	23 62 13 00	Indirect-Fired Absorption Water Chillers

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SECTION 23 64 16 16 - FAN-COIL UNITS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for fan-coil units. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes fan-coil units and accessories.

C. Definitions
1. BAS: Building automation system.

D. Submittals
1. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
2. LEED Submittals:
   a. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.
   b. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
3. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   a. Wiring Diagrams: Power, signal, and control wiring.
4. Manufacturer Seismic Qualification Certification: Submit certification that fan-coil units, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
5. Field quality-control test reports.
6. Operation and maintenance data.
7. Warranty: Special warranty specified in this Section.

E. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
3. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

F. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Compressor failure.
      2) Condenser coil leak.
   b. Warranty Period: Four **OR** Five **OR** 10, **as directed**, years from date of Final Completion.
   c. Warranty Period (Compressor Only): Five **OR** 10, **as directed**, years from date of Final Completion.

d. Warranty Period (Condenser Coil Only): Five years from date of Final Completion.

1.2 PRODUCTS

A. Fan-Coil Units
1. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.
2. Coil Section Insulation: 1/2-inch (13-mm) **OR** 1-inch (25-mm), **as directed**, thick, coated glass fiber **OR** foil-covered, closed-cell foam **OR** matte-finish, closed-cell foam, **as directed**, complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
    a. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
    b. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
3. Main and Auxiliary Drain Pans: Plastic **OR** Stainless steel **OR** Insulated galvanized steel with plastic liner, **as directed**. Fabricate pans and drain connections to comply with ASHRAE 62.1. Drain pans shall be removable, **as directed**.
4. Chassis: Galvanized steel where exposed to moisture. Floor-mounting units shall have leveling screws.
5. Cabinet: Steel with factory prime coating, ready for field painting **OR** baked-enamel finish in manufacturer's standard paint color as selected by the Owner **OR** baked-enamel finish in manufacturer's custom paint color as selected by the Owner, **as directed**.
    a. Vertical Unit Front Panels: Removable, steel, with integral stamped **OR** polyethylene **OR** steel, **as directed**, discharge grille and channel-formed edges, cam fasteners, and insulation on back of panel.
    b. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain; with integral stamped **OR** cast-aluminum, **as directed**, discharge grilles.
    c. Stack Unit Discharge and Return Grille: Aluminum double-deflection discharge grille, and louvered- or panel-type return grille; color as selected by the Owner from manufacturer's standard **OR** custom, **as directed**, colors. Return grille shall provide maintenance access to fan-coil unit.
    d. Steel recessing flanges for recessing fan-coil units into ceiling or wall.
6. Outdoor-Air Wall Box: Minimum 0.1265-inch- (3.2-mm-) thick, aluminum, rain-resistant louver and box with integral eliminators and bird screen.
    a. Louver Configuration: Horizontal **OR** Vertical, **as directed**, rain-resistant louver.
    b. Louver Material: Aluminum **OR** Steel, **as directed**.
    c. Bird Screen: 1/2-inch (13-mm) mesh screen on interior side of louver.
    d. Decorative Grille: On outside of intake.
    e. Finish: Anodized aluminum **OR** Baked enamel, **as directed**, color as selected by the Owner from manufacturer's standard **OR** custom, **as directed**, colors.
7. Outdoor-Air Damper: Galvanized-steel blades with edge and end seals and nylon bearings; with electronic **OR** pneumatic, **as directed**, two-position **OR** modulating, **as directed**, actuators.
8. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
    a. Washable Foam: 70 percent arrestance and 3 MERV.
    b. Glass Fiber Treated with Adhesive: 80 percent arrestance and 5 MERV.
    c. Pleated Cotton-Polyester Media: 90 percent arrestance and 7 MERV.
9. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), rated for a minimum working pressure of 200 psig (1378 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain valve.

10. Steam Coils: Copper distributing, **as directed**, tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), rated for a minimum working pressure of 75 psig (517 kPa).
11. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
12. Fan and Motor Board: Removable.
    a. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
    b. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
    c. Wiring Termination: Connect motor to chassis wiring with plug connection.
13. Factory, Hydronic Piping Package: ASTM B 88, Type L (ASTM B 88M, Type B) **OR** ASTM B 88, Type M (ASTM B 88M Type C), **as directed**, copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.
    a. Two **OR** Three, **as directed**,-way, two-position **OR** modulating, **as directed**, control valve for dual-temperature coil.
    b. Two **OR** Three, **as directed**,-way, two-position **OR** modulating, **as directed**, control valve for chilled-water coil.
    c. Two **OR** Three, **as directed**,-way, two-position **OR** modulating, **as directed**, control valve for heating coil.
    d. Two **OR** Three, **as directed**,-way two-position **OR** modulating, **as directed**, control valve for hot-water reheat coil.
    e. Hose Kits: Minimum 400-psig (2758-kPa) working pressure, and operating temperatures from 33 to 211 deg F (0.5 to 99 deg C). Tag hose kits to equipment designations.
        1) Length: 24 inches (600 mm) **OR** 36 inches (900 mm), **as directed**.
        2) Minimum Diameter: Equal to fan-coil-unit connection size.
    f. Two-Piece Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig (4140-kPa) minimum CWP rating and blowout-proof stem.
    g. Calibrated-Orifice Balancing Valves: Bronze body, ball type; 125-psig (860-kPa) working pressure, 250-deg F (121-deg C) maximum operating temperature; with calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, threaded ends, and equipped with a memory stop to retain set position.
    h. Automatic Flow-Control Valve: Brass or ferrous-metal body; 300-psig (2070-kPa) working pressure at 250 deg F (121 deg C), with removable, corrosion-resistant, tamperproof, self-cleaning piston spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of 2 to 80 psig (13.8 to 552 kPa).
    i. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A 126, Class B); 125-psig (860-kPa) working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 (DN 15) hose-end, full-port, ball-type blowdown valve in drain connection.
    j. Wrought-Copper Unions: ASME B16.22.
    k. Risers: ASTM B 88, Type L (ASTM B 88M, Type B) **OR** ASTM B 88, Type M (ASTM B 88M Type C), **as directed**, copper pipe with hose and ball valve for system flushing.
14. Control devices and operational sequences are specified in Division 23 Section(s) "Instrumentation And Control For Hvac" AND "Sequence Of Operations For Hvac Controls".
15. Basic Unit Controls:
    a. Control voltage transformer.
    b. Wall-mounting **OR** Unit-mounted, **as directed**, thermostat with the following features:
        1) Heat-cool-off switch.
        2) Fan on-auto switch.
        3) Fan-speed switch.

4) Manual **OR** Automatic, **as directed**, changeover.
5) Adjustable deadband.
6) Concealed **OR** Exposed, **as directed**, set point.
7) Concealed **OR** Exposed, **as directed**, indication.
8) Degree F **OR** Degree C, **as directed**, indication.

c. Wall-mounting **OR** Unit-mounted, **as directed**, humidistat.
1) Concealed **OR** Exposed, **as directed**, set point.
2) Concealed **OR** Exposed, **as directed**, indication.

d. Wall-mounting **OR** Unit-mounted, **as directed**, temperature sensor.

e. Unoccupied-period-override push button.

f. Data entry and access port.
1) Input data includes room temperature, and humidity set points and occupied and unoccupied periods.
2) Output data includes room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status.

16. DDC, **as directed**, Terminal Controller:

a. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.

b. Unoccupied Period Override Operation: Two, **as directed**, hours.

c. Unit Supply-Air Fan Operation:
1) Occupied Periods: Fan runs continuously.
2) Unoccupied Periods: Fan cycles to maintain room setback temperature.

d. Hydronic-Cooling-Coil Operation:
1) Occupied Periods: Open **OR** Modulate, **as directed**, control valve to maintain room temperature.
2) Unoccupied Periods: Close control valve.

e. Heating-Coil Operation:
1) Occupied Periods: Open control valve **OR** Modulate control valve **OR** Energize electric-resistance coil, **as directed**, to provide heating if room temperature falls below thermostat set point.
2) Unoccupied Periods: Start fan and open control valve **OR** modulate control valve **OR** energize electric-resistance coil, **as directed**, if room temperature falls below setback temperature.

f. Dual-Temperature Hydronic-Coil Operation:
1) Occupied Periods: When chilled water is available, open **OR** modulate, **as directed**, control valve if room temperature exceeds thermostat set point. When hot water is available, open control valve if temperature falls below thermostat set point.
2) Unoccupied Periods: When chilled water is available, close control valve. When hot water is available, open **OR** modulate, **as directed**, control valve if room temperature falls below thermostat setback temperature.

g. Reheat-Coil Operation:
1) Humidity Control for Occupied Periods:
a) Humidistat opens control valve **OR** modulates control valve **OR** energizes electric-resistance coil, **as directed**, to provide heating. As space temperature rises above the set point, cooling coil valve opens **OR** modulates, **as directed**, to maintain room temperature.
2) Humidity Control for Unoccupied Periods: Close control valve **OR** De-energize, **as directed**.
3) Occupied Periods:
a) Heating Operations: Open control valve **OR** Modulate control valve **OR** Energize electric-resistance coil, **as directed**, to provide heating if room temperature falls below thermostat set point.
b) Humidity-Control Operations: Humidistat opens control valve **OR** modulates control valve **OR** energizes electric-resistance coil, **as directed**, to provide

heating. As space temperature rises above the set point, cooling coil valve opens **OR** modulates, **as directed**, to maintain room temperature.
4) Unoccupied Periods: Start fan and open control valve **OR** modulate control valve **OR** energize electric-resistance coil, **as directed**, if room temperature falls below setback temperature. Humidity control is not available.
h. Outdoor-Air Damper Operation:
1) Occupied Periods: Open damper to fixed position for 25 percent outdoor air.
2) Unoccupied periods: Close damper.
i. Outdoor-Air Damper Operation:
1) Occupied Periods:
a) Outdoor-Air Temperature below Room Temperature: If room temperature is above thermostat set point, modulate outdoor-air damper to maintain room temperature (outdoor-air economizer). If room temperature is below thermostat set point, position damper to fixed minimum position.
b) Outdoor-Air Temperature above Room Temperature: Position damper to fixed minimum position for 25 percent outdoor air.
2) Unoccupied Periods: Close damper.
j. Controller shall have volatile-memory backup.
17. BAS Interface Requirements:
a. Interface relay for scheduled operation.
b. Interface relay to provide indication of fault at the central workstation.
c. Provide BACnet **OR** LonWorks, **as directed**, interface for central BAS workstation for the following functions:
1) Adjust set points.
2) Fan-coil-unit start, stop, and operating status.
3) Data inquiry, including outdoor-air damper position, **as directed**, supply- and room-air temperature and humidity, **as directed**.
4) Occupied and unoccupied schedules.
18. Electrical Connection: Factory wire motors and controls for a single electrical connection.

B. Ducted Fan-Coil Units
1. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.
2. Coil Section Insulation: 1/2-inch (13-mm) **OR** 1-inch (25-mm), **as directed**, thick coated **OR** foil-faced, **as directed**, glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
a. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
b. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
3. Drain Pans: Plastic **OR** Stainless steel **OR** Insulated galvanized steel with plastic liner, **as directed**. Fabricate pans and drain connections to comply with ASHRAE 62.1.
4. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panels.
5. Cabinets: Steel with baked-enamel finish in manufacturer's standard paint color.
a. Supply-Air Plenum: Sheet metal plenum finished and insulated to match the chassis with mill-finish, aluminum, double-deflection grille, **as directed**.
b. Return-Air Plenum: Sheet metal plenum finished to match the chassis.
c. Mixing Plenum: Sheet metal plenum finished and insulated to match the chassis with outdoor- and return-air, formed-steel dampers.
d. Dampers: Galvanized steel with extruded-vinyl blade seals, flexible-metal jamb seals, and interlocking linkage.
6. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
a. Washable Foam: 70 percent arrestance and 3 MERV.

b. Glass Fiber Treated with Adhesive: 80 percent arrestance and 5 MERV.
c. Pleated Cotton-Polyester Media: 90 percent arrestance and 7 MERV.

7. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), rated for a minimum working pressure of 200 psig (1378 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain.
8. Indoor Refrigerant Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), and brazed joints at fittings. Comply with ARI 210/240, and leak test to minimum 450 psig (3105 kPa) for a minimum 300-psig (2070-kPa) working pressure. Include thermal expansion valve.
9. Steam Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), rated for a minimum working pressure of 75 psig (517 kPa).
10. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
11. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.

    OR

    Belt-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the cabinet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.

    a. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
12. Factory, Hydronic Piping Package: ASTM B 88, Type L (ASTM B 88M, Type B) **OR** ASTM B 88, Type M (ASTM B 88M Type C), **as directed**, copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.
    a. Two **OR** Three, **as directed**,-way, two-position **OR** modulating, **as directed**, control valve for chilled-water coil.
    b. Two **OR** Three, **as directed**,-way, two-position **OR** modulating, **as directed**, control valve for heating coil.
    c. Two **OR** Three, **as directed**,-way, two-position **OR** modulating, **as directed**, control valve for dual-temperature coil.
    d. Two **OR** Three, **as directed**,-way, two-position **OR** modulating, **as directed**, control valve for reheat coil.
    e. Hose Kits: Minimum 400-psig (2758-kPa) working pressure, and operating temperatures from 33 to 211 deg F (0.5 to 99 deg C). Tag hose kits to equipment designations.
        1) Length: 24 inches (600 mm) **OR** 36 inches (900 mm), **as directed**.
        2) Minimum Diameter: Equal to fan-coil-unit connection size.
    f. Two-Piece Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig (4140-kPa) minimum CWP rating and blowout-proof stem.
    g. Calibrated-Orifice Balancing Valves: Bronze body, ball type; 125-psig (860-kPa) working pressure, 250 deg F (121 deg C) maximum operating temperature; with calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, threaded ends, and equipped with a memory stop to retain set position.
    h. Automatic Flow-Control Valve: Brass or ferrous-metal body; 300-psig (2070-kPa) working pressure at 250 deg F (121 deg C); with removable, corrosion-resistant, tamperproof, self-cleaning piston spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of 2 to 80 psig (13.8 to 552 kPa).
    i. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A 126, Class B); 125-psig (860-kPa) working pressure, with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 (DN 15) hose-end, full-port, ball-type blowdown valve in drain connection.
    j. Wrought-Copper Unions: ASME B16.22.

13. Remote condensing units are specified in Division 23 Section "Packaged Compressor And Condenser Units".
14. Remote Condensing Units: Factory assembled and tested, consisting of compressors, condenser coils, fans, motors, refrigerant receiver, and operating controls. Construct, test, and rate condensing units according to ARI 210/240 and ASHRAE 15.
    a. Casing: Steel with baked-enamel finish, removable panels for access to controls, weep holes for water drainage, and mounting holes in base.
    b. Compressor: Hermetic, scroll **OR** reciprocating, **as directed**, type; internally isolated for vibration with factory-installed safety devices as follows:
        1) Antirecycle timer.
        2) High-pressure cutout.
        3) Low-pressure cutout or loss-of-charge switch.
        4) Internal thermal-overload protection.
        5) Current and voltage sensitive safety devices.
    c. Compressor Motor: Start capacitor, relay, and contactor. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
    d. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Standard for Buildings except Low-Rise Residential Buildings."
    e. Refrigerant Piping Materials: ASTM B 743 copper tube with wrought-copper fittings and brazed joints.
    f. Refrigerant: R-407C **OR** R-410A, **as directed**.
    g. Low ambient controls to permit operation down to 45 deg F (7 deg C).
    h. Crankcase heater.
    i. Charging and service fittings on exterior of casing.
    j. Filter dryer.
    k. Air-to-Air Heat Pump: Pilot-operated, sliding-type reversing valve with replaceable magnetic coil, and controls for air-to-air heat pump operation with supplemental heat operation.
    l. Hot-gas-bypass, constant-pressure expansion valve and controls to maintain continuous refrigeration system operation at 10 percent of full load.
    m. Condenser: Copper-tube, aluminum-fin coil, with liquid subcooler.
    n. Condenser Fan: Direct-drive, aluminum propeller fan.
        1) Motor: Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
    o. Accessories: Polyethylene mounting base to provide a permanent foundation.
15. Control devices and operational sequence are specified in Division 23 Section(s) "Instrumentation And Control For Hvac" AND "Sequence Of Operations For Hvac Controls".
16. Basic Unit Controls:
    a. Control voltage transformer.
    b. Wall-mounting **OR** Unit-mounted, **as directed**, thermostat with the following features.
        1) Heat-cool-off switch.
        2) Fan on-auto switch.
        3) Fan-speed switch.
        4) Manual **OR** Automatic, **as directed**, changeover.
        5) Adjustable deadband.
        6) Concealed **OR** Exposed, **as directed**, set point.
        7) Concealed **OR** Exposed, **as directed**, indication.
        8) Degree F **OR** Degree C, **as directed**, indication.
    c. Wall-mounting **OR** Unit-mounted, **as directed**, humidistat.
        1) Concealed **OR** Exposed, **as directed**, set point.
        2) Concealed **OR** Exposed, **as directed**, indication.
    d. Wall-mounting **OR** Unit-mounted, **as directed**, temperature sensor.
    e. Unoccupied-period-override push button.
    f. Data entry and access port.
        1) Input data includes room temperature, and humidity set points and occupied and unoccupied periods.

2) Output data includes room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status.

17. DDC, **as directed**, Terminal Controller:
   a. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
   b. Unoccupied Period Override Operation: Two, **as directed**, hours.
   c. Unit Supply-Air Fan Operation:
      1) Occupied Periods: Fan runs continuously.
      2) Unoccupied Periods: Fan cycles to maintain room setback temperature.
   d. Hydronic-Cooling-Coil Operation:
      1) Occupied Periods: Open **OR** Modulate, **as directed**, control valve to maintain room temperature.
      2) Unoccupied Periods: Close control valve.
   e. Refrigerant-Coil Operation:
      1) Occupied Periods: Start compressor to maintain room temperature or humidistat set point.
      2) Unoccupied Periods: Stop compressor cooling and cycle compressor for heating to maintain setback temperature.
   f. Supplemental, **as directed**, Heating-Coil Operation:
      1) Occupied Periods: Open control valve **OR** Modulate control valve **OR** Energize electric-resistance coil, **as directed**, to provide heating if room temperature falls below thermostat set point.
      2) Unoccupied Periods: Start fan and open control valve **OR** modulate control valve **OR** energize electric-resistance coil, **as directed**, if room temperature falls below setback temperature.
      3) Switch refrigerant-reversing valve to operate supplemental coil for heating when outdoor temperature is below 25 deg F (4 deg C).
   g. Dual-Temperature Hydronic-Coil Operation:
      1) Occupied Periods: When chilled water is available, open **OR** modulate, **as directed**, control valve if room temperature exceeds thermostat set point. When hot water is available, open **OR** modulate, **as directed**, control valve if temperature falls below thermostat set point.
      2) Unoccupied Periods: When chilled water is available, close valve. When hot water is available, open **OR** modulate, **as directed**, control valve if room temperature falls below thermostat setback temperature.
   h. Reheat-Coil Operation:
      1) Humidity Control for Occupied Periods: Humidistat opens control valve **OR** modulates control valve **OR** energizes electric-resistance coil, **as directed**, to provide heating. As room temperature rises above the set point, cooling coil valve opens **OR** modulates, **as directed**, to maintain room temperature.
      2) Humidity Control for Unoccupied Periods: Close control valve **OR** De-energize, **as directed**.
      3) Occupied Periods:
         a) Heating Operations: Open control valve **OR** Modulate control valve **OR** Energize electric-resistance coil, **as directed**, to provide heating if room temperature falls below thermostat set point.
         b) Humidity-Control Operations: Humidistat opens control valve **OR** modulates control valve **OR** energizes electric-resistance coil, **as directed**, to provide heating. As room temperature rises above the set point, cooling coil valve opens **OR** modulates, **as directed**, to maintain room temperature.
      4) Unoccupied Periods: Start fan and open control valve **OR** modulate control valve **OR** energize electric-resistance coil, **as directed**, if room temperature falls below setback temperature. Humidity control is not available.
   i. Outdoor-Air Damper Operation (for fixed, minimum outdoor-air intake):
      1) Occupied Periods: Open damper to fixed position for 25 percent outdoor air.

2) Unoccupied Periods: Close damper.

j. Outdoor-Air Damper Operation (for outdoor-air economizer cycle based on temperature):

1) Occupied Periods:

a) Outdoor-Air Temperature below Room Temperature: If room temperature is above room-temperature set point, modulate outdoor- and return-air dampers to maintain room-temperature set point (outdoor-air economizer). If room temperature is below set point, position damper to fixed minimum setting.

b) Outdoor-Air Temperature above Room Temperature: Position damper to fixed minimum position for 25 percent outdoor air.

2) Unoccupied Periods: Close outdoor-air damper and open return-air damper.

k. Outdoor-Air Damper Operation (for outdoor-air economizer cycle based on enthalpy):

1) Occupied Periods:

a) Outdoor-Air Enthalpy below Room Enthalpy: If room temperature is above room-temperature set point, modulate outdoor-air damper to maintain room temperature (outdoor-air economizer). If room temperature is below set point, position damper to fixed minimum position for 25 percent outdoor air.

b) Outdoor-Air Enthalpy above Room Enthalpy: Position damper to fixed minimum position for 25 percent outdoor air.

2) Unoccupied Periods: Close outdoor-air damper and open return-air damper.

l. Controller shall have volatile-memory backup.

18. BAS Interface Requirements:

a. Interface relay for scheduled operation.

b. Interface relay to provide indication of fault at the central workstation.

c. Provide BACnet **OR** LonWorks, **as directed**, interface for central BAS workstation for the following functions:

1) Adjust set points.

2) Fan-coil-unit start, stop, and operating status.

3) Data inquiry including outdoor-air damper position,, **as directed** supply- and room-air temperature and humidity, **as directed**.

4) Occupied and unoccupied schedules.

19. Electrical Connection: Factory wire motors and controls for a single electrical connection.

1.3 EXECUTION

A. Installation

1. Install fan-coil units level and plumb.

2. Install fan-coil units to comply with NFPA 90A.

3. Suspend fan-coil units from structure with elastomeric hangers. Vibration isolators are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".

4. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches (1220 mm) **OR** 60 inches (1525 mm), **as directed**, above finished floor.

5. Install new filters in each fan-coil unit within two weeks after Final Completion.

B. Connections

1. Piping installation requirements are specified in other Division 21. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

a. Install piping adjacent to machine to allow service and maintenance.

b. Connect piping to fan-coil-unit factory hydronic piping package. Install piping package if shipped loose.

c. Connect condensate drain to indirect waste.

1) Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.

2. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Division 23 Section "Air Duct Accessories". Comply with safety requirements in UL 1995 for duct connections.
3. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
4. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Field Quality Control
1. Perform the following field tests and inspections and prepare test reports:
   a. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   b. Operate electric heating elements through each stage to verify proper operation and electrical connections.
   c. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
2. Remove and replace malfunctioning units and retest as specified above.

D. Adjusting
1. Adjust initial temperature and humidity set points.
2. Occupancy Adjustments: When requested within 12 months of date of Final Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

E. Demonstration
1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan-coil units.

END OF SECTION 23 64 16 16

Task	Specification	Specification Description
23 64 16 16	23 61 16 00	Centrifugal Water Chillers

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SECTION 23 64 23 13 - SCROLL WATER CHILLERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for scroll water chillers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
    a. Packaged, water-cooled, electric-motor-driven, scroll water chillers.
    b. Packaged, air-cooled, electric-motor-driven, scroll water chillers.
    c. Packaged refrigerant recovery units.

C. Definitions
1. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.
2. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.
3. IPLV: Integrated part-load value. A single number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and referenced to ARI standard rating conditions.
4. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.
5. NPLV: Nonstandard part-load value. A single number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and intended for operating conditions other than the ARI standard rating conditions.

D. Performance Requirements
1. Seismic Performance: Scroll water chillers shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

E. Submittals
1. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
2. LEED Submittal:
    a. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.
3. Certificates: For certification required in "Quality Assurance" Article.
4. Seismic Qualification Certificates: For water chillers, accessories, and components from manufacturers.
    a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
    c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
5. Startup service reports.
6. Operation and maintenance data.
7. Warranty: Sample of special warranty.

F. Quality Assurance
  1. ARI Certification: Certify chiller according to ARI 590 certification program.
  2. ARI Rating: Rate water chiller performance according to requirements in ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."
  3. ASHRAE Compliance: ASHRAE 15 for safety code for mechanical refrigeration.
  4. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
  5. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.
  6. Comply with NFPA 70.

G. Delivery, Storage, And Handling
  1. Ship water chillers from the factory fully charged with refrigerant and filled with oil.
  2. Package water chiller for export shipping.

H. Warranty
  1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water chillers that fail in materials or workmanship within five years from date of Final Completion.

1.2 PRODUCTS

A. Packaged Water-Cooled Water Chillers
  1. Description: Factory-assembled and run-tested water chiller complete with compressor(s), compressor motors and motor controllers, evaporator, condenser where indicated, electrical power, controls, and indicated accessories.
  2. Fabricate water chiller mounting base with reinforcement strong enough to resist water chiller movement during a seismic event when water chiller is anchored to field support structure.
  3. Compressors:
    a. Description: Positive-displacement direct drive with hermetically sealed casing.
    b. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.
    c. Operating Speed: Nominal 3600 rpm for 60-Hz applications.
    d. Capacity Control: On-off compressor cycling, plus hot-gas bypass, **as directed**.
    e. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug, and initial oil charge.
    f. Vibration Isolation: Mount individual compressors on vibration isolators.
    g. Sound-reduction package shall consist of acoustic enclosures around the compressors that are designed to reduce sound level without affecting performance.
  4. Compressor Motors:
    a. Hermetically sealed and cooled by refrigerant suction gas.
    b. High-torque, two-pole induction type with inherent thermal-overload protection on each phase.
  5. Compressor Motor Controllers:
    a. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.
  6. Refrigeration:
    a. Refrigerant: R-407C **OR** R-410A, **as directed**2. Classified as Safety Group A1 according to ASHRAE 34.
    b. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
    c. Refrigerant Circuit: Each circuit shall include a thermal-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.

d. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line and the refrigerant liquid-line to allow the isolation and storage of the refrigerant charge in the chiller condenser.

7. Evaporator:
    a. Brazed-plate or shell-and-tube design, as indicated.
    b. Shell and Tube:
        1) Description: Direct-expansion, shell-and-tube design with fluid flowing through the shell and refrigerant flowing through the tubes within the shell.
        2) Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
        3) Shell Material: Carbon steel.
        4) Shell Heads: Removable carbon-steel heads with multipass baffles designed to ensure positive oil return and located at each end of the tube bundle.
        5) Shell Nozzles: Fluid nozzles located along the side of the shell and terminated with mechanical-coupling end connections for connection to field piping.
        6) Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
    c. Brazed Plate:
        1) Direct-expansion, single-pass, brazed-plate design.
        2) Type 316 stainless-steel construction.
        3) Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
        4) Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping.
8. Condenser:
    a. Shell and tube or without integral condenser; as indicated.
    b. Shell and Tube:
        1) Description: Shell-and-tube design with refrigerant flowing through the shell and fluid flowing through the tubes within the shell.
        2) Provides positive subcooling of liquid refrigerant.
        3) Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
        4) Shell Material: Carbon steel.
        5) Water Boxes: Removable, of carbon-steel construction, located at each end of the tube bundle with fluid nozzles terminated with mechanical-coupling end connections for connection to field piping.
        6) Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
        7) Provide each condenser with a pressure relief device, purge cock, and liquid-line shutoff valve.
    c. Provide water chiller without an integral condenser and design chiller for field connection to remote condenser. Coordinate requirements with Division 23 Section "Air-cooled Refrigerant Condensers".
9. Electrical Power:
    a. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.
    b. House in a unit-mounted, NEMA 250, Type 1, **as directed**, enclosure with hinged access door with lock and key or padlock and key.
    c. Wiring shall be numbered and color-coded to match wiring diagram.
    d. Install factory wiring outside of an enclosure in a raceway.
    e. Field power interface shall be to wire lugs **OR** NEMA KS 1, heavy-duty, nonfused disconnect switch, **as directed**.
    f. Provide branch power circuit to each motor and to controls with one of the following disconnecting means:
        1) NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.

2) NEMA KS 1, heavy-duty, nonfusible switch.
3) NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

g. Provide each motor with overcurrent protection.
h. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.
i. Phase-Failure and Undervoltage: Solid-state sensing with adjustable settings.
j. Controls Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
k. Control Relays: Auxiliary and adjustable time-delay relays.
l. Indicate the following for water chiller electrical power supply:
1) Current, phase to phase, for all three phases.
2) Voltage, phase to phase and phase to neutral for all three phases.
3) Three-phase real power (kilowatts).
4) Three-phase reactive power (kilovolt amperes reactive).
5) Power factor.
6) Running log of total power versus time (kilowatt hours).
7) Fault log, with time and date of each.

10. Controls:
a. Stand-alone, microprocessor based.
b. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.
c. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, backlit, liquid-crystal display or light-emitting diodes. Display the following:
1) Date and time.
2) Operating or alarm status.
3) Operating hours.
4) Outside-air temperature if required for chilled-water reset.
5) Temperature and pressure of operating set points.
6) Entering and leaving temperatures of chilled water.
7) Entering and leaving temperatures of condenser water.
8) Refrigerant pressures in evaporator and condenser.
9) Saturation temperature in evaporator and condenser.
10) No cooling load condition.
11) Elapsed time meter (compressor run status).
12) Pump status.
13) Antirecycling timer status.
14) Percent of maximum motor amperage.
15) Current-limit set point.
16) Number of compressor starts.
d. Control Functions:
1) Manual or automatic startup and shutdown time schedule.
2) Entering and leaving chilled-water temperatures, control set points, and motor load limit. Chilled-water leaving temperature shall be reset based on return-water **OR** outside-air **OR** space, **as directed**, temperature.
3) Current limit and demand limit.
4) Condenser-water temperature.
5) External water chiller emergency stop.
6) Antirecycling timer.
7) Automatic lead-lag switching.
e. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:
1) Low evaporator pressure or high condenser pressure.
2) Low chilled-water temperature.
3) Refrigerant high pressure.

4) High or low oil pressure.
5) High oil temperature.
6) Loss of chilled-water flow.
7) Loss of condenser-water flow.
8) Control device failure.

f. Building Automation System Interface: Factory-installed hardware and software to enable building automation system to monitor, control, and display water chiller status and alarms.
1) Hardwired Points:
a) Monitoring: On/off status, common trouble alarm **OR** electrical power demand (kilowatts) **OR** electrical power consumption (kilowatt hours), **as directed**.
b) Control: On/off operation, chilled-water discharge temperature set-point adjustment **OR** electrical power demand limit, **as directed**.
2) ASHRAE 135 (BACnet) **OR** LonTalk **OR** Modbus **OR** Industry-accepted open-protocol, **as directed**, communication interface with building automation system shall enable building automation system operator to remotely control and monitor the water chiller from an operator workstation. Control features and monitoring points displayed locally at water chiller control panel shall be available through building automation system.

11. Insulation:
a. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I, for tubular materials and Type II, for sheet materials.
b. Thickness: 3/4 inch (19 mm).
c. Factory-applied insulation over cold surfaces of water chiller components.
1) Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.
d. Apply protective coating to exposed surfaces of insulation.

12. Accessories:
a. Factory-furnished, chilled-water and condenser-water, **as directed**, flow switches for field installation.
b. Individual compressor suction and discharge pressure gages with shutoff valves for each refrigeration circuit.
c. Factory-furnished neoprene **OR** spring, **as directed**, isolators for field installation.

B. Packaged Air-Cooled Water Chillers
1. Description: Factory-assembled and run-tested water chiller complete with base and frame, condenser casing, compressors, compressor motors and motor controllers, evaporator, condenser coils, condenser fans and motors, electrical power, controls, and accessories.
2. Fabricate base, frame, and attachment to water chiller components strong enough to resist movement during a seismic event when water chiller base is anchored to field support structure.
3. Cabinet:
a. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
b. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.
c. Casing: Galvanized steel.
d. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 500-hour salt-spray test according to ASTM B 117.
e. Sound-reduction package consisting of the following:
1) Acoustic enclosure around compressors.
2) Reduced-speed fans with acoustic treatment.
3) Designed to reduce sound level without affecting performance.
f. Security Package: Provide security grilles with fasteners for additional protection of compressors, evaporator, and condenser coils. Grilles shall be coated for corrosion resistance and shall be removable for service access.
4. Compressors:

a. Description: Positive-displacement direct drive with hermetically sealed casing.
b. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.
c. Operating Speed: Nominal 3600 rpm for 60-Hz applications.
d. Capacity Control: On-off compressor cycling, plus hot-gas bypass, **as directed**.
e. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug, and initial oil charge.
f. Vibration Isolation: Mount individual compressors on vibration isolators.

5. Compressor Motors:
   a. Hermetically sealed and cooled by refrigerant suction gas.
   b. High-torque, two-pole induction type with inherent thermal-overload protection on each phase.
6. Compressor Motor Controllers:
   a. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.
7. Refrigeration:
   a. Refrigerant: R-407c **OR** R-410a, **as directed**. Classified as Safety Group A1 according to ASHRAE 34.
   b. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
   c. Refrigerant Circuit: Each circuit shall include a thermal-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
   d. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line and the refrigerant liquid-line to allow the isolation and storage of the refrigerant charge in the chiller condenser.
8. Evaporator:
   a. Brazed-plate or shell-and-tube design, as indicated.
   b. Shell and Tube:
      1) Description: Direct-expansion, shell-and-tube design with fluid flowing through the shell and refrigerant flowing through the tubes within the shell.
      2) Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
      3) Shell Material: Carbon steel.
      4) Shell Heads: Removable carbon-steel heads with multipass baffles designed to ensure positive oil return and located at each end of the tube bundle.
      5) Shell Nozzles: Fluid nozzles located along the side of the shell and terminated with mechanical-coupling end connections for connection to field piping.
      6) Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
   c. Brazed Plate:
      1) Direct-expansion, single-pass, brazed-plate design.
      2) Type 316 stainless-steel construction.
      3) Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
      4) Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping.
   d. Heater: Factory-installed and -wired electric heater with integral controls designed to protect the evaporator to minus 20 deg F (minus 29 deg C).
   e. Remote Mounting: Designed for remote field mounting where indicated. Provide kit for field installation.
9. Air-Cooled Condenser:
   a. Plate-fin coil with integral subcooling on each circuit, rated at 450 psig (3103 kPa).
      1) Construct coils of copper tubes mechanically bonded to aluminum **OR** aluminum with precoated epoxy-phenolic **OR** copper, **as directed**, fins.

2) Coat coils with a baked epoxy corrosion-resistant coating after fabrication.
3) Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.

b. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.
c. Fan Motors: Totally enclosed nonventilating (TENV) or totally enclosed air over (TEAO) enclosure, with permanently lubricated bearings, and having built-in overcurrent- and thermal-overload protection.
d. Fan Guards: Steel safety guards with corrosion-resistant coating.

10. Electrical Power:
a. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.
b. House in a unit-mounted, NEMA 250, Type 3R, **as directed**, enclosure with hinged access door with lock and key or padlock and key.
c. Wiring shall be numbered and color-coded to match wiring diagram.
d. Install factory wiring outside of an enclosure in a raceway.
e. Field power interface shall be to wire lugs **OR** NEMA KS 1, heavy-duty, nonfused disconnect switch, **as directed**.
f. Provide branch power circuit to each motor and to controls with one of the following disconnecting means:
1) NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
2) NEMA KS 1, heavy-duty, nonfusible switch.
3) NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

g. Provide each motor with overcurrent protection.
h. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.
i. Phase-Failure and Undervoltage: Solid-state sensing with adjustable settings.
j. Provide power factor correction capacitors to correct power factor to 0.90 **OR** 0.95, **as directed**, at full load.
k. Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
1) Power unit-mounted controls where indicated.
2) Power unit-mounted, ground fault interrupt (GFI) duplex receptacle.

l. Control Relays: Auxiliary and adjustable time-delay relays.
m. Indicate the following for water chiller electrical power supply:
1) Current, phase to phase, for all three phases.
2) Voltage, phase to phase and phase to neutral for all three phases.
3) Three-phase real power (kilowatts).
4) Three-phase reactive power (kilovolt amperes reactive).
5) Power factor.
6) Running log of total power versus time (kilowatt hours).
7) Fault log, with time and date of each.

11. Controls:
a. Stand-alone, microprocessor based.
b. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.
c. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, backlit, liquid-crystal display or light-emitting diodes. Display the following:
1) Date and time.
2) Operating or alarm status.
3) Operating hours.
4) Outside-air temperature if required for chilled-water reset.
5) Temperature and pressure of operating set points.
6) Entering and leaving temperatures of chilled water.

7) Refrigerant pressures in evaporator and condenser.
8) Saturation temperature in evaporator and condenser.
9) No cooling load condition.
10) Elapsed time meter (compressor run status).
11) Pump status.
12) Antirecycling timer status.
13) Percent of maximum motor amperage.
14) Current-limit set point.
15) Number of compressor starts.

d. Control Functions:
1) Manual or automatic startup and shutdown time schedule.
2) Entering and leaving chilled-water temperatures, control set points, and motor load limit. Chilled-water leaving temperature shall be reset based on return-water **OR** outside-air **OR** space, **as directed**, temperature.
3) Current limit and demand limit.
4) External water chiller emergency stop.
5) Antirecycling timer.
6) Automatic lead-lag switching.

e. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:
1) Low evaporator pressure or high condenser pressure.
2) Low chilled-water temperature.
3) Refrigerant high pressure.
4) High or low oil pressure.
5) High oil temperature.
6) Loss of chilled-water flow.
7) Control device failure.

f. Building Automation System Interface: Factory-installed hardware and software to enable building automation system to monitor, control, and display water chiller status and alarms.
1) Hardwired Points:
a) Monitoring: On/off status, common trouble alarm **OR** electrical power demand (kilowatts) **OR** electrical power consumption (kilowatt hours), **as directed**.
b) Control: On/off operation, chilled-water discharge temperature set-point adjustment **OR** electrical power demand limit, **as directed**.
2) ASHRAE 135 (BACnet) **OR** LonTalk **OR** Industry-accepted open-protocol, **as directed**, communication interface with building automation system shall enable building automation system operator to remotely control and monitor the water chiller from an operator workstation. Control features and monitoring points displayed locally at water chiller control panel shall be available through building automation system.

12. Insulation:
a. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I, for tubular materials and Type II, for sheet materials.
b. Thickness: 3/4 inch (19 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
c. Factory-applied insulation over cold surfaces of water chiller components.
1) Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.
d. Apply protective coating to exposed surfaces of insulation.

13. Accessories:
a. Factory-furnished, chilled-water and condenser-water, **as directed**, flow switches for field installation.
b. Individual compressor suction and discharge pressure gages with shutoff valves for each refrigeration circuit.
c. Factory-furnished neoprene **OR** spring, **as directed**, isolators for field installation.

C. Packaged Refrigerant Recovery Units
1. Packaged portable unit shall consist of compressor, air-cooled condenser, recovery system, tank pressure gages, filter-dryer, and valving that allows for switching between liquid and vapor recovery mode. Refrigerant recovery unit shall be factory mounted on an ASME-constructed and -stamped refrigerant storage vessel that is sized to hold the full refrigerant charge of the largest water chiller.

D. Source Quality Control
1. Perform functional test of water chillers before shipping.
2. Factory performance test water chillers, **as directed**, before shipping, according to ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."
   a. Allow the Owner access to place where water chillers are being tested. Notify the Owner 14 days in advance of testing.
3. Factory test and inspect evaporator and water-cooled condenser, **as directed**, according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.
4. For water chillers located indoors, rate sound power level according to ARI 575 procedure.
5. For water chillers located outdoors, rate sound power level according to ARI 370 procedure.

1.3 EXECUTION

A. Water Chiller Installation
1. Install water chillers on support structure indicated.
2. Equipment Mounting: Install water chiller on concrete bases using elastomeric pads **OR** elastomeric mounts **OR** restrained spring isolators, **as directed**. Comply with requirements in Division 03 Section "Cast-in-place Concrete". Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
   a. Minimum Deflection: 1/4 inch (6 mm) **OR** 1 inch (25 mm), **as directed**.
   b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   e. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Equipment Mounting: Install water chiller using elastomeric pads **OR** elastomeric mounts **OR** restrained spring isolators, **as directed**. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
   a. Minimum Deflection: 1/4 inch (6 mm) **OR** 1 inch (25 mm), **as directed**.
4. Equipment Mounting: Install water chiller on vibration isolation inertia bases. Comply with requirements specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
5. Equipment Mounting: Install water chiller on concrete bases. Comply with requirements in Division 03 Section "Cast-in-place Concrete".
   a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   d. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Maintain manufacturer's recommended clearances for service and maintenance.
7. Charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.
8. Install separate devices furnished by manufacturer and not factory installed.

B. Connections
1. Comply with requirements in Division 23 Section "Hydronic Piping". Drawings indicate general arrangement of piping, fittings, and specialties.
2. Comply with requirements in Division 23 Section "Refrigerant Piping". Drawings indicate general arrangement of piping, fittings, and specialties.
3. Install piping adjacent to chiller to allow service and maintenance.
4. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, strainer, **as directed**, flexible connector, **as directed**, thermometer, and plugged tee with pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, **as directed**, flow switch, thermometer, plugged tee with pressure gage, flow meter, **as directed**, and drain connection with valve. Make connections to water chiller with a union **OR** flange **OR** mechanical coupling, **as directed**.
5. Condenser Fluid Connections: Connect to condenser inlet with shutoff valve, strainer, **as directed**, flexible connector, **as directed**, thermometer, and plugged tee with pressure gage. Connect to condenser outlet with shutoff valve, balancing valve, flexible connector, **as directed**, flow switch, thermometer, plugged tee with pressure gage, flow meter, **as directed**, and drain connection with valve. Make connections to water chiller with a union **OR** flange **OR** mechanical coupling, **as directed**.
6. Refrigerant Pressure Relief Valve Connections: For water chillers installed indoors, extend vent piping to the outside without valves or restrictions. Comply with ASHRAE 15, **as directed**.
7. Connect each drain connection with a union and drain pipe and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection if required.

C. Startup Service
1. Perform startup service.
2. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.
3. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
   a. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
   b. Verify that pumps are installed and functional.
   c. Verify that thermometers and gages are installed.
   d. Operate water chiller for run-in period.
   e. Check bearing lubrication and oil levels.
   f. Verify that refrigerant pressure relief device for chillers installed indoors is vented outside.
   g. Verify proper motor rotation.
   h. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
   i. Verify and record performance of chilled-water and condenser-water, **as directed**, flow and low-temperature interlocks.
   j. Verify and record performance of water chiller protection devices.
   k. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
4. Prepare a written startup report that records results of tests and inspections.

END OF SECTION 23 64 23 13

SECTION 23 64 23 16 - RECIPROCATING WATER CHILLERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for reciprocating water chillers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Packaged, water-cooled, electric-motor-driven, reciprocating water chillers.
b. Packaged, air-cooled, electric-motor-driven, reciprocating water chillers.
c. Packaged refrigerant recovery units.

C. Definitions
1. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.
2. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.
3. IPLV: Integrated part-load value. A single number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and referenced to ARI standard rating conditions.
4. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.
5. NPLV: Nonstandard part-load value. A single number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and intended for operating conditions other than the ARI standard rating conditions.

D. Performance Requirements
1. Seismic Performance: Reciprocating water chillers shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

E. Submittals
1. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
2. Seismic Qualification Certificates: For water chillers, accessories, and components, from manufacturer.
a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
3. Source quality-control test reports.
4. Startup service reports.
5. Operation and maintenance data.
6. Warranty: Sample of special warranty.

F. Quality Assurance
1. ARI Certification: Certify chiller according to ARI 590 certification program.

2. ARI Rating: Rate water chiller performance according to requirements in ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."
3. ASHRAE Compliance: ASHRAE 15 for safety code for mechanical refrigeration.
4. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
5. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.
6. Comply with NFPA 70.

G. Delivery, Storage, And Handling
1. Ship water chillers from the factory fully charged with refrigerant and filled with oil.
2. Package water chiller for export shipping.

H. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water chillers that fail in materials or workmanship within five years from date of Final Completion.

1.2 PRODUCTS

A. Packaged Water-Cooled Water Chillers
1. Description: Factory-assembled and run-tested water chiller complete with compressor(s), compressor motors and motor controllers, evaporator, condenser where indicated, electrical power, controls, and indicated accessories.
2. Fabricate water chiller mounting base with reinforcement strong enough to resist water chiller movement during a seismic event when water chiller is anchored to field support structure.
3. Compressors:
   a. Description: Positive-displacement direct drive with semihermetically sealed and accessible bolted casings.
   b. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.
   c. Operating Speed: 1750 rpm for 60-Hz applications.
   d. Capacity Control: Combinations of cylinder unloading and on-off compressor cycling of multiple compressors, **as directed**, plus hot-gas bypass, **as directed**. Compressor shall be capable of operating at part-load conditions without increased vibration over normal vibration at full-load operation and shall be capable of continuous operation at its lowest step of unloading.
   e. Oil Lubrication System: Automatically reversible, positive-displacement pump with strainer, sight glass, filling connection, filter with magnetic plug, and initial oil charge.
   f. Vibration Isolation: Mount individual compressors on either neoprene or spring isolators.
   g. Sound-reduction package shall consist of acoustic enclosures around the compressors that are designed to reduce sound level without affecting performance.
4. Compressor Motors:
   a. Hermetically sealed and cooled by refrigerant suction gas.
   b. High-torque, four-pole induction type with inherent thermal-overload protection on each phase.
5. Compressor Motor Controllers:
   a. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.
      OR
      Part-Wind Start: NEMA ICS 2, Class A, reduced voltage, nonreversing.
6. Refrigeration:
   a. Refrigerant: R-407C **OR** R-410A, **as directed.** Classified as Safety Group A1 according to ASHRAE 34.

b. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.

c. Refrigerant Circuit: Each circuit shall include a thermal **OR** an electronic, **as directed**, expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.

d. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line and the refrigerant liquid-line to allow the isolation and storage of the refrigerant charge in the chiller condenser.

7. Evaporator:
   a. Brazed-plate or shell-and-tube design, as indicated.
   b. Shell and Tube:
      1) Description: Direct-expansion, shell-and-tube design with fluid flowing through the shell and refrigerant flowing through the tubes within the shell.
      2) Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
      3) Shell Material: Carbon steel.
      4) Shell Heads: Removable carbon-steel heads with multipass baffles designed to ensure positive oil return and located at each end of the tube bundle.
      5) Shell Nozzles: Fluid nozzles located along the side of the shell and terminated with mechanical-coupling end connections for connection to field piping.
      6) Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
   c. Brazed Plate:
      1) Direct-expansion, single-pass, brazed-plate design.
      2) Type 316 stainless-steel construction.
      3) Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
      4) Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping.

8. Condenser:
   a. Shell and tube, brazed plate, or without integral condenser; as indicated.
   b. Shell and Tube:
      1) Description: Shell-and-tube design with refrigerant flowing through the shell and fluid flowing through the tubes within the shell.
      2) Provides positive subcooling of liquid refrigerant.
      3) Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
      4) Shell Material: Carbon steel.
      5) Water Boxes: Removable, of carbon-steel construction, located at each end of the tube bundle with fluid nozzles terminated with mechanical-coupling end connections for connection to field piping.
      6) Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
      7) Provide each condenser with a pressure relief device, purge cock, and liquid-line shutoff valve.
   c. Brazed Plate:
      1) Single-pass, brazed-plate design provides positive subcooling of liquid refrigerant.
      2) Type 316 stainless-steel construction.
      3) Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
      4) Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping.
      5) Provide each condenser with a liquid-line shutoff valve.

d. Provide water chiller without an integral condenser and design chiller for field connection to remote condenser. Coordinate requirements with Division 23 Section "Air-cooled Refrigerant Condensers".

9. Electrical Power:
   a. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.
   b. House in a unit-mounted, NEMA 250, Type 1, **as directed**, enclosure with hinged access door with lock and key or padlock and key.
   c. Wiring shall be numbered and color-coded to match wiring diagram.
   d. Install factory wiring outside of an enclosure in a raceway.
   e. Field power interface shall be to wire lugs **OR** NEMA KS 1, heavy-duty, nonfused disconnect switch, **as directed**.
   f. Provide branch power circuit to each motor and to controls with one of the following disconnecting means:
      1) NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
      2) NEMA KS 1, heavy-duty, nonfusible switch.
      3) NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
   g. Provide each motor with overcurrent protection.
   h. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.
   i. Phase-Failure and Undervoltage: Solid-state sensing with adjustable settings.
   j. Controls Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
   k. Control Relays: Auxiliary and adjustable time-delay relays.
   l. Indicate the following for water chiller electrical power supply:
      1) Current, phase to phase, for all three phases.
      2) Voltage, phase to phase and phase to neutral for all three phases.
      3) Three-phase real power (kilowatts).
      4) Three-phase reactive power (kilovolt amperes reactive).
      5) Power factor.
      6) Running log of total power versus time (kilowatt hours).
      7) Fault log, with time and date of each.

10. Controls:
   a. Stand-alone, microprocessor based.
   b. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.
   c. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, backlit, liquid-crystal display or light-emitting diodes. Display the following:
      1) Date and time.
      2) Operating or alarm status.
      3) Operating hours.
      4) Outside-air temperature if required for chilled-water reset.
      5) Temperature and pressure of operating set points.
      6) Entering and leaving temperatures of chilled water.
      7) Entering and leaving temperatures of condenser water.
      8) Refrigerant pressures in evaporator and condenser.
      9) Saturation temperature in evaporator and condenser.
      10) No cooling load condition.
      11) Elapsed time meter (compressor run status).
      12) Pump status.
      13) Antirecycling timer status.
      14) Percent of maximum motor amperage.
      15) Current-limit set point.

16) Number of compressor starts.

d. Control Functions:
1) Manual or automatic startup and shutdown time schedule.
2) Entering and leaving chilled-water temperatures, control set points, and motor load limit. Chilled-water leaving temperature shall be reset based on return-water **OR** outside-air **OR** space, **as directed**, temperature.
3) Current limit and demand limit.
4) Condenser-water temperature.
5) External water chiller emergency stop.
6) Antirecycling timer.
7) Automatic lead-lag switching.

e. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:
1) Low evaporator pressure or high condenser pressure.
2) Low chilled-water temperature.
3) Refrigerant high pressure.
4) High or low oil pressure.
5) High oil temperature.
6) Loss of chilled-water flow.
7) Loss of condenser-water flow.
8) Control device failure.

f. Building Automation System Interface: Factory-installed hardware and software to enable building automation system to monitor, control, and display water chiller status and alarms.
1) Hardwired Points:
a) Monitoring: On/off status, common trouble alarm **OR** electrical power demand (kilowatts) **OR** electrical power consumption (kilowatt hours), **as directed**.
b) Control: On/off operation, chilled-water discharge temperature set-point adjustment **OR** electrical power demand limit, **as directed**.
2) ASHRAE 135 (BACnet) **OR** LonTalk **OR** Industry-accepted open-protocol, **as directed**, communication interface with building automation system shall enable building automation system operator to control and monitor the water chiller from a remote operator workstation. Control features and monitoring points displayed locally at water chiller control panel shall be available through building automation system.

11. Insulation:
a. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I, for tubular materials and Type II, for sheet materials.
b. Thickness: 3/4 inch (19 mm).
c. Factory-applied insulation over cold surfaces of water chiller components.
1) Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.
d. Apply protective coating to exposed surfaces of insulation.

12. Accessories:
a. Factory-furnished, chilled-water and condenser-water, **as directed**, flow switches for field installation.
b. Individual compressor suction and discharge pressure gages with shutoff valves.
c. Factory-furnished spring isolators for field installation.

B. Packaged Air-Cooled Water Chillers
1. Description: Factory-assembled and run-tested water chiller complete with base and frame, condenser casing, compressors, compressor motors and motor controllers, evaporator, condenser coils, condenser fans and motors, electrical power, controls, and accessories.
2. Fabricate base, frame, and attachment to water chiller components strong enough to resist movement during a seismic event when water chiller base is anchored to field support structure.
3. Cabinet:

a. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit. Base shall be designed to limit deflection to L/200 and shall be a minimum of 4 inches (100 mm) high.
b. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.
c. Casing: Galvanized steel.
d. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 500-hour salt-spray test according to ASTM B 117.
e. Sound-reduction package consisting of the following:
    1) Acoustic enclosure around compressors.
    2) Reduced-speed fans with acoustic treatment.
    3) Designed to reduce sound level without affecting performance.
f. Security Package: Provide security grilles with fasteners for additional protection of compressors, evaporator, and condenser coils. Grilles shall be coated for corrosion resistance and shall be removable for service access.

4. Compressors:
    a. Description: Positive-displacement direct drive with semihermetically sealed and accessible bolted casings.
    b. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.
    c. Operating Speed: 1750 rpm for 60-Hz applications.
    d. Capacity Control: Combinations of cylinder unloading and on-off compressor cycling of multiple compressors, plus hot-gas bypass, **as directed**. Compressor shall be capable of operating at part-load conditions without increased vibration over normal vibration at full-load operation and shall be capable of continuous operation at its lowest step of unloading.
    e. Oil Lubrication System: Automatically reversible, positive-displacement pump with strainer, sight glass, filling connection, filter with magnetic plug, and initial oil charge.
    f. Vibration Isolation: Mount individual compressors on spring isolators with an isolation efficiency of 95 percent.
5. Compressor Motors:
    a. Hermetically sealed and cooled by refrigerant suction gas.
    b. High-torque, four-pole induction type with inherent thermal-overload protection on each phase.
6. Compressor Motor Controllers:
    a. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.
    OR
    Part-Wind Start: NEMA ICS 2, Class A, reduced voltage, nonreversing.
7. Refrigeration:
    a. Refrigerant: R-407C **OR** R-410A, **as directed**. Classified as Safety Group A1 according to ASHRAE 34.
    b. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
    c. Refrigerant Circuit: Each circuit shall include a thermal **OR** an electronic, **as directed**, expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
    d. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line and the refrigerant liquid-line to allow the isolation and storage of the refrigerant charge in the chiller condenser.
8. Evaporator:
    a. Description: Direct-expansion shell-and-tube design with fluid flowing through the shell and refrigerant flowing through the tubes within the shell.
    b. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.

c. Shell Material: Carbon steel.
d. Shell Heads: Removable carbon-steel heads with multipass baffles designed to ensure positive oil return and located at each end of the tube bundle.
e. Shell Nozzles: Fluid nozzles located along the side of the shell and terminated with mechanical-coupling end connections for connection to field piping.
f. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
g. Heater: Factory-installed and -wired electric heater with integral controls designed to protect the evaporator to minus 20 deg F (minus 29 deg C).
h. Remote Mounting: Designed for remote field mounting where indicated. Provide kit for field installation.

9. Air-Cooled Condenser:
   a. Plate-fin coil with integral subcooling circuit, leak tested at 150 psig (1034 kPa).
      1) Construct coils of copper tubes mechanically bonded to aluminum **OR** aluminum with precoated epoxy-phenolic **OR** copper, **as directed**, fins.
      2) Coat coils with a baked epoxy corrosion-resistant coating after fabrication.
      3) Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.
   b. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.
   c. Fan Motors: Totally enclosed air over (TEAO) enclosure, with permanently lubricated bearings, and having built-in overcurrent- and thermal-overload protection.
   d. Fan Guards: Steel safety guards with corrosion-resistant coating.
10. Electrical Power:
   a. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.
   b. House in a unit-mounted, NEMA 250, Type 3R **OR** Type 4, **as directed**, enclosure with hinged access door with lock and key or padlock and key.
   c. Wiring shall be numbered and color-coded to match wiring diagram.
   d. Install factory wiring outside of an enclosure in a raceway.
   e. Field power interface shall be to wire lugs **OR** NEMA KS 1, heavy-duty, nonfused disconnect switch, **as directed**.
   f. Provide branch power circuit to each motor and to controls with one of the following disconnecting means:
      1) NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
      2) NEMA KS 1, heavy-duty, nonfusible switch.
      3) NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
   g. Provide each motor with overcurrent protection.
   h. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.
   i. Phase-Failure and Undervoltage: Solid-state sensing with adjustable settings.
   j. Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
      1) Power unit-mounted controls where indicated.
      2) Power unit-mounted, ground-fault interrupt (GFI) duplex receptacle.
   k. Control Relays: Auxiliary and adjustable time-delay relays.
   l. Indicate the following for water chiller electrical power supply:
      1) Current, phase to phase, for all three phases.
      2) Voltage, phase to phase and phase to neutral for all three phases.
      3) Three-phase real power (kilowatts).
      4) Three-phase reactive power (kilovolt amperes reactive).
      5) Power factor.
      6) Running log of total power versus time (kilowatt hours).
      7) Fault log, with time and date of each.

11. Controls:
    a. Stand-alone, microprocessor based.
    b. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.
    c. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, backlit, liquid-crystal display or light-emitting diodes. Display the following:
        1) Date and time.
        2) Operating or alarm status.
        3) Operating hours.
        4) Outside-air temperature if required for chilled-water reset.
        5) Temperature and pressure of operating set points.
        6) Entering and leaving temperatures of chilled water.
        7) Refrigerant pressures in evaporator and condenser.
        8) Saturation temperature in evaporator and condenser.
        9) No cooling load condition.
        10) Elapsed time meter (compressor run status).
        11) Pump status.
        12) Antirecycling timer status.
        13) Percent of maximum motor amperage.
        14) Current-limit set point.
        15) Number of compressor starts.
    d. Control Functions:
        1) Manual or automatic startup and shutdown time schedule.
        2) Entering and leaving chilled-water temperature, control set points, and motor load limit. Chilled-water leaving temperature shall be reset based on return-water **OR** outside-air **OR** space, **as directed**, temperature.
        3) Current limit and demand limit.
        4) External water chiller emergency stop.
        5) Antirecycling timer.
        6) Automatic lead-lag switching.
    e. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:
        1) Low evaporator pressure or high condenser pressure.
        2) Low chilled-water temperature.
        3) Refrigerant high pressure.
        4) High or low oil pressure.
        5) High oil temperature.
        6) Loss of chilled-water flow.
        7) Control device failure.
    f. Building Automation System Interface: Factory-installed hardware and software to enable building automation system to monitor, control, and display water chiller status and alarms.
        1) Hardwired Points:
            a) Monitoring: On/off status, common trouble alarm **OR** electrical power demand (kilowatts) **OR** electrical power consumption (kilowatt hours), **as directed**.
            b) Control: On/off operation, chilled-water discharge temperature set-point adjustment **OR** electrical power demand limit, **as directed**.
        2) ASHRAE 135 (BACnet) **OR** LonTalk **OR** Industry-accepted open-protocol, **as directed**, communication interface with building automation system shall enable building automation system operator to control and monitor the water chiller from a remote operator workstation. Control features and monitoring points displayed locally at water chiller control panel shall be available through building automation system.
12. Insulation:

a. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I, for tubular materials and Type II, for sheet materials.
b. Thickness: 3/4 inch (19 mm).
c. Factory-applied insulation over cold surfaces of water chiller components.
1) Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.
d. Apply protective coating to exposed surfaces of insulation.
13. Accessories:
a. Factory-furnished, chilled-water and condenser-water, **as directed**, flow switches for field installation.
b. Individual compressor suction and discharge pressure gages with shutoff valves.
c. Factory-furnished spring isolators for field installation.

C. Packaged Refrigerant Recovery Units
1. Packaged portable unit shall consist of compressor, air-cooled condenser, recovery system, tank pressure gages, filter-dryer, and valving that allows for switching between liquid and vapor recovery mode. Refrigerant recovery unit shall be factory mounted on an ASME-constructed and -stamped refrigerant storage vessel that is sized to hold the full refrigerant charge of the largest water chiller.

D. Source Quality Control
1. Perform functional test of water chillers before shipping.
2. Factory performance test water chillers, **as directed**, before shipping, according to ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."
a. Allow the Owner access to place where water chillers are being tested. Notify the Owner 14 days in advance of testing.
3. Factory test and inspect evaporator and water-cooled condenser, **as directed**, according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.
4. For water chillers located indoors, rate sound power level according to ARI 575 procedure.
5. For water chillers located outdoors, rate sound power level according to ARI 370 procedure.

1.3 EXECUTION

A. Water Chiller Installation
1. Install water chillers on support structure indicated.
2. Equipment Mounting: Install water chiller on concrete bases using elastomeric pads **OR** elastomeric mounts **OR** restrained spring isolators, **as directed**. Comply with requirements in Division 03 Section "Cast-in-place Concrete". Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
a. Minimum Deflection: 1/4 inch (6 mm) **OR** 1 inch (25 mm), **as directed**.
b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
e. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Equipment Mounting: Install water chiller using elastomeric pads **OR** elastomeric mounts **OR** restrained spring isolators, **as directed**. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
a. Minimum Deflection: 1/4 inch (6 mm) **OR** 1 inch (25 mm), **as directed**.

4. Equipment Mounting: Install water chiller on vibration isolation inertia bases. Comply with requirements specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
5. Equipment Mounting: Install water chiller on concrete bases. Comply with requirements in Division 03 Section "Cast-in-place Concrete".
   a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   d. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Maintain manufacturer's recommended clearances for service and maintenance.
7. Charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.
8. Install separate devices furnished by manufacturer and not factory installed.

B. Connections
1. Comply with requirements in Division 23 Section "Hydronic Piping". Drawings indicate general arrangement of piping, fittings, and specialties.
2. Comply with requirements in Division 23 Section "Refrigerant Piping". Drawings indicate general arrangement of piping, fittings, and specialties.
3. Install piping adjacent to chiller to allow service and maintenance.
4. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, strainer, **as directed**, flexible connector, **as directed**, thermometer, and plugged tee with pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, **as directed**, flow switch, thermometer, plugged tee with pressure gage, flow meter, **as directed**, and drain connection with valve. Make connections to water chiller with a union **OR** flange **OR** mechanical coupling, **as directed**.
5. Condenser Fluid Connections: Connect to condenser inlet with shutoff valve, strainer, **as directed**, flexible connector, **as directed**, thermometer, and plugged tee with pressure gage. Connect to condenser outlet with shutoff valve, balancing valve, flexible connector, **as directed**, flow switch, thermometer, plugged tee with pressure gage, flow meter, **as directed**, and drain connection with valve. Make connections to water chiller with a union **OR** flange **OR** mechanical coupling, **as directed**.
6. Refrigerant Pressure Relief Valve Connections: For water chillers installed indoors, extend vent piping to the outside without valves or restrictions. Comply with ASHRAE 15, **as directed**.
7. Connect each drain connection with a union and drain pipe, and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection if required.

C. Startup Service
1. Perform startup service.
2. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.
3. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
   a. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
   b. Verify that pumps are installed and functional.
   c. Verify that thermometers and gages are installed.
   d. Operate water chiller for run-in period.
   e. Check bearing lubrication and oil levels.
   f. Verify that refrigerant pressure relief for chillers installed indoors is vented outside.
   g. Verify proper motor rotation.
   h. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.

i. Verify and record performance of chilled-water and condenser-water, **as directed**, flow and low-temperature interlocks.
j. Verify and record performance of water chiller protection devices.
k. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

4. Prepare a written startup report that records results of tests and inspections.

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Task	Specification	Specification Description
23 64 26 13	23 61 16 00a	Rotary-Screw Water Chillers

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SECTION 23 65 13 16 - COOLING TOWERS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for cooling towers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Closed-circuit, forced-draft, counterflow cooling towers.
   b. Closed-circuit, induced-draft, combined-flow cooling towers.
   c. Closed-circuit, induced-draft, counterflow cooling towers.
   d. Open-circuit, forced-draft, counterflow cooling towers.
   e. Open-circuit, induced-draft, counterflow cooling towers.
   f. Open-circuit, induced-draft, crossflow cooling towers.

C. Definitions

1. BMS: Building management system.
2. FRP: Fiber-reinforced polyester.

D. Performance Requirements

1. Delegated Design: Design cooling tower support structure and seismic restraints, **as directed**, and wind restraints, **as directed**, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Structural Performance: Cooling tower support structure shall withstand the effects of gravity loads and loads and stresses within limits and under conditions indicated according to SEI/ASCE 7.
3. Seismic Performance: Cooling towers shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

E. Submittals

1. Product Data: For each type of product indicated. Include rated capacities, pressure drop, fan performance data, rating curves with selected points indicated, furnished specialties, and accessories.
   a. Maximum flow rate.
   b. Minimum flow rate.
   c. Drift loss as percent of design flow rate.
   d. Volume of water in suspension for purposes of sizing a remote storage tank.
   e. Sound power levels in eight octave bands for operation with fans off, fans at minimum, and design speed.
   f. Performance curves for the following:
      1) Varying entering-water temperatures from design to minimum.
      2) Varying ambient wet-bulb temperatures from design to minimum.
      3) Varying water flow rates from design to minimum.
      4) Varying fan operation (off, minimum, and design speed).
   g. Fan airflow, brake horsepower, and drive losses.
   h. Pump flow rate, head, brake horsepower, and efficiency.

i. Motor amperage, efficiency, and power factor at 100, 75, 50, and 25 percent of nameplate horsepower.
j. Electrical power requirements for each cooling tower component requiring power.

2. Shop Drawings: Complete set of manufacturer's prints of cooling tower assemblies, control panels, sections and elevations, and unit isolation. Include the following:
   a. Assembled unit dimensions.
   b. Weight and load distribution.
   c. Required clearances for maintenance and operation.
   d. Sizes and locations of piping and wiring connections.
   e. Wiring Diagrams: For power, signal, and control wiring.
3. Delegated-Design Submittal: For cooling tower support structure indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   a. Detail fabrication and assembly of support structure.
   b. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
   c. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints, **as directed**, and wind restraints, **as directed**, and for designing vibration isolation bases.
   d. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
   e. Structural supports.
   f. Piping roughing-in requirements.
   g. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
   h. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.
4. Certificates: For certification required in "Quality Assurance" Article.
5. Seismic Qualification Certificates: For cooling towers, accessories, and components, from manufacturers.
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
6. Source quality-control reports.
7. Field quality-control reports.
8. Startup service reports.
9. Operation and Maintenance Data: For each cooling tower to include in emergency, operation, and maintenance manuals.
10. Warranty: Sample of special warranty.

F. Quality Assurance

1. Testing Agency Qualifications: Certified by CTI **OR** An NRTL, **as directed**.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
4. ASME Compliance: Fabricate and label heat-exchanger coils to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
5. CTI Certification: Cooling tower thermal performance according to CTI STD 201, "Certification Standard for Commercial Water-Cooling Towers Thermal Performance."
6. FMG approval and listing in the latest edition of FMG's "Approval Guide."

G. Coordination
1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.
3. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

H. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace the following components of cooling towers that fail in materials or workmanship within specified warranty period:
   a. Fan assembly including fan, drive, and motor.
   b. All components of cooling tower.
   c. Warranty Period: Five years from date of Final Completion.

1.2 PRODUCTS

A. Closed-Circuit, Forced-Draft, Counterflow Cooling Towers
1. Fabricate cooling tower mounting base with reinforcement strong enough to resist cooling tower movement during a seismic event when cooling tower is anchored to field support structure.
2. Cooling tower designed to resist wind load of 30 lbf/sq. ft. (1.44 kPa) **OR as directed**.
3. Casing and Frame:
   a. Casing **OR** Casing and Frame, **as directed**, Material: FRP with UV inhibitors **OR** Galvanized steel, ASTM A 653/A 653M, G210 (Z600) coating **OR** Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating **OR** Polymer-coated galvanized steel **OR** Stainless steel, **as directed**.
   b. Frame Material: FRP with UV inhibitors **OR** Galvanized steel, ASTM A 653/A 653M, G210 (Z600) coating **OR** Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating **OR** Polymer-coated galvanized steel **OR** Stainless steel, **as directed**.
   c. Fasteners: Galvanized **OR** Stainless, **as directed**, steel.
   d. Joints and Seams: Sealed watertight.
   e. Welded Connections: Continuous and watertight.
4. Collection Basin: Configure tower for installation with a field-constructed collection basin.
   OR
   Collection Basin:
   a. Material: FRP with UV inhibitors **OR** Galvanized steel, ASTM A 653/A 653M, G210 (Z600) coating **OR** Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating **OR** Polymer-coated galvanized steel **OR** Stainless steel, **as directed**.
   b. Strainer: Removable stainless-steel, **as directed**, strainer with openings smaller than nozzle orifices.
   c. Overflow and drain connections.
   d. Makeup water connection.
   e. Basin Sweeper Distribution Piping and Nozzles:
      1) Pipe Material: PVC.
      2) Nozzle Material: Plastic.
      3) Configure piping and nozzles to minimize sediment from collecting in the collection basin.
5. Mechanically Operated, Collection Basin Water-Level Control: Manufacturer's standard adjustable, mechanical float assembly and valve.
   OR
   Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve:
   a. Enclosure: NEMA 250, Type 4 **OR** Type 4X, **as directed**.
   b. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to provide control of water makeup valve **OR** control of water makeup valve and low-level alarm **OR** control of water makeup valve and low- and high-level alarms **OR**

control of water makeup valve, low- and high-level alarms, and output for shutoff of pump on low level, **as directed**.

c. Electrode Probes: Stainless steel.

d. Water Stilling Chamber: Corrosion-resistant material **OR** FRP **OR** Galvanized steel **OR** PVC pipe **OR** Stainless steel, **as directed**.

e. Solenoid Valve: Slow closing with stainless-steel body, **as directed**, controlled and powered through level controller in response to water-level set point.

f. Electrical Connection Requirements: 120 V, single phase, 60 Hz.

6. Electric Basin Heater:

a. Stainless-Steel Electric Immersion Heaters: Installed in a threaded coupling on the side of the collection basin.

b. Heater Control Panel: Mounted on the side of each cooling tower cell.

c. Enclosure: NEMA 250, Type 3R **OR** Type 4 **OR** Type 4X, **as directed**.

d. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor cooling tower water level and de-energize the heater when the water reaches low-level set point.

e. Control-circuit transformer with primary and secondary side fuses.

f. Terminal blocks with numbered and color-coded wiring to match wiring diagram.

g. Single-point, field-power connection to a fused disconnect switch **OR** nonfused disconnect switch **OR** circuit breaker, **as directed**, and heater branch circuiting complying with NFPA 70.

h. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures, except make connections to each electric basin heater with liquidtight conduit.

OR

Hot-Water-Coil Basin Heater: Manufacturer's standard offering to provide capacity indicated.

OR

Steam-Coil Basin Heater: Manufacturer's standard offering to provide capacity indicated.

OR

Steam-Injector Basin Heater: Manufacturer's standard offering to provide capacity indicated.

7. Water Distribution Piping: Main header and lateral branch piping designed for even distribution over fill throughout the flow range without the need for balancing valves and for connecting individual, removable, nonclogging spray nozzles.

a. Pipe Material: Fiberglass **OR** PVC **OR** Galvanized steel, **as directed**.

b. Spray Nozzle Material: Plastic **OR** Polypropylene **OR** PVC, **as directed**.

c. Piping Supports: Corrosion-resistant hangers and supports designed to resist movement during operation and shipment.

8. Recirculating Piping: PVC, **as directed**, with connections for separately provided, remote spray pump, **as directed**.

9. Spray Pump: Close-coupled, end-suction, single-stage, bronze-fitted centrifugal pump; with suction strainer and flow balancing valve, and mechanical seal suitable for outdoor service.

a. General Requirements for Spray Pump Motor: Comply with NEMA designation and temperature-rating requirements specified in Division 15 Section "Common Motor Requirements for HVAC Equipment" and not indicated below.

b. Motor Enclosure: Totally enclosed **OR** Totally enclosed nonventilated (TENV) **OR** Totally enclosed fan cooled (TEFC), **as directed**, with epoxy or polyurethane finish, **as directed**.

c. Energy Efficiency: Comply with ASHRAE/IESNA 90.1 **OR** NEMA Premium Efficient, **as directed**.

d. Service Factor: 1.0 **OR** 1.15, **as directed**.

10. Heat-Exchanger Coils:

a. Tube and Tube Sheet Materials: Copper tube with stainless-steel sheet **OR** Stainless-steel tube and sheet **OR** Prime-coated steel tube and sheet with outer surface of tube and sheet hot-dip galvanized after fabrication, **as directed**.

b. Heat-Exchanger Arrangement: Serpentine tubes **OR** Serpentine tubes with removable cover plate on inlet and outlet headers **OR** Straight tubes with removable header cover

plate on both ends of heat exchanger for straight-through access to each tube, **as directed**; and sloped for complete drainage of fluid by gravity.
OR
ASME Compliance: Designed, manufactured, and tested according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, and bearing ASME "U" stamp; and sloped for complete drainage of fluid by gravity.
c. Field Piping Connections: Vent, supply, and return suitable for mating to ASME B16.5, Class 150 flange, **as directed**.

11. Removable, **as directed**, Drift Eliminator:
    a. Material: FRP **OR** PVC, **as directed**; with maximum flame-spread index of 5 **OR** 25, **as directed**, according to ASTM E 84.
    b. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
    c. Configuration: Multipass, designed and tested to reduce water carryover to achieve performance indicated.
12. Removable, **as directed**, Air-Intake Screens: Galvanized **OR** Polymer-coated, galvanized **OR** Stainless, **as directed**,-steel wire mesh.
13. Centrifugal Fan: Double-width, double-inlet, forward-curved blades, and statically and dynamically balanced at the factory after assembly.
    a. Number of Fans: Each cooling tower cell shall have a single fan or multiple fans connected to a common shaft.
    b. Fan Wheel and Housing Materials: Galvanized steel.
    c. Fan Shaft: Steel, coated to resist corrosion.
    d. Protective Enclosure: Removable, galvanized-steel, wire-mesh screens complying with OSHA regulations.
    e. Fan Shaft Bearings: Self-aligning, grease-lubricated ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F (minus 29 and plus 149 deg C). Bearings designed for an L-10 life of 40,000 **OR** 50,000, **as directed**, hours.
    f. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.
14. Belt Drive:
    a. Belt-Drive Service Factor: 1.5 based on motor nameplate horsepower.
    b. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.
    c. Belt: Multiple V-belt design with a matched set of cogged, **as directed**, belts.
    OR
    Belt: One-piece, multigrooved, solid-back belt.
    d. Belt Material: Oil resistant, nonstatic conducting, and constructed of neoprene polyester cord.
    e. Belt-Drive Guard: Comply with OSHA regulations.
    f. Two-Motor, Single-Fan Drive:
        1) Two single-speed motors per fan, one sized for full speed and load, and the other sized for 67 percent of full-load speed.
        2) Belt Drives: Each motor shall have belt drive complying with requirements for belt drives and configured for operation when other motor fails.
        3) Motor controller and wiring same as two-speed, two-winding motor.
15. Fan Motor:
    a. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Division 23 Section "Common Motor Requirements For Hvac Equipment" and not indicated below.
    b. Motor Enclosure: Totally enclosed **OR** Totally enclosed air over (TEAO) **OR** Totally enclosed fan cooled (TEFC), **as directed**, with epoxy or polyurethane finish, **as directed**.
    c. Energy Efficiency: Comply with ASHRAE/IESNA 90.1 **OR** NEMA Premium Efficient, **as directed**.
    d. Service Factor: 1.15.
    e. Insulation: Class F **OR** Class H, **as directed**.

f. Variable-Speed Motors: Inverter-duty rated per NEMA MG-1, Section IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors."
g. Severe-duty rating with the following features:
   1) Rotor and stator protected with corrosion-inhibiting epoxy resin.
   2) Double-shielded, vacuum-degassed bearings lubricated with premium moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F (minus 29 and plus 149 deg C).
   3) Internal heater automatically energized when motor is de-energized.
h. Motor Base: Adjustable, or other suitable provision for adjusting belt tension.

16. Discharge Hoods:
   a. Hood Configuration: Tapered **OR** Straight, **as directed**; totally surrounding drift eliminators and constructed of same material as casing; and having factory-installed insulation, **as directed**, and access doors.
   b. Discharge Dampers: Positive-closure, automatic, isolation dampers with electric actuators.
      1) Provide field power and controls to open dampers when pump is energized and close dampers when pump is de-energized.
17. Capacity-Control Dampers: Galvanized-steel **OR** Stainless-steel, **as directed**, dampers, with linkages, electric operator, controller, limit switches, transformer, and weatherproof enclosure.
18. Vibration Switch: For each fan drive.
   a. Enclosure: NEMA 250, Type 4 **OR** Type 4X, **as directed**.
   b. Vibration Detection: Sensor with a field-adjustable acceleration sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
   c. Provide switch with manual-reset button, **as directed**, for field connection to a BMS and, **as directed**, hardwired connection to fan motor electrical circuit.
   d. Switch shall, on sensing excessive vibration, signal an alarm through the BMS and, **as directed**, shut down the fan.
19. Controls: Comply with requirements in Division 23 Section "Instrumentation And Control For Hvac".
   OR
   Control Package: Factory installed and wired, and functionally tested at factory before shipment.
   a. NEMA 250, Type 3R **OR** Type 4 **OR** Type 4X, **as directed**, enclosure with removable internally mount backplate.
   b. Control-circuit transformer with primary and secondary side fuses.
   c. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
   d. Microprocessor-based controller for automatic control of fan and spray pump, **as directed**, based on cooling tower leaving-water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
   e. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead stage rotation.
   f. Collection basin, electric/electronic level controller complying with requirements in "Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve" Paragraph.
   g. Electric basin heaters with temperature control and low-water-level safety switch for each cell, complying with requirements in "Electric Basin Heater" Paragraph.
   h. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
   i. Controls and wiring for "two-motor, single-fan drives" shall be same as two-speed, two-winding motor.
   j. Power and controls to open discharge hood dampers when pump is energized and close dampers when pump is de-energized.
   k. Single-point, field-power connection to a fused disconnect switch **OR** nonfused disconnect switch **OR** circuit breaker, **as directed**, for each cooling tower cell, **as directed**.

1) Branch power circuit to each motor and electric basin heater and to controls with a disconnect switch or circuit breaker, **as directed**.
2) NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller with manual bypass and line reactors for each variable-speed motor indicated.

l. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquidtight conduit.
m. Visual indication of status and alarm with momentary test push button, **as directed**, for each motor.
n. Audible alarm and silence switch.
o. Visual indication of elapsed run time, graduated in hours for each motor.
p. Cooling tower shall have hardware to enable BMS to remotely monitor and display the following:
1) Operational status of each motor.
2) Position of dampers.
3) Cooling tower leaving-fluid temperature.
4) Fan vibration alarm.
5) Collection basin high **OR** low **OR** high- and low, **as directed**,-water-level alarms.

20. Personnel Access Components:
a. Doors: Large enough for personnel to access cooling tower internal components from both, **as directed**, cooling tower end walls. Doors shall be operable from both sides of the door, **as directed**.
b. External Ladders with Safety Cages: Aluminum, galvanized- or stainless-steel, fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.
c. External Platforms with Handrails: Aluminum, FRP, or galvanized-steel bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.
d. Handrail: Aluminum, galvanized steel, or stainless steel complete with kneerail and toeboard at platforms and around top of cooling tower. Comply with 29 CFR 1910.23.
e. Internal Platforms: Aluminum, FRP, or galvanized-steel bar grating.
1) Spanning the collection basin from one end of cooling tower to the other and positioned to form a path between the access doors. Platform shall be elevated so that all parts are above the high water level of the collection basin.

B. Closed-Circuit, Induced-Draft, Combined-Flow Cooling Towers
1. Fabricate cooling tower mounting base with reinforcement strong enough to resist cooling tower movement during a seismic event when cooling tower is anchored to field support structure.
2. Cooling tower designed to resist wind load of 30 lbf/sq. ft. (1.44 kPa) **OR as directed**.
3. Casing and Frame:
a. Casing and Frame, **as directed**, Material: FRP with UV inhibitors **OR** Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating **OR** Polymer-coated galvanized steel **OR** Stainless steel, **as directed**.
b. Frame Material: FRP with UV inhibitors **OR** Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating **OR** Polymer-coated galvanized steel **OR** Stainless steel, **as directed**.
c. Fasteners: Galvanized **OR** Stainless, **as directed**, steel.
d. Joints and Seams: Sealed watertight.
e. Welded Connections: Continuous and watertight.
4. Collection Basin: Configure tower for installation with a field-constructed collection basin.
OR
Collection Basin:
a. Material: FRP with UV inhibitors **OR** Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating **OR** Polymer-coated galvanized steel **OR** Stainless steel, **as directed**.
b. Strainer: Removable stainless-steel, **as directed**, strainer with openings smaller than nozzle orifices.
c. Overflow and drain connections.

d. Makeup water connection.
e. Basin Sweeper Distribution Piping and Nozzles:
   1) Pipe Material: PVC, **as directed**.
   2) Nozzle Material: Plastic, **as directed**.
   3) Configure piping and nozzles to minimize sediment from collecting in the collection basin.

5. Mechanically Operated, Collection Basin Water-Level Control: Manufacturer's standard adjustable, mechanical float assembly and valve.
OR
Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve:
a. Enclosure: NEMA 250, Type 4 **OR** Type 4X, **as directed**.
b. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to provide control of water makeup valve **OR** control of water makeup valve and low-level alarm **OR** control of water makeup valve and low- and high-level alarms **OR** control of water makeup valve, low- and high-level alarms, and output for shutoff of pump on low level, **as directed**.
c. Electrode Probes: Stainless steel.
d. Water Stilling Chamber: Corrosion-resistant material **OR** FRP **OR** Galvanized steel **OR** PVC pipe **OR** Stainless steel, **as directed**.
e. Solenoid Valve: Slow closing with stainless-steel body, **as directed**, controlled and powered through level controller in response to water-level set point.
f. Electrical Connection Requirements: 120 V, single phase, 60 Hz.

OR
Ultrasonic Collection Basin Water-Level Controller with Solenoid Valve:
a. Enclosure: NEMA 250, Type 4 **OR** Type 4X, **as directed**.
b. Controller: Ultrasonic level sensor/transmitter and relays factory wired to a terminal strip to control water makeup valve and signal a level alarm. Controller shall provide continuous level indication through a 4- to 20-mA signal for connection to BMS, **as directed**.
c. Water Stilling Chamber: Corrosion-resistant material **OR** FRP **OR** Galvanized steel **OR** PVC pipe **OR** Stainless steel, **as directed**.
d. Solenoid Valve: Slow closing with stainless-steel body, **as directed**, controlled and powered through level controller in response to water-level set point.
e. Electrical Connection Requirements: 120 V, single phase, 60 Hz.

6. Electric Basin Heater:
a. Stainless-Steel Electric Immersion Heaters: Installed in a threaded coupling on the side of the collection basin.
b. Heater Control Panel: Mounted on the side of each cooling tower cell.
c. Enclosure: NEMA 250, Type 3R **OR** Type 4 **OR** Type 4X, **as directed**.
d. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor cooling tower water level and de-energize the heater when the water reaches low-level set point.
e. Control-circuit transformer with primary and secondary side fuses.
f. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
g. Single-point, field-power connection to a fused disconnect switch **OR** nonfused disconnect switch **OR** circuit breaker, **as directed**, and heater branch circuiting complying with NFPA 70.
h. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures, except make connections to each electric basin heater with liquidtight conduit.

OR
Hot-Water-Coil Basin Heater: Manufacturer's standard offering to provide capacity indicated.
OR
Steam-Coil Basin Heater: Manufacturer's standard offering to provide capacity indicated.
OR
Steam-Injector Basin Heater: Manufacturer's standard offering to provide capacity indicated.

7. Gravity Water Distribution Basin: Nonpressurized design with head of water level in basin adequate to overcome spray nozzle losses and designed to evenly distribute water over fill throughout the flow range indicated.
   a. Material: FRP with UV inhibitors **OR** Galvanized steel, ASTM A 653/A 653M, G210 (Z600) coating **OR** Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating **OR** Polymer-coated galvanized steel **OR** Stainless steel, **as directed**.
   b. Location: Over each bank of fill with easily replaceable plastic, **as directed**, spray nozzles mounted in bottom of basin.
   c. Joints and Seams: Sealed watertight.
   d. Partitioning Dams: Same material as basin to distribute water over the fill to minimize icing while operating throughout the flow range indicated.
   e. Removable Panels: Same material as basin to completely cover top of basin. Secure panels to basin with removable corrosion-resistant **OR** stainless-steel, **as directed**, hardware.
   f. Valves: Manufacturer's standard valve installed at each inlet connection and arranged to balance or shut off flow to each gravity water distribution basin.
8. Pressurized Water Distribution Piping: Main header and lateral branch piping designed for even distribution over heat-exchanger coil or fill throughout the flow range without the need for balancing valves and for connecting individual, removable, nonclogging spray nozzles.
   a. Pipe Material: PVC **OR** Galvanized steel, **as directed**.
   b. Spray Nozzle Material: Plastic **OR** Polypropylene, **as directed**.
   c. Piping Supports: Corrosion-resistant hangers and supports to resist movement during operation and shipment.
9. Recirculating Piping: PVC, **as directed**, with connections for separately provided, remote spray pump, **as directed**.
10. Spray Pump: Close-coupled, end-suction, single-stage, bronze-fitted centrifugal pump; with suction strainer and flow balancing valve, and mechanical seal suitable for outdoor service.
    a. General Requirements for Spray Pump Motor: Comply with NEMA designation and temperature-rating requirements specified in Division 23 Section "Common Motor Requirements For Hvac Equipment" and not indicated below.
    b. Motor Enclosure: Totally enclosed **OR** Totally enclosed nonventilated (TENV) **OR** Totally enclosed fan cooled (TEFC), **as directed**, with epoxy or polyurethane finish, **as directed**.
    c. Energy Efficiency: Comply with ASHRAE/IESNA 90.1 **OR** NEMA Premium Efficient, **as directed**.
    d. Service Factor: 1.0 **OR** 1.15, **as directed**.
11. Fill:
    a. Materials: PVC, **as directed**, with maximum flame-spread index of 5 **OR** 25, **as directed**, according to ASTM E 84.
    b. Minimum Thickness: 15 mils (0.4 mm) **OR** 20 mils (0.5 mm), **as directed**, before forming.
    c. Fabrication: Fill-type sheets fabricated, formed, and bonded together after forming into removable assemblies that are factory installed by manufacturer.
    d. Fill Material Operating Temperature: Suitable for entering-water temperatures up through 120 deg F (49 deg C).
12. Heat-Exchanger Coils:
    a. Tube and Tube Sheet Materials: Copper tube with stainless-steel sheet **OR** Stainless-steel tube and sheet **OR** Prime-coated steel tube and sheet with outer surface of tube and sheet hot-dip galvanized after fabrication, **as directed**.
    b. Heat-Exchanger Arrangement: Serpentine tubes **OR** Serpentine tubes with removable cover plate on inlet and outlet headers **OR** Straight tubes with removable header cover plate on both ends of heat exchanger for straight-through access to each tube, **as directed**; and sloped for complete drainage of fluid by gravity.

       OR

       ASME Compliance: Designed, manufactured, and tested according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1 and bearing ASME "U" stamp; and sloped for complete drainage of fluid by gravity.

c. Field Piping Connections: Vent, supply, and return suitable for mating to ASME B16.5, Class 150 flange, **as directed**.

13. Drift Eliminator:
    a. Material: FRP **OR** PVC, **as directed**; with maximum flame-spread index of 5 according to ASTM E 84.
    b. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
    c. Configuration: Multipass, designed and tested to reduce water carryover to achieve performance indicated.
    d. Fill Drift Eliminators: Integral to **OR** Separate and removable from, **as directed**, fill.
    e. Heat-Exchanger Coil Drift Eliminators: Located on discharge side and removable.
14. Air-Intake Louvers:
    a. Material: FRP **OR** PVC **OR** Matching casing, **as directed**.
    b. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
    c. Louver Blades: Arranged to uniformly direct air into cooling tower, to minimize air resistance, and to prevent water from splashing out of tower during all modes of operation including operation with fans off.
    d. Location: Integral to **OR** Separate from, **as directed**, fill.
15. Removable, **as directed**, Air-Intake Screens: Galvanized **OR** Polymer-coated, galvanized **OR** Stainless, **as directed**,-steel wire mesh.
16. Axial Fan: Balanced at the factory after assembly.
    a. Blade Material: Aluminum **OR** FRP, **as directed**.
    b. Hub Material: Aluminum **OR** FRP, **as directed**.
    c. Blade Pitch: Field adjustable.
    d. Protective Enclosure: Removable, galvanized-steel, wire-mesh screens complying with OSHA regulations.
    e. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F (minus 29 and plus 149 deg C). Bearings designed for an L-10 life of 40,000 **OR** 50,000, **as directed**, hours.
    f. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.
17. Belt Drive:
    a. Service Factor: 1.5 based on motor nameplate horsepower.
    b. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.
    c. Belt: Multiple V-belt design with a matched set of cogged, **as directed**, belts.
       OR
       Belt: One-piece, multigrooved, solid-back belt.
    d. Belt Material: Oil resistant, nonstatic conducting, and constructed of neoprene polyester cord.
    e. Belt-Drive Guard: Comply with OSHA regulations.
    f. Two-Motor, Single-Fan Drive:
       1) Two single-speed motors per fan, one sized for full speed and load and the other sized for 67 percent of full-load speed.
       2) Each motor with belt drive and configured for operation when other motor fails.
       3) Controls and wiring same as two-speed, two-winding motor.
18. Gear Drive: Right angle, reduced speed, and designed for cooling tower applications according to CTI STD 111. Motor and gear drive shall be aligned before shipment.
    a. Gear Drive and Coupling Service Factor: 2.0 based on motor nameplate horsepower.
    b. Housing: Cast iron, with epoxy or polyurethane finish, beveled high-strength steel gears continuously bathed in oil, and with lubrication to other internal parts at all operating speeds.
    c. Mounting: Directly mounted to fan hub and connected to motor so motor shaft is in horizontal position.
    d. Operation: Able to operate both forward and in reverse.

e. Drive-to-Motor Connection: Close coupled to motor using a flexible coupling **OR** Connected to motor located outside of cooling tower casing by a full-floating drive shaft, **as directed**.
f. Drive Shaft Material: Corrosion resistant **OR** Stainless steel, **as directed**, and fitted with flexible couplings on both ends. Provide exposed shaft and couplings with guards according to OSHA regulations.
g. Extend oil fill, drain, and vent to outside of cooling tower casing using galvanized-steel piping. Provide installation with oil-level sight glass.

19. Fan Motor:
   a. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Division 23 Section "Common Motor Requirements For Hvac Equipment" and not indicated below.
   b. Motor Enclosure: Totally enclosed **OR** Totally enclosed air over (TEAO) **OR** Totally enclosed fan cooled (TEFC), **as directed**, with epoxy or polyurethane finish, **as directed**.
   c. Energy Efficiency: Comply with ASHRAE/IESNA 90.1 **OR** NEMA Premium Efficient, **as directed**.
   d. Service Factor: 1.15.
   e. Insulation: Class F **OR** Class H, **as directed**.
   f. Variable-Speed Motors: Inverter-duty rated per NEMA MG-1, Section IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors."
   g. Motor Location: Mounted outside of cooling tower casing and cooling tower discharge airstream.
   h. Severe-duty rating with the following features:
      1) Rotor and stator protected with corrosion-inhibiting epoxy resin.
      2) Double-shielded, vacuum-degassed bearings lubricated with premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F (minus 29 and plus 149 deg C).
      3) Internal heater automatically energized when motor is de-energized.
   i. Motor Base: Adjustable, or other suitable provision for adjusting belt tension.

20. Fan Discharge Stack: Material shall match casing, manufacturer's standard **OR** velocity recovery, **as directed**, design.
   a. Stack Extension: Fabricated to extend above fan deck unless otherwise indicated.
   b. Stack Termination: Wire-mesh, galvanized-steel screens; complying with OSHA regulations.

21. Vibration Switch: For each fan drive.
   a. Enclosure: NEMA 250, Type 4 **OR** Type 4X, **as directed**.
   b. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
   c. Provide switch with manual-reset button, **as directed**, for field connection to a BMS, **as directed**, and hardwired connection to fan motor electrical circuit.
   d. Switch shall, on sensing excessive vibration, signal an alarm through the BMS, **as directed**, and shut down the fan.

22. Gear-Drive, Oil-Level Switch: Low-oil-level warning switch for connection to a BMS, **as directed**.
   a. Switch shall, on reaching a low-oil-level set point recommended by cooling tower manufacturer, signal an alarm through the BMS, **as directed**.

23. Controls: Comply with requirements in Division 23 Section "Instrumentation And Control For Hvac".
   OR
   Control Package: Factory installed and wired, and functionally tested at factory before shipment.
   a. NEMA 250, Type 3R **OR** Type 4 **OR** Type 4X, **as directed**, enclosure with removable internally mount backplate.
   b. Control-circuit transformer with primary and secondary side fuses.
   c. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.

d. Microprocessor-based controller for automatic control of fan and spray pump, **as directed**, based on cooling tower leaving-water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
e. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead stage rotation.
f. Collection basin level controller complying with requirements in "Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve" **OR** "Ultrasonic Collection Basin Water-Level Controller with Solenoid Valve", **as directed**, Paragraph.
g. Electric basin heaters with temperature control and low-water-level safety switch for each cell, complying with requirements in "Electric Basin Heater" Paragraph.
h. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
i. Oil-level switch for each fan with a gear drive, complying with requirement in "Gear-Drive, Oil-Level Switch" Paragraph.
j. Single-point, field-power connection to a fused disconnect switch **OR** nonfused disconnect switch **OR** circuit breaker, **as directed**, for each cooling tower cell, **as directed**.
   1) Branch power circuit to each motor and electric basin heater and to controls with a disconnect switch or circuit breaker, **as directed**.
   2) NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller with manual bypass and line reactors for each variable-speed motor indicated.
k. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquidtight conduit.
l. Visual indication of status and alarm with momentary test push button, **as directed**, for each motor.
m. Audible alarm and silence switch.
n. Visual indication of elapsed run time, graduated in hours for each motor.
o. Cooling tower shall have hardware to enable BMS to remotely monitor and display the following:
   1) Operational status of each motor.
   2) Position of dampers.
   3) Cooling tower leaving-fluid temperature.
   4) Fan vibration alarm.
   5) Oil-level alarm.
   6) Collection basin high **OR** low **OR** high- and low, **as directed**,-water-level alarms.

24. Personnel Access Components:
a. Doors: Large enough for personnel to access cooling tower internal components from both cooling tower end walls. Doors shall be operable from both sides of the door.
b. External Ladders with Safety Cages: Aluminum, galvanized- or stainless-steel, fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.
c. External Platforms with Handrails: Aluminum, FRP, or galvanized-steel bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.
d. Handrail: Aluminum, galvanized steel, or stainless steel complete with kneerail and toeboard, around top of cooling tower. Comply with 29 CFR 1910.23.
e. Internal Platforms: Aluminum, FRP, or galvanized-steel bar grating.
   1) Spanning the collection basin from one end of cooling tower to the other and positioned to form a path between the access doors. Platform shall be elevated so that all parts are above the high water level of the collection basin.
   2) Elevated internal platforms with handrails accessible from fixed vertical ladders to access the fan drive assembly when out of reach from collection basin platform.

C. Closed-Circuit, Induced-Draft, Counterflow Cooling Towers

1. Fabricate cooling tower mounting base with reinforcement strong enough to resist cooling tower movement during a seismic event when cooling tower is anchored to field support structure.
2. Cooling tower designed to resist wind load of 30 lbf/sq. ft. (1.44 kPa) **OR as directed**.
3. Casing and Frame:
   a. Casing and Frame, **as directed**, Material: FRP with UV inhibitors **OR** Galvanized steel, ASTM A 653/A 653M, G210 (Z600) coating **OR** Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating **OR** Stainless steel, **as directed**.
   b. Frame Material: FRP with UV inhibitors **OR** Galvanized steel, ASTM A 653/A 653M, G210 (Z600) coating **OR** Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating **OR** Polymer-coated galvanized steel **OR** Stainless steel, **as directed**.
   c. Fasteners: Galvanized **OR** Stainless, **as directed**, steel.
   d. Joints and Seams: Sealed watertight.
   e. Welded Connections: Continuous and watertight.
4. Collection Basin: Configure tower for installation with a field-constructed collection basin.
   OR
   Collection Basin:
   a. Material: Galvanized steel, ASTM A 653/A 653M, G210 (Z600) coating **OR** Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating **OR** Stainless steel, **as directed**.
   b. Overflow and drain connections.
   c. Makeup water connection.
5. Mechanically Operated, Collection Basin Water-Level Control: Manufacturer's standard adjustable, mechanical float assembly and valve.
   OR
   Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve:
   a. Enclosure: NEMA 250, Type 4 **OR** Type 4X, **as directed**.
   b. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to provide control of water makeup valve **OR** control of water makeup valve and low-level alarm **OR** control of water makeup valve and low- and high-level alarms **OR** control of water makeup valve, low- and high-level alarms, and output for shutoff of pump on low level, **as directed**.
   c. Electrode Probes: Stainless steel.
   d. Water Stilling Chamber: Corrosion-resistant material **OR** FRP **OR** Galvanized steel **OR** PVC pipe **OR** Stainless steel, **as directed**.
   e. Solenoid Valve: Slow closing with stainless-steel body, **as directed**; controlled and powered through level controller in response to water-level set point.
   f. Electrical Connection Requirements: 120 V, single phase, 60 Hz.
6. Electric Basin Heater:
   a. Stainless-Steel Electric Immersion Heaters: Installed in a threaded coupling on the side of the collection basin.
   b. Heater Control Panel: Mounted on the side of each cooling tower cell.
   c. Enclosure: NEMA 250, Type 3R **OR** Type 4 **OR** Type 4X, **as directed**.
   d. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor cooling tower water level and de-energize the heater when the water reaches low-level set point.
   e. Control-circuit transformer with primary and secondary side fuses.
   f. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
   g. Single-point, field-power connection to a fused disconnect switch **OR** nonfused disconnect switch **OR** circuit breaker, **as directed**, and heater branch circuiting complying with NFPA 70.
   h. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures, except make connections to each electric basin heater with liquidtight conduit.
   OR
   Hot-Water-Coil Basin Heater: Manufacturer's standard offering to provide capacity indicated.
   OR
   Steam-Coil Basin Heater: Manufacturer's standard offering to provide capacity indicated.
   OR

Steam-Injector Basin Heater: Manufacturer's standard offering to provide capacity indicated.

7. Pressurized Water Distribution Piping: Main header and lateral branch piping designed for even distribution over heat-exchanger coil or fill throughout the flow range without the need for balancing valves and for connecting individual, removable, nonclogging spray nozzles.
   a. Pipe Material: Fiberglass **OR** PVC **OR** Galvanized steel, **as directed**.
   b. Spray Nozzle Material: Plastic **OR** Polypropylene **OR** PVC, **as directed**.
   c. Piping Supports: Corrosion-resistant hangers and supports to resist movement during operation and shipment.
8. Recirculating Piping: PVC, **as directed**, with connections for separately provided, remote spray pump, **as directed**.
9. Spray Pump: Close-coupled, end-suction, single-stage, bronze-fitted centrifugal pump; with suction strainer and flow balancing valve, and mechanical seal suitable for outdoor service.
10. General Requirements for Spray Pump Motor: Comply with NEMA designation and temperature-rating requirements specified in Division 23 Section "Common Motor Requirements For Hvac Equipment" and not indicated below.
    a. Motor Enclosure: Totally enclosed **OR** Totally enclosed nonventilated (TENV) **OR** Totally enclosed fan cooled (TEFC), **as directed**, with epoxy or polyurethane finish, **as directed**.
    b. Energy Efficiency: Comply with ASHRAE/IESNA 90.1 **OR** NEMA Premium Efficient, **as directed**.
    c. Service Factor: 1.0 **OR** 1.15, **as directed**.
11. Heat-Exchanger Coils:
    a. Tube and Tube Sheet Materials: Copper tube with stainless-steel sheet **OR** Stainless-steel tube and sheet **OR** Prime-coated steel tube and sheet with outer surface of tube and sheet hot-dip galvanized after fabrication, **as directed**.
    b. Heat-Exchanger Arrangement: Serpentine tubes **OR** Serpentine tubes with removable cover plate on inlet and outlet headers **OR** Straight tubes with removable header cover plate on both ends of heat exchanger for straight-through access to each tube, **as directed**; and sloped for complete drainage of fluid by gravity.
       OR
       ASME Compliance: Designed, manufactured, and tested according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1 and bearing ASME "U" stamp; and sloped for complete drainage of fluid by gravity.
    c. Field Piping Connections: Vent, supply, and return suitable for mating to ASME B16.5, Class 150 flange, **as directed**.
12. Removable, **as directed**, Drift Eliminator:
    a. Material: FRP **OR** PVC, **as directed**; with maximum flame-spread index of 5 **OR** 25, **as directed**, according to ASTM E 84.
    b. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
    c. Configuration: Multipass, designed and tested to reduce water carryover to achieve performance indicated.
13. Air-Intake Louvers:
    a. Material: FRP **OR** PVC **OR** Matching casing, **as directed**.
    b. UV Treatment: Treat louvers with inhibitors to protect against damage caused by UV radiation.
    c. Louver Blades: Arranged to uniformly direct air into cooling tower, to minimize air resistance, and to prevent water from splashing out during all modes of operation including operation with fans off.
14. Axial Fan: Balanced at the factory after assembly.
    a. Blade Material: Aluminum **OR** FRP **OR** Galvanized steel, **as directed**.
    b. Hub Material: Aluminum **OR** FRP **OR** Galvanized steel, **as directed**.
    c. Blade Pitch: Field adjustable.
    d. Protective Enclosure: Removable, galvanized-steel, wire-mesh screens complying with OSHA regulations.
    e. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus

300 deg F (minus 29 and plus 149 deg C). Bearings designed for an L-10 life of 40,000 **OR** 50,000, **as directed**, hours.
f. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.

15. Belt Drive:
    a. Service Factor: 1.5 based on motor nameplate horsepower.
    b. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.
    c. Belt: Multiple V-belt design with a matched set of cogged, **as directed**, belts.
    OR
    Belt: One-piece, multigrooved, solid-back belt.
    d. Belt Material: Oil resistant, nonstatic conducting, and constructed of neoprene polyester cord.
    e. Belt-Drive Guard: Comply with OSHA regulations.
    f. Two-Motor, Single-Fan Drive:
        1) Two single-speed motors per fan, one sized for full speed and load and the other sized for 67 percent of full-load speed.
        2) Each motor with belt drive and configured for operation when other motor fails.
        3) Controls and wiring same as two-speed, two-winding motor.
16. Fan Motor:
    a. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Division 23 Section "Common Motor Requirements For Hvac Equipment" and not indicated below.
    b. Motor Enclosure: Totally enclosed **OR** Totally enclosed air over (TEAO) **OR** Totally enclosed fan cooled (TEFC), **as directed**, with epoxy or polyurethane finish, **as directed**.
    c. Energy Efficiency: Comply with ASHRAE/IESNA 90.1 **OR** NEMA Premium Efficient, **as directed**.
    d. Service Factor: 1.15.
    e. Insulation: Class F **OR** Class H, **as directed**.
    f. Variable-Speed Motors: Inverter-duty rated per NEMA MG-1, Section IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors."
    g. Severe-duty rating with the following features:
        1) Rotor and stator protected with corrosion-inhibiting epoxy resin.
        2) Double-shielded, vacuum-degassed bearings lubricated with premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F (minus 29 and plus 149 deg C).
        3) Internal heater automatically energized when motor is de-energized.
    h. Motor Base: Adjustable, or other suitable provision for adjusting belt tension.
17. Fan Discharge Stack: Material shall match casing, manufacturer's standard **OR** velocity recovery, **as directed**, design.
    a. Stack Extension: Fabricated to extend above fan deck unless otherwise indicated.
    b. Stack Termination: Wire-mesh, galvanized-steel screens; complying with OSHA regulations.
18. Vibration Switch: For each fan drive.
    a. Enclosure: NEMA 250, Type 4 **OR** Type 4X, **as directed**.
    b. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
    c. Provide switch with manual-reset button, **as directed**, for field connection to a BMS, **as directed**, and hardwired connection to fan motor electrical circuit.
    d. Switch shall, on sensing excessive vibration, signal an alarm through the BMS, **as directed**, and shut down the fan.
19. Controls: Comply with requirements in Division 23 Section "Instrumentation And Control For Hvac".
    OR
    Control Package: Factory installed and wired, and functionally tested at factory before shipment.

a. NEMA 250, Type 3R **OR** Type 4 **OR** Type 4X, **as directed**, enclosure with removable internally mount backplate.

b. Control-circuit transformer with primary and secondary side fuses.

c. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.

d. Microprocessor-based controller for automatic control of fan and spray pump, **as directed**, based on cooling tower leaving-water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.

e. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead stage rotation.

f. Collection basin electric/electronic level controller complying with requirements in "Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve" Paragraph.

g. Electric basin heaters with temperature control and low-water-level safety switch for each cell, complying with requirements in "Electric Basin Heater" Paragraph.

h. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.

i. Single-point, field-power connection to a fused disconnect switch **OR** nonfused disconnect switch **OR** circuit breaker **OR** for each cooling tower cell, **as directed**.

   1) Branch power circuit to each motor and electric basin heater and to controls with a disconnect switch or circuit breaker, **as directed**.

   2) NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller with manual bypass and line reactors for each variable-speed motor indicated.

j. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquidtight conduit.

k. Visual indication of status and alarm with momentary test push button, **as directed**, for each motor.

l. Audible alarm and silence switch.

m. Visual indication of elapsed run time, graduated in hours for each motor.

n. Cooling tower shall have hardware to enable BMS to remotely monitor and display the following:

   1) Operational status of each motor.

   2) Cooling tower leaving-fluid temperature.

   3) Fan vibration alarm.

   4) Collection basin high **OR** low **OR** high- and low, **as directed**,-water-level alarms.

20. Personnel Access Components:

a. Doors: Large enough for personnel to access cooling tower internal components from both cooling tower end walls. Doors shall be operable from both sides of the door.

b. External Ladders with Safety Cages: Aluminum, galvanized- or stainless-steel, fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.

c. External Platforms with Handrails: Aluminum, FRP, or galvanized-steel bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.

d. Handrail: Aluminum, galvanized steel, or stainless steel complete with kneerail and toeboard, around top of cooling tower. Comply with 29 CFR 1910.23.

e. Internal Platforms: Aluminum, FRP, or galvanized-steel bar grating.

   1) Spanning the collection basin from one end of cooling tower to the other and positioned to form a path between the access doors. Platform shall be elevated so that all parts are above the high water level of the collection basin.

   2) Elevated internal platforms with handrails accessible from fixed vertical ladders to access the fan drive assembly when out of reach from collection basin platform.

D. Open-Circuit, Forced-Draft, Counterflow Cooling Towers

1. Fabricate cooling tower mounting base with reinforcement strong enough to resist cooling tower movement during a seismic event when cooling tower is anchored to field support structure.
2. Cooling tower designed to resist wind load of 30 lbf/sq. ft. (1.44 kPa) **OR as directed**.
3. Casing and Frame:
    a. Casing and Frame, **as directed**, Material: FRP with UV inhibitors **OR** Galvanized steel, ASTM A 653/A 653M, G210 (Z600) coating **OR** Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating **OR** Polymer-coated galvanized steel **OR** Stainless steel, **as directed**.
    b. Frame Material: FRP with UV inhibitors **OR** Galvanized steel, ASTM A 653/A 653M, G210 (Z600) coating **OR** Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating **OR** Polymer-coated galvanized steel **OR** Stainless steel, **as directed**.
    c. Fasteners: Galvanized **OR** Stainless, **as directed**, steel.
    d. Joints and Seams: Sealed watertight.
    e. Welded Connections: Continuous and watertight.
4. Collection Basin: Configure tower for installation with a field-constructed collection basin.
   OR
   Collection Basin:
    a. Material: FRP with UV inhibitors **OR** Galvanized steel, ASTM A 653/A 653M, G210 (Z600) coating **OR** Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating **OR** Polymer-coated galvanized steel **OR** Stainless steel, **as directed**.
    b. Strainer: Removable stainless-steel, **as directed**, strainer with openings smaller than nozzle orifices.
    c. Overflow and drain connections.
    d. Makeup water connection.
    e. Basin Sweeper Distribution Piping and Nozzles:
        1) Pipe Material: PVC, **as directed**.
        2) Nozzle Material: Plastic, **as directed**.
        3) Configure piping and nozzles to minimize sediment from collecting in the collection basin.
5. Mechanically Operated, Collection Basin Water-Level Control: Manufacturer's standard adjustable, mechanical float assembly and valve.
6. Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve:
    a. Enclosure: NEMA 250, Type 4 **OR** Type 4X, **as directed**.
    b. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to provide control of water makeup valve **OR** control of water makeup valve and low-level alarm **OR** control of water makeup valve and low- and high-level alarms **OR** control of water makeup valve, low- and high-level alarms, and output for shutoff of pump on low level, **as directed**.
    c. Electrode Probes: Stainless steel.
    d. Water Stilling Chamber: Corrosion-resistant material **OR** FRP **OR** Galvanized steel **OR** PVC pipe **OR** Stainless steel, **as directed**.
    e. Solenoid Valve: Slow closing with stainless-steel body, **as directed**, controlled and powered through level controller in response to water-level set point.
    f. Electrical Connection Requirements: 120 V, single phase, 60 Hz.
7. Electric Basin Heater:
    a. Stainless-Steel Electric Immersion Heaters: Installed in a threaded coupling on the side of the collection basin.
    b. Heater Control Panel: Mounted on the side of each cooling tower cell.
    c. Enclosure: NEMA 250, Type 3R **OR** Type 4 **OR** Type 4X, **as directed**.
    d. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor cooling tower water level and de-energize the heater when the water reaches low-level set point.
    e. Control-circuit transformer with primary and secondary side fuses.
    f. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
    g. Single-point, field-power connection to a fused disconnect switch **OR** nonfused disconnect switch **OR** circuit breaker, **as directed**, and heater branch circuiting complying with NFPA 70.

h. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures, except make connections to each electric basin heater with liquidtight conduit.
i. Hot-Water-Coil Basin Heater: Manufacturer's standard offering to provide capacity indicated.

OR

Steam-Coil Basin Heater: Manufacturer's standard offering to provide capacity indicated.

OR

Steam-Injector Basin Heater: Manufacturer's standard offering to provide capacity indicated.

8. Pressurized Water Distribution Piping: Main header and lateral branch piping designed for even distribution over heat-exchanger coil or fill throughout the flow range without the need for balancing valves and for connecting individual, removable, nonclogging spray nozzles.
   a. Pipe Material: Fiberglass **OR** PVC **OR** Galvanized steel, **as directed**.
   b. Spray Nozzle Material: Plastic **OR** Polypropylene **OR** PVC, **as directed**.
   c. Piping Supports: Corrosion-resistant hangers and supports to resist movement during operation and shipment.
9. Fill:
   a. Materials: PVC, **as directed**, with maximum flame-spread index of 5 according to ASTM E 84.
   b. Minimum Thickness: 15 mils (0.4 mm) **OR** 20 mils (0.5 mm), **as directed**, before forming.
   c. Fabrication: Fill-type sheets, fabricated, formed, and bonded together after forming into removable assemblies that are factory installed by manufacturer.
   d. Fill Material Operating Temperature: Suitable for entering-water temperatures up through 120 deg F (49 deg C).
10. Removable, **as directed**, Drift Eliminator:
    a. Material: FRP **OR** PVC, **as directed**; with maximum flame-spread index of 5 **OR** 25, **as directed**, according to ASTM E 84.
    b. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
    c. Configuration: Multipass, designed and tested to reduce water carryover to achieve performance indicated.
11. Removable, **as directed**, Air-Intake Screens: Galvanized **OR** Polymer-coated, galvanized **OR** Stainless, **as directed**,-steel wire mesh.
12. Centrifugal Fan: Double-width, double-inlet, forward-curved blades, and statically and dynamically balanced at the factory after assembly.
    a. Number of Fans: Each cooling tower cell shall have a single fan or multiple fans connected to a common shaft.
    b. Fan Wheel and Housing Materials: Galvanized steel.
    c. Fan Shaft: Steel, coated to resist corrosion.
    d. Protective Enclosure: Removable, galvanized-steel, wire-mesh screens complying with OSHA regulations.
    e. Fan Shaft Bearings: Self-aligning, grease-lubricated ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F (minus 29 and plus 149 deg C). Bearings designed for an L-10 life of 40,000 **OR** 50,000, **as directed**, hours.
    f. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.
13. Axial Fan: Balanced at the factory after assembly.
    a. Blade Material: FRP, **as directed**.
    b. Hub Material: Aluminum **OR** FRP, **as directed**.
    c. Blade Pitch: Field adjustable.
    d. Protective Enclosure: Removable, galvanized-steel, wire-mesh screens complying with OSHA regulations.
    e. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F (minus 29 and plus 149 deg C). Bearings designed for an L-10 life of 40,000 **OR** 50,000, **as directed**, hours.
    f. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.

14. Belt Drive:
    a. Service Factor: 1.5 based on motor nameplate horsepower.
    b. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.
    c. Belt: Multiple V-belt design with a matched set of cogged, **as directed**, belts.
       OR
       Belt: One-piece, multigrooved, solid-back belt.
    d. Belt Material: Oil resistant, nonstatic conducting, and constructed of neoprene polyester cord.
    e. Belt-Drive Guard: Comply with OSHA regulations.
    f. Two-Motor, Single-Fan Drive:
       1) Two single-speed motors per fan, one sized for full speed and load and the other sized for 67 percent of full-load speed.
       2) Each motor with belt drive and configured for operation when other motor fails.
       3) Controls and wiring same as two-speed, two-winding motor.
15. Direct Drive: Fan hub directly connected, and properly secured, to motor shaft.
16. Fan Motor:
    a. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Division 15 Section "Common Motor Requirements for HVAC Equipment" and not indicated below.
    b. Motor Enclosure: Totally enclosed **OR** Totally enclosed air over (TEAO) **OR** Totally enclosed fan cooled (TEFC), **as directed**, with epoxy or polyurethane finish, **as directed**.
    c. Energy Efficiency: Comply with ASHRAE/IESNA 90.1 **OR** NEMA Premium Efficient, **as directed**.
    d. Service Factor: 1.15.
    e. Insulation: Class F **OR** Class H, **as directed**.
    f. Variable-Speed Motors: Inverter-duty rated per NEMA MG-1, Section IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors."
    g. Severe-duty rating with the following features:
       1) Rotor and stator protected with corrosion-inhibiting epoxy resin.
       2) Double-shielded, vacuum-degassed bearings lubricated with premium, moisture-resistant grease suitable for temperatures between minus 20 and 300 deg F (minus 29 and 149 deg C).
       3) Internal heater automatically energized when motor is de-energized.
    h. Motor Base: Adjustable, or other suitable provision for adjusting belt tension.
17. Discharge Hoods:
    a. Hood Configuration: Tapered **OR** Straight, **as directed**; totally surrounding drift eliminators and constructed of same material as casing; and having factory-installed insulation, **as directed**, and access doors.
    b. Discharge Dampers: Positive-closure, automatic, isolation dampers with electric actuators.
       1) Provide field power and controls to open dampers when pump is energized and close dampers when pump is de-energized.
18. Capacity-Control Dampers: Galvanized-steel **OR** Stainless-steel, **as directed**, dampers, with linkages, electric operator, controller, limit switches, transformer, and weatherproof enclosure.
19. Vibration Switch: For each fan drive.
    a. Enclosure: NEMA 250, Type 4 **OR** Type 4X, **as directed**.
    b. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
    c. Provide switch with manual-reset button, **as directed**, for field connection to a BMS, **as directed**, and hardwired connection to fan motor electrical circuit.
    d. Switch shall, on sensing excessive vibration, signal an alarm through the BMS, **as directed**, and shut down the fan.
20. Controls: Comply with requirements in Division 23 Section "Instrumentation And Control For Hvac".

OR

Control Package: Factory installed and wired, and functionally tested at factory before shipment.

a. NEMA 250, Type 3R **OR** Type 4 **OR** Type 4X, **as directed**, enclosure with removable internally mount backplate.
b. Control-circuit transformer with primary and secondary side fuses.
c. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
d. Microprocessor-based controller for automatic control of fan based on cooling tower leaving-water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
e. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead stage rotation.
f. Factory-installed and -wired, collection basin electric/electronic level controller.
g. Collection basin electric/electronic level controller complying with requirements in "Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve" Paragraph.
h. Electric basin heaters with temperature control and low-water-level safety switch for each cell, complying with requirements in "Electric Basin Heater" Paragraph.
i. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
j. Controls and wiring for "two-motor, single-fan drives" shall be same as two-speed, two-winding motor.
k. Single-point, field-power connection to a fused disconnect switch **OR** nonfused disconnect switch **OR** circuit breaker, **as directed**, for each cooling tower cell, **as directed**.
    1) Branch power circuit to each motor and electric basin heater and to controls with a disconnect switch or circuit breaker, **as directed**.
    2) NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller with manual bypass and line reactors for each variable-speed motor indicated.
l. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquidtight conduit.
m. Visual indication of status and alarm with momentary test push button, **as directed**, for each motor.
n. Audible alarm and silence switch.
o. Visual indication of elapsed run time, graduated in hours for each motor.
p. Cooling tower shall have hardware to enable BMS to remotely monitor and display the following:
    1) Operational status of each motor.
    2) Position of dampers.
    3) Cooling tower leaving-fluid temperature.
    4) Fan vibration alarm.
    5) Collection basin high **OR** low **OR** high- and low, **as directed**,-water-level alarms.

21. Personnel Access Components:
a. Doors: Large enough for personnel to access cooling tower internal components from both cooling tower end walls. Doors shall be operable from both sides of the door.
b. External Ladders with Safety Cages: Aluminum, galvanized- or stainless-steel, fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.
c. External Platforms with Handrails: Aluminum, FRP, or galvanized-steel bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.
d. Handrail: Aluminum, galvanized steel, or stainless steel complete with kneerail and toeboard, around top of cooling tower. Comply with 29 CFR 1910.23.
e. Internal Platforms: Aluminum, FRP, or galvanized-steel bar grating.

1) Spanning the collection basin from one end of cooling tower to the other and positioned to form a path between the access doors. Platform shall be elevated so that all parts are above the high water level of the collection basin.
2) Elevated internal platforms with handrails accessible from fixed vertical ladders to access the fan drive assembly when out of reach from collection basin platform.

E. Open-Circuit, Induced-Draft, Counterflow Cooling Towers
1. Fabricate cooling tower mounting base with reinforcement strong enough to resist cooling tower movement during a seismic event when cooling tower is anchored to field support structure.
2. Cooling tower designed to resist wind load of 30 lbf/sq. ft. (1.44 kPa) **OR as directed**.
3. Casing and Frame:
a. Casing and Frame, **as directed**, Material: FRP with UV inhibitors **OR** Galvanized steel, ASTM A 653/A 653M, G210 (Z600) coating **OR** Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating **OR** Stainless steel, **as directed**.
b. Frame Material: FRP with UV inhibitors **OR** Galvanized steel, ASTM A 653/A 653M, G210 (Z600) coating **OR** Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating **OR** Stainless steel, **as directed**.
c. Fasteners: Galvanized **OR** Stainless, **as directed**, steel.
d. Joints and Seams: Sealed watertight.
e. Welded Connections: Continuous and watertight.
4. Collection Basin: Configure tower for installation with a field-constructed collection basin.
OR
Collection Basin:
a. Material: FRP with UV inhibitors **OR** Galvanized steel, ASTM A 653/A 653M, G210 (Z600) coating **OR** Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating **OR** Polymer-coated galvanized steel **OR** Stainless steel, **as directed**.
b. Strainer: Removable stainless-steel, **as directed**, strainer with openings smaller than nozzle orifices.
c. Overflow and drain connections.
d. Makeup water connection.
e. Outlet Connection: ASME B16.5, Class 150 flange.
f. Removable equalization flume plate between adjacent cells of multiple-cell towers.
g. Equalizer connection for field-installed equalizer piping.
h. Basin Sweeper Distribution Piping and Nozzles:
1) Pipe Material: PVC, **as directed**.
2) Nozzle Material: Plastic, **as directed**.
3) Configure piping and nozzles to minimize sediment from collecting in the collection basin.
5. Mechanically Operated, Collection Basin Water-Level Control: Manufacturer's standard adjustable, mechanical float assembly and valve.
OR
Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve:
a. Enclosure: NEMA 250, Type 4 **OR** Type 4X, **as directed**.
b. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to provide control of water makeup valve **OR** control of water makeup valve and low-level alarm **OR** control of water makeup valve and low- and high-level alarms **OR** control of water makeup valve, low- and high-level alarms, and output for shutoff of pump on low level, **as directed**.
c. Electrode Probes: Stainless steel.
d. Water Stilling Chamber: Corrosion-resistant material **OR** FRP **OR** Galvanized steel **OR** PVC pipe **OR** Stainless steel, **as directed**.
e. Solenoid Valve: Slow closing with stainless-steel body, **as directed**; controlled and powered through level controller in response to water-level set point.
f. Electrical Connection Requirements: 120 V, single phase, 60 Hz.
OR
Ultrasonic Collection Basin Water-Level Controller with Solenoid Valve:

a. Enclosure: NEMA 250, Type 4 **OR** Type 4X, **as directed**.
b. Controller: Ultrasonic level sensor/transmitter and relays factory wired to a terminal strip to control water makeup valve and signal a level alarm. Controller shall provide continuous level indication through a 4- to 20-mA signal for connection to BMS, **as directed**.
c. Water Stilling Chamber: Corrosion-resistant material **OR** FRP **OR** Galvanized steel **OR** PVC pipe **OR** Stainless steel, **as directed**.
d. Solenoid Valve: Slow closing with stainless-steel body, **as directed**; controlled and powered through level controller in response to water-level set point.
e. Electrical Connection Requirements: 120 V, single phase, 60 Hz.

6. Electric Basin Heater:
a. Stainless-Steel Electric Immersion Heaters: Installed in a threaded coupling on the side of the collection basin.
b. Heater Control Panel: Mounted on the side of each cooling tower cell.
c. Enclosure: NEMA 250, Type 3R **OR** Type 4 **OR** Type 4X, **as directed**.
d. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor cooling tower water level and de-energize the heater when the water reaches low-level set point.
e. Control-circuit transformer with primary and secondary side fuses.
f. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
g. Single-point, field-power connection to a fused disconnect switch **OR** nonfused disconnect switch **OR** circuit breaker, **as directed**, and heater branch circuiting complying with NFPA 70.
h. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures, except make connections to each electric basin heater with liquidtight conduit.

OR

Hot-Water-Coil Basin Heater: Manufacturer's standard offering to provide capacity indicated.

OR

Steam-Coil Basin Heater: Manufacturer's standard offering to provide capacity indicated.

OR

Steam-Injector Basin Heater: Manufacturer's standard offering to provide capacity indicated.

7. Pressurized Water Distribution Piping: Main header and lateral branch piping designed for even distribution over heat-exchanger coil or fill throughout the flow range without the need for balancing valves and for connecting individual, removable, nonclogging spray nozzles.
a. Pipe Material: Fiberglass **OR** PVC **OR** Galvanized steel, **as directed**.
b. Spray Nozzle Material: Plastic **OR** Polypropylene **OR** PVC, **as directed**.
c. Piping Supports: Corrosion-resistant hangers and supports to resist movement during operation and shipment.

8. Fill:
a. Materials: CPVC **OR** PVC, **as directed**, resistant to rot, decay, and biological attack; with maximum flame-spread index of 5 **OR** 25, **as directed**, according to ASTM E 84.
b. Minimum Thickness: 15 mils (0.4 mm) **OR** 20 mils (0.5 mm), **as directed**, before forming.
c. Fabrication: Fill-type sheets, fabricated, formed, and bonded together after forming into removable assemblies that are factory installed by manufacturer.
d. Fill Material Operating Temperature: Suitable for entering-water temperatures up through 120 deg F (49 deg C).

9. Removable, **as directed**, Drift Eliminator:
a. Material: FRP **OR** PVC, **as directed**; resistant to rot, decay, and biological attack; with maximum flame-spread index of 5 **OR** 25, **as directed**, according to ASTM E 84.
b. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
c. Configuration: Multipass, designed and tested to reduce water carryover to achieve performance indicated.

10. Air-Intake Louvers:
a. Material: FRP **OR** PVC **OR** Matching casing, **as directed**.
b. UV Treatment: Inhibitors to protect against damage caused by UV radiation.

c. Louver Blades: Arranged to uniformly direct air into cooling tower, to minimize air resistance, and to prevent water from splashing out of tower during all modes of operation including operation with fans off.

11. Removable, **as directed**, Air-Intake Screens: Galvanized **OR** Polymer-coated, galvanized **OR** Stainless, **as directed**,-steel wire mesh.
12. Axial Fan: Balanced at the factory after assembly.
    a. Blade Material: Aluminum **OR** FRP **OR** Galvanized steel, **as directed**.
    b. Hub Material: Aluminum **OR** FRP **OR** Galvanized steel, **as directed**.
    c. Blade Pitch: Field adjustable.
    d. Protective Enclosure: Removable, galvanized-steel, wire-mesh screens, complying with OSHA regulations.
    e. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F (minus 29 and plus 149 deg C). Bearings designed for an L-10 life of 40,000 **OR** 50,000, **as directed**, hours.
    f. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.
13. Belt Drive:
    a. Service Factor: 1.5 based on motor nameplate horsepower.
    b. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.
    c. Belt: Multiple V-belt design with a matched set of cogged, **as directed**, belts.
    OR
    Belt: One-piece, multigrooved, solid-back belt.
    d. Belt Material: Oil resistant, nonstatic conducting, and constructed of neoprene polyester cord.
    e. Belt-Drive Guard: Comply with OSHA regulations.
14. Direct Drive: Fan hub directly connected, and properly secured, to motor shaft.
15. Gear Drive: Right angle, reduced speed, and designed for cooling tower applications according to CTI STD 111. Motor and gear drive shall be aligned before shipment.
    a. Gear Drive and Coupling Service Factor: 2.0 based on motor nameplate horsepower.
    b. Housing: Cast iron, with epoxy or polyurethane finish, beveled high-strength steel gears continuously bathed in oil, and with lubrication to other internal parts at all operating speeds.
    c. Mounting: Directly mounted to fan hub and connected to motor so motor shaft is in horizontal position.
    d. Operation: Able to operate both forward and in reverse.
    e. Drive-to-Motor Connection: Close coupled to motor using a flexible coupling **OR** Connected to motor located outside of cooling tower casing by a full-floating drive shaft, **as directed**.
    f. Drive Shaft Material: Corrosion resistant **OR** Stainless steel, **as directed**, and fitted with flexible couplings on both ends. Provide exposed shaft and couplings with guards according to OSHA regulations.
    g. Extend oil fill, drain, and vent to outside of cooling tower casing using galvanized-steel piping. Provide installation with oil-level sight glass.
16. Fan Motor:
    a. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Division 15 Section "Common Motor Requirements for HVAC Equipment" and not indicated below.
    b. Motor Enclosure: Totally enclosed **OR** Totally enclosed air over (TEAO) **OR** Totally enclosed fan cooled (TEFC), **as directed**, with epoxy or polyurethane finish, **as directed**.
    c. Energy Efficiency: Comply with ASHRAE/IESNA 90.1 **OR** NEMA Premium Efficient, **as directed**.
    d. Service Factor: 1.15.
    e. Insulation: Class F **OR** Class H, **as directed**.

f. Variable-Speed Motors: Inverter-duty rated per NEMA MG-1, Section IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors."
g. Motor Location: Mounted outside of cooling tower casing and cooling tower discharge airstream.
h. Severe-duty rating with the following features:
   1) Rotor and stator protected with corrosion-inhibiting epoxy resin.
   2) Double-shielded, vacuum-degassed bearings lubricated with premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F (minus 29 and plus 149 deg C).
   3) Internal heater automatically energized when motor is de-energized.
i. Motor Base: Adjustable, or other suitable provision for adjusting belt tension.

17. Fan Discharge Stack: Material shall match casing, manufacturer's standard **OR** velocity recovery, **as directed**, design.
   a. Stack Extension: Fabricated to extend above fan deck unless otherwise indicated.
   b. Stack Termination: Wire-mesh, galvanized-steel screens; complying with OSHA regulations.
18. Vibration Switch: For each fan drive.
   a. Enclosure: NEMA 250, Type 4 **OR** Type 4X, **as directed**.
   b. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
   c. Provide switch with manual-reset button, **as directed**, for field connection to a BMS, **as directed**, and hardwired connection to fan motor electrical circuit.
   d. Switch shall, on sensing excessive vibration, signal an alarm through the BMS, **as directed**, and shut down the fan.
19. Gear-Drive, Oil-Level Switch: Low-oil-level warning switch for connection to a BMS, **as directed**.
   a. Switch shall, on reaching a low-oil-level set point recommended by cooling tower manufacturer, signal an alarm through the BMS, **as directed**.
20. Controls: Comply with requirements in Division 23 Section "Instrumentation And Control For Hvac".
   OR
   Control Package: Factory installed and wired, and functionally tested at factory before shipment.
   a. NEMA 250, Type 3R **OR** Type 4 **OR** Type 4X, **as directed**, enclosure with removable internally mount backplate.
   b. Control-circuit transformer with primary and secondary side fuses.
   c. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
   d. Microprocessor-based controller for automatic control of fan based on cooling tower leaving-water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
   e. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead stage rotation.
   f. Collection basin level controller complying with requirements in "Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve" **OR** "Ultrasonic Collection Basin Water-Level Controller with Solenoid Valve", **as directed**, Paragraph.
   g. Electric basin heaters with temperature control and low-water-level safety switch for each cell, complying with requirements in "Electric Basin Heater" Paragraph.
   h. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
   i. Oil-level switch for each fan with a gear drive, complying with requirement in "Gear-Drive, Oil-Level Switch" Paragraph.
   j. Single-point, field-power connection to a fused disconnect switch **OR** nonfused disconnect switch **OR** circuit breaker, **as directed**, for each cooling tower cell, **as directed**.
      1) Branch power circuit to each motor and electric basin heater and to controls with a disconnect switch or circuit breaker, **as directed**.

2) NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller with manual bypass and line reactors for each variable-speed motor indicated.

k. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquidtight conduit.

l. Visual indication of status and alarm with momentary test push button, **as directed**, for each motor.

m. Audible alarm and silence switch.

n. Visual indication of elapsed run time, graduated in hours for each motor.

o. Cooling tower shall have hardware to enable BMS to remotely monitor and display the following:

1) Operational status of each motor.
2) Position of dampers.
3) Cooling tower leaving-fluid temperature.
4) Fan vibration alarm.
5) Oil-level alarm.
6) Collection basin high **OR** low **OR** high- and low, **as directed**,-water-level alarms.

21. Personnel Access Components:

a. Doors: Large enough for personnel to access cooling tower internal components from both cooling tower end walls. Doors shall be operable from both sides of the door.

b. External Ladders with Safety Cages: Aluminum, galvanized- or stainless-steel, fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.

c. External Platforms with Handrails: Aluminum, FRP, or galvanized-steel bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.

d. Handrail: Aluminum, galvanized steel, or stainless steel complete with kneerail and toeboard, around top of cooling tower. Comply with 29 CFR 1910.23.

e. Internal Platforms: Aluminum, FRP, or galvanized-steel bar grating.

1) Spanning the collection basin from one end of cooling tower to the other and positioned to form a path between the access doors. Platform shall be elevated so that all parts are above the high water level of the collection basin.
2) Elevated internal platforms with handrails accessible from fixed vertical ladders to access the fan drive assembly when out of reach from collection basin platform.

F. Open-Circuit, Induced-Draft, Crossflow Cooling Towers

1. Fabricate cooling tower mounting base with reinforcement strong enough to resist cooling tower movement during a seismic event when cooling tower is anchored to field support structure.

2. Cooling tower designed to resist wind load of 30 lbf/sq. ft. (1.44 kPa), **as directed**.

3. Casing and Frame:

a. Casing and Frame, **as directed**, Material: FRP with UV inhibitors **OR** Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating **OR** Polymer-coated galvanized steel **OR** Stainless steel, **as directed**.

b. Frame Material: FRP with UV inhibitors **OR** Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating **OR** Polymer-coated galvanized steel **OR** Stainless steel, **as directed**.

c. Fasteners: Galvanized **OR** Stainless, **as directed**, steel.

d. Joints and Seams: Sealed watertight.

e. Welded Connections: Continuous and watertight.

4. Collection Basin: Configure tower for installation with a field-constructed collection basin.

OR

Collection Basin:

a. Material: FRP with UV inhibitors **OR** Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating **OR** Polymer-coated galvanized steel **OR** Stainless steel, **as directed.**

b. Removable stainless-steel, **as directed**, strainer with openings smaller than nozzle orifices.

c. Overflow and drain connections.

d. Makeup water connection.
e. Outlet Connection: ASME B16.5, Class 150 flange.
f. Removable equalization flume plate between adjacent cells of multiple-cell towers.
g. Equalizer connection for field-installed equalizer piping.
h. Basin Sweeper Distribution Piping and Nozzles:
    1) Pipe Material: PVC, **as directed**.
    2) Nozzle Material: Plastic, **as directed**.
    3) Configure piping and nozzles to minimize sediment from collecting in the collection basin.

5. Mechanically Operated, Collection Basin Water-Level Control: Manufacturer's standard adjustable, mechanical float assembly and valve.

   OR

   Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve:
   a. Enclosures: NEMA 250, Type 4 **OR** Type 4X, **as directed**.
   b. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to provide control of water makeup valve **OR** control of water makeup valve and low-level alarm **OR** control of water makeup valve and low- and high-level alarms **OR** control of water makeup valve, low- and high-level alarms, and output for shutoff of pump on low level, **as directed**.
   c. Electrode Probes: Stainless steel.
   d. Water Stilling Chamber: Corrosion-resistant material **OR** FRP **OR** Galvanized steel **OR** PVC pipe **OR** Stainless steel, **as directed**.
   e. Solenoid Valve: Slow closing with stainless-steel body, **as directed**, controlled and powered through level controller in response to water-level set point.
   f. Electrical Connection Requirements: 120 V, single phase, 60 Hz.

   OR

   Ultrasonic Collection Basin Water-Level Controller with Solenoid Valve:
   a. Enclosure: NEMA 250, Type 4 **OR** Type 4X, **as directed**.
   b. Controller: Ultrasonic level sensor/transmitter and relays factory wired to a terminal strip to control water makeup valve and signal a level alarm. Controller shall provide continuous level indication through a 4- to 20-mA signal for connection to BMS, **as directed**.
   c. Water Stilling Chamber: Corrosion-resistant material **OR** FRP **OR** Galvanized steel **OR** PVC pipe **OR** Stainless steel, **as directed**.
   d. Solenoid Valve: Slow closing with stainless-steel body, **as directed**; controlled and powered through level controller in response to water-level set point.
   e. Electrical Connection Requirements: 120 V, single phase, 60 Hz.

6. Electric Basin Heater:
   a. Stainless-Steel Electric Immersion Heaters: Installed in a threaded coupling on the side of the collection basin.
   b. Heater Control Panel: Mounted on the side of each cooling tower cell.
   c. Enclosure: NEMA 250, Type 3R **OR** Type 4 **OR** Type 4X, **as directed**.
   d. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor cooling tower water level and de-energize the heater when the water reaches low-level set point.
   e. Control-circuit transformer with primary and secondary side fuses.
   f. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
   g. Single-point, field-power connection to a fused disconnect switch **OR** nonfused disconnect switch **OR** circuit breaker, **as directed**, and heater branch circuiting complying with NFPA 70.
   h. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures, except make connections to each electric basin heater with liquidtight conduit.

   OR

   Hot-Water-Coil Basin Heater: Manufacturer's standard offering to provide capacity indicated.

   OR

   Steam-Coil Basin Heater: Manufacturer's standard offering to provide capacity indicated.

OR
Steam-Injector Basin Heater: Manufacturer's standard offering to provide capacity indicated.

7. Gravity Water Distribution Basin: Nonpressurized design with head of water level in basin adequate to overcome spray nozzle losses and designed to evenly distribute water over fill throughout the flow range indicated.
   a. Material: FRP with UV inhibitors **OR** Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating **OR** Polymer-coated galvanized steel **OR** Stainless steel, **as directed**.
   b. Location: Over each bank of fill with easily replaceable plastic, **as directed**, spray nozzles mounted in bottom of basin.
   c. Inlet Connection: ASME B16.5, Class 150 flange.
   d. Joints and Seams: Sealed watertight.
   e. Partitioning Dams: Same material as basin to distribute water over the fill to minimize icing while operating throughout the flow range indicated.
   f. Removable Panels: Same material as basin to completely cover top of basin. Secure panels to basin with removable corrosion-resistant **OR** stainless-steel, **as directed**, hardware.
   g. Valves: Manufacturer's standard valve installed at each inlet connection and arranged to balance or shut off flow to each gravity distribution basin.
   h. Single-Inlet, Field Pipe Connection: Galvanized-steel **OR** PVC, **as directed**, pipe arranged to provide balancing of flow within cooling tower cell without the need for additional balancing valves. Pipe each cooling tower cell internally to a single, field connection suitable for mating to ASME B16.5, Class 150 flange and located on the bottom **OR** side, **as directed**, unless otherwise indicated.
8. Fill:
   a. Materials: PVC, with maximum flame-spread index of 5 **OR** 25, **as directed**, according to ASTM E 84.
   b. Minimum Thickness: 15 mils (0.4 mm) **OR** 20 mils (0.5 mm), **as directed**, before forming.
   c. Fabrication: Fill-type sheets, fabricated, formed, and bonded together after forming into removable assemblies that are factory installed by manufacturer.
   d. Fill Material Operating Temperature: Suitable for entering-water temperatures up through 120 deg F (49 deg C).
9. Drift Eliminator:
   a. Material: FRP **OR** PVC, **as directed**; with maximum flame-spread index of 5 **OR** 25, **as directed**, according to ASTM E 84.
   b. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
   c. Configuration: Multipass, designed and tested to reduce water carryover to achieve performance indicated.
   d. Location: Integral to **OR** Separate and removable from, **as directed**, fill.
10. Air-Intake Louvers:
   a. Material: FRP **OR** PVC **OR** Matching casing, **as directed**.
   b. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
   c. Louver Blades: Arranged to uniformly direct air into cooling tower, to minimize air resistance, and to prevent water from splashing out of tower during all modes of operation including operation with fans off.
   d. Location: Integral to **OR** Separate from, **as directed**, fill.
11. Removable, **as directed**, Air-Intake Screens: Galvanized **OR** Polymer-coated, galvanized **OR** Stainless, **as directed**,-steel wire mesh.
12. Axial Fan: Balanced at the factory after assembly.
   a. Blade Material: Aluminum **OR** FRP **OR** Galvanized steel, **as directed**.
   b. Hub Material: Aluminum **OR** FRP **OR** Galvanized steel, **as directed**.
   c. Blade Pitch: Field adjustable.
   d. Protective Enclosure: Removable, galvanized-steel, wire-mesh screens complying with OSHA regulations.
   e. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus

300 deg F (minus 29 and plus 149 deg C). Bearings designed for an L-10 life of 40,000 **OR** 50,000, **as directed**, hours.
f. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.
13. Belt Drive:
a. Service Factor: 1.5 based on motor nameplate horsepower.
b. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.
c. Belt: Multiple V-belt design with a matched set of cogged, **as directed**, belts.
OR
Belt: One-piece, multigrooved, solid-back belt.
d. Belt Material: Oil resistant, nonstatic conducting, and constructed of neoprene polyester cord.
e. Belt-Drive Guard: Comply with OSHA regulations.
f. Two-Motor, Single-Fan Drive:
1) Two single-speed motors per fan, one sized for full speed and load and the other sized for 67 percent of full-load speed.
2) Each motor with belt drive and configured for operation when other motor fails.
3) Controls and wiring same as two-speed, two-winding motor.
14. Gear Drive: Right angle, reduced speed, and designed for cooling tower applications according to CTI STD 111. Motor and gear drive shall be aligned before shipment.
a. Gear Drive and Coupling Service Factor: 2.0 based on motor nameplate horsepower.
b. Housing: Cast iron, with epoxy or polyurethane finish, beveled high-strength steel gears continuously bathed in oil, and with lubrication to other internal parts at all operating speeds.
c. Mounting: Directly mounted to fan hub and connected to motor so motor shaft is in horizontal position.
d. Operation: Able to operate both forward and in reverse.
e. Drive-to-Motor Connection: Close coupled to motor using a flexible coupling **OR** Connected to motor located outside of cooling tower casing by a full-floating drive shaft, **as directed**.
f. Drive Shaft Material: Corrosion resistant **OR** Stainless steel, **as directed**, and fitted with flexible couplings on both ends. Provide exposed shaft and couplings with guards according to OSHA regulations.
g. Extend oil fill, drain, and vent to outside of cooling tower casing using galvanized-steel piping. Provide installation with oil-level sight glass.
15. Fan Motor:
a. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Division 23 Section "Common Motor Requirements For Hvac Equipment" and not indicated below.
b. Motor Enclosure: Totally enclosed **OR** Totally enclosed air over (TEAO) **OR** Totally enclosed fan cooled (TEFC), **as directed**, with epoxy or polyurethane finish, **as directed**.
c. Energy Efficiency: Comply with ASHRAE/IESNA 90.1 **OR** NEMA Premium Efficient, **as directed**.
d. Service Factor: 1.15.
e. Insulation: Class F **OR** Class H, **as directed**.
f. Variable-Speed Motors: Inverter-duty rated per NEMA MG-1, Section IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors."
g. Motor Location: Mounted outside of cooling tower casing and cooling tower discharge airstream.
h. Severe-duty rating with the following features:
1) Rotor and stator protected with corrosion-inhibiting epoxy resin.
2) Double-shielded, vacuum-degassed bearings lubricated with premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F (minus 29 and plus 149 deg C).

3) Internal heater automatically energized when motor is de-energized.
i. Motor Base: Adjustable, or other suitable provision for adjusting belt tension.
16. Fan Discharge Stack: Material shall match casing, manufacturer's standard **OR** velocity recovery, **as directed**, design.
a. Stack Extension: Fabricated to extend above fan deck unless otherwise indicated.
b. Stack Termination: Wire-mesh, galvanized-steel screens; complying with OSHA regulations.
17. Vibration Switch: For each fan drive.
a. Enclosure: NEMA 250, Type 4 **OR** Type 4X, **as directed**.
b. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
c. Provide switch with manual-reset button, **as directed**, for field connection to a BMS, **as directed**, and hardwired connection to fan motor electrical circuit.
d. Switch shall, on sensing excessive vibration, signal an alarm through the BMS, **as directed**, and shut down the fan.
18. Gear-Drive, Oil-Level Switch: Low-oil-level warning switch for connection to a BMS, **as directed**.
a. Switch shall, on reaching a low-oil-level set point recommended by cooling tower manufacturer, signal an alarm through the BMS, **as directed**.
19. Capacity-Control Dampers: Galvanized-steel **OR** Stainless-steel, **as directed**, dampers, with linkages, electric operator, controller, limit switches, transformer, and weatherproof enclosure.
20. Controls: Comply with requirements in Division 23 Section "Instrumentation And Control For Hvac".
OR
Control Package: Factory installed and wired, and functionally tested at factory before shipment.
a. NEMA 250, Type 3R **OR** Type 4 **OR** Type 4X, **as directed**, enclosure with removable internally mount backplate.
b. Control-circuit transformer with primary and secondary side fuses.
c. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
d. Microprocessor-based controller for automatic control of fan based on cooling tower leaving-water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
e. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead stage rotation.
f. Collection basin level controller complying with requirements in "Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve" **OR** "Ultrasonic Collection Basin Water-Level Controller with Solenoid Valve", **as directed**, Paragraph.
g. Electric basin heaters with temperature control and low-water-level safety switch for each cell, complying with requirements in "Electric Basin Heater" Paragraph.
h. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
i. Oil-level switch for each fan with a gear drive, complying with requirement in "Gear-Drive, Oil-Level Switch" Paragraph.
j. Single-point, field-power connection to a fused disconnect switch **OR** nonfused disconnect switch **OR** circuit breaker, **as directed**, for each cooling tower cell, **as directed**.
1) Branch power circuit to each motor and electric basin heater and to controls with a disconnect switch or circuit breaker, **as directed**.
2) NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller with manual bypass and line reactors for each variable-speed motor indicated.
k. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquidtight conduit.
l. Visual indication of status and alarm with momentary test push button, **as directed**, for each motor.
m. Audible alarm and silence switch.
n. Visual indication of elapsed run time, graduated in hours for each motor.

o. Cooling tower shall have hardware to enable BMS to remotely monitor and display the following:
   1) Operational status of each motor.
   2) Position of dampers.
   3) Cooling tower leaving-fluid temperature.
   4) Fan vibration alarm.
   5) Oil-level alarm.
   6) Collection basin high **OR** low **OR** high- and low, **as directed**,-water-level alarms.

21. Personnel Access Components:
   a. Doors: Large enough for personnel to access cooling tower internal components from both cooling tower end walls. Doors shall be operable from both sides of the door.
   b. External Ladders with Safety Cages: Aluminum, galvanized- or stainless-steel, fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.
   c. External Platforms with Handrails: Aluminum, FRP, or galvanized-steel bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.
   d. Handrail: Aluminum, galvanized steel, or stainless steel complete with kneerail and toeboard, around top of cooling tower. Comply with 29 CFR 1910.23.
   e. Internal Platforms: Aluminum, FRP, or galvanized-steel bar grating.
      1) Spanning the collection basin from one end of cooling tower to the other and positioned to form a path between the access doors. Platform shall be elevated so that all parts are above the high water level of the collection basin.
      2) Elevated internal platforms with handrails accessible from fixed vertical ladders to access the fan drive assembly when out of reach from collection basin platform.

G. Source Quality Control
   1. Verification of Performance: Test and certify cooling tower performance according to CTI STD 201, "Certification Standard for Commercial Water-Cooling Towers Thermal Performance."
   2. Factory pressure test heat exchangers after fabrication and prove to be free of leaks.

1.3 EXECUTION

A. Examination
   1. Before cooling tower installation, examine roughing-in for tower support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting tower performance, maintenance, and operation.
      a. Cooling tower locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
   2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation
   1. Install cooling towers on support structure indicated.
   2. Equipment Mounting: Install cooling tower on concrete bases using elastomeric pads **OR** elastomeric mounts **OR** restrained spring isolators, **as directed**. Comply with requirements in Division 03 Section "Cast-in-place Concrete". Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
      a. Minimum Deflection: 1/2 inch (13 mm) **OR** 1 inch (25 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**.
      b. Provide galvanized **OR** stainless, **as directed**,-steel plate to equally distribute weight over elastomeric pad.

c. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
d. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
e. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3. Equipment Mounting: Install cooling tower using elastomeric pads **OR** elastomeric mounts **OR** restrained spring isolators, **as directed**. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
   a. Minimum Deflection: 1/2 inch (13 mm) **OR** 1 inch (25 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**.
   b. Provide galvanized **OR** stainless, **as directed**,-steel plate to equally distribute weight over elastomeric pad.
4. Equipment Mounting: Install cooling tower on concrete bases. Comply with requirements in Division 03 Section "Cast-in-place Concrete".
   a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Maintain manufacturer's recommended clearances for service and maintenance.
7. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

C. Connections
1. Piping installation requirements are specified in other Division 21. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to cooling towers to allow service and maintenance.
3. Install flexible pipe connectors at pipe connections of cooling towers mounted on vibration isolators.
4. Provide drain piping with valve at cooling tower drain connections and at low points in piping.
5. Connect cooling tower overflows and drains, and piping drains to sanitary sewage system.
6. Domestic Water Piping: Comply with applicable requirements in Division 22 Section "Domestic Water Piping". Connect to water-level control with shutoff valve and union, flange, or mechanical coupling at each connection.
7. Supply and Return Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping". Connect to entering cooling tower connections with shutoff valve, balancing valve, thermometer, plugged tee with pressure gage, flow meter, **as directed**, and drain connection with valve. Connect to leaving cooling tower connection with shutoff valve. Make connections to cooling tower with a union **OR** flange **OR** mechanical coupling, **as directed**.
8. Equalizer Piping: Piping requirements to match supply and return piping. Connect an equalizer pipe, full size of cooling tower connection, between tower cells. Connect to cooling tower with shutoff valve.
9. Hot-Water Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping". Connect to supply and return basin heater with shutoff valve, strainer, control valve, and union or flange on supply connection and union or flange and balancing valve on return connection. Provide supply and return piping with pressure gage and thermometer.
10. Steam and Condensate Piping: Comply with applicable requirements in Division 23 Section "Steam And Condensate Heating Piping". Connect steam supply to basin heater with shutoff valve, strainer, control valve, and union or flange and condensate piping with union or flange, shutoff valve, strainer, and an appropriate steam trap.

D. Field Quality Control

1. Perform tests and inspections.
2. Tests and Inspections: Comply with ASME PTC 23, "ASME Performance Test Codes - Code on Atmospheric Water Cooling Equipment **OR** CTI ATC 105, "Acceptance Test Code for Water Cooling Towers", **as directed**.
3. Cooling towers will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

E. Startup Service
1. Perform startup service.
2. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.
3. Obtain performance data from manufacturer.
   a. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
      1) Clean entire unit including basins.
      2) Verify that accessories are properly installed.
      3) Verify clearances for airflow and for cooling tower servicing.
      4) Check for vibration isolation and structural support.
      5) Lubricate bearings.
      6) Verify fan rotation for correct direction and for vibration or binding and correct problems.
      7) Adjust belts to proper alignment and tension.
      8) Verify proper oil level in gear-drive housing. Fill with oil to proper level.
      9) Operate variable-speed fans through entire operating range and check for harmonic vibration imbalance. Set motor controller to skip speeds resulting in abnormal vibration.
      10) Check vibration switch setting. Verify operation.
      11) Verify water level in tower basin. Fill to proper startup level. Check makeup water-level control and valve.
      12) Verify operation of basin heater and control.
      13) Verify that cooling tower air discharge is not recirculating air into tower or HVAC air intakes. Recommend corrective action.
      14) Replace defective and malfunctioning units.
4. Start cooling tower and associated water pumps. Follow manufacturer's written starting procedures.
5. Prepare a written startup report that records the results of tests and inspections.

F. Adjusting
1. Set and balance water flow to each tower inlet.
2. Adjust water-level control for proper operating level.

G. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain cooling towers.

END OF SECTION 23 65 13 16

Task	Specification	Specification Description
23 65 14 13	23 65 13 16	Cooling Towers
23 65 14 14	23 65 13 16	Cooling Towers
23 65 14 16	23 65 13 16	Cooling Towers
23 65 43 00	01 22 16 00	No Specification Required
23 65 43 00	23 65 13 16	Cooling Towers
23 71 13 23	21 05 23 00	Piped Utilities Basic Materials And Methods

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SECTION 23 72 13 00 - AIR-TO-AIR ENERGY RECOVERY UNITS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for air-to-air energy recovery equipment. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Heat wheels.
b. Heat-pipe heat exchangers.
c. Fixed-plate sensible heat exchangers.
d. Fixed-plate total heat exchangers.
e. Packaged energy recovery units.

C. Performance Requirements
1. Delegated Design: Design vibration isolation and seismic-restraint details, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Seismic Performance: Air-to-air energy recovery equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

D. Submittals
1. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
2. LEED Submittals:
a. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.
b. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
3. Shop Drawings: For air-to-air energy recovery equipment. Include plans, elevations, sections, details, and attachments to other work.
a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
b. Wiring Diagrams: For power, signal, and control wiring.
4. Delegated-Design Submittal: For air-to-air energy recovery equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
a. Detail fabrication and assembly of air-to-air energy recovery equipment.
b. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
c. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Coordination Drawings: Plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
a. Suspended ceiling components.

b. Structural members to which equipment or suspension systems will be attached.

6. Seismic Qualification Certificates: For air-to-air energy recovery equipment, accessories, and components, from manufacturer.
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
7. Field quality-control reports.
8. Operation and Maintenance Data: For air-to-air energy recovery equipment to include in maintenance manuals.

E. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. ARI Compliance:
   a. Capacity ratings for air-to-air energy recovery equipment shall comply with ARI 1060, "Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment."
   b. Capacity ratings for air coils shall comply with ARI 410, "Forced-Circulation Air- Cooling and Air-Heating Coils."
3. ASHRAE Compliance:
   a. Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
   b. Capacity ratings for air-to-air energy recovery equipment shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat Exchangers."
4. NRCA Compliance: Roof curbs for roof-mounted equipment shall be constructed according to recommendations of NRCA.
5. UL Compliance:
   a. Packaged heat recovery ventilators shall comply with requirements in UL 1812, "Ducted Heat Recovery Ventilators"; or UL 1815, "Nonducted Heat Recovery Ventilators."
   b. Electric coils shall comply with requirements in UL 1995, "Heating and Cooling Equipment."

F. Coordination
1. Coordinate layout and installation of air-to-air energy recovery equipment and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
2. Coordinate sizes and locations of concrete bases with actual equipment provided.
3. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of air-to-air energy recovery equipment that fail in materials or workmanship within specified warranty period.
   a. Warranty Period for Packaged Energy Recovery Units: Two years.
   b. Warranty Period for Fixed-Plate Total Heat Exchangers: 10 years.

1.2 PRODUCTS

A. Heat Wheels
1. Casing:
   a. Steel with standard factory-painted finish.

b. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg (0.05 percent at 400-Pa and 0.20 percent at 1000-Pa) differential pressure.
c. Casing seals on periphery of rotor and on duct divider and purge section.
d. Support vertical rotors on grease-lubricated ball bearings having extended grease fittings or permanently lubricated bearings. Support horizontal rotors on tapered roller bearing.

2. Rotor: Aluminum segmented wheel strengthened with radial spokes, with nontoxic, noncorrosive, silica-gel desiccant coating, **as directed**.
   a. Maximum Solid Size for Media to Pass: 500 **OR** 800 **OR** 1200, **as directed**, micrometer.
3. Rotor: Glass-fiber **OR** Polymer, **as directed**, segmented wheel strengthened with radial spokes impregnated with nonmigrating, water-selective, molecular-sieve desiccant coating.
   a. Maximum Solid Size for Media to Pass: 800 **OR** 1200, **as directed**, micrometer.
4. Drive: Fractional horsepower motor and gear reducer, with speed changed by variable frequency controller, **as directed**, and self-adjusting multilink belt around outside of rotor.
   a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
   b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
5. Controls:
   a. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
   b. Variable frequency controller, factory mounted and wired, permitting input of field connected 4-20 mA or 1-10-V control signal.
      OR
      Variable frequency controller, factory mounted and wired, with exhaust-air sensor to vary rotor speed and maintain exhaust temperature above freezing.
      OR
      Variable frequency controller, factory mounted and wired, with exhaust- and outdoor-air sensors, automatic changeover thermostat and set-point adjuster, to vary rotor speed and maintain exhaust temperature above freezing and, **as directed**, air differential temperature above set point. Rotor speed shall increase to maximum when exhaust-air temperature is less than outdoor-air temperature.
   c. Pilot-Light Indicator: Display rotor rotation and speed.
   d. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.
6. Disposable Panel Filters:
   a. Comply with NFPA 90A.
   b. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
   c. Factory-fabricated, viscous-coated, flat-panel type.
   d. Thickness: 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**.
   e. Minimum Arrestance: 80, according to ASHRAE 52.1.
   f. Minimum Merv: 5, according to ASHRAE 52.2.
   g. Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent, **as directed**.
   h. Frame: Galvanized steel with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles.
7. Extended-Surface, Disposable Panel Filters:
   a. Comply with NFPA 90A.
   b. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
   c. Factory-fabricated, dry, extended-surface type.
   d. Thickness: 1 inch (25 mm) **OR** 2 inches (50 mm) **OR** 4 inches (100 mm), **as directed**.
   e. Minimum Arrestance: 90, according to ASHRAE 52.1.
   f. Minimum Merv: 7, according to ASHRAE 52.2.

g. Media: Fibrous material formed into deep-V-shaped pleats with antimicrobial agent, **as directed**, and held by self-supporting wire grid.
h. Media-Grid Frame: Nonflammable cardboard **OR** Galvanized steel **OR** Fire-retardant, 3/4-inch (20-mm) particleboard with gaskets, **as directed**.
i. Mounting Frames: Welded, galvanized steel with gaskets and fasteners, suitable for bolting together into built-up filter banks.

8. Extended-Surface, Nonsupported-Media Filters:
   a. Comply with NFPA 90A.
   b. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
   c. Factory-fabricated, dry, extended-surface, self-supporting type.
   d. Minimum Arrestance: 95, according to ASHRAE 52.1.
   e. Minimum Merv: 13, according to ASHRAE 52.2.
   f. Media: Fibrous material constructed so individual pleats are maintained in tapered form by flexible internal supports under rated-airflow conditions and antimicrobial agent, **as directed**.
   g. Filter-Media Frame: Galvanized steel **OR** Hard polyurethane foam, **as directed**.
   h. Mounting Frames: Welded, galvanized steel with gaskets and fasteners, suitable for bolting together into built-up filter banks with space for prefilter, **as directed**.

B. Heat-Pipe Heat Exchangers
1. Casing: Galvanized-steel flanged casing, with airtight partition between airstreams.
2. Refrigerant: ASHRAE 15, Group 1..
3. Tubes: 5/8-inch- (16-mm-) **OR** 1-inch- (25-mm-), **as directed**, diameter, aluminum **OR** copper, **as directed**.
4. Fins: Aluminum **OR** Integral aluminum **OR** Copper, **as directed**.
   a. Fin Spacing: 0.125 inch (3.18 mm) **OR** 0.091 inch (2.31 mm) **OR** 0.071 inch (1.80 mm) **OR** 0.067 inch (1.70 mm) **OR** 0.056 inch (1.42 mm) **OR** 0.0075 inch (0.19 mm), **as directed**.
   b. Fin and Tube Joint: Mechanical bond **OR** Silver brazed, **as directed**.
5. Coating: Thermoplastic vinyl **OR** Epoxy **OR** Synthetic resin **OR** Phenolic **OR** Polytetrafluoroethylene **OR** Vinyl ester, **as directed**; apply to supply and exhaust.
6. Control: Integral plenum containing heat-pipe coil and gasketed, face-and-bypass, opposed-blade dampers with rods extended outside casing for damper operator and linkage.
   OR
   Control: Pivot center of bottom of heat-pipe coil on shaft and bearings to tilt coil. Include tilt controls with electronic controller, electric actuator and linkage, thermostats, sensors, and polyester fabric with PVC-coated flexible connector for automatic supply temperature regulation, summer/winter changeover, and frost protection.

C. Fixed-Plate Sensible Heat Exchangers
1. Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
2. Casing: Aluminum **OR** Galvanized steel **OR** Enameled steel, with galvanized-steel liner **OR** Enameled steel, **as directed**, with duct collars.
3. Casing Insulation: 1/2-inch- (13-mm-) thick, foil-faced glass fiber **OR** 1-inch- (25-mm-) thick, foil-faced glass fiber **OR** 1 inch (25 mm) thick, ASTM C 1071 with coated surface **OR** 1 inch (25 mm) thick, fiber free, **as directed**.
4. Drain Pan: Same material as casing, with drain connections on exhaust and supply side **OR** Molded ABS covering bottom of case, with drain connections on exhaust and supply side, ,**as directed**.
   a. Comply with requirements in ASHRAE 62.1.
5. Plates: Evenly spaced and sealed and arranged for counter airflow.
   a. Plate Material: Embossed aluminum **OR** Stainless steel **OR** Polypropylene copolymer (high-density plastic), **as directed**.
   b. Plate Coating: Epoxy **OR** Air-dried phenolic, **as directed**.

6. Bypass Plenum: Within casing, with gasketed face-and-bypass dampers having operating rods extended outside casing.
7. Water Wash: Automatic system, with spray manifold to individual spray tubes or traversing type with stainless-steel-screw operating mechanism and electric motor drive; activated by time clock, with detergent injection, **as directed**.
8. Disposable Panel Filters:
   a. Comply with NFPA 90A.
   b. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
   c. Factory-fabricated, viscous-coated, flat-panel type.
   d. Thickness: 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**.
   e. Minimum Arrestance: 80, according to ASHRAE 52.1.
   f. Minimum Merv: 5, according to ASHRAE 52.2.
   g. Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent, **as directed**.
   h. Frame: Galvanized steel with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles.
9. Extended-Surface, Disposable Panel Filters:
   a. Comply with NFPA 90A.
   b. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
   c. Factory-fabricated, dry, extended-surface type.
   d. Thickness: 1 inch (25 mm) **OR** 2 inches (50 mm) **OR** 4 inches (100 mm), **as directed**.
   e. Minimum Arrestance: 90, according to ASHRAE 52.1.
   f. Minimum Merv: 7, according to ASHRAE 52.2.
   g. Media: Fibrous material formed into deep-V-shaped pleats with antimicrobial agent, **as directed**, and held by self-supporting wire grid.
   h. Media-Grid Frame: Nonflammable cardboard **OR** Galvanized steel **OR** Fire-retardant, 3/4-inch (20-mm) particleboard with gaskets, **as directed**.
   i. Mounting Frames: Welded, galvanized steel with gaskets and fasteners, suitable for bolting together into built-up filter banks.
10. Extended-Surface, Nonsupported-Media Filters:
   a. Comply with NFPA 90A.
   b. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
   c. Factory-fabricated, dry, extended-surface, self-supporting type.
   d. Minimum Arrestance: 95, according to ASHRAE 52.1.
   e. Minimum Merv: 13, according to ASHRAE 52.2.
   f. Media: Fibrous material constructed so individual pleats are maintained in tapered form by flexible internal supports under rated-airflow conditions and antimicrobial agent, **as directed**.
   g. Filter-Media Frame: Galvanized steel **OR** Hard polyurethane foam, **as directed**.
   h. Mounting Frames: Welded, galvanized steel with gaskets and fasteners, suitable for bolting together into built-up filter banks with space for prefilter, **as directed**.

D. Fixed-Plate Total Heat Exchangers
1. Casing: Galvanized steel.
2. Plates: Evenly spaced and sealed and arranged for counter airflow.
   a. Plate Material: Chemically treated paper with selective hydroscopicity and moisture permeability, and gas barrier properties.
3. Bypass Plenum: Within casing, with gasketed face-and-bypass dampers having operating rods extended outside casing.
4. Disposable Panel Filters:
   a. Comply with NFPA 90A.
   b. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.

c. Factory-fabricated, viscous-coated, flat-panel type.
d. Thickness: 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**.
e. Minimum Arrestance: 80, according to ASHRAE 52.1.
f. Minimum Merv: 5, according to ASHRAE 52.2.
g. Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent, **as directed**.
h. Frame: Galvanized steel with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles.

5. Extended-Surface, Disposable Panel Filters:
   a. Comply with NFPA 90A.
   b. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
   c. Factory-fabricated, dry, extended-surface type.
   d. Thickness: 1 inch (25 mm) **OR** 2 inches (50 mm) **OR** 4 inches (100 mm), **as directed**.
   e. Minimum Arrestance: 90, according to ASHRAE 52.1.
   f. Minimum Merv: 7, according to ASHRAE 52.2.
   g. Media: Fibrous material formed into deep-V-shaped pleats with antimicrobial agent, **as directed**, and held by self-supporting wire grid.
   h. Media-Grid Frame: Nonflammable cardboard **OR** Galvanized steel **OR** Fire-retardant, 3/4-inch (20-mm) particleboard with gaskets, **as directed**.
   i. Mounting Frames: Welded, galvanized steel with gaskets and fasteners, suitable for bolting together into built-up filter banks.

E. Packaged Energy Recovery Units
1. Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
2. Housing: Manufacturer's standard construction with corrosion-protection coating and exterior finish, gasketed and calked weathertight, **as directed**, hinged access doors **OR** removable panels, **as directed**, with neoprene gaskets for inspection and access to internal parts, minimum 1-inch- (25-mm-) **OR** 2-inch- (50-mm-), **as directed**, thick thermal insulation, knockouts for electrical and piping connections, exterior drain connection, and lifting lugs.
   a. Inlet: Weatherproof hood **OR** louver, **as directed**, with damper for exhaust and supply.
      1) Exhaust: Gravity backdraft damper **OR** Spring-return, two-position, motor-operated damper, **as directed**.
      2) Supply: Gravity backdraft damper **OR** Spring-return, two-position, motor-operated damper, **as directed**.
   b. Roof Curb: Refer to Division 07 Section "Roof Accessories" for roof curbs and equipment supports.
3. Heat Recovery Device: Heat wheel **OR** Heat-pipe heat exchanger **OR** Fixed-plate heat exchanger, **as directed**.
4. Supply and Exhaust Fans: Forward-curved, centrifugal **OR** Propeller **OR** Backward-inclined, SWSI centrifugal **OR** Backward-inclined, plenum centrifugal, **as directed**, fan with spring isolators **OR** restrained, spring isolators **OR** spring hangers **OR** spring hangers with vertical-limit stops, **as directed**, and insulated, **as directed**, flexible duct connections.
   a. Motor and Drive: Direct driven **OR** Belt driven with adjustable sheaves, motor mounted on adjustable base **OR** Drive type indicated on Drawings, **as directed**.
   b. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
   c. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   d. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 22.
   e. Spring isolators on each fan having 1-inch (25-mm) static deflection.
5. Disposable Panel Filters:
   a. Comply with NFPA 90A.

b. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
c. Factory-fabricated, viscous-coated, flat-panel type.
d. Thickness: 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**.
e. Minimum Arrestance: 80, according to ASHRAE 52.1.
f. Minimum Merv: 5, according to ASHRAE 52.2.
g. Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent, **as directed**.
h. Frame: Galvanized steel with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles.

6. Extended-Surface, Disposable Panel Filters:
a. Comply with NFPA 90A.
b. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
c. Factory-fabricated, dry, extended-surface type.
d. Thickness: 1 inch (25 mm) **OR** 2 inches (50 mm) **OR** 4 inches (100 mm), **as directed**.
e. Minimum Arrestance: 90, according to ASHRAE 52.1.
f. Minimum Merv: 7, according to ASHRAE 52.2.
g. Media: Fibrous material formed into deep-V-shaped pleats with antimicrobial agent, **as directed**, and held by self-supporting wire grid.
h. Media-Grid Frame: Nonflammable cardboard **OR** Galvanized steel **OR** Fire-retardant, 3/4-inch (20-mm) particleboard with gaskets, **as directed**.
i. Mounting Frames: Welded, galvanized steel with gaskets and fasteners, suitable for bolting together into built-up filter banks.

7. Extended-Surface, Nonsupported-Media Filters:
a. Comply with NFPA 90A.
b. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
c. Factory-fabricated, dry, extended-surface, self-supporting type.
d. Minimum Arrestance: 95, according to ASHRAE 52.1.
e. Minimum Merv: 13, according to ASHRAE 52.2.
f. Media: Fibrous material constructed so individual pleats are maintained in tapered form by flexible internal supports under rated-airflow conditions and antimicrobial agent, **as directed**.
g. Filter-Media Frame: Galvanized steel **OR** Hard polyurethane foam, **as directed**.
h. Mounting Frames: Welded, galvanized steel with gaskets and fasteners, suitable for bolting together into built-up filter banks with space for prefilter, **as directed**.

8. Cooling Coils: Rated according to ARI 410 and ASHRAE 33, and bearing the ARI label, **as directed**.
a. Access: Fabricate coil section to allow removal and replacement of coil and to allow in-place access for service and maintenance of coil(s).
b. Casing: Manufacturer's standard material **OR** Aluminum **OR** Galvanized steel **OR** Stainless steel, **as directed**.
c. Tubes: Copper.
d. Tube Headers: Manufacturer's standard material **OR** Copper **OR** Carbon steel **OR** Red brass, **as directed**.
e. Fins: Aluminum **OR** Copper, **as directed**.
f. Fin and Tube Joint: Mechanical bond.
g. Leak Test: Coils shall be leak tested with air under water.
h. Refrigerant Coils:
1) Capacity Reduction: Circuit coils for face **OR** row **OR** interleaved, **as directed**, control.
2) Suction and Distributor: Seamless copper tube with brazed joints.
i. Coating: Phenolic epoxy corrosion-protection coating after assembly.

9. Cooling-Coil Condensate Drain Pans:

a. Fabricated from galvanized steel **OR** stainless-steel, **as directed**, sheet and sloped in multiple planes to collect and drain condensate from cooling coils, coil piping connections, coil headers, and return bends.
b. Complying with requirements in ASHRAE 62.1.
c. Drain Connections: At low point of pan with minimum <**Insert size**> threaded nipple.
d. Units with stacked coils shall have an intermediate drain pan to collect and drain condensate from top coil.

10. Hot-Water Coils: Rated according to ARI 410 and ASHRAE 33, and bearing the ARI label, **as directed**.
    a. Access: Fabricate coil section to allow removal and replacement of coil and to allow in-place access for service and maintenance of coil(s).
    b. Casing: Manufacturer's standard material **OR** Aluminum **OR** Galvanized steel **OR** Stainless steel, **as directed**.
    c. Tubes: Copper.
    d. Tube Headers: Manufacturer's standard material **OR** Copper **OR** Carbon steel **OR** Red brass, **as directed**.
    e. Fins: Aluminum **OR** Copper, **as directed**.
    f. Fin and Tube Joint: Mechanical bond.
    g. Leak Test: Coils shall be leak tested with air under water.
    h. Coating: Phenolic epoxy corrosion-protection coating after assembly.
11. Nonfreeze Type, **as directed**, Steam Coils: Rated according to ARI 410 and ASHRAE 33, and bearing the ARI label, **as directed**.
    a. Access: Fabricate coil section to allow removal and replacement of coil and to allow in-place access for service and maintenance of coil(s).
    b. Casing: Manufacturer's standard material **OR** Aluminum **OR** Galvanized steel **OR** Stainless steel, **as directed**.
    c. Tubes: Copper.
    d. Tube Headers: Manufacturer's standard material **OR** Copper **OR** Carbon steel **OR** Red brass, **as directed**.
    e. Fins: Aluminum **OR** Copper, **as directed**.
    f. Fin and Tube Joint: Mechanical bond.
    g. Leak Test: Coils shall be leak tested with air under water.
    h. Coating: Phenolic epoxy corrosion-protection coating after assembly.
12. Electrical Coils, Controls, and Accessories: Comply with UL 1995.
    a. Casing Assembly: Slip-in **OR** Flanged, **as directed**, type with galvanized-steel frame.
    b. Access: Fabricate coil section to allow removal and replacement of coil and to allow in-place access for service.
    c. Sheathed Heating Elements: Coiled resistance wire of 80 percent nickel and 20 percent chromium surrounded by compacted magnesium-oxide powder in tubular-steel sheath; with spiral-wound, copper-plated, steel fins continuously brazed to sheath.
       OR
       Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
    d. Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.
    e. Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
    f. Control Panel: Unit **OR** Remote, **as directed**, mounted with disconnecting means and overcurrent protection.
       1) Magnetic **OR** Mercury, **as directed**, contactor.
       2) Solid-state, stepless pulse controller.
       3) Toggle switches, one per step.
       4) Step controller.
       5) Time-delay relay.

6) Pilot lights, one per step.
7) Airflow proving switch.

13. Indirect-Fired Gas Furnaces:
 a. Description: Factory assembled, piped, and wired; complying with NFPA 54, "National Fuel Gas Code," and ANSI Z21.47, "Gas-Fired Central Furnaces."
  1) AGA Approval: Furnace shall bear label of AGA.
 b. Burners: Aluminized steel with stainless-steel inserts **OR** Stainless steel, **as directed**.
  1) Ignition: Electronically controlled electric spark with flame sensor.
  2) High-Altitude Model **OR** Kit, **as directed**: For Project at elevations more than 2000 feet (610 m) above sea level.
 c. Heat-Exchanger Drain Pan: Stainless steel.
 d. Venting: Gravity vented.
  OR
  Power Vent: Integral, motorized centrifugal fan interlocked with gas valve.
 e. Gas Control Valve: Single stage **OR** Two stage **OR** Electronic modulating, **as directed**.
 f. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff. Control devices and control sequence shall comply with requirements of FMG **OR** IRI, **as directed**.
 g. Access: Fabricate section to allow removal and replacement of furnace and to allow in-place access for service.
14. Piping and Wiring: Fabricate units with space within housing for piping and electrical conduits. Wire motors and controls so only external connections are required during installation.
 a. Indoor Enclosure: NEMA 250, Type 12 enclosure contains relays, starters, and terminal strip.
 b. Outdoor Enclosure: NEMA 250, Type 3R enclosure contains relays, starters, and terminal strip.
 c. Include fused **OR** nonfused, **as directed**, disconnect switches.
 d. Variable-speed controller to vary fan capacity from 100 to approximately 50 percent.
15. Accessories:
 a. Roof Curb: Steel **OR** Galvanized steel **OR** Aluminum, **as directed**, with gasketing, and factory-installed wood nailer; complying with NRCA standards; minimum height of 14 inches (350 mm) **OR** 24 inches (600 mm), **as directed**.
 b. Intake weather hood with 2-inch- (50-mm-) thick filters.
 c. Louvered intake weather hood with 2-inch- (50-mm-) thick filters in V-bank configuration.
 d. Exhaust weather hood with birdscreen.
 e. Low-Leakage, Isolation Dampers: Double-skin, airfoil-blade, galvanized-steel **OR** aluminum **OR** extruded-aluminum, **as directed**, dampers with compressible jamb seals and extruded-vinyl blade edge seals, in opposed-blade **OR** parallel-blade, **as directed**, arrangement with steel **OR** cadmium-plated steel, **as directed**, operating rods rotating in stainless-steel sleeve **OR** sintered bronze or nylon, **as directed**, bearings mounted in a single galvanized-steel **OR** aluminum **OR** extruded-aluminum, **as directed**, frame, with operating rods connected with a common linkage, and electric damper operator factory wired. Leakage rate shall not exceed 5 cfm/sq. ft. (0.22 L/s per sq. m) at 1-inch wg (250 Pa) and 9 cfm/sq. ft. (0.4 L/s per sq. m) at 4-inch wg (1.0 MPa).
  OR
  Isolation Dampers: Opposed-blade, galvanized-steel **OR** aluminum **OR** extruded-aluminum, **as directed**, dampers with steel **OR** cadmium-plated steel, **as directed**, operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel **OR** aluminum **OR** extruded-aluminum, **as directed**, frame with operating rods connected with a common linkage, and electric damper operator factory wired. Blades shall have gaskets and edge seals, and shall be mechanically fastened to operating rod.
 f. Duct flanges.
 g. Rubber-in-shear isolators for ceiling-mounted units.
 h. Hinged access doors with quarter-turn latches.
 i. Drain pans for condensate removal complying with ASHRAE 62.1, **as directed**.

j. Automatic, in-place, spray-wash system.
k. Weatherproofing for tilt-control system.

F. Controls
1. Time Clock: Solid-state, programmable, microprocessor-based unit for wall mounting **OR** mounting in outdoor NEMA 250, Type 3R enclosure, **as directed**, with up to eight on/off cycles per day and battery backup protection of program settings against power failure to energize unit.
2. Motion (Occupancy) Sensor: Passive infrared sensor for wall **OR** ceiling, **as directed**, mounting with adjustable time-off delay of up to 30 minutes to energize unit.
3. Carbon Monoxide Sensor: Adjustable control from 600 to 2000 ppm for wall **OR** duct, **as directed**, mounting with digital display and computer/building management system interface to energize unit.
4. Humidistat: Adjustable, wall-mounted instrument to energize unit when space relative humidity exceeds 50 percent.
5. Chilled-Water-Cooling-Coils Controls:
    a. For chilled-water cooling coils with discharge-air temperature control: Factory-mounted sensor in unit discharge **OR** Remote-mounted sensor for field installation in supply-air duct, **as directed**, with sensor adjustment located in control panel to modulate factory-mounted **OR** furnished, **as directed**, coil-control valve to maintain temperature.
    b. For chilled-water cooling coils with remote temperature control: Wall-mounted, space-temperature sensor with temperature adjustment **OR** unit-mounted temperature adjustment **OR** adjustment on remote-control panel, **as directed**, to modulate factory-mounted **OR** furnished, **as directed**, coil-control valve to maintain temperature.
6. Refrigerant-Cooling-Coils Controls:
    a. For refrigerant cooling coils with discharge-air temperature control: Factory-mounted sensor in unit discharge **OR** Remote-mounted sensor for field installation in supply-air duct, **as directed**, with sensor adjustment located in control panel to control remote condensing unit to maintain temperature.
    b. For refrigerant cooling coils coils with remote temperature control: Wall-mounted, space-temperature sensor with temperature adjustment **OR** unit-mounted temperature adjustment **OR** adjustment on remote-control panel, **as directed**, controls remote condensing unit to maintain temperature.
    c. Cooling Capacity Control: On/off **OR** Multiple steps, **as directed**.
7. Hot-Water- and Steam-Coils Controls:
    a. For hot-water or steam coils with discharge-air temperature control: Factory-mounted sensor in unit discharge **OR** Remote-mounted sensor for field installation in supply-air duct, **as directed**, with sensor adjustment located in control panel to modulate factory-mounted **OR** furnished, **as directed**, coil-control valve to maintain temperature.
    b. For hot-water or steam coils with remote temperature control: Wall-mounted, space-temperature sensor with temperature adjustment **OR** unit-mounted temperature adjustment **OR** adjustment on remote-control panel, **as directed**, to modulate factory-mounted **OR** furnished, **as directed**, coil-control valve to maintain temperature.
8. Electric-Coils Controls:
    a. For electric coils with discharge-air temperature control: Factory-mounted sensor in unit discharge **OR** Remote-mounted sensor for field installation in supply-air duct, **as directed**, with sensor adjustment located in control panel to control electric coil to maintain temperature.
    b. For electric coils with remote temperature control: Wall-mounted, space-temperature sensor with temperature adjustment **OR** unit-mounted temperature adjustment **OR** adjustment on remote-control panel, **as directed**, to control electric coil to maintain temperature.
    c. Coil Controls: On/off **OR** Multiple steps **OR** Modulating SCR, **as directed**.
9. Indirect-Fired-Gas-Furnaces Controls:
    a. For indirect-fired gas furnaces with discharge-air temperature control: Factory-mounted sensor in unit discharge **OR** Remote-mounted sensor for field installation in supply-air duct,

as directed, with sensor adjustment located in control panel to control gas furnace burner to maintain temperature.

b. For indirect-fired gas furnaces with remote temperature control: Wall-mounted, space-temperature sensor with temperature adjustment **OR** unit-mounted temperature adjustment **OR** adjustment on remote-control panel, **as directed**, to control gas furnace burner to maintain temperature.

c. Burner Controls: On/off **OR** Multiple steps **OR** Modulating, **as directed**.

1.3 EXECUTION

A. Examination

1. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
2. Examine casing insulation materials and filter media before air-to-air energy recovery equipment installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
3. Examine roughing-in for electrical services to verify actual locations of connections before installation.
4. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation

1. Install heat wheels so supply and exhaust airstreams flow in opposite directions and rotation is away from exhaust side to purge section to supply side.
   a. Install access doors in both supply and exhaust ducts, both upstream and downstream, for access to wheel surfaces, drive motor, and seals.
   b. Install removable panels or access doors between supply and exhaust ducts on building side for bypass during startup.
   c. Access doors and panels are specified in Division 23 Section "Air Duct Accessories".
2. Install heat-pipe heat exchangers so supply and exhaust airstreams flow in opposite directions. Install flexible connectors on ducts to enable tilt control; make connections airtight and with slack to compensate for full tilt.
   a. Install heat exchanger with clearance space for heat-pipe coil removal.
   b. Install duct access doors in both supply and exhaust ducts, both upstream and downstream, for access to both sides of heat-pipe coil. Access doors and panels are specified in Division 23 Section "Air Duct Accessories".
   c. Install tilt-control components, including electronic controller, electric actuator and linkage, thermostats, and sensors.
3. Install fixed-plate heat exchangers so supply and exhaust airstreams flow in opposite directions.
   a. Install duct access doors in both supply and exhaust ducts, both upstream and downstream, for access to heat exchanger. Access doors and panels are specified in Division 23 Section "Air Duct Accessories".
4. Install gas-fired furnaces according to NFPA 54, "National Fuel Gas Code."
5. Install floor-mounted units on 4-inch- (100-mm-) high concrete base designed to withstand, without damage to equipment, seismic force required by code, **as directed**.
6. Equipment Mounting (for equipment supported on a concrete base on grade without vibration isolation devices): Install air-to-air energy recovery equipment on concrete bases. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-place Concrete".
   a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Roof Curb: Install on roof structure or concrete base, level and secure, according to The NRCA "Roofing and Waterproofing Manual - Volume 4: Construction Details - Low-Slope Roofing,"

Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts" **OR** ARI Guideline B, **as directed**. Install air-to-air energy recovery equipment on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 07 Section "Roof Accessories". Secure air-to-air energy recovery equipment to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

8. Unit Support: Install unit level on structural curbs **OR** pilings, **as directed**. Coordinate wall penetrations and flashing with wall construction. Secure air-to-air energy recovery equipment to structural support with anchor bolts.
9. Install wind and seismic restraints according to manufacturers' written instructions. Wind and seismically restrained vibration isolation roof-curb rails are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
10. Suspended Units: Suspend and brace, **as directed**, units from structural-steel support frame using threaded steel rods and spring hangers. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
11. Install units with clearances for service and maintenance.
12. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.
13. Pipe drains from units and drain pans to nearest floor drain; use ASTM B 88, Type L (ASTM B 88M, Type B), drawn-temper copper water tubing with soldered joints **OR** ASTM D 1785, Schedule 40 PVC pipe and solvent-welded fittings, **as directed**, same size as condensate drain connection.
    a. Requirements for Low-Emitting Materials:
        1) Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
        2) Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Connections
1. Comply with requirements for piping specified in Division 23 Section "Hydronic Piping". Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to unit to allow service and maintenance.
3. Connect piping to units mounted on vibration isolators with flexible connectors.
4. Connect cooling condensate drain pans with air seal trap at connection to drain pan and install cleanouts at changes in pipe direction.
5. Chilled and Hot Water Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping". Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.
6. Steam and Condensate Piping: Comply with applicable requirements in Division 23 Section "Steam And Condensate Heating Piping". Install shutoff valve at steam coil connections, float and thermostatic trap, and union or flange at each coil return connection.
7. Refrigerant Piping: Comply with applicable requirements in Division 23 Section "Refrigerant Piping".
8. Gas Piping: Comply with requirements in Division 23 Section(s) "Facility Natural-gas Piping" OR "Facility Liquefied-petroleum Gas Piping", **as directed**. Connect gas piping with shutoff valve and union and with sufficient clearance for burner removal and service. Make connection with AGA-approved flexible connectors.
9. Comply with requirements for ductwork specified in Division 23 Section "Metal Ducts".
10. Indirect-Fired Furnace Vent Connections: Comply with Division 23 Section "Breechings, Chimneys, And Stacks".
11. Electrical Connections: Comply with applicable requirements in Division 22.
    a. Install electrical devices furnished with units but not factory mounted.

D. Field Quality Control
1. Perform tests and inspections.

2. Tests and Inspections:
    a. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
    b. Adjust seals and purge.
    c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
    d. Set initial temperature and humidity set points.
    e. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
3. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

E. Demonstration
    1. Train Owner's maintenance personnel to adjust, operate, and maintain air-to-air energy recovery units.

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Task	Specification	Specification Description
23 72 16 00	23 72 13 00	Air-To-Air Energy Recovery Units

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SECTION 23 73 13 00 - MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for modular indoor central-station air-handling units. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Constant-air-volume, single-zone air-handling units.
b. Constant-air-volume, multizone air-handling units.
c. Constant-air-volume, dual-duct air-handling units.
d. Variable-air-volume, single-zone air-handling units.
e. Variable-air-volume, dual-duct air-handling units.

C. Performance Requirements
1. Delegated Design: Design vibration isolation and seismic-restraint details, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 133 percent of internal static pressures indicated, without panel joints exceeding a deflection of L/200 **OR** L/100, **as directed**, where "L" is the unsupported span length within completed casings.
3. Seismic Performance: Air-handling units shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

D. Submittals
1. Product Data: For each air-handling unit indicated.
a. Unit dimensions and weight.
b. Cabinet material, metal thickness, finishes, insulation, and accessories.
c. Fans:
1) Certified fan-performance curves with system operating conditions indicated.
2) Certified fan-sound power ratings.
3) Fan construction and accessories.
4) Motor ratings, electrical characteristics, and motor accessories.
d. Certified coil-performance ratings with system operating conditions indicated.
e. Dampers, including housings, linkages, and operators.
f. Filters with performance characteristics.
2. LEED Submittal:
a. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
3. Delegated-Design Submittal: For vibration isolation and seismic restraints, **as directed**, indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
a. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
b. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints, **as directed**, and for designing vibration isolation bases.

4. Seismic Qualification Certificates: For air-handling units, accessories, and components, from manufacturer.
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
5. Source quality-control reports.
6. Field quality-control reports.
7. Operation and maintenance data

E. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
3. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.
4. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
5. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
6. Comply with NFPA 70.

1.2 PRODUCTS

A. Unit Casings
1. General Fabrication Requirements for Casings:
   a. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
   b. Casing Joints: Sheet metal screws or pop rivets.
   c. Sealing: Seal all joints with water-resistant sealant.
   d. Factory Finish for Steel and Galvanized-Steel Casings: Apply manufacturer's standard primer immediately after cleaning and pretreating.
      OR
      Factory Finish for Steel and Galvanized-Steel Casings: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on enamel finish, consisting of prime coat and thermosetting topcoat.
      OR
      Casing Coating: Thermoplastic vinyl **OR** Epoxy **OR** Zinc **OR** Synthetic resin **OR** Phenolic **OR** Polytetrafluoroethylene **OR** Vinyl ester **OR** Hot-dip galvanized **OR** Powder-baked enamel, **as directed**.
   e. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
2. Casing Insulation and Adhesive:
   a. Materials: ASTM C 1071, Type I **OR** Type II, **as directed**.
   b. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from, and including, the cooling-coil section.
      1) Liner Adhesive: Comply with ASTM C 916, Type I.
      2) Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.

3) Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service-air velocity.

OR

Location and Application: Encased between outside and inside casing.

3. Inspection and Access Panels and Access Doors:
   a. Panel and Door Fabrication: Formed and reinforced, single- or double-wall and insulated panels of same materials and thicknesses as casing.
   b. Inspection and Access Panels:
      1) Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
      2) Gasket: Neoprene, applied around entire perimeters of panel frames.
      3) Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.
   c. Access Doors:
      1) Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
      2) Gasket: Neoprene, applied around entire perimeters of panel frames.
      3) Fabricate windows in fan section doors of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.
      4) Size: At least 18 inches (450 mm) **OR** 24 inches (600 mm), **as directed**, wide by full height of unit casing up to a maximum height of 60 inches (1500 mm) **OR** 72 inches (1800 mm), **as directed**.
   d. Locations and Applications:
      1) Fan Section: Inspection and access panels **OR** Doors **OR** Doors and inspection and access panels, **as directed**.
      2) Access Section: Doors.
      3) Coil Section: Inspection and access panel.
      4) Damper Section: Inspection and access panels **OR** Doors, **as directed**.
      5) Filter Section: Inspection and access panels **OR** Doors, **as directed**, large enough to allow periodic removal and installation of filters.
      6) Mixing Section: Doors.
      7) Humidifier Section: Doors.
   e. Service Light: 100-W vaporproof fixture with switched junction box located outside **OR** inside, **as directed**, adjacent to door.
      1) Locations: Each section accessed with door **OR** Fan section, **as directed**.
4. Condensate Drain Pans:
   a. Fabricated with one **OR** two, **as directed**, percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
      1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
      2) Depth: A minimum of 2 inches (50 mm) deep.
   b. Formed sections **OR** Integral part of floor plating, **as directed**.
   c. Single-wall, galvanized-steel **OR** stainless-steel, **as directed**, sheet.

      OR

      Double-wall, galvanized-steel **OR** stainless-steel, **as directed**, sheet with space between walls filled with foam insulation and moisture-tight seal.
   d. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end **OR** both ends, **as directed**, of pan.
      1) Minimum Connection Size: NPS 1 (DN 25) **OR** NPS 2 (DN 50), **as directed**.
   e. Pan-Top Surface Coating: Asphaltic waterproofing compound, for galvanized-steel drain pans.

f. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

5. Service Platform: Steel **OR** Galvanized steel **OR** Aluminum, **as directed**, 42 inches (1070 mm) wide running entire length of unit and located on service access side, with angle side rails, 4-inch (100-mm) kick plates, and expanded metal floor. Provide platform with a fixed ladder that extends from the top of the side rail to the floor.
6. Air-Handling-Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.
   a. Seismic Fabrication Requirements: Fabricate mounting base and attachment to air-handling unit sections, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment" when air-handling unit frame is anchored to building structure.

B. Fan, Drive, And Motor Section

1. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
   a. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.
      1) Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
      2) Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
2. Centrifugal Fan Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
   a. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
   b. Horizontal-Flanged, Split Housing: Bolted construction.
   c. Housing for Supply Fan: Attach housing to fan-section casing with metal-edged flexible duct connector.
   d. Flexible Connector: Factory fabricated with a fabric strip 3-1/2 inches (89 mm) **OR** 5-3/4 inches (146 mm), **as directed**, wide attached to 2 strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized-steel sheet or 0.032-inch- (0.8-mm-) thick aluminum sheets; select metal compatible with casing.
      1) Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.
         a) Fabric Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
         b) Fabric Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
         c) Fabric Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
3. Plenum Fan Housings: Steel frame and panel; fabricated without fan scroll and volute housing.
4. Backward-Inclined, Centrifugal Fan Wheels: Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
   OR
   Forward-Curved, Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.
   OR
   Airfoil, Centrifugal Fan Wheels: Smooth-curved inlet flange, backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
   OR

Axial Fans: Fan wheel and housing, straightening-vane section, factory-mounted motor with belt drive or direct drive, an inlet cone section, and accessories.

a. Variable-Pitch Fans: Internally mounted pneumatic **OR** electric **OR** electronic, **as directed**, actuator, externally mounted positive positioner, and mechanical-blade-pitch indicator.

b. Housings: Steel **OR** Galvanized steel **OR** Aluminum, **as directed**.

1) Inlet and Outlet Connections: Flanges.

2) Guide Vane Section: Integral guide vanes downstream from fan wheel designed to straighten airflow.

5. Fan Shaft Bearings:

a. Prelubricated and Sealed, Ball Bearings: Self-aligning, pillow-block type with a rated life of 50,000 **OR** 120,000, **as directed**, hours according to ABMA 9.

OR

Grease-Lubricated, Tapered-Roller Bearings: Self-aligning, pillow-block type with double-locking collars and 2-piece, cast-iron housing with grease lines extended to outside unit, **as directed**, and a rated life of 50,000 **OR** 120,000, **as directed**, hours according to ABMA 11.

OR

Grease-Lubricated Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing with grease lines extended to outside unit, **as directed**.

6. Belt Drives: Factory mounted, with adjustable alignment and belt tensioning, and with 1.5 **OR** 1.4 **OR** 1.3 **OR** 1.2, **as directed**, service factor based on fan motor.

a. Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.

b. Motor Pulleys: Adjustable pitch for use with 5-hp motors and smaller; fixed pitch for use with motors larger than 5 hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.

c. Belts: Oil resistant, nonsparking, and nonstatic; in matched sets for multiple-belt drives.

d. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.1046-inch- (2.7-mm-) thick, 3/4-inch (20-mm) diamond-mesh wire screen, welded to steel angle frame; prime coated.

7. Variable-Inlet Vanes: Steel, with blades supported at both ends with permanently lubricated bearings. Variable mechanism terminating in single lever for connection to control actuator with connecting shaft for second set of variable inlet vanes on double-width fans.

OR

Discharge Dampers: Heavy-duty steel assembly with channel frame and sealed ball bearings, and opposed **OR** parallel, **as directed**, blades constructed of two plates formed around and welded to shaft, with blades linked out of air stream to single control lever.

8. Internal Vibration Isolation and Seismic Control, **as directed**: Fans shall be factory mounted with manufacturer's standard restrained, **as directed**, vibration isolation mounting devices having a minimum static deflection of 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**.

a. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment" when fan-mounting frame and air-handling-unit mounting frame are anchored to building structure.

9. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".

a. Enclosure Type: Totally enclosed, fan cooled.

b. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.

c. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

d. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 21.
e. Mount unit-mounted disconnect switches on exterior **OR** interior, **as directed**, of unit.

10. Variable Frequency Controllers:
    a. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.
    b. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range **OR** 66 Hz, with torque constant as speed changes **OR** 120 Hz, with horsepower constant throughout speed range, **as directed**.
    c. Unit Operating Requirements:
        1) Input ac voltage tolerance of 208 V, plus or minus 5 **OR** 380 to 500 V, plus or minus 10 **OR** 525 to 575 V, plus or minus 10, **as directed**, percent.
        2) Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
        3) Minimum Efficiency: 96 percent at 60 Hz, full load.
        4) Minimum Displacement Primary-Side Power Factor: 96 percent.
        5) Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
        6) Starting Torque: 100 percent of rated torque or as indicated.
        7) Speed Regulation: Plus or minus 1 percent.
    d. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
    e. Internal Adjustability Capabilities:
        1) Minimum Speed: 5 to 25 percent of maximum rpm.
        2) Maximum Speed: 80 to 100 percent of maximum rpm.
        3) Acceleration: 2 to a minimum of 22 seconds.
        4) Deceleration: 2 to a minimum of 22 seconds.
        5) Current Limit: 50 to a minimum of 110 percent of maximum rating.
    f. Self-Protection and Reliability Features:
        1) Input transient protection by means of surge suppressors.
        2) Undervoltage and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
        3) Adjustable motor overload relays capable of NEMA ICS 2, Class 10 **OR** Class 20 **OR** Class 30, **as directed**, performance.
        4) Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
        5) Instantaneous line-to-line and line-to-ground overcurrent trips.
        6) Loss-of-phase protection.
        7) Reverse-phase protection.
        8) Short-circuit protection.
        9) Motor overtemperature fault.
    g. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.
    h. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.
    i. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
    j. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
    k. Door-mounted LED status lights shall indicate the following conditions:
        1) Power on.

2) Run.
3) Overvoltage.
4) Line fault.
5) Overcurrent.
6) External fault.

l. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual-speed-control potentiometer and elapsed time meter.

m. Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
1) Output frequency (Hertz).
2) Motor speed (rpm).
3) Motor status (running, stop, fault).
4) Motor current (amperes).
5) Motor torque (percent).
6) Fault or alarming status (code).
7) Proportional-integral-derivative (PID) feedback signal (percent).
8) DC-link voltage (volts direct current).
9) Set-point frequency (Hertz).
10) Motor output voltage (volts).

n. Control Signal Interface:
1) Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
2) Remote signal inputs capable of accepting any of the following speed-setting input signals from the control system:
a) 0 to 10-V dc.
b) 0-20 or 4-20 mA.
c) Potentiometer using up/down digital inputs.
d) Fixed frequencies using digital inputs.
e) RS485.
f) Keypad display for local hand operation.
3) Output signal interface with a minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
a) Output frequency (Hertz).
b) Output current (load).
c) DC-link voltage (volts direct current).
d) Motor torque (percent).
e) Motor speed (rpm).
f) Set-point frequency (Hertz).
4) Remote indication interface with a minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
a) Motor running.
b) Set-point speed reached.
c) Fault and warning indication (overtemperature or overcurrent).
d) High- or low-speed limits reached.

o. Communications: RS485 interface allows VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.

p. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker **OR** NEMA AB 1, molded-case switch **OR** NEMA KS 1, nonfusible switch **OR** NEMA KS 1, fusible switch, **as directed**, with lockable handle.

q. Accessories:
1) Devices shall be factory installed in controller enclosure unless otherwise indicated.
2) Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
3) Standard Displays:

a) Output frequency (Hertz).
b) Set-point frequency (Hertz).
c) Motor current (amperes).
d) DC-link voltage (volts direct current).
e) Motor torque (percent).
f) Motor speed (rpm).
g) Motor output voltage (volts).

C. Coil Section
1. General Requirements for Coil Section:
a. Comply with ARI 410.
b. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
c. For multizone units, provide air deflectors and air baffles to balance airflow across coils.
d. Coils shall not act as structural component of unit.
e. Seismic Fabrication Requirements: Fabricate coil section, internal mounting frame and attachment to coils, and other coil section components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment" when coil-mounting frame and air-handling-unit mounting frame are anchored to building structure.
2. Electrical Heating Coils, Controls, and Accessories: Comply with UL 1995.
a. Casing Assembly: Slip-in **OR** Flanged, **as directed**, type with galvanized-steel frame.
b. Sheathed Heating Elements: Coiled resistance wire of 80 percent nickel and 20 percent chromium surrounded by compacted magnesium-oxide powder in tubular-steel sheath; with spiral-wound, copper-plated, steel fins continuously brazed to sheath.
OR
Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
c. Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.
d. Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
e. Control Panel: Unit **OR** Remote, **as directed**, mounted with disconnecting means and overcurrent protection.
1) Magnetic **OR** Mercury, **as directed**, contactor.
2) Solid-state, stepless pulse controller.
3) Toggle switches, one per step.
4) Step controller.
5) Time-delay relay.
6) Pilot lights, one per step.
7) Airflow proving switch.

D. Air Filtration Section
1. General Requirements for Air Filtration Section:
a. Comply with NFPA 90A.
b. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
c. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
2. Disposable Panel Filters:
a. Factory-fabricated, viscous-coated, flat-panel type.
b. Thickness: 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**.
c. Dust-Holding Capacity: as directed by the Owner.

d. Initial Resistance: as directed by the Owner.
e. Recommended Final Resistance: as directed by the Owner.
f. Arrestance (ASHRAE 52.1): 80.
g. Merv (ASHRAE 52.2): 5.
h. Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent, **as directed**.
i. Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles.

3. Extended-Surface, Disposable Panel Filters:
   a. Factory-fabricated, dry, extended-surface type.
   b. Thickness: 1 inch (25 mm) **OR** 2 inches (50 mm) **OR** 4 inches (100 mm), **as directed**.
   c. Dust-Holding Capacity: as directed by the Owner.
   d. Initial Resistance: as directed by the Owner.
   e. Recommended Final Resistance: as directed by the Owner.
   f. Arrestance (ASHRAE 52.1): 90.
   g. Merv (ASHRAE 52.2): 7.
   h. Media: Fibrous material formed into deep-V-shaped pleats with antimicrobial agent, **as directed**, and held by self-supporting wire grid.
   i. Media-Grid Frame: Nonflammable cardboard **OR** Galvanized steel **OR** Fire-retardant, 3/4-inch (20-mm) particleboard with gaskets, **as directed**.
   j. Mounting Frames: Welded, galvanized steel, with gaskets and fasteners, suitable for bolting together into built-up filter banks.
4. Extended-Surface, Nonsupported-Media Filters:
   a. Factory-fabricated, dry, extended-surface, self-supporting type.
   b. Dust-Holding Capacity: as directed by the Owner.
   c. Initial Resistance: as directed by the Owner.
   d. Recommended Final Resistance: as directed by the Owner.
   e. Arrestance (ASHRAE 52.1): 95.
   f. Merv (ASHRAE 52.2): 13.
   g. Media: Fibrous material with antimicrobial agent, **as directed**, constructed so individual pleats are maintained in tapered form by flexible internal supports under rated-airflow conditions.
   h. Filter-Media Frame: Galvanized steel **OR** Hard polyurethane foam, **as directed**.
   i. Mounting Frames: Welded, galvanized steel, with gaskets and fasteners, suitable for bolting together into built-up filter banks with space for prefilter, **as directed**.
5. Automatic Roll Filters:
   a. Factory-fabricated, automatic, motor-driven, roll type.
   b. Arrangement: Horizontal **OR** Vertical, **as directed**.
   c. Dust-Holding Capacity: as directed by the Owner.
   d. Initial Resistance: as directed by the Owner.
   e. Recommended Final Resistance: as directed by the Owner.
   f. Arrestance (ASHRAE 52.1): 80.
   g. Merv (ASHRAE 52.2): 5.
   h. Media: Compressed and rolled, fibrous-glass material viscous coated, and with antimicrobial agent, **as directed**.
   i. Holding Frame: Galvanized steel, with enclosed, clean media roll arranged to allow upstream replacement of filter media.
   j. Auxiliary Frame: Locate on downstream side of unit with downstream **OR** side, **as directed**, access.
   k. Final Filter: Extended-surface, retained-media **OR** nonsupported-media **OR** HEPA, **as directed**, filters.
   l. Control and Drive:
      1) Mechanism: Electric, gear-reducer, motor-driven, feed control equipped with manual media advance and runout switches for stopping media movement of filter bank and operating remote warning signal lights.

2) Manual Control: Manual switch to advance media and wired to override automatic controls.
3) Automatic Control: Prewired control package to advance media when filter resistance exceeds adjustable high limit **OR** after adjustable operating time, **as directed**.

6. Activated-Carbon Panel Filters:
   a. Factory-fabricated unit with activated-carbon media.
   b. Flat-Panel Media: Multilayer filter with inlet layer of polyester fibers, layer of activated-carbon granules bonded to fibers, layer of polyurethane foam, and housed in cardboard frame.
   c. Pleated Media: Multilayer filter with inlet layer of cotton and synthetic fibers and layer of activated-carbon granules bonded to synthetic fibers, formed into deep-V-shaped pleats and held by self-wire grid, and housed in nonflammable cardboard frame.
   d. Mounting Frames: Welded galvanized steel, with polyurethane gaskets and fasteners, capable of holding media and media frame in place and suitable for bolting together into built-up filter banks.
7. Activated-Carbon Filters:
   a. Factory-fabricated unit in deep-V arrangement with disposable panel prefilter.
   b. Media: Activated carbon mounted in removable carbon-cell trays of epoxy-coated steel.
   c. Activated-Carbon Capacity: 12 lb (5.4 kg) of activated carbon per 500 cfm (236 L/s) **OR** 8.8 lb (4.0 kg) of activated carbon per 2000 cfm (944 L/s), **as directed**, of airflow.
   d. Housing: 0.064-inch- (1.6-mm-) thick, galvanized steel, for side servicing through gasketed access doors on both sides. Equip housings with metal slide channel tracks to hold activated-carbon trays.
8. HEPA Filters:
   a. Factory-fabricated unit.
   b. Dust-Holding Capacity: as directed by the Owner.
   c. Initial Resistance: as directed by the Owner.
   d. Recommended Final Resistance: as directed by the Owner.
   e. Arrestance (ASHRAE 52.1): 95 percent on 0.3-micrometer D.O.P. particles **OR** 99.97 percent on 0.3-micrometer D.O.P. particles **OR** 99.9995 percent on 0.1- and 0.2-micrometer D.O.P. particles **OR** 99.99995 percent on 0.1- and 0.2-micrometer D.O.P. particles, **as directed**.
   f. Media: UL 586, fibrous glass, constructed of continuous sheets with closely spaced pleats with aluminum separators **OR** vinyl-coated aluminum separators **OR** separators of ribbons of filter media, **as directed**.
   g. Frame Material: 3/4-inch- (19-mm-) thick, fire-retardant plywood **OR** 3/4-inch- (19-mm-) thick, fire-retardant particleboard **OR** 3/4-inch- (19-mm-) thick plywood **OR** 3/4-inch- (19-mm-) thick particleboard **OR** Galvanized steel **OR** Aluminized steel **OR** Cadmium-plated steel **OR** Stainless steel **OR** Aluminum, **as directed**.
   h. Media to Frame Side Bond: Polyurethane foam **OR** Silicone **OR** Neoprene adhesive **OR** Fiberglass-mat packing **OR** Thermosetting sealant **OR** Knife edge in fluid-filled channel, **as directed**.
   i. Face Gasket: Neoprene expanded rubber **OR** Ceramic fiber **OR** Silicone, **as directed**.
   j. Mounting Frames: Downstream corners of holding device shall have cushion pads to protect media. Bolted filter-sealing mechanism shall mount and continuously seal each individual filter.
9. Filter Gage:
   a. 3-1/2-inch- (90-mm-) **OR** 2-inch- (50-mm-), **as directed**, diameter, diaphragm-actuated dial in metal case.
   b. Vent valves.
   c. Black figures on white background.
   d. Front recalibration adjustment.
   e. 2 **OR** 3, **as directed**, percent of full-scale accuracy.

f. Range: 0- to 0.5-inch wg (0 to 125 Pa) **OR** 0- to 1.0-inch wg (0 to 250 Pa) **OR** 0- to 2.0-inch wg (0 to 500 Pa) **OR** 0- to 3.0-inch wg (0 to 750 Pa) **OR** 0- to 4.0-inch wg (0 to 1000 Pa), **as directed**.

g. Accessories: Static-pressure tips with integral compression fittings, 1/4-inch (6-mm) aluminum **OR** plastic, **as directed**, tubing, and 2- or 3-way vent valves.

E. Dampers

1. General Requirements for Dampers: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 2 percent of air quantity at 2000-fpm (10-m/s) face velocity through damper and 4-inch wg (1000-Pa) pressure differential.
2. Damper Operators: Comply with requirements in Division 23 Section "Instrumentation And Control For Hvac".
   OR
   Electronic Damper Operators:
   a. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
   b. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
   c. Operator Motors:
      1) Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Work Results For Hvac".
      2) Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
      3) Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
   d. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
   e. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).
   f. Size dampers for running torque calculated as follows:
      1) Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
      2) Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.
      3) Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft (49.6 kg-cm/sq. m) of damper.
      4) Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. (37.2 kg-cm/sq. m) of damper.
      5) Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
      6) Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.
   g. Coupling: V-bolt and V-shaped, toothed cradle.
   h. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
   i. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
   j. Power Requirements (Two-Position Spring Return): 24 **OR** 120 **OR** 230, **as directed**,-V ac.
   k. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
   l. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
   m. Temperature Rating: Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C) **OR** 40 to 104 deg F (5 to 40 deg C), **as directed**.

n. Run Time: 12 seconds open, 5 seconds closed **OR** 30 seconds **OR** 60 seconds **OR** 120 seconds, **as directed**.

OR

Pneumatic Damper Operators:

a. Rolling-diaphragm piston type with adjustable stops and spring return, sized to operate with sufficient reserve power to provide smooth modulating action or two-position action. Where actuators operate in sequence, provide pilot positioners.

b. Pneumatic Damper Position Indicator: Potentiometer mounted in enclosure with adjustable crank-arm assembly connected to damper to transmit 0 to 100 percent valve/damper travel.

c. Pilot Positioners:
   1) Start Point: Adjustable from 2 to 12 psig (14 to 83 kPa).
   2) Operating Span: Adjustable from 5 to 13 psig (35 to 90 kPa).
   3) Linearity: Plus or minus 10 percent of output signal span.
   4) Hysteresis: 3 percent of span.
   5) Response: 0.25-psig (1723-Pa) input change.
   6) Maximum Pilot Signal Pressure: 20 psig (140 kPa).
   7) Maximum Control Air-Supply Pressure: 60 psig (410 kPa).

d. Actuator Housing: Molded or die-cast zinc or aluminum. Terminal unit actuators may be high-impact plastic with ambient temperature rating of 50 to 140 deg F (10 to 60 deg C) unless located in return-air plenums, **as directed**.

e. Inlet-Vane Operators: High pressure, with pilot positioners.

3. Zone Dampers: Two single-blade, galvanized-steel **OR** aluminum **OR** extruded-aluminum, **as directed**, dampers offset 90 degrees from each other on cadmium-plated, **as directed,** steel operating rod rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel **OR** aluminum **OR** extruded-aluminum, **as directed**, frame. Provide blade gaskets and edge seals, and mechanically fasten blades to operating rod.

4. Face-and-Bypass Dampers: Opposed-blade, galvanized-steel **OR** aluminum **OR** extruded-aluminum, **as directed**, dampers with cadmium-plated, **as directed**, steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel **OR** aluminum **OR** extruded-aluminum, **as directed**, frame and with operating rods connected with a common linkage. Provide blade gaskets and edge seals, and mechanically fasten blades to operating rod.

5. Outdoor- and Return-Air Mixing Dampers: Parallel-blade, galvanized-steel **OR** aluminum **OR** extruded-aluminum, **as directed**, dampers mechanically fastened to cadmium-plated, **as directed**, steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

6. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, galvanized-steel **OR** aluminum **OR** extruded-aluminum, **as directed**, dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed-blade **OR** parallel-blade, **as directed**, arrangement with cadmium-plated, **as directed**, steel operating rods rotating in stainless-steel sleeve **OR** sintered bronze or nylon, **as directed**, bearings mounted in a single galvanized-steel **OR** aluminum **OR** extruded-aluminum, **as directed**, frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 5 cfm/sq. ft. (0.22 L/s per sq. m) at 1-inch wg (250 Pa) and 9 cfm/sq. ft. (0.4 L/s per sq. m) at 4-inch wg (1.0 MPa).

7. Mixing Section: Multiple-blade, air-mixer assembly located immediately downstream of mixing section.

8. Combination Filter and Mixing Section:
   a. Cabinet support members shall hold 2-inch- (50-mm-) thick, pleated, flat, permanent or throwaway filters.
   b. Multiple-blade, air-mixer assembly shall mix air to prevent stratification, located immediately downstream of mixing box.

F. Humidifiers

1. Steam Grid Humidifier:
   a. Manifold:

1) ASTM A 666, Type 304 stainless steel.
2) Steam jacketed.
3) Insulated with 1/2-inch (13-mm) fiberglass and stainless-steel jacket.
4) Manifold shall extend the full width of unit with mounting brackets at ends.

b. Steam Separator: Cast iron, **OR** ASTM A 666, Type 304 stainless steel, **as directed**, with separate, **as directed**, humidifier control valve.

c. Humidifier Control Valve: Actuator: Pneumatic **OR** Electric, **as directed**, modulating with spring return.
OR
Humidifier Control Valve: Actuator: As specified in Division 23 Section "Instrumentation And Control For Hvac".

d. Steam Trap: Inverted-bucket type, sized for a minimum of three times the maximum rated condensate flow of humidifier at 1/2-psig (3.4-kPa) inlet pressure.

e. Aquastat: For separate mounting on steam condensate, return piping to prevent cold operation of humidifier.

f. Strainer: In-line type.

g. Airflow Switch: To prevent humidifier operation in the absence of airflow.

2. Wet Glass Cell Washer Section:

a. 3-inch- (75-mm-) deep cells with random packed, glass-fiber media in galvanized-steel **OR** stainless-steel, **as directed**, frames.

b. Access Door: Watertight with brass fittings, wire glass window, **as directed**, and locking handles.

c. Spray Tree Assembly: Brass **OR** Stainless-steel, **as directed**, nozzles and galvanized-steel **OR** stainless-steel, **as directed**, piping.

d. Eliminator: Galvanized-steel **OR** Stainless-steel, **as directed**, plates.

e. Tank:
1) Welded steel **OR** stainless steel, **as directed**, with interior and exterior surfaces blasted and painted with zinc-chromate paint, **as directed**.
2) Copper suction screen.
3) Drain, overflow, and suction connections.
4) Makeup connection with brass, **as directed**, float valve, and with quick-fill connection.

f. Insulate exterior with duct insulation and mount on 2-inch (-(50-mm-)) thick, rigid insulation board.

3. Evaporative Humidifier Section:

a. Access Door: Watertight cast iron, **as directed**, with brass fittings, wire glass window, and locking handles.

b. Spray Tree Assembly: Brass nozzles and galvanized piping, galvanized eliminator plates with flooding nozzles and header, and galvanized antisplash baffles **OR** cross-fluted cellulose media, **as directed**.

c. Tank:
1) Welded steel tank with interior and exterior surfaces blasted and painted with zinc-chromate paint.
2) Copper suction screen, drain, overflow, and suction connections.
3) Makeup connection with brass, **as directed**, float valve, and with quick-fill connection.

d. Insulation: Insulate with duct insulation on exterior and mount on 2-inch (-50-mm-) thick, rigid insulation board.

G. Air-To-Air Energy Recovery

1. Heat Wheels:

a. Casing:
1) Steel, with manufacturer's standard paint coating.
2) Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg (0.05 percent at 400-Pa and 0.20 percent at 1000-Pa) differential pressure.

3) Casing seals on periphery of rotor, on duct divider, and on purge section.
4) Support rotor on grease-lubricated ball bearings with extended grease fittings. Mount horizontal wheels on tapered roller bearing.

b. Rotor: Aluminum, segmented wheel, strengthened with radial spokes, with nontoxic, noncorrosive, silica-gel desiccant coating, **as directed**. Construct media for passing maximum 500 **OR** 800 **OR** 1200, **as directed**,-micrometer solids.
OR
Rotor: Glass-fiber **OR** Polymer, **as directed**, segmented wheel, strengthened with radial spokes impregnated with nonmigrating, water-selective, molecular-sieve desiccant coating. Construct media for passing maximum 800 **OR** 1200, **as directed**,-micrometer solids.

c. Drive: Fractional horsepower motor and gear reducer, with speed changed by variable frequency controller, **as directed**, and self-adjusting multilink belt around outside of rotor.

d. Controls:
1) Starting relay, factory mounted and wired, and manual motor starter for field wiring.
2) Variable frequency controller, factory mounted and wired, permitting input of field connected 4-20 mA or 1-10-V control signal.
OR
Variable frequency controller, factory mounted and wired, with exhaust-air sensor to vary rotor speed and maintain exhaust temperature above freezing.
OR
Variable frequency controller, factory mounted and wired, with exhaust- and outdoor-air sensors, automatic changeover thermostat and set-point adjuster, to vary rotor speed and maintain exhaust temperature above freezing, **as directed**, and air differential temperature above set point. Provide maximum rotor speed when exhaust-air temperature is less than outdoor-air temperature.
3) Pilot-Light Indicator: Display rotor rotation and speed.
4) Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.

2. Fixed-Plate Sensible Heat Exchangers:

a. Casing: Aluminum **OR** Galvanized steel **OR** Enameled steel, with galvanized-steel liner **OR** Enameled steel, **as directed**.
b. Plates: Evenly spaced and sealed and arranged for counter airflow.
c. Plate Material: Embossed aluminum **OR** Stainless steel **OR** Polypropylene copolymer (high-density plastic), **as directed**.
1) Plate Coating: Epoxy **OR** Air-dried phenolic, **as directed**.
d. Bypass: Plenum within casing, with gasketed face-and-bypass dampers that have operating rods extended outside casing.
e. Water Wash: Automatic system, with spray manifold to individual spray tubes or traversing type with stainless-steel-screw operating mechanism and electric motor drive; activated by time clock, with detergent injection, **as directed**.
f. Heat-Exchanger Prefilters: 1 inch (25 mm) thick, disposable **OR** 2 inches (50 mm) thick, disposable **OR** Medium efficiency **OR** Electrostatic, **as directed**.

H. Source Quality Control

1. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
2. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."
3. Water Coils: Factory tested to 300 psig (2070 kPa) according to ARI 410 and ASHRAE 33.
4. Steam Coils: Factory tested to 300 psig (2070 kPa) and to 200 psig (1380 kPa) underwater according to ARI 410 and ASHRAE 33.
5. Refrigerant Coils: Factory tested to 450 psig (3105 kPa) according to ARI 410 and ASHRAE 33.

1.3 EXECUTION

A. Installation

1. Equipment Mounting: Install air-handling units on concrete bases using elastomeric pads **OR** using elastomeric mounts **OR** using restrained spring isolators **OR** without vibration isolation devices, **as directed**. Secure units to anchor bolts installed in concrete bases. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-place Concrete". Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
   a. Minimum Deflection: 1/2 inch (13 mm) **OR** 1 inch (25 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**.
   b. Install galvanized-steel **OR** stainless-steel, **as directed**, plate to equally distribute weight over elastomeric pad.
   c. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   d. Install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   e. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   f. Install anchor bolts to elevations required for proper attachment to supported equipment.

   OR

   Equipment Mounting: Install air-handling unit using elastomeric pads **OR** using elastomeric mounts **OR** using restrained spring isolators **OR** without vibration isolation devices, **as directed**. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
   g. Minimum Deflection: 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** 1 inch (25 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**.
   h. Install galvanized-steel **OR** stainless-steel, **as directed**, plate to equally distribute weight over elastomeric pad.
2. Suspended Units: Suspend and brace, **as directed**, units from structural-steel support frame using threaded steel rods and spring hangers. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
3. Arrange installation of units to provide access space around air-handling units for service and maintenance.
4. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.
5. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

B. Connections

1. Comply with requirements for piping specified in other Division 21. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to air-handling unit to allow service and maintenance.
3. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.
4. Connect condensate drain pans using NPS 1-1/4 (DN 32), ASTM B 88, Type M (ASTM B 88M, Type C) copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
5. Hot- and Chilled-Water Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping". Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.
6. Steam and Condensate Piping: Comply with applicable requirements in Division 23 Section "Steam And Condensate Heating Piping". Install shutoff valve at steam supply connections, float and thermostatic trap, and union or flange at each coil return connection. Install gate valve and

inlet strainer at supply connection of dry steam humidifiers, and inverted bucket steam trap to condensate return connection.

7. Refrigerant Piping: Comply with applicable requirements in Division 23 Section "Refrigerant Piping". Install shutoff valve and union or flange at each supply and return connection.
8. Connect duct to air-handling units with flexible connections. Comply with requirements in Division 23 Section "Air Duct Accessories".

C. Field Quality Control

1. Perform tests and inspections.
2. Tests and Inspections:
   a. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
   b. Charge refrigerant coils with refrigerant and test for leaks.
   c. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   d. Automatic-Roll-Filter Operational Test: Operate filters to demonstrate compliance with requirements. Test for leakage of unfiltered air while system is operating.
   e. HEPA-Filter Operational Test: Pressurize housing to a minimum of 3-inch wg (750 Pa) or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter with soapy water to check for air leaks.
   f. HEPA-Filter Operational Test: Pressurize housing to a minimum of 3-inch wg (750 Pa) or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter for air leaks according to ASME N510, pressure-decay method.
   g. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.
4. Prepare test and inspection reports.

D. Startup Service

1. Perform startup service.
   a. Complete installation and startup checks according to manufacturer's written instructions.
   b. Verify that shipping, blocking, and bracing are removed.
   c. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
   d. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
   e. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
   f. Verify that zone dampers fully open and close for each zone.
   g. Verify that face-and-bypass dampers provide full face flow.
   h. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
   i. Comb coil fins for parallel orientation.
   j. Verify that proper thermal-overload protection is installed for electric coils.
   k. Install new, clean filters.
   l. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.
2. Starting procedures for air-handling units include the following:
   a. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions, **as directed**.
   b. Measure and record motor electrical values for voltage and amperage.

c. Manually operate dampers from fully closed to fully open position and record fan performance.

E. Adjusting
1. Adjust damper linkages for proper damper operation.
2. Comply with requirements in Division 23 Section "Testing, Adjusting, And Balancing For Hvac" for air-handling system testing, adjusting, and balancing.

F. Cleaning
1. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

G. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 23 73 13 00

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Task	Specification	Specification Description
23 73 13 00	07 72 23 00	Roof Accessories

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SECTION 23 74 16 13 - ROOFTOP REPLACEMENT AIR UNITS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for rooftop replacement-air units. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes cooling-only and cooling and heating rooftop replacement-air units.

C. Definitions
   1. DDC: Direct-digital controls.

D. Submittals
   1. Product Data: Include rated capacities, furnished specialties, and accessories.
   2. Shop Drawings: Include details of installation and wiring diagrams.
   3. Coordination Drawings: Rooftop replacement-air units to roof-curb mounting details drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
      a. Size and location of rooftop replacement-air unit mounting rails and anchor points and methods for anchoring units to roof curb.
      b. Required roof penetrations for ducts, pipes, and electrical raceways, including size and location of each penetration.
   4. Startup service reports.
   5. Operation and maintenance data.
   6. Warranty: Special warranty specified in this Section.
   7. LEED Submittals:
      a. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.
      b. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."

E. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
   3. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

F. Warranty
   1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components listed below that fail in materials or workmanship within specified warranty period.
      a. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Final Completion.
      b. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than five **OR** 10, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Cabinet
1. Construction: Single **OR** Double, **as directed**, wall.
2. Exterior Casing: Galvanized steel with baked-enamel paint finish and **OR** Stainless steel, **as directed**, with lifting lugs and knockouts for electrical and piping connections.
3. Interior Casing: Galvanized-steel **OR** Stainless steel, **as directed**.
4. Base Rails: Galvanized-steel **OR** Stainless-steel, **as directed**, rails for mounting on roof curb.
5. Service Doors: Hinged access doors with neoprene gaskets.
6. Internal Insulation: Fibrous-glass duct lining complying with ASTM C 1071, Type II.
   a. Thickness: 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**.
   b. Insulation Adhesive: Comply with ASTM C 916, Type I.
   c. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to casing without damaging liner and without causing air leakage when applied as recommended by manufacturer.
7. Condensate Drain Pans: Formed sections of galvanized-steel **OR** stainless-steel, **as directed**, sheet designed for self-drainage. Fabricate pans and drain connection to comply with ASHRAE 62.1.
8. Roof Curb: Full-perimeter curb of sheet metal, minimum 8 inches (200 mm) **OR** 12 inches (300 mm) **OR** 16 inches (400 mm), **as directed**, high, with wood nailer, neoprene sealing strip, and welded Z-bar flashing.
9. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

B. Supply-Air Fan
1. Fan: Forward-curved centrifugal; statically and dynamically balanced, galvanized **OR** coated, **as directed**, steel, mounted on solid-steel shaft with self-aligning, permanently lubricated ball bearings **OR** pillow-block bearings rated L_{50} for 200,000 hours and having external grease fittings, **as directed**.
2. Motor: Open dripproof **OR** Totally enclosed, **as directed**, single-speed **OR** two-speed, **as directed**, motor.
3. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly with minimum 1.4 service factor.
4. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with restrained, **as directed**, elastomeric **OR** spring, **as directed**, isolators.

C. Refrigeration System
1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."
2. Compressors: Reciprocating **OR** Scroll, **as directed**, compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief, and crankcase heater, **as directed**.
3. Minimum Efficiency: As defined by ASHRAE/IESNA 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."
4. Refrigerant: R-407C **OR** R-410A, **as directed**.
5. Refrigeration System Specialties:
   a. Expansion valve with replaceable thermostatic element.
   b. Refrigerant dryer.
   c. High-pressure switch.
   d. Low-pressure switch.
   e. Thermostat for coil freeze-up protection during low ambient temperature operation or loss of air.
   f. Brass service valves installed in discharge and liquid lines.
   g. Operating charge of refrigerant.

6. Capacity Control: Hot-gas bypass refrigerant control for capacity control with continuous dehumidification on a single compressor.
OR
Capacity Control: Patented, Rawal APR control with zero to 100 percent modulating capacity control using hot-gas bypass. Evaporator coil shall be continuously active for dehumidification.
OR
Capacity Control: Single compressor with evaporator and condenser coil within the refrigerant section to provide initial precooling and reheat for humidity control.
OR
Capacity Control: Heat-pipe heat exchanger shall wrap around the evaporator coil to precool the air entering the evaporator coil, and reheat the air leaving the evaporator coil to control humidity.
7. Refrigerant Coils: Evaporator and condenser **OR** Evaporator, condenser, and reheat condenser, **as directed**, coils shall be designed, tested, fabricated, and rated according to ARI 410 and ASHRAE 33. Coils shall be leak tested under water with air at 315 psig (2170 kPa).
   a. Capacity Reduction: Circuit coils for face **OR** row **OR** interleaved, **as directed**, control.
   b. Tubes: Copper.
   c. Fins: Aluminum **OR** Copper, **as directed**, with minimum fin spacing of 0.071 inch (1.81 mm), **as directed**.
   d. Fin and Tube Joint: Mechanical bond.
   e. Suction and Distributor: Seamless copper tube with brazed joints.
   f. Coating: Phenolic epoxy corrosion-protection coating on both coils.
   g. Source Quality Control: Test to 450 psig (3105 kPa), and to 300 psig (2070 kPa) underwater.
8. Condenser Fan: Propeller type, directly driven by motor.
9. Safety Controls:
   a. Compressor motor and outside-coil fan motor low ambient lockout.
   b. Overcurrent protection for compressor motor and outside-coil fan motors.

D. Direct-Fired Gas Furnace
1. Description: Factory assembled, piped, and wired; complying with NFPA 54, "National Fuel Gas Code"; ANSI Z83.4, "Non-Recirculating Direct Gas-Fired Industrial Air Heaters"; and ANSI Z83.18, "Direct Gas-Fired Industrial Air Heaters," for direct-fired gas furnace.
2. Burners: Cast-iron burner with stainless-steel mixing plates.
   a. Rated for a maximum turndown ratio of 30:1.
   b. Fuel: Natural **OR** Propane, **as directed**, gas.
3. Safety Controls:
   a. Gas manifold safety switches and controls shall comply with ANSI standards and FMG **OR** and IRI, **as directed**.
   b. Pilot: Intermittent spark igniter.
   c. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.
   d. External gas-pressure regulator shall regulate pressure to not more than 0.5 psig (3.4 kPa).
   e. Airflow Proving Switch: Dual pressure switch senses correct airflow before energizing pilot and requires airflow to be maintained within minimum and maximum pressure settings across burner.
   f. Manual-Reset, High-Limit Switch: Stops burner and closes main gas valve if high-limit temperature is exceeded.
   g. Gas Train: Redundant, main gas valves, electric pilot valve, main and pilot gas-pressure regulators, main and pilot manual shutoff valves, main and pilot pressure taps, and high-low gas-pressure switches **OR** to comply with FMG requirements **OR** to comply with IRI requirements, **as directed**.

E. Indirect-Fired Gas Furnace
1. Description: Factory assembled, piped, and wired; complying with NFPA 54, "National Fuel Gas Code," and ANSI Z21.47, "Gas-Fired Central Furnaces."
   a. AGA Approval: Designed and certified by and bearing label of AGA.

2. Burners: Aluminized steel with stainless-steel inserts **OR** Stainless steel, **as directed**.
   a. Minimum AFUE: <**Insert value**> percent.
      OR
      Minimum Thermal Efficiency: <**Insert value**> percent.
      OR
      Minimum Combustion Efficiency: <**Insert value**> percent.
   b. Fuel: Natural **OR** Propane, **as directed**, gas.
   c. Ignition: Electronically controlled electric spark with flame sensor.
   d. High-Altitude Model **OR** Kit, **as directed**: For Project elevations more than 2000 feet (610 m) above sea level.
3. Heat-Exchanger Drain Pan: Stainless steel.
4. Venting: Gravity vented.
   OR
   Power Vent: Integral, motorized centrifugal fan interlocked with gas valve.
5. Safety Controls:
   a. Gas Control Valve: Single stage **OR** Two stage **OR** Electronic modulating, **as directed**.
   b. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

F. Electric-Resistance Heating
1. Electric-Resistance Heating Elements: Coiled resistance wire of 80 percent nickel and 20 percent chromium; surrounded by compacted magnesium oxide powder in tubular-steel sheath; with spiral-wound, copper-plated, steel fins continuously brazed to sheath.
   OR
   Electric-Resistance Heating Elements: Open-coil resistance wire of 80 percent nickel and 20 percent chromium; supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
   a. Heating Capacity: Low density 35 W per sq. in. (54 kW per sq. m), factory wired for single-point wiring connection; with time delay for element staging, and overcurrent and overheat protective devices.
   b. Safety Controls:
      1) Blower-motor interlock, air-pressure switch.
      2) Quiet mercury contactors.
      3) Time delay between steps.
      4) Integral, nonfused power disconnect switch.

G. Heating Coils
1. Hot-Water Coils: Continuous-circuit **OR** Self-draining **OR** Cleanable, **as directed**, coil fabricated and tested according to ARI 410 with aluminum fins and seamless copper tube in galvanized-steel **OR** stainless-steel, **as directed**, casing.
   a. Headers: Cast iron with drain and air vent tappings **OR** Cast iron with cleaning plugs, and drain and air vent tappings **OR** Seamless copper tube with brazed joints, prime coated **OR** Fabricated steel with brazed joints, prime coated, **as directed**.
   b. Control valves are specified in Division 23 Section "Instrumentation And Control For Hvac".
2. Steam Coils: Distributing coil fabricated and tested according to ARI 410, with threaded steam supply and condensate connections. Nonfreeze type having aluminum-plate fin and seamless copper double tube in galvanized-steel casing, pitched for proper drainage; tested to 150 psig (1035 kPa) and leak tested to 100 psig (690 kPa) with air under water.
   a. Control valves are specified in Division 23 Section "Instrumentation And Control For Hvac".

H. Cooling Coils
1. Chilled-Water Coils: Continuous-circuit **OR** Self-draining **OR** Cleanable, **as directed**, coil fabricated and tested according to ARI 410 with aluminum fins and seamless copper tube in galvanized-steel **OR** stainless-steel, **as directed**, casing.

a. Headers: Cast iron with drain and air vent tappings **OR** Cast iron with cleaning plugs, and drain and air vent tappings **OR** Seamless copper tube with brazed joints, prime coated **OR** Fabricated steel with brazed joints, prime coated, **as directed**.
b. Control valves are specified in Division 23 Section "Instrumentation And Control For Hvac".

I. Outdoor-Air Intake And Dampers
1. Dampers: Leakage rate, according to AMCA 500, shall not exceed 2 percent of air quantity at face velocity of 2000 fpm (10 m/s) through damper and pressure differential of 4-inch wg (1000 Pa).
2. Damper Operators: Electric.
3. Mixing Boxes: Parallel-blade, galvanized-steel dampers mechanically fastened to steel operating rod inside cabinet. Connect operating rods with common interconnecting linkages so dampers operate simultaneously.
4. Outdoor-Air Intake Hoods: Galvanized-steel **OR** Stainless steel, **as directed**, with bird screen complying with ASHRAE 62.1 and finish to match cabinet.

J. Filters
1. Comply with NFPA 90A.
2. Cleanable Filters: 2-inch- (50-mm-) thick, cleanable metal mesh.
OR
Disposable Panel Filters: 2-inch- (50-mm-) thick, factory-fabricated, flat-panel-type, disposable air filters with holding frames, with a minimum efficiency report value of 6 according to ASHRAE 52.2 and 90 percent average arrestance according to ASHRAE 52.1, **as directed**.
a. Media: Interlaced glass fibers sprayed with nonflammable adhesive.
b. Frame: Galvanized steel.

K. Controls
1. Factory-wire connection for controls' power supply.
2. Control devices, including sensors, transmitters, relays, switches, thermostats, humidistats, detectors, operators, actuators, and valves, shall be manufacturer's standard items to accomplish indicated control functions.
3. Unit Controls: Solid-state control board and components with field-adjustable control parameters.
4. Supply-Fan Control: Units shall be electrically interlocked with corresponding exhaust fans, to operate continuously when exhaust fans are running. Time clock shall switch operation from occupied to unoccupied. Night setback thermostat shall cycle fan during unoccupied periods to maintain space temperature.
a. Timer: Seven-day electronic clock.
b. Electrically interlock kitchen hood fire-extinguishing system to de-energize replacement-air unit when fire-extinguishing system discharges.
5. Remote **OR** Unit, **as directed**,-Mounted Status Panel:
a. Cooling/Off/Heating Controls: Control operational mode.
b. Damper Position: Indicates position of outdoor-air dampers in terms of percentage of outdoor air.
c. Status Lights:
1) Filter dirty.
2) Fan operating.
3) Cooling operating.
4) Heating operating.
6. Refrigeration System Controls:
a. Unit-mounted enthalpy controller shall lock out refrigerant system when outdoor-air enthalpy is less than 28 Btu/lb (65 kJ/kg) of dry air or outdoor-air temperature is less than 60 deg F (15 deg C).
b. Outdoor-air sensor de-energizes dehumidifier operation when outdoor-air temperature is less than 60 deg F (15 deg C).
c. Wall-mounting, relative-humidity sensor energizes dehumidifier operation when relative humidity is more than 60 percent.

7. Heating Controls:
   a. Factory-mounted sensor in supply-fan outlet **OR** Remote-mounting sensor for field installation in supply-air duct, **as directed**, with sensor adjustment located in control panel modulates gas furnace burner to maintain space temperature.
   b. Wall-mounting, space-temperature sensor with temperature adjustment **OR** unit-mounted temperature adjustment **OR** adjustment on remote-control panel, **as directed**, that modulates gas furnace burner to maintain space temperature.
   c. Remote Setback Thermostat: Adjustable room thermostat selected by timer, set at 50 deg F (10 deg C); cycles supply fan and gas furnace burner to maintain space temperature.
   d. Staged Burner Control: Two **OR** Four, **as directed**, steps of control.
      OR
      Electromechanical or Electronic Burner Control: 20 to 100 percent modulation of the firing rate. 10 to 100 percent with dual furnace units.
8. Electric-Resistance Heating Controls: Wall-mounting thermostat controls SCR **OR** sequences stages, **as directed**.
9. Damper Controls:
   a. Wall-mounting pressure sensor modulates outdoor- and return-air dampers to maintain a positive pressure in space served by rooftop replacement-air unit at minimum 0.05-inch wg (12.4 Pa).
   b. When exhaust fans stop, set outdoor- and return-air damper to 75 **OR** 50 **OR** 25, **as directed**, percent outdoor air. When exhaust fans start, close return-air damper and fully open outdoor-air damper.
10. Integral Smoke Alarm: Smoke detector installed in supply and return air.
11. DDC Temperature Control: Stand-alone control module for link between unit controls and DDC temperature-control system. Control module shall be compatible with temperature-control system specified in Division 23 Section "Instrumentation And Control For Hvac". Links shall include the following:
   a. Start/stop interface relay, and relay to notify DDC temperature-control system alarm condition.
   b. Hardware interface or additional sensors for the following:
      1) Room temperature.
      2) Discharge air temperature.
      3) Refrigeration system operating.
      4) Furnace operating.

L. Motors
   1. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".

1.3 EXECUTION

A. Installation
   1. Install roof curb on roof structure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts" **OR** ARI Guideline B, **as directed**. Install and secure rooftop replacement-air units on curbs and coordinate roof penetrations and flashing with roof construction.
      OR
      Install restrained vibration isolation roof-curb rails on roof structure according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts" **OR** ARI Guideline B, **as directed**. Install and secure rooftop replacement-air units on rails and coordinate roof penetrations and flashing with roof construction. Restrained isolation roof-curb rails are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".

2. Install wall- and duct-mounting sensors, thermostats, and humidistats furnished by manufacturers for field installation. Install control wiring and make final connections to control devices and unit control panel.
3. Install 3000-psi (20.7-MPa), compressive strength (28-day) concrete base inside roof curb, 4 inches (100 mm) thick. Concrete and reinforcement are specified in Division 31.

B. Connections
1. Piping installation requirements are specified in other Division 21-. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to machine to allow service and maintenance.
   a. Gas Burner Connections: Comply with requirements in Division 23 Section(s) "Facility Natural-gas Piping" OR "Facility Liquefied-petroleum Gas Piping", **as directed**. Connect gas piping to burner, full size of gas train inlet, and connect with union, pressure regulator, **as directed**, and shutoff valve with sufficient clearance for burner removal and service.
   b. Water Coil Connections: Comply with requirements in Division 23 Section "Hydronic Piping". Connect to supply and return coil with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.
   c. Steam Coil Connections: Comply with requirements in Division 23 Section "Steam And Condensate Heating Piping". Connect to steam piping with shutoff valve and union or flange; for condensate piping, starting from the coil connection, connect with union or flange, strainer, trap, and shutoff valve.
3. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts". Drawings indicate the general arrangement of ducts. Connect supply and return, **as directed**, ducts to rooftop replacement-air units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories".
4. Electrical Connections: Comply with requirements in Division 22 for power wiring, switches, and motor controls.
5. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".

C. Startup Service
1. Engage a factory-authorized service representative to perform startup service.
2. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
   a. Inspect for visible damage to furnace combustion chamber.
   b. Inspect for visible damage to compressor, air-cooled outside coil, and fans.
   c. Inspect casing insulation for integrity, moisture content, and adhesion.
   d. Verify that clearances have been provided for servicing.
   e. Verify that controls are connected and operable.
   f. Verify that filters are installed.
   g. Clean outside coil and inspect for construction debris.
   h. Clean furnace flue and inspect for construction debris.
   i. Inspect operation of power vents.
   j. Purge gas line.
   k. Inspect and adjust vibration isolators and seismic restraints.
   l. Verify bearing lubrication.
   m. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
   n. Adjust fan belts to proper alignment and tension.
   o. Start unit.
   p. Start refrigeration system when outdoor-air temperature is within normal operating limits.
   q. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
   r. Operate unit for run-in period.
   s. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:

1) Measure gas pressure at manifold.
2) Measure combustion-air temperature at inlet to combustion chamber.
3) Measure flue-gas temperature at furnace discharge.
4) Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
5) Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

t. Calibrate thermostats.
u. Adjust and inspect high-temperature limits.
v. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers, **as directed**.
w. Start refrigeration system and measure and record the following:
   1) Coil leaving-air, dry- and wet-bulb temperatures.
   2) Coil entering-air, dry- and wet-bulb temperatures.
   3) Outdoor-air, dry-bulb temperature.
   4) Outdoor-air-coil, discharge-air, dry-bulb temperature.
x. Verify operational sequence of controls.
y. Measure and record the following airflows. Plot fan volumes on fan curve.
   1) Supply-air volume.
   2) Return-air volume.
   3) Outdoor-air intake volume.
z. Simulate maximum cooling demand and inspect the following:
   1) Compressor refrigerant suction and hot-gas pressures.
   2) Short circuiting of air through outside coil or from outside coil to outdoor-air intake.
aa. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
   1) High-limit heat exchanger.
   2) Alarms.

3. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.
4. Remove and replace components that do not pass tests and inspections and retest as specified above.
5. Prepare written report of the results of startup services.

D. Adjusting
1. Adjust initial temperature and humidity set points.
2. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
3. Occupancy Adjustments: When requested within 12 months of date of Final Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

E. Demonstration
1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain rooftop replacement-air units.

END OF SECTION 23 74 16 13

SECTION 23 74 16 13a - SELF-CONTAINED AIR-CONDITIONERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for self-contained air-conditioners. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes packaged air **OR** water-cooled air-conditioning units, **as directed,** with refrigerant compressors and controls, intended for indoor installations.

C. Submittals
1. Product Data: For each unit indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. LEED Submittals:
   a. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.
   b. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
3. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   b. Wiring Diagrams: For power, signal, and control wiring.
4. Samples for Initial Selection: For units with factory-applied color finishes.
5. Operation and Maintenance Data: For self-contained air conditioners to include in emergency, operation, and maintenance manuals.
6. Warranty: Sample of special warranty.

D. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency and marked for intended locations and application.
2. ARI Compliance:
   a. Applicable requirements in ARI 210/240.
   b. Applicable requirements in ARI 340/360.
   c. Applicable requirements in ARI 390.
3. ASHRAE Compliance:
   a. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
   b. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."
4. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

E. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of self-contained air conditioners that fail in materials or workmanship within specified warranty period.
   a. Warranty Period:
      1) For Compressor: One **OR** Five year(s), **as directed,** from date of Final Completion.
      2) For Parts: One **OR** Five year(s), **as directed,** from date of Final Completion.
      3) For Labor: One **OR** Five year(s), **as directed,** from date of Final Completion.

1.2 PRODUCTS

A. Packaged Units
1. Description: Factory-assembled, wired, and tested, and fully charged with refrigerant and oil.
2. Configuration: Horizontal, ceiling-plenum mounted.
3. Configuration: Vertical, floor mounted; vertical and horizontal discharge.
4. Configuration: Horizontal, ceiling mounted and vertical, floor mounted; vertical and horizontal discharge.
5. Disconnect Switch: Factory mounted in control panel **OR** on equipment, **as directed**.

B. Cabinet
1. Frame and Panels: Structural-steel frame with galvanized-steel panels and access doors or panels.
   a. Exterior-Surface Finish: Factory painted in color selected by Architect.
   b. Interior-Surface Finish: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
2. Insulation: Minimum 1-inch- (25-mm-), thick, glass-fiber duct liner complying with ASTM C 1091 and having a microbial coating on cabinet interior and control panel. 1/2-inch- (13-mm-) thick liner is acceptable for units smaller than 15 tons (50 kW).
3. Return-Air Opening: Rear, open **OR** flange for duct connection**, as directed**.
4. Corrosion-Resistant Treatment: Phenolic coating on unit interior and exterior.

C. Supply-Air Fan
1. Fan Material: Galvanized steel.
2. Configuration: Double-width, double-inlet, forward-curved **OR** airfoil, **as directed**, centrifugal fan; statically and dynamically balanced. Vertical **OR** Horizontal discharge, **as directed**, with flexible discharge collar.
3. Drive: Belt, with fan mounted on permanently lubricated bearings **OR** Direct, with fan and motor resiliently mounted, **as directed**.
4. Fan Sheaves: Variable pitch, dynamically balanced, bored to fit shafts and keyed for initial startup.
5. Motor Sheave: Variable and adjustable pitch dynamically balanced, and selected to achieve specified rpm when set at midposition.
6. Belt Rating: As recommended by the manufacturer or a minimum of one and one-half times nameplate rating of motor.
7. Bearings: Grease lubricated with grease lines extended to exterior of unit with L-50 life at 200,000 hours.
8. Variable Air Volume: Variable-frequency motor controller with bypass.
9. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
   a. Special Motor Features: Premium efficiency, as defined in Division 23 Section "Common Motor Requirements For Hvac Equipment".
10. Isolation: Mount fan and motor on common subbase and mount assembly on spring isolators with minimum static deflection of **1 inch (25 mm).**
11. Outdoor-Air-Intake Accessories:
    a. Barometric Outdoor-Air Damper: Adjustable-blade damper allowing induction of up to 25 percent outdoor air when evaporator fan is running.
    b. Motorized Outdoor-Air Damper: Motorized, two-position blade damper allowing induction of up to 25 percent outdoor air; with spring-return, low-voltage damper motor.
    c. Energy-Recovery Ventilator: Assembly of desiccant-coated, heat-recovery wheels and centrifugal exhaust fans to transfer approximately 67 percent of the difference between the sensible and latent heat of outdoor and exhaust air.

d. Air-Side Economizer: Damper assembly allowing induction of up to 100 percent outdoor air to maintain a selected mixed-air temperature; and exhaust damper and spring-return, low-voltage, modulating damper motor with minimum position adjustment.

D. Refrigeration System
1. Compressor: Scroll type, hermetically sealed, 3600 rpm maximum, and resiliently mounted with positive lubrication and internal motor protection.
2. Refrigerant Coils (Indoor and Outdoor for Air-Cooled Units): Seamless copper tubes expanded into aluminum fins.
a. Corrosion-Resistant Treatment: Phenolic coating applied with multiple dips and baked.
b. Refrigerant Circuits: A separate circuit for each compressor, with externally equalized thermal-expansion valve with adjustable superheat, filter dryer, sight glass, high-pressure relief valve, and charging valves.
c. Mount coil assembly over stainless-steel drain pan complying with ASHRAE 62.1 and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir.
d. Refrigerant: R-407C or R-410A.
e. Expansion valve with replaceable thermostatic element.
f. Refrigerant dryer.
g. High-pressure switch.
h. Low-pressure switch.
i. Thermostat for coil freeze-up protection during low ambient temperature operation or loss of air.
j. Low ambient temperature switch.
k. Brass service valves installed in discharge and liquid lines.
3. Water-Cooled Condenser:
a. Description: Factory assembled and tested; tube in tube coaxial type with water-regulating valve.
b. Tubing: Nonferrous **OR** Copper **OR** Cupro-nickel, **as directed,** inner tube; steel with corrosion-resistant coating; refrigerant and water-side leak tested to 400 psig (2760 kPa) underwater.
4. Water-Side Economizer Section:
a. Description: Factory assembled and tested; consisting of water coil, modulating valves, controls, piping with cleanouts, and access panels.
b. Water Coil: Two **OR** Four rows, **as directed**, copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), and copper **OR** cast-iron, **as directed** headers; leak tested to 300 psig (2070 kPa) underwater; and having a two-position control valve.

E. Heating Coil
1. Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm); leak tested to 300 psig (2070 kPa) underwater; and having a two-position control valve.
2. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow-proving device; and one-time fuses in terminal box for overcurrent protection.

F. Controls
1. Control Package: Factory wired, including contactor, high- and low-pressure cutouts, internal-winding thermostat for compressor, control-circuit transformer, and noncycling reset relay.
2. Time-Delay Relay: Five-minute delay to prevent compressor cycling.
3. Adjustable Thermostat: Unit mounted **OR** Remote, **as directed**, to control the following:
a. Supply fan.
b. Compressor.
c. Condenser.

d. Hot-water coil valve.
e. Electric heater.
4. System Selector Switch: Heat-off-cool **OR** Off-heat-auto-cool, **as directed**.
5. Fan Control Switch: Auto-on.
6. Time Clock, **as directed**: Cycle unit on and off.
7. Microprocessor Control Panel: Controls unit functions, including refrigeration and safety controls, and the following:
a. Supply fan.
b. Supply-fan motor speed.
c. Compressors.
d. Air-cooled condenser.
e. Cooling tower pump.
f. Modulating, hot-water coil valve.
g. Multistep, electric heater.
h. Time-of-day control to cycle unit on and off.
i. Night-heat, morning warm-up cycle.
j. Economizer control.
k. Panel-mounted control switch to operate unit in remote or local control mode, or to stop or reset.
l. Panel-mounted indication of the following:
1) Operating status.
2) System diagnostics and safety alarms.
3) Supply-air temperature set point.
4) Zone heating-temperature set point.
5) Supply-air pressure set point.
6) Economizer minimum position set point.
7) Supply-air-pressure, high-limit set point.
8) Monitor constant and variable motor loads.
9) Monitor variable-frequency drive operation.
10) Monitor economizer cycle.
11) Monitor cooling load.
12) Monitor air distribution static pressure and ventilation air volumes.

G. Evaporator Coil
1. Direct-Expansion Coil: Seamless copper tubes expanded into aluminum fins.
a. Corrosion-Resistant Treatment, **as directed**: Phenolic coating applied with multiple dips and baked.
2. Refrigerant Circuits: A separate circuit for each compressor, with externally equalized thermal-expansion valve with adjustable superheat, **as directed**, filter-dryer, sight glass, high-pressure relief valve, **as directed**, and charging valves.

H. Remote Air-Cooled Condenser
1. Description: Factory assembled and tested; consisting of condenser coil, fans and motors, and operating controls; suitable for roof mounting.
a. Condenser Coil: Aluminum-fin copper tube with integral subcooler; leak tested to 450 psig (3110 kPa).
b. Condenser Fans: Direct-drive propeller type.
c. Fan Motors: Three-phase, permanently lubricated, ball-bearing motors with built-in thermal-overload protection. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
d. Refrigerant Line Kits: Annealed-copper suction and liquid lines that are factory cleaned, dried, pressurized, and sealed; insulated suction line; flared fittings at evaporator end, no fitting at condenser end; and service valves for both suction and liquid lines.
e. Terminate suction and liquid refrigerant piping with service valves within unit.
f. Low Ambient Control: Cycles fans to permit operation down to 45 deg F (7 deg C).

OR
Low Ambient Control: Cycles fans and modulates condenser fan damper assembly to permit operation down to 0 deg F (minus 18 deg C).
g. Coil Guard: Painted galvanized steel with louvered grilles.
h. Corrosion-Resistant Treatment: Phenolic coating applied in multiple dips and baked.

I. Integral Air-Cooled Condenser For Units 15 Tons (50 kW) And Smaller
1. Description: Factory assembled and tested; consisting of condenser coil, fans and motors, and cabinet.
a. Condenser Coil: Aluminum-fin copper tube with integral subcooler; leak tested to 425 psig (2930 kPa).
b. Condenser Fan: Direct-drive propeller type with permanently lubricated motor with built-in thermal-overload protection.
c. Low Ambient Control: Cycles fans to permit operation down to 0 deg F (minus 18 deg C).

J. Air Filters
1. Permanent Filters: 1-inch- (25-mm-) thick, cleanable panel filters.
OR
Disposable Filters: 1-inch- (25-mm-) **OR** 2-inch- (50-mm-), **as directed**, thick, glass-fiber, flat **OR** pleated, **as directed**, panel filters.
OR
Extended-Surface, Disposable Panel Filters: 2-inch- (50-mm-) **OR** 4-inch- (100-mm-), **as directed**, thick, dry, filters with fibrous media material formed into deep-V-shaped pleats and held by self-supporting wire grid holding frames, with nonflammable cardboard media and media-grid frame.
a. Efficiency: ASHRAE 52.2 MERV rating of 6 or higher.
2. Air-Pressure Switch (for units larger than 15 tons (50 kW)): Indicates dirty filters.

K. Accessories:

1. Manual outdoor-air damper.
2. Motorized outdoor-air damper.
3. Air-side economizer.
4. Water-side economizer.
5. Hot-gas bypass.
6. Air Pressure Switch: Indicates when differential pressure exceeds set point representing dirty filters.

L. Single-Point Electrical Characteristics:

1. Volts: 120 **OR** 208 **OR** 230 **OR** 460**, as directed**.
2. Phase: Single **OR** Three**, as directed**.
3. Hertz: 60.
4. Full-Load Amperes: **as directed**.
5. Minimum Circuit Ampacity: **as directed**.
6. Maximum Overcurrent Protection: **as directed**.

1.3 EXECUTION

A. Installation
1. Install units level and plumb.
2. Anchor units to structure.
3. Install seismic restraints.
4. Install static-pressure probe (for units larger than 15 tons (50 kW) equipped with inlet vanes).

5. Install water-cooled units with thermometer and pressure gage at the water supply and return connection.
6. Install vibration spring isolators under base of unit, with minimum static deflection of 1 inch (25 mm). Refer to Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".

B. Connections
1. Piping installation requirements are specified in other Division 21. Drawings indicate general arrangement of piping, fittings, and specialties.
   a. Water Coil Connections: Comply with requirements in Division 23 Section "Hydronic Piping". Connect to supply and return coil with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.
   b. Water-Cooled Condenser Connections: Comply with requirements in Division 23 Section "Hydronic Piping". Connect to supply and return with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.
2. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
3. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts". Drawings indicate the general arrangement of ducts. Connect supply and return, **as directed**, ducts to self-contained air-conditioners with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories".

C. Field Quality Control
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
2. Perform tests and inspections.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
3. Tests and Inspections:
   a. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Units will be considered defective if they do not pass tests and inspections.
5. Prepare test and inspection reports.

D. Startup Service
1. Engage a factory-authorized service representative to perform **OR** perform startup service, **as directed**.

E. Demonstration
1. Engage a factory-authorized service representative to train **OR train** the Owner's maintenance personnel, **as directed** to adjust, operate, and maintain units.

END OF SECTION 23 74 16 13a

SECTION 23 74 16 13b - UNIT VENTILATORS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for unit ventilators. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes unit ventilators and accessories with the following heating and cooling features:
      a. Hydronic, Steam, and Electric heating coil.
      b. Hydronic, Steam,and Electric reheat coil.
      c. Hydronic and Direct-expansion refrigerant cooling coil.

C. Definitions
   1. BAS: Building automation system.
   2. HGBP: Hot-gas bypass.

D. Submittals
   1. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for each unit type and configuration.
   2. LEED Submittals:
      a. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.
      b. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
   3. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      a. Plans, elevations, sections, and details.
      b. Details of anchorages and attachments to structure and to supported equipment.
      c. Wiring Diagrams: Power, signal, and control wiring.
   4. Manufacturer Seismic Qualification Certification: Submit certification that unit ventilators, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
   5. Field quality-control test reports.
   6. Operation and maintenance data.
   7. Warranty: Special warranty specified in this Section.

E. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   2. Comply with NFPA 70.
   3. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
   4. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

F. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Compressor failure.
      2) Condenser coil leak.
   b. Warranty Period: Four **OR** Five **OR** 10, **as directed**, years from date of Final Completion.
   c. Warranty Period (Compressor Only): Five **OR** 10, **as directed**, years from date of Final Completion.
   d. Warranty Period (Condenser Coil Only): Five years from date of Final Completion.

1.2 PRODUCTS

A. Manufactured Units
   1. Description: Factory-packaged and -tested units rated according to ARI 840, ASHRAE 33, and UL 1995, including finished cabinet, filter, cooling coil, drain pan, supply-air fan and motor in blow-through **OR** draw-through, **as directed**, configuration, and hydronic cooling coil.

B. Cabinets
   1. Insulation: Minimum 1/2-inch (13-mm) **OR** 1-inch (25-mm), **as directed**, thick, coated glass fiber **OR** foil-covered, closed-cell foam **OR** matte-finish, closed-cell foam, **as directed**, complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
      a. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
      b. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
   2. Drain Pans: Plastic **OR** Insulated galvanized steel with plastic liner, **as directed**, formed as required by ASHRAE 62.1. Drain pan shall be removable, **as directed**.
   3. Cabinet Frame and Access Panels: Welded-steel frame with removable panels fastened with hex-head tamperproof fasteners and key-operated control and valve access doors, **as directed**.
      a. Steel components exposed to moisture shall be hot-dip galvanized after fabrication.
   4. Cabinet Finish: Baked-on primer ready for field painting.
   5. Cabinet Finish: Baked enamel, in manufacturer's standard **OR** custom, **as directed**, paint color as selected by the Owner.
   6. Indoor-Supply-Air Grille: Steel **OR** Aluminum, **as directed**, double deflection, adjustable **OR** adjustable linear bar, **as directed**.
   7. Return-Air Inlet: Front toe space **OR** Back inlet with top inlet grille, **as directed**.
   8. End Panels: Matching material and finish of unit ventilator.
   9. Outdoor-Air Wall Box: Minimum 0.1265-inch- (3.2-mm-) thick, aluminum, rain-resistant louver and box with integral eliminators and bird screen.
      a. Louver Configuration: Horizontal **OR** Vertical, **as directed**, rain-resistant louver.
      b. Louver Material: Aluminum **OR** Steel, **as directed**.
      c. Bird Screen: 1/2-inch (13-mm) mesh screen on interior side of louver.
      d. Decorative Grille: On outside of intake.
      e. Finish: Anodized aluminum **OR** Baked enamel, **as directed**, color as selected by the Owner from manufacturer's standard **OR** custom, **as directed**, colors.

C. Coils
   1. Test and rate unit ventilator coils according to ASHRAE 33.
   2. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), rated for a minimum working pressure of 200 psig (1378 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain valve.

3. Steam Coils: Copper distributing, **as directed**, tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), rated for a minimum working pressure of 75 psig (517 kPa).
4. Electric-Resistance Heating Coils: Nickel-chromium heating wire or tubular elements in coil fins, free of expansion noise and hum, with fuses in terminal box for overcurrent protection, and continuous limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
5. Indoor Refrigerant Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), and brazed joints at fittings. Comply with ARI 210/240, and leak test to minimum 450 psig (3105 kPa) for a minimum 300-psig (2070-kPa) working pressure. Include thermal expansion valve.

D. Indoor Fan
1. Fan and Motor Board: Removable.
   a. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels; and aluminum, painted-steel, or galvanized-steel fan scrolls.
   b. Fan Shaft and Bearings: Hollow steel shaft with permanently lubricated, resiliently mounted bearings.
   c. Motor: Permanently lubricated, multispeed, resiliently mounted on motor board. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
   d. Wiring Termination: Connect motor to chassis wiring with plug connection.

E. Dampers
1. Mixing Dampers: Galvanized-steel blades with edge and end seals and nylon bearings; with electric **OR** pneumatic, **as directed**, actuator.
2. Outdoor-Air Dampers: Galvanized-steel blades with edge and end seals and nylon bearings; with electric **OR** pneumatic, **as directed**, actuator.
3. Face and Bypass Dampers: Galvanized-steel damper blades with edge and end seals and nylon bearings; with factory-mounted electric **OR** pneumatic, **as directed**, actuator.
4. Comply with ASHRAE/IESNA 90.1.

F. Accessories
1. Exhaust Shutter: Barometric **OR** Motorized, modulating, **as directed**, type designed to limit room pressure to maximum 0.10-inch wg (25 kPa) with steel **OR** aluminum **OR** fabric, **as directed**, damper blades including edge and end seals, in galvanized-steel frame with outdoor **OR** indoor **OR** outdoor and interior, **as diredcted**, wall grille.
2. Subbase: Sheet metal floor-mounting base with leveling screws and black enamel finish.
3. Insulated false back with gasket seals on wall and outdoor-air plenum.
   a. Insulation: Minimum 1/2-inch (13-mm) **OR** 1-inch (25-mm), **as directed**, thick, coated glass fiber **OR** foil-covered, closed-cell foam **OR** matte-finish, closed-cell foam, **as directed**, complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
      1) Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
      2) Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
4. Return-air plenum, 6 inches (150 mm) thick, designed to take return air from top inlet grilles in cabinets on both sides of unit ventilator with gasket seals on wall and outdoor-air plenum extension.
5. Duct flanges for supply-, return-, and outdoor-air connections.
6. Radiation Grille: Steel **OR** Aluminum, **as directed**, linear-bar **OR** stamped, **as directed**, grille with finish to match discharge-air grille.

7. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
   a. Washable Foam: 70 percent arrestance and 3 MERV.
      OR
      Glass Fiber Treated with Adhesive: 80 percent arrestance and 5 MERV.
      OR
      Pleated Cotton-Polyester Media: 90 percent arrestance and 7 MERV.
8. Energy Recovery Wheel:
   a. Casing: Steel with manufacturer's standard paint coating and with the following:
      1) Integral purge section.
      2) Casing seals on periphery of rotor, on duct divider, and on purge section.
      3) Support rotor on grease-lubricated ball bearings with extended grease fittings. Mount horizontal wheels on tapered roller bearing.
   b. Rotor: Corrugated-aluminum, segmented wheel strengthened with radial spokes, and having nontoxic, noncorrosive silica-gel desiccant coating. Construct media for passing maximum 800-micrometer solids and maximum 0.04 percent cross contamination by volume of exhaust air. Drive rotor with belt around outside of rotor.
   c. Defrost Coils: Electric defrost coil in the exhaust airstream.
   d. Drive: Fractional horsepower motor and gear reducer, with speed changed by adjustable variable frequency controller.
   e. Inlet and Discharge Fans: Forward curved, centrifugal; resiliently mounted with flexible duct connections.
      1) Motor and Drive: Permanently lubricated, direct driven. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
   f. Filters: 1-inch- (25-mm-) thick, disposable type, mounted in galvanized-steel frame upstream of energy recovery wheel in both supply and exhaust airstreams.
   g. Electrical: Single electrical connection from attached unit ventilator.

G. Factory Hydronic Piping Package
1. Piping: ASTM B 88, Type L (ASTM B 88M, Type B) **OR** ASTM B 88, Type M (ASTM B 88M Type C), **as directed**, copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet. Crossover piping, NPS 1-1/2 (DN 40) **OR** NPS 2 (DN 50), **as directed**, with shutoff valves.
2. Control Valves: Electric **OR** Pneumatic, **as directed**, actuators compatible with terminal controller and building controls.
   a. Two **OR** Three, **as directed**,-way, two-position **OR** modulating, **as directed**, control valve for dual-temperature-water coil.
   b. Two **OR** Three, **as directed**,-way, two-position **OR** modulating, **as directed**, control valve for chilled-water coil.
   c. Two **OR** Three, **as directed**,-way, two-position **OR** modulating, **as directed**, control valve for hot-water heating coil.
   d. Two **OR** Three, **as directed**,-way, two-position **OR** modulating, **as directed**, control valve for hot-water reheat coil.
3. Hose Kits: Minimum 400-psig (2758-kPa) working pressure, and operating temperatures from 33 to 211 deg F (0.5 to 99 deg C). Tag hose kits to equipment designations.
   a. Length: 24 inches (600 mm) **OR** 36 inches (900 mm), **as directed**.
   b. Minimum Diameter: Equal to unit ventilator connection size.
4. Isolation Valves, Strainers, Unions, and Balance Valves:
   a. Two-Piece Ball Valves: Bronze body with stainless-steel ball and stem and galvanized-steel lever handle for each supply and return connection. If balancing device is combination shutoff type with memory stop, isolation valve may be omitted on the return.
   b. Calibrated-Orifice Balancing Valves: Bronze body, ball type; 125-psig (860-kPa) working pressure, 250 deg F (121 deg C) maximum operating temperature; with calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, threaded ends, and equipped with a memory stop to retain set position.

c. Automatic Flow-Control Valve: Brass or ferrous-metal body; 300-psig (2070-kPa) working pressure at 250 deg F (121 deg C), with removable, corrosion-resistant, tamperproof, self-cleaning piston spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of 2 to 80 psig (13.8 to 552 kPa).
d. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A 126, Class B); 125-psig (860-kPa) working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 (DN 15) hose-end, full-port, ball-type blowdown valve in drain connection.
e. Wrought-Copper Unions: ASME B16.22.

H. Remote Condensing Units
1. Description: Factory assembled and tested; consisting of compressors, condenser coils, fans, motors, refrigerant receiver, and operating controls. Construct, test, and rate condensing units according to ARI 210/240 and ASHRAE 15.
2. Casing: Steel with baked-enamel finish; removable panels for access to controls, weep holes for water drainage, and mounting holes in base.
   a. Casing Finish: Baked enamel, in manufacturer's standard **OR** custom, **as directed**, paint color as selected by the Owner.
3. Compressor: Hermetic, scroll **OR** reciprocating, **as directed**, type; internally isolated for vibration with factory-installed safety devices as follows:
   a. Antirecycle timer.
   b. High-pressure cutout.
   c. Low-pressure cutout or loss-of-charge switch.
   d. Internal thermal-overload protection.
   e. Current and voltage sensitive safety devices.
4. Compressor Motor: Start capacitor, relay, and contactor. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
5. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Standard for Buildings except Low-Rise Residential Buildings."
6. Refrigerant Piping Materials:
   a. Drawn-Temper Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B).
   b. Annealed-Temper Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) **OR** ASTM B 88, Type K (ASTM B 88M, Type A), **as directed**.
   c. Wrought-Copper Fittings: ASME B16.22.
7. Refrigerant: R-407C **OR** R-410A, **as directed**.
8. Low ambient controls to permit operation down to 45 deg F (7 deg C).
9. Crankcase heater.
10. Charging and service fittings on exterior of casing.
11. Filter dryer.
12. Air-to-Air Heat Pump: Pilot-operated, sliding-type reversing valve with replaceable magnetic coil, and controls for air-to-air heat pump operation with supplemental heat.
13. HGBP, constant-pressure expansion valve and controls to maintain continuous refrigeration system operation at 10 percent of full load.
14. Condenser: Copper-tube, aluminum-fin coil, with liquid subcooler.
15. Condenser Fan: Direct-drive, aluminum propeller fan; motor with thermal-overload protection.
   a. Motor: Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
16. Accessories: Polyethylene mounting base to provide a permanent foundation.

I. Integral Cooling Chassis
1. Description: Assembly mounted within unit ventilator, factory assembled and tested; consisting of compressors, condenser coils, fans, motors, and refrigerant receivers; removable for maintenance, with plug and receptacle connections for control and power wiring. Construct, test, and rate condensing units according to ARI 210/240 and ASHRAE 15.
2. Casing: Galvanized steel with removable panels for access to controls and refrigerant piping.
3. Exterior Louver: Extruded aluminum.

4. Compressor: Hermetic, scroll **OR** reciprocating, **as directed**, type; internally isolated for vibration with factory-installed safety devices as follows:
    a. Antirecycle timer.
    b. High-pressure cutout.
    c. Low-pressure cutout or loss-of-charge switch.
    d. Internal thermal-overload protection.
    e. Current- and voltage-sensitive safety devices.
5. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Standard for Buildings except Low-Rise Residential Buildings."
6. Refrigerant Piping Materials:
    a. Drawn-Temper Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B).
    b. Annealed-Temper Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) **OR** ASTM B 88, Type K (ASTM B 88M, Type A), **as directed**.
    c. Wrought-Copper Fittings: ASME B16.22.
7. Refrigerant: R-407C **OR** R-410A, **as directed**.
8. Low ambient controls to permit operation down to 45 deg F (7 deg C).
9. Crankcase heater.
10. Charging and service fittings.
11. Filter dryer.
12. Air-to-Air Heat Pump: Pilot-operated, sliding-type reversing valve with replaceable magnetic coil, and controls for air-to-air heat pump operation with supplemental heat.
13. HGBP, constant-pressure expansion valve and controls to maintain continuous refrigeration system operation at 10 percent of full load.
14. Condenser: Copper-tube, aluminum-fin coil, with liquid subcooler.
15. Direct-Driven Condenser Fan: Forward curved, double width, centrifugal; thermoplastic or painted-steel wheels and galvanized-steel fan scrolls.
    a. Motor: Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".

J. Basic Unit Controls
1. Control devices and operational sequences are specified in Division 23 Section(s) "Instrumentation And Control For Hvac" AND "Sequence Of Operations For Hvac Controls".
   OR
   Basic Unit Controls:
    a. Control voltage transformer.
    b. Wall-mounting **OR** Unit-mounted, **as directed**, thermostat with the following features.
        1) Heat-cool-off switch.
        2) Fan on-auto switch.
        3) Fan-speed switch.
        4) Manual **OR** Automatic, **as directed**, changeover.
        5) Adjustable deadband.
        6) Concealed **OR** Exposed, **as directed**, set point.
        7) Concealed **OR** Exposed, **as directed**, indication.
        8) Degree F **OR** Degree C, **as directed**, indication.
    c. Wall-mounting **OR** Unit-mounted, **as directed**, humidistat.
        1) Concealed **OR** Exposed, **as directed**, set point.
        2) Concealed **OR** Exposed, **as directed**, indication.
    d. Wall-mounting **OR** Unit-mounted, **as directed**, temperature sensor.
    e. Unoccupied-period-override push button.
    f. Data entry and access port.
        1) Input data includes room temperature and humidity set points, and occupied and unoccupied periods.
        2) Output data includes room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status.
2. DDC, **as directed**, Terminal Controller:

a. Safety Controls Operation: Freezestat shall stop fan and close outdoor-air damper if air less than 38 deg F (3 deg C) enters coils.
b. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
c. Unoccupied Period Override Operation: Two, **as directed**, hours.
d. Dual-Temperature Coil Operation:
   1) Occupied Periods: When chilled water is available, open **OR** modulate, **as directed**, control valve if room temperature exceeds thermostat set point. When hot water is available, open **OR** modulate, **as directed**, control valve if room temperature falls below thermostat set point.
   2) Unoccupied Periods: When chilled water is available, close control valve. When hot water is available, open **OR** modulate, **as directed**, control valve if room temperature falls below thermostat setback temperature.
e. Hydronic Cooling-Coil Operation:
   1) Occupied Periods: Open **OR** Modulate, **as directed**, control valve to provide cooling if room temperature exceeds thermostat set point.
   2) Unoccupied Periods: Close control valve.
f. Refrigerant-Coil Operation:
   1) Occupied Periods: Start compressor to maintain room temperature.
   2) Unoccupied Periods: Stop compressor cooling **OR** Cycle compressor for heating to maintain setback temperature, **as directed**.
g. Supplemental, **as directed**, Heating-Coil Operation:
   1) Occupied Periods: Open control valve **OR** Modulate control valve **OR** Energize electric-resistance coil, **as directed**, to provide heating if room temperature falls below thermostat set point.
   2) Unoccupied Periods: Start fan and open control valve **OR** modulate control valve **OR** energize electric-resistance coil, **as directed**, if room temperature falls below setback temperature.
   3) Switch refrigerant-reversing valve to operate supplemental coil for heating when outdoor temperature is below 25 deg F (4 deg C).
h. Reheat-Coil Operation:
   1) Humidity Control for Occupied Periods: Humidistat opens control valve **OR** modulates control valve **OR** energizes electric-resistance coil, **as directed**, to provide heating. As room temperature rises above the set point, cooling coil valve opens **OR** modulates, **as directed**, to maintain room temperature.
   2) Humidity Control for Unoccupied Periods: Close control valve **OR** De-energize, **as directed**.
i. Outdoor-Air Damper Operation: Open to 25 percent fixed minimum intake during occupied periods, and close during unoccupied periods.
j. Outdoor-Air Damper Operation: Open to 25 percent fixed minimum intake, and maximum 100 percent of the fan capacity to comply with ASHRAE Cycle II during occupied periods, and close during unoccupied periods. Microprocessor controller shall permit air-side economizer operation when outdoor air is less than 60 deg F (15 deg C).
k. Carbon Dioxide Sensor Operation: During occupied periods, reset minimum outdoor-air ratio down to minimum 10 percent to maintain maximum 800-ppm concentration.
l. Face-and-Bypass Damper Operation: Position damper to face of coils until room temperature equals thermostat set point; bypass after room-temperature set point is achieved.
m. Cooling Lockout: During economizer cycle operation, block out cooling.
n. HGBP: Open HGBP solenoid valve to maintain minimum suction pressure at compressor.
o. Energy Recovery Wheel Operation:
   1) Factory-mounted and -wired, starting relay and manual motor starter for field wiring.
   2) Occupied period is established by remote signal **OR** room occupancy sensor, **as directed**.
   3) Energy recovery wheel and inlet and discharge fans operate during occupied periods after room temperature set point has been achieved.

4) Energy recovery wheel operates during occupied periods, but stops when unit ventilator controls call for cooling, and outdoor-air temperatures permit free air cooling.
5) Energy recovery wheel and fans stop during unoccupied periods.

p. Controller shall have volatile-memory backup.

3. BAS Interface Requirements:
   a. Interface relay for scheduled operation.
   b. Interface relay to provide indication of fault at the central workstation.
   c. Provide BACnet **OR** LonWorks, **as directed**, interface for central BAS workstation for the following functions:
      1) Adjust set points.
      2) Unit ventilator start, stop, and operating status.
      3) Data inquiry to include outdoor-air damper position, **as directed**, supply- and room-air temperature and humidity, **as directed**.
      4) Occupied and unoccupied schedules.
4. Electrical Connection: Factory wire motors and controls for a single electrical connection.

K. Metal Shelves And Cabinets
1. Include manufacturer's standard cabinets to match unit ventilators with required installation hardware as indicated:
   a. Open Shelving with Reinforced Shelves:
      1) Return-air plenum **OR** Radiation enclosure, **as directed**, and aluminum bar grille with finish to match unit ventilator grille.
      2) Through-piping enclosure with solid top.
   b. Closed Shelving with Reinforced Shelves:
      1) Return-air plenum **OR** Radiation enclosure, **as directed**, and aluminum bar grille with finish to match unit ventilator grille.
      2) Through-piping enclosure with solid top.
      3) Two sliding doors with key-operated locks.
   c. Utility compartment with access panel with key-operated lock.
   d. Wall and corner filler sections, and end panels finished to match shelving.
2. Painted Finish: Manufacturer's standard **OR** custom, **as directed**, baked enamel, in color selected by the Owner, applied to shelving before shipping.
3. Cabinet Top: Plastic-laminate top in color and pattern selected by the Owner from manufacturer's standard **OR** custom, **as directed**, colors.

1.3 EXECUTION

A. Installation
1. Install unit ventilators to comply with NFPA 90A.
2. Suspend horizontal unit ventilators from structure with threaded steel rods and minimum 0.25-inch (6.35-mm) static-deflection, elastomeric vibration isolation hanger **OR** 1.0-inch (25-mm) static-deflection spring hangers, **as directed**. Vibration isolators are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
3. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches (1220 mm) **OR** 60 inches (1525 mm), **as directed**, above finished floor.
4. Refer to Division 23 Section "Packaged Compressor And Condenser Units" for condensing units matched to refrigerant cooling coil packaged in unit ventilators.

B. Connections
1. Piping installation requirements are specified in other Division 21. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
   a. Install piping adjacent to machine to allow service and maintenance.

b. Connect piping to unit ventilator factory hydronic piping package. Install piping package if shipped loose.
c. Connect condensate drain to indirect waste.
2. Install refrigerant piping as required by Division 23 Section "Refrigerant Piping", and add refrigerant as required to compensate for length of piping.
3. Connect supply and return ducts to unit ventilators with flexible duct connectors specified in Division 23 Section "Air Duct Accessories". Comply with safety requirements in UL 1995 for duct connections.
4. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
5. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Field Quality Control
1. Perform the following field tests and inspections and prepare test reports:
a. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
b. Operate electric heating elements through each stage to verify proper operation and electrical connections.
c. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
d. Record temperatures entering and leaving energy recovery wheel when outdoor-air temperature is a minimum of 15 deg F (8.3 deg C) higher, or 20 deg F (11 deg C) lower, than room temperature.
2. Remove and replace malfunctioning units and retest as specified above.

D. Adjusting
1. Adjust initial temperature and humidity set points.
2. Occupancy Adjustments: When requested within 12 months of date of Final Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

E. Demonstration
1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain unit ventilators.

END OF SECTION 23 74 16 13b

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Task	Specification	Specification Description
23 74 16 13	07 72 13 00	Packaged, Outdoor, Central-Station Air-Handling Units

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SECTION 23 74 23 13 - DIRECT-FIRED, MAKEUP AIR UNITS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for direct-fired H&V units. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes direct-fired H&V units with an evaporative cooling package, **as directed**.

C. Submittals

1. Product Data: Include rated capacities, furnished specialties, and accessories.
2. LEED Submittal:
   a. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
3. Shop Drawings:
   a. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
   b. Wiring Diagrams: Power, signal, and control wiring.
4. Operation and maintenance data.

D. Quality Assurance

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. Comply with NFPA 70.
3. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
4. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.2 PRODUCTS

A. Packaged Units

1. Factory-assembled, prewired, self-contained unit consisting of cabinet, supply fan, controls, filters, **as directed**, evaporative cooling package, **as directed**, and direct-fired gas furnace to be installed outside **OR** inside, **as directed**, the building.

B. Cabinet

1. Cabinet: Single-wall **OR** Double-wall, **as directed**, galvanized-steel panels, formed to ensure rigidity and supported by galvanized-steel channels or structural channel supports with lifting lugs. Cabinet shall be fully weatherized for outside installation, **as directed**.
2. Access Panels: Lift-out **OR** Piano hinged with cam-lock fasteners, **as directed**, for furnace and fan motor assemblies on both sides of unit.
3. Internal Insulation: Fibrous-glass duct lining, comply with ASTM C 1071, Type II, applied on complete unit **OR** furnace and fan sections only, **as directed**.
   a. Thickness: 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**.
   b. Insulation Adhesive: Comply with ASTM C 916, Type I.

c. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to casing without damaging liner when applied as recommended by manufacturer and without causing air leakage.

4. Finish: Heat-resistant, baked enamel.
5. Discharge: Horizontal **OR** Vertical, **as directed**,-pattern, galvanized-steel assembly with diffusers incorporating individually adjustable vanes.
6. Roof Curb: Full-perimeter curb of sheet metal, minimum 16 inches (400 mm) high, with wood nailer, neoprene sealing strip, and welded Z-bar flashing.
7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Supply-Air Fan
1. Fan Type: Centrifugal, rated according to AMCA 210; statically and dynamically balanced, galvanized steel; mounted on solid-steel shaft with heavy-duty, self-aligning, permanently lubricated ball bearings **OR** pillow-block bearings rated for L50 or 200,000 hours with external grease fittings, **as directed**.
2. Motor: Open dripproof **OR** Totally enclosed, **as directed**, single **OR** two, **as directed**,-speed motor.
3. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly.
4. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with restrained, **as directed**, elastomeric **OR** spring, **as directed**, isolators.

D. Outdoor-Air Intake
1. Outdoor-Air Hood: Galvanized steel with rain baffles, bird screen complying with ASHRAE 62.1, **as directed**, and finish to match cabinet; and sized to supply maximum 100 percent outdoor air.

E. Air Filters
1. Comply with NFPA 90A.
2. Cleanable Filters: 1-inch- (25-mm-) **OR** 2-inch-0 (50-mm-), **as directed**, thick, cleanable metal mesh.
3. Disposable Panel Filters: 1-inch- (25-mm-) **OR** 2-inch- (50-mm-), **as directed**, thick, factory-fabricated, flat-panel-type, disposable air filters with holding frames, with a minimum efficiency report value of 6 according to ASHRAE 52.2 and 90 percent average arrestance according to ASHRAE 52.1, **as directed**.
   a. Media: Interlaced glass **OR** polyester, **as directed**, fibers.
   b. Frame: Galvanized steel.

F. Dampers
1. Outdoor-Air and Return-Air, **as directed**, Damper: Galvanized-steel, opposed-blade dampers with vinyl blade seals and stainless-steel jamb seals, having a maximum leakage of 10 cfm/sq. ft. (51 L/s per sq. m) of damper area, at differential pressure of 2-inch wg (448 Pa).
2. Fan-Discharge Dampers: Galvanized-steel, opposed-blade damper.
3. Balancing/Bypass Dampers: Galvanized-steel, opposed-blade damper.
4. Damper Operator: Direct coupled, electronic with spring return or fully modulating as required by the control sequence.

G. Direct-Fired Gas Furnace
1. Description: Factory assembled, piped, and wired; and complying with ANSI Z83.4, "Direct Gas-Fired Make-Up Air Heaters"; ANSI Z83.18, "Direct Gas-Fired Industrial Air Heaters"; and NFPA 54, "National Fuel Gas Code."
2. Inside Unit External Housing: Steel cabinet with integral support inserts.
3. Outside Unit External Housing: Weatherproof steel cabinet with integral support inserts.
   a. External Casing and Cabinet Finish: Baked enamel **OR** Powder coating, **as directed**, over corrosion-resistant-treated surface in color to match fan section.
4. Burners: Cast-iron burner with stainless-steel mixing plates.

a. Control Valve: Single stage **OR** Two stage **OR** Modulating with minimum turndown ratio of 25:1or as otherwise directed**, as directed**.
b. Fuel: Natural **OR** Propane, **as directed**, gas.
c. Pilot: Electrically ignited by hot-surface ceramic igniter.

5. Safety Controls:
a. Gas Manifold: Safety switches and controls to comply with ANSI standards **OR** FMG **OR** IRI, **as directed**.
b. Purge-Period Timer: Automatically delays burner ignition and bypasses low-limit control.
c. Airflow Proving Switch: Dual pressure switch senses correct airflow before energizing pilot and requires airflow to be maintained within minimum and maximum pressure settings across burner.
d. Manual-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.
e. Gas Train: Redundant, automatic main gas valves, electric pilot valve, hydraulic **OR** electronic, **as directed**,-modulating temperature control valve, main and pilot gas regulators, main and pilot manual shutoff valves, main and pilot pressure taps, and high-low gas pressure switches, **as directed**, to comply with IRI requirements **OR** to comply with FMG requirements, **as directed**.
f. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.
g. Control Transformer: Integrally mounted 24-V ac.

H. Evaporative Cooling Package
1. Cabinet: Single-wall **OR** Double-wall, **as directed**, galvanized- or aluminized-steel panels lined with ABS polymer, **as directed**, formed to ensure rigidity and supported by galvanized-steel channels or structural channel supports with lifting lugs and having a stainless-steel reservoir with overflow and drain with full-port, brass-fitted ball valve. Cabinet shall be fully weatherized for outside installation, **as directed**.
a. External Casing and Cabinet Finish: Baked enamel **OR** Powder coating, **as directed**, over corrosion-resistant-treated surface in color to match fan section.
2. Media: UL 900, Class 2, 6-inch- (150-mm-) **OR** 8-inch- (200-mm-) **OR** 12-inch- (300-mm-), **as directed**, thick cellulose **OR** glass-fiber, **as directed**, media with rigidizing agents, fungicides, and wetting agents. Minimum 90 percent contact factor.
a. Moisture elimination pad.
3. Water-Circulation System: Submersible centrifugal sump pump with inlet strainer, brass balancing valve located in pump discharge, and thermally protected motor; water distribution troughs or piping at top of media pads; and float-operated, makeup water and bleed-off valves.
a. Automatic Fill and Drain Kit: Water supply and drain, solenoid valves for initial sump fill and for draining sump.
4. Water-Saver System: Timer, solenoid valve, and water distribution piping to apply the water supply to the media.
5. Comply with applicable requirements in ASHRAE 62.1.

I. Controls
1. Factory-wired, fuse-protected control transformer, connection for power supply and field-wired unit to remote control panel.
2. Control Panel: Surface-mounted **OR** Recessed, with trim ring, **as directed**, remote panel, with engraved plastic cover, and the following lights and switches:
a. On-off **OR** On-off-auto, **as directed**, switch.
b. Summer-winter **OR** Heat-off-cool, **as directed**, switch. Automatic changeover, **as directed**.
c. Supply-fan operation indicating light.
d. Heating operation indicating light.
e. Damper position potentiometer.
f. Thermostat.
g. Cooling operation indicating light.

h. Dirty-filter indicating light operated by unit-mounted differential pressure switch.
i. Safety-lockout indicating light.

3. Refer to Division 23 Section "Instrumentation And Control For Hvac" for control equipment and sequence of operation.
4. Control Devices:
   a. Remote Thermostat: Adjustable room thermostat with temperature readout.
   b. Remote Setback Thermostat: Adjustable room thermostat without temperature readout.
   c. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
   d. Fire-Protection Thermostats: Fixed or adjustable settings to operate at not less than 75 deg F (24 deg C) above normal maximum operating temperature.
   e. Timers: Seven-day, programming-switch timer with synchronous-timing motor and seven-day dial; continuously charged, nickel-cadmium-battery-driven, eight-hour, power-failure carryover; multiple-switch trippers; minimum of two and maximum of eight signals per day with two normally open and two normally closed output contacts.
      OR
      Timers: Solid-state, programmable time control with 4 separate programs; 24-hour battery carryover; individual on-off-auto switches for each program; 365-day calendar with 20 programmable holidays; choice of fail-safe operation for each program; and system fault alarm.
   f. Ionization-Type Smoke Detectors: 24-V dc, nominal; self-restoring; plug-in arrangement; integral visual-indicating light; sensitivity that can be tested and adjusted in place after installation; integral addressable module; remote controllability; responsive to both visible and invisible products of combustion; self-compensating for changes in environmental conditions.
   g. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed. Equip with filtered circuit to eliminate radio interference.
5. Fan Control: Interlock fan to start with exhaust fan(s). See Division 23 Section(s) "Axial Hvac Fans" OR "Centrifugal Hvac Fans" OR "Hvac Power Ventilators" OR "Sequence Of Operations For Hvac Controls", **as directed**, for exhaust fan controls.
   OR
   Fan Control: Timer starts and stops direct-fired H&V unit and exhaust fan(s).
   a. Fan-Discharge Thermostat: Stops fan when discharge-air temperature is less than 40 deg F (4 deg C).
   b. Smoke detectors, located in supply and return, **as directed**, air, shall stop fans when the presence of smoke is detected.
   c. Controls two **OR** variable, **as directed**,-speed motor controller using speed switch on control panel **OR** variable-speed potentiometer on control panel **OR** static-pressure transmitter, **as directed**.
6. Outdoor-Air Damper Control, 100 Percent Outdoor-Air Units: Outdoor-air damper shall open when supply fan starts, and close when fan stops.
   OR
   Outdoor-Air and Fan-Discharge Damper Control, 100 Percent Outdoor-Air Units:
   a. Outdoor-air damper shall open when supply fan starts, and close when fan stops.
   b. Fan-discharge dampers shall operate to vary the amount of outdoor air to match exhaust-fan operation.

   OR
   Outdoor-Air and Balancing/Bypass Damper Control, Variable Outdoor-Air Units:
   a. Outdoor-air damper shall open when supply fan starts, and close when fan stops.
   b. Balancing/bypass dampers shall modulate to maintain minimum air velocity through burner.

   OR
   Outdoor-Air, Balancing/Bypass, and Return-Air Damper Control:
   a. Outdoor-air damper shall open when supply fan starts, and close when fan stops.

b. Return-air dampers shall modulate in response to potentiometer on control panel **OR** building pressure control, **as directed**.
c. Balancing/bypass dampers shall modulate to maintain minimum air velocity through the burner.

7. Temperature Control: Operates gas valve to maintain supply-air or room temperature.
   a. Operates gas valve to maintain discharge-air temperature with factory-mounted sensor in fan outlet.
      OR
      Operates gas valve to maintain space temperature with wall-mounting, field-wired sensor with temperature adjustment, **as directed**, and unit-mounted control adjustment **OR** and adjustment on remote control panel, **as directed**.
   b. Timer shall select remote setback thermostat to maintain space temperature at 50 deg F (10 deg C).
8. Evaporative Cooling Controls:
   a. Start and stop water-circulation-system sump pump to maintain space temperature.
   b. Automatic Fill Control: A switch in the unit control panel shall close sump drain valve and open makeup water valve.
   c. Automatic Drain Control: Opens sump drain valve and closes makeup water valve from a switch in the unit control panel **OR** when an outside thermostat senses 40 deg F (4 deg C) or less, **as directed**.
   d. Water-Saver System: Remote thermostat shall open water-supply valve to maintain dry-bulb temperature in space. Timer shall activate thermostat circuit.
9. DDC: Stand-alone control module for link between unit controls and DDC system. Control module shall be compatible with temperature-control system specified in Division 23 Section "Instrumentation And Control For Hvac".
   a. Provide start and stop interface relay, and relay to notify DDC system alarm condition.
   b. Provide hardware interface or additional sensors as follows:
      1) Room temperature.
      2) Discharge-air temperature.
      3) Furnace operating.

J. Motors
   1. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".

1.3 EXECUTION

A. Installation
   1. Install gas-fired units according to NFPA 54, "National Fuel Gas Code."
   2. Install roof curb on roof structure, according to ARI Guideline B **OR** NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts", **as directed**. Install and secure direct-fired H&V units on curbs, and coordinate roof penetrations and flashing with roof construction.
      OR
      Install restrained vibration isolation roof-curb rails on roof structure according to ARI Guideline B **OR** NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts", **as directed**. Install and secure direct-fired H&V units on rails, and coordinate roof penetrations and flashing with roof construction. Restrained isolation roof-curb rails are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
   3. Install suspended units from spring hangers with minimum 1-inch (25-mm) static deflection; refer to Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
      OR

Install floor-mounted units on restrained, **as directed**, spring isolators with minimum 1-inch (25-mm) static deflection; refer to Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
4. Install controls and equipment shipped by manufacturer for field installation with direct-fired H&V units.

B. Connections
1. Piping Connections: Drawings indicate general arrangement of piping, fittings, and specialties. Install piping adjacent to machine to allow service and maintenance.
    a. Gas Piping: Comply with requirements in Division 23 Section(s) "Facility Natural-gas Piping" OR "Facility Liquefied-petroleum Gas Piping", **as directed**. Connect gas piping with shutoff valve and union and with sufficient clearance for burner removal and service. Provide AGA-approved flexible connectors.
    b. Makeup Water: Comply with requirements in Division 22 Section "Domestic Water Piping" for valves and accessories on piping connections to evaporative cooling units.
    c. Drain: Comply with requirements in Division 22 Section "Sanitary Waste And Vent Piping" for traps and accessories on piping connections to evaporative cooling units.
2. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts". Drawings indicate the general arrangement of ducts. Connect supply and return, **as directed**, ducts to direct-fired H&V units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories".
3. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
4. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Startup Service
1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
    a. Inspect for visible damage to furnace combustion chamber.
    b. Inspect casing insulation for integrity, moisture content, and adhesion.
    c. Verify that clearances have been provided for servicing.
    d. Verify that controls are connected and operable.
    e. Verify that filters are installed.
    f. Purge gas line.
    g. Inspect and adjust vibration isolators and seismic restraints, **as directed**.
    h. Verify bearing lubrication.
    i. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
    j. Adjust fan belts to proper alignment and tension.
    k. Start unit according to manufacturer's written instructions.
    l. Complete startup sheets and attach copy with Contractor's startup report.
    m. Inspect and record performance of interlocks and protective devices; verify sequences.
    n. Operate unit for run-in period recommended by manufacturer.
    o. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:
        1) Measure gas pressure on manifold.
        2) Measure combustion-air temperature at inlet to combustion chamber.
        3) Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
    p. Calibrate thermostats.
    q. Adjust and inspect high-temperature limits.
    r. Inspect dampers, if any, for proper stroke and interlock with return-air dampers.
    s. Start evaporative cooler system and measure and record the following:
        1) Leaving-air, dry- and wet-bulb temperatures.
        2) Entering-air, dry- and wet-bulb temperatures.

t. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
u. Measure and record airflow. Plot fan volumes on fan curve.
v. Verify operation of remote panel, including pilot-operation and failure modes. Inspect the following:
   1) High-limit heat.
   2) Alarms.
w. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.

2. Remove and replace malfunctioning components that do not pass tests and inspections and retest as specified above.
3. Prepare written report of the results of startup services.

D. Adjusting
1. Adjust initial temperature set points.
2. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
3. Occupancy Adjustments: When requested within 12 months of date of Final Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

E. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain direct-fired H&V units.

END OF SECTION 23 74 23 13

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SECTION 23 74 23 13a - INDIRECT-FIRED, PACKAGED H&V UNITS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for indirect-fired, H&V units. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes indirect-fired H&V units with the following accessories:
a. Gas or Oil furnace.
b. Evaporative cooling package.

C. Submittals
1. Product Data: Include rated capacities, furnished specialties, and accessories.
2. Shop Drawings:
a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
b. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
c. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.
d. Wiring Diagrams: Power, signal, and control wiring.
3. Operation and maintenance data.
4. Warranty: Special warranty specified in this Section.

D. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. Comply with NFPA 70.

E. Warranty
1. Manufacturer's standard form in which manufacturer agrees to replace heat exchangers of indirect-fired H&V units that fail in materials or workmanship within five years **OR** 10 years, **as directed**, from date of Final Completion.

1.2 PRODUCTS

A. Packaged Units
1. Factory-assembled, prewired, self-contained unit consisting of cabinet, supply fan, controls, filters, evaporative cooling package, **as directed**, and indirect-fired gas **OR** oil, **as directed**, furnace to be installed outside **OR** inside, **as directed**, the building.

B. Cabinet
1. Cabinet: Single-wall **OR** Double-wall, **as directed**, galvanized-steel panels, formed to ensure rigidity and supported by galvanized-steel channels or structural channel supports with lifting lugs. Cabinet shall be fully weatherized for outside installation, **as directed**.
2. Access Panels: Lift-out **OR** Piano hinged with cam-lock fasteners, **as directed**, for furnace and fan motor assemblies on both sides of unit.

3. Internal Insulation: Fibrous-glass duct lining, comply with ASTM C 1071, Type II, applied on complete unit for outside unit or furnace and fan sections only for inside unit.
    a. Thickness: 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**.
    b. Insulation Adhesive: Comply with ASTM C 916, Type I.
    c. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to casing without damaging liner when applied as recommended by manufacturer and without causing air leakage.
4. Finish: Heat-resistant, baked enamel.
5. Discharge: Horizontal-pattern **OR** Vertical-pattern, **as directed**, galvanized-steel assembly with diffusers incorporating individually adjustable vanes.
6. Roof Curb: Full-perimeter curb of sheet metal, minimum 16 inches (400 mm), unless directed otherwise, high, with wood nailer, neoprene sealing strip, and welded Z-bar flashing.

C. Supply-Air Fan
1. Fan Type: Centrifugal, rated according to AMCA 210; statically and dynamically balanced, galvanized steel; mounted on solid-steel shaft with heavy-duty, self-aligning, permanently lubricated ball bearings **OR** pillow-block bearings rated for L50 or 200,000 hours with external grease fittings, **as directed**.
2. Motor: Open dripproof **OR** Totally enclosed, **as directed**, single-speed motor.
3. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly.
4. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with restrained (for seismic areas), elastomeric **OR** spring, **as directed**, isolators.

D. Outdoor-Air Intake
1. Outdoor-Air Hood: Galvanized steel with rain baffles, bird screen, and finish to match cabinet; and sized to supply maximum 30 percent **OR** 100 percent, **as directed**, outdoor air.

E. Air Filters
1. Comply with NFPA 90A.
2. Cleanable Filters: 1-inch- (25-mm-) **OR** 2-inch- (50-mm-), **as directed**, thick, cleanable metal mesh.
3. Disposable Panel Filters: 1-inch- (25-mm-) **OR** 2-inch- (50-mm-), **as directed**, thick, factory-fabricated, flat-panel-type, disposable air filters with holding frames, with a minimum efficiency report value of 6 according to ASHRAE 52.2 and 90 percent average arrestance according to ASHRAE 52.1.
    a. Media: Interlaced glass **OR** polyester, **as directed**, fibers.
    b. Frame: Galvanized steel.

F. Dampers
1. Outdoor-Air and Return-Air, **as directed**, Damper: Galvanized-steel, opposed-blade dampers with vinyl blade seals and stainless-steel jamb seals, having a maximum leakage of 10 cfm/sq. ft. (51 L/s per sq. m) of damper area, at differential pressure of 2-inch wg (448 Pa).
2. Damper Operator: Direct coupled, electronic with spring return or fully modulating as required by the control sequence.

G. Indirect-Fired Gas Furnace
1. Description: Factory assembled, piped, and wired; and complying with ANSI Z21.47, "Gas-Fired Central Furnaces," and NFPA 54, "National Fuel Gas Code."
    a. AGA Approval: Designed and certified by and bearing label of AGA.
    b. Burners: Aluminized steel with stainless-steel inserts **OR** Stainless steel, **as directed**.
        1) Gas Control Valve: Single stage **OR** Two stage **OR** Modulating, **as directed**.
        2) Fuel: Natural **OR** Propane, **as directed**, gas.
        3) Minimum Thermal Efficiency: 80 percent.
        4) Ignition: Electronically controlled electric spark with flame sensor.
        5) High-Altitude Model **OR** Kit, **as directed**: For Project elevation above sea level.

2. Venting: Gravity vented.
3. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve.
4. Combustion-Air Intake: Separate combustion-air intake and vent terminal assembly.
5. Inside Unit External Housing: Steel cabinet with integral support inserts and removable bottom arranged to serve as drain pan.
6. Outside Unit External Housing: Weatherproof steel cabinet with integral support inserts and removable bottom arranged to serve as drain pan.
   a. External Casing and Cabinet Finish: Baked enamel **OR** Powder coating, **as directed**, over corrosion-resistant-treated surface in color to match fan section.
7. Internal Casing: Aluminized steel, arranged to contain airflow, with duct flanges at inlet and outlet.
8. Heat Exchanger: Aluminized **OR** Stainless steel, **as directed**.
9. Heat-Exchanger Drain Pan: Stainless steel.
10. Safety Controls:
    a. Vent Flow Verification: Differential pressure switch to verify open vent **OR** Flame rollout switch, **as directed**.
    b. Control Transformer: 24-V ac.
    c. High Limit: Thermal switch or fuse to stop burner.
    d. Gas Train: Regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, hydraulic-modulating **OR** electronic-modulating, **as directed**, temperature control valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
    e. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.
    f. Gas Manifold: Safety switches and controls to comply with ANSI standards and FMG **OR** IRI, **as directed**.
    g. Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.
    h. Automatic-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.
    i. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.

H. Oil-Fired Furnace
1. Description: Factory assembled, piped, and wired; and complying with UL 727, "Oil-Fired Central Furnaces."
2. Inside Unit External Housing: Steel cabinet with integral support inserts and removable bottom arranged to serve as a drain pan.
3. Outside Unit External Housing: Weatherproof steel cabinet with integral support inserts and removable bottom arranged to serve as drain pan.
   a. External Casing and Cabinet Finish: Baked enamel **OR** Powder coating, **as directed**, over corrosion-resistant-treated surface in color to match fan section.
4. Internal Casing: Aluminized steel, arranged to contain airflow, with duct flanges at inlet and outlet.
5. Heat Exchanger: Welded, stainless steel, unless directed otherwise, with flame observation port, carbon dioxide sample port, and access panels for clean-out and service.
6. Burners: Flame-retention, pressure-atomizing, forced-draft, gun type; with integral fuel pump and electronic spark ignition.
   a. Fuel: No. 2, unless directed otherwise, fuel oil.
   b. Minimum Thermal Efficiency: 80 percent **OR** 81 percent, **as directed**.
   c. Ignition: Electronically controlled electric spark with flame sensor.
7. Safety Controls:
   a. Factory piped and wired to electrical junction box mounted on unit.
   b. Oil-pressure switch.
   c. Control Transformer: Integrally mounted 24-V ac.
   d. Cad-cell safety system.
   e. Manual reset flame safety.
8. Accessories:

a. Factory mounted and wired to electrical junction box on unit.
b. Oil Booster Pump: 30-gph (108-L/h) **OR** 70-gph (252-L/h), **as directed**, capacity; motor and 2-stage fuel unit with pressure-regulating valve and strainer.
c. Oil-pressure relief valve.
d. Outdoor Combustion-Air Adapter: Sealed to housing and fitted with quick access cover, or door and fitting for terminating outdoor-air duct.

I. Evaporative Cooling Package
1. Cabinet: Single-wall **OR** Double-wall, **as directed**, galvanized- or aluminized-steel panels lined with ABS polymer, as required, formed to ensure rigidity and supported by galvanized-steel channels or structural channel supports with lifting lugs and having a stainless-steel reservoir with overflow and drain with full-port, brass-fitted ball valve. Cabinet shall be fully weatherized for outside installation, **as directed**.
   a. External Casing and Cabinet Finish: Baked enamel, **unless directed otherwise to be** Powder coating, over corrosion-resistant-treated surface in color to match fan section.
2. Media: UL 900, Class 2, 6-inch- (150-mm-) **OR** 8-inch- (200-mm-) **OR** 12-inch- (300-mm-), **as directed**, thick cellulose **OR** glass-fiber, **as directed**, media with rigidizing agents, fungicides, and wetting agents. Minimum 90 percent contact factor.
   a. Moisture elimination pad.
3. Water-Circulation System: Submersible centrifugal sump pump with inlet strainer, brass balancing valve located in pump discharge, and thermally protected motor; water distribution troughs or piping at top of media pads; and float-operated, makeup water and bleed-off valves.
   a. Automatic Fill and Drain Kit: Water supply and drain, solenoid valves for initial sump fill and for draining sump.
4. Water-Saver System: Timer, solenoid valve, and water distribution piping to apply the water supply to the media.

J. Controls
1. Factory-wired, fuse-protected control transformer, connection for power supply and field-wired unit to remote control panel.
2. Control Panel: Surface-mounted **OR** Recessed, **as directed**, with trim ring, remote panel, with engraved plastic cover, and the following lights and switches:
   a. On-off **OR** On-off-auto, **as directed**, fan switch.
   b. Summer-winter **OR** Heat-off-cool, **as directed**, switch. Automatic changeover, **as directed**.
   c. Supply-fan operation indicating light.
   d. Heating operation indicating light.
   e. Damper position potentiometer.
   f. Thermostat.
   g. Cooling operation indicating light.
   h. Dirty-filter indicating light operated by unit-mounted differential pressure switch.
   i. Safety-lockout indicating light.
3. Control Devices:
   a. Remote Thermostat: Adjustable room thermostat with temperature readout.
   b. Remote Setback Thermostat: Adjustable room thermostat without temperature readout.
   c. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
   d. Fire-Protection Thermostats: Fixed or adjustable settings to operate at not less than 75 deg F (24 deg C) above normal maximum operating temperature.
   e. Timers: Seven-day, programming-switch timer with synchronous-timing motor and seven-day dial; continuously charged, nickel-cadmium-battery-driven, eight-hour, power-failure carryover; multiple-switch trippers; minimum of two and maximum of eight signals per day with two normally open and two normally closed output contacts.
      OR

Timers: Solid-state, programmable time control with 4 separate programs; 24-hour battery carryover; individual on-off-auto switches for each program; 365-day calendar with 20 programmable holidays; choice of fail-safe operation for each program; and system fault alarm.

f. Ionization-Type Smoke Detectors: 24-V dc, nominal; self-restoring; plug-in arrangement; integral visual-indicating light; sensitivity that can be tested and adjusted in place after installation; integral addressable module; remote controllability; responsive to both visible and invisible products of combustion; self-compensating for changes in environmental conditions.

4. Fan Control: Interlock fan to start with exhaust fan(s). See Division 23 Section(s) "Axial Hvac Fans" OR "Centrifugal Hvac Fans" OR "Hvac Power Ventilators" OR "Sequence Of Operations For Hvac Controls", **as directed**, for exhaust fan controls.
5. Fan Control: Timer starts and stops direct-fired H&V unit and exhaust fan(s).
   a. Fan-Discharge Thermostat (for units with evaporative cooling package): Stops fan when discharge-air temperature is less than 40 deg F (4 deg C).
   b. Smoke detectors, located in supply and return, **as directed**, air, shall stop fans when the presence of smoke is detected.
6. Outdoor-Air Damper Control, 100 Percent Outdoor-Air Units: Outdoor-air damper shall open when supply fan starts, and close when fan stops.
7. Mixed Outdoor- and Return-Air Damper Control: When fan is running, outdoor- and return-air dampers shall modulate to supply minimum outdoor air as follows:
   a. Minimum 30 percent outdoor air.
   b. Outdoor-air quantity adjusted by potentiometer on control panel.
   c. Outdoor-air quantity to maintain minimum building static pressure.
8. Temperature Control: Operates gas valve to maintain supply-air temperature.
   a. Operates gas valve to maintain discharge-air temperature with factory-mounted sensor in blower outlet.
   b. Operates gas valve to maintain space temperature with wall-mounting, field-wired sensor with temperature adjustment, **as directed**, and unit-mounted control adjustment, **OR** and adjustment on remote-control panel, **as directed**.
   c. Timer shall select remote setback thermostat to maintain space temperature at 50 deg F (10 deg C).
   d. Furnace Control: Two or four steps of control using one or two furnace sections in series.
      OR
      Furnace Control: 20 to 100 percent modulation of the firing rate. 10 to 100 percent with dual furnace units.
9. Evaporative Cooling Controls:
   a. Start and stop water-circulation-system sump pump to maintain space temperature.
   b. Automatic Fill Control: A switch in the unit control panel shall close sump drain valve and open makeup water valve.
   c. Automatic Drain Control: Opens sump drain valve and closes makeup water valve from a switch in the unit control panel **OR** when an outside thermostat senses 40 deg F (4 deg C) or less, **as directed**.
   d. Water-Saver System: Remote thermostat shall open water-supply valve to maintain dry-bulb temperature in space. Timer shall activate thermostat circuit.
10. DDC: Stand-alone control module for link between unit controls and DDC system. Control module shall be compatible with temperature-control system specified in Division 23 Section "Instrumentation And Control For Hvac".
    a. Provide start and stop interface relay, and relay to notify DDC system alarm condition.
    b. Provide hardware interface or additional sensors as follows:
       1) Room temperature.
       2) Discharge-air temperature.
       3) Furnace operating.

K. Motors

1. Comply with requirements are specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".

1.3 EXECUTION

A. Installation
1. Install gas-fired units according to NFPA 54, "National Fuel Gas Code."
2. Install oil-fired duct heaters and associated fuel and vent piping according to NFPA 31 and applicable local codes and regulations.
3. Install roof curb on roof structure, according to ARI Guideline B **OR** NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts," **as directed**. Install and secure direct-fired H&V units on curbs, and coordinate roof penetrations and flashing with roof construction.
OR
Install restrained vibration isolation roof-curb rails on roof structure according to ARI Guideline B **OR** NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts," **as directed**. Install and secure indirect-fired H&V units on rails, and coordinate roof penetrations and flashing with roof construction. Restrained isolation roof-curb rails are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
4. Install suspended units from spring hangers with minimum 1-inch (25-mm) static deflection; refer to Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
5. Install floor-mounted units on restrained, **as directed**, spring isolators with minimum 1-inch (25-mm) static deflection; refer to Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
6. Install controls and equipment shipped by manufacturer for field installation with indirect-fired H&V units.
7. Piping Connections: Drawings indicate general arrangement of piping, fittings, and specialties. Install piping adjacent to machine to allow service and maintenance.
   a. Gas Piping: Comply with requirements in Division 23 Section(s) "Facility Natural-gas Piping" OR "Facility Liquefied-petroleum Gas Piping", **as directed**. Connect gas piping with shutoff valve and union and with sufficient clearance for burner removal and service. Provide AGA-approved flexible connectors.
   b. Fuel Oil Piping: Comply with requirements in Division 23 Section "Facility Fuel-oil Piping". Connect to fuel oil supply and return piping with shutoff valve and union at each connection.
   c. Makeup Water: Comply with requirements in Division 22 Section "Domestic Water Piping" for valves and accessories on piping connections to evaporative cooling units.
   d. Drain: Comply with requirements in Division 22 Section "Sanitary Waste And Vent Piping" for traps and accessories on piping connections to evaporative cooling units.
8. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts". Drawings indicate the general arrangement of ducts. Connect supply and return, **as directed**, ducts to indirect-fired H&V units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories".
9. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
10. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

END OF SECTION 23 74 23 13a

SECTION 23 76 13 00 - DEHUMIDIFICATION UNITS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for mechanical dehumidification units. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes packaged, factory-assembled and -tested, refrigerant-type, mechanical dehumidification units designed for outdoor and indoor installation.

C. Performance Requirements
1. Seismic Performance: Dehumidification units shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

D. Submittals
1. Product Data: For each dehumidification unit indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. LEED Submittals:
   a. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.
   b. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5, "Systems and Equipment."
3. Shop Drawings: For each dehumidification unit indicated. Include plans, elevations, sections, details, and attachments to other work.
   a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   b. Wiring Diagrams: For power, signal, and control wiring.
4. Delegated-Design Submittal: For dehumidification units indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   a. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
   b. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Seismic Qualification Certificates: For accessories, and components, from manufacturer.
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
6. Source quality-control reports.
7. Field quality-control reports.
8. Operation and Maintenance Data: For dehumidification units to include in emergency, operation, and maintenance manuals.
9. Warranty: Sample of special warranty.

E. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. ASHRAE Compliance:
   a. Applicable requirements in ASHRAE 62.1, Section 5, "Systems and Equipment" and Section 7, "Construction and Startup."
   b. Applicable requirements in ASHRAE 15, "Safety Standard for Refrigeration Systems."
3. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6, "Heating, Ventilating, and Air-Conditioning."

F. Coordination
1. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases.
2. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of dehumidification units that fail in materials or workmanship within specified warranty period.
   a. Warranty Period for Compressors: Manufacturer's standard, but not less than two **OR** five, **as directed**, years from date of Final Completion.
   b. Warranty Period for Refrigerant Coils: Manufacturer's standard, but not less than five years from date of Final Completion.

1.2 PRODUCTS

A. Casings
1. Casing: Single-wall **OR** Double-wall, **as directed**, construction with corrosion-protective coating and exterior baked-enamel **OR** powder-coated, **as directed**, finish, stainless-steel fasteners, knockouts for electrical and piping connections, condensate drain connection, and lifting lugs.
   a. Access: Removable panels **OR** Hinged access doors, **as directed**, with neoprene gaskets.
   b. Insulation: Minimum 1/2-inch- (13-mm-) thick thermal insulation **OR** 2-inch- (50-mm-) thick, glass-fiber-insulation fill with no metal structure through the insulation, **as directed**.
   c. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
2. Drain Pan and Connection: Plastic **OR** Stainless steel, **as directed**; insulated and complying with ASHRAE 62.1, **as directed**.

B. Fans
1. Supply Fans: Forward curved **OR** Backward inclined, **as directed**, centrifugal; galvanized steel with baked-enamel **OR** powder-coated, **as directed**, finish; belt driven with adjustable sheaves and self-aligning, grease-lubricated ball bearings with extended grease fittings easily accessible inside the casing of dehumidification unit.
2. Exhaust **OR** Return, **as directed**, Fans: Forward curved **OR** Backward inclined, **as directed**, centrifugal; galvanized steel with baked-enamel **OR** powder-coated, **as directed**, finish; belt driven with adjustable sheaves and self-aligning, grease-lubricated ball bearings with extended grease fittings easily accessible inside the casing of dehumidification unit.
3. Fan Motor: Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
   a. Enclosure Type: Totally enclosed, fan cooled.

C. Filters
1. Glass Fiber: Minimum 80 percent arrestance according to ASHRAE 52.1, and MERV 5 according to ASHRAE 52.2.

2. Pleated: Minimum 90 percent arrestance according to ASHRAE 52.1, and MERV 7 according to ASHRAE 52.2.

D. Refrigeration System
1. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1.
2. Refrigerant Coils: Copper tubes with mechanically bonded aluminum fins; factory fabricated and tested to comply with ASHRAE 33 and ARI 410; with multiple refrigerant circuits, seamless-copper headers with brazed connections, and galvanized **OR** stainless, **as directed**,-steel frame. Coil and fins shall have a polyester coating. Coils shall have a minimum 300-psig (2070-kPa) working-pressure rating and be factory tested to 450 psig (3105 kPa) and to 300 psig (2070 kPa) while underwater.
3. Compressors: Hermetic, scroll compressors with integral vibration isolators and crankcase heaters that de-energize during compressor operation; with thermal-expansion valves, filter-dryers, sight glasses, compressor service valves, and liquid- and suction-line service valves.
   a. Number of Refrigerant Circuits: Two for compressor capacities more than 7-1/2 tons (26.4 kW).
   b. Refrigerant: R-134a **OR** R-407C **OR** R-410A, **as directed**.
   c. Capacity Control:
      1) Hot-gas bypass valve and piping on one compressor.
      2) Cycle compressor.
   d. Low-Pressure Cutout: Manual reset after three automatic-reset failures.
   e. High-Pressure Cutout: Manual reset.
   f. Compressor Motor Overload Protection: Manual reset.
   g. Antirecycling Timing Device: Prevent compressor restart for five minutes after shutdown.
   h. Defrost Cycle (for ice rinks): Adjustable timer shuts off supply fan. Compressor cycles until suction line temperature confirms thawed evaporator coil. Timer limits defrost time to 10 minutes.
4. Energy Recovery Heat Exchanger (Pool Heater): Cupronickel, coaxial, vented, double-wall construction for potable-water service.

E. Remote-Mounted, Air-Cooled Condenser Unit
1. Casing: Steel, finished with baked enamel; with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Refrigerant Coil: ARI 210/240, copper tube with mechanically bonded aluminum fins; with liquid subcooler.
3. Fan: Aluminum-propeller type, directly connected to permanently lubricated motor with integral thermal-overload protection.
4. Adjustable, Low Ambient Head-Pressure Control: Designed to operate at temperatures as low as 0 deg F (minus 18 deg C) by cycling condenser fans and controlling speed of last fan of each circuit.
5. Mounting Base: Polyethylene.

F. Heating Coils
1. Hot-Water Coil: Continuous circuit coil fabricated according to ARI 410.
   a. Tubes: Copper.
   b. Fins: Aluminum **OR** Copper, **as directed**, with fin spacing 0.125 inch (3.18 mm) **OR** 0.091 inch (2.31 mm) **OR** 0.071 inch (1.80 mm) **OR** 0.067 inch (1.70 mm) **OR** 0.056 inch (1.42 mm) **OR** 0.0075 inch (0.19 mm), **as directed**.
   c. Fin and Tube Joints: Mechanical bond.
   d. Headers: Cast iron with drain and air vent tappings.
   e. Frames: Galvanized-steel channel, 0.052 inch (1.3 mm).
   f. Ratings: Design tested and rated according to ASHRAE 33 and ARI 410.
      1) Working-Pressure Ratings: 200 psig (1380 kPa), 325 deg F (163 deg C).
   g. Source Quality Control: Test to 300 psig (2070 kPa).

2. Steam Coil: Distribution header coil fabricated according to ARI 410, with threaded steam supply and condensate connections.
   a. Tubes: Copper.
   b. Fins: Aluminum **OR** Copper, **as directed**, with fin spacing 0.125 inch (3.18 mm) **OR** 0.091 inch (2.31 mm) **OR** 0.071 inch (1.80 mm) **OR** 0.067 inch (1.70 mm) **OR** 0.056 inch (1.42 mm) **OR** 0.0075 inch (0.19 mm), **as directed**.
   c. Fin and Tube Joints: Mechanical bond.
   d. Headers: Cast iron with drain and air vent tappings.
   e. Frames: Galvanized-steel channel, 0.052 inch (1.3 mm).
   f. Ratings: Design tested and rated according to ASHRAE 33 and ARI 410.
      1) Working-Pressure Ratings: 100 psig (690 kPa), 400 deg F (205 deg C).
   g. Source Quality Control: Test to 200 psig (1380 kPa).
3. Electric-Resistance Heating Coil: Comply with UL 1995.
   a. Heating Element: Coiled resistance wire of 80 percent nickel and 20 percent chromium; surrounded by compacted magnesium oxide powder in tubular-steel sheath; with spiral-wound, copper-plated steel fins continuously brazed to sheath.
      OR
      Heating Element: Open-coil resistance wire of 80 percent nickel and 20 percent chromium; supported and insulated by floating ceramic bushings recessed into casing openings; fastened to supporting brackets and mounted in galvanized-steel frame.
   b. Overtemperature Protection: Disk-type, automatic-reset, thermal-cutout safety device; serviceable through terminal box without removing heater from unit.
   c. Thermal Cutouts: Load carrying, manual reset or replaceable, and factory wired in series with each heater stage.
   d. Control: Disconnecting means, overcurrent protection, and airflow proving switch.

G. Dampers
1. Outdoor-Air Dampers: Opposed-blade, galvanized-steel **OR** aluminum **OR** extruded-aluminum, **as directed**, dampers with steel **OR** cadmium-plated steel, **as directed**, operating rod rotating in sintered bronze or nylon bearings. Provide blade gaskets and edge seals, and mechanically fasten blades to operating rod. Size for 0 to 25 percent outdoor air, with manual **OR** motorized, **as directed**, operator and filter.
2. Face-and-Bypass Dampers: Opposed-blade, galvanized-steel **OR** aluminum **OR** extruded-aluminum, **as directed**, dampers with steel **OR** cadmium-plated steel, **as directed**, operating rods rotating in sintered bronze or nylon bearings with operating rods connected with a common linkage. Provide blade gaskets and edge seals, and mechanically fasten blades to operating rod.
3. Outdoor- and Return-Air **OR** Outdoor-, Return-, and Exhaust-Air, **as directed**, Dampers: Parallel-blade, galvanized-steel **OR** aluminum **OR** extruded-aluminum, **as directed**, dampers mechanically fastened to steel **OR** cadmium-plated steel, **as directed**, operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
4. Outdoor- and Return-Air **OR** Outdoor-, Return-, and Exhaust-Air, **as directed**, Dampers: Low-leakage, double-skin, airfoil-blade, galvanized-steel **OR** aluminum **OR** extruded-aluminum, **as directed**, dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed-blade **OR** parallel-blade, **as directed**, arrangement with steel **OR** cadmium-plated steel, **as directed**, operating rods rotating in stainless-steel sleeve **OR** sintered bronze or nylon, **as directed**, bearings mounted in a single galvanized-steel **OR** aluminum **OR** extruded-aluminum, **as directed**, frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 5 cfm/sq. ft. (0.22 L/s per sq. m) at 1-inch wg (250 Pa) and 9 cfm/sq. ft. (0.4 L/s per sq. m) at 4-inch wg (1.0 MPa).
5. Damper Operator: 115 **OR** 24, **as directed**,-V ac, close coupled, with gear train sealed in oil and with spring return.

H. Controls

1. Comply with requirements in Division 23 Section "Instrumentation And Control For Hvac" for control equipment and in Division 23 Section "Sequence Of Operations For Hvac Controls".
2. Control Panel: Integral service compartment containing fan-motor thermal and overload cutouts, compressor thermal and overload cutouts, 115-V control transformer if required, magnetic contactors for fan and compressor motors, and a nonfused factory-mounted and -wired disconnect switch for single external electrical power connection.
3. Building Automation System Interface: Factory-installed hardware and software to enable the building automation system to monitor, control, and display status and alarms.
4. Operating Control: Space humidistat cycles the compressor. Humidistat shall incorporate fan on-off-auto switch.
5. Operating Controls (for indoor pool units with typical manufacturer's control panel): Factory-installed microprocessor controller, capable of being remotely mounted.
    a. Display the following on the face of controller:
        1) System on.
        2) System dehumidifying mode.
        3) System air-conditioning mode.
        4) System outdoor-air (economizer) mode.
        5) System heating pool water.
        6) Auxiliary space heat is operating.
        7) Unit requires service.
        8) Return-air (space) temperature.
        9) Return-air (space) humidity.
        10) Pool-water temperature.
        11) Outdoor-air temperature.
    b. Indicate the following sensor failures on panel:
        1) Airflow: Dirty air filter, blocked airflow, and fan failure.
        2) Refrigerant high and low pressure.
        3) High water temperature.
        4) High and low evaporator temperature.
        5) Low water flow.
        6) Communication fault.
        7) System off.
        8) Antishort cycle delay.
        9) Power failure.
    c. Provide access to the following set points on panel:
        1) Space temperature.
        2) Space relative humidity.
        3) Outdoor ventilation/air-conditioning changeover temperature.
        4) Airflow alarm.
    d. Provide the following displays on panel:
        1) Space temperature.
        2) Space relative humidity.
        3) Outdoor-air temperature.
        4) Supply-air temperature.
        5) Return-air temperature.
        6) Airflow rating.
        7) Air-off evaporator temperature.
        8) Return-air relative humidity.
        9) Service codes.
    e. Provide the following controls on panel:
        1) System on-off, fan continues to run.
        2) Fan on-off.
        3) Service code access.
        4) System dehumidifying mode.
        5) System air-conditioning mode.
        6) System outdoor-air (economizer) mode.

7) Auxiliary space heat is operating.
8) Outdoor-air-temperature, conditioned-space-temperature, and control set-point-temperature digital display.
9) Outdoor enthalpy digital display.
10) Filter pressure drop digital display.
11) Status: Airflow, fans, system, unit operation, and operating mode.
12) Alarm digital display.

6. Operating Controls: Factory-installed microprocessor controller.
   a. Factory-installed operator panel with backlit display, capable of being remotely mounted, allows menu-driven display for navigation and control of unit.
   b. Integral clock.
   c. Personal computer interface.
   d. Integral local area network for direct connection to BACnet **OR** LonWorks **OR** MODBUS, **as directed**.
   e. Factory programmed.
   f. Unit-Mounted Sensors:
      1) Airflow switch.
      2) Compressor-discharge temperature.
      3) Evaporator-air temperature.
      4) Pool-water-out temperature.
      5) Pool-water-in temperature.
      6) Relative humidity.
      7) Return-air temperature.
      8) Supply-air temperature.
   g. Integral diagnostics.
   h. Nonvolatile memory.
   i. IP or SI display.
   j. Provide the following status and alarm functions:
      1) System: On-off.
      2) Power failure.
      3) Fan: Off, overload.
      4) Compressor: On, turned off, overload, high pressure, low pressure, overheat, oil failure, and pumpdown.
      5) Evaporator damper closed.
      6) Pool: Low water flow, heating on.
      7) Dehumidification: Call for, on.
      8) Air Conditioning: Call for, on.
      9) System outdoor-air (economizer) mode.
      10) Auxiliary space heat on.
      11) Alarms: Firestat, freezestat, and filters.
   k. Provide the following controls via operator panel:
      1) Compressor auto-off.
      2) Fan auto-off.
      3) Set-Point Adjustments: Relative humidity, temperatures, deadbands, and differentials.
      4) Sensor calibration.
   l. Monitor constant and variable motor loads.
   m. Monitor cooling load.
   n. Monitor economizer cycles.
   o. Monitor ventilation air volumes.

I. Accessories
1. Water-Cooling Heat Exchanger: Coaxial, vented, double-wall construction; with three-way refrigerant control valve.
2. Smoke Detectors: Photoelectric detector located in return-air plenum, to de-energize unit.

a. Operating Voltage: 24-V dc, nominal.
b. Self-Restoring: Detectors do not require resetting or readjusting after actuation to restore them to normal operation.
c. Plug-in Arrangement: Detector and associated electronic components mounted in module with tamper-resistant connection to fixed base with twist-locking plug. Terminals in fixed base accept building wiring.
d. Integral Visual-Indicating Light: Digital-display type indicating detector operation.
e. Sensitivity: Can be tested and adjusted in-place after installation.
f. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the fire-alarm control panel.
g. Sensor: Digital display or infrared light source with matching silicon-cell receiver.
h. Detector Sensitivity: Between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) of smoke obscuration when tested according to UL 268A.
i. Integral Thermal Detector: Fixed-temperature type with 135 deg F (57 deg C) setting.

3. Electrical Convenience Outlet: 115-V ac fused, duplex, straight-blade receptacles, separately fused and located inside casing of dehumidification unit or in roof-curb perimeter.

J. Roof Curbs
1. Roof curbs with vibration isolators and wind or seismic restraints are specified in Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
2. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
3. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
   a. Materials: ASTM C 1071, Type I or II.
   b. Thickness: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**.
   c. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
   d. Liner Adhesive: Comply with ASTM C 916, Type I.
   e. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
   f. Liner materials applied in this location shall have airstream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric, depending on service-air velocity.
4. Curb Height: 14 inches (355 mm) **OR** 24 inches (610 mm) **OR** 36 inches (910 mm), **as directed**.
5. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match dehumidification unit; used to anchor unit to the curb and designed for loads at Project site. Comply with requirements in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment" for wind-load requirements.

K. Source Quality Control
1. Verification of Performance: Factory test and rate dehumidification units according to ARI 910.
2. Sound-Power-Level Ratings: Factory test and rate dehumidification units according to ARI 575.

1.3 EXECUTION

A. Examination
1. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
2. Examine roughing-in for hot-water **OR** steam **OR** refrigerant, **as directed**, piping systems to verify actual locations of piping connections before equipment installation.
3. Examine walls, floors, and roofs for suitable conditions where dehumidification units will be installed.
4. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation
1. Equipment Mounting (for indoor or outdoor equipment supported on slabs-on-grade without vibration isolation devices): Install dehumidification units on concrete base(s). Comply with requirements for concrete base(s) specified in Division 03 Section "Cast-in-place Concrete".
   a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
   c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   d. Install anchor bolts to elevations required for proper attachment to supported equipment.
2. Equipment Mounting (for indoor or outdoor equipment supported on concrete equipment base with vibration isolation devices): Install dehumidification units on concrete base(s) using elastomeric pads **OR** elastomeric mounts **OR** restrained spring isolators, **as directed**. Comply with requirements for concrete base(s) specified in Division 03 Section "Cast-in-place Concrete". Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
   a. Minimum Deflection: 1/4 inch (6 mm) **OR** 1 inch (25 mm), **as directed**.
   b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
   d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   e. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Equipment Mounting (for installation of indoor or outdoor equipment on vibration isolation devices without concrete base): Install dehumidification units using elastomeric pads **OR** elastomeric mounts **OR** restrained spring isolators, **as directed**. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
   a. Minimum Deflection: 1/4 inch (6 mm) **OR** 1 inch (25 mm), **as directed**.
4. Equipment Mounting (for installation of indoor or outdoor equipment on vibration isolation equipment base): Install dehumidification units on vibration isolation equipment base. Comply with requirements specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
5. For installation of indoor or outdoor equipment without vibration isolation devices, with seismic restraints, and without concrete base: Install dehumidification units with <**Insert seismic-restraint device**>. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
6. For indoor units suspended from structure: Install continuous-thread hanger rods and elastomeric hangers **OR** spring hangers **OR** spring hangers with vertical-limit stop, **as directed**, of size required to support weight of dehumidification unit.
   a. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment". Fabricate brackets or supports as required.
   b. Comply with requirements for hangers and supports specified in Division 23 Section "Hangers And Supports For Hvac Piping And Equipment".
7. Curb Support (if curbs are furnished with dehumidification units for rooftop installations): Install roof curb on roof structure, level and secure, according to NRCA's "The NRCA Roofing and Waterproofing Manual, Fifth Edition." Install and secure dehumidification units on curbs, and coordinate roof penetrations and flashing with roof construction. Secure units to curb support with anchor bolts.
8. Unit Support: Install dehumidification units level on structural curbs **OR** pilings, **as directed**. Coordinate wall penetrations and flashing with wall construction. Secure units to structural support with anchor bolts.

9. Isolation Curb Support (for units mounted on isolation curbs): Install dehumidification units on isolation curbs, and install flexible duct connectors and vibration isolation and seismic-control devices. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories". Vibration isolation and seismic-control devices are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".

C. Connections
1. Where piping is installed adjacent to dehumidification units, allow space for service and maintenance of dehumidification units.
2. Connect piping to dehumidification units mounted on vibration isolators with flexible connectors.
3. Connect condensate drain pans using minimum NPS 1-1/4 (DN 32) copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan, and install cleanout at changes in direction.
4. Refrigerant Piping: Comply with requirements in Division 23 Section "Refrigerant Piping". Connect to supply and return coil tappings with shutoff valve and union or flange at each connection.
5. Hot-Water Piping: Comply with requirements in Division 23 Section "Hydronic Piping". Connect to supply coil tappings with shutoff valve, return coil tappings with balancing valve, and union or flange at each connection.
6. Steam and Condensate Piping: Comply with requirements in Division 23 Section "Steam And Condensate Heating Piping". Connect with shutoff valve and union or flange.
7. Duct installation requirements are specified in other Division 21. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
   a. Install ducts to termination in roof-mounted frames. Where indicated, terminate return-air duct through roof structure and insulate the space between roof and bottom of dehumidification unit.

D. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
   a. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks. Repair leaks and retest until no leaks exist.
   b. Charge refrigerant coils with refrigerant and test for leaks. Repair leaks and retest until no leaks exist.
   c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Dehumidification unit will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

E. Startup Service
1. Perform startup service.
   a. Complete installation and startup checks according to manufacturer's written instructions.
2. Perform the following final checks before startup:
   a. Verify that shipping, blocking, and bracing are removed.
   b. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   c. Perform cleaning and adjusting specified in this Section.
   d. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
   e. Check lubrication of bearings, pulleys, belts, and other moving parts.
   f. Set outside- and return-air mixing dampers to minimum outside-air setting.
   g. Install clean filters.
   h. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

3. Starting procedures for dehumidification units include the following:
   a. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace malfunctioning motors, bearings, and fan wheels.
   b. Measure and record motor's electrical values for voltage and amperage.
   c. Manually operate dampers from fully closed to fully open position and record fan performance.
4. Comply with requirements in Division 23 Section "Testing, Adjusting, And Balancing For Hvac" for testing, adjusting, and balancing of dehumidification unit.
5. Startup Report: Report findings during startup. Identify startup steps, corrective measures taken, and final results.

F. Adjusting
1. Adjust damper linkages for proper damper operation.
2. Adjust initial temperature and humidity set points.

G. Cleaning
1. Clean dehumidification units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils' entering-air face.
2. After completing system installation, testing, and startup service of dehumidification units, clean filter housings and install new filters.

H. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain dehumidification units.

END OF SECTION 23 76 13 00

Task	Specification	Specification Description
23 76 13 00	23 74 23 13	Direct-Fired, Makeup Air Units
23 76 13 00	23 74 23 13a	Indirect-Fired, Packaged H&V Units

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SECTION 23 81 13 11 - PACKAGED TERMINAL AIR CONDITIONERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for packaged terminal air conditioners. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes packaged terminal air conditioners and their accessories and controls, in the following configurations:
   a. Through-the-wall and freestanding air conditioners.
   b. Cooling-only units.
   c. Heat-pump units.
   d. Cooling units with electric heat.
   e. Cooling units with hydronic heat.
   f. Cooling units with indirect-fired gas heat.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.
   b. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
3. Shop Drawings: For packaged terminal air conditioners. Include plans, elevations, sections, details for wall penetrations, seismic bracing, **as directed**, and attachments to other work.
   a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   b. Wiring Diagrams: For power, signal, and control wiring.
4. Color Samples: For unit cabinet, discharge grille, and exterior louver, and for each color and texture specified.
5. Field quality-control reports.
6. Operation and maintenance data.
7. Warranty: Sample of special warranty.

D. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."
3. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

E. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged terminal air conditioners that fail in materials or workmanship within specified warranty period.
   a. Warranty Period for Sealed Refrigeration System: Manufacturer's standard, but not less than five years from date of Final Completion, including components and labor.
   b. Warranty Period for Nonsealed System Parts: Manufacturer's standard, but not less than five years from date of Final Completion, including only components and excluding labor.

c. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than five years from date of Final Completion.

1.2 PRODUCTS

A. Manufactured Units

1. Description: Factory-assembled and -tested, self-contained, packaged terminal air conditioner with room cabinet, electric refrigeration system, heating, **as directed**, and temperature controls; fully charged with refrigerant and filled with oil; with cord-connected **OR** hardwired, **as directed**, chassis.

B. Chassis

1. Cabinet: 0.052-inch- (1.32-mm-) thick steel with removable front panel with concealed latches.
   a. Mounting: Wall with wall sleeve **OR** Floor with subbase, **as directed**.
   b. Discharge Grille: Punched-louver discharge grille allowing four-way discharge-air pattern **OR** Extruded-aluminum discharge grille **OR** Reversible polycarbonate discharge grille allowing upward and horizontal airflow, **as directed**.
   c. Louvers: Extruded aluminum with enamel finish **OR** Stamped aluminum with clear-anodized finish **OR** Stamped steel with enamel finish, **as directed**; white **OR** bronze **OR** brown **OR** beige, **as directed**, color.
   d. Finish: Epoxy coating **OR** Baked enamel, **as directed**.
   e. Access Door: Hinged door in top of cabinet for access to controls.
   f. Cabinet Extension: Matching cabinet in construction and finish, allowing diversion of airflow to adjoining room; with grille.
   g. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
   h. Subbase: Enameled steel with adjustable leveling feet and adjustable end plates, with factory-installed and -wired, fused disconnect switch and receptacle sized for unit, **as directed**.
   i. Wall Sleeves: Galvanized steel with polyester finish **OR** Molded polymer **OR** Molded fiberglass-reinforced polyester, **as directed**.
2. Refrigeration System: Direct-expansion indoor coil with capillary restrictor; and hermetically sealed scroll compressor with vibration isolation and overload protection.
   a. Indoor and Outdoor Coils: Seamless copper tubes mechanically expanded into aluminum fins with capillary tube distributor on indoor coil, **as directed**.
   b. Accumulator.
   c. Constant-pressure expansion valve.
   d. Reversing valve.
   e. Charge: R-407C **OR** R-410A, **as directed**.
3. Indoor Fan: Forward curved, centrifugal; with motor and positive-pressure ventilation damper with concealed manual **OR** electric, **as directed**, operator.
4. Filters: Washable polyurethane in molded plastic frame.
5. Condensate Drain: Drain pan to direct condensate to outdoor coil for re-evaporation **OR** and piping to direct condensate to building waste and vent piping, **as directed**.
   a. Comply with ASHRAE 62.1 for drain pan construction and connections.
6. Outdoor Fan: Forward curved, centrifugal **OR** Propeller, **as directed**, type with separate **OR** driven by indoor fan, **as directed**, motor.
   a. Indoor and Outdoor Fan Motors: Two speed; comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
      1) Fan Motors: Permanently lubricated split capacitor.
      2) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

3) Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 22.

C. Heating
1. Electric-Resistance Heating Coil: Nickel-chromium-wire, electric-resistance heating elements with contactor and high-temperature-limit switch.
OR
Hot-Water Heating Coil: Seamless copper tubes mechanically expanded into aluminum fins with two-way modulating control valve and air vent.
OR
Gas Heat:
a. General Requirements for Gas-Fired, Noncondensing Furnaces: Factory assembled, piped, wired, and tested; complying with ANSI Z21.86/CSA 2.32, "Vented Gas-Fired Space Heating Appliances," and with NFPA 54.
b. Type of Gas: Natural **OR** Propane, **as directed**.
c. Heat Exchanger: Aluminized-steel **OR** Stainless steel, **as directed**.
d. Burner:
1) Gas Valve: 100 percent safety two-stage **OR** modulating, **as directed**, main gas valve, main shutoff valve, pressure regulator, safety pilot with electronic flame sensor, limit control, transformer, and combination ignition/fan timer control board.
2) Ignition: Electric pilot ignition with hot-surface igniter or electric spark ignition.
e. Gas-Burner Safety Controls:
1) Electronic Flame Sensor: Prevents gas valve from opening until pilot flame is proven; stops gas flow on ignition failure.
2) Flame Rollout Switch: Installed on burner box; prevents burner operation.
3) Limit Control: Fixed stop at maximum permissible setting; de-energizes burner on excessive bonnet temperature; automatic reset.
f. Combustion-Air Inducer: Centrifugal fan prepurges heat exchanger and vents combustion products; thermally protected motor with sleeve bearings; pressure switch prevents operation if combustion-air inlet or flue outlet is blocked.
g. Furnace Controls: Solid-state board integrates ignition, heat, cooling, and fan speeds; adjustable fan-on and fan-off timing; and terminals for connection to accessories.

D. Controls
1. Control Module: Unit-mounted digital panel with touchpad temperature control and with touchpad for heating, cooling, and fan operation. Include the following features:
a. Low Ambient Lockout Control: Prevents cooling-cycle operation below 40 deg F (5 deg C) outdoor air temperature.
b. Heat-Pump Ambient Control: Field-adjustable switch changes to heat-pump heating operation above 40 deg F (5 deg C) and to supplemental heating below plus 25 deg F (minus 4 deg C).
c. Temperature-Limit Control: Prevents occupant from exceeding preset setback **OR** setup, **as directed**, temperature.
d. Building Automation System Interface: Allows remote on-off control with setback temperature control.
e. Reverse-Cycle Defrost: Solid-state sensor monitors frost buildup on indoor **OR** outdoor, **as directed**, coil and reverses unit to melt frost.
2. Remote Control: Standard unit-mounted controls with remote-mounted, low-voltage adjustable thermostat with heat anticipator, heat-off-cool-auto **OR** heat-off-cool, **as directed**, switch, and on-auto, **as directed**, fan switch.
3. Outdoor Air: Manual **OR** Motorized, **as directed**, intake damper. Open intake when unit indoor air fan runs, **as directed**.

E. Source Quality Control
1. Sound-Power Level Ratings: Factory test to comply with ARI 300, "Sound Rating and Sound Transmission Loss of Packaged Terminal Equipment."

2. Unit Performance Ratings: Factory test to comply with ARI 310/380/CSA C744, "Packaged Terminal Air-Conditioners and Heat Pumps."

1.3 EXECUTION

A. Installation
1. Install units level and plumb, maintaining manufacturer's recommended clearances and tolerances.
2. Install wall sleeves in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Division 07 Section "Joint Sealants".
3. Install and anchor wall sleeves to withstand, without damage to equipment and structure, seismic forces required by building code.

B. Connections
1. Comply with requirements for piping specified in Division 23 Section "Hydronic Piping". Drawings indicate general arrangement of piping, fittings, and specialties.
2. Comply with requirements for piping specified in Division 23 Section "Facility Natural-gas Piping". Drawings indicate general arrangement of piping, fittings, and specialties.
3. Install piping adjacent to machine to allow service and maintenance.

C. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
   a. Inspect for and remove shipping bolts, blocks, and tie-down straps.
   b. After installing packaged terminal air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
   c. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Packaged terminal air conditioners will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

D. Startup Service
1. Perform startup service.
2. After installation, verify the following:
   a. Unit is level on base and is flashed in exterior wall.
   b. Unit casing has no visible damage.
   c. Compressor, air-cooled condenser coil, and fans have no visible damage.
   d. Labels are clearly visible.
   e. Controls are connected and operable.
   f. Shipping bolts, blocks, and tie-down straps are removed.
   g. Filters are installed and clean.
   h. Drain pan and drain line are installed correctly.
   i. Electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 22.
   j. Installation. Perform startup checks according to manufacturer's written instructions, including the following:
      1) Lubricate bearings on fan.
      2) Check fan-wheel rotation for correct direction without vibration and binding.
3. After startup service and performance test, change filters.

E. Adjusting

1. Adjust initial temperature set points.
2. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

F. Demonstration
   1. Train Owner's maintenance personnel to adjust, operate, and maintain packaged terminal air conditioners.

END OF SECTION 23 81 13 11

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Task	Specification	Specification Description
23 81 13 13	23 81 13 11	Packaged Terminal Air Conditioners
23 81 16 00	23 81 13 11	Packaged Terminal Air Conditioners

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SECTION 23 81 23 12 - COMPUTER-ROOM AIR-CONDITIONERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for computer-room air-conditioners. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Floor-mounted computer-room air conditioners, 6 tons (21 kW) and larger.
   b. Floor-mounted computer-room air conditioners, 5 tons (18 kW) and smaller.
   c. Ceiling-mounted computer-room air conditioners.
   d. Console computer-room air conditioners.

C. Definition
1. BAS: Building automation system.

D. Performance Requirements
1. Seismic Performance: Computer-room air conditioners shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

E. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.
   b. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
3. Shop Drawings: For computer-room air conditioners. Include plans, elevations, sections, details, and attachments to other work.
   a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   b. Wiring Diagrams: For power, signal, and control wiring.
4. Color Samples: For unit cabinet, discharge grille, and exterior louver and for each color and texture specified.
5. Seismic Qualification Certificates: For computer-room air conditioners, accessories, and components, from manufacturer.
6. Field quality-control reports.
7. Operation and maintenance data.
8. Warranty: Sample of special warranty.

F. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. ASHRAE Compliance:
   a. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."

b. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

3. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
4. ASME Compliance: Fabricate and label water-cooled condenser shell to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of computer-room air conditioners that fail in materials or workmanship within specified warranty period.
   a. Warranty Period for Compressors: Manufacturer's standard, but not less than five **OR** 10, **as directed**, years from date of Final Completion.
   b. Warranty Period for Humidifiers: Manufacturer's standard, but not less than three years from date of Final Completion.
   c. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Final Completion.

1.2 PRODUCTS

A. Floor-Mounted Units 6 Tons (21 kW) And Larger
1. Description: Packaged, factory assembled, prewired, and prepiped; consisting of cabinet, fans, filters, humidifier, and controls.
2. Cabinet and Frame: Welded steel, braced for rigidity, and supporting compressors and other mechanical equipment and fittings.
   a. Doors and Access Panels: Galvanized steel with polyurethane gaskets, hinges, and concealed fastening devices.
   b. Insulation: Thermally and acoustically insulate cabinet interior with 1-inch- (25-mm-) thick duct liner.
   c. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
   d. Finish of Exterior Surfaces: Baked-on, textured vinyl enamel; color as selected from manufacturer's standard colors **OR** to match computer equipment, **as directed**.
   e. Floor Stand: Welded tubular steel with adjustable legs and vibration isolation pads.
3. Supply-Air Fan(s):
   a. Double-inlet, forward-curved centrifugal fan(s); statically and dynamically balanced.
   b. Drive: V-belt, with steel shaft with self-aligning ball bearings and cast-iron or steel sheaves, variable- and adjustable-pitch motor sheave, minimum of two matched belts, with drive rated at a minimum of two times the nameplate rating of motor.
4. Refrigeration System:
   a. Compressors: Semihermetic reciprocating; with suction-gas-cooled, 1750-rpm motors; thermal overloads; oil sight glass; suction-line strainer; and reversible oil pumps; with oil strainer, internal motor overload protection, **as directed**, resilient suspension system, crankcase heater, manual-reset high-pressure switch, and pump-down low-pressure switch.

      OR

      Compressors: Hermetic reciprocating; with oil strainer, internal motor overload protection, **as directed**, resilient suspension system, crankcase heater, manual-reset high-pressure switch, and pump-down low-pressure switch.

      Compressors: Hermetic scroll; with oil strainer, internal motor overload protection, **as directed**, resilient suspension system, crankcase heater, manual-reset high-pressure switch, and pump-down low-pressure switch.

b. Refrigeration Circuits: Two; each with hot-gas mufflers, thermal-expansion valve with external equalizer, liquid-line solenoid valve, liquid-line filter-dryer, sight glass with moisture indicator, service shutoff valves, charging valves, and charge of refrigerant.
c. Refrigerant: R-407C **OR** R-410A, **as directed**.
d. Refrigerant Evaporator Coil: Alternate-row or split-face-circuit, direct-expansion coil of seamless copper tubes expanded into aluminum fins.
    1) Mount coil assembly over stainless-steel drain pan complying with ASHRAE 62.1, **as directed**, and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir, **as directed**.
e. Integral, Water-Cooled Refrigerant Condenser: Shell-and-tube type fabricated and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII **OR** Coaxial tube-in-tube type, **as directed**, with liquid-line stop valve and head-pressure-actuated, two-way **OR** three-way, **as directed**, regulating valve. Terminate fluid connections outside cabinet.
    1) Cooling Medium: Water **OR** Glycol solution, **as directed**.

    OR

    Remote Air-Cooled Refrigerant Condenser: Corrosion-resistant cabinet, copper-tube aluminum-fin coils arranged for two circuits, multiple direct-drive propeller fans with permanently lubricated ball bearings, and single-phase motors with internal overload protection and integral electric control panel and disconnect switch, **as directed**. Control capacity by cycling fans **OR** modulating fan speeds **OR** three-way refrigerant bypass with receiver and isolation valve, **as directed**.

5. Hydronic Cooling Coil: Seamless copper tubes expanded into aluminum fins with modulating two-way **OR** three-way, **as directed**, control valve.
    a. Cooling Medium: Water **OR** Glycol solution, **as directed**.
    b. Control Valve: Class 125 body.
        1) Maximum Pressure Drop: 3 psig (21 kPa) **OR** 5 psig (35 kPa), **as directed**, at design flow rate.
        2) Close-Off (Differential) Pressure Rating: 100 percent of pressure differential across valve or 100 percent of total system (pump) head.
    c. Mount coil assembly over stainless-steel drain pan complying with ASHRAE 62.1, **as directed**, and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir, **as directed**.

    OR

    Remote, Air-Cooled, Glycol-Solution Cooler: Corrosion-resistant cabinet, copper-tube aluminum-fin coil, multiple direct-drive propeller fans with fan guards, and single-phase motors with internal overload protection and integral electric control panel. Control capacity by cycling fans.
    d. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.
6. Glycol-Solution Pump Package: Weatherproof and vented enclosure of enameled, galvanized steel on structural base frame containing one **OR** two, **as directed**, centrifugal pump(s) with mechanical seals; electrical-control cabinet with starters, lead-lag switch, automatic switchover, and alarm light.
    a. Piping: Interconnecting piping, to and from remote, air-cooled, glycol-solution cooler, with shutoff valves, flow switches, check valves in pump discharge, unions, and pressurized expansion tank with air purge vent and system-charging connection.
    b. Glycol: Inhibited ethylene glycol and water solution mixed 50:50, suitable for operating temperature of minus 40 deg F (minus 40 deg C).
    c. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.
7. Electric-Resistance Heating Coil: Enclosed finned-tube electric elements arranged for minimum of three stages, with thermal safety switches, manual-reset overload protection, and branch-circuit overcurrent protection.

    OR

    Refrigerant Heating Coil: Hot-gas coil of seamless copper tubes expanded into aluminum fins with three-way solenoid valve on first-stage refrigerant circuit.

    OR

Hot-Water Heating Coil: Seamless copper tubes expanded into aluminum fins with two-way modulating control valve and strainer.

a. Control Valve: Class 125 body.
   1) Maximum Pressure Drop: 3 psig (21 kPa) **OR** 5 psig (35 kPa), **as directed**, at design flow rate.
   2) Close-Off (Differential) Pressure Rating: 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

OR

Steam Heating Coil: Seamless copper tubes expanded into aluminum fins with two-way modulating control valve, strainer, and float-and-thermostatic trap.

b. Control Valve: Class 125 body.
   1) Maximum Pressure Drop (15-psig (103-kPa) Steam): 80 percent of inlet steam pressure.
   2) Close-Off (Differential) Pressure Rating: 150 percent of operating (inlet) pressure.

8. Extended-Surface, Disposable, Panel Filter: Pleated, lofted, nonwoven, reinforced cotton fabric; supported and bonded to welded-wire grid; enclosed in cardboard frame with 2-inch- (50-mm-) thick, disposable, glass-fiber prefilter, **as directed**.
   a. Thickness: 2 inches (50 mm) **OR** 4 inches (100 mm), **as directed**.
   b. Initial Resistance: as directed by the Owner.
   c. Recommended Final Resistance: as directed by the Owner.
   d. Arrestance (ASHRAE 52.1): 90 percent.
   e. Merv (ASHRAE 52.2): 7.
9. Infrared Humidifier: High-intensity quartz lamps mounted above stainless-steel evaporator pan, serviceable without disconnecting water, drain, or electrical connections; prepiped and using condensate water from cooling coils with stainless-steel or brass float-valve mechanism; located in bypass airstream; with flush-cycle timer and solenoid drain valve.
10. Evaporative Pan Humidifier: Stainless-steel pan and cover, serviceable without disconnecting water, drain, or electrical connections; prepiped with stainless-steel or brass float-valve mechanism; electric-resistance heating coil; low-water-cutoff switch; flush-cycle timer; and solenoid drain valve.
11. Electrode Steam Humidifier: Self-contained, microprocessor-controlled unit with disposable, polypropylene-plastic cylinders, and having field-adjustable steel electrodes and stainless-steel steam dispersion tube.
    a. Plumbing Components and Valve Bodies: Plastic, linked by flexible rubber hosing, with water fill with air gap and solenoid valve incorporating built-in strainer, pressure-reducing and flow-regulating orifice, and drain with integral air gap.
    b. Control: Fully modulating to provide gradual 0 to 100 percent capacity with field-adjustable maximum capacity; with high-water probe.
    c. Drain Cycle: Field-adjustable drain duration and drain interval.
12. Integral Electrical Controls: Unit-mounted electrical enclosure with piano-hinged door, grounding lug, combination magnetic starters with overload relays, circuit breakers and cover interlock, and fusible control-circuit transformer.
13. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.
14. Electronic-Control System: Solid state, with start button, stop button, temporary loss of power indicator, manual-reset circuit breakers, temperature control, humidity control, and monitor panel.
    a. Monitor Panel: Backlighted, with no visible indicator lights until operating function is activated; indicators include cooling, humidification, loss of airflow, change filters, high temperature, low temperature, high humidity, low humidity, high head pressure (each compressor), and low suction pressure (each compressor).
    b. Temperature- and Humidity-Control Modules: Solid state, plug-in; with adjustable set point, push-to-test calibration check button, and built-in visual indicators to show mode of operation.
    c. Location: Behind hinged door in front of unit; isolated from conditioned airstream to allow service while system is operating.

15. Microprocessor-Control System: Continuously monitors operation of process cooling system; continuously displays room temperature and room relative humidity; sounds alarm on system malfunction and simultaneously displays problem. If more than one malfunction occurs, system displays fault in sequence with room temperature and continues to display fault when malfunction is cleared until system is reset.
    a. Malfunctions:
        1) Power loss.
        2) Loss of airflow.
        3) Clogged air filter.
        4) High room temperature.
        5) Low room temperature.
        6) High humidity.
        7) Low humidity.
        8) Smoke/fire.
        9) Water under floor.
        10) Supply fan overload.
        11) Compressor No. 1 - Overload.
        12) Compressor No. 1 - Low Pressure.
        13) Compressor No. 1 - High Pressure.
        14) Compressor No. 2 - Overload.
        15) Compressor No. 2 - Low Pressure.
        16) Compressor No. 2 - High Pressure.
    b. Digital Display:
        1) Control power on.
        2) Humidifying.
        3) Dehumidifying.
        4) Compressor No. 1 - Operating.
        5) Compressor No. 2 - Operating.
        6) Heat operating.
        7) Economy cooling.
    c. Push buttons shall stop and start process cooling system, silence audible alarm, test indicators, and display room's relative humidity.
    d. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display unit status and alarms.
        1) Hardwired Points:
            a) Monitoring: On-off status, common trouble alarm **OR** space temperature **OR** space relative humidity, **as directed**.
            b) Control: On-off operation, space temperature set-point adjustment **OR** space relative humidity set-point adjustment, **as directed**.
        2) ASHRAE 135 (BACnet) **OR** LonTalk **OR** Modbus **OR** Industry-accepted, open-protocol, **as directed**, communication interface with the BAS shall enable the BAS operator to remotely control and monitor the unit from an operator workstation. Control features and monitoring points displayed locally at unit control panel shall be available through the BAS.

B. Floor-Mounted Units 5 Tons (18 kW) And Smaller
1. Description: Self-contained, factory assembled, prewired, and prepiped; consisting of cabinet, fan, filters, and controls; for vertical floor mounting in upflow or downflow configuration.
2. Cabinet and Frame: Welded tubular-steel frame with removable steel panels with baked-enamel finish, insulated with 1-inch- (25-mm-) thick duct liner.
    a. Floor Stand: Welded tubular steel with adjustable legs and vibration isolation pads.
    b. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
3. Supply-Air Fan: Forward curved, centrifugal, and with adjustable V-belt drive.
4. Refrigeration System:

a. Compressor: Hermetic, with oil strainer, internal motor overload protection, resilient suspension system, and crankcase heater.
b. Refrigeration Circuit: Low-pressure switch, manual-reset high-pressure switch, thermal-expansion valve with external equalizer, sight glass with moisture indicator, service shutoff valves, charging valves, and charge of refrigerant.
c. Refrigerant: R-407C **OR** R-410A, **as directed**.
d. Refrigerant Evaporator Coil: Direct-expansion coil of seamless copper tubes expanded into aluminum fins, with two circuits, each with solenoid valve.
1) Mount coil assembly over stainless-steel drain pan complying with ASHRAE 62.1, **as directed**, and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir, **as directed**.
e. Integral, Water-Cooled Refrigerant Condenser: Brazed-plate type with liquid-line stop valve and head-pressure-actuated, two-way regulating valve.
1) Cooling Medium: Water **OR** Glycol solution, **as directed**.
OR
Remote Air-Cooled Refrigerant Condenser: Integral, copper-tube aluminum-fin coil with propeller **OR** centrifugal, **as directed**, fan, direct **OR** belt, **as directed**, driven.
2) Split system shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection.

5. Hydronic Cooling Coil: Seamless copper tubes expanded into aluminum fins with modulating three-way control valve.
a. Cooling Medium: Water **OR** Glycol solution, **as directed**.
b. Mount coil assembly over stainless-steel drain pan complying with ASHRAE 62.1, **as directed**, and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir, **as directed**.
OR
Remote Air-Cooled, Glycol-Solution Cooler: Corrosion-resistant cabinet, copper-tube aluminum-fin coil, direct-drive propeller fan with fan guards, and single-phase motors with internal overload protection.
c. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.
6. Glycol-Solution Pump Package: Weatherproof and vented enclosure of enameled, galvanized steel on structural base frame containing centrifugal pump with mechanical seal.
a. Piping: Interconnecting piping, from suction to discharge, with shutoff valves, flow switches, unions, and pressurized expansion tank with air purge vent and system-charging connection.
b. Glycol: Inhibited ethylene glycol and water solution mixed 50:50, suitable for operating temperature of minus 40 deg F (minus 40 deg C).
c. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.
7. Electric-Resistance Heating Coil: Finned-tube electric elements with contactor and high-temperature-limit switches.
8. Filter: 2-inch- (50-mm-) thick, disposable, glass-fiber media.
a. Initial Resistance: as directed by the Owner.
b. Recommended Final Resistance: as directed by the Owner.
c. Arrestance (ASHRAE 52.1): 90 percent.
d. Merv (ASHRAE 52.2): 7.
9. Infrared Humidifier: High-intensity quartz lamps mounted above stainless-steel evaporator pan, serviceable without disconnecting water, drain, or electrical connections; prepiped and located in bypass airstream; with flush-cycle timer and solenoid drain valve.
10. Electrode Steam Humidifier: Self-contained, microprocessor-controlled unit with disposable, polypropylene-plastic cylinders and having field-adjustable steel electrodes and stainless-steel steam dispersion tube.

a. Plumbing Components and Valve Bodies: Plastic, linked by flexible rubber hosing, with water fill with air gap and solenoid valve incorporating built-in strainer, pressure-reducing and flow-regulating orifice, and drain with integral air gap.
b. Control: Fully modulating to provide gradual 0 to 100 percent capacity with field-adjustable maximum capacity; with high-water probe.
c. Drain Cycle: Field-adjustable drain duration and drain interval.

11. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.
12. Control System: Unit-mounted panel with main fan contactor, compressor contactor, compressor start capacitor, control transformer with circuit breaker, solid-state temperature- and humidity-, **as directed**, control modules, humidity contactor, **as directed**, time-delay relay, heating contactor, and high-temperature thermostat. Provide solid-state, wall-mounted control panel with start-stop switch, adjustable humidity set point, **as directed**, and adjustable temperature set point.

C. Ceiling-Mounted Units

1. Description: Self-contained, factory assembled, prewired, and prepiped; consisting of cabinet, fan, filters, and controls; for horizontal ceiling mounting to fit T-bar ceiling opening of 24 by 48 inches (610 by 1220 mm).
2. Cabinet: Galvanized steel with baked-enamel finish, insulated with 1/2-inch- (13-mm-) thick duct liner.
   a. Integral factory-supplied supply and return grille to fit ceiling grid kit of 24 by 48 inches (610 by 1220 mm), with filter.
   b. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
3. Supply-Air Fan: Forward curved, centrifugal, and directly driven by two-speed motor.
4. Refrigeration System:
   a. Compressor: Hermetic, with oil strainer, internal motor overload protection, resilient suspension system, and crankcase heater.
   b. Refrigeration Circuit: Low-pressure switch, manual-reset high-pressure switch, thermal-expansion valve with external equalizer, sight glass with moisture indicator, service shutoff valves, charging valves, and charge of refrigerant.
   c. Refrigerant: R-407C **OR** R-410A, **as directed**.
   d. Refrigerant Evaporator Coil: Direct-expansion coil of seamless copper tubes expanded into aluminum fins.
      1) Mount coil assembly over stainless-steel drain pan complying with ASHRAE 62.1, **as directed**, and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir, **as directed**.
   e. Integral, Water-Cooled Refrigerant Condenser: Coaxial, counterflow, tube-in-tube **OR** Brazed-plate, **as directed**, type with liquid-line stop valve and head-pressure-actuated, water-regulating valve.
      1) Cooling Medium: Water **OR** Glycol solution, **as directed**.

      OR

      Remote Air-Cooled Refrigerant Condenser: Integral, copper-tube aluminum-fin coil with propeller **OR** centrifugal, **as directed**, fan, direct driven.
   f. Split system shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection.
5. Hydronic Cooling Coil: Seamless copper tubes expanded into aluminum fins with two-way control valve.
   a. Cooling Medium: Water **OR** Glycol solution, **as directed**.
   b. Mount coil assembly over stainless-steel drain pan complying with ASHRAE 62.1, **as directed**, and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir, **as directed**.

   OR

   Remote, Air-Cooled, Glycol-Solution Cooler: Corrosion-resistant cabinet, copper-tube aluminum-fin coil, direct-drive propeller fan with fan guards, and single-phase motors with internal overload protection.

6. Glycol-Solution Pump Package: Weatherproof and vented enclosure of enameled, galvanized steel on structural base frame containing centrifugal pump with mechanical seal.
   a. Piping: Interconnecting piping, to and from remote, air-cooled glycol-solution cooler, with shutoff valves, flow switches, unions, and pressurized expansion tank with air purge vent and system-charging connection.
   b. Glycol: Inhibited ethylene glycol and water solution mixed 50:50, suitable for operating temperature of minus 40 deg F (minus 40 deg C).
7. Electric-Resistance Heating Coil: Finned-tube electric elements with contactor, dehumidification relay, and high-temperature-limit switches.
8. Filter: 1-inch- (25-mm-) thick, disposable, glass-fiber media.
   a. Initial Resistance: as directed by the Owner.
   b. Recommended Final Resistance: as directed by the Owner.
   c. Arrestance (ASHRAE 52.1): 90 percent.
   d. Merv (ASHRAE 52.2): 7.
9. Atomizing Humidifier: Centrifugal atomizer with stainless-steel pan, demister pad, and solenoid valve.
10. Electrode Steam Humidifier: Self-contained, microprocessor-controlled unit with disposable, polypropylene-plastic cylinders, and having field-adjustable steel electrodes and stainless-steel steam dispersion tube.
    a. Plumbing Components and Valve Bodies: Plastic, linked by flexible rubber hosing, with water fill with air gap and solenoid valve incorporating built-in strainer, pressure-reducing and flow-regulating orifice, and drain with integral air gap.
    b. Control: Fully modulating to provide gradual 0 to 100 percent capacity with field-adjustable maximum capacity; with high-water probe.
    c. Drain Cycle: Field-adjustable drain duration and drain interval.
11. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.
12. Control System: Unit-mounted panel with main fan contactor, compressor contactor, compressor start capacitor, control transformer with circuit breaker, solid-state temperature- and humidity-, **as directed**,control modules, humidity contactor, **as directed**, time-delay relay, heating contactor, and high-temperature thermostat. Provide solid-state, wall-mounted control panel with start-stop switch, adjustable humidity set point, **as directed**, and adjustable temperature set point.

D. Console Units
1. Description: Split system consisting of evaporator section for floor or wall mounting and remote condensing section.
2. Evaporator Cabinet: Furniture-grade steel with baked-enamel finish; with front access and containing direct-drive centrifugal fans and two-speed motor.
   a. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
3. Condenser Cabinet: Steel with baked-enamel finish and containing compressor and condenser.
4. Refrigeration System:
   a. Compressor: Hermetic, with oil strainer, internal motor overload protection, resilient suspension system, and crankcase heater.
   b. Refrigeration Circuit: Filter/dryer, manual-reset high-pressure switch, thermal-expansion valve with external equalizer, sight glass with moisture indicator, service shutoff valves, charging valves, and charge of refrigerant.
   c. Refrigerant: R-407C **OR** R-410A, **as directed**.
   d. Refrigerant Evaporator Coil: Direct-expansion coil of seamless copper tubes expanded into aluminum fins.
      1) Mount coil assembly over stainless-steel drain pan complying with ASHRAE 62.1, **as directed**, and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir, **as directed**.

e. Integral, Water-Cooled Refrigerant Condenser: Coaxial, counterflow, tube-in-tube **OR** Brazed-plate, **as directed**, type with liquid-line stop valve and head-pressure-actuated, water-regulating valve.
OR
Remote Air-Cooled Refrigerant Condenser: Integral, copper-tube aluminum-fin coil with propeller **OR** centrifugal, **as directed**, fan, direct driven.
f. Split system shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection.

5. Hydronic Cooling Coil: Seamless copper tubes expanded into aluminum fins with modulating control valve.
   a. Cooling Medium: Water **OR** Glycol solution, **as directed**.
   b. Mount coil assembly over stainless-steel drain pan complying with ASHRAE 62.1, **as directed**, and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir, **as directed**.

   OR
   Remote, Air-Cooled, Glycol-Solution Cooler: Corrosion-resistant cabinet, copper-tube aluminum-fin coil, direct-drive propeller fan with fan guards, and single-phase motor with internal overload protection.
6. Glycol-Solution Pump Package: Weatherproof and vented enclosure of enameled, galvanized steel on structural base frame containing centrifugal pump with mechanical seal.
   a. Piping: Interconnecting piping, to and from remote, air-cooled, glycol-solution cooler, with shutoff valves, flow switches, unions, and pressurized expansion tank with air purge vent and system-charging connection.
   b. Glycol: Inhibited ethylene glycol and water solution mixed 50:50, suitable for operating temperature of minus 40 deg F (minus 40 deg C).
7. Electric-Resistance Heating Coil: Finned-tube electric elements with contactor and high-temperature-limit switches.
8. Filter: Cleanable.
   OR
   Filter: 1-inch- (25-mm-) thick, disposable, glass-fiber media.
   a. Initial Resistance: as directed by the Owner.
   b. Recommended Final Resistance: as directed by the Owner.
   c. Arrestance (ASHRAE 52.1): 90 percent.
   d. Merv (ASHRAE 52.2): 7.
9. Electrode Steam Humidifier: Self-contained and microprocessor controlled; with replaceable cylinder.
10. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.
11. Control System: Unit-mounted panel with contactors, control transformer with circuit breaker, and solid-state temperature- and humidity-, **as directed**,control modules. Provide solid-state, unit-mounted control panel with start-stop switch, adjustable humidity set point, **as directed**, and adjustable temperature set point.

E. Fan Motors
1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
   a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 22.

1.3 EXECUTION

A. Installation

1. Install computer-room air conditioners level and plumb, maintaining manufacturer's recommended clearances. Install according to ARI Guideline B, **as directed**.
2. Computer-Room Air-Conditioner Mounting: Install using elastomeric pads **OR** elastomeric mounts **OR** restrained spring isolators, **as directed**. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
   a. Minimum Deflection: 1/4 inch (6 mm) **OR** 1 inch (25 mm), **as directed**.
3. Suspended Computer-Room Air Conditioners: Install using continuous-thread hanger rods and elastomeric hangers **OR** spring hangers **OR** spring hangers with vertical-limit stop, **as directed**, of size required to support weight of computer-room air conditioner.
   a. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment". Fabricate brackets or supports as required.
   b. Comply with requirements for hangers and supports specified in Division 23 Section "Hangers And Supports For Hvac Piping And Equipment".
4. Air-Cooled Refrigerant Condenser Mounting: Install using elastomeric pads **OR** elastomeric mounts **OR** restrained spring isolators, **as directed**. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
   a. Minimum Deflection: 1/4 inch (6 mm) **OR** 1 inch (25 mm), **as directed**.
5. Remote, Air-Cooled, Glycol-Solution Cooler Mounting: Install using elastomeric pads **OR** elastomeric mounts **OR** restrained spring isolators, **as directed**. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
   a. Minimum Deflection: 1/4 inch (6 mm) **OR** 1 inch (25 mm), **as directed**.
6. Glycol-Solution Pump Package Mounting: Install using elastomeric pads **OR** elastomeric mounts, **as directed**. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".

B. Connections
1. Piping installation requirements are specified in other Division 21. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to machine to allow service and maintenance.
3. Water and Drainage Connections: Comply with applicable requirements in Division 22 Section "Domestic Water Piping". Provide adequate connections for water-cooled units, condensate drain, and humidifier flushing system.
4. Hot-Water Heating Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping". Provide shutoff valves in inlet and outlet piping to heating coils.
5. Steam and Condensate Piping: Comply with applicable requirements in Division 23 Section "Steam And Condensate Heating Piping". Provide shutoff valves in steam inlet and steam trap in condensate outlet piping to heating coils.
6. Condenser-Water Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping". Provide shutoff valves in water inlet and outlet piping on water-cooled units.
7. Refrigerant Piping: Comply with applicable requirements in Division 23 Section "Refrigerant Piping". Provide shutoff valves and piping.

C. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
   a. Inspect for and remove shipping bolts, blocks, and tie-down straps.
   b. After installing computer-room air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
   c. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Computer-room air conditioners will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.
5. After startup service and performance test, change filters and flush humidifier.

D. Adjusting
1. Adjust initial temperature and humidity, **as directed**, set points.
2. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
3. Occupancy Adjustments: When requested within 12 months of date of Final Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

E. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain computer-room air conditioners.

END OF SECTION 23 81 23 12

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Task	Specification	Specification Description
23 81 23 13	23 81 23 12	Computer-Room Air-Conditioners
23 81 43 00	23 81 13 11	Packaged Terminal Air Conditioners
23 81 49 00	23 63 13 00a	Split-System Air-Conditioning Units

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SECTION 23 82 16 11 - AIR COILS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for air coils. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following types of air coils that are not an integral part of air-handling units:
   a. Hot-water.
   b. Chilled-water.
   c. Steam.
   d. Refrigerant.
   e. Electric.

C. Submittals
1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil. Include rated capacity and pressure drop for each air coil.
2. Shop Drawings: Diagram power, signal, and control wiring.
3. Field quality-control test reports.
4. Operation and maintenance data.

D. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. ASHRAE Compliance:
   a. Comply with ASHRAE 15 for refrigeration system safety.
   b. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
   c. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

1.2 PRODUCTS

A. Water Coils
1. Performance Ratings: Tested and rated according to ARI 410 and ASHRAE 33.
2. Minimum Working-Pressure/Temperature Ratings: 200 psig (1380 kPa), 325 deg F (163 deg C).
3. Source Quality Control: Factory tested to 300 psig (2070 kPa).
4. Tubes: ASTM B 743 copper, minimum 0.020 inch (0.508 mm) **OR** 0.035 inch (0.889 mm) **OR** 0.049 inch (1.245 mm), **as directed**, thick.
5. Fins: Aluminum **OR** Copper, **as directed**, minimum 0.006 inch (0.152 mm) **OR** 0.010 inch (0.254 mm), **as directed**, thick.
6. Headers: Cast iron with drain and air vent tappings **OR** Cast iron with cleaning plugs, and drain and air vent tappings **OR** Seamless copper tube with brazed joints, prime coated **OR** Steel with brazed joints, prime coated, **as directed**.
7. Frames: Galvanized-steel channel frame, minimum 0.052 inch (1.3 mm) **OR** 0.064 inch (1.6 mm) **OR** 0.079 inch (2.0 mm) **OR** 0.0625 inch (1.6 mm), **as directed**, thick for slip-in **OR** flanged, **as directed**, mounting.

OR
Frames: ASTM A 666, Type 304 **OR** 316, **as directed**, stainless steel, minimum 0.0625 inch (1.6 mm) thick for slip-in **OR** flanged, **as directed**, mounting.

8. Hot-Water Coil and Steam Coil, Face-and-Bypass Dampers: Alternating arrangement of coil segments and dampers.
   a. Coil Configuration: Horizontal **OR** Vertical, **as directed**, tubes.
   b. Dampers: Extruded-aluminum **OR** Galvanized-steel, **as directed**, blades with edge and end seals; full-length drive rod and mount for actuator in **OR** outside, **as directed**, the airstream.

B. Steam Coils
1. Performance Ratings: Tested and rated according to ARI 410 and ASHRAE 33.
2. Minimum Working-Pressure/Temperature Ratings: 100 psig (690 kPa), 400 deg F (204 deg C).
3. Source Quality Control: Factory tested to 300 psig (2070 kPa).
4. Tubes: ASTM B 743 copper, minimum 0.025 inch (0.635 mm) **OR** 0.035 inch (0.889 mm) **OR** 0.049 inch (1.245 mm), **as directed**, thick.
5. Fins: Aluminum **OR** Copper, **as directed**, minimum 0.006 inch (0.152 mm) **OR** 0.010 inch (0.254 mm), **as directed**, thick.
6. Headers: Cast iron with drain and air vent tappings **OR** Cast iron with cleaning plugs, and drain and air vent tappings **OR** Seamless copper tube with brazed joints, prime coated **OR** Steel with brazed joints, prime coated, **as directed**.
7. Tube Type: Single or distributing as indicated.
8. Frames: Galvanized-steel channel frame, minimum 0.052 inch (1.3 mm) **OR** 0.064 inch (1.6 mm) **OR** 0.079 inch (2.0 mm) **OR** 0.0625 inch (1.6 mm), **as directed**, thick for slip-in **OR** flanged, **as directed**, mounting.
   OR
   Frames: ASTM A 666, Type 304 **OR** 316, **as directed**, stainless steel, minimum 0.0625 inch (1.6 mm) thick for slip-in **OR** flanged, **as directed**, mounting.
9. Face-and-Bypass Dampers: Alternating arrangement of coil segments and dampers.
   a. Coil Configuration: Horizontal **OR** Vertical, **as directed**, tubes.
   b. Dampers: Extruded-aluminum **OR** Galvanized-steel, **as directed**, blades with edge and end seals; full-length drive rod and mount for actuator in **OR** outside, **as directed**, the airstream.

C. Refrigerant Coils
1. Performance Ratings: Tested and rated according to ARI 410 and ASHRAE 33.
2. Minimum Working-Pressure Rating: 300 psig (2070 kPa).
3. Source Quality Control: Factory tested to 450 psig (3105 kPa).
4. Tubes: ASTM B 743 copper, minimum 0.020 inch (0.508 mm) **OR** 0.035 inch (0.889 mm) **OR** 0.049 inch (1.245 mm), **as directed**, thick.
5. Fins: Aluminum **OR** Copper, **as directed**, minimum 0.006 inch (0.152 mm) **OR** 0.010 inch (0.254 mm), **as directed**, thick.
6. Suction and Distributor Piping: ASTM B 88, Type L (ASTM B 88M, Type B) copper tube with brazed joints.
7. Frames: Galvanized-steel channel frame, minimum 0.052 inch (1.3 mm) **OR** 0.064 inch (1.6 mm) **OR** 0.079 inch (2.0 mm) **OR** 0.0625 inch (1.6 mm), **as directed**, thick for slip-in **OR** flanged, **as directed**, mounting.
   OR
   Frames: ASTM A 666, Type 304 **OR** 316, **as directed**, stainless steel, minimum 0.0625 inch (1.6 mm) thick for slip-in **OR** flanged, **as directed**, mounting.

D. Electric Coils
1. Coil Assembly: Comply with UL 1995.

2. Heating Elements: Coiled resistance wire of 80 percent nickel and 20 percent chromium; surrounded by compacted magnesium-oxide powder in tubular-steel sheath; with spiral-wound, copper-plated, steel fins continuously brazed to sheath.
OR
Heating Elements: Open-coil resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, and fastened to supporting brackets.
3. High-Temperature Coil Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box without removing heater from duct or casing.
    a. Secondary Protection: Load-carrying, manually reset or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
4. Frames: Galvanized-steel channel frame, minimum 0.052 inch (1.3 mm) **OR** 0.064 inch (1.6 mm) **OR** 0.079 inch (2.0 mm) **OR** 0.0625 inch (1.6 mm), **as directed**, thick for slip-in **OR** flanged, **as directed**, mounting.
5. Control Panel: Unit **OR** Remote, **as directed**, mounted with disconnecting means and overcurrent protection. Include the following controls:
    a. Magnetic contactor.
    b. Mercury contactor.
    c. Toggle switches; one per step.
    d. Step controller.
    e. Time-delay relay.
    f. Pilot lights; one per step.
    g. Airflow proving switch.
6. Refer to Division 23 Section "Instrumentation And Control For Hvac" for thermostat.
OR
Thermostats: Wall-mounted thermostats, with temperature range from 50 to 90 deg F (10 to plus 32 deg C), and 2.5 deg F (1.4 deg C) throttling range.

1.3 EXECUTION

A. Installation
1. Install coils level and plumb.
2. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."
3. Install galvanized-steel **OR** stainless-steel, **as directed**, drain pan under each cooling coil.
    a. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1, **as directed**.
    b. Construct drain pans to extend beyond coil length and width and to connect to condensate trap and drainage.
    c. Extend drain pan upstream and downstream from coil face.
    d. Extend drain pan under coil headers and exposed supply piping.
4. Install moisture eliminators for cooling coils. Extend drain pan under moisture eliminator.
5. Straighten bent fins on air coils.
6. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

B. Connections
1. Piping installation requirements are specified in other Division 21. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to coils to allow service and maintenance.
3. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Division 23 Section "Instrumentation And Control For Hvac", and other piping specialties are specified in Division 23 Section "Hydronic Piping".
4. Connect steam piping with gate valve and union and steam condensate piping with union, strainer, trap, and gate valve to allow coils to be disconnected without draining piping. Control

valves are specified in Division 23 Section "Instrumentation And Control For Hvac", and other piping specialties are specified in Division 23 Section "Steam And Condensate Heating Piping".

5. Connect refrigerant piping according to Division 23 Section "Refrigerant Piping".
6. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
7. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Field Quality Control
1. Perform the following field tests and inspections and prepare test reports:
   a. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
   b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 23 82 16 11

Task	Specification	Specification Description
23 82 16 12	23 82 16 11	Air Coils
23 82 16 13	23 82 16 11	Air Coils
23 82 16 14	23 74 16 13b	Unit Ventilators
23 82 19 00	23 64 16 16	Fan-Coil Units

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SECTION 23 82 29 00 - CONVECTION HEATING UNITS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for convection heating units. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Hydronic, Steam, and Electric baseboard radiators.
   b. Hydronic, Steam, and Electric finned-tube radiators.
   c. Hydronic, Steam, and Electric convectors.
   d. Flat-pipe steel radiators.

C. Submittals
1. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.
2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Field quality-control test reports.
4. Operation and maintenance data.

D. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.2 PRODUCTS

A. Electric Baseboard Radiators
1. Description: Factory-packaged units constructed according to UL 499, UL 1030, and UL 2021.
2. Heating Elements: Nickel-chromium-wire heating element enclosed in metallic sheath mechanically bonded to fins, with high-temperature cutout and sensor running the full length of the element. Element supports shall eliminate thermal expansion noise.
3. Enclosures: Minimum 0.0329-inch- (0.85-mm-) **OR** 0.0428-inch- (1.1-mm-), **as directed,** thick steel, removable front cover.
4. Rust-Resistant Enclosures: Minimum 0.040-inch- (1.0-mm-) **OR** 0.052-inch- (1.3-mm-), **as directed,** thick ASTM A 653/A 653M, G60 galvanized-steel, removable front cover.
   a. Full-height back.
   b. Full-length damper.
   c. End panel.
   d. Plastic end **OR** End, **as directed,** caps.
   e. Inside and outside corners.
   f. Joiner pieces to snap together.
   g. Finish: Baked-enamel finish in manufacturer's standard **OR** custom, **as directed,** color as selected.
   h. Element Brackets: Primed and painted steel to support front panel and element.
5. Unit Controls: Integral line-voltage thermostat **OR** Integral electronic thermostat **OR** Remote line-voltage thermostat, **as directed**.

6. Accessories:
    a. Filler sections without a heating element matching the adjacent enclosure.
    b. Straight-blade-type receptacles complying with DSCC W-C-596G/GEN, NEMA WD 1, NEMA WD 6, and UL 498; in color selected.

B. Hot-Water Baseboard Radiators
1. Performance Ratings: Rate baseboard radiators according to Hydronics Institute's "I=B=R Testing and Rating Standard for Baseboard Radiation."
2. Heating Elements: Copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins resting on polypropylene element glides. One end of tube shall be belled.
    a. Tube Diameter: NPS 1/2 (DN 15) **OR** NPS 3/4 (DN 20) **OR** NPS 1 (DN 25) **OR** NPS 1-1/4 (DN 32), **as directed**.
    b. Fin Size: 2-1/2 by 2-1/2 inches (63 by 63 mm) **OR** 3 by 3 inches (76 by 76 mm), **as directed**.
    c. Fin Spacing: 40 per foot (131 per meter) **OR** 50 per foot (164 per meter) **OR** 58 per foot (190 per meter), **as directed**.
    d. Entering Air Temperature: 65 deg F (18 deg C).
    e. Average Water Temperature: 180 deg F (82 deg C).
    f. Minimum Water Velocity: 1/2 fps (0.15 m/s).
    g. Entering Steam Pressure: 1 psig (6.9 kPa).
3. Heating Elements: Steel tubing mechanically expanded into flanged collars of evenly spaced steel fins resting on polypropylene element glides. Tube ends shall be threaded.
    a. Tube Diameter: NPS 1-1/4 (DN 32).
    b. Fin Size: 3 by 3 inches (76 by 76 mm).
    c. Fin Spacing: 52 per foot (171 per meter).
    d. Entering Air Temperature: 65 deg F (18 deg C).
    e. Average Water Temperature: 180 deg F (82 deg C).
    f. Minimum Water Velocity: 1/2 fps (0.15 m/s).
    g. Entering Steam Pressure: 1 psig (6.9 kPa).
4. Enclosures: Minimum 0.0329-inch- (0.85-mm-) **OR** 0.0428-inch- (1.1-mm-), **as directed,** thick steel, removable front cover.
5. Rust-Resistant Enclosures: Minimum 0.040-inch- (1.0-mm-) **OR** 0.052-inch- (1.3-mm-), **as directed,** thick ASTM A 653/A 653M, G60 galvanized-steel, removable front cover.
    a. Full-height back.
    b. Full-length damper.
    c. End panel.
    d. End caps.
    e. Inside and outside corners.
    f. Valve access door.
    g. Joiner pieces to snap together.
    h. Finish: Baked-enamel finish in manufacturer's standard **OR** custom, **as directed,** color as selected.
    i. Element Brackets: Primed and painted steel to support front panel and element.

C. Electric Finned-Tube Radiators
1. Description: Factory-packaged units constructed according to UL 499, UL 1030, and UL 2021.
2. Heating Elements: Nickel-chromium-wire heating element enclosed in metallic sheath mechanically bonded into fins, with high-temperature cutout and sensor running the full length of the element. Element supports shall eliminate thermal expansion noise.
3. Front Panel: Minimum 0.0428-inch- (1.1-mm-) **OR** 0.0528-inch- (1.35-mm-), **as directed,** thick steel.
4. Rust-Resistant Front Panel: Minimum 0.052-inch- (1.3-mm-) **OR** 0.064-inch- (1.6-mm-), **as directed,** thick ASTM A 653/A 653M, G60 galvanized steel.
5. Wall-Mounting Back Panel: Minimum 0.0329-inch- (0.85-mm-) thick steel, full height, with full-length channel support for front panel without exposed fasteners.

6. Floor-Mounting Pedestals: Conceal conduit for power and control wiring at maximum 36-inch (914-mm) spacing. Pedestal-mounting back panel shall be solid panel matching front panel.
7. Support Brackets: Locate at maximum 36-inch (914-mm) spacing to support front panel and element.
8. Finish: Baked-enamel **OR**-epoxy, **as directed,** finish in manufacturer's standard **OR** custom, **as directed,** color as selected.
9. Damper: Knob-operated internal damper at enclosure outlet.
10. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches (150 by 175 mm), integral with enclosure.
11. Enclosure Style: Sloped **OR** Flat, **as directed,** top.
    a. Front Inlet Grille: Punched louver; painted to match enclosure.
    b. Front Inlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.
        1) Mill-finish aluminum.
        2) Anodized finish color as selected from manufacturer's standard **OR** custom, **as directed,** colors.
        3) Painted to match enclosure.
    c. Top **OR** Front, **as directed,** Outlet Grille: Punched louver; painted to match enclosure.
    d. Top **OR** Front, **as directed,** Outlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.
        1) Mill-finish aluminum.
        2) Anodized finish color as selected from manufacturer's standard **OR** custom, **as directed**, colors.
        3) Painted to match enclosure.
12. Unit Controls: Integral line-voltage thermostat with minimum range of 60 to 90 deg F (15 to 32 deg C) **OR** low-voltage relay and control transformer for remote thermostat, **as directed**.
13. Accessories: Integral disconnect switch, filler sections, corners, relay sections, and splice plates all matching the enclosure and grille finishes.

D. Hot-Water Finned-Tube Radiators
1. Performance Ratings: Rate finned-tube radiators according to Hydronics Institute's "I=B=R Testing and Rating Standard for Finned-Tube (Commercial) Radiation."
2. Heating Elements: Copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins resting on element supports. One tube end shall be belled.
    a. Tube Diameter: NPS 3/4 (DN 20) **OR** NPS 1 (DN 25) **OR** NPS 1-1/4 (DN 32), **as directed**.
    b. Fin Size: 3 by 3 inches (76 by 76 mm) **OR** 4 by 4 inches (102 by 102 mm), **as directed**.
    c. Fin Spacing: 40 per foot (131 per meter) **OR** 50 per foot (164 per meter) **OR** 58 per foot (190 per meter), **as directed**.
    d. Entering Air Temperature: 65 deg F (18 deg C).
    e. Average Water Temperature: 180 deg F (82 deg C).
    f. Minimum Water Velocity: 1/2 fps (0.15 m/s).
    g. Entering Steam Pressure: 1 psig (6.9 kPa).
3. Heating Elements: Steel tubing mechanically expanded into flanged collars of evenly spaced steel fins resting on element supports. Tube ends shall be threaded.
    a. Tube Diameter: NPS 1-1/4 (DN 32).
    b. Fin Size: 4 by 4 inches (102 by 102 mm).
    c. Fin Spacing: 52 per foot (171 per meter).
    d. Entering Air Temperature: 65 deg F (18 deg C).
    e. Average Water Temperature: 180 deg F (82 deg C).
    f. Minimum Water Velocity: 1/2 fps (0.15 m/s).
    g. Entering Steam Pressure: 1 psig (6.9 kPa).
4. Element Supports: Ball-bearing cradle type to permit longitudinal movement on enclosure brackets.
5. Front Panel: Minimum 0.0428-inch- (1.1-mm-) **OR** 0.0528-inch- (1.35-mm-), **as directed,** thick steel.
6. Rust-Resistant Front Panel: Minimum 0.052-inch- (1.3-mm-) **OR** 0.064-inch- (1.6-mm-), **as directed,** thick, ASTM A 653/A 653M, G60 galvanized steel.

7. Wall-Mounting Back Panel: Minimum 0.0329-inch- (0.85-mm-) thick steel, full height, with full-length channel support for front panel without exposed fasteners.
8. Floor-Mounting Pedestals: Conceal insulated piping at maximum 36-inch (914-mm) spacing. Pedestal-mounting back panel shall be solid panel matching front panel. Provide stainless-steel escutcheon for floor openings at pedestals.
9. Support Brackets: Locate at maximum 36-inch (914-mm) spacing to support front panel and element.
10. Finish: Baked-enamel **OR**-epoxy, **as directed,** finish in manufacturer's standard **OR** custom, **as directed** color as selected.
11. Damper: Knob-operated internal damper at enclosure outlet.
12. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches (150 by 175 mm), integral with enclosure.
13. Enclosure Style: Sloped **OR** Flat, **as directed,** top.
    a. Front Inlet Grille: Punched louver; painted to match enclosure.
    b. Front Inlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.
        1) Mill-finish aluminum.
        2) Anodized finish, color as selected from manufacturer's standard **OR** custom, **as directed,** colors.
        3) Painted to match enclosure.
    c. Top **OR** Front, **as directed,** Outlet Grille: Punched louver; painted to match enclosure.
    d. Top **OR** Front, **as directed**, Outlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.
        1) Mill-finish aluminum.
        2) Anodized finish, color as selected from manufacturer's standard **OR** custom, **as directed,** colors.
        3) Painted to match enclosure.
14. Accessories: Filler sections, corners, relay sections, and splice plates all matching the enclosure and grille finishes.

E. Electric Convectors
1. Description: Factory-packaged units constructed according to UL 499, UL 1030, and UL 2021.
2. Heating Elements: Nickel-chromium-wire heating element enclosed in metallic sheath mechanically bonded into fins, with high-temperature cutout and sensor running the full length of element. Element supports shall eliminate thermal expansion noise.
    a. Heat Output: 300 **OR** 500 **OR** 750 **OR** 1000 **OR** 1250 **OR** 1500 **OR** 1750 **OR** 2000 **OR** 2250 **OR** 2500, **as directed,** W.
3. Front and Top Panel: Minimum 0.0528-inch- (1.35-mm-) **OR** 0.0677-inch- (1.7-mm-), **as directed** thick steel with exposed corners rounded; removable front panels with tamper-resistant fasteners braced and reinforced for stiffness.
4. Wall-Mounting Back and End Panels: Minimum 0.0428-inch- (1.1-mm-) thick steel.
5. Floor-Mounting Pedestals: Conceal conduit for power and control wiring at maximum 36-inch (914-mm) spacing. Pedestal-mounting back panel shall be solid panel matching front panel.
6. Support Brackets: Locate at maximum 36-inch (914-mm) spacing to support front panel and element.
7. Insulation: 1/2-inch- (13-mm-) thick, fibrous glass on inside of the back of the enclosure.
8. Finish: Baked-enamel finish in manufacturer's standard **OR** custom, **as directed,** color as selected.
9. Damper: Knob-operated internal damper.
10. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches (150 by 175 mm), integral with enclosure.
11. Enclosure Style: Sloped **OR** Flat, **as directed,** top.
    a. Front Inlet Grille: Punched louver; painted to match enclosure.
    b. Front Inlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.
        1) Mill-finish aluminum.

2) Anodized finish, color as selected from manufacturer's standard **OR** custom, **as directed,** colors.
3) Painted to match enclosure.

c. Top **OR** Front, **as directed,** Outlet Grille: Punched louver; painted to match enclosure.
d. Top **OR** Front, **as directed,** Outlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.
1) Mill-finish aluminum.
2) Anodized finish, color as selected from manufacturer's standard **OR** custom, **as directed,** colors.
3) Painted to match enclosure.

12. Unit Controls: Integral line-voltage thermostat with minimum range of 60 to 90 deg F (15 to 32 deg C) **OR** low-voltage relay and control transformer for remote thermostat\, **as directed**.
13. Accessories: Integral disconnect switch, recessing flanges finished to match enclosure or overlapping front cover for fully recessed units, and rubber gaskets to seal cabinet at wall.

F. Hot-Water Or Steam Convectors

1. Convector Elements: Seamless copper tubing mechanically expanded into evenly spaced aluminum fins and rolled into cast-iron or brass headers with inlet/outlet and air vent; steel side plates and supports. Factory-pressure-test element at minimum 100 psig (690 kPa).
a. Entering Air Temperature: 65 deg F (18 deg C).
b. Average Water Temperature: 180 deg F (82 deg C).
c. Temperature Drop: 10 deg F (5.56 deg C) **OR** 20 deg F (11.1 deg C) **OR** 30 deg F (16.6 deg C), **as directed**.
d. Entering Steam Pressure: 1 psig (6.9 kPa).
2. Front and Top Panel: Minimum 0.0528-inch- (1.35-mm-) **OR** 0.0677-inch- (1.7-mm-), **as directed,** thick steel with exposed corners rounded; removable front panels with tamper-resistant fasteners braced and reinforced for stiffness.
3. Wall-Mounting Back and End Panels: Minimum 0.0428-inch- (1.1-mm-) thick steel.
4. Floor-Mounting Pedestals: Conceal conduit for power and control wiring at maximum 36-inch (914-mm) spacing. Pedestal-mounting back panel shall be solid panel matching front panel.
5. Support Brackets: Locate at maximum 36-inch (914-mm) spacing to support front panel and element.
6. Insulation: 1/2-inch- (13-mm-) thick, fibrous glass on inside of the back of the enclosure.
7. Finish: Baked-enamel finish in manufacturer's standard **OR** custom, **as directed** color as selected.
8. Damper: Knob-operated internal damper.
9. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches (150 by 175 mm), integral with enclosure.
10. Enclosure Style: Sloped **OR** Flat, **as directed,** top.
a. Front Inlet Grille: Punched louver; painted to match enclosure.
b. Front Inlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.
1) Mill-finish aluminum.
2) Anodized finish, color as selected from manufacturer's standard **OR** custom, **as directed,** colors.
3) Painted to match enclosure.
c. Top **OR** Front, **as directed,** Outlet Grille: Punched louver; painted to match enclosure.
d. Top **OR** Front, **as directed,** Outlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.
1) Mill-finish aluminum.
2) Anodized finish, color as selected from manufacturer's standard **OR** custom, **as directed,** colors.
3) Painted to match enclosure.

G. Flat-Pipe Steel Radiators

1. Heating Elements: Steel, welded and formed into flat, square, steel header with minimum thickness of 0.109 inches (2.76 mm). Include threaded piping and air vent connections.

a. Working Pressure 56 psig (386 kPa): 0.048 inch (1.22 mm).
b. Working Pressure 85 psig (585 kPa): 0.058 inch (1.47 mm).
c. Working Pressure 128 psig (881 kPa): 0.078 inch (1.98 mm).
d. Room Air Temperature: 65 deg F (18 deg C).
e. Average Water Temperature: 180 deg F (82 deg C).
f. Temperature Drop: 10 deg F (5.56 deg C) **OR** 20 deg F (11.1 deg C) **OR** 30 deg F (16.6 deg C), **as directed**.

2. Mounting: Wall brackets **OR** Floor pedestals, **as directed,** on maximum spacing of 36 inches (914 mm).
3. Finish: Baked-enamel finish in manufacturer's standard **OR** custom, **as directed,** color as selected.
4. Accessories:
   a. Steel piping covers finished to match radiator finish.
   b. Flexible Expansion Compensation Hoses: Minimum 400-psig (2758-kPa) working pressure, and operating temperatures from 33 to 211 deg F (0.5 to 99.5 deg C).
      1) Length: 24 inches (600 mm) **OR** 36 inches (900 mm), **as directed**.
      2) Minimum Diameter: Equal to connection size.

1.3 EXECUTION

A. Baseboard Radiator Installation
1. Install units level and plumb.
2. Install baseboard radiators according to Guide 2000 - Residential Hydronic Heating.
3. Install enclosure continuously around corners, using outside and inside corner fittings.
4. Join sections with splice plates and filler pieces to provide continuous enclosure.
5. Install access doors for access to valves.
6. Install enclosure continuously from wall to wall.
7. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.
8. Install valves within reach of access door provided in enclosure.
9. Install air-seal gasket between wall and recessing flanges or front cover of fully recessed unit.
10. Install piping within pedestals for freestanding units.

B. Finned-Tube Radiator Installation
1. Install units level and plumb.
2. Install finned-tube radiators according to Guide 2000 - Residential Hydronic Heating.
3. Install enclosure continuously around corners, using outside and inside corner fittings.
4. Join sections with splice plates and filler pieces to provide continuous enclosure.
5. Install access doors for access to valves.
6. Install enclosure continuously from wall to wall.
7. Terminate enclosures with manufacturer's end caps, except where enclosures are indicated to extend to adjoining walls.
8. Install valves within reach of access door provided in enclosure.
9. Install air-seal gasket between wall and recessing flanges or front cover of fully recessed unit.
10. Install piping within pedestals for freestanding units.

C. Convector Installation
1. Install units level and plumb.
2. Install valves within reach of access door provided in enclosure.
3. Install air-seal gasketing between wall and recessing flanges or front cover of fully recessed unit.
4. Install piping within pedestals for freestanding units.

D. Flat-Pipe Steel Radiator Installation
1. Install units level and plumb.

2. Install expansion compensation hoses.
3. Install piping covers.

E. Connections
1. Piping installation requirements are specified in Division 23 Section(s) "Hydronic Piping" OR "Steam And Condensate Heating Piping", **as applicable.** Drawings indicate general arrangement of piping, fittings, and specialties.
2. Connect hot-water units and components to piping according to Division 23 Section "Hydronic Piping".
   a. Install shutoff valves on inlet and outlet, and balancing valve on outlet.
3. Connect steam units and components to piping according to Division 23 Section "Steam And Condensate Heating Piping".
   a. Install shutoff valve on inlet; install strainer, steam trap, and shutoff valve on outlet.
4. Install control valves as required by Division 23 Section "Instrumentation And Control For Hvac".
5. Install piping adjacent to convection heating units to allow service and maintenance.
6. Ground electric convection heating units according to Division 26 Section "Grounding And Bonding For Electrical Systems".
7. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

F. Field Quality Control
1. Perform the following field tests and inspections and prepare test reports:
   a. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   b. Operational Test: After electrical circuitry has been energized, start units to confirm proper convection heating unit operation.
   c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Remove and replace convection heating units that do not pass tests and inspections and retest as specified above.

END OF SECTION 23 82 29 00

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Task	Specification	Specification Description
23 82 29 00	01 22 16 00	No Specification Required
23 82 33 00	01 22 16 00	No Specification Required
23 82 33 00	23 82 29 00	Convection Heating Units
23 82 36 00	01 22 16 00	No Specification Required
23 82 36 00	23 82 29 00	Convection Heating Units
23 82 39 13	01 22 16 00	No Specification Required
23 82 39 13	23 55 33 00a	Unit Heaters
23 82 39 16	01 22 16 00	No Specification Required
23 82 39 16	23 55 33 00a	Unit Heaters
23 82 39 19	01 22 16 00	No Specification Required
23 82 39 19	23 55 33 00a	Unit Heaters

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SECTION 23 84 13 23 - HUMIDIFIERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for humidifiers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following humidifiers:
   a. Atomizing.
   b. Steam injection.
   c. Self-contained.
   d. Heated pan.
   e. Heat exchanger.

C. Definition
1. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

D. Submittals
1. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
2. Shop Drawings: Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components, manifolds, and attachments to other work.
   a. Wiring Diagrams: Power, signal, and control wiring.
3. Field quality-control test reports.
4. Operation and maintenance data.

E. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. Comply with ARI 640, "Commercial and Industrial Humidifiers."

1.2 Products

A. Water-Pressure Atomizing Humidifiers
1. Nozzles: ASTM A 666, Type 304 **OR** 316, **as directed**, stainless steel.
2. Manifold: ASTM A 269, Type 304 **OR** 316, **as directed**, stainless-steel piping.
3. Droplet Filter: Biocide-treated polyethylene with maximum 0.30-inch wg (75-Pa) resistance.
4. Piping and Fittings: ASTM A 269, Type 304 **OR** 316, **as directed**, stainless-steel pipe and fittings.
   OR
   Piping and Fittings: ASTM B 88 (ASTM B 88M), Type L copper pipe and wrought-copper fittings with brazed joints.
5. Water Pump: Enclosed belt-drive ceramic plunger pump with stainless-steel **OR** bronze, **as directed**, heads, and single **OR** variable, **as directed**,-speed, totally enclosed, fan-cooled motor.
6. Final Water-Filter Efficiency: Minimum 98 percent retention of suspended particles 10 **OR** 20, **as directed**, microns and larger from makeup water.

7. Final Water-Filter Pressure Drop: Maximum 2 psig (14 kPa) at design flow when clean, and <**Insert value**> when dirty, **as directed**.
8. Pump Controls:
    a. Cycle **OR** Vary speed of, **as directed**, motor to satisfy humidistat.
    b. High-pressure solenoid valve for each control zone shown on Drawings.
    c. Building automation system interface for each control zone for start/stop and status indication and control at central workstation.
9. Dispersion Fan:
    a. Aluminum blade propeller fan with finger guard and single-speed motor interlocked to operate with humidifier.
    b. Fan Mounting: Above and behind manifold on bracket integral to wall-mounting manifold.
10. Accessories:
    a. Humidistat: Wall **OR** Return-duct, **as directed**,-mounting, solid-state, electronic-sensor controller capable of full-modulation or cycling control.
    b. Duct-mounting, high-limit humidistat.
    c. Airflow switch for preventing humidifier operation without airflow.

B. Compressed-Air Atomizing Humidifiers
1. Nozzles: ASTM A 666, Type 304 **OR** 316, **as directed**, stainless steel.
2. Manifold: ASTM A 269, Type 304 **OR** 316, **as directed**, stainless-steel piping.
3. Droplet Filter: Biocide-treated polyethylene with maximum 0.30-inch wg (75-Pa) resistance.
4. Piping and Fittings: ASTM A 269, Type 304 **OR** 316, **as directed**, stainless-steel pipe and fittings.
5. Compressed-Air and Water, **as directed**, Piping and Fittings: ASTM B 88 (ASTM B 88M), Type L copper pipe and wrought-copper fittings with soldered joints.
6. Final Water-Filter Efficiency: Minimum 98 percent retention of suspended particles 10 **OR** 20, **as directed**, microns and larger from makeup water.
7. Final Water-Filter Pressure Drop: Maximum 2 psig (14 kPa) at design flow when clean, and <**Insert value**> when dirty, **as directed**.
8. Air and Water Solenoid Controls:
    a. Cycle valves to satisfy humidistat.
    b. Solenoid valves for each control zone shown on Drawings.
    c. Building automation system interface for each control zone for start/stop and status indication and control at central workstation.
9. Dispersion Fan:
    a. Aluminum blade propeller fan with finger guard and single-speed motor interlocked to operate with humidifier.
    b. Fan Mounting: Above and behind manifold on bracket integral to wall-mounting manifold.
10. Accessories:
    a. Humidistat: Wall **OR** Return-duct, **as directed**,-mounting, solid-state, electronic-sensor controller capable of full-modulation or cycling control.
    b. Duct-mounting, high-limit humidistat.
    c. Airflow switch for preventing humidifier operation without airflow.

C. Steam-Injection Humidifiers
1. Manifold: ASTM A 666, Type 304 stainless steel, steam jacketed, **as directed**; insulated with 1/2-inch (13-mm) fiberglass and stainless-steel jacket; and , **as directed**,extending the full width of duct or plenum with mounting brackets at ends.
2. Discharge Nozzle and Dispersion Fan:
    a. Steam-jacketed discharge nozzle, aluminum blade propeller fan with finger guard, and single-speed motor interlocked to operate with humidifier.
    b. Fan Mounting: Above and behind discharge outlet on bracket integral to discharge outlet.
3. Steam Separator: Cast iron **OR** ASTM A 666, Type 304 stainless steel, **as directed**, with separate, **as directed**, humidifier control valve.
4. Humidifier Control Valve:

a. Actuator: Pneumatic **OR** Electric, **as directed**, modulating with spring return.
OR
Actuator: As specified in Division 23 Section "Instrumentation And Control For Hvac".

5. Steam Trap: Inverted-bucket type, sized for a minimum of 3 times the maximum rated condensate flow of humidifier at 1/2-psig (3.4-kPa) inlet pressure.
6. Accessories:
   a. Wall **OR** Return-duct, **as directed**,-mounting humidistat.
   b. Duct-mounting, high-limit humidistat.
   c. Aquastat mounted on steam condensate return piping to prevent cold operation of humidifier.
   d. In-line strainer.
   e. Airflow switch for preventing humidifier operation without airflow.

D. Self-Contained Humidifiers
1. Electric-Resistance Heater Container: Cleanable, ASTM A 666, Type 304 **OR** 316, **as directed**, stainless steel. Comply with UL 499.
2. Electrode Cylinder: Replaceable plastic assembly with disposable ionic bed inserts, **as directed**. Comply with UL 499.
3. Gas-Fired Steam Generator: Factory assembled and tested.
   a. Standard: Fabricate and label steam generator to comply with CSA.
   b. Maximum Steam Pressure: 10 inches wg (2488 Pa).
   c. Burner Type: Natural-gas **OR** Propane, **as directed**, fired with modulating, low NOx infrared burner, minimum 82 percent efficient.
   d. Gas Train: Safety shutoff valves, gas cock, strainer, pressure-regulating valve.
   e. Ignition: Hot-surface ignition with flame safety system.
   f. Combustion Chamber: Sealed with outdoor-air and flue-vent connections.
   g. Heat-Exchanger Tank: Cleanable, ASTM A 666, Type 304 **OR** 316, **as directed**, stainless steel with corrosion-resistant coating and disposable ionic bed inserts, **as directed**.
4. Manifold: Stainless-steel tube with integral fan to discharge vapor directly into occupied space.
OR
Manifold: ASTM A 666, Type 304 **OR** 316, **as directed**, stainless-steel tube extending across entire width of duct or plenum and equipped with mounting brackets on ends.
5. Cabinet: Sheet metal enclosure for housing heater cylinder, electrical wiring, components, controls, and control panel. Enclosure shall include baked-enamel finish, hinged or removable access door, and threaded outlet in bottom of cabinet for drain piping.
6. Control Panel:
   a. Factory-wired disconnect switch.
   b. Liquid-crystal display.
   c. Programmable keyboard.
   d. Set-point adjustment.
   e. Warning signal indicating end of replaceable cylinder or ionic bed insert, **as directed**, life.
   f. Low-voltage, control circuit.
   g. Diagnostic, maintenance, alarm, and status features.
   h. High-water sensor **OR** float, **as directed**, to prevent overfilling.
7. Controls:
   a. Microprocessor-based control system for modulating or cycling control, and start/stop and status monitoring for interface to central HVAC instrumentation and controls.
   b. Solenoid-fill and automatic drain valves to maintain water level and temper hot drain water.
   c. Field-adjustable timer to control drain cycle for flush duration and interval.
   d. Controls shall drain tanks if no demand for humidification for more than 72 hours.
   e. Conductivity **OR** Float, **as directed**,-type level controls.
8. Accessories:
   a. Humidistat: Wall **OR** Return-duct, **as directed**,-mounting, solid-state, electronic-sensor controller capable of full modulation or cycling control.
   b. Duct-mounting, high-limit humidistat.
   c. Airflow switch for preventing humidifier operation without airflow.

E. Heated-Pan Humidifiers
1. Heat Source: Hot water **OR** Steam **OR** Electric resistance, **as directed**.
2. Comply with UL 499.
3. Pan and Heat-Exchange Piping: ASTM A 666, Type 304 **OR** 316, **as directed**, stainless steel with corrosion-resistant coating, overflow, and drain fittings. Include disposable ionic bed inserts, **as directed**.
4. Manifold: ASTM A 666, Type 304 **OR** 316, **as directed**, stainless-steel, duct-mounting, single- or manifold-grid connected to heated-pan housing with flexible hose and extending across width of duct or plenum. Manifold shall have mounting brackets at both ends.
OR
Manifold: Inverted, ASTM A 666, Type 304 **OR** 316, **as directed**, stainless-steel U-tube with humidifier mounted directly under the duct.
OR
Manifold: ASTM A 666, Type 304 **OR** 316, **as directed**, stainless-steel tube with flexible hose to connect to humidifier, integral fan to discharge vapor directly into occupied space, and wall- or ceiling-mounting brackets.
5. Controls:
a. Solenoid-fill and automatic drain valves to maintain water level and temper hot drain water.
b. Field-adjustable timer to control drain cycle for flush duration and interval.
c. Conductivity **OR** Float, **as directed**,-type level controls.
6. Piping Specialties: Inlet strainer, control valve, and steam trap.
7. Piping Specialties: Inlet strainer and control valve.
8. Accessories:
a. Humidistat: Wall **OR** Return-duct, **as directed**,-mounting, solid-state, electronic-sensor controller capable of full modulation or cycling control.
b. Duct-mounting, high-limit humidistat.
c. Airflow switch for preventing humidifier operation without airflow.

F. Heat-Exchanger Humidifiers
1. Fabricate and label steam generator to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Heat Exchanger: ASTM A 666, Type 304 **OR** 316, **as directed**, stainless steel with corrosion-resistant coating, overflow, and drain fittings. Include disposable ionic bed inserts, **as directed**.
3. Manifold: ASTM A 666, Type 304 **OR** 316, **as directed**, stainless-steel, steam-jacketed, **as directed**, duct-mounting, single- or manifold-grid connected to steam generator with flexible hose and extending across width of duct or plenum. Manifold shall have mounting brackets for both ends. Insulate with 1/2-inch (13-mm) fiberglass and stainless-steel jacket extending full width of duct or plenum with mounting brackets at ends, **as directed**.
OR
Manifold: ASTM A 666, Type 304 **OR** 316, **as directed**, stainless-steel tube with flexible hose to connect to humidifier and integral fan to discharge vapor directly into occupied space. Manifold shall have wall- or ceiling-mounting brackets.
4. Controls:
a. Solenoid-fill and automatic drain valves to maintain water level and temper hot drain water.
b. Field-adjustable timer to control drain cycle for flush duration and interval.
c. Conductivity **OR** Float, **as directed**,-type level controls.
5. Accessories:
a. Humidistat: Wall **OR** Return-duct, **as directed**,-mounting, solid-state, electronic-sensor controller capable of full modulation.
b. Duct-mounting, high-limit humidistat.
c. Airflow switch for preventing humidifier operation without airflow.

1.3 EXECUTION

A. Installation
1. Install humidifiers with required clearance for service and maintenance. Maintain path, downstream from humidifiers, clear of obstructions as required by ASHRAE 62.1, **as directed**.
2. Seal humidifier manifold duct or plenum penetrations with flange.
3. Install humidifier manifolds in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."
4. Install galvanized **OR** stainless, **as directed**,-steel drain pan under each manifold mounted in duct.
   a. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1, **as directed**.
   b. Connect to condensate trap and drainage piping.
   c. Extend drain pan upstream and downstream from manifold a minimum distance recommended by manufacturer but not less than required by ASHRAE 62.1.
5. Install manifold supply piping pitched to drain condensate back to humidifier.
6. Install drip leg upstream from steam trap a minimum of 12 inches (300 mm) tall for proper operation of trap.
7. Install steam generator level on concrete base. Concrete base is specified in Division 23 Section "Common Work Results For Hvac".
8. Concrete Bases: Anchor steam generator to concrete base.
   a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
   b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   d. Install anchor bolts to elevations required for proper attachment to supported equipment.
   e. Cast-in-place concrete materials and placement requirements are specified in Division 31.
9. Install seismic restraints on humidifiers. Seismic restraints are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
10. Install gas-fired steam generators according to NFPA 54.

B. Connections
1. Piping installation requirements are specified in other Division 21. Drawings indicate general arrangement of piping, fittings, and specialties.
   a. Install piping adjacent to humidifiers to allow service and maintenance.
   b. Install shutoff valve, strainer, backflow preventer, and union in humidifier makeup line.
2. Install electrical devices and piping specialties furnished by manufacturer but not factory mounted.
3. Install piping from safety relief valves to nearest floor drain.
4. Connect gas piping full size to steam-generator, gas-train inlet with union. Gas piping materials and specialties are specified in Division 23 Section(s) "Facility Natural-gas Piping" OR "Facility Liquefied-petroleum Gas Piping", **as directed**.
5. Connect breeching full size to steam-generator outlet. Venting materials are specified in Division 23 Section "Breechings, Chimneys, And Stacks".
6. Connect combustion-air inlet to intake terminal using PVC piping with solvent-cemented joints. Run from boiler connection to outside and terminate adjacent to flue termination.
7. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
8. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Field Quality Control
1. Perform tests and inspections and prepare test reports.
2. Tests and Inspections:

a. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
b. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Remove and replace malfunctioning units and retest as specified above.

D. Demonstration
1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain humidifiers.

END OF SECTION 23 84 13 23

Task	Specification	Specification Description
23 84 13 29	23 84 13 23	Humidifiers
23 84 16 33	01 22 16 00	No Specification Required
23 84 16 33	23 76 13 00	Dehumidification Units

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Task	Specification	Specification Description
25 55 00 00	23 09 00 00	HVAC Instrumentation And Controls

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Task	Specification	Specification Description
26 01 30 91	01 22 16 00	No Specification Required
26 01 50 51	01 22 16 00	No Specification Required
26 01 50 51	02 84 16 00	Removal of Fluorescent Light Ballasts/Capacitors and Fluorescent Light Tubes
26 01 50 51	02 84 16 00a	Interior Lighting
26 01 50 51	02 84 16 00b	Exterior Lighting
26 01 50 52	02 84 16 00	Removal of Fluorescent Light Ballasts/Capacitors and Fluorescent Light Tubes
26 01 50 52	02 84 16 00a	Interior Lighting
26 01 50 52	02 84 16 00b	Exterior Lighting
26 01 50 53	02 84 16 00	Removal of Fluorescent Light Ballasts/Capacitors and Fluorescent Light Tubes
26 01 50 53	02 84 16 00a	Interior Lighting
26 01 50 53	02 84 16 00b	Exterior Lighting
26 01 50 81	02 84 16 00a	Interior Lighting

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SECTION 26 05 00 00 - COMMON WORK RESULTS FOR ELECTRICAL

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for common work results for electrical. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Electrical equipment coordination and installation.
      b. Sleeves for raceways and cables.
      c. Sleeve seals.
      d. Grout.
      e. Common electrical installation requirements.

C. Definitions
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

D. Submittals
   1. Product Data: For sleeve seals.

1.2 PRODUCTS

A. Sleeves For Raceways And Cables
   1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
   2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
   3. Sleeves for Rectangular Openings: Galvanized sheet steel.
      a. Minimum Metal Thickness:
         1) For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
         2) For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

B. Sleeve Seals
   1. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
      a. Sealing Elements: EPDM **OR** NBR, **as directed**, interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
      b. Pressure Plates: Plastic **OR** Carbon steel **OR** Stainless steel, **as directed**. Include two for each sealing element.
      c. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating **OR** Stainless steel, **as directed**, of length required to secure pressure plates to sealing elements. Include one for each sealing element.

C. Grout

1. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

1.3 EXECUTION

A. Common Requirements For Electrical Installation
   1. Comply with NECA 1.
   2. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
   3. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
   4. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
   5. Right of Way: Give to piping systems installed at a required slope.

B. Sleeve Installation For Electrical Penetrations
   1. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
   2. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
   3. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
   4. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
   5. Cut sleeves to length for mounting flush with both surfaces of walls.
   6. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.
   7. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.
   8. Seal space outside of sleeves with grout for penetrations of concrete and masonry
      a. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
   9. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants".
   10. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping".
   11. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
   12. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel **OR** cast-iron, **as directed**, pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   13. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

C. Sleeve-Seal Installation
   1. Install to seal exterior wall penetrations.
   2. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve

seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

D. Firestopping

1. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping".

END OF SECTION 26 05 00 00

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SECTION 26 05 13 16 - CONDUCTORS AND CABLES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of conductors and cables. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Building wires and cables rated 600 V and less.
      b. Connectors, splices, and terminations rated 600 V and less.
      c. Sleeves and sleeve seals for cables.

C. Definitions
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

D. Submittals
   1. Product Data: For each type of product indicated.
   2. Field quality-control test reports.

E. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   2. Comply with NFPA 70.

1.2 PRODUCTS

A. Conductors And Cables
   1. Aluminum and Copper, **as directed**, Conductors: Comply with NEMA WC 70.
   2. Conductor Insulation: Comply with NEMA WC 70 for Types THW **OR** THHN-THWN **OR** XHHW **OR** UF **OR** USE **OR** SO, **as directed**.
   3. Multiconductor Cable: Comply with NEMA WC 70 for armored cable, Type AC **OR** metal-clad cable, Type MC **OR** mineral-insulated, metal-sheathed cable, Type MI **OR** nonmetallic-sheathed cable, Type NM **OR** Type SO **OR** Type USE, **as directed**, with ground wire.

B. Connectors And Splices
   1. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

C. Sleeves For Cables
   1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
   2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
   3. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch (1.3- or 3.5-mm) thickness as indicated and of length to suit application.
   4. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".

D. Sleeve Seals
1. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
a. Sealing Elements: EPDM **OR** NBR, **as directed**, interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
b. Pressure Plates: Plastic **OR** Carbon steel **OR** Stainless steel, **as directed**. Include two for each sealing element.
c. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating **OR** Stainless steel, **as directed**, of length required to secure pressure plates to sealing elements. Include one for each sealing element.

1.3 EXECUTION

A. Conductor Material Applications
1. Feeders: Copper **OR** Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger, **as directed**. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
2. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Conductor Insulation And Multiconductor Cable Applications And Wiring Methods
1. Service Entrance: Type THHN-THWN, single conductors in raceway **OR** Type XHHW, single conductors in raceway **OR** Mineral-insulated, metal-sheathed cable, Type MI **OR** Type SE or USE multiconductor cable, **as directed**.
2. Exposed Feeders: Type THHN-THWN, single conductors in raceway **OR** Armored cable, Type AC **OR** Metal-clad cable, Type MC **OR** Mineral-insulated, metal-sheathed cable, Type MI **OR** Nonmetallic-sheathed cable, Type NM, **as directed**.
3. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway **OR** Armored cable, Type AC **OR** Metal-clad cable, Type MC **OR** Mineral-insulated, metal-sheathed cable, Type MI **OR** Nonmetallic-sheathed cable, Type NM, **as directed**.
4. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway **OR** Underground feeder cable, Type UF, **as directed**.
5. Feeders Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway **OR** Armored cable, Type AC **OR** Metal-clad cable, Type MC **OR** Mineral-insulated, metal-sheathed cable, Type MI, **as directed**.
6. Feeders in Cable Tray: Type THHN-THWN, single conductors in raceway **OR** Armored cable, Type AC **OR** Metal-clad cable, Type MC **OR** Mineral-insulated, metal-sheathed cable, Type MI **OR** Nonmetallic-sheathed cable, Type NM, **as directed**.
7. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway **OR** Armored cable, Type AC **OR** Metal-clad cable, Type MC **OR** Mineral-insulated, metal-sheathed cable, Type MI **OR** Nonmetallic-sheathed cable, Type NM, **as directed**.
8. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway **OR** Armored cable, Type AC **OR** Metal-clad cable, Type MC **OR** Mineral-insulated, metal-sheathed cable, Type MI **OR** Nonmetallic-sheathed cable, Type NM, **as directed**.
9. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway **OR** Underground branch-circuit cable, Type UF, **as directed**.
10. Branch Circuits Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway **OR** Armored cable, Type AC **OR** Metal-clad cable, Type MC **OR** Mineral-insulated, metal-sheathed cable, Type MI, **as directed**.

11. Branch Circuits in Cable Tray: Type THHN-THWN, single conductors in raceway **OR** Armored cable, Type AC **OR** Metal-clad cable, Type MC **OR** Mineral-insulated, metal-sheathed cable, Type MI, **as directed**.
12. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
13. Class 1 Control Circuits: Type THHN-THWN, in raceway.
14. Class 2 Control Circuits: Type THHN-THWN, in raceway **OR** Power-limited cable, concealed in building finishes **OR** Power-limited tray cable, in cable tray, **as directed**.

C. Installation Of Conductors And Cables
1. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
2. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
3. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
4. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
5. Support cables according to Division 26 Section "Hangers And Supports For Electrical Systems".
6. Identify and color-code conductors and cables according to Division 26 Section "Identification For Electrical Systems".
7. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
8. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
   a. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
9. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) **OR** 12 inches (300 mm), **as directed**, of slack.

D. Sleeve Installation For Electrical Penetrations
1. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".
2. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
3. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
4. Rectangular Sleeve Minimum Metal Thickness:
   a. For sleeve rectangle perimeter less than 50 inches (1270 mm) and no side greater than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
   b. For sleeve rectangle perimeter equal to, or greater than, 50 inches (1270 mm) and 1 or more sides equal to, or greater than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).
5. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
6. Cut sleeves to length for mounting flush with both wall surfaces.
7. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.
8. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and cable unless sleeve seal is to be installed or unless seismic criteria require different clearance, **as directed**.
9. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies, **as directed**.
10. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 07 Section "Joint Sealants".

11. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 07 Section "Penetration Firestopping".
12. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.
13. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
14. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between cable and sleeve for installing mechanical sleeve seals.

E. Sleeve-Seal Installation
   1. Install to seal underground exterior-wall penetrations.
   2. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

F. Firestopping
   1. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping".

G. Field Quality Control
   1. Perform tests and inspections and prepare test reports.
   2. Tests and Inspections:
      a. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and conductors feeding the following critical equipment and services, **as directed**, for compliance with requirements.
      b. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
      c. Infrared Scanning: After Final Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
         1) Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Final Completion.
         2) Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
         3) Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
   3. Test Reports: Prepare a written report to record the following:
      a. Test procedures used.
      b. Test results that comply with requirements.
      c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
   4. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 26 05 13 16

SECTION 26 05 13 16a - UNDERCARPET CABLES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of undercarpet cables. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Undercarpet cable and service fittings for branch circuits.
   b. Undercarpet cable and service fittings for communication and data transmission.

C. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Include plans, elevations, sections, details of components, and attachments to other work.
   a. Indicate cable types, accessories, and transition boxes.
   b. Indicate proposed layering of cables, cable dimensions, and installation requirements.
3. Field quality-control test reports.
4. Operation and maintenance data.

D. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. Comply with NEMA UC 2, "Undercarpet Power Distribution Systems" and with NFPA 70.

1.2 PRODUCTS

A. Power Distribution Cable
1. Cable: Factory laminated and complying with NEMA UC 2; three-piece assembly including bottom shield, conductor assembly, and top shield.
   a. Bottom Shield: Abrasion resistant, nonmetallic **OR** Metallic, **as directed**.
   b. Conductor Assembly: Two **OR** Three **OR** Four, **as directed**,-wire branch circuit with insulated ground, **as directed**.
   c. Top Shield: Copper or copper alloy.
2. Current Rating: 20 **OR** 30 **OR** 20 and 30, **as directed**, A.

B. Communication And Data Cable
1. Category 5e Communication and Data Cable: Extruded-vinyl jacket over 4 unshielded, twisted pairs, No. 24 AWG, copper; complying with TIA/EIA 568-B; and tested to 300-lb (136-kg) rollover test.

C. Pedestals
1. Description: Manufacturer's standard low **OR** regular, **as directed**,-profile type, single **OR** two **OR** three, **as directed**, gang with single **OR** duplex, **as directed**, receptacles and Category 5e modular connectors, **as directed**.
   a. Pedestal Colors: As selected from manufacturer's full range.

D. Power Cable Transition Unit

1. Description: Interface transition unit, with junction box, for connecting three-, four-, or five-conductor, flat-conductor cable to building wiring system.

E. Communication And Data Cable Transition Unit
   1. Description: Category 5 transition termination circuit board in wall-mounted box to convert round incoming cable to outgoing flat-undercarpet cable.

1.3 EXECUTION

A. Installation
   1. Do not begin installation until heavy construction is completed and wheeled traffic is no longer a threat.
   2. Do not stack cables in circulation routes.
   3. Limit total installed height to 0.09 inch (2.29 mm).
   4. Install cables in proper order with power-transmission cable first, followed by telephone cable and then data cable. Cross cables at 90-degree angles.
   5. Install undercarpet cables and accessories using special tools as recommended by undercarpet cable manufacturer.

B. Connections
   1. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
   2. Connect undercarpet cable and components to branch circuits and to ground as indicated and instructed by manufacturer.

C. Field Quality Control
   1. Perform tests and inspections and prepare test reports.
   2. Tests and Inspections:
      a. Branch-Circuit Cables: After cables have been installed and energized, perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
      b. Communication and Data Cables: After cables have been installed and connected between telecommunications outlet and system cross-connect panel, test each cable according to TIA/EIA TSB67. Certify compliance with test parameters.
   3. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 26 05 13 16a

SECTION 26 05 13 16b - MEDIUM-VOLTAGE CABLES

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of medium-voltage cables. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes cables and related splices, terminations, and accessories for medium-voltage electrical distribution systems.

C. Definitions

1. NETA ATS: Acceptance Testing Specification.

D. Submittals

1. Product Data: For each type of cable indicated. Include splices and terminations for cables and cable accessories.
2. Field quality-control test reports.

E. Quality Assurance

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. Comply with IEEE C2 and NFPA 70.

1.2 PRODUCTS

A. Cables

1. Cable Type: MV90 **OR** MV105, **as directed**.
2. Comply with UL 1072, AEIC CS 8, ICEA S-93-639, and ICEA S-97-682, **OR** ICEA S-94-649, **as directed**.
3. Conductor: Copper **OR** Aluminum, **as directed**.
4. Conductor Stranding: Compact round, concentric lay, Class B) **OR** Concentric lay, Class B, **as directed**.
5. Strand Filling: Conductor interstices are filled with impermeable compound.
6. Conductor Insulation: Crosslinked polyethylene **OR** Ethylene-propylene rubber, **as directed**.
   a. Voltage Rating: 5 **OR** 8 **OR** 15 **OR** 25 **OR** 35, **as directed,** kV.
   b. Insulation Thickness: 100 **OR** 133, **as directed,** percent insulation level.
7. Shielding: Copper tape **OR** Solid copper wires, **as directed**, helically applied over semiconducting insulation shield.
8. Shielding and Jacket: Corrugated copper drain wires embedded in extruded, chlorinated, polyethylene jacket.
9. Three-Conductor Cable Assembly: Three insulated, shielded conductors cabled together with ground conductors, **as directed**.
   a. Circuit Identification: Color-coded tape (black, red, blue) under the metallic shielding.
10. Cable Armor: Interlocked aluminum **OR** Interlocked galvanized steel **OR** Corrugated aluminum tube, **as directed,** applied over cable.
11. Cable Jacket: Sunlight-resistant PVC **OR** Chlorosulfonated polyethylene, CPE, **as directed**.

B. Splice Kits

1. Connectors and Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.
2. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.
   a. Combination tape and cold-shrink-rubber sleeve kit with rejacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.
   b. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.
   c. Premolded, cold-shrink-rubber, in-line splicing kit.
   d. Premolded EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.

C. Solid Terminations
1. Multiconductor Cable Sheath Seals: Type recommended by seal manufacturer for type of cable and installation conditions, including orientation.
   a. Compound-filled, cast-metal body, metal-clad cable terminator for metal-clad cable with **OR** without, **as directed,** external plastic jacket.
   b. Cold-shrink sheath seal kit with preformed sleeve openings sized for cable and insulated conductors.
   c. Heat-shrink sheath seal kit with phase- and ground-conductor rejacketing tubes, cable-end sealing boot, and sealing plugs for unused ground-wire openings in boot.
   d. Cast-epoxy-resin sheath seal kit with wraparound mold and packaged, two-part, epoxy-resin casting material.
2. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations.
   a. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.
   b. Class 1 Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.
   c. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules; shield ground strap; and compression-type connector.
   d. Class 1 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, compression-type connector, and end seal.
   e. Class 2 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, and compression-type connector. Include silicone-rubber tape, cold-shrink-rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.
   f. Class 3 Terminations: Kit with stress cone and compression-type connector.
3. Nonshielded-Cable Terminations: Kit with compression-type connector. Include silicone-rubber tape, cold-shrink-rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.

D. Separable Insulated Connectors
1. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.
2. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.
3. Load-Break Cable Terminators: Elbow-type units with 200-A load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

4. Dead-Break Cable Terminators: Elbow-type unit with 600-A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.
5. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.
   a. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
   b. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
   c. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.
   d. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.
6. Test-Point Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.
7. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

E. Arc-Proofing Materials
1. Tape for First Course on Metal Objects: 10-mil- (250-micrometer-) thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.
2. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch (8 mm) thick, compatible with cable jacket.
3. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1/2 inch (13 mm) wide.

F. Fault Indicators
1. Indicators: Automatically **OR** Manually, **as directed,** reset fault indicator with inrush restraint feature, arranged to clamp to cable sheath and provide a display after a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions.
2. Resetting Tool: Designed for use with fault indicators, with moisture-resistant storage and carrying case.

G. Source Quality Control
1. Test and inspect cables according to ICEA S-97-682 **OR** ICEA S-94-649, **as directed,** before shipping.
2. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig (35 kPa).

1.3 EXECUTION

A. Installation
1. Install cables according to IEEE 576.
2. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
   a. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.
   b. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.

3. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
4. Support cables according to Division 26 Section "Common Work Results For Electrical".
5. Install direct-buried cables on leveled and tamped bed of 3-inch- (75-mm-) thick, clean sand. Separate cables crossing other cables or piping by a minimum of 4 inches (100 mm) of tamped earth. Install permanent markers at ends of cable runs, changes in direction, and buried splices.
6. Install "buried-cable" warning tape 12 inches (305 mm) above cables.
7. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.
8. Install cable splices at pull points and elsewhere as indicated; use standard kits.
9. Install terminations at ends of conductors and seal multiconductor cable ends with standard kits.
10. Install separable insulated-connector components as follows:
    a. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
    b. Portable Feed-Through Accessory: Three.
    c. Standoff Insulator: Three.
11. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:
    a. Clean cable sheath.
    b. Wrap metallic cable components with 10-mil (250-micrometer) pipe-wrapping tape.
    c. Smooth surface contours with electrical insulation putty.
    d. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
    e. Band arc-proofing tape with 1-inch- (25-mm-) wide bands of half-lapped, adhesive, glass-cloth tape 2 inches (50 mm) o.c.
12. Seal around cables passing through fire-rated elements according to Division 07 Section "Penetration Firestopping".
13. Install fault indicators on each phase where indicated.
14. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.
15. Identify cables according to Division 26 Section "Identification For Electrical Systems".

B. Field Quality Control
1. Perform the following field tests and inspections and prepare test reports:
    a. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
    b. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
2. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 26 05 13 16b

SECTION 26 05 19 13 - UNDERFLOOR RACEWAYS FOR ELECTRICAL SYSTEMS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of underfloor raceways for electrical systems. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Flat-top, single-channel, underfloor raceways.
      b. Flat-top, multichannel, underfloor raceways.
      c. Flush, flat-top underfloor raceways.
      d. Cellular metal underfloor raceways.
      e. Trench-type underfloor raceways.
      f. Electrical connection components for precast concrete, hollow-core, floor decks.
      g. Electrical connection components for electrified cellular steel floor decks.
      h. Service fittings.

C. Definitions
   1. Flush Outlet: Underfloor raceway outlet installed so the top of the fixed portions of the receptacles, jacks, and connector assemblies is located approximately at the surface of the floor or floor covering, and with the bodies of connected plugs exposed above the surface of the floor.
   2. Flush Underfloor Raceway: Rectangular cross-section, flat-top raceway installed with the top of the raceway flush with the surface of the concrete in which it is embedded.
   3. Header Raceway: Rectangular cross-section, single-channel or multichannel, underfloor raceway arranged as feeder raceway to bring wires and cables to service raceways from panelboards and communication terminal components.
   4. Recessed Outlet: Underfloor raceway outlet installed with the top of the fixed portion of the connector assemblies located below the surface of the floor or floor covering and arranged to receive plug connectors with the bodies of the plugs concealed below the floor level.
   5. Service Raceway: Underfloor distribution raceway providing direct connection to service fittings using preset or afterset inserts.
   6. Trench Header: Trench-type raceway arranged as feeder raceway to bring wires and cables to service raceways from panelboards and communication terminal equipment.
   7. Underfloor Raceway: A conduit, duct, or cell assembly, or trench located within the floor material or with its top at the floor surface.

D. Submittals
   1. Product Data: For underfloor raceway components, fittings, and accessories.
   2. Shop Drawings: For underfloor raceways. Include floor plans, assembly drawings, sections, and details.
      a. Identify components and accessories such as expansion-joint assemblies, straight raceway lengths, preset and afterset inserts, and service fittings.
      b. Provide dimensions locating raceway header and distribution elements. Include spacing between preset inserts and between preset inserts and ends of duct runs, walls, columns, junction boxes, and header duct connections.
      c. Show connections between raceway elements and relationships between components and adjacent structural and architectural elements including slab reinforcement, floor finish work, permanent partitions, architectural module lines, and pretensioning or post-tensioning components.

d. Indicate height of preset inserts, junction boxes, and raceways coordinated with depth of concrete slab and floor fill.
e. Indicate thickening of slabs where required for adequate encasement of raceway components.
f. Document coordination of exposed components with floor-covering materials to ensure that fittings and trim are suitable for indicated floor-covering material.
g. Revise locations from those indicated in the Contract Documents, as required to suit field conditions and to ensure a functioning layout. Identify proposed deviations from the Contract Documents.
h. Show details of connections and terminations of underfloor raceways at panelboards and communication terminal equipment in equipment rooms, wire closets, and similar spaces.
i. Identify those cells of cellular floor deck that are to be connected and fitted for the following underfloor distribution:
1) Power.
2) Voice.
3) Data.
4) Signal.
5) Communications.

3. Samples: For typical underfloor raceway products, in specified finish, including the following:
a. Service fittings and flush and recessed outlet and junction-box covers.
b. A section of each service raceway configuration with specified preset insert and service fitting installed.
c. A junction box of each size and type for use with underfloor raceway.
d. A section of each header raceway configuration, complete with provisions for connection with service raceway.
e. A section of trench-type raceway, complete with cover and required trim.
f. A junction box of each size and type, complete with cover and trim.

4. Operation and Maintenance Data: For underfloor raceways, to include in emergency, operation, and maintenance manuals. Include the following:
a. Manufacturer's written instructions for locating preset inserts and for installing afterset inserts.

E. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NFPA 70.

1.2 PRODUCTS

A. Flat-Top, Single-Channel, Underfloor Raceways
1. Description:
a. Material: Steel.
b. Cross-Section Shape: Rectangular.
c. Number of Levels: One **OR** Two, **as directed**.
d. Minimum Bending Radius for Communication Cables: Combination of raceways, fittings, inserts, junction boxes, service fittings, and mounting and connection arrangements for wiring devices and jacks shall provide a 2-inch- (50-mm-) minimum bending radius for communication cables.

2. Service Raceways: Fitted with preset inserts.
a. Nominal Raceway Dimensions:
1) Depth: 1-1/2 inches (38 mm).
2) Power Service Raceway Width: 3-1/2 inches (90 mm).
3) Communication Service Raceway Width: 3-1/2 inches (90 mm) **OR** 6-1/2 inches (165 mm), **as directed**.

b. Number of Single-Channel Raceways per Run: One **OR** Two **OR** Three **OR** Four **OR** Five, **as directed**, unless otherwise indicated.
c. Preset Inserts: Rectangular **OR** Round, **as directed**.
1) Spacing: 24 inches (600 mm) **OR** 12 inches (300 mm), **as directed,** o.c.
2) Size: Rectangular dimensions as required to accommodate mounting and connection of flush-mounted, duplex receptacle or dual communication-jack or connector service fitting.
3) Size: 2 inches (50 mm) in diameter.
4) Equip each insert with a disposable cover and select insert height so cover is 1/8 inch (3 mm) below surface of concrete.
5) Arrange insert for optional attachment of flush-, surface-, or wiring- extension service fitting to replace disposable cover.
3. Header Raceways: Single channel, without preset inserts (blank raceway).
a. Nominal Raceway Dimensions:
1) Depth: 1-1/2 inches (38 mm).
2) Power Header Raceway Width: 3-1/2 inches (90 mm).
3) Communication Header Raceway Width: 3-1/2 inches (90 mm) **OR** 6-1/2 inches (165 mm), **as directed**.
b. Arrangement: In same plane as **OR** Below, **as directed**, service raceways.
c. Connections: Arranged to connect with service raceways at single-level **OR** two-level, **as directed**, junction boxes.

B. Flat-Top, Multichannel, Underfloor Raceways
1. Description:
a. Material: Steel.
b. Cross-Section Shape: Rectangular.
c. Number of Longitudinal Channels: Two **OR** Three **OR** Four, **as directed**, separated by steel wall(s).
d. Number of Levels: One **OR** Two, **as directed**.
e. Minimum Bending Radius for Communication Cables: Combination of raceways, fittings, inserts, junction boxes, service fittings, and mounting and connection arrangements for wiring devices and jacks shall provide a 2-inch- (50-mm-) minimum bending radius for communication cables.
2. Service Raceways: Fitted with preset inserts.
a. Nominal Raceway Dimensions:
1) Depth: 1-3/8 inches (35 mm).
2) Power Service Channel Width: 3-1/2 inches (90 mm) **OR** 4-3/8-inches (111 mm), **as directed**.
3) Communication Service Channel Width: 3-1/2 inches (90 mm) **OR** 4 inches (102 mm) **OR** 6-1/2 inches (165 mm), **as directed**.
b. Preset Inserts:
1) Spacing: 24 inches (600 mm) **OR** 12 inches (300 mm), **as directed,** o.c.
2) Size: Dimensions as required to accommodate mounting and connection of flush- and surface-mounted, single- and multiple-system service fittings or to connect to wiring extensions for feeding wall outlets for power **OR** communications **OR** power and communications, **as directed.**
3) Equip each insert with a disposable cover arranged for installation with top 1/8 inch (3 mm) below surface of concrete.
4) Arrange inserts for optional attachment of flush-, surface-, or wiring-extension service fitting to replace disposable cover. Arrange brackets, mountings, barriers, and floor access covers to support, isolate, and provide access to flush or surface outlet-mounting connector, jack, and receptacle devices.
3. Header Raceways: Multichannel, without preset inserts (blank raceway).
a. Nominal Raceway Dimensions:
1) Header Raceway Depth: Same as service raceways **OR** 2-1/2 inches (64 mm) **OR** 2-3/4 inches (70 mm) **OR** 3 inches (76 mm) **OR** 3-1/2 inches (90 mm), **as directed**.

2) Power Header Channel Width: 3-1/2 inches (90 mm) **OR** 4-3/8-inches (111 mm), **as directed**.
3) Communication Header Channel Width: 3-1/2 inches (90 mm) **OR** 4 inches (102 mm) **OR** 6-1/2 inches (165 mm), **as directed**.

b. Arrangement: In same plane as **OR** Below, **as directed**, service raceways.
c. Connections: Arranged to connect with service raceways at single-level **OR** two-level, **as directed**, junction boxes.

C. Flush, Flat-Top Underfloor Raceways

1. Description:
   a. Material: Steel.
   b. Cross-Section Shape: Rectangular, single channel and multichannel, separated by steel wall(s).
   c. Listed and labeled for installation with top flush with concrete floor.
   d. Number of Levels: One.
2. Service Raceways: Fitted with preset inserts.
   a. Number of Longitudinal Channels per Multichannel Raceway: Two **OR** Three, **as directed**.
   b. Number of Single-Channel Raceways per Run: One **OR** Two **OR** Three, **as directed**, unless otherwise indicated.
   c. Nominal Channel Dimensions: 3 inches (76 mm) wide by 1-1/4 inches (32 mm) deep.
   d. Preset Inserts: Threaded opening with removable steel plug that is flush with top of raceway when screwed in place.
      1) Spacing: 24 inches (600 mm) **OR** 12 inches (300 mm), **as directed**, o.c., full length of each service raceway.
      2) Arrangement: Stagger insert locations on parallel raceways or channels to accommodate placement of adjacent service fittings.
      3) Size: 1-5/8-inch (41-mm) diameter.
3. Header Raceways: Raceways same as service raceways except without preset inserts (blank raceway).
   a. Nominal Channel Dimensions: Same as service raceways.
   b. Arrangement: In same plane as service raceways.
   c. Connections: Arranged to connect with service raceways at junction boxes.

D. Cellular Metal Underfloor Raceways

1. Service Raceways: Fitted with preset inserts.
   a. Material: Steel.
   b. Number of Longitudinal Cells: Three, separated by steel walls.
   c. Nominal Dimensions of Cells:
      1) Overall Depth: 1-1/4 inches (32 mm) unless otherwise indicated.
      2) Cross-Sectional Area of Cells: Power cells: 5-1/2 sq. in. (35.5 sq. cm); communication system cells: 16 sq. in. (103 sq. cm).
   d. Minimum Bending Radius for Communication Cables: Combination of raceways, fittings, inserts, junction boxes, service fittings, and mounting and connection arrangements for wiring devices and jacks shall provide a 2-inch- (50-mm-) minimum bending radius for communication cables.
   e. Preset Inserts: Rectangular-shaped metal housing assemblies arranged to provide electrical outlet access to each cell of each raceway designated for service raceway use. Inserts shall be provided throughout the entire length of each such raceway.
      1) Spacing: 30 inches (762 mm) **OR** 24 inches (600 mm) **OR** 12 inches (300 mm), **as directed,** o.c.
      2) Include housing and connecting provisions for a flush or recessed, single-, double-, or triple-system service fitting.
      3) Include mounting and connecting provisions for a surface, single- or multiple-system service fitting.

4) Include connecting provisions for a wiring-extension service fitting to feed wall outlets.
5) Equip each insert with a disposable cover plate arranged for installation with top 1/8 inch (3 mm) below surface of concrete. Arrange insert to receive a flush-, recessed-, or wiring-extension service fitting to replace disposable top.

2. Header Assembly: A junction box and raceway arrangement arranged to feed wires and cables to service raceways.
   a. Three-compartment junction box connecting blank, multicell cellular header raceway (no inserts) with cellular service raceways.
      1) Arrange junction box in the center of a 60-inch (152-cm) length of header raceway.
      2) Cellular header raceway shall have same dimensions as service raceways.
      3) Provide capability for service raceways to be run in both directions from intersection with header raceway.
   b. Three-compartment junction box preassembled with blank, flat-top, multichannel header raceway (no inserts) and fitted to connect with cellular service raceway at right angles to header raceway.
      1) Arrange junction box in the center of a 60-inch (152-cm) length of header raceway.
      2) Provide capability for service raceways to be run in both directions from intersection with header raceway.

E. Trench-Type Underfloor Raceways
1. Trench: Steel, shop or factory welded and fabricated to indicated sizes. Include the following features:
   a. Slab Depth Adjustment: Minimum of minus 1/8 inch (3 mm) to plus 5/8 inch (16 mm) before and during concrete placement.
   b. Cover Supports: Height adjustable, with leveling screws to rigidly support cover assembly.
   c. Screed Strip: Extruded aluminum along both edges at proper elevation without requiring shim material.
   d. Trim Strip: Select to accommodate floor finish material.
   e. Partitions: Arranged to separate channels and isolate wiring of different systems.
   f. Grommeted openings in active floor cells or service raceways.
   g. Manufacturer's standard corrosion-resistant finish, applied after fabrication.
2. Cover Plates: Removable, steel plates, 1/4 inch (6 mm) thick, each weighing 60 lb (27 kg) or less with full gasket attached to side units. Fabricate intermediate supports to limit unsupported spans to 15 inches (380 mm) or less. Fabricate covers with appropriate depth recess to receive indicated floor finish.

F. Electrical Connection Components For Cellular Steel Floor Deck
1. Preset Inserts: Rectangular metal-housing assemblies.
   a. Spacing: 30 inches (762 mm) **OR** 24 inches (600 mm) **OR** 12 inches (300 mm), **as directed,** o.c.
   b. Size: As required to provide electrical outlet access to each cell of each group of three cells that is designated for electrical service raceway use.
   c. Equip each insert with a disposable cover arranged for installation with top 1/8 inch (3 mm) below surface of concrete. Arrange insert to receive a flush-, recessed-, or wiring-extension service fitting to replace disposable cover.
   d. Include housing and connecting provisions for a flush or recessed, single-, double-, or triple-system service fitting.
   e. Include mounting and connecting provisions for a surface, single-, double-, or triple-system service fitting.
   f. Include connecting provisions for a wiring-extension service fitting to feed wall outlets.

G. Electrical Connection Components For Cellular Concrete Floor Deck
1. Afterset Inserts: Round metal-nipple assembly with internal and external threading, arranged to screw into plug driven into 1-7/8-inch (48-mm) hole drilled through floor fill, where present, and deck-cell wall into floor raceway cell.

a. Inserts shall be compatible with floor-mounting service fittings.
b. Inserts shall provide wiring path from cell to power **OR** communication **OR** power and communication, **as directed**, wall and ceiling outlets.
c. Inserts shall provide wiring path from cell to header raceway.

H. Supports, Fittings, And Hardware
1. Supports, fittings, and hardware shall be compatible with raceway and outlet system and shall be listed for use with raceway systems and components specified.
2. Supports: Adjustable for height and arranged to maintain alignment and spacing of raceways during concrete placement. Include hold-down straps.
3. Raceway Fittings: Couplings, expansion-joint sleeves, cross-under offsets, vertical and horizontal elbows, grounding screws, adapters, end caps, and other fittings suitable for use with basic components to form a complete installation.

I. Junction Boxes
1. Description: Manufacturer's standard enclosure for indicated type, quantity, arrangement, and configuration of raceways at each raceway junction, intersection, and access location. Include the following accessories and features:
a. Mounting brackets.
b. Escutcheons and holders to accommodate surrounding floor covering.
c. Means for leveling and height adjustment more than 3/8 inch (10 mm) before and after concrete is placed.
d. Raceway Openings: For underfloor raceways and conduits arranged to accommodate raceway layout.
e. Covers shall have appropriate depth recess to receive specific floor finish material.
f. Partitions to separate wiring of different systems.

J. Service Fittings
1. Exposed Parts Finish: Brass **OR** Brushed Aluminum, **as directed**.
2. Flush, Single-System Service Fitting for Round Inserts: Include mounting and cover to support and provide access to single connector, jack, or receptacle device; mounted flush with floor within body of insert.
a. Connector, Jack, and Receptacle Devices: Single modular type; complying with Division 26 Section(s) "Wiring Devices" AND Division 27 Section(s) "Communications Horizontal Cabling".
b. Power Receptacle Outlet: Suitable for 20-A device.
3. Flush, Single- or Multiple-System Service Fitting for Rectangular Inserts: Include mounting, hinged cover, and trim to support and provide access to connector, jack, or receptacle devices mounted flush with floor within insert.
a. Connector, Jack, and Receptacle Devices: Modular type; complying with Division 26 Section(s) "Wiring Devices" AND Division 27 Section(s) "Communications Horizontal Cabling".
b. Power Receptacle Rating: 20 A, 120 V unless otherwise indicated.
4. Recess-Mounted Service Fitting: Modular fittings compatible with preset inserts and shall include covers; provisions for receptacles, jacks, and connectors; and associated device plates for indicated systems. Include hinged flush handhole covers with recessed depth to match thickness of floor finish material. Provide for internally mounted receptacle- and communication-jack and connector assemblies complying with requirements in Division 26 Section(s) "Wiring Devices" AND Division 27 Section(s) "Communications Horizontal Cabling".
a. Duplex receptacle.
b. Duplex telephone-data jacks.
c. Double duplex receptacles.
d. Duplex receptacle and duplex telephone-data jacks.
e. Double duplex telephone-data jacks, Category 5 **OR** Category 5e **OR** Category 6, **as directed**.

f. Fiber-optic cable connector.

5. Surface-Mounted Service Fitting: Modular pedestal type, with locking attachment matched to insert floor opening.
   a. Power-outlet, double-faced, surface-mounted unit for duplex receptacle on both sides.
   b. Power-outlet, single-faced, surface-mounted unit for duplex receptacle on one side.
   c. Communication-outlet, double-faced, surface-mounted unit.
      1) Include bushed openings on both sides; 1-inch (25-mm) minimum diameter; insulated with nonconducting material.
      2) Include provisions for modular dual fiber-optic connector assembly on both sides.
      3) Include provisions for modular dual jack-connector assembly, rated for Category 5 **OR** Category 5e **OR** Category 6, **as directed**, on both sides.
   d. Communication-outlet, single-faced, surface-mounted unit with bushed opening on one side; 1-inch (25-mm) minimum diameter; insulated with nonconducting material.
   e. Combination surface-mounted unit for duplex receptacle on one side and with communication cable connection provision on opposite side.
      1) Communication Side: Include bushed opening; 1-inch (25-mm) minimum diameter; insulated with nonconducting material.
      2) Communication Side: Include provisions for modular dual fiber-optic connector assembly.
      3) Communication Side: Include provisions for modular dual jack-connector assembly, rated for Category 5 **OR** Category 5e **OR** Category 6, **as directed**.
6. Flush-Mounted Service Fittings: Modular fittings compatible with preset inserts and shall include covers, provisions for receptacles jacks and connector assemblies and wiring extensions to wall-mounted outlets, and associated device plates for indicated systems. Include flush handhole covers, recessed to suit floor finish material. Internally mounted, modular, receptacle, jack and connector assemblies shall comply with requirements in Division 26 Section(s) "Wiring Devices" AND Division 27 Section(s) "Communications Horizontal Cabling".
   a. Duplex convenience receptacle.
   b. Duplex telephone-data outlets.
   c. Double duplex convenience receptacles.
   d. Duplex convenience receptacle and duplex telephone-data outlets.
   e. Double duplex telephone-data outlets.
   f. Duplex communication jack, rated for Category 5 **OR** Category 5e **OR** Category 6, **as directed**.
   g. Duplex fiber-optic communication connector.
   h. Wiring-Extension Service Fittings: Arrangement of brackets and mountings to support, and provide access to wiring or cabling of a cell, and to connect the cable or raceway that extends the system to an individual wall outlet. Provide for connection of FMC **OR** ENT **OR** Type MC cable, **as directed**, for power extensions, and FMC **OR** ENT **OR** optical fiber/communication cable raceway, **as directed**, for communication system extensions.

1.3 EXECUTION

A. Installation
1. Install raceways aligned and leveled and, unless otherwise indicated, parallel or perpendicular to building walls.
2. Provide a concrete base for support of cellular metal raceway.
3. Arrange supports to attain proper elevation, alignment, and spacing of raceways. Install supports securely at ends and at intervals not to exceed 60 inches (1500 mm), to prevent movement during concrete pour.
4. Level raceway components with finished slab and make adjustments for floor finishes.
5. Adjust supports to maintain a 1/16- to 3/8-inch (1.6- to 10-mm) finished concrete cover over preset inserts.
6. Remove burrs, sharp edges, dents, and mechanical defects.
7. Cap or plug boxes, insert- and service-fitting openings, and open ends of raceways.

8. Seal raceways, cells, junction boxes, and inserts to prevent water, concrete, or foreign matter from entering raceways before and during pouring slab or placing fill. Tape joints, or seal with compound, as recommended in writing by underfloor raceway manufacturer.
9. Junction Boxes: Install tops level and flush with finished floor. Install blank closure plates or plugs to close unused junction-box openings. Grout boxes in place to prevent movement during construction. Place top covers in inverted position during construction to prevent damage to surface of cover. Reinstall covers in proper position prior to final acceptance of Work.
10. Afterset Inserts: Cut, hole saw, and drill slab and raceways to allow for installation.
11. Ground underfloor raceway components.
12. Install a marker at the center of the last insert of each cell and channel of each straight run of metal underfloor service raceway to locate the insert and identify the system.
    a. Install markers at last inserts on both sides of permanent walls and at first inserts adjacent to each junction box.
    b. Install markers flush at screed line before pouring slab or placing fill. Extend marker with grommeted screw when floor covering is placed. Do not extend through carpet.
    c. Use slotted-head screw to identify electrical power; use Phillips-head screw to identify conventional communications.
    d. Use another distinctive screw head to identify third system such as special-purpose wiring.
13. Level raceway components with finished slab and make adjustments in raceway component elevation to accommodate indicated floor finishes.

B. Field Quality Control
1. Perform tests and inspections.
    a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Tests and Inspections:
    a. Perform visual inspection of interior of each junction box **OR** section of trench raceway, **as directed**, to verify absence of dirt, dust, construction debris, and moisture. Replace damaged and malfunctioning components.
    b. Perform point-to-point tests of ground continuity and resistance of ground path between the most remote accessible fitting on each branch of each underfloor raceway system and the main electrical distribution grounding system.
        1) Determine cause and perform correction of any point-to-point resistance value that exceeds 0.05 ohms.
        2) Comply with NETA Acceptance Testing Specifications about safety, suitability of test equipment, test instrument calibration, and test report and records.

C. Cleaning
1. Clean and swab out underfloor raceways, inserts, and junction boxes after finish has been applied to floor slab, and remove foreign material, dirt, and moisture. Leave interiors clean and dry.

END OF SECTION 26 05 19 13

Task	Specification	Specification Description
26 05 19 13	26 05 13 16a	Undercarpet Cables

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SECTION 26 05 19 16 - COMMON WORK RESULTS FOR COMMUNICATIONS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for common work results for communications. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Communications equipment coordination and installation.
      b. Sleeves for pathways and cables.
      c. Sleeve seals.
      d. Grout.
      e. Common communications installation requirements.

C. Definitions
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

D. Submittals
   1. Product Data: For sleeve seals.

1.2 PRODUCTS

A. Sleeves For Pathways And Cables
   1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
   2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
   3. Sleeves for Rectangular Openings: Galvanized sheet steel.
      a. Minimum Metal Thickness:
         1) For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
         2) For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

B. Sleeve Seals
   1. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.
      a. Sealing Elements: EPDM **OR** NBR, **as directed**, interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of pathway or cable.
      b. Pressure Plates: Plastic **OR** Carbon steel **OR** Stainless steel, **as directed**. Include two for each sealing element.
      c. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating **OR** Stainless steel, **as directed**, of length required to secure pressure plates to sealing elements. Include one for each sealing element.

C. Grout

1. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

1.3 EXECUTION

A. Common Requirements For Communications Installation
1. Comply with NECA 1.
2. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
3. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
4. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
5. Right of Way: Give to piping systems installed at a required slope.

B. Sleeve Installation For Communications Penetrations
1. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
2. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
3. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
4. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
5. Cut sleeves to length for mounting flush with both surfaces of walls.
6. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.
7. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pathway or cable, unless indicated otherwise.
8. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   a. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
9. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants".
10. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping".
11. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.
12. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel **OR** cast-iron, **as directed**, pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
13. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

C. Sleeve-Seal Installation
1. Install to seal exterior wall penetrations.
2. Use type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve

seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

D. Firestopping
   1. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping".

END OF SECTION 26 05 19 16

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SECTION 26 05 19 16a - COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for common work results for electronic safety and security. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Electronic safety and security equipment coordination and installation.
      b. Sleeves for raceways and cables.
      c. Sleeve seals.
      d. Grout.
      e. Common electronic safety and security installation requirements.

C. Definitions
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

D. Submittals
   1. Product Data: For sleeve seals.

1.2 PRODUCTS

A. Sleeves For Raceways And Cables
   1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
   2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
   3. Sleeves for Rectangular Openings: Galvanized sheet steel.
      a. Minimum Metal Thickness:
         1) For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
         2) For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

B. Sleeve Seals
   1. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
      a. Sealing Elements: EPDM **OR** NBR, **as directed**, interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
      b. Pressure Plates: Plastic **OR** Carbon steel **OR** Stainless steel, **as directed**. Include two for each sealing element.
      c. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating **OR** Stainless steel, **as directed**, of length required to secure pressure plates to sealing elements. Include one for each sealing element.

C. Grout

1. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

1.3 EXECUTION

A. Common Requirements For Electronic Safety And Security Installation
1. Comply with NECA 1.
2. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
3. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
4. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electronic safety and security equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
5. Right of Way: Give to piping systems installed at a required slope.

B. Sleeve Installation For Electronic Safety And Security Penetrations
1. Electronic safety and security penetrations occur when raceways, pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
2. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
3. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
4. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
5. Cut sleeves to length for mounting flush with both surfaces of walls.
6. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.
7. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.
8. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   a. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
9. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants".
10. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping".
11. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
12. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel **OR** cast-iron, **as directed**, pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
13. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

C. Sleeve-Seal Installation
1. Install to seal exterior wall penetrations.

2. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

D. Firestopping
   1. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electronic safety and security installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping".

END OF SECTION 26 05 19 16a

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SECTION 26 05 19 16b - ELECTRICAL RENOVATION

1.1 DESCRIPTION OF WORK

A. This specification covers the furnishing and installation of materials for electrical renovation. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 GENERAL

A. Quality Assurance
1. Regulatory Requirements: Comply with following:
a. Electrical: National Fire Protection Association (NFPA): NFPA 70 - National Electrical Code (NEC).
b. Accessibility:
1) Architectural Barriers Act of 1968 as amended (42 USC 4151-4157) and HUD implementing regulations (24 CFR Part 40).
a) Uniform Federal Accessibility Standards (UFAS).
2) Section 504 of the Rehabilitation Act of 1973 as amended (29 USC 794) and HUD implementing regulations 24 CFR Part 8.
3) Fair Housing Accessibility Guidelines (24 CFR Chapter 1).
4) Americans with Disabilities Act of 1990 (ADA) (42 USC §§ 12101, et seq.) and implementing regulations (28 CFR Part 35).

B. Project Conditions
1. Existing Conditions: Buildings will be occupied during construction. See Division 1 Section “Summary of Work.” Do not interfere with use of occupied portions of building. Maintain free and safe passage to and from occupied areas.

C. Scheduling And Sequencing
1. Scheduling and Completion: Comply with requirements of Detailed Scope of Work.

D. Alterations, Cutting And Protection
1. Protection: Protect existing finishes, equipment, utilities and adjacent work, which is scheduled to remain, from damage.
2. Existing Operating Facilities: Confine operations to immediate vicinity of new work and do not interfere with or obstruct ingress or egress to and from adjacent facilities.

1.3 PRODUCTS

A. Materials
1. Electrical Materials and Devices: Comply with NFPA 70 (NEC):
a. Boxes: Galvanized steel, not less than 1.6 mm (0.0625 inch) thickness (NEC 370-20) grounded in accordance with NEC, Article 250, suitable for recess mounting.
1) Provide boxes of appropriate shape and size for intended purpose.
b. Devices:
1) Duplex Receptacles: 15 A or 20 A 115 V, UL Listed with screw side connections and corrugated bearing pads.
a) GFIC Outlets: 115 V, 60 Hz, 15/20 A rating, UL Listed.
2) Switches: 15 A. 115 V, single pole, single throw switch, UL Listed, with side screw connections and corrugated bearing pads.

a) Garbage Disposal: Heavy duty, 120/277 VAC, 60 Hz, single pole, single throw, 20 A rate, UL listed and CSA certified.
3) Cover Plates: Smooth plastic in color to match existing.
c. Wiring: Insulated wire, Type NM 600 V with ground wire, sized as appropriate for intended purpose and in accordance with NEC.
1) Aluminum Wire: Not allowed unless existing wiring is aluminum.
2) Provide necessary fittings in accordance with NEC.

1.4 EXECUTION

A. Examination
1. Units, Spaces and Areas to be Renovated: Inspect to become familiar with existing conditions and to take measurements which are necessary for renovation work to be completed in accordance with contract requirements.
a. Carefully inspect condition of existing spaces including, but not limited to walls, floors, plumbing, electrical, etc. as essential to successful completion of renovation work.
b. Survey each space and verify dimensions for work.

B. Preparation
1. Building Occupation: Carry out renovation work to cause as little inconvenience to occupants as possible. See Division 1 Section "Summary of Work."
2. Protection: Protect and be responsible for existing buildings, facilities, utilities, and improvements within areas of construction operations.
a. Tenant's Property: Be responsible for any damage or loss to residents' property and to other work. Replace any material, which, in opinion of the Owner, has become damaged to extent that it could not be restored to its original condition.
b. Take precautions to protect residents and public from injury from construction operations.

C. Laying Out Work
1. Discrepancies: Verify dimensions and elevations indicated in layout of existing work.
a. Prior to commencing work, carefully compare and check Drawings (if any), for discrepancies in locations or elevations of work to be executed.
b. Refer discrepancies among Drawings (if any), Specifications and existing conditions to the Owner for adjustment before work affected is performed.
1) Failure to make such notification shall place responsibility on Contractor to carry out work in satisfactory, workmanlike manner.
2. Contractor: Responsible for location and elevation of construction contemplated by Construction Documents.

D. Location Of Equipment And Piping
1. Drawings (if any) indicating location of equipment, piping, ductwork, etc. are diagrammatic and job conditions shall not always permit their installation in location shown. When this situation occurs, bring condition to the Owner's attention immediately. Relocation will be determined in joint conference.
2. Contractor: Do not relocate any items without first obtaining the Owner's acceptance. Remove and relocate such relocated items at own expense if so directed.

E. Electrical Work
1. General: Install boxes, wiring, and devices as indicated and required to connect and control electrical devices in accordance with NFPA 70 (NEC).
a. Boxes: Solidly anchor to framing or blocking.
2. Removing Electrical Switch or Duplex Outlet (Non-Hazardous Locations):
a. Box to Remain:
1) Remove electrical device; cap hot and neutral with set-screw wire connectors.

2) Attach ground wire to remaining box with solid screw attachment.
3) Provide and install natural finish aluminum blank cover plate with screw fasteners integral to match size of box remaining.

b. Box to be removed:
1) Remove electrical device and box and pull wire out of wall back to first circuit panel, disconnecting from circuit panel.
2) Patch and repair hole in partition to match existing.

3. Garbage Disposal Electrical Hook-up: See Section "Plumbing." Comply with NFPA 70 (NEC):
a. Wiring: Install from disposal through concealed spaces to house panel, anchoring wire, and providing necessary fittings.
b. Switch: Install above counter top backsplash.

4. Range Hood Electrical Hook-up: See Section "Residential Appliances." Comply with NFPA 70 (NEC):
a. Electric service: Install insulated wire from range hood through concealed spaces to house panel, anchoring wire, and providing necessary fittings.

5. Water Heater Electrical Hook-up: See Division 15 Section "Domestic Water Heaters." Comply with NFPA 70 (NEC).
6. Furnace Electrical Hook-up: See Section "Furnaces." Comply with NFPA 70 (NEC).
7. Smoke Detector Electrical Hook-up: See "Fire Alarm." Comply with NFPA 70 (NEC).

F. Integrating Existing Work
1. Protection: Protect existing improvements from damage.
a. Where new work is to be connected to existing work, exercise special care not to disturb or damage existing work more than necessary.
b. Damaged Work: Replace, repair and restored to its original condition at no cost to the Owner.

END OF SECTION 26 05 19 16b

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SECTION 26 05 19 16c - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of control-voltage electrical power cables. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. UTP cabling.
b. 50/125 **OR** 62.5/125, **as directed**,-micrometer, multimode optical fiber cabling.
c. RS-232 cabling.
d. RS-485 cabling.
e. Low-voltage control cabling.
f. Control-circuit conductors.
g. Identification products.

C. Definitions
1. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.
2. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel section.
3. EMI: Electromagnetic interference.
4. IDC: Insulation displacement connector.
5. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).
6. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
7. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).
8. RCDD: Registered Communications Distribution Designer.
9. Solid-Bottom or Nonventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal side rails, and a bottom without ventilation openings.
10. Trough or Ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal rails and a bottom having openings sufficient for the passage of air and using 75 percent or less of the plan area of the surface to support cables.
11. UTP: Unshielded twisted pair.

D. Submittals
1. Product Data: For each type of product indicated.
2. Field quality-control reports.
3. Maintenance data.

E. Quality Assurance
1. Testing Agency Qualifications: Member company of an NRTL.
a. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing **OR** possess the standards and experience for membership, **as directed**.
2. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
a. Flame-Spread Index: 25 or less.
b. Smoke-Developed Index: 50 **OR** 450, **as directed**, or less.

3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Delivery, Storage, And Handling
1. Test cables upon receipt at Project site.
   a. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight **OR** optical loss test set, **as directed**.
   b. Test optical fiber cable on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; include the loss value of each. Retain test data and include the record in maintenance data.
   c. Test each pair of UTP cable for open and short circuits.

1.2 PRODUCTS

A. Pathways
1. Support of Open Cabling: NRTL labeled for support of Category 5e **OR** Category 6, **as directed**, cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
   a. Support brackets with cable tie slots for fastening cable ties to brackets.
   b. Lacing bars, spools, J-hooks, and D-rings.
   c. Straps and other devices.
2. Cable Trays:
   a. Cable Tray Materials: Metal, suitable for indoors and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inch (0.012 mm) thick **OR** hot-dip galvanizing, complying with ASTM A 123/A 123M, Grade 0.55, not less than 0.002165 inch (0.055 mm) thick, **as directed**.
      1) Basket Cable Trays: 6 inches (150 mm) wide and 2 inches (50 mm) deep. Wire mesh spacing shall not exceed 2 by 4 inches (50 by 100 mm).
      2) Trough or Ventilated Cable Trays: Nominally 6 inches (150 mm) wide.
      3) Ladder Cable Trays: Nominally 18 inches (455 mm) wide, and a rung spacing of 12 inches (305 mm).
      4) Channel Cable Trays: One-piece construction, nominally 4 inches (100 mm) wide. Slot spacing shall not exceed 4-1/2 inches (115 mm) o.c.
      5) Solid-Bottom or Nonventilated Cable Trays: One-piece construction, nominally 12 inches (305 mm) wide. Provide with **OR** without, **as directed**, solid covers.
3. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems". Flexible metal conduit shall not be used, **as directed**.
   a. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

B. Backboards
1. Description: Plywood, fire-retardant treated, **as directed**, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels in Division 06 Section "Rough Carpentry".

C. UTP Cable
1. Description: 100-ohm, four-pair UTP, formed into 25-pair binder groups covered with a blue thermoplastic jacket, **as directed**.
   a. Comply with ICEA S-90-661 for mechanical properties.
   b. Comply with TIA/EIA-568-B.1 for performance specifications.
   c. Comply with TIA/EIA-568-B.2, Category 5e **OR** Category 6, **as directed**.
   d. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

1) Communications, General Purpose: Type CM or Type CMG; or Type MPP, Type CMP, Type MPR, Type CMR, Type MP, or Type MPG, **as directed**.
2) Communications, Plenum Rated: Type CMP or Type MPP, **as directed**, complying with NFPA 262.
3) Communications, Riser Rated: Type CMR; or Type MPP, Type CMP, or Type MPR, **as directed**; complying with UL 1666.
4) Communications, Limited Purpose: Type CMX; or Type MPP, Type CMP, Type MPR, Type CMR, Type MP, Type MPG, Type CM, or Type CMG, **as directed**.
5) Multipurpose: Type MP or Type MPG; or Type MPP or Type MPR, **as directed**.
6) Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
7) Multipurpose, Riser Rated: Type MPR or Type MPP, **as directed**, complying with UL 1666.

D. UTP Cable Hardware
1. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.
2. Connecting Blocks: 110 style for Category 5e **OR** 110 style for Category 6 **OR** 66 style for Category 5e, **as directed**. Provide blocks for the number of cables terminated on the block, plus 25 percent spare; integral with connector bodies, including plugs and jacks where indicated.

E. Optical Fiber Cable
1. Description: Multimode, 50/125 **OR** 62.5/125, **as directed**,-micrometer, 24-fiber, nonconductive, **as directed**, tight buffer, optical fiber cable.
a. Comply with ICEA S-83-596 for mechanical properties.
b. Comply with TIA/EIA-568-B.3 for performance specifications.
c. Comply with TIA/EIA-492AAAA-B **OR** TIA/EIA-492AAAA-A, **as directed**, for detailed specifications.
d. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
1) General Purpose, Nonconductive: Type OFN or OFNG, or Type OFNR or Type OFNP, **as directed**.
2) Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
3) Riser Rated, Nonconductive: Type OFNR or Type OFNP, **as directed**, complying with UL 1666.
4) General Purpose, Conductive: Type OFC or Type OFCG; or Type OFNG, Type OFN, Type OFCR, Type OFNR, Type OFCP, or Type OFNP, **as directed**.
5) Plenum Rated, Conductive: Type OFCP or Type OFNP, **as directed**, complying with NFPA 262.
6) Riser Rated, Conductive: Type OFCR; or Type OFNR, Type OFCP, or Type OFNP, **as directed**; complying with UL 1666.
e. Conductive cable shall be steel **OR** aluminum, **as directed**,-armored type.
f. Maximum Attenuation: 3.5 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
g. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
2. Jacket:
a. Jacket Color: Aqua for 50/125 **OR** Orange for 62.5/125, **as directed**,-micrometer cable.
b. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
c. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

F. Optical Fiber Cable Hardware
1. Cable Connecting Hardware: Comply with the Fiber Optic Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
a. Quick-connect, simplex and duplex, Type SC **OR** Type ST **OR** Type LC **OR** Type MT-RJ, **as directed**, connectors. Insertion loss not more than 0.75 dB.
b. Type SFF connectors may be used in termination racks, panels, and equipment packages.

G. RS-232 Cable
1. Standard Cable: NFPA 70, Type CM.
   a. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
   b. Polypropylene insulation.
   c. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
   d. PVC jacket.
   e. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
   f. Flame Resistance: Comply with UL 1581.
2. Plenum-Rated Cable: NFPA 70, Type CMP.
   a. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
   b. Plastic insulation.
   c. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
   d. Plastic jacket.
   e. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
   f. Flame Resistance: Comply with NFPA 262.

H. RS-485 Cable
1. Standard Cable: NFPA 70, Type CM or Type CMG, **as directed**.
   a. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
   b. PVC insulation.
   c. Unshielded.
   d. PVC jacket.
   e. Flame Resistance: Comply with UL 1581.
2. Plenum-Rated Cable: NFPA 70, Type CMP.
   a. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
   b. Fluorinated ethylene propylene insulation.
   c. Unshielded.
   d. Fluorinated ethylene propylene jacket.
   e. Flame Resistance: NFPA 262, Flame Test.

I. Low-Voltage Control Cable
1. Paired Cable: NFPA 70, Type CMG.
   a. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
   b. PVC insulation.
   c. Unshielded.
   d. PVC jacket.
   e. Flame Resistance: Comply with UL 1581.
2. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
   a. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
   b. PVC insulation.
   c. Unshielded.
   d. PVC jacket.
   e. Flame Resistance: Comply with NFPA 262.
3. Paired Cable: NFPA 70, Type CMG.
   a. One pair, twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.
   b. PVC insulation.
   c. Unshielded.
   d. PVC jacket.
   e. Flame Resistance: Comply with UL 1581.
4. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
   a. One pair, twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.
   b. Fluorinated ethylene propylene insulation.
   c. Unshielded.

d. Plastic jacket.
e. Flame Resistance: NFPA 262, Flame Test.

J. Control-Circuit Conductors
1. Class 1 Control Circuits: Stranded copper, Type THHN-THWN **OR** Type XHHN, **as directed**, in raceway, complying with UL 83 **OR** UL 44, **as directed**.
2. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, in raceway **OR** Type XHHN, in raceway **OR** power-limited cable, concealed in building finishes **OR** power-limited tray cable, in cable tray, **as directed**, complying with UL 83 **OR** UL 44, **as directed**.
3. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or Type TF, complying with UL 83.

K. Identification Products
1. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
2. Comply with requirements in Division 26 Section "Identification For Electrical Systems".

L. Source Quality Control
1. Testing Agency: Engage a qualified testing agency to evaluate cables.
2. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.
3. Factory test UTP cables according to TIA/EIA-568-B.2.
4. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.
5. Cable will be considered defective if it does not pass tests and inspections.
6. Prepare test and inspection reports.

1.3 EXECUTION

A. Installation Of Pathways
1. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.
2. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.
3. Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems" for installation of conduits and wireways.
4. Install manufactured conduit sweeps and long-radius elbows if possible.
5. Pathway Installation in Equipment Rooms:
a. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed or in the corner of room if multiple sheets of plywood are installed around perimeter walls of room.
b. Install cable trays to route cables if conduits cannot be located in these positions.
c. Secure conduits to backboard if entering room from overhead.
d. Extend conduits 3 inches (75 mm) above finished floor.
e. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
6. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

B. Installation Of Conductors And Cables
1. Comply with NECA 1.
2. General Requirements for Cabling:
a. Comply with TIA/EIA-568-B.1.
b. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
c. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.

d. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
e. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
f. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
g. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
h. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

3. UTP Cable Installation:
a. Comply with TIA/EIA-568-B.2.
b. Install 110-style IDC termination hardware unless otherwise indicated.
c. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.

4. Installation of Control-Circuit Conductors:
a. Install wiring in raceways. Comply with requirements specified in Division 26 Section "Raceway And Boxes For Electrical Systems".

5. Optical Fiber Cable Installation:
a. Comply with TIA/EIA-568-B.3.
b. Cable shall be terminated on connecting hardware that is rack or cabinet mounted.

6. Open-Cable Installation:
a. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
b. Suspend copper cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1525 mm) apart.
c. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

7. Installation of Cable Routed Exposed under Raised Floors:
a. Install plenum-rated cable only.
b. Install cabling after the flooring system has been installed in raised floor areas.
c. Coil cable 72 inches (1830 mm) long shall be neatly coiled not less than 12 inches (305 mm) in diameter below each feed point.

8. Separation from EMI Sources:
a. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
b. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
   2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (305 mm).
   3) Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).
c. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
   2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
   3) Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (305 mm).
d. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

1) Electrical Equipment Rating Less Than 2 kVA: No requirement.
2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).
3) Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

e. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
f. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

C. Removal Of Conductors And Cables
1. Remove abandoned conductors and cables.

D. Control-Circuit Conductors
1. Minimum Conductor Sizes:
a. Class 1 remote-control and signal circuits, No 14 AWG.
b. Class 2 low-energy, remote-control, and signal circuits, No. 16 AWG.
c. Class 3 low-energy, remote-control, alarm, and signal circuits, No 12 AWG.

E. Firestopping
1. Comply with requirements in Division 07 Section "Penetration Firestopping".
2. Comply with TIA/EIA-569-A, Annex A, "Firestopping."
3. Comply with BICSI TDMM, "Firestopping Systems" Article.

F. Grounding
1. For data communication wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
2. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding And Bonding For Electrical Systems".

G. Identification

H. Identify system components, wiring, and cabling according to TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".

I. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
a. Visually inspect UTP and optical fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.
b. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
c. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not after cross connection.
1) Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

d. Optical Fiber Cable Tests:
1) Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
2) Link End-to-End Attenuation Tests:
a) Multimode Link Measurements: Test at 850 or 1300 nm in one direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.

b) Attenuation test results for links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.

3. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
4. End-to-end cabling will be considered defective if it does not pass tests and inspections.
5. Prepare test and inspection reports.

END OF SECTION 26 05 19 16c

SECTION 26 05 19 16d - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for communications equipment room fittings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Telecommunications mounting elements.
b. Backboards.
c. Telecommunications equipment racks and cabinets.
d. Telecommunications service entrance pathways.
e. Grounding.

C. Definitions
1. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.
2. BICSI: Building Industry Consulting Service International.
3. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel not exceeding 6 inches (152 mm) in width.
4. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).
5. LAN: Local area network.
6. RCDD: Registered Communications Distribution Designer.
7. Solid-Bottom or Nonventilated Cable Tray: A fabricated structure consisting of a bottom without ventilation openings within integral or separate longitudinal side rails.
8. Trough or Ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal rails and a bottom having openings sufficient for the passage of air and using 75 percent or less of the plan area of the surface to support cables.

D. Performance Requirements
1. Seismic Performance: Floor-mounted cabinets and cable pathways shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

E. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.
a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
b. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
c. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.
3. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.
4. Seismic Qualification Certificates: For floor-mounted cabinets, accessories, and components, from manufacturer.

a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

F. Quality Assurance
1. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff **OR** personnel must possess the standards and experience for membership.
a. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD **OR** RCDD/NTS **OR** possess the standards and experience for membership **OR** Commercial Installer, Level 2, **as directed**.
b. Installation Supervision: Installation shall be under the direct supervision of Registered Technician **OR** Level 2 Installer, **as directed**, who shall be present at all times when Work of this Section is performed at Project site.
c. Field Inspector: Currently registered by BICSI as RCDD **OR** possess the standards and experience for membership **OR** Commercial Installer, Level 2, **as directed**, to perform the on-site inspection.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.
4. Grounding: Comply with ANSI-J-STD-607-A.

G. Project Conditions
1. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and work above ceilings is complete.

H. Coordination
1. Coordinate layout and installation of communications equipment with the Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.
a. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and the Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
b. Record agreements reached in meetings and distribute them to other participants.
c. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
d. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.
2. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

1.2 PRODUCTS

A. Pathways
1. General Requirements: Comply with TIA/EIA-569-A.

2. Cable Support: NRTL labeled. Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable. Cable tie slots fasten cable ties to brackets.
   a. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.
   b. Support brackets with cable tie slots for fastening cable ties to brackets.
   c. Lacing bars, spools, J-hooks, and D-rings.
   d. Straps and other devices.
3. Cable Trays:
   a. Cable Tray Materials: Metal, suitable for indoors and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inch (0.012 mm) thick **OR** hot-dip galvanizing, complying with ASTM A 123/A 123M, Grade 0.55, not less than 0.002165 inch (0.055 mm) thick, **as directed**.
      1) Basket Cable Trays: 6 inches (150 mm) wide and 2 inches (50 mm) deep. Wire mesh spacing shall not exceed 2 by 4 inches (50 by 100 mm).
      2) Trough Cable Trays: Nominally 6 inches (150 mm) wide.
      3) Ladder Cable Trays: Nominally 18 inches (455 mm) wide, and a rung spacing of 12 inches (305 mm).
      4) Channel Cable Trays: One-piece construction, nominally 4 inches (100 mm) wide. Slot spacing shall not exceed 4-1/2 inches (115 mm) o.c.
      5) Solid-Bottom Cable Trays: One-piece construction, nominally 12 inches (305 mm) wide. Provide with **OR** without, **as directed**, solid covers.
4. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems". Flexible metal conduit shall not be used.
   a. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

B. Backboards
1. Backboards: Plywood, fire-retardant treated, **as directed**, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels specified in Division 06 Section "Rough Carpentry".

C. Equipment Frames
1. General Frame Requirements:
   a. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
   b. Module Dimension: Width compatible with EIA 310 standard, 19-inch (480-mm) panel mounting.
   c. Finish: Manufacturer's standard, baked-polyester powder coat.
2. Floor-Mounted Racks: Modular-type, steel **OR** aluminum, **as directed**, construction.
   a. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip, **as directed**.
   b. Baked-polyester powder coat finish.
3. Modular Freestanding Cabinets:
   a. Removable and lockable side panels.
   b. Hinged and lockable front and rear doors.
   c. Adjustable feet for leveling.
   d. Screened ventilation openings in the roof and rear door.
   e. Cable access provisions in the roof and base.
   f. Grounding bus bar.
   g. Rack **OR** Roof, **as directed**,-mounted, 550-cfm (260-L/s) fan with filter.
   h. Power strip.
   i. Baked-polyester powder coat finish.
   j. All cabinets keyed alike.

4. Modular Wall Cabinets:
    a. Wall mounting.
    b. Steel **OR** Aluminum, **as directed**, construction.
    c. Treated to resist corrosion.
    d. Lockable front and rear doors.
    e. Louvered side panels.
    f. Cable access provisions top and bottom.
    g. Grounding lug.
    h. Rack **OR** Roof, **as directed**,-mounted, 250-cfm (118-L/s) fan.
    i. Power strip.
    j. All cabinets keyed alike.
5. Cable Management for Equipment Frames:
    a. Metal, with integral wire retaining fingers.
    b. Baked-polyester powder coat finish.
    c. Vertical cable management panels shall have front and rear channels, with covers.
    d. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

D. Power Strips
1. Power Strips: Comply with UL 1363.
    a. Rack mounting.
    b. Six, 15-A, 120-V ac, NEMA WD 6, Configuration 5-15R **OR** 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R, **as directed**, receptacles.
    c. LED indicator lights for power and protection status.
    d. LED indicator lights for reverse polarity and open outlet ground.
    e. Circuit Breaker and Thermal Fusing:
        1) When protection is lost, circuit opens and cannot be reset.
        OR
        Unit continues to supply power if protection is lost.
    f. Close-coupled, direct plug-in **OR** Cord connected with 15-foot (4.5-m), **as directed**, line cord.
    g. Rocker-type on-off switch, illuminated when in on position.
    h. Peak Single-Impulse Surge Current Rating: 33 **OR** 26 **OR** 13, **as directed**, kA per phase.
    i. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all 3 modes shall be not more than 330 V.

E. Grounding
1. Comply with requirements in Division 26 Section "Grounding And Bonding For Electrical Systems" for grounding conductors and connectors.
2. Telecommunications Main Bus Bar:
    a. Connectors: Mechanical type, cast silicon bronze, solderless compression **OR** exothermic, **as directed**,-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
    b. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide (6 mm thick by 100 mm wide) with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart.
    c. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.
3. Comply with ANSI-J-STD-607-A.

F. Labeling
1. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

1.3 EXECUTION

A. Entrance Facilities
1. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.
2. Install underground **OR** buried **OR** aerial, **as directed**, pathways complying with recommendations in TIA/EIA-569-A, "Entrance Facilities" Article.
a. Install underground **OR** buried, **as directed**, entrance pathway complying with Division 26 Section "Raceway And Boxes For Electrical Systems".

B. Installation
1. Comply with NECA 1.
2. Comply with BICSI TDMM for layout and installation of communications equipment rooms.
3. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.
4. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

C. Firestopping
1. Comply with requirements in Division 07 Section "Penetration Firestopping".
2. Comply with TIA/EIA-569-A, Annex A, "Firestopping."
3. Comply with BICSI TDMM, "Firestopping Systems" Article.

D. Grounding
1. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
2. Comply with ANSI-J-STD-607-A.
3. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
4. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.
a. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

E. Identification
1. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Division 26 Section "Identification For Electrical Systems".
2. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
3. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 **OR** Class 3 **OR** Class 4, **as directed**, level of administration including optional identification requirements of this standard, **as directed**.
4. Labels shall be preprinted or computer-printed type.

END OF SECTION 26 05 19 16d

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SECTION 26 05 19 16e - COMMUNICATIONS BACKBONE CABLING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for communications backbone cabling. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Pathways.
b. UTP cable.
c. 50/125 and 62.5/125-micrometer, optical fiber cabling.
d. Coaxial cable.
e. Cable connecting hardware, patch panels, and cross-connects.
f. Cabling identification products.

C. Definitions
1. BICSI: Building Industry Consulting Service International.
2. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
3. EMI: Electromagnetic interference.
4. IDC: Insulation displacement connector.
5. LAN: Local area network.
6. RCDD: Registered Communications Distribution Designer.
7. UTP: Unshielded twisted pair.

D. Backbone Cabling Description
1. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.
2. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

E. Performance Requirements
1. General Performance: Backbone cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

F. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings:
a. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by the Owner.
b. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
c. Cabling administration drawings and printouts.
d. Wiring diagrams to show typical wiring schematics including the following:
1) Cross-connects.
2) Patch panels.
3) Patch cords.

e. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
f. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements.

3. Qualification Data: For Installer, **as directed**, qualified layout technician, installation supervisor, and field inspector.
4. Source quality-control reports.
5. Field quality-control reports.
6. Maintenance Data.
7. Software and Firmware Operational Documentation:
   a. Software operating and upgrade manuals.
   b. Program Software Backup: On magnetic media or compact disk, complete with data files.
   c. Device address list.
   d. Printout of software application and graphic screens.

G. Quality Assurance

1. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff **OR** personnel must possess the standards and experience for membership, **as directed**.
   a. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD **OR** personnel that possess the standards and experience for membership, **as directed**.
   b. Installation Supervision: Installation shall be under the direct supervision of Registered Technician **OR** Level 2 Installer, **as directed**, who shall be present at all times when Work of this Section is performed at Project site.
2. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   a. Flame-Spread Index: 25 or less.
   b. Smoke-Developed Index: 50 **OR** 450, **as directed**, or less.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.
5. Grounding: Comply with ANSI-J-STD-607-A.

H. Delivery, Storage, And Handling

1. Test cables upon receipt at Project site.
   a. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
   b. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.
   c. Test each pair of UTP cable for open and short circuits.

I. Software Service Agreement

1. Technical Support: Beginning with Final Completion, provide software support for two years.
2. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Final Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
   a. Provide 30 days' notice to the Owner to allow scheduling and access to system and to allow the Owner to upgrade computer equipment if necessary.

1.2 PRODUCTS

A. Pathways
1. General Requirements: Comply with TIA/EIA-569-A.
2. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
   a. Support brackets with cable tie slots for fastening cable ties to brackets.
   b. Lacing bars, spools, J-hooks, and D-rings.
   c. Straps and other devices.
3. Cable Trays:
   a. Cable Tray Material: Metal, suitable for indoors, and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inches (0.012 mm) thick **OR** hot-dip galvanizing, complying with ASTM A 123/A 123M, Grade 0.55, not less than 0.002165 inches (0.055 mm) thick, **as directed**.
      1) Basket Cable Trays: 6 inches (150 mm) wide and 2 inches (50 mm) deep. Wire mesh spacing shall not exceed 2 by 4 inches (50 by 100 mm).
      2) Trough Cable Trays: Nominally 6 inches (150 mm) wide.
      3) Ladder Cable Trays: Nominally 18 inches (455 mm) wide, and a rung spacing of 12 inches (305 mm).
      4) Channel Cable Trays: One-piece construction, nominally 4 inches (100 mm) wide. Slot spacing shall not exceed 4-1/2 inches (115 mm) o.c.
      5) Solid-Bottom Cable Trays: One-piece construction, nominally 12 inches (305 mm) wide. Provide with **OR** without, **as directed**, solid covers.
4. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems". Flexible metal conduit shall not be used.
   a. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

B. Backboards
1. Backboards: Plywood, fire-retardant treated, **as directed**, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements in Division 06 Section "Rough Carpentry" for plywood backing panels.

C. UTP Cable
1. Description: 100-ohm, 100-pair UTP, formed into 25-pair binder groups covered with a gray thermoplastic jacket and overall metallic shield.
   a. Comply with ICEA S-90-661 for mechanical properties.
   b. Comply with TIA/EIA-568-B.1 for performance specifications.
   c. Comply with TIA/EIA-568-B.2, Category 5e **OR** Category 6, **OR** Category 6e **as directed**.
   d. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
      1) Communications, General Purpose: Type CM or CMG; or MPP, CMP, MPR, CMR, MP, or MPG, **as directed**.
      2) Communications, Plenum Rated: Type CMP or MPP, **as directed**, complying with NFPA 262.
      3) Communications, Riser Rated: Type CMR; or MPP, CMP, or MPR, **as directed**, complying with UL 1666.
      4) Communications, Limited Purpose: Type CMX; or MPP, CMP, MPR, CMR, MP, MPG, CM, or CMG, **as directed**.
      5) Multipurpose: Type MP or MPG; or MPP or MPR, **as directed**.
      6) Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
      7) Multipurpose, Riser Rated: Type MPR or MPP, **as directed**, complying with UL 1666.

D. UTP Cable Hardware

1. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
2. Connecting Blocks: 110-style IDC for Category 5e **OR** 110-style IDC for Category 6 **OR** 66-style IDC for Category 5e, **OR** 110-style IDC for Category 6e **as directed**. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.
3. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
   a. Number of Terminals per Field: One for each conductor in assigned cables.
4. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
   a. Number of Jacks per Field: One for each four-pair UTP cable indicated **OR** conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria, **as directed**.
5. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.
6. Patch Cords: Factory-made, 4-pair cables in 36-inch (900-mm) **OR** 48-inch (1200-mm), **as directed**, lengths; terminated with 8-position modular plug at each end.
   a. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
   b. Patch cords shall have color-coded boots for circuit identification.

E. Optical Fiber Cable
1. Description: Multimode, 50/125 **OR** 62.5/125, **as directed**,-micrometer, 24-fiber, nonconductive, **as directed**, tight buffer, optical fiber cable.
   a. Comply with ICEA S-83-596 for mechanical properties.
   b. Comply with TIA/EIA-568-B.3 for performance specifications.
   c. Comply with TIA/EIA-492AAAA-B **OR** TIA/EIA-492AAAA-A, **as directed**, for detailed specifications.
   d. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
      1) General Purpose, Nonconductive: Type OFN or OFNG, or OFNR, OFNP, **as directed**.
      2) Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
      3) Riser Rated, Nonconductive: Type OFNR or OFNP, **as directed**, complying with UL 1666.
      4) General Purpose, Conductive: Type OFC or OFCG; or OFNG, OFN, OFCR, OFNR, OFCP, or OFNP, **as directed**.
      5) Plenum Rated, Conductive: Type OFCP or OFNP, **as directed**, complying with NFPA 262.
      6) Riser Rated, Conductive: Type OFCR; or OFNR, OFCP, or OFNP, **as directed**, complying with UL 1666.
   e. Conductive cable shall be steel **OR** aluminum, **as directed**, armored type.
   f. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
   g. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
2. Jacket:
   a. Jacket Color: Aqua for 50/125-micrometer cable **OR** Orange for 62.5/125-micrometer cable, **as directed**.
   b. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
   c. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

F. Optical Fiber Cable Hardware

1. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
   a. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.
2. Patch Cords: Factory-made, dual-fiber cables in 36-inch (900-mm) lengths.
3. Cable Connecting Hardware:
   a. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
   b. Quick-connect, simplex and duplex, Type SC **OR** Type ST **OR** Type LC **OR** Type MT-RJ, **as directed**, connectors. Insertion loss not more than 0.75 dB.
   c. Type SFF connectors may be used in termination racks, panels, and equipment packages.

G. Coaxial Cable
1. General Coaxial Cable Requirements: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.
2. RG-11/U: NFPA 70, Type CATV.
   a. No. 14 AWG, solid, copper-covered steel conductor.
   b. Gas-injected, foam-PE insulation.
   c. Double shielded with 100 percent aluminum polyester tape and 60 percent aluminum braid.
   d. Jacketed with sunlight-resistant, black PVC or PE.
   e. Suitable for outdoor installations in ambient temperatures ranging from minus 40 to plus 85 deg C.
3. RG59/U: NFPA 70, Type CATVR.
   a. No. 20 AWG, solid, silver-plated, copper-covered steel conductor.
   b. Gas-injected, foam-PE insulation.
   c. Triple shielded with 100 percent aluminum polyester tape and 95 percent aluminum braid; covered by aluminum foil with grounding strip.
   d. Color-coded PVC jacket.
4. RG-6/U: NFPA 70, Type CATV or CM.
   a. No. 16 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
   b. Double shielded with 100 percent aluminum-foil shield and 60 percent aluminum braid.
   c. Jacketed with black PVC or PE.
   d. Suitable for indoor installations.
5. RG59/U: NFPA 70, Type CATV.
   a. No. 20 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
   b. Double shielded with 100 percent aluminum polyester tape and 40 percent aluminum braid.
   c. PVC jacket.
6. RG59/U (Plenum Rated): NFPA 70, Type CMP.
   a. No. 20 AWG, solid, copper-covered steel conductor; foam fluorinated ethylene propylene insulation.
   b. Double shielded with 100 percent aluminum-foil shield and 65 percent aluminum braid.
   c. Copolymer jacket.
7. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70, "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:
   a. CATV Cable: Type CATV, or CATVP or CATVR, **as directed**.
   b. CATV Plenum Rated: Type CATVP, complying with NFPA 262.
   c. CATV Riser Rated: Type CATVR; or CATVP, CATVR, or CATV, **as directed**, complying with UL 1666.
   d. CATV Limited Rating: Type CATVX.

H. Coaxial Cable Hardware
1. Coaxial-Cable Connectors: Type BNC, 75 ohms.

I. Grounding

1. Comply with requirements in Division 26 Section "Grounding And Bonding For Electrical Systems" for grounding conductors and connectors.
2. Comply with ANSI-J-STD-607-A.

J. Identification Products
   1. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

K. Source Quality Control
   1. Testing Agency: Engage a qualified testing agency to evaluate cables.
   2. Factory test cables on reels according to TIA/EIA-568-B.1.
   3. Factory test UTP cables according to TIA/EIA-568-B.2.
   4. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.
   5. Cable will be considered defective if it does not pass tests and inspections.
   6. Prepare test and inspection reports.

1.3 EXECUTION

A. Entrance Facilities
   1. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

B. Wiring Methods
   1. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
      a. Install plenum cable in environmental air spaces, including plenum ceilings.
      b. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway And Boxes For Electrical Systems".
   2. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
   3. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

C. Installation Of Pathways
   1. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A.
   2. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 27 Section "Communications Equipment Room Fittings". Drawings indicate general arrangement of pathways and fittings.
   3. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.
   4. Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems" for installation of conduits and wireways.
   5. Install manufactured conduit sweeps and long-radius elbows whenever possible.
   6. Pathway Installation in Communications Equipment Rooms:
      a. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
      b. Install cable trays to route cables if conduits cannot be located in these positions.
      c. Secure conduits to backboard when entering room from overhead.
      d. Extend conduits 3 inches (76 mm) above finished floor.

e. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

7. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

D. Installation Of Cables
1. Comply with NECA 1.
2. General Requirements for Cabling:
   a. Comply with TIA/EIA-568-B.1.
   b. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
   c. Install 110-style IDC termination hardware unless otherwise indicated.
   d. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
   e. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   f. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
   g. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
   h. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
   i. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
   j. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
   k. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
3. UTP Cable Installation:
   a. Comply with TIA/EIA-568-B.2.
   b. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.
4. Optical Fiber Cable Installation:
   a. Comply with TIA/EIA-568-B.3.
   b. Cable may be terminated on connecting hardware that is rack or cabinet mounted.
5. Open-Cable Installation:
   a. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   b. Suspend UTP cable not in a wireway or pathway, a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1524 mm) apart.
   c. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
6. Installation of Cable Routed Exposed under Raised Floors:
   a. Install plenum-rated cable only.
   b. Install cabling after the flooring system has been installed in raised floor areas.
   c. Coil cable 6 feet (1800 mm) long not less than 12 inches (300 mm) in diameter below each feed point.
7. Outdoor Coaxial Cable Installation:
   a. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
   b. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches (915 mm).
8. Group connecting hardware for cables into separate logical fields.
9. Separation from EMI Sources:

a. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

b. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
   2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
   3) Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).

c. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
   2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
   3) Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

d. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   1) Electrical Equipment Rating Less Than 2 kVA: No requirement.
   2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
   3) Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

e. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).

f. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

E. Firestopping
1. Comply with requirements in Division 07 Section "Penetration Firestopping".
2. Comply with TIA/EIA-569-A, Annex A, "Firestopping."
3. Comply with BICSI TDMM, "Firestopping Systems" Article.

F. Grounding
1. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
2. Comply with ANSI-J-STD-607-A.
3. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
4. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

G. Identification
1. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".
   a. Administration Class: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
   b. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
2. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
3. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 **OR** Class 3 **OR** Class 4, **as directed**, level of administration including optional identification requirements of this standard.

4. Comply with requirements in Division 27 Section "Communications Horizontal Cabling" for cable and asset management software.
5. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
6. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
7. Cable and Wire Identification:
    a. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
    b. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
    c. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
    d. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
        1) Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
        2) Label each unit and field within distribution racks and frames.
    e. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
8. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-A, for the following:
    a. Cables use flexible vinyl or polyester that flexes as cables are bent.

H. Field Quality Control
1. Tests and Inspections:
    a. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
    b. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
    c. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
        1) Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    d. Optical Fiber Cable Tests:
        1) Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
        2) Link End-to-End Attenuation Tests:

a) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.

b) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.

2. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
3. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
4. End-to-end cabling will be considered defective if it does not pass tests and inspections.
5. Prepare test and inspection reports.

END OF SECTION 26 05 19 16e

SECTION 26 05 19 16f - COMMUNICATIONS HORIZONTAL CABLING

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for communications horizontal cabling. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Pathways.
   b. UTP cabling.
   c. 50/125 and 62.5/125-micrometer, optical fiber cabling.
   d. Coaxial cable.
   e. Multiuser telecommunications outlet assemblies.
   f. Cable connecting hardware, patch panels, and cross-connects.
   g. Telecommunications outlet/connectors.
   h. Cabling system identification products.
   i. Cable management system.

C. Definitions

1. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.
2. BICSI: Building Industry Consulting Service International.
3. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel.
4. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.
5. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
6. EMI: Electromagnetic interference.
7. IDC: Insulation displacement connector.
8. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).
9. LAN: Local area network.
10. MUTOA: Multiuser telecommunications outlet assembly, a grouping in one location of several telecommunications outlet/connectors.
11. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.
12. RCDD: Registered Communications Distribution Designer.
13. Solid-Bottom or Nonventilated Cable Tray: A fabricated structure consisting of longitudinal side rails and a bottom without ventilation openings.
14. Trough or Ventilated Cable Tray: A fabricated structure consisting of longitudinal side rails and a bottom having openings for the passage of air.
15. UTP: Unshielded twisted pair.

D. Horizontal Cabling Description

1. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.
   a. TIA/EIA-568-B.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.

b. Horizontal cabling shall contain no more that one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
c. Bridged taps and splices shall not be installed in the horizontal cabling.
d. Splitters shall not be installed as part of the optical fiber cabling.

2. A work area is approximately 100 sq. ft. (9.3 sq. m), and includes the components that extend from the telecommunications outlet/connectors to the station equipment.
3. The maximum allowable horizontal cable length is 295 feet (90 m). This maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) to the workstation equipment. The maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) in the horizontal cross-connect.

E. Performance Requirements

1. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

F. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings:
   a. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by the Owner.
   b. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
   c. Cabling administration drawings and printouts.
   d. Wiring diagrams to show typical wiring schematics, including the following:
      1) Cross-connects.
      2) Patch panels.
      3) Patch cords.
   e. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
   f. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements.
3. Samples: For workstation outlets, jacks, jack assemblies, in specified finish, one for each size and outlet configuration and faceplates for color selection and evaluation of technical features.
4. Qualification Data: For Installer, **as directed**, qualified layout technician, installation supervisor, and field inspector.
5. Source quality-control reports.
6. Field quality-control reports.
7. Maintenance Data.
8. Software and Firmware Operational Documentation:
   a. Software operating and upgrade manuals.
   b. Program Software Backup: On magnetic media or compact disk, complete with data files.
   c. Device address list.
   d. Printout of software application and graphic screens.

G. Quality Assurance

1. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff **OR** personnel must possess the standards and experience for membership, **as directed**.
   a. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD **OR** personnel that possess the standards and experience for membership, **as directed**.
   b. Installation Supervision: Installation shall be under the direct supervision of Registered Technician **OR** Level 2 Installer, **as directed**, who shall be present at all times when Work of this Section is performed at Project site.

2. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   a. Flame-Spread Index: 25 or less.
   b. Smoke-Developed Index: 50 **OR** 450, **as directions**, or less.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.
5. Grounding: Comply with ANSI-J-STD-607-A.

H. Delivery, Storage, And Handling
1. Test cables upon receipt at Project site.
   a. Test optical fiber cables to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
   b. Test optical fiber cables while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; including the loss value of each. Retain test data and include the record in maintenance data.
   c. Test each pair of UTP cable for open and short circuits.

I. Software Service Agreement
1. Technical Support: Beginning with Final Completion, provide software support for two years.
2. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Final Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
   a. Provide 30 days' notice to the Owner to allow scheduling and access to system and to allow the Owner to upgrade computer equipment if necessary.

1.2 PRODUCTS

A. Pathways
1. General Requirements: Comply with TIA/EIA-569-A.
2. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
   a. Support brackets with cable tie slots for fastening cable ties to brackets.
   b. Lacing bars, spools, J-hooks, and D-rings.
   c. Straps and other devices.
3. Cable Trays:
   a. Cable Tray Materials: Metal, suitable for indoors, and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inch (0.012 mm) thick **OR** hot-dip galvanizing, complying with ASTM A 123/A 123M, Grade 0.55, not less than 0.002165 inch (0.055 mm) thick, **as directed**.
      1) Basket Cable Trays: 6 inches (150 mm) wide and 2 inches (50 mm) deep. Wire mesh spacing shall not exceed 2 by 4 inches (50 by 100 mm).
      2) Trough Cable Trays: Nominally 6 inches (150 mm) wide.
      3) Ladder Cable Trays: Nominally 18 inches (455 mm) wide, and a rung spacing of 12 inches (305 mm).
      4) Channel Cable Trays: One-piece construction, nominally 4 inches (100 mm) wide. Slot spacing shall not exceed 4-1/2 inches (115 mm) o.c.
      5) Solid-Bottom Cable Trays: One-piece construction, nominally 12 inches (305 mm) wide. Provide with **OR** without, **as directed**, solid covers.
4. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems". Flexible metal conduit shall not be used.

a. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

B. Backboards
1. Backboards: Plywood, fire-retardant treated, **as directed**, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements in Division 06 Section "Rough Carpentry" for plywood backing panels.

C. UTP Cable
1. Description: 100-ohm, 4-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket.
   a. Comply with ICEA S-90-661 for mechanical properties.
   b. Comply with TIA/EIA-568-B.1 for performance specifications.
   c. Comply with TIA/EIA-568-B.2, Category 5e **OR** Category 6, **OR** Category 6e **as directed**.
   d. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
      1) Communications, General Purpose: Type CM or CMG; or MPP, CMP, MPR, CMR, MP, or MPG, **as directed**.
      2) Communications, Plenum Rated: Type CMP or MPP, **as directed**, complying with NFPA 262.
      3) Communications, Riser Rated: Type CMR; or MPP, CMP, or MPR, **as directed**, complying with UL 1666.
      4) Communications, Limited Purpose: Type CMX; or MPP, CMP, MPR, CMR, MP, MPG, CM, or CMG, **as directed**.
      5) Multipurpose: Type MP or MPG; or MPP or MPR, **as directed**.
      6) Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
      7) Multipurpose, Riser Rated: Type MPR or MPP, **as directed**, complying with UL 1666.

D. UTP Cable Hardware
1. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
2. Connecting Blocks: 110-style IDC for Category 5e **OR** 110-style IDC for Category 6 **OR** 66-style IDC for Category 5e, OR 110-style IDC for Category 6e **as directed**. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.
3. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
   a. Number of Terminals per Field: One for each conductor in assigned cables.
4. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
   a. Number of Jacks per Field: One for each four-pair UTP cable indicated **OR** conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria, **as directed**.
5. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.
6. Patch Cords: Factory-made, four-pair cables in 36-inch (900 mm) **OR** 48-inch (1200-mm), **as directed**, lengths; terminated with eight-position modular plug at each end.
   a. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
   b. Patch cords shall have color-coded boots for circuit identification.

E. Optical Fiber Cable

1. Description: Multimode, 50/125 **OR** 62.5/125, **as directed**,-micrometer, 24-fiber, nonconductive, **as directed**, tight buffer, optical fiber cable.
   a. Comply with ICEA S-83-596 for mechanical properties.
   b. Comply with TIA/EIA-568-B.3 for performance specifications.
   c. Comply with TIA/EIA-492AAAA-B **OR** TIA/EIA-492AAAA-A, **as directed**, for detailed specifications.
   d. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
      1) General Purpose, Nonconductive: Type OFN or OFNG, or OFNR, OFNP, **as directed**.
      2) Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
      3) Riser Rated, Nonconductive: Type OFNR or OFNP, **as directed**, complying with UL 1666.
      4) General Purpose, Conductive: Type OFC or OFCG; or OFNG, OFN, OFCR, OFNR, OFCP, or OFNP, **as directed**.
      5) Plenum Rated, Conductive: Type OFCP or OFNP, **as directed**, complying with NFPA 262.
      6) Riser Rated, Conductive: Type OFCR; or OFNR, OFCP, or OFNP, **as directed**, complying with UL 1666.
   e. Conductive cable shall be steel **OR** aluminum, **as directed**, armored type.
   f. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
   g. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
2. Jacket:
   a. Jacket Color: Aqua for 50/125-micrometer cable **OR** Orange for 62.5/125-micrometer cable, **as directed**.
   b. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
   c. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

F. Optical Fiber Cable Hardware
1. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
   a. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.
2. Patch Cords: Factory-made, dual-fiber cables in 36-inch (900-mm) lengths.
3. Cable Connecting Hardware:
   a. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
   b. Quick-connect, simplex and duplex, Type SC **OR** Type ST **OR** Type LC **OR** Type MT-RJ, **as directed**, connectors. Insertion loss not more than 0.75 dB.
   c. Type SFF connectors may be used in termination racks, panels, and equipment packages.

G. Coaxial Cable
1. Cable Characteristics: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.
2. RG-11/U: NFPA 70, Type CATV.
   a. No. 14 AWG, solid, copper-covered steel conductor.
   b. Gas-injected, foam-PE insulation.
   c. Double shielded with 100 percent aluminum polyester tape and 60 percent aluminum braid.
   d. Jacketed with sunlight-resistant, black PVC or PE.
   e. Suitable for outdoor installations in ambient temperatures ranging from minus 40 to plus 85 deg C.
3. RG59/U: NFPA 70, Type CATVR.
   a. No. 20 AWG, solid, silver-plated, copper-covered steel conductor.
   b. Gas-injected, foam-PE insulation.

c. Triple shielded with 100 percent aluminum polyester tape and 95 percent aluminum braid; covered by aluminum foil with grounding strip.
d. Color-coded PVC jacket.
4. RG-6/U: NFPA 70, Type CATV or CM.
a. No. 16 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
b. Double shielded with 100 percent aluminum-foil shield and 60 percent aluminum braid.
c. Jacketed with black PVC or PE.
d. Suitable for indoor installations.
5. RG59/U: NFPA 70, Type CATV.
a. No. 20 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
b. Double shielded with 100 percent aluminum polyester tape and 40 percent aluminum braid.
c. PVC jacket.
6. RG59/U (Plenum Rated): NFPA 70, Type CMP.
a. No. 20 AWG, solid, copper-covered steel conductor; foam fluorinated ethylene propylene insulation.
b. Double shielded with 100 percent aluminum-foil shield and 65 percent aluminum braid.
c. Copolymer jacket.
7. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70 "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:
a. CATV Cable: Type CATV or CATVP or CATVR, **as directed**.
b. CATV Plenum Rated: Type CATVP, complying with NFPA 262.
c. CATV Riser Rated: Type CATVR; or CATVP, CATVR, or CATV, **as directed**, complying with UL 1666.
d. CATV Limited Rating: Type CATVX.

H. Coaxial Cable Hardware
1. Coaxial-Cable Connectors: Type BNC, 75 ohms.

I. Consolidation Points
1. Description: Consolidation points shall comply with requirements for cable connecting hardware.
a. Number of Terminals per Field: One for each conductor in assigned cables.
b. Number of Connectors per Field:
1) One for each four-pair UTP cable indicated.
2) One for each four-pair conductor group of indicated cables, plus 25 percent spare positions.
c. Mounting: Recessed in ceiling **OR** Wall **OR** Desk **OR** Furniture, **as directed**.
d. NRTL listed as complying with UL 50 and UL 1863.
e. When installed in plenums used for environmental air, NRTL listed as complying with UL 2043.

J. Multiuser Telecommunications Outlet Assembly (MUTOA)
1. Description: MUTOAs shall meet the requirements for cable connecting hardware.
a. Number of Terminals per Field: One for each conductor in assigned cables.
b. Number of Connectors per Field:
1) One for each four-pair UTP cable indicated.
2) One for each four-pair conductor group of indicated cables, plus 25 percent spare positions.
c. Mounting: Recessed in ceiling **OR** Wall **OR** Desk **OR** Furniture, **as directed**.
d. NRTL listed as complying with UL 50 and UL 1863.
e. Label shall include maximum length of work area cords, based on TIA/EIA-568-B.1.
f. When installed in plenums used for environmental air, NRTL listed as complying with UL 2043.

K. Telecommunications Outlet/Connectors

1. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.
2. Workstation Outlets: Two **OR** Four, **as directed**,-port-connector assemblies mounted in single or multigang faceplate.
   a. Plastic Faceplate: High-impact plastic. Coordinate color with Division 26 Section "Wiring Devices".
   b. Metal Faceplate: Stainless steel **OR** Brass, **as directed**, complying with requirements in Division 26 Section "Wiring Devices".
   c. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.
      1) Flush mounting jacks, positioning the cord at a 45-degree angle.
   d. Legend:
      1) Factory labeled by silk-screening or engraving for stainless steel **OR** brass, **as directed**, faceplates.
         OR
         Machine printed, in the field, using adhesive-tape label.
         OR
         Snap-in, clear-label covers and machine-printed paper inserts.

L. Grounding
1. Comply with requirements in Division 26 Section "Grounding And Bonding For Electrical Systems" for grounding conductors and connectors.
2. Comply with ANSI-J-STD-607-A.

M. Identification Products
1. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
2. Comply with requirements in Division 26 Section "Identification For Electrical Systems".

N. Cable Management System
1. Description: Computer-based cable management system, with integrated database and graphic, **as directed**, capabilities.
2. Document physical characteristics by recording the network, TIA/EIA details, and connections between equipment and cable.
3. Information shall be presented in database view, schematic plans, or technical drawings.
   a. Microsoft Visio Professional or AutoCAD drawing software shall be used as drawing and schematic plans software.
4. System shall interface with the following testing and recording devices:
   a. Direct upload tests from circuit testing instrument into the personal computer.
   b. Direct download circuit labeling into labeling printer.

O. Source Quality Control
1. Testing Agency: Engage a qualified testing agency to evaluate cables.
2. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.
3. Factory test UTP cables according to TIA/EIA-568-B.2.
4. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.
5. Factory-sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.
6. Cable will be considered defective if it does not pass tests and inspections.
7. Prepare test and inspection reports.

1.3 EXECUTION

A. Entrance Facilities

1. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

B. Wiring Methods
  1. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
     a. Install plenum cable in environmental air spaces, including plenum ceilings.
     b. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway And Boxes For Electrical Systems".
  2. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
  3. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

C. Installation Of Pathways
  1. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.
  2. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 27 Section "Communications Equipment Room Fittings". Drawings indicate general arrangement of pathways and fittings.
  3. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.
  4. Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems" for installation of conduits and wireways.
  5. Install manufactured conduit sweeps and long-radius elbows whenever possible.
  6. Pathway Installation in Communications Equipment Rooms:
     a. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
     b. Install cable trays to route cables if conduits cannot be located in these positions.
     c. Secure conduits to backboard when entering room from overhead.
     d. Extend conduits 3 inches (76 mm) above finished floor.
     e. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
  7. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

D. Installation Of Cables
  1. Comply with NECA 1.
  2. General Requirements for Cabling:
     a. Comply with TIA/EIA-568-B.1.
     b. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
     c. Install 110-style IDC termination hardware unless otherwise indicated.
     d. MUTOA shall not be used as a cross-connect point.
     e. Consolidation points may be used only for making a direct connection to telecommunications outlet/connectors:
        1) Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
        2) Locate consolidation points for UTP at least 49 feet (15 m) from communications equipment room.
     f. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.

g. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
h. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
i. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
j. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
k. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
l. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
m. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

3. UTP Cable Installation:
   a. Comply with TIA/EIA-568-B.2.
   b. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.
4. Optical Fiber Cable Installation:
   a. Comply with TIA/EIA-568-B.3.
   b. Cable may be terminated on connecting hardware that is rack or cabinet mounted.
5. Open-Cable Installation:
   a. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   b. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1524 mm) apart.
   c. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
6. Installation of Cable Routed Exposed under Raised Floors:
   a. Install plenum-rated cable only.
   b. Install cabling after the flooring system has been installed in raised floor areas.
   c. Coil cable 6 feet (1800 mm) long not less than 12 inches (300 mm) in diameter below each feed point.
7. Outdoor Coaxial Cable Installation:
   a. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
   b. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches (915 mm).
8. Group connecting hardware for cables into separate logical fields.
9. Separation from EMI Sources:
   a. Comply with BICSI TDMM and TIA/EIA-569-A for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
   b. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
      1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
      2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
      3) Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).
   c. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
      1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).

2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
3) Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

d. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
1) Electrical Equipment Rating Less Than 2 kVA: No requirement.
2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
3) Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

e. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).

f. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

E. Firestopping
1. Comply with requirements in Division 07 Section "Penetration Firestopping".
2. Comply with TIA/EIA-569-A, Annex A, "Firestopping."
3. Comply with BICSI TDMM, "Firestopping Systems" Article.

F. Grounding
1. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
2. Comply with ANSI-J-STD-607-A.
3. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
4. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

G. Identification
1. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".
   a. Administration Class: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
   b. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.
2. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.
3. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
4. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 **OR** Class 3 **OR** Class 4, **as directed**, level of administration, including optional identification requirements of this standard.
5. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
6. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and

equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by the Owner.

7. Cable and Wire Identification:
   a. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
   b. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
   c. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
   d. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
      1) Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
      2) Label each unit and field within distribution racks and frames.
   e. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
   f. Uniquely identify and label work area cables extending from the MUTOA to the work area. These cables may not exceed the length stated on the MUTOA label.
8. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.
   a. Cables use flexible vinyl or polyester that flex as cables are bent.

H. Field Quality Control
1. Tests and Inspections:
   a. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
   b. Visually confirm Category 5e **OR** Category 6, **OR** Category 6e **as directed**, marking of outlets, cover plates, outlet/connectors, and patch panels.
   c. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
   d. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
      1) Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   e. Optical Fiber Cable Tests:
      1) Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
      2) Link End-to-End Attenuation Tests:
         a) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.
         b) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.
   f. UTP Performance Tests:

1) Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:
    a) Wire map.
    b) Length (physical vs. electrical, and length requirements).
    c) Insertion loss.
    d) Near-end crosstalk (NEXT) loss.
    e) Power sum near-end crosstalk (PSNEXT) loss.
    f) Equal-level far-end crosstalk (ELFEXT).
    g) Power sum equal-level far-end crosstalk (PSELFEXT).
    h) Return loss.
    i) Propagation delay.
    j) Delay skew.

g. Optical Fiber Cable Performance Tests: Perform optical fiber end-to-end link tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.3.

h. Coaxial Cable Tests: Conduct tests according to Division 27 Section "Master Antenna Television System".

i. Final Verification Tests: Perform verification tests for UTP and optical fiber systems after the complete communications cabling and workstation outlet/connectors are installed.
    1) Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
    2) Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

2. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
3. End-to-end cabling will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

END OF SECTION 26 05 19 16f

SECTION 26 05 19 16g - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

1.1 GENERAL

A. Description of Work
   1. This specification covers the furnishing and installation of materials for conductors and cables for electronic safety and security. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. UTP cabling.
      b. 50/125 and 62.5/125-micrometer, multimode optical fiber cabling.
      c. Coaxial cabling.
      d. RS-232 cabling.
      e. RS-485 cabling.
      f. Low-voltage control cabling.
      g. Control-circuit conductors.
      h. Fire alarm wire and cable.
      i. Identification products.

C. Definitions
   1. BICSI: Building Industry Consulting Service International.
   2. EMI: Electromagnetic interference.
   3. IDC: Insulation displacement connector.
   4. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
   5. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).
   6. RCDD: Registered Communications Distribution Designer.

D. Performance Requirements
   1. Seismic Performance: Pathways shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

E. Submittals
   1. Product Data: For each type of product indicated.
      a. For coaxial cable, include the following installation data for each type used:
         1) Nominal OD.
         2) Minimum bending radius.
         3) Maximum pulling tension.
   2. Shop Drawings: Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
      a. Vertical and horizontal offsets and transitions.
      b. Clearances for access above and to side of cable trays.
      c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
   3. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.
   4. Seismic Qualification Certificates: For pathways, accessories, and components, from manufacturer.

a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
5. Source quality-control reports.
6. Field quality-control reports.
7. Operation and Maintenance Data: For wire and cable to include in operation and maintenance manuals. Include the following:
a. Allowable pulling tension of cable.
b. Cable connectors and terminations recommended by the manufacturer.

F. Quality Assurance
1. Testing Agency Qualifications: An NRTL.
a. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD **OR** possess the standards and experience for membership, **as directed,** to supervise on-site testing.
2. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
a. Flame-Spread Index: 25 or less.
b. Smoke-Developed Index: 50 **OR** 450, **as directed**, or less.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Delivery, Storage, And Handling
1. Test cables upon receipt at Project site.
a. Test optical fiber cable to determine the continuity of the strand end to end. Use optical-fiber flashlight or optical loss test set.
b. Test optical fiber cable on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; include the loss value of each. Retain test data and include the record in maintenance data.
c. Test each pair of UTP cable for open and short circuits.

H. Project Conditions
1. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.
a. Indications that wire and cables are wet or moisture damaged include, but are not limited to, discoloration and sagging of factory packing materials.
2. Environmental Limitations: Do not deliver or install UTP, optical fiber, and coaxial cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.2 PRODUCTS

A. Pathways
1. Support of Open Cabling: NRTL labeled for support of Category 5e **OR** Category 6, **OR** Category 6e **as directed**, cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
a. Support brackets with cable tie slots for fastening cable ties to brackets.
b. Lacing bars, spools, J-hooks, and D-rings.
c. Straps and other devices.
2. Cable Trays:

a. Cable Tray Materials: Metal, suitable for indoors, and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inch (0.012 mm) thick **OR** hot-dip galvanizing, complying with ASTM A 123/A 123M Grade 0.55, not less than 0.002165 inch (0.055 mm) thick, **as directed**.
1) Basket Cable Trays: 6 inches (150 mm) wide and 2 inches (50 mm) deep, **as directed**. Wire mesh spacing shall not exceed 2 by 4 inches (50 by 100 mm).
2) Trough Cable Trays: Nominally 6 inches (150 mm), **as directed**, wide.
3) Ladder Cable Trays: Nominally 18 inches (455 mm), **as directed**, wide, and a rung spacing of 12 inches (305 mm), **as directed**.
4) Channel Cable Trays: One-piece construction, nominally 4 inches (100 mm), **as directed**, wide. Slot spacing shall not exceed 4-1/2 inches (115 mm) o.c.
5) Solid-Bottom Cable Trays: One-piece construction, nominally 12 inches (305 mm), **as directed**, wide. Provide with **OR** without, **as directed**, solid covers.

3. Conduit and Boxes: Comply with requirements in Division 16 Section "Raceways and Boxes." Flexible metal conduit shall not be used, **as directed**.
4. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

B. Backboards
1. Backboards: Plywood, fire-retardant treated, **as directed**, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels in Division 06 Section "Rough Carpentry".

C. UTP Cable
1. Description: 100-ohm, 4-pair UTP, covered with a blue thermoplastic jacket.
a. Comply with ICEA S-90-661 for mechanical properties.
b. Comply with TIA/EIA-568-B.1 for performance specifications.
c. Comply with TIA/EIA-568-B.2, Category 5e **OR** Category 6, **OR** Category 6e **as directed**.
d. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
1) Communications, General Purpose: Type CM or CMG; **OR** MPP, CMP, MPR, CMR, MP, or MPG, **as directed**.
2) Communications, Plenum Rated: Type CMP **OR** MPP, **as directed**, complying with NFPA 262.
3) Communications, Riser Rated: Type CMR; **OR** MPP, CMP, or MPR, **as directed**, complying with UL 1666.
4) Communications, Limited Purpose: Type CMX; **OR** MPP, CMP, MPR, CMR, MP, MPG, CM, or CMG, **as directed**.
5) Multipurpose: Type MP or MPG; **OR** MPP or MPR, **as directed**.
6) Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
7) Multipurpose, Riser Rated: Type MPR **OR** MPP, **as directed**, complying with UL 1666.

D. UTP Cable Hardware
1. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.
2. Connecting Blocks: 110-style for Category 5e **OR** 110-style for Category 6 **OR** 66-style for Category 5e, **OR** 110-style for Category 6e **as directed**. Provide blocks for the number of cables terminated on the block, plus 25, **as directed**, percent spare. Integral with connector bodies, including plugs and jacks where indicated.

E. Optical Fiber Cable
1. Description: Multimode, 50/125 **OR** 62.5/125, **as directed**,-micrometer, 24-fiber, **as directed**, nonconductive, **as directed**, tight buffer, optical fiber cable.

a. Comply with ICEA S-83-596 for indoor cable OR ICEA S-87-640 for outside plant, as directed, for mechanical properties.
b. Comply with TIA/EIA-568-B.3 for performance specifications.
c. Comply with TIA-492AAAB **OR** TIA-492AAAA-A, **as directed**, for detailed specifications.
d. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
   1) General Purpose, Nonconductive: Type OFN or OFNG, **OR** OFNR, OFNP, **as directed**.
   2) Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
   3) Riser Rated, Nonconductive: Type OFNR or OFNP, complying with UL 1666.
   4) General Purpose, Conductive: Type OFC or OFCG; **OR** OFNG, OFN, OFCR, OFNR, OFCP, or OFNP, **as directed**.
   5) Plenum Rated, Conductive: Type OFCP or OFNP, complying with NFPA 262.
   6) Riser Rated, Conductive: Type OFCR; or OFNR, OFCP, or OFNP, **asa directed**, complying with UL 1666.
e. Conductive cable shall be steel **OR** aluminum, **as directed**, armored type.
f. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
g. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

2. Jacket:
   a. Jacket Color: Aqua for 50/125-micrometer cable **OR** Orange for 62.5/125-micrometer cable, **as directed**.
   b. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-C.
   c. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

F. Optical Fiber Cable Hardware
1. Cable Connecting Hardware: Meet the Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA-604-2-B, TIA-604-3-B, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
   a. Quick-connect, simplex and duplex, Type SC **OR** Type ST **OR** Type LC **OR** Type MT-RJ, **as directed**, connectors. Insertion loss not more than 0.75 dB.
   b. Type SFF connectors may be used in termination racks, panels, and equipment packages.

G. Coaxial Cable
1. General Coaxial Cable Requirements: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.
2. RG-11/U: NFPA 70, Type CATV.
   a. No. 14 AWG, solid, copper-covered steel conductor.
   b. Gas-injected, foam-PE insulation.
   c. Double shielded with 100 percent aluminum polyester tape and 60 percent aluminum braid.
   d. Jacketed with sunlight-resistant, black PVC or PE.
   e. Suitable for outdoor installations in ambient temperatures ranging from minus 40 to plus 85 deg C.
3. RG59/U: NFPA 70, Type CATVR.
   a. No. 20 AWG, solid, silver-plated, copper-covered steel conductor.
   b. Gas-injected, foam-PE insulation.
   c. Triple shielded with 100 percent aluminum polyester tape and 95 percent aluminum braid; covered by aluminum foil with grounding strip.
   d. Color-coded PVC jacket.
4. RG-6/U: NFPA 70, Type CATV or CM.
   a. No. 16 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
   b. Double shielded with 100 percent aluminum-foil shield and 60 percent aluminum braid.
   c. Jacketed with black PVC or PE.

d. Suitable for indoor installations.
5. RG59/U: NFPA 70, Type CATV.
a. No. 20 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
b. Double shielded with 100 percent aluminum polyester tape and 40 percent aluminum braid.
c. PVC jacket.
6. RG59/U (Plenum Rated): NFPA 70, Type CMP.
a. No. 20 AWG, solid, copper-covered steel conductor; foam fluorinated ethylene propylene insulation.
b. Double shielded with 100 percent aluminum-foil shield and 65 percent aluminum braid.
c. Copolymer jacket.
7. NFPA and UL Compliance: Coaxial cables shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655, and with NFPA 70 "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:
a. CATV Cable: Type CATV, **OR** CATVP or CATVR, **as directed**.
b. CATV Plenum Rated: Type CATVP, complying with NFPA 262.
c. CATV Riser Rated: Type CATVR; **OR** CATVP, CATVR, or CATV, **as directed**, complying with UL 1666.
d. CATV Limited Rating: Type CATVX.

H. Coaxial Cable Hardware
1. Coaxial-Cable Connectors: Type BNC, 75 ohms.

I. RS-232 Cable
1. Standard Cable: NFPA 70, Type CM.
a. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
b. Polypropylene insulation.
c. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
d. PVC jacket.
e. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
f. Flame Resistance: Comply with UL 1581.
2. Plenum-Rated Cable: NFPA 70, Type CMP.
a. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
b. Plastic insulation.
c. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
d. Plastic jacket.
e. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
f. Flame Resistance: Comply with NFPA 262.

J. RS-485 Cable
1. Standard Cable: NFPA 70, Type CM **OR** CMG, **as directed**.
a. Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
b. PVC insulation.
c. Unshielded.
d. PVC jacket.
e. Flame Resistance: Comply with UL 1581.
2. Plenum-Rated Cable: NFPA 70, Type CMP.
a. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
b. Fluorinated ethylene propylene insulation.
c. Unshielded.
d. Fluorinated ethylene propylene jacket.
e. Flame Resistance: NFPA 262, Flame Test.

K. Low-Voltage Control Cable

1. Paired Cable: NFPA 70, Type CMG.
   a. 1 pair, twisted, No. 16 AWG, stranded (19x29) and No. 18 AWG, stranded (19x30) tinned copper conductors.
   b. PVC insulation.
   c. Unshielded.
   d. PVC jacket.
   e. Flame Resistance: Comply with UL 1581.
2. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
   a. 1 pair, twisted, No. 16 AWG, stranded (19x29) and No. 18 AWG, stranded (19x30) tinned copper conductors.
   b. PVC insulation.
   c. Unshielded.
   d. PVC jacket.
   e. Flame Resistance: Comply with NFPA 262.

L. Control-Circuit Conductors
1. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway **OR** Type XHHN, complying with UL 44, in raceway, **as directed**.
2. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway **OR** power-limited cable, complying with UL 83, concealed in building finishes **OR** power-limited tray cable, complying with UL 83, in cable tray **OR** Type XHHN, complying with UL 44, in raceway, **as directed**.
3. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or TF, complying with UL 83.

M. Fire Alarm Wire And Cable
1. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
2. Signaling Line Circuits: Twisted, shielded pair, not less than **OR** No. 18 AWG **OR** size as recommended by system manufacturer, **as directed**.
   a. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.
3. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
   a. Low-Voltage Circuits: No. 16 AWG, minimum.
   b. Line-Voltage Circuits: No. 12 AWG, minimum.
   c. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket, **as directed**, with red identifier stripe, NTRL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

N. Identification Products
1. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
2. Comply with requirements in Division 26 Section "Identification For Electrical Systems".

O. Source Quality Control
1. Testing Agency: Engage a qualified testing agency to evaluate cables.
2. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.
3. Factory test UTP cables according to TIA/EIA-568-B.2.
4. Factory test multimode optical fiber cables according to TIA-526-14-A and TIA/EIA-568-B.3.

5. Factory sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.
6. Cable will be considered defective if it does not pass tests and inspections.
7. Prepare test and inspection reports.

1.3 EXECUTION

A. Installation Of Pathways
1. Cable Trays: Comply with NEMA VE 2 and TIA-569-B.
2. Comply with TIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.
3. Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems" for installation of conduits and wireways.
4. Install manufactured conduit sweeps and long-radius elbows whenever possible.
5. Pathway Installation in Equipment Rooms:
   a. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
   b. Install cable trays to route cables if conduits cannot be located in these positions.
   c. Secure conduits to backboard when entering room from overhead.
   d. Extend conduits 3 inches (75 mm) above finished floor.
   e. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
6. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

B. Installation Of Hangers And Supports
1. Comply with requirements in Division 26 Section "Hangers And Supports For Electrical Systems" for installation of supports for pathways, conductors and cables.

C. Wiring Method
1. Install wiring in metal raceways and wireways. Conceal raceway except in unfinished spaces and as indicated. Minimum conduit size shall be 3/4 inch (21 mm). Control and data transmission wiring shall not share conduit with other building wiring systems.
2. Install wiring in raceways except in accessible indoor ceiling spaces and in interior hollow gypsum board partitions where cable may be used. Conceal raceways and wiring except in unfinished spaces and as indicated. Minimum conduit size shall be 3/4 inch (21 mm). Control and data transmission wiring shall not share conduit with other building wiring systems.
3. Install cable, concealed in accessible ceilings, walls, and floors when possible.
4. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Installation Of Conductors And Cables
1. Comply with NECA 1.
2. Conductors: Size according to system manufacturer's written instructions unless otherwise indicated.
3. General Requirements for Cabling:
   a. Comply with TIA/EIA-568-B.1.
   b. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."

c. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
d. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
e. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
f. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
g. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
h. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

4. UTP Cable Installation: Install using techniques, practices, and methods that are consistent with Category 5e **OR** Category 6, **OR** Category 6e **as directed**, rating of components and that ensure Category 5e **OR** Category 6, **OR** Category 6e **as directed**, performance of completed and linked signal paths, end to end.
   a. Comply with TIA/EIA-568-B.2.
   b. Install 110-style IDC termination hardware unless otherwise indicated.
   c. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.
5. Optical Fiber Cable Installation:
   a. Comply with TIA/EIA-568-B.3.
   b. Cable shall be terminated on connecting hardware that is rack or cabinet mounted.
6. Outdoor Coaxial Cable Installation:
   a. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
   b. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches (915 mm).
7. Open-Cable Installation:
   a. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   b. Suspend copper cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1525 mm) apart.
   c. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
8. Installation of Cable Routed Exposed under Raised Floors:
   a. Install plenum-rated cable only.
   b. Install cabling after the flooring system has been installed in raised floor areas.
   c. Coil cable 72 inches (1830 mm) long shall be neatly coiled not less than 12 inches (300 mm) in diameter below each feed point.
9. Separation from EMI Sources:
   a. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
   b. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
      1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
      2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
      3) Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).

c. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
   2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
   3) Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
d. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   1) Electrical Equipment Rating Less Than 2 kVA: No requirement.
   2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).
   3) Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
e. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
f. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

E. Fire Alarm Wiring Installation
1. Comply with NECA 1 and NFPA 72.
2. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceway And Boxes For Electrical Systems".
   a. Install plenum cable in environmental air spaces, including plenum ceilings.
   b. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.
3. Wiring Method:
   a. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
   b. Fire-Rated Cables: Use of 2-hour, fire-rated fire alarm cables, NFPA 70, Types MI and CI, is **OR** is not, **as directed**, permitted.
   c. Signaling Line Circuits: Power-limited fire alarm cables may **OR** shall not, **as directed**, be installed in the same cable or raceway as signaling line circuits.
4. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
5. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
6. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.
7. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.
8. Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

F. Power And Control-Circuit Conductors
1. 120-V Power Wiring: Install according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables" unless otherwise indicated.
2. Minimum Conductor Sizes:
   a. Class 1 remote-control and signal circuits, No. 14 AWG.

b. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
c. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

G. Connections
1. Comply with requirements in Division 28 Section "Perimeter Security Systems" for connecting, terminating, and identifying wires and cables.
2. Comply with requirements in Division 28 Section "Intrusion Detection" for connecting, terminating, and identifying wires and cables.
3. Comply with requirements in Division 28 Section "Access Control" for connecting, terminating, and identifying wires and cables.
4. Comply with requirements in Division 28 Section "Video Surveillance" for connecting, terminating, and identifying wires and cables.
5. Comply with requirements in Division 28 Section "Plc Electronic Detention Monitoring And Control Systems" for connecting, terminating, and identifying wires and cables.
6. Comply with requirements in Division 28 Section(s) "Digital, Addressable Fire-alarm System" OR "Zoned (dc Loop) Fire-alarm System", **as directed**, for connecting, terminating, and identifying wires and cables.
7. Comply with requirements in Division 28 Section "Refrigerant Detection And Alarm" for connecting, terminating, and identifying wires and cables.

H. Firestopping
1. Comply with requirements in Division 07 Section "Penetration Firestopping".
2. Comply with TIA-569-B, "Firestopping" Annex A.
3. Comply with BICSI TDMM, "Firestopping Systems" Article.

I. Grounding
1. For communications wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
2. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding And Bonding For Electrical Systems".

J. Identification
1. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".

K. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
a. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.
b. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
c. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross connection.
1) Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
d. Optical Fiber Cable Tests:

1) Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
2) Link End-to-End Attenuation Tests:
   a) Multimode Link Measurements: Test at 850 or 1300 nm in 1 direction according to TIA-526-14-A, Method B, One Reference Jumper.
   b) Attenuation test results for links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.

e. Coaxial Cable Tests: Comply with requirements in Division 27 Section "Master Antenna Television System".

3. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
4. End-to-end cabling will be considered defective if it does not pass tests and inspections.
5. Prepare test and inspection reports.

END OF SECTION 26 05 19 16g

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Task	Specification	Specification Description
26 05 19 16	01 22 16 00	No Specification Required
26 05 19 16	26 05 00 00	Common Work Results for Electrical
26 05 19 16	26 05 13 16	Conductors And Cables
26 05 19 16	26 05 13 16a	Undercarpet Cables
26 05 19 16	26 05 13 16b	Medium-Voltage Cables
26 05 23 00	26 05 19 16c	Control-Voltage Electrical Power Cables

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SECTION 26 05 26 00 - GROUNDING AND BONDING

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for grounding and bonding. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes methods and materials for grounding systems and equipment, plus the following special applications, **as directed**:
   a. Overhead-lines grounding.
   b. Underground distribution grounding.
   c. Common ground bonding with lightning protection system.

C. Submittals

1. Product Data: For each type of product indicated.
2. Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
   a. Test wells.
   b. Ground rods.
   c. Ground rings.
   d. Grounding arrangements and connections for separately derived systems.
   e. Grounding for sensitive electronic equipment.
3. Qualification Data: For qualified testing agency and testing agency's field supervisor.
4. Field quality-control test reports.
5. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation And Maintenance Data", include the following:
   a. Instructions for periodic testing and inspection of grounding features at test wells **OR** ground rings **OR** grounding connections for separately derived systems**, as directed** based on NETA MTS **OR** NFPA 70B**, as directed.**
      1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
      2) Include recommended testing intervals.

D. Quality Assurance

1. Testing Agency Qualifications: Member company of NETA or an NRTL **OR** one who meets the requirements necessary for certification, **as directed**.
   a. Testing Agency's Field Supervisor: Currently certified by NETA **OR** one who meets the requirements necessary for certification, **as directed,** to supervise on-site testing.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
3. Comply with UL 467 for grounding and bonding materials and equipment.

1.2 PRODUCTS

A. Conductors

1. Insulated Conductors: Copper **OR** Tinned-copper, **as directed**, wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

2. Bare Copper Conductors:
   a. Solid Conductors: ASTM B 3.
   b. Stranded Conductors: ASTM B 8.
   c. Tinned Conductors: ASTM B 33.
   d. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
   e. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
   f. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
   g. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
3. Bare Grounding Conductor and Conductor Protector for Wood Poles:
   a. No. 4 AWG minimum, soft-drawn copper.
   b. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir or cypress or cedar.
4. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 2 inches (6 by 50 mm), **as directed**, in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

B. Connectors
1. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
2. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
   a. Pipe Connectors: Clamp type, sized for pipe.
3. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
4. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression **OR** exothermic-type wire terminals, **as directed**, and long-barrel, two-bolt connection to ground bus bar.

C. Grounding Electrodes
1. Ground Rods: Copper-clad **OR** Zinc-coated **OR** Stainless, **as directed,** steel, sectional type, **as directed**; 3/4 inch by10 feet (19 mm by 3 m) **OR** 5/8 by 96 inches (16 by 2400 mm), **as directed,** in diameter.
2. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.
   a. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches (1200 mm) long.
   b. Backfill Material: Electrode manufacturer's recommended material.

1.3 EXECUTION

A. Applications
1. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
2. Underground Grounding Conductors: Install bare copper **OR** tinned-copper, **as directed**, conductor, No. 2/0 AWG minimum. Bury at least 24 inches (600 mm) below grade.
   a. Bury at least 24 inches (600 mm) below grade.
   b. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.

3. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
4. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
   a. Install bus on insulated spacers 1 inch (25 mm), minimum, from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
   b. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.
5. Conductor Terminations and Connections:
   a. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   b. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
   c. Connections to Ground Rods at Test Wells: Bolted connectors.
   d. Connections to Structural Steel: Welded connectors.

B. Grounding Overhead Lines
1. Comply with IEEE C2 grounding requirements.
2. Install 2 parallel ground rods if resistance to ground by a single, ground-rod electrode exceeds 25 ohms.
3. Drive ground rods until tops are 12 inches (300 mm) below finished grade in undisturbed earth.
4. Ground-Rod Connections: Install bolted connectors for underground connections and connections to rods.
5. Lightning Arrester Grounding Conductors: Separate from other grounding conductors.
6. Secondary Neutral and Transformer Enclosure: Interconnect and connect to grounding conductor.
7. Protect grounding conductors running on surface of wood poles with molding extended from grade level up to and through communication service and transformer spaces.

C. Grounding Underground Distribution System Components
1. Comply with IEEE C2 grounding requirements.
2. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.
3. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
4. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

D. Equipment Grounding
1. Install insulated equipment grounding conductors with all feeders and branch circuits.
2. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
   a. Feeders and branch circuits.

b. Lighting circuits.
c. Receptacle circuits.
d. Single-phase motor and appliance branch circuits.
e. Three-phase motor and appliance branch circuits.
f. Flexible raceway runs.
g. Armored and metal-clad cable runs.
h. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
i. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
j. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.

3. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
4. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
5. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
6. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
7. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
   a. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch (6-by-50-by-300-mm) grounding bus.
   b. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
8. Metal and Wood Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

E. Installation
1. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
2. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
3. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
   a. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

b. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

4. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts And Raceways For Electrical Systems" and shall be at least 12 inches (300 mm) deep, with cover.
   a. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
5. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
   a. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
   b. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
   c. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
6. Grounding and Bonding for Piping:
   a. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
   b. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
   c. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
7. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
8. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.
9. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column **OR** indicated item, **as directed**, extending around the perimeter of building **OR** area or item indicated, **as directed**.
   a. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
   b. Bury ground ring not less than 24 inches (600 mm) from building foundation.
10. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet (6 m) of bare copper conductor not smaller than No. 4 AWG.
   a. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within base of foundation.
   b. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

F. Labeling
1. Comply with requirements in Division 26 Section "Identification For Electrical Systems" for instruction signs. The label or its text shall be green.
2. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.
   a. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

G. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Tests and Inspections:
   a. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   b. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells.
      1) Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
      2) Perform tests by fall-of-potential method according to IEEE 81.
   c. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
3. Report measured ground resistances that exceed the following values:
   a. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
   b. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
   c. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
   d. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 **OR** 3, **as directed,** ohm(s).
   e. Substations and Pad-Mounted Equipment: 5 ohms.
   f. Manhole Grounds: 10 ohms.
4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify the Owner promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26 00

Task	Specification	Specification Description
26 05 26 00	01 22 16 00	No Specification Required
26 05 26 00	13 46 13 00	Lightning Protection
26 05 26 00	02 84 33 00	Overhead Electrical Distribution

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SECTION 26 05 29 00 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for hangers and supports for electrical systems. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Hangers and supports for electrical equipment and systems.
      b. Construction requirements for concrete bases.

C. Definitions
   1. EMT: Electrical metallic tubing.
   2. IMC: Intermediate metal conduit.
   3. RMC: Rigid metal conduit.

D. Performance Requirements
   1. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
   2. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
   3. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
   4. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

E. Submittals
   1. Product Data: For the following:
      a. Steel slotted support systems.
      b. Nonmetallic slotted support systems.
   2. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
      a. Trapeze hangers. Include Product Data for components.
      b. Steel slotted channel systems. Include Product Data for components.
      c. Nonmetallic slotted channel systems. Include Product Data for components.
      d. Equipment supports.
   3. Welding certificates.

F. Quality Assurance
   1. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   2. Comply with NFPA 70.

1.2 PRODUCTS

A. Support, Anchorage, And Attachment Components

1. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   a. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   b. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
   c. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
   d. Channel Dimensions: Selected for applicable load criteria.
2. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.
   a. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
   b. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
   c. Rated Strength: Selected to suit applicable load criteria.
3. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
4. Conduit and Cable Support Devices: Steel **OR** Steel and malleable-iron, **as directed**, hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
5. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
6. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
7. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   a. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   b. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel **OR** stainless steel, **as directed**, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   c. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
   d. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
   e. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
   f. Toggle Bolts: All-steel springhead type.
   g. Hanger Rods: Threaded steel.

B. Fabricated Metal Equipment Support Assemblies
1. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
2. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

1.3 EXECUTION

A. Application
1. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
2. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by **OR** scheduled in NECA 1, where its Table 1 lists maximum

spacings less than stated in, **as directed**, NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

3. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   a. Secure raceways and cables to these supports with two-bolt conduit clamps **OR** single-bolt conduit clamps **OR** single-bolt conduit clamps using spring friction action for retention in support channel, **as directed**.
4. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

B. Support Installation
1. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
2. Raceway Support Methods: In addition to methods described in NECA 1, EMT **OR** IMC **OR** RMC, **as directed**, may be supported by openings through structure members, as permitted in NFPA 70.
3. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
4. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   a. To Wood: Fasten with lag screws or through bolts.
   b. To New Concrete: Bolt to concrete inserts.
   c. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   d. To Existing Concrete: Expansion anchor fasteners.
   e. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
   f. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts **OR** Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 **OR** Spring-tension clamps, **as directed**.
   g. To Light Steel: Sheet metal screws.
   h. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
5. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

C. Installation Of Fabricated Metal Supports
1. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
2. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
3. Field Welding: Comply with AWS D1.1/D1.1M.

D. Concrete Bases
1. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

2. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-place Concrete".
3. Anchor equipment to concrete base.
    a. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    b. Install anchor bolts to elevations required for proper attachment to supported equipment.
    c. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

E. Painting
1. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
    a. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
2. Touchup: Comply with requirements in Division 07 OR Division 09 Section(s) "High-performance Coatings" **as directed,** for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
3. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29 00

SECTION 26 05 29 00a - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for vibration and seismic controls for electrical systems. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes the following:
   a. Isolation pads.
   b. Spring isolators.
   c. Restrained spring isolators.
   d. Channel support systems.
   e. Restraint cables.
   f. Hanger rod stiffeners.
   g. Anchorage bushings and washers.

C. Definitions

1. The IBC: International Building Code.
2. ICC-ES: ICC-Evaluation Service.
3. OSHPD: Office of Statewide Health Planning and Development for the State of California.

D. Performance Requirements

1. Seismic-Restraint Loading:
   a. Site Class as Defined in the IBC: A **OR** B **OR** C **OR** D **OR** E **OR** F, **as directed**.
   b. Assigned Seismic Use Group or Building Category as Defined in the IBC: I **OR** II **OR** III, **as directed**.
      1) Component Importance Factor: 1.0 **OR** 1.5, **as directed**.
      2) Component Response Modification Factor: 1.5 **OR** 2.5 **OR** 3.5 **OR** 5.0, **as directed**.
      3) Component Amplification Factor: 1.0 **OR** 2.5, **as directed**.
   c. Design Spectral Response Acceleration at Short Periods (0.2 Second): As required to meet Project requirements.
   d. Design Spectral Response Acceleration at 1.0-Second Period: As required to meet Project requirements.

E. Submittals

1. Product Data: For the following:
   a. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
   b. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
      1) Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES **OR** OSHPD **OR** an agency acceptable to authorities having jurisdiction, **as directed**.
      2) Annotate to indicate application of each product submitted and compliance with requirements.
   c. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.
2. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

a. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.
   1) Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other Division 22 for equipment mounted outdoors.
b. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
c. Field-fabricated supports.
d. Seismic-Restraint Details:
   1) Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
   2) Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
   3) Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES **OR** OSHPD **OR** an agency acceptable to authorities having jurisdiction, **as directed**, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

3. Welding certificates.
4. Field quality-control test reports.

F. Quality Assurance
1. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
2. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
3. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
4. Comply with NFPA 70.

1.2 PRODUCTS

A. Vibration Isolators
1. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
   a. Resilient Material: Oil- and water-resistant neoprene **OR** rubber **OR** hermetically sealed compressed fiberglass, **as directed**.
2. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
   a. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   b. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   c. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   d. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

e. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- (6-mm-) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig (3447 kPa).
f. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

3. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
   a. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
   b. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
   c. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   d. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   e. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   f. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

B. Seismic-Restraint Devices
1. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an evaluation service member of ICC-ES **OR** OSHPD **OR** an agency acceptable to authorities having jurisdiction, **as directed**.
   a. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
2. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
3. Restraint Cables: ASTM A 603 galvanized-steel **OR** ASTM A 492 stainless-steel, **as directed**, cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
4. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections **OR** Reinforcing steel angle clamped, **as directed**, to hanger rod. Do not weld stiffeners to rods.
5. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.
6. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.
7. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
8. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
9. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

C. Factory Finishes

1. Finish:
   a. Manufacturer's standard prime-coat finish ready for field painting.
   b. Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
      1) Powder coating on springs and housings.
      2) All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
      3) Baked enamel or powder coat for metal components on isolators for interior use.
      4) Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

1.3 EXECUTION

A. Applications
   1. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an evaluation service member of ICC-ES **OR** OSHPD **OR** an agency acceptable to authorities having jurisdiction, **as directed**.
   2. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
   3. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

B. Seismic-Restraint Device Installation
   1. Equipment and Hanger Restraints:
      a. Install restrained isolators on electrical equipment.
      b. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
      c. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES **OR** OSHPD **OR** an agency acceptable to authorities having jurisdiction, **as directed**, providing required submittals for component.
   2. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
   3. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
   4. Drilled-in Anchors:
      a. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
      b. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
      c. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
      d. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
      e. Set anchors to manufacturer's recommended torque, using a torque wrench.
      f. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

C. Accommodation Of Differential Seismic Motion
1. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

D. Field Quality Control
1. Tests and Inspections:
a. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
b. Schedule test with the Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
c. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
d. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
e. Test to 90 percent of rated proof load of device.
f. Measure isolator restraint clearance.
g. Measure isolator deflection.
h. Verify snubber minimum clearances.
i. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
2. Remove and replace malfunctioning units and retest as specified above.
3. Prepare test and inspection reports.

E. Adjusting
1. Adjust isolators after isolated equipment is at operating weight.
2. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
3. Adjust active height of spring isolators.
4. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 26 05 29 00a

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Task	Specification	Specification Description
26 05 29 00	01 22 16 00	No Specification Required
26 05 29 00	05 12 23 00	Cold-Formed Metal Framing
26 05 29 00	05 50 00 00	Metal Fabrications
26 05 33 13	26 05 00 00	Common Work Results for Electrical
26 05 33 13	26 05 19 16	Common Work Results for Communications
26 05 33 13	26 05 19 16a	Common Work Results for Electronic Safety and Security
26 05 33 13	26 05 19 16b	Electrical Renovation
26 05 33 13	26 05 13 16	Conductors And Cables
26 05 33 13	26 05 19 16d	Communications Equipment Room Fittings
26 05 33 13	26 05 19 16e	Communications Backbone Cabling
26 05 33 13	26 05 19 16f	Communications Horizontal Cabling
26 05 33 13	26 05 19 16g	Conductors and Cables for Electronic Safety and Security

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SECTION 26 05 33 16 - RACEWAYS AND BOXES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of raceways and boxes. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

C. Definitions
   1. EMT: Electrical metallic tubing.
   2. ENT: Electrical nonmetallic tubing.
   3. EPDM: Ethylene-propylene-diene terpolymer rubber.
   4. FMC: Flexible metal conduit.
   5. IMC: Intermediate metal conduit.
   6. LFMC: Liquidtight flexible metal conduit.
   7. LFNC: Liquidtight flexible nonmetallic conduit.
   8. NBR: Acrylonitrile-butadiene rubber.
   9. RNC: Rigid nonmetallic conduit.

D. Submittals
   1. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
   2. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
      a. Custom enclosures and cabinets.
      b. For handholes and boxes for underground wiring, including the following:
         1) Duct entry provisions, including locations and duct sizes.
         2) Frame and cover design.
         3) Grounding details.
         4) Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
         5) Joint details.
   3. Samples: For each type of exposed finish required for wireways, nonmetallic wireways and surface raceways, prepared on Samples of size indicated below.
   4. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
      a. Structural members in the paths of conduit groups with common supports.
      b. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.
   5. Manufacturer Seismic Qualification Certification: Submit certification that enclosures and cabinets and their mounting provisions, including those for internal components, will withstand seismic forces defined in Division 26 Section(s) "Hangers And Supports For Electrical Systems" AND "Vibration And Seismic Controls For Electrical Systems". Include the following:
      a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
         1) The term "withstand" means "the cabinet or enclosure will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will retain its enclosure characteristics, including its interior accessibility, after the seismic event."

   b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
6. Qualification Data: For professional engineer and testing agency.
7. Source quality-control test reports.

E. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. Comply with NFPA 70.

1.2 PRODUCTS

A. Metal Conduit And Tubing
1. Rigid Steel Conduit: ANSI C80.1.
2. Aluminum Rigid Conduit: ANSI C80.5.
3. IMC: ANSI C80.6.
4. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit **OR** IMC, **as directed**.
   a. Comply with NEMA RN 1.
   b. Coating Thickness: 0.040 inch (1 mm), minimum.
5. EMT: ANSI C80.3.
6. FMC: Zinc-coated steel **OR** Aluminum **OR** Zinc-coated steel or aluminum, **as directed**.
7. LFMC: Flexible steel conduit with PVC jacket.
8. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
   a. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
   b. Fittings for EMT: Steel **OR** Die-cast, **as directed**, set-screw **OR** compression, **as directed**, type.
   c. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
9. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

B. Nonmetallic Conduit And Tubing
1. ENT: NEMA TC 13.
2. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
3. LFNC: UL 1660.
4. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.
5. Fittings for LFNC: UL 514B.

C. Optical Fiber/Communications Cable Raceway And Fittings
1. Description: Comply with UL 2024; flexible type, approved for plenum **OR** riser **OR** general-use, **as directed**, installation.

D. Metal Wireways
1. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1 **OR** 12 **OR** 3R, **as directed**, unless otherwise indicated.
2. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

3. Wireway Covers: Hinged type **OR** Screw-cover type **OR** Flanged-and-gasketed type **OR** As indicated, **as directed**.
4. Finish: Manufacturer's standard enamel finish.

E. Nonmetallic Wireways
1. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.
   OR
   Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
2. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

F. Surface Raceways
1. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected **OR** Prime coating, ready for field painting, **as directed**.
2. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected from manufacturer's standard **OR** custom, **as directed**, colors.

G. Boxes, Enclosures, And Cabinets
1. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
2. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy **OR** aluminum, **as directed**, Type FD, with gasketed cover.
3. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
4. Metal Floor Boxes: Cast metal **OR** Sheet metal, **as directed**, fully adjustable **OR** semi-adjustable, **as directed**, rectangular.
5. Nonmetallic Floor Boxes: Nonadjustable, round.
6. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
7. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum **OR** galvanized, cast iron, **as directed**, with gasketed cover.
8. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
   a. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   b. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint, **as directed**.
9. Cabinets:
   a. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
   b. Hinged door in front cover with flush latch and concealed hinge.
   c. Key latch to match panelboards.
   d. Metal barriers to separate wiring of different systems and voltage.
   e. Accessory feet where required for freestanding equipment.

H. Handholes And Boxes For Exterior Underground Wiring
1. Description: Comply with SCTE 77.
   a. Color of Frame and Cover: Gray **OR** Green **as directed**.
   b. Configuration: Units shall be designed for flush burial and have open **OR** closed **OR** integral closed, **as directed**, bottom, unless otherwise indicated.
   c. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
   d. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   e. Cover Legend: Molded lettering, "ELECTRIC" **OR** "TELEPHONE" **OR** as indicated for each service, **as directed**.

f. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
g. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.
3. Fiberglass Handholes and Boxes with Polymer-Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester-resin enclosure joined to polymer-concrete top ring or frame.
4. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of polymer concrete **OR** reinforced concrete **OR** cast iron **OR** hot-dip galvanized-steel diamond plate **OR** fiberglass, **as directed**.

I. Sleeves For Raceways
1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
3. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch (1.3- or 3.5-mm) thickness as indicated and of length to suit application.
4. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".

J. Sleeve Seals
1. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
a. Sealing Elements: EPDM **OR** NBR, **as directed**, interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
b. Pressure Plates: Plastic **OR** Carbon steel **OR** Stainless steel, **as directed**. Include two for each sealing element.
c. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating **OR** Stainless steel, **as directed**, of length required to secure pressure plates to sealing elements. Include one for each sealing element.

K. Source Quality Control For Underground Enclosures
1. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
a. Tests of materials shall be performed by a independent testing agency.
b. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
c. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

1.3 EXECUTION

A. Raceway Application
1. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
a. Exposed Conduit: Rigid steel conduit **OR** IMC **OR** RNC, Type EPC-40-PVC **OR** RNC, Type EPC-80-PVC, **as directed**.
b. Concealed Conduit, Aboveground: Rigid steel conduit **OR** IMC **OR** EMT **OR** RNC, Type EPC-40-PVC, **as directed**.
c. Underground Conduit: RNC, Type EPC-40 **OR** 80, **as directed**,-PVC, direct buried.

d. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC **OR** LFNC, **as directed**.
e. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R **OR** 4, **as directed**.
f. Application of Handholes and Boxes for Underground Wiring:
1) Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete **OR** Fiberglass enclosures with polymer-concrete frame and cover **OR** Fiberglass-reinforced polyester resin, **as directed**, SCTE 77, Tier 15 structural load rating.
2) Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer-concrete units **OR** Heavy-duty fiberglass units with polymer-concrete frame and cover, **as directed**, SCTE 77, Tier 8 structural load rating.
3) Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.

2. Comply with the following indoor applications, unless otherwise indicated:
a. Exposed, Not Subject to Physical Damage: EMT **OR** ENT **OR** RNC, **as directed**.
b. Exposed, Not Subject to Severe Physical Damage: EMT **OR** RNC identified for such use, **as directed**.
c. Exposed and Subject to Severe Physical Damage: Rigid steel conduit **OR** IMC, **as directed**. Includes raceways in the following locations:
1) Loading dock.
2) Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
3) Mechanical rooms.
d. Concealed in Ceilings and Interior Walls and Partitions: EMT **OR** ENT **OR** RNC, Type EPC-40-PVC, **as directed**.
e. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
f. Damp or Wet Locations: Rigid steel conduit **OR** IMC, **as directed**.
g. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical fiber/communications cable raceway **OR** EMT, **as directed**.
h. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: Riser-type, optical fiber/communications cable raceway **OR** EMT, **as directed**.
i. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: General-use, optical fiber/communications cable raceway **OR** Riser-type, optical fiber/communications cable raceway **OR** Plenum-type, optical fiber/communications cable raceway **OR** EMT, **as directed**.
j. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel **OR** nonmetallic, **as directed**, in damp or wet locations.

3. Minimum Raceway Size: 1/2-inch (16-mm) **OR** 3/4-inch (21-mm), **as directed**, trade size.
4. Raceway Fittings: Compatible with raceways and suitable for use and location.
a. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
b. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.
5. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
6. Do not install aluminum conduits in contact with concrete.

B. Installation
1. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
2. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

3. Complete raceway installation before starting conductor installation.
4. Support raceways as specified in Division 26 Section(s) "Hangers And Supports For Electrical Systems" AND "Vibration And Seismic Controls For Electrical Systems".
5. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
6. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
7. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
8. Raceways Embedded in Slabs:
    a. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
    b. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
    c. Change from ENT to RNC, Type EPC-40-PVC, rigid steel conduit, or IMC before rising above the floor.
9. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
10. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
11. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.
12. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:
    a. 3/4-Inch (19-mm) Trade Size and Smaller: Install raceways in maximum lengths of 50 feet (15 m).
    b. 1-Inch (25-mm) Trade Size and Larger: Install raceways in maximum lengths of 75 feet (23 m).
    c. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
13. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
    a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
    b. Where otherwise required by NFPA 70.
14. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m).
    a. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
        1) Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
        2) Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
        3) Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
        4) Attics: 135 deg F (75 deg C) temperature change.
    b. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change.

c. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

15. Flexible Conduit Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures, **as directed**, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
    a. Use LFMC in damp or wet locations subject to severe physical damage.
    b. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
16. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.
17. Set metal floor boxes level and flush with finished floor surface.
18. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

C. Installation Of Underground Conduit
1. Direct-Buried Conduit:
    a. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
    b. Install backfill as specified in Division 31 Section "Earth Moving"
    c. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving".
    d. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
    OR
    Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
        1) Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
        OR
        For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
    e. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits, placing them 24 inches (600 mm) o.c. Align planks along the width and along the centerline of conduit.

D. Installation Of Underground Handholes And Boxes
1. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
2. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
3. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.
4. Install handholes and boxes with bottom below the frost line, <**Insert depth of frost line below grade at Project site**> below grade.
5. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

6. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

E. Sleeve Installation For Electrical Penetrations
   1. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".
   2. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
   3. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
   4. Rectangular Sleeve Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side greater than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
      b. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches (1270 mm) and 1 or more sides equal to, or greater than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).
   5. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
   6. Cut sleeves to length for mounting flush with both surfaces of walls.
   7. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.
   8. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway unless sleeve seal is to be installed or unless seismic criteria require different clearance.
   9. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies, **as directed**.
   10. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
   11. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 07 Section "Penetration Firestopping".
   12. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.
   13. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   14. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway and sleeve for installing mechanical sleeve seals.

F. Sleeve-Seal Installation
   1. Install to seal underground, exterior wall penetrations.
   2. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

G. Firestopping
   1. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping".

H. Protection
   1. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Final Completion.

a. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
b. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33 16

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SECTION 26 05 33 16a - WIRING DEVICES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of wiring devices. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Receptacles, receptacles with integral GFCI, and associated device plates.
      b. Twist-locking receptacles.
      c. Receptacles with integral surge suppression units.
      d. Wall-box motion sensors.
      e. Isolated-ground receptacles.
      f. Hospital-grade receptacles.
      g. Snap switches and wall-box dimmers.
      h. Solid-state fan speed controls.
      i. Wall-switch and exterior occupancy sensors.
      j. Communications outlets.
      k. Pendant cord-connector devices.
      l. Cord and plug sets.
      m. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

C. Definitions
   1. EMI: Electromagnetic interference.
   2. GFCI: Ground-fault circuit interrupter.
   3. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
   4. RFI: Radio-frequency interference.
   5. TVSS: Transient voltage surge suppressor.
   6. UTP: Unshielded twisted pair.

D. Submittals
   1. Product Data: For each type of product indicated.
   2. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
   3. Samples: One for each type of device and wall plate specified, in each color specified.
   4. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

E. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   2. Comply with NFPA 70.

1.2 PRODUCTS

A. Straight Blade Receptacles
   1. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

2. Hospital-Grade, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498 Supplement SD.
3. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
   a. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.
4. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
   a. Description: Labeled to comply with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

B. GFCI Receptacles
1. General Description: Straight blade, feed **OR** non-feed, **as directed**,-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.
2. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
3. Hospital-Grade, Duplex GFCI Convenience Receptacles, 125 V, 20 A: Comply with UL 498 Supplement SD.

C. TVSS Receptacles
1. General Description: Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 1449, with integral TVSS in line to ground, line to neutral, and neutral to ground.
   a. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 volts and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
   b. Active TVSS Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."
2. Duplex TVSS Convenience Receptacles:
   a. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R.
3. Isolated-Ground, Duplex Convenience Receptacles:
   a. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.
4. Hospital-Grade, Duplex Convenience Receptacles: Comply with UL 498 Supplement SD.
   a. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R.
5. Isolated-Ground, Hospital-Grade, Duplex Convenience Receptacles:
   a. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R. Comply with UL 498 Supplement SD. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

D. Hazardous (Classified) Location Receptacles
1. Available Wiring Devices for Hazardous (Classified) Locations: Comply with NEMA FB 11 and UL 1010.

E. Twist-Locking Receptacles
1. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.
2. Isolated-Ground, Single Convenience Receptacles, 125 V, 20 A:
   a. Description: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498. Equipment grounding contacts shall be connected only to the green grounding screw

terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

F. Pendant Cord-Connector Devices
1. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.
a. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
b. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

G. Cord And Plug Sets
1. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
a. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
b. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

H. Snap Switches
1. Comply with NEMA WD 1 and UL 20.
2. Switches, 120/277 V, 20 A:
3. Pilot Light Switches, 20 A:
a. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."
4. Key-Operated Switches, 120/277 V, 20 A:
a. Description: Single pole, with factory-supplied key in lieu of switch handle.
5. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.
6. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

I. Wall-Box Dimmers
1. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
2. Control: Continuously adjustable slider **OR** toggle switch **OR** rotary knob, **as directed**; with single-pole or three-way switching. Comply with UL 1472.
3. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.
a. 600 W; dimmers shall require no derating when ganged with other devices. Illuminated when "OFF," **as directed**.
4. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

J. Fan Speed Controls
1. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters. Comply with UL 1917.
a. Continuously adjustable slider **OR** toggle switch **OR** rotary knob, **as directed**, 5 A **OR** 1.5 A, **as directed**.
b. Three-speed adjustable slider **OR** rotary knob, **as directed**, 1.5 A.

K. Occupancy Sensors
1. Wall-Switch Sensors:

a. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).

2. Wall-Switch Sensors:
   a. Description: Adaptive-technology type, 120/277 V, adjustable time delay up to 20 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).
3. Long-Range Wall-Switch Sensors:
   a. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, with a minimum coverage area of 1200 sq. ft. (111 sq. m).
4. Long-Range Wall-Switch Sensors:
   a. Description: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, and a minimum coverage area of 1200 sq. ft. (111 sq. m).
5. Wide-Range Wall-Switch Sensors:
   a. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 150-degree field of view, with a minimum coverage area of 1200 sq. ft. (111 sq. m).
6. Exterior Occupancy Sensors:
   a. Description: Passive-infrared type, 120/277 V, weatherproof, adjustable time delay up to 15 minutes, 180-degree field of view, and 110-foot (34-m) detection range. Minimum switch rating: 1000-W incandescent, 500-VA fluorescent.

L. Communications Outlets
1. Telephone Outlet:
   a. Description: Single RJ-45 jack for terminating 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e. Comply with UL 1863.
2. Combination TV and Telephone Outlet:
   a. Description: Single RJ-45 jack for 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e; and one Type F coaxial cable connector.

M. Wall Plates
1. Single and combination types to match corresponding wiring devices.
   a. Plate-Securing Screws: Metal with head color to match plate finish.
   b. Material for Finished Spaces: Steel with white baked enamel, suitable for field painting **OR** Smooth, high-impact thermoplastic **OR** 0.035-inch- (1-mm-) thick, satin-finished stainless steel **OR** 0.04-inch- (1-mm-) thick, brushed brass with factory polymer finish **OR** 0.05-inch- (1.2-mm-) thick anodized aluminum **OR** 0.04-inch- (1-mm-) thick steel with chrome-plated finish, **as directed**.
   c. Material for Unfinished Spaces: Galvanized steel **OR** Smooth, high-impact thermoplastic, **as directed**.
   d. Material for Damp Locations: Thermoplastic **OR** Cast aluminum, **as directed**, with spring-loaded lift cover, and listed and labeled for use in "wet locations."
2. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum **OR** thermoplastic, **as directed**, with lockable cover.

N. Floor Service Fittings
1. Type: Modular, flush-type **OR** flap-type **OR** above-floor, **as directed**, dual-service units suitable for wiring method used.
2. Compartments: Barrier separates power from voice and data communication cabling.
3. Service Plate: Rectangular **OR** Round, **as directed**, die-cast aluminum **OR** solid brass, **as directed**, with satin finish.
4. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.
5. Voice and Data Communication Outlet: Blank cover with bushed cable opening **OR** Two modular, keyed, color-coded, RJ-45 Category 5e jacks for UTP cable, **as directed**.

O. Poke-Through Assemblies

1. Description: Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.
   a. Service Outlet Assembly: Pedestal type with services indicated **OR** Flush type with two simplex receptacles and space for two RJ-45 jacks **OR** Flush type with four simplex receptacles and space for four RJ-45 jacks, **as directed**.
   b. Size: Selected to fit nominal 3-inch (75-mm) **OR** 4-inch (100-mm), **as directed**, cored holes in floor and matched to floor thickness.
   c. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
   d. Closure Plug: Arranged to close unused 3-inch (75-mm) **OR** 4-inch (100-mm), **as directed**, cored openings and reestablish fire rating of floor.
   e. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of two **OR** four, **as directed**, 4-pair, Category 5e voice and data communication cables.

P. Multioutlet Assemblies
1. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
2. Raceway Material: Metal, with manufacturer's standard finish **OR** PVC, **as directed**.
3. Wire: No. 12 AWG.

Q. Service Poles
1. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.
   a. Poles: Nominal 2.5-inch- (65-mm-) square cross section, with height adequate to extend from floor to at least 6 inches (150 mm) above ceiling, and with separate channels for power wiring and voice and data communication cabling.
   b. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
   c. Finishes: Manufacturer's standard painted finish and trim combination **OR** Satin-anodized aluminum, **as directed**.
   d. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, 4-pair, Category 3 or 5 voice and data communication cables.
   e. Power Receptacles: Two duplex, 20-A, heavy-duty, NEMA WD 6 configuration 5-20R units.
   f. Voice and Data Communication Outlets: Blank insert with bushed cable opening **OR** Two RJ-45 Category 5e jacks **OR** Four RJ-45 Category 5e jacks, **as directed**.

R. Finishes
1. Color: Wiring device catalog numbers in Section Text do not designate device color.
   a. Wiring Devices Connected to Normal Power System: Almond **OR** Black **OR** Brown **OR** Gray **OR** Ivory **OR** White **OR** As selected, **as directed**, unless otherwise indicated or required by NFPA 70 or device listing.
   b. Wiring Devices Connected to Emergency Power System: Red.
   c. TVSS Devices: Blue.
   d. Isolated-Ground Receptacles: Orange **OR** As specified above, with orange triangle on face, **as directed**.

1.3 EXECUTION

A. Installation
1. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
2. Coordination with Other Trades:

a. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
b. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
c. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
d. Install wiring devices after all wall preparation, including painting, is complete.

3. Conductors:
   a. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
   b. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
   c. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
   d. Existing Conductors:
      1) Cut back and pigtail, or replace all damaged conductors.
      2) Straighten conductors that remain and remove corrosion and foreign matter.
      3) Pigtailing existing conductors is permitted provided the outlet box is large enough.
4. Device Installation:
   a. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
   b. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
   c. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
   d. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
   e. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
   f. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
   g. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
   h. Tighten unused terminal screws on the device.
   i. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
5. Receptacle Orientation:
   a. Install ground pin of vertically mounted receptacles up **OR** down, **as directed**, and on horizontally mounted receptacles to the right **OR** left, **as directed**.
   b. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.
6. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
7. Dimmers:
   a. Install dimmers within terms of their listing.
   b. Verify that dimmers used for fan speed control are listed for that application.
   c. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
8. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
9. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

B. Identification
1. Comply with Division 26 Section "Identification For Electrical Systems".
    a. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black **OR** white **OR** red, **as directed**,-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

C. Field Quality Control
1. Perform tests and inspections and prepare test reports.
    a. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
    b. Test Instruments: Use instruments that comply with UL 1436.
    c. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
2. Tests for Convenience Receptacles:
    a. Line Voltage: Acceptable range is 105 to 132 V.
    b. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
    c. Ground Impedance: Values of up to 2 ohms are acceptable.
    d. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
    e. Using the test plug, verify that the device and its outlet box are securely mounted.
    f. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
3. Test straight blade convenience outlets in patient-care areas **OR** hospital-grade convenience outlets, **as directed**, for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz. (115 g).

END OF SECTION 26 05 33 16a

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Task	Specification	Specification Description
26 05 33 16	26 05 19 16b	Electrical Renovation
26 05 33 23	26 05 33 16	Raceways And Boxes
26 05 33 23	26 05 19 13	Underfloor Raceways For Electrical Systems

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SECTION 26 05 36 00 - CABLE TRAYS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of cable trays. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes steel, aluminum, stainless-steel, and fiberglass cable trays and accessories.

C. Submittals
1. Product Data: Include data indicating dimensions and finishes for each type of cable tray indicated.
2. Shop Drawings: For each type of cable tray.
   a. Show fabrication and installation details of cable tray, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
   b. Seismic-Restraint Details, **as directed**: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
      1) Design Calculations: Calculate requirements for selecting seismic restraints.
      2) Detail fabrication, including anchorages and attachments to structure and to supported cable trays.
3. Field quality-control reports.
4. Operation and Maintenance Data.

D. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. Comply with NFPA 70.

E. Delivery, Storage, And Handling
1. Steel cable tray, hot dip galvanized after fabrication, **OR** Aluminum cable tray **OR** Stainless-steel cable tray **OR** Fiberglass cable tray, ,**as directed** may be stored outside without cover, but shall be loosely stacked, elevated off the ground, and ventilated to prevent staining during storage.
2. Store indoors to prevent water or other foreign materials from staining or adhering to cable tray. Unpack and dry wet materials before storage.
3. Steel, mill galvanized **OR** electrogalvanized **OR** factory-primed, **as directed**, cable tray shall be stored in a well-ventilated, dry location. Unpack and dry wet materials before storage.
4. PVC-coated **OR** Field-painted, **as directed**, cable tray shall be stored indoors. Protect cable tray from scratching and marring of finish. Unpack and dry wet materials before storage.

1.2 PRODUCTS

A. Materials And Finishes
1. Cable Trays, Fittings, and Accessories: Steel, complying with NEMA VE 1.

a. Factory-standard primer, ready for field painting; with cadmium-plated hardware according to ASTM B 766.
b. Mill galvanized before fabrication, complying with ASTM A 653/A 653M, G90 (Z275) coating; with hardware galvanized according to ASTM B 633 **OR** cadmium plated according to ASTM B 766, **as directed**.
c. Electrogalvanized before fabrication, complying with ASTM B 633; with hardware galvanized according to ASTM B 633.
d. Hot-dip galvanized after fabrication, complying with ASTM A 123/A 123M, Class B2; with chromium-zinc, ASTM F 1136, **OR** Type 316 stainless-steel, **as directed**, hardware.
e. PVC coating applied in a fluidized bed or by electrostatic spray; with chromium-zinc, ASTM F 1136 **OR** Type 316 stainless-steel, **as directed**, hardware.
f. Epoxy-resin paint over paint manufacturer's recommended primer and corrosion-inhibiting treatment; with cadmium-plated hardware according to ASTM B 766 **OR** Type 316 stainless-steel hardware, **as directed**.

2. Cable Trays, Fittings, and Accessories: Aluminum, complying with NEMA VE 1, Aluminum Association's Alloy 6063-T6 for rails, rungs, and cable trays, and Alloy 5052-H32 or Alloy 6061-T6 for fabricated parts; with chromium-zinc, ASTM F 1136, **OR** Type 316 stainless-steel, **as directed**, splice-plate fasteners, bolts, and screws
3. Cable Trays, Fittings, and Accessories: Stainless steel, Type 304 **OR** 316, **as directed**, complying with NEMA VE 1.
4. Cable Trays, Fittings, and Accessories: Fiberglass, complying with NEMA FG 1 and UL 568. Splice-plate fasteners, bolts, and screws shall be fiberglass-encapsulated stainless steel. Design fasteners so that no metal is visible when fully assembled and tightened. Fastener encapsulation shall not be damaged when torqued to manufacturer's recommended value.
5. Sizes and Configurations: Refer to the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.
   a. Center-hanger supports may be used only when specifically indicated.

B. Cable Tray Accessories
1. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
2. Covers: Solid **OR** Louvered **OR** Ventilated-hat **OR** 2-in-3 pitch cover, **as directed**, type of same materials and finishes as cable tray.
3. Barrier Strips: Same materials and finishes as cable tray.
4. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

C. Warning Signs
1. Lettering: 1-1/2-inch- (40-mm-) high, black letters on yellow background with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."
2. Materials and fastening are specified in Division 26 Section "Identification For Electrical Systems".

1.3 EXECUTION

A. Cable Tray Installation
1. Comply with recommendations in NEMA VE 2. Install as a complete system, including all necessary fasteners, hold-down clips, splice-plate support systems, barrier strips, hinged horizontal and vertical splice plates, elbows, reducers, tees, and crosses.
2. Remove burrs and sharp edges from cable trays.
3. Fasten cable tray supports to building structure and install seismic restraints, **as directed**.

a. Design each fastener and support to carry load indicated by seismic requirements and to comply with seismic-restraint details according to Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
b. Place supports so that spans do not exceed maximum spans on schedules.
c. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
d. Support bus assembly to prevent twisting from eccentric loading.
e. Manufacture center-hung support, designed for 60 percent versus 40 percent eccentric loading condition, with a safety factor of 3.
f. Locate and install supports according to NEMA FG 1 **OR** NEMA VE 1, **as directed**.

4. Make connections to equipment with flanged fittings fastened to cable tray and to equipment. Support cable tray independent of fittings. Do not carry weight of cable tray on equipment enclosure.
5. Install expansion connectors where cable tray crosses building expansion joint and in cable tray runs that exceed dimensions recommended in NEMA FG 1 **OR** NEMA VE 1, **as directed**. Space connectors and set gaps according to applicable standard.
6. Make changes in direction and elevation using standard fittings.
7. Make cable tray connections using standard fittings.
8. Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping".
9. Sleeves for Future Cables: Install capped sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
10. Workspace: Install cable trays with enough space to permit access for installing cables.
11. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.
12. After installation of cable trays is completed, install warning signs in visible locations on or near cable trays.

B. Cable Installation
1. Install cables only when cable tray installation has been completed and inspected.
2. Fasten cables on horizontal runs with cable clamps or cable ties as recommended by NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.
3. On vertical runs, fasten cables to tray every 18 inches (457 mm). Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
4. In existing construction, remove inactive or dead cables from cable tray.
5. Install covers after installation of cable is completed.

C. Connections
1. Ground cable trays according to manufacturer's written instructions.
2. Install an insulated equipment grounding conductor with cable tray, in addition to those required by NFPA 70.

D. Field Quality Control
1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements. Perform the following field quality-control survey:
a. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable tray, vibration, and thermal expansion and contraction conditions, which may cause or have caused damage.
b. Verify that the number, size, and voltage of cables in cable tray do not exceed that permitted by NFPA 70. Verify that communication or data-processing circuits are separated from power circuits by barriers.
c. Verify that there is no intrusion of such items as pipe, hangers, or other equipment that could damage cables.

d. Remove deposits of dust, industrial process materials, trash of any description, and any blockage of tray ventilation.
e. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
f. Check for missing or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
g. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable tray.

2. Report results in writing.

E. Protection
1. Protect installed cable trays.
a. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
b. Repair damage to PVC or paint finishes with matching touchup coating recommended by cable tray manufacturer.
c. Install temporary protection for cables in open trays to protect exposed cables from falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials until the risk of damage is over.

END OF SECTION 26 05 36 00

Task	Specification	Specification Description
26 05 39 00	26 05 19 13	Underfloor Raceways For Electrical Systems
26 05 46 00	02 84 33 00	Overhead Electrical Distribution

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SECTION 26 05 53 00 - ELECTRICAL IDENTIFICATION

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for electrical identification. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Identification for raceways.
   b. Identification of power and control cables.
   c. Identification for conductors.
   d. Underground-line warning tape.
   e. Warning labels and signs.
   f. Instruction signs.
   g. Equipment identification labels.
   h. Miscellaneous identification products.

C. Submittals

1. Product Data: For each electrical identification product indicated.
2. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.
3. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

D. Quality Assurance

1. Comply with ANSI A13.1 and IEEE C2, **as directed**.
2. Comply with NFPA 70.
3. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
4. Comply with ANSI Z535.4 for safety signs and labels.
5. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.2 PRODUCTS

A. Power Raceway Identification Materials

1. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
2. Colors for Raceways Carrying Circuits at 600 V or Less:
   a. Black letters on an orange field.
   b. Legend: Indicate voltage and system or service type, **as directed**.
3. Colors for Raceways Carrying Circuits at More Than 600 V:
   a. Black letters on an orange field.
   b. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- (75-mm-) high letters on 20-inch (500-mm) centers.
4. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

5. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
6. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
7. Tape and Stencil for Raceways Carrying Circuits More Than 600 V: 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers diagonally over orange background that extends full length of raceway or duct and is 12 inches (300 mm) wide. Stop stripes at legends.
8. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.
9. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) **OR** 0.015 inch (0.38 mm), **as directed**, thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
   a. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
      OR
      Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

B. Armored And Metal-Clad Cable Identification Materials
1. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
2. Colors for Raceways Carrying Circuits at 600 V and Less:
   a. Black letters on an orange field.
   b. Legend: Indicate voltage and system or service type, **as directed**.
3. Colors for Raceways Carrying Circuits at More Than 600 V:
   a. Black letters on an orange field.
   b. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- (75-mm-) high letters on 20-inch (500-mm) centers.
4. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
   OR
   Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

C. Power And Control Cable Identification Materials
1. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
2. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
3. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.
4. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) **OR** 0.015 inch (0.38 mm), **as directed**, thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
   a. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
      OR
      Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.
5. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

6. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Conductor Identification Materials
1. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.
2. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
3. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
4. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
5. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
6. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) **OR** 0.015 inch (0.38 mm), **as directed**, thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
   a. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
   OR
   Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

E. Floor Marking Tape
1. 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

F. Underground-Line Warning Tape
1. Tape:
   a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
   b. Printing on tape shall be permanent and shall not be damaged by burial operations.
   c. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
2. Color and Printing:
   a. Comply with ANSI Z535.1 through ANSI Z535.5.
   b. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
   c. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.
3. Tag: Type I:
   a. Pigmented polyolefin, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
   b. Thickness: 4 mils (0.1 mm).
   c. Weight: 18.5 lb/1000 sq. ft. (9.0 kg/100 sq. m).
   d. 3-Inch (75-mm) Tensile According to ASTM D 882: 30 lbf (133.4 N), and 2500 psi (17.2 MPa).
4. Tag: Type II:
   a. Multilayer laminate consisting of high-density polyethylene scrim coated with pigmented polyolefin, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
   b. Thickness: 12 mils (0.3 mm).
   c. Weight: 36.1 lb/1000 sq. ft. (17.6 kg/100 sq. m).

d. 3-Inch (75-mm) Tensile According to ASTM D 882: 400 lbf (1780 N), and 11,500 psi (79.2 MPa).

5. Tag: Type ID:
   a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
   b. Overall Thickness: 5 mils (0.125 mm).
   c. Foil Core Thickness: 0.35 mil (0.00889 mm).
   d. Weight: 28 lb/1000 sq. ft. (13.7 kg/100 sq. m).
   e. 3-Inch (75-mm) Tensile According to ASTM D 882: 70 lbf (311.3 N), and 4600 psi (31.7 MPa).
6. Tag: Type IID:
   a. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
   b. Overall Thickness: 8 mils (0.2 mm).
   c. Foil Core Thickness: 0.35 mil (0.00889 mm).
   d. Weight: 34 lb/1000 sq. ft. (16.6 kg/100 sq. m).
   e. 3-Inch (75-mm) Tensile According to ASTM D 882: 300 lbf (1334 N), and 12,500 psi (86.1 MPa).

G. Warning Labels And Signs
1. Comply with NFPA 70 and 29 CFR 1910.145.
2. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
3. Baked-Enamel Warning Signs:
   a. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
   b. 1/4-inch (6.4-mm) grommets in corners for mounting.
   c. Nominal size, 7 by 10 inches (180 by 250 mm).
4. Metal-Backed, Butyrate Warning Signs:
   a. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
   b. 1/4-inch (6.4-mm) grommets in corners for mounting.
   c. Nominal size, 10 by 14 inches (250 by 360 mm).
5. Warning label and sign shall include, but are not limited to, the following legends:
   a. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
   b. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

H. Instruction Signs
1. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
   a. Engraved legend with black letters on white face.
   b. Punched or drilled for mechanical fasteners.
   c. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
2. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).
3. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

I. Equipment Identification Labels
1. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).
2. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.
3. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).
4. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).
5. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).

J. Cable Ties
1. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
   a. Minimum Width: 3/16 inch (5 mm).
   b. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
   c. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
   d. Color: Black except where used for color-coding.
2. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
   a. Minimum Width: 3/16 inch (5 mm).
   b. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
   c. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
   d. Color: Black.
3. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
   a. Minimum Width: 3/16 inch (5 mm).
   b. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).
   c. UL 94 Flame Rating: 94V-0.
   d. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
   e. Color: Black.

K. Miscellaneous Identification Products
1. Paint: Comply with requirements in Division 07 for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
2. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

1.3 EXECUTION

A. Installation
1. Verify identity of each item before installing identification products.
2. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
3. Apply identification devices to surfaces that require finish after completing finish work.
4. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
5. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
6. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot

(15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

7. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
8. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
   a. Outdoors: UV-stabilized nylon.
   b. In Spaces Handling Environmental Air: Plenum rated.
9. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.
10. Painted Identification: Comply with requirements in Division 07 for surface preparation and paint application.

B. Identification Schedule
1. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers over orange background that extends full length of raceway or duct and is 12 inches (300 mm) wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- (75-mm-) high black letters on 20-inch (500-mm) centers. Stop stripes at legends. Apply to the following finished surfaces:
   a. Floor surface directly above conduits running beneath and within 12 inches (300 mm) of a floor that is in contact with earth or is framed above unexcavated space.
   b. Wall surfaces directly external to raceways concealed within wall.
   c. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
2. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Self-adhesive vinyl **OR** Snap-around, **as directed**, labels. Install labels at 10-foot (3-m) **OR** 30-foot (10-m), **as directed**, maximum intervals.
3. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Identify with self-adhesive vinyl label **OR** self-adhesive vinyl tape applied in bands, **as directed**. Install labels at 10-foot (3-m) **OR** 30-foot (10-m), **as directed**, maximum intervals.
4. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
   a. Emergency Power.
   b. Power.
   c. UPS.
5. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
   a. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
      1) Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
      2) Colors for 208/120-V Circuits:
         a) Phase A: Black.
         b) Phase B: Red.
         c) Phase C: Blue.
      3) Colors for 480/277-V Circuits:
         a) Phase A: Brown.
         b) Phase B: Orange.
         c) Phase C: Yellow.
      4) Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where

splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

6. Power-Circuit Conductor Identification, More than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use write-on tags **OR** nonmetallic plastic tag holder with adhesive-backed phase tags, and a separate tag with the circuit designation, **as directed**.
7. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
8. Conductors to Be Extended in the Future: Attach write-on tags **OR** marker tape, **as directed**, to conductors and list source.
9. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
   a. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
   b. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
   c. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
10. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
    a. Limit use of underground-line warning tape to direct-buried cables.
    b. Install underground-line warning tape for both direct-buried cables and cables in raceway.
11. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
12. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels **OR** Baked-enamel warning signs **OR** Metal-backed, butyrate warning signs, **as directed**.
    a. Comply with 29 CFR 1910.145.
    b. Identify system voltage with black letters on an orange background.
    c. Apply to exterior of door, cover, or other access.
    d. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
       1) Power transfer switches.
       2) Controls with external control power connections.
13. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
14. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer **OR** load shedding, **as directed**.
15. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
    a. Labeling Instructions:
       1) Indoor Equipment: Adhesive film label **OR** Adhesive film label with clear protective overlay **OR** Self-adhesive, engraved, laminated acrylic or melamine label **OR** Engraved, laminated acrylic or melamine label, **as directed**. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
       2) Outdoor Equipment: Engraved, laminated acrylic or melamine label **OR** Stenciled legend 4 inches (100 mm) high, **as directed**.

3) Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
4) Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

b. Equipment to Be Labeled:
1) Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved **OR** engraved, **as directed**, laminated acrylic or melamine label.
2) Enclosures and electrical cabinets.
3) Access doors and panels for concealed electrical items.
4) Switchgear.
5) Switchboards.
6) Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
7) Substations.
8) Emergency system boxes and enclosures.
9) Motor-control centers.
10) Enclosed switches.
11) Enclosed circuit breakers.
12) Enclosed controllers.
13) Variable-speed controllers.
14) Push-button stations.
15) Power transfer equipment.
16) Contactors.
17) Remote-controlled switches, dimmer modules, and control devices.
18) Battery-inverter units.
19) Battery racks.
20) Power-generating units.
21) Monitoring and control equipment.
22) UPS equipment.

END OF SECTION 26 05 53 00

SECTION 26 05 53 00a - INTERCOMMUNICATIONS AND PROGRAM SYSTEMS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for intercommunications and program systems. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes: Manually switched and Microprocessor-switched intercommunications and program systems with the following components:
      a. Master stations.
      b. Speaker-microphone stations.
      c. Call-switch unit.
      d. All-call amplifier.
      e. Intercommunication amplifier.
      f. Paging amplifier.
      g. Loudspeakers/speaker microphones.
      h. Conductors and cables.
      i. Raceways.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. Shop Drawings: For intercommunications and program systems. Include plans, elevations, sections, details, and attachments to other work.
      a. Wiring Diagrams: For power, signal, and control wiring.
         1) Identify terminals to facilitate installation, operation, and maintenance.
         2) Single-line diagram showing interconnection of components.
         3) Cabling diagram showing cable routing.
   3. Field quality-control reports.
   4. Operation and maintenance data.

D. Quality Assurance
   1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
   2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   3. Comply with NFPA 70.

1.2 PRODUCTS

A. Functional Description Of Manually Switched Systems
   1. Master Station:
      a. Communicating selectively with other master and speaker-microphone stations by actuating selector switches.
      b. Communicating simultaneously with all other stations by actuating a single all-call switch.
      c. Communicating with individual stations in privacy.
      d. Including other master-station connections in a multiple-station conference call.
      e. Accessing separate paging speakers or groups of paging speakers by actuating selector switches.
      f. Overriding any conversation by a designated master station.

2. Speaker-Microphone Station:
   a. Having privacy from remote monitoring without a warning tone signal at monitored station. Designated speaker-microphone stations have a privacy switch to prevent another station from listening and to permit incoming calls.
   b. Communicating hands free.
   c. Calling master station by actuating call switch.
   d. Returning a busy signal to indicate that station is already in use.
   e. Being free of noise and distortion during operation and when in standby mode.
3. Speakers: Free of noise and distortion during operation and when in standby mode.

B. Functional Description Of Microprocessor-Switched Systems
1. Master Station:
   a. Communicating selectively with other master and speaker-microphone stations by dialing station's number on a 12-digit keypad.
   b. Communicating simultaneously with all other stations by dialing a designated number on a 12-digit keypad.
   c. Communicating with individual stations in privacy.
   d. Including other master-station connections in a multiple-station conference call.
   e. Accessing separate paging speakers or groups of paging speakers by dialing designated numbers on a 12-digit keypad.
   f. Overriding any conversation by a designated master station.
   g. Displaying selected station.
2. Speaker-Microphone Station:
   a. Having privacy from remote monitoring without a warning tone signal at monitored station. Designated speaker-microphone stations have a privacy switch to prevent another station from listening and to permit incoming calls.
   b. Communicating hands free.
   c. Calling master station by actuating call switch.
   d. Returning a busy signal to indicate that station is already in use.
   e. Being free of noise and distortion during operation and when in standby mode.
3. Speakers: Free of noise and distortion during operation and when in standby mode.

C. General Requirements For Equipment And Materials
1. Coordinate features and select components to form an integrated system. Match components and interconnections for optimum performance of specified functions.
2. Expansion Capability: Increase number of stations in the future by 25 percent above those indicated without adding any internal or external components or main trunk cable conductors.
3. Equipment: Modular type using solid-state components, fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.
4. Weather-Resistant Equipment: Listed and labeled by an NRTL for duty outdoors or in damp locations.

D. Master Station For Manually Switched Systems
1. Station-Selector and Talk-Listen Switches: Heavy-duty type with gold-plated contacts rated for five million operations.
2. Volume Control: Regulates incoming-call volume.
3. LED Annunciation: Identifies calling stations and stations in use. LED remains on until call is answered.
4. Tone Annunciation: Momentary audible tone signal announces incoming calls.
5. Speaker Microphone: Transmits and receives calls.
6. Handset with Hook Switch: Telephone type with 18-inch- (450-mm-) long, permanently coiled cord. Arrange to disconnect speaker when handset is lifted.
7. Equipment Cabinet: Comply with TIA/EIA-310-D. Lockable, ventilated metal cabinet houses terminal strips, power supplies, amplifiers, system volume control, and auxiliary equipment.

E. Master Station For Microprocessor-Switched Systems
1. 12-Digit Keypad Selector: Transmits calls to other stations and initiates commands for programming and operation.
2. Volume Control: Regulates incoming-call volume.
3. LED Annunciation: Identifies calling stations and stations in use. LED remains on until call is answered.
4. Tone Annunciation: Momentary audible tone signal announces incoming calls.
5. Handset with Hook Switch: Telephone type with 18-inch- (450-mm-) long, permanently coiled cord. Arrange to disconnect speaker when handset is lifted.
6. Reset Control: Cancels call and resets system for next call.
7. Equipment Cabinet: Comply with TIA/EIA-310-D. Lockable, ventilated metal cabinet houses terminal strips, power supplies, amplifiers, system volume control, and other switching and control devices required for conversation channels and control functions.

F. Speaker-Microphone Stations
1. Mounting: Flush unless otherwise indicated, and suitable for mounting conditions indicated.
2. Faceplate: Stainless steel or anodized aluminum with tamperproof mounting screws.
3. Back Box: Two-gang galvanized steel with 2-1/2-inch (64-mm) minimum depth.
4. Speaker: 3 inches (76 mm), 2.3 oz. (65 g) minimum; permanent magnet.
5. Tone Annunciation: Recurring momentary tone indicates incoming calls.
6. Call Switch: Mount on faceplate. Permits calls to master station.
7. Privacy Switch: Mount on faceplate. When in on position, switch prevents transmission of sound from remote station to system; when in off position, without further switch manipulation, response can be made to incoming calls.
8. Handset with Hook Switch: Telephone type with 18-inch- (450-mm-) long, permanently coiled cord. Arrange to disconnect speaker when handset is lifted.

G. Call-Switch Unit
1. Enclosure: Single-gang box with stainless-steel faceplate.
2. Call Switch: Momentary contact signals system that a call has been placed.
3. Privacy Switch: Prevents transmission of sound signals from station to system.
4. Volume Control: Operated by screwdriver blade through a hole in faceplate to adjust output level of associated speaker.
5. Handset with Hook Switch: Telephone type with 18-inch- (450-mm-) long, permanently coiled cord. Arrange to disconnect speaker when handset is lifted.

H. All-Call Amplifier
1. Output Power: 70-V balanced line. 80 percent of the sum of wattage settings of connected for each station and speaker connected in all-call mode of operation, plus an allowance for future stations.
2. Total Harmonic Distortion: Less than 5 percent at rated output power with load equivalent to quantity of stations connected in all-call mode of operation.
3. Minimum Signal-to-Noise Ratio: 45 dB, at rated output.
4. Frequency Response: Within plus or minus 3 dB from 70 to 12,000 Hz.
5. Output Regulation: Maintains output level within 2 dB from full to no load.
6. Input Sensitivity: Compatible with master stations and central equipment so amplifier delivers full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on master stations, speaker microphones, or handset transmitters.
7. Amplifier Protection: Prevents damage from shorted or open output.

I. Intercommunication Amplifier
1. Minimum Output Power: 2 W; adequate for all functions.
2. Total Harmonic Distortion: Less than 5 percent at rated output power with load equivalent to one station connected to output terminals.
3. Minimum Signal-to-Noise Ratio: 45 dB, at rated output.
4. Frequency Response: Within plus or minus 3 dB from 70 to 10,000 Hz.

5. Output Regulation: Maintains output level within 2 dB from full to no load.
6. Input Sensitivity: Matched to input circuit and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on master stations, speaker microphones, or handset transmitters.
7. Amplifier Protection: Prevents damage from shorted or open output.

J. Paging Amplifier
1. Input Voltage: 120-V ac, 60 Hz.
2. Frequency Response: Within plus or minus 3 dB from 60 to 10,000 Hz.
3. Minimum Signal-to-Noise Ratio: 60 dB, at rated output.
4. Total Harmonic Distortion: Less than 3 percent at rated power output from 70 to 12,000 Hz.
5. Output Regulation: Less than 2 dB from full to no load.
6. Controls: On-off, input levels, and low-cut filter.
7. Input Sensitivity: Matched to input circuit and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphones or handset transmitters.
8. Amplifier Protection: Prevents damage from shorted or open output.
9. Output Circuit: 70-V line.

K. Cone-Type Loudspeakers/Speaker Microphones
1. Minimum Axial Sensitivity: 91 dB at one meter, with 1-W input.
2. Frequency Response: Within plus or minus 3 dB from 70 to 15,000 Hz.
3. Minimum Dispersion Angle: 100 degrees.
4. Line Transformer: Maximum insertion loss of 0.5 dB, power rating equal to speaker's, and at least four level taps.
5. Enclosures: Steel housings or back boxes, acoustically dampened, with front face of at least 0.0478-inch (1.2-mm) steel and whole assembly rust proofed and factory primed; complete with mounting assembly and suitable for surface ceiling, flush ceiling, pendant or wall mounting; with relief of back pressure.
6. Baffle: For flush speakers, minimum thickness of 0.032-inch (0.8-mm) aluminum brushed to a satin sheen and lacquered **OR** with textured white finish, **as directed**.
7. Vandal-Proof, High-Strength Baffle: For flush **OR** surface, **as directed**,-mounted speakers, self-aging cast aluminum with tensile strength of 44,000 psi (303 MN/sq. m), 0.025-inch (0.65-mm) minimum thickness; countersunk heat-treated alloy mounting screws; and textured white epoxy finish.
8. Size: 8 inches (200 mm) with 1-inch (25-mm) voice coil and minimum 5-oz. (140-g) ceramic magnet.

L. Horn-Type Loudspeakers/Speaker Microphones
1. Speakers shall be all-metal, weatherproof construction; complete with universal mounting brackets.
2. Frequency Response: Within plus or minus 3 dB from 275 to 14,000 Hz.
3. Minimum Power Rating of Driver: 15 W, continuous.
4. Minimum Dispersion Angle: 110 degrees.
5. Line Transformer: Maximum insertion loss of 0.5 dB, power rating equal to speaker's, and at least four level taps.

M. Horn-Type Explosion-Proof Loudspeakers
1. Speakers shall be all-metal construction; complete with universal mounting brackets.
2. Units in Hazardous (Classified) Locations: Listed and labeled for environment in which they are located.
3. Frequency Response: Within plus or minus 3 dB from 300 to 12,000 Hz.
4. Minimum Power Rating of Driver: 30 **OR** 60, **as directed**, W, continuous.
5. Minimum Dispersion Angle: 95 **OR** 60 by 120, **as directed**, degrees.
6. Line Transformer: Internally mounted and factory installed, power rating equal to speaker's, and at least four level taps.

N. Conductors And Cables
1. Conductors: Jacketed, twisted pair and twisted multipair, untinned solid copper. Sizes as recommended by system manufacturer, but no smaller than No. 22 AWG.
2. Insulation: Thermoplastic, not less than 1/32 inch (0.8 mm) thick.
3. Shielding: For speaker-microphone leads and elsewhere where recommended by manufacturer; No. 34 AWG, tinned, soft-copper strands formed into a braid or equivalent foil.
a. Minimum Shielding Coverage on Conductors: 60 percent.
4. Plenum Cable: Listed and labeled for plenum installation.

O. Raceways
1. Intercommunication and Program System Raceways and Boxes: Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems".
2. Intercommunication and Program System Raceways and Boxes: Same as required for electrical branch circuits specified in Division 26 Section "Raceway And Boxes For Electrical Systems".
3. Intercommunication and Program System Raceways and Boxes: EMT **OR** ENT **OR** RNC **OR** Optical-fiber/communication raceways and fittings **OR** Metal wireways **OR** Nonmetal wireways **OR** Surface metal raceways **OR** Surface nonmetal raceways, **as directed**.
4. Outlet boxes shall be not less than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.
5. Flexible metal conduit is prohibited.

1.3 EXECUTION

A. Wiring Methods
1. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
a. Install plenum cable in environmental air spaces, including plenum ceilings.
b. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway And Boxes For Electrical Systems".
2. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
3. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

B. Installation Of Raceways
1. Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems" for installation of conduits and wireways.
2. Install manufactured conduit sweeps and long-radius elbows whenever possible.

C. Installation Of Cables
1. Comply with NECA 1.
2. General Requirements:
a. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
b. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
c. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
d. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

e. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

f. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.

3. Open-Cable Installation:
   a. Install cabling with horizontal and vertical cable guides in telecommunication spaces with terminating hardware and interconnection equipment.
   b. Suspend speaker cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceiling by cable supports not more than 60 inches (1524 mm) apart.
   c. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.
4. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches (300 mm) apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

D. Installation
1. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.
2. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.
3. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.
4. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.
5. Connect wiring according to Division 26 Section "Grounding And Bonding For Electrical Systems".

E. Grounding
1. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
2. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.
3. Install grounding electrodes as specified in Division 26 Section "Grounding And Bonding For Electrical Systems".

F. System Programming
1. Programming: Fully brief the Owner on available programming options. Record the Owner's decisions and set up initial system program. Prepare a written record of decisions, implementation methodology, and final results.

G. Field Quality Control
1. Perform tests and inspections.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Tests and Inspections:
   a. Schedule tests with at least seven days' advance notice of test performance.
   b. After installing intercommunications and program systems and after electrical circuitry has been energized, test for compliance with requirements.
   c. Operational Test: Test originating station-to-station, all-call, and page messages at each intercommunication station. Verify proper routing and volume levels and that system is

free of noise and distortion. Test each available message path from each station on system.

d. Frequency Response Test: Determine frequency response of two transmission paths, including all-call and paging, by transmitting and recording audio tones. Minimum acceptable performance is within 3 dB from 150 to 2500 Hz.

e. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:
   1) Disconnect speaker microphone and replace it in the circuit with a signal generator using a 1000-Hz signal. Measure signal-to-noise ratio at speakers or paging speakers.
   2) Repeat test for four speaker microphones and for each separately controlled zone of paging loudspeakers.
   3) Minimum acceptable ratio is 35 dB.

f. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 150, 200, 400, 1000, and 2500 Hz into each paging and all-call amplifier, and a minimum of two selected intercommunication amplifiers. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 5 percent total harmonics.

g. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at three locations in each paging zone. Maximum permissible variation in level is plus or minus 3 dB; in levels between adjacent zones, plus or minus 5 dB.

h. Power Output Test: Measure electrical power output of each paging amplifier at normal gain settings of 150, 1000, and 2500 Hz. Maximum variation in power output at these frequencies is plus or minus 3 dB.

i. Signal Ground Test: Measure and report ground resistance at system signal ground. Comply with testing requirements in Division 26 Section "Grounding And Bonding For Electrical Systems".

3. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.
4. Intercommunications and program systems will be considered defective if they do not pass tests and inspections.
5. Prepare test and inspection reports.

END OF SECTION 26 05 53 00a

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Task	Specification	Specification Description
26 05 83 00	26 05 13 16	Conductors And Cables
26 05 83 00	26 05 13 16a	Undercarpet Cables
26 05 83 00	26 05 13 16b	Medium-Voltage Cables

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SECTION 26 09 23 00 - LIGHTING CONTROLS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for lighting controls. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes manually operated lighting controls with relays, electrically operated circuit breakers, and control module.
2. This Section includes manually operated, PC-based, digital lighting controls with external signal source, relays, electrically operated circuit breakers, and control module.
3. This Section includes individually addressable lighting control devices communicating with data-entry and -retrieval devices using DALI protocol.

C. Definitions
1. BACnet: A networking communication protocol that complies with ASHRAE 135.
2. BAS: Building automation system.
3. DALI: Digital addressable lighting interface.
4. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.
5. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.
6. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
7. PC: Personal computer; sometimes plural as "PCs."
8. Power Line Carrier: Use of radio-frequency energy to transmit information over transmission lines whose primary purpose is the transmission of power.
9. RS-485: A serial network protocol, similar to RS-232, complying with TIA/EIA-485-A.

D. Submittals
1. Product Data: For control modules, power distribution components, DALI network materials, manual switches and plates, and conductors and cables.
2. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on this Project.
   a. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
   b. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
   c. Wiring Diagrams: Power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
3. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
   a. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
   b. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.

4. Software and Firmware Operational Documentation:
   a. Software operating and upgrade manuals.
   b. Program Software Backup: On a magnetic media or compact disc, complete with data files.
   c. Device address list.
   d. Printout of software application and graphic screens.
5. Field quality-control test reports.
6. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.
7. Operation and maintenance data.
8. Warranty: Special warranty specified in this Section.

E. Quality Assurance
1. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
3. Comply with 47 CFR, Subparts A and B, for Class A digital devices.
4. Comply with protocol described in IEC 60929, Annex E, for DALI lighting control devices, wiring, and computer hardware and software.
5. Comply with NFPA 70.

F. Coordination
1. Coordinate lighting control components to form an integrated interconnection of compatible components. Match components and interconnections for optimum performance of lighting control functions.
   a. Coordinate lighting controls with BAS **OR** HVAC controls, **as directed**. Design display graphics showing building areas controlled; include the status of lighting controls in each area.
   b. Coordinate lighting controls with that in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.
2. Coordinate lighting control components specified in this Section with components specified in Division 26 Section "Panelboards".

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship or from transient voltage surges within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Failure of software input/output to execute switching or dimming commands.
      2) Failure of modular relays to operate under manual or software commands.
      3) Damage of electronic components due to transient voltage surges.
   b. Warranty Period: Two years from date of Final Completion.
   c. Extended Warranty Period Failure Due to Transient Voltage Surges: Eight years.
   d. Extended Warranty Period for Electrically Held Relays: 10 years from date of Final Completion.

H. Software Service Agreement (May Not Be Allowed For Publicly Funded Projects)
1. Technical Support: Beginning with Final Completion, provide software support for two years.
2. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Final Completion. Upgrading software shall include operating system. Upgrade shall include new or revise licenses for use of the software.

a. Provide 30-day notice to the Owner to allow scheduling and access to system and to allow the Owner to upgrade computer equipment, if necessary.

1.2 PRODUCTS

A. System Requirements

1. Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.
2. Performance Requirements (for programmable system that controls manual and automatic operation that is not PC based): Manual switch operation sends a signal to programmable-system control module that processes the signal according to its programming and routes an open or close command to one or more relays **OR** electrically operated circuit breakers, **as directed**, in the power-supply circuits to groups of lighting fixtures or other loads.
3. Performance Requirements (for PC-based programmable system that controls manual and automatic operation): Manual switches, an internal timing and control unit, and external sensors or other control signal sources send a signal to a PC-based programmable-system control module that processes the signal according to its programming and routes an open or close command to one or more relays **OR** electrically operated circuit breakers, **as directed**, in the power-supply circuits, or routes variable commands to one or more dimmers, for groups of lighting fixtures or other loads.
4. Performance Requirements (for DALI-compliant program): Individually addressable devices (such as electronic ballasts, dimmers, and manual switches) are operated from digital signals received through a DALI-compliant bus, from data-entry and -retrieval devices (such as PCs, personal digital assistants (PDAs), hand-held infrared programming devices, wired Ethernet hubs, wireless IEEE 802.11 hubs). Devices also report status to data-entry and -retrieval devices though the bus.
5. BAS Interface: Provide hardware and software to enable the BAS to monitor, control, display, and record data for use in processing reports.
   a. Hardwired Points:
      1) Monitoring: On-off status, <**Insert monitoring point**>.
      2) Control: On-off operation, <**Insert control point**>.
   b. ASHRAE 135 (BACnet) **OR** LonTalk **OR** Modbus **OR** Industry-accepted, open-protocol, **as directed**, communication interface with the BAS shall enable the BAS operator to remotely control and monitor lighting from a BAS operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the BAS.

B. Control Module

1. Control Module Description: (This is a generic, nonproprietary control module that is not PC based.) Comply with UL 916 (CSA C22.2, No. 205); microprocessor-based, solid-state, 365-day timing and control unit. Output circuits shall be switched on or off by internally programmed time signals or by program-controlled analog or digital signals from external sources. Output circuits shall be pilot-duty relays compatible with power switching devices. An integral keypad shall provide local programming and control capability. A key-locked cover and a programmed security access code shall protect keypad use. An integral alphanumeric LCD or LED shall display menu-assisted programming and control.
2. Control Module Description: (These are typical systems developed by time-switch manufacturers as an expansion and refinement of their microprocessor-based, digital, time-switch product lines - controls are not PC based.) Comply with UL 916 (CSA C22.2, No. 205); microprocessor-based, solid-state, 365-day timing and control unit. Unit shall be programmable for control of indicated number of output circuits. Output circuits shall be switched on or off by internally programmed time signals or by program-controlled analog or digital signals from external sources. Output circuits shall be pilot-duty relays compatible with power switching devices, all located in other enclosures. An integral keypad shall provide local programming and control capability. A key-locked cover and a programmed security access code shall protect keypad use. An integral

alphanumeric LCD shall display manual-control and programming steps. Modules and their associated control panels shall include the following features:

a. Multichannel output with <**Insert number**> channels.
   OR
   Multiple inputs and multichannel output arranged for <**Insert number**> channels.
b. Multiple inputs for indicated occupancy sensors and hand-held programming device.

3. Control Module Description: (These are low-voltage control systems developed by high-end, remote-control dimmer system manufacturers - controls are not PC based.) Comply with UL 916 (CSA C22.2, No. 205); microprocessor-based, solid-state, 365-day timing and control unit. Control units shall be programmable and capable of receiving inputs from indicated sensors and hand-held programmer. Output circuits shall be pilot-duty relays compatible with power switching devices. Output circuits shall include digital circuits arranged to transmit control commands to remote preset dimmers. Modules and their associated control panels shall include the following features:
   a. Multichannel output with <**Insert number**> channels.
      OR
      Multiple inputs and multichannel output arranged for <**Insert number**> channels.
   b. Multiple inputs for occupancy sensors, daylight sensors, and dimming systems with associated daylight sensors.
4. Control Module Description: (This is a low-voltage control system developed around panelboards with electrically operated, molded-case circuit breakers and control module installed in panelboard - controls are not PC based.) Panelboard mounted; comply with UL 916 (CSA C22.2, No. 205); microprocessor based, solid-state, 365-day timing and control unit. Control units shall be programmable and capable of receiving inputs from sensors and other sources. Panelboard shall use low-voltage-controlled, electrically operated, molded-case branch circuit breakers as prime power-circuit switching devices. Circuit breakers and a limited number of digital or analog, low-voltage control-circuit outputs shall be individually controlled by control module. Line-voltage components and wiring shall be separated from low-voltage components and wiring by barriers. Control module shall be locally programmable. Panelboard shall also comply with Division 26 Section "Panelboards".
5. Control Module Description: (This is a refinement of classic low-voltage control system originally developed for manual, multipoint lighting control using latching-type, single-pole relays to switch 120- and 277-V circuits - controls are not PC based.) Comply with UL 508 (CSA C22.2, No. 14); microprocessor-based, programmable, control unit; mounted in preassembled, modular relay panel. Low-voltage-controlled, latching-type, single-pole lighting circuit relays shall be prime output circuit devices. Where indicated, a limited number of digital or analog, low-voltage control-circuit outputs shall be supported by control unit and circuit boards associated with relays. Control units shall be capable of receiving inputs from sensors and other sources. Line-voltage components and wiring shall be separated from low-voltage components and wiring by barriers. Control module shall be locally programmable.
6. Control Module Description: (This is a typical PC-based software control system developed to operate panelboards with electrically operated circuit breakers, relay boards with latching-type control relays, and individually addressable DALI-compliant devices. This control scheme is also suitable for integrating one or more of these boards to a PC-based control network (such as BAS, detention monitoring and control system, and HVAC control system) specified in another Section.) Programmable, PC-based unit with 17-inch color video monitor **OR** 15-inch color LCD, **as directed**, and keyboard for graphic display and programming of system status and to override breaker status; and to display status of local override controls and diagnostic information. If the control module is applied to emergency lighting units, control unit shall indicate failure of normal power and that the lighting units are, or are not, powered by the alternate power source.
   a. Display: Single graphic display for programming lighting control panelboards.
      OR
      Display: Separate graphic displays for programming each lighting control panelboard.
   b. Interoperability: Control module shall be configured to connect with other control systems using RS-485 network to enable remote workstations to use control module functions.

OR
Interoperability: Control module shall be configured to connect to LonWorks-compliant **OR** BACnet-compliant, **as directed**, network, resulting in extending control to any network-compliant devices such as occupancy switches.
OR
Interoperability: Lighting control shall be configured to allow individual users to turn lighting on and off with their PCs. Software shall be written for Windows operating system, with Web page as the display and ActiveX controls that can be accessed through an Internet browser. Include at least three levels of password protection. Include an egress lighting option that will provide each user with a lighted path for exiting the building after normal working hours.
OR
Interoperability: Lighting control shall be configured to allow individual users to turn lighting on and off with DALI-compliant, digital-communication devices. Software shall be written for Windows operating system, with the full suite of DALI commands and device parameter settings.

c. System Memory: Nonvolatile. System shall reboot program and reset time automatically without errors after power outages up to 90 days' duration.
d. Software: Lighting control software shall be capable of linking switch inputs to relay outputs, retrieving links, viewing relay output status, controlling relay outputs, simulating switch inputs, setting device addresses, and assigning switch input and relay output modes.
e. Automatic Time Adjustment: System shall automatically adjust for leap year and daylight saving time and shall provide weekly routine and annual holiday scheduling.
f. Astronomic Control: Automatic adjustment of dawn and dusk switching.
g. Demand Control: Demand shall be monitored through pulses from a remote meter and shall be controlled by programmed switching of loads. System capability shall include sliding window averaging and programming of load priorities and characteristics. Minimum of two different time-of-day demand schedules shall execute load-management control actions by switching output circuits or by transmitting other types of load-control signals.
h. Confirmation: Each relay or contactor device operated by system shall have auxiliary contacts that provide a confirmation signal to the system of on or off status of device. On or off status confirmation for each electrically operated circuit breaker shall be provided by an auxiliary contact or by a sensing device at load terminal.
   1) Software shall interpret status signals, provide for their display, and initiate failure signals.
   OR
   Lamp or LED at control module or display panel shall identify status of each controlled circuit.
i. Remote Communication Capability: Allow programming, data-gathering interrogation, status display, and controlled command override from a PC at a remote location over telephone lines **OR** data links **OR** DALI networks **OR** power line carrier, **as directed**. System shall include modem, communications and control software, and remote computer compatibility verification for this purpose.
j. Telephone Override Capability: Override programmed lighting shutdown commands by telephoning computer and shall enter a voice-menu-guided, override touch-tone code specific to zone being controlled.
k. Local Override Capability: Manual, low-voltage control devices shall override programmed shutdown of lighting and shall override other programmed control for intervals that may be duration programmed.
l. Automatic Control of Local Override: Automatic control shall switch lighting off if lighting has been switched on by local override. Comply with provisions in California Code of Regulations, Title 24, Part 6, **as directed**.
m. Automatic battery backup shall provide power to maintain program and system clock operation for 90 days' minimum duration when power is off.
n. Programmed time signals shall change preset scenes and dimmer settings.

o. Daylight Balancing Dimming Control: Control module shall interpret variable analog signal from photoelectric sensor and shall route dimming signals to dimming fluorescent ballast control circuits. Signal shall control dimming of fixture so illumination level remains constant as daylight contribution varies.

p. Daylight Compensating Switch Control: Control module shall interpret a preset threshold illumination-level signal from a photoelectric relay and shall activate relays controlling power to selected groups of lighting fixtures to turn them on and off to maintain adjustable minimum illumination level as daylight contribution varies.

q. Energy Conservation: Bilevel control of special ballasts or dimming circuits to comply with local energy codes.

r. Flick Warning: Programmable momentary turnoff of lights shall warn that programmed shutoff will occur after a preset interval. Warning shall be repeated after a second preset interval before end of programmed override period.

s. Diagnostics: When system operates improperly, software shall initiate factory-programmed diagnosis of failure and display messages identifying problem and possible causes.

t. Additional Programming: In addition to system programming by the PC, individual control modules shall be programmable using data-entry and -retrieval (such as PCs, personal digital assistants (PDAs), hand-held infrared programming devices, wired Ethernet hubs, wireless IEEE 802.11 hubs).

C. Power Distribution Components (For DALI-Compliant Networks)

1. Modular Relay Panel: Comply with UL 508 (CSA C22.2, No. 14) and UL 916 (CSA C22.2, No. 205); factory assembled with modular single-pole relays, power supplies, and accessory components required for specified performance.
   a. Cabinet: Steel with hinged, locking door.
      1) Barriers separate low-voltage and line-voltage components.
      2) Directory: Mounted on back of door. Identifies each relay as to load groups controlled and each programmed pilot device if any.
      3) Control Power Supply: Transformer and full-wave rectifier with filtered dc output.
   b. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type.
      1) Low-Voltage Leads: Plug connector to the connector strip in cabinet and pilot light power where indicated.
      2) Rated Capacity (Mounted in Relay Panel): 20 A, 125-V ac for tungsten filaments; 20 A, 277-V ac for ballasts.
      3) Endurance: 50,000 cycles at rated capacity.
      4) Mounting: Provision for easy removal and installation in relay cabinet.
2. Electrically Operated, Molded-Case Circuit-Breaker Panelboard: Comply with NEMA PB 1 and UL 50 (CSA C22.2, No. 94), UL 67 (CSA C22.2, No. 29), UL 489 (CSA C22.2, No. 65), and UL 916 (CSA C22.2, No. 205).
   a. Cabinets: In addition to requirements specified below, comply with Division 26 Section "Panelboards".
   b. Electrically Operated, Molded-Case Circuit Breakers: Bolt-on type.
      1) Switching Endurance Ratings: Certified by manufacturer or by a nationally recognized testing laboratory (NRTL) for at least 20,000 open and close operations under rated load at 0.8 power factor.
      2) Minimum 30,000 open and close operations with load equal to circuit-breaker trip rating and consisting of 100 percent tungsten filament load.
      3) Minimum 30,000 open and close operations with load equal to circuit-breaker trip rating and consisting of 100 percent fluorescent ballasts rated for 10 percent total harmonic distortion.
      4) Listed and labeled as complying with UL SWD, HCAR, and HID ratings by a national recognized testing laboratory (NRTL) acceptable to authorities having jurisdiction.
3. Line-Voltage Surge Suppression: Factory installed as an integral part of 120- and 277-V ac, solid-state control panels.

OR
Line-Voltage Surge Suppression: Field-mounting surge suppressors that comply with Division 26 Section "Transient-voltage Suppression For Low-voltage Electrical Power Circuits" for Category A locations.
OR
Line-Voltage Surge Suppression: Factory installed as an integral part of 120- and 277-V ac, solid-state control panels or field-mounting surge suppressors that comply with Division 26 Section "Transient-voltage Suppression For Low-voltage Electrical Power Circuits" for Category A locations.

D. DALI Network Materials
1. Network Power Supply and Router: Interface device connecting TCP/IP control networks to DALI-compliant network.
   a. DALI-Compliant Network Power Rating: One full-rated network for **OR** Two full-rated networks, each capable of, **as directed**, powering up to 64 addressable devices for each network; suitable for use with NFPA 70, Class 1 and Class 2 control circuits; and 16 V dc, 250 mA.
   b. Primary Power: 120 or 277 V, field selectable; 12 VA.
   c. 10basT Ethernet port.
   d. LED indicator lights for Ethernet status (link, send, and receive), power-on, and DALI network failure.
2. Lighting Control Software:
   a. Five-tier hierarchical architecture; high-speed, parallel query; and distributed-logic processing scalable from single rooms to full campuses.
   b. Automatic backup for all settings and parameters.
   c. TCP/IP network protocol.
   d. Interactive with other building management systems at TCP/IP level.
   e. At least three security levels.
   f. Support the full suite of DALI commands and device parameter settings.
   g. Scheduling modules to provide building-wide scene scheduling.
   h. Billing modules to track energy use for multiple tenants and able to produce monthly billing statements.
   i. Support load shedding, peak shaving, sweeps with local override, and other energy-conservation measures.
   j. Able to report individual device status, including inoperative lamps, ballast failure detection, and dimmer position.

E. Manual Switches And Plates
1. Push-Button Switches: Modular, momentary-contact, low-voltage type.
   a. Match color specified in Division 26 Section "Wiring Devices".
   b. Integral green LED **OR** neon, **as directed**, pilot light to indicate when circuit is on.
   c. Internal white LED **OR** neon, **as directed**, locator light to illuminate when circuit is off.
2. Manual, Maintained Contact, Full- or Low-Voltage Switch: Comply with Division 26 Section "Wiring Devices".
3. Wall-Box Dimmers: Comply with Division 26 Section "Wiring Devices".
4. Wall Plates: Single and multigang plates as specified in Division 26 Section "Wiring Devices"
5. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

F. Conductors And Cables
1. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
2. Classes 2 and 3 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 **OR** 22 **OR** 24, **as directed**, AWG, complying with Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

3. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 **OR** 16 **OR** 18, **as directed**, AWG, complying with Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
4. Digital and Multiplexed Signal Cables: Unshielded, twisted-pair cable with copper conductors, complying with TIA/EIA-568-B.2, Category 5e **OR** 6, **as directed**, for horizontal copper cable and with Division 28 Section "Conductors And Cables For Electronic Safety And Security".

1.3 EXECUTION

A. Wiring Installation
1. Comply with NECA 1.
2. Wiring Method: Install wiring in raceways except where installed in accessible ceilings and gypsum board partitions. Comply with Division 26 Section "Low-voltage Electrical Power Conductors And Cables". Minimum conduit size shall be 1/2 inch (13 mm).
3. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.
4. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.
5. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
6. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes.
7. Identify components and power and control wiring according to Division 26 Section "Identification For Electrical Systems".

B. Field Quality Control
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and assist in field testing. Report results in writing.
2. Perform the following field tests and inspections and prepare test reports:
   a. Test for circuit continuity.
   b. Verify that the control module features are operational.
   c. Check operation of local override controls.
   d. Test system diagnostics by simulating improper operation of several components selected by the Owner.

C. Software Installation
1. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.

D. Adjusting
1. Occupancy Adjustments: When requested within 12 months of date of Final Completion, provide on-site assistance in adjusting sensors and to assist the Owner's personnel in making program changes to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

E. Demonstration
1. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain lighting controls and software training for PC-based control systems.

END OF SECTION 26 09 23 00

SECTION 26 09 23 00a - LIGHTING CONTROL DEVICES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for lighting control devices. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following lighting control devices:
      a. Time switches.
      b. Outdoor and Indoor photoelectric switches.
      c. Indoor occupancy sensors.
      d. Outdoor motion sensors.
      e. Lighting contactors.
      f. Emergency shunt relays.

C. Definitions
   1. LED: Light-emitting diode.
   2. PIR: Passive infrared.

D. Submittals
   1. Product Data: For each type of product indicated.
   2. Field quality-control test reports.
   3. Operation and maintenance data.

E. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.2 PRODUCTS

A. Time Switches
   1. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.
      a. Contact Configuration: SPST **OR** DPST **OR** DPDT, **as directed**.
      b. Contact Rating: 30-A inductive or resistive, 240-V ac **OR** 20-A ballast load, 120/240-V ac, **as directed**.
      c. Program: 8 on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays, **as directed**.
         OR
         Program: 2 on-off set points on a 24-hour schedule, allowing different set points for each day of the week and an annual holiday schedule that overrides the weekly operation on holidays, **as directed**.
         OR
         Programs: channels; each channel shall be individually programmable with 8 on-off set points on a 24-hour schedule.
         OR
         Programs: channels; each channel shall be individually programmable with 2 on-off set points on a 24-hour schedule with skip-a-day weekly schedule.

OR
Programs: channels; each channel shall be individually programmable with 2 on-off set points on a 24-hour schedule, allowing different set points for each day of the week.
OR
Programs: channels; each channel shall be individually programmable with 40 on-off operations per week and an annual holiday schedule that overrides the weekly operation on holidays.
OR
Programs: channels; each channel shall be individually programmable with 40 on-off operations per week, plus 4 seasonal schedules that modify the basic program, and an annual holiday schedule that overrides the weekly operation on holidays.
OR
Program: Configuration, as directed by the Owner and an annual holiday schedule that overrides the weekly operation on holidays, **as directed**.

d. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels, **as directed**.
e. Astronomic Time: All **OR** Selected, **as directed**, channels.
f. Battery Backup: For schedules and time clock.

2. Electromechanical-Dial Time Switches: Type complying with UL 917.
   a. Contact Configuration: SPST **OR** DPST **OR** SPDT **OR** DPDT, **as directed**.
   b. Contact Rating: 30-A inductive or resistive, 240-V ac **OR** 20-A ballast load, 120/240-V ac, **as directed**.
   c. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
   d. Astronomic time dial.
   e. Eight-Day Program: Uniquely programmable for each weekday and holidays.
   f. Skip-a-day mode.
   g. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of 16 hours.

B. Outdoor Photoelectric Switches
1. Description: Solid state, with SPST **OR** DPST, **as directed**, dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
   a. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off, **as directed**.
   b. Time Delay: 15-second minimum, to prevent false operation.
   c. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
   d. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

OR
Description: Solid state, with SPST **OR** DPST, **as directed**, dry contacts rated for 1800 VA to operate connected load, relay, or contactor coils; complying with UL 773.
   a. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range.
   b. Time Delay: 30-second minimum, to prevent false operation.
   c. Lightning Arrester: Air-gap type.
   d. Mounting: Twist lock complying with IEEE C136.10, with base.

C. Indoor Photoelectric Switches

1. Ceiling-Mounted Photoelectric Switch: Solid-state, light-level sensor unit, with separate relay unit mounted on luminaire, **as directed**, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.
   a. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
   b. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
   c. Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lx) **OR** 100 to 1000 fc (1080 to 10 800 lx), **as directed**, with an adjustment for turn-on and turn-off levels within that range.
   d. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
   e. Indicator: Two LEDs to indicate the beginning of on-off cycles.
2. Skylight Photoelectric Sensors: Solid-state, light-level sensor; housed in a threaded, plastic fitting for mounting under skylight, facing up at skylight; with separate relay unit mounted on luminaire, **as directed**, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.
   a. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
   b. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
   c. Light-Level Monitoring Range: 1000 to 10,000 fc (10 800 to 108 000 lx), with an adjustment for turn-on and turn-off levels within that range.
   d. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
   e. Indicator: Two LEDs to indicate the beginning of on-off cycles.

D. Indoor Occupancy Sensors
1. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.
   a. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
   b. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
   c. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
   d. Mounting:
      1) Sensor: Suitable for mounting in any position on a standard outlet box.
      2) Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
      3) Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
   e. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
   f. Bypass Switch: Override the on function in case of sensor failure.
   g. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lx); keep lighting off when selected lighting level is present.
2. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.
   a. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
   b. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

c. Detection Coverage (Corridor): Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.

3. Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.
   a. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
   b. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
   c. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
   d. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
   e. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).
4. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.
   a. Sensitivity Adjustment: Separate for each sensing technology.
   b. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
   c. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

E. Outdoor Motion Sensors (PIR):
1. Performance Requirements: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F (minus 40 to plus 54 deg C), rated as raintight according to UL 773A.
   a. Operation: Turn lights on when sensing infrared energy changes between background and moving body in area of coverage; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
   b. Mounting:
      1) Sensor: Suitable for mounting in any position on a standard outdoor junction box.
      2) Relay: Internally mounted in a standard weatherproof electrical enclosure.
      3) Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
   c. Bypass Switch: Override the on function in case of sensor failure.
   d. Automatic Light-Level Sensor: Adjustable from 1 to 20 fc (11 to 215 lx); keep lighting off during daylight hours.
2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
3. Detection Coverage: Up to 35 feet (11 m), with a field of view of 90 degrees **OR** Up to 100 feet (30 m), with a field of view of 60 degrees **OR** Up to 35 feet (11 m), with a field of view of 180 degrees **OR** Up to 52.5 feet (16 m), with a field of view of 270 degrees, **as directed**.
4. Lighting Fixture Mounted Sensor: Suitable for switching 300 W of tungsten load at 120- or 277-V ac.
5. Individually Mounted Sensor: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
   a. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.

b. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.

F. Lighting Contactors

1. Description: Electrically operated and mechanically **OR** electrically, **as directed**, held, combination type with fusible switch **OR** nonfused disconnect, **as directed**, complying with NEMA ICS 2 and UL 508.
    a. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
    b. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
    c. Enclosure: Comply with NEMA 250.
    d. Provide with control and pilot devices as indicated on Drawings **OR** scheduled, **as directed**, matching the NEMA type specified for the enclosure.
2. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.
    a. Monitoring: On-off status, as directed by the Owner.
    b. Control: On-off operation, as directed by the Owner.

G. Emergency Shunt Relay

1. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic, **as directed**, switching contacts; complying with UL 924.
    a. Coil Rating: 120 **OR** 277, **as directed**, V.

H. Conductors And Cables

1. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
2. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 **OR** 22 **OR** 24, **as directed**, AWG. Comply with requirements in Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
3. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 **OR** 16 **OR** 18, **as directed**, AWG. Comply with requirements in Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

1.3 EXECUTION

A. Sensor Installation

1. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

B. Contactor Installation

1. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

C. Wiring Installation

1. Wiring Method: Comply with Division 26 Section "Low-voltage Electrical Power Conductors And Cables". Minimum conduit size shall be 1/2 inch (13 mm).
2. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
3. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

4. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

D. Identification
1. Identify components and power and control wiring according to Division 26 Section "Identification For Electrical Systems".
    a. Identify controlled circuits in lighting contactors.
    b. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.
2. Label time switches and contactors with a unique designation.

E. Field Quality Control
1. Perform the following field tests and inspections and prepare test reports:
    a. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
    b. Operational Test: Verify operation of each lighting control device, and adjust time delays.
2. Lighting control devices that fail tests and inspections are defective work.

END OF SECTION 26 09 23 00a

SECTION 26 09 23 00b - ELECTRICAL POWER MONITORING AND CONTROL

1.1 GENERAL

A. Description Of Work
  1. This specification covers the furnishing and installation of materials for electrical power monitoring and control. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
  1. This Section includes the following for monitoring and control of electrical power system:
     a. PC-based workstation(s) and software.
     b. Communication network and interface modules for RS-232; RS-485, Modbus TCP/IP; and IEEE 802.3 data transmission protocols.

C. Definitions
  1. Ethernet: Local area network based on IEEE 802.3 standards.
  2. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.
  3. HTML: Hypertext markup language.
  4. I/O: Input/output.
  5. KB: Short for kilobyte. When used to describe data storage, "KB" represents 1024 bytes.
  6. KY Pulse: A term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay changing status in response to the rotation of the disk in the meter.
  7. LAN: Local area network; sometimes plural as "LANs."
  8. LCD: Liquid crystal display.
  9. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less that 50 V or remote-control, signaling and power-limited circuits.
  10. Modbus TCP/IP: An open protocol for exchange of process data.
  11. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
  12. PC: Personal computer; sometimes plural as "PCs."
  13. rms: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.
  14. RS-232: A TIA standard for asynchronous serial data communications between terminal devices.
  15. RS-485: A TIA standard for multipoint communications using two twisted-pairs.
  16. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.
  17. THD: Total harmonic distortion.
  18. UPS: Uninterruptible power supply; used both in singular and plural context.
  19. WAN: Wide area network.

D. Submittals
  1. Product Data: For each type of product indicated.
     a. Attach copies of approved Product Data submittals for products (such as switchboards and switchgear) that describe power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.
  2. Shop Drawings: For power monitoring and control equipment. Include plans, elevations, sections, details, and attachments to other work.
     a. Outline Drawings: Indicate arrangement of components and clearance and access requirements.

b. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
c. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
d. Wiring Diagrams: Power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
e. UPS sizing calculations for workstation.

3. Software and Firmware Operational Documentation:
   a. Self-study guide describing the process for setting equipment's network address; setting the Owner's options; procedures to ensure data access from any PC on the network, using a standard Web browser; and recommended firewall setup.
   b. Software operating and upgrade manuals.
   c. Software Backup: On a magnetic media or compact disc, complete with the Owner-selected options.
   d. Device address list and the set point of each device and operator option, as set in applications software.
   e. Graphic file and printout of graphic screens and related icons, with legend.
4. Software Upgrade Kit: For the Owner to use in modifying software to suit future power system revisions or power monitoring and control revisions.
5. Software licenses and upgrades required by and installed for operating and programming digital and analog devices.
6. Field quality-control test reports.
7. Operation and Maintenance Data: For power monitoring and control units, to include in emergency, operation, and maintenance manuals. Include the following:
   a. Operating and applications software documentation.
   b. Software licenses.
   c. Software service agreement.
   d. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware. Provide separately for each PC.
   e. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy submittal.
8. Other Informational Submittals:
   a. System installation and setup guides, with data forms to plan and record options and setup decisions.

E. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Software Service Agreement
   1. Technical Support: Beginning with Final Completion, provide software support for two years.
   2. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Final Completion. Upgrading software shall include the operating systems. Upgrade shall include new or revised licenses for use of software.
      a. Provide 30-day notice to the Owner to allow scheduling and access to system and to allow the Owner to upgrade computer equipment if necessary.

1.2 PRODUCTS

A. Functional Description
1. Instrumentation and Recording Devices: Monitor and record load profiles and chart energy consumption patterns.
a. Calculate and Record the Following:
1) Load factor.
2) Peak demand periods.
3) Consumption correlated with facility activities.
b. Measure and Record Metering Data for the Following:
1) Electricity.
2) Domestic water.
3) Natural gas.
2. Software: Calculate allocation of utility costs.
a. Automatically Import Energy Usage Records to Allocate Energy Costs for the Following:
1) At least 15 departments.
2) At least 30 tenants.
3) At least five processes.
4) At least five buildings.
b. Verify utility bills and analyze alternate energy rates, **as directed**.
3. Power Quality Monitoring: Identify power system anomalies and measure, display, and record trends and alarms of the following power quality parameters:
a. Voltage regulation and unbalance.
b. Continuous three-phase rms voltage.
c. Periodic max./min./avg. samples.
d. Harmonics.
e. Voltage excursions.
4. Emergency Load Shedding. Preserve critical loads or avoid total shutdown due to unforeseen loss of power sources according to the following logic:
a. Determine system topology.
b. Evaluate remaining loads and sources.
c. Shed loads in less than 100 ms.
5. Demand Management:
a. Peaking or co-generator control.
b. Load interlocking.
c. Load shedding.
d. Load trimming.
6. System: Report equipment status and power system control.

B. System Requirements
1. Monitoring and Control System: Include PC-based workstation **OR** multiple PC-based workstations **OR** multiple PC-based workstations with graphics capability and Web access, **as directed**, with its operating system and application software, connected to data transmission network.
2. Surge Protection: For external wiring of each conductor entry connection to components to protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads.
a. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Division 26 Section "Transient-voltage Suppression For Low-voltage Electrical Power Circuits".
b. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Comply with requirements as recommended by manufacturer for type of line being protected.
3. Addressable Devices: All transmitters and receivers shall communicate unique device identification and status reports to monitoring and control clients.

4. BAS Interface: Provide factory-installed hardware and software to enable the BAS to monitor, display, and record data for use in processing reports.
   a. Hardwired Monitoring Points: Electrical power demand (kilowatts), electrical power consumption (kilowatt-hours), power factor, **as directed**.
      OR
      ASHRAE 135 (BACnet) **OR** LonTalk **OR** Modbus **OR** Industry-accepted, open-protocol, **as directed**, communication interface with the BAS shall enable the BAS operator to remotely monitor meter information from a BAS operator workstation. Control features and monitoring points displayed locally at metering panel shall be available through the BAS.

C. Operating System
1. Software: Configured to run on a portable laptop computer, a single PC, or a palm computer, with capability for accessing a single meter at a time. System is not connected to a LAN. Modbus TCP/IP, RS-232, and RS-485 digital communications.
   OR
   Software: Configured to run on a single PC, with capability for accessing multiple devices simultaneously. Modbus TCP/IP, RS-232, and RS-485 digital communications.
   OR
   Software: Configured for a server and multiple client PCs, each with capability for accessing multiple devices simultaneously. Ethernet, Modbus TCP/IP, RS-232, and RS-485 digital communications.
   OR
   Software: Configured for a server and multiple client PCs, each with capability for accessing multiple devices simultaneously. Software shall include interactive graphics client and shall be Web enabled. Workstations and portable computers shall not require any software except for an Internet browser to provide connectivity and full functionality. Include a firewall recommended by manufacturer. 100 Base-T Ethernet, Modbus TCP/IP RS-232, and RS-485 digital communications.
2. Operating System Software: Based on 32-bit, Microsoft Windows workstation operating system. Software shall have the following features:
   a. Multiuser and multitasking to allow independent activities and monitoring to occur simultaneously at different workstations.
   b. Graphical user interface to show pull-down menus and a menu tree format.
   c. Capability for future additions within the indicated system size limits.
3. Peer Computer Control Software: Shall detect a failure of workstation and associated server, **as directed**, and shall cause other workstation and associated server, **as directed**, to assume control of all system functions without interruption of operation. Drivers shall be provided in both central computers to support this mode of operation.

D. Applications Software
1. Basic Requirements:
   a. Fully compatible with and based on the approved operating system.
   b. Password-protected operator login and access; three levels, minimum.
   c. Password-protected setup functions.
   d. Context sensitive on-line help.
   e. Capability of creating, deleting, and copying files; and automatically maintaining a directory of all files, including size and location of each sequential and random-ordered record.
   f. Capability for importing custom icons into graphic views to represent alarms and I/O devices.
   g. Automatic and encrypted backups for database and history; automatically stored at central control PC **OR** selected workstation, **as directed**, and encrypted with a nine-character alphanumeric password, which must be used to restore or read data contained in backup.
   h. Operator audit trail for recording and reporting all changes made to user-defined system options.
2. Workstation Server Functions:

a. Support other client PCs on the LAN and WAN, **as directed**.
b. Maintain recorded data in databases accessible from other PCs on the LAN and WAN, **as directed**.

3. Data Formats:
   a. User-programmable export and import of data to and from commonly used Microsoft Windows spreadsheet, database, billing, and other applications; using dynamic data exchange technology.
   b. Option to convert reports and graphics to HTML format.
   c. Interactive graphics.
   d. Option to send preprogrammed or operator designed e-mail reports.
4. Metered Data: Display metered values in real time.
5. Remote Control:
   a. Display circuit-breaker status and allow breaker control.
   b. User defined with load-shedding automatically initiated and executed schemes responding to programmed time schedules, set points of metered demands, utility contracted load shedding, or combinations of these.
6. Equipment Documentation: Database for recording of equipment ratings and characteristics; with capability for graphic display on monitors.
7. Graphics: Interactive color-graphics platform with pull-down menus and mouse-driven generation of power system graphics, in formats widely used for such drafting; to include the following:
   a. Site plan.
   b. Floor plans.
   c. Equipment elevations.
   d. Single-line diagrams.
8. User-Defined Monitoring and Control Events: Display and record with date and time stamps accurate to 0.1 second, and including the following:
   a. Operator log on/off.
   b. Attempted operator log on/off.
   c. All alarms.
   d. Equipment operation counters.
   e. Out-of-limit, pickup, trip, and no-response events.
9. Trending Reports: Display data acquired in real-time from different meters or devices, in historical format over user-defined time; unlimited as to interval, duration, or quantity of trends.
   a. Spreadsheet functions of sum, delta, percent, average, mean, standard deviation, and related functions applied to recorded data.
   b. Charting, statistical, and display functions of standard Windows-based spreadsheet.
10. Alarms: Display and record alarm messages from discrete input and controls outputs, according to user programmable protocol.
    a. Functions requiring user acknowledgment shall run in background during computer use for other applications and override other presentations when they occur.
11. Waveform Data: Display and record waveforms on demand or automatically on an alarm or programmed event; include the graphic displays of the following, based on user-specified criteria:
    a. Phase voltages, phase currents, and residual current.
    b. Overlay of three-phase currents, and overlay each phase voltage and current.
    c. Waveforms ranging in length from 2 cycles to 5 minutes.
    d. Disturbance and steady-state waveforms up to 512 points per cycle.
    e. Transient waveforms up to 83,333 points per cycle on 60-Hz base.
    f. Calculated waveform on a minimum of four cycles of data of the following:
       1) THD.
       2) rms magnitudes.
       3) Peak values.
       4) Crest factors.
       5) Magnitude of individual harmonics.
12. Data Sharing: Allow export of recorded displays and tabular data to third-party applications software.
13. Tenant or Activity Billing Software:

a. Automatically compute and prepare tenant bills **OR** activity demand and energy-use statements, **as directed**, based on metering of energy use and peak demand integrated over user-defined interval.
b. Intervals shall be same as used by electric utilities, including current vendor.
c. Import metered data from saved records that were generated by metering and monitoring software.
d. Maintain separate directory for each tenant's historical billing information.
e. Prepare summary reports in user-defined formats and time intervals.

14. Reporting: User commands initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.
a. Print a record of user-defined alarm, supervisory, and trouble events on workstation printer.
b. Sort and report by device name and by function.
c. Report type of signal (alarm, supervisory, or trouble), description, date, and time of occurrence.
d. Differentiate alarm signals from other indications.
e. When system is reset, report reset event with same information concerning device, location, date, and time.

E. Communication Components And Networks
1. Transient Voltage Surge Suppression and Electromagnetic-Interference Immunity: Include in solid-state equipment. Comply with IEEE C37.90.
2. Network Configuration: High-speed, multi-access, open nonproprietary, industry standard communication protocol; LANs complying with EIA 485, 100 Base-T Ethernet, and Modbus TCP/IP.

F. Power Monitors
1. Separately mounted, permanently installed instrument for power monitoring and control.
a. Enclosure: NEMA 250, Type 1 **OR** 12, **as directed**.
2. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
a. Indoor installation in non-air-conditioned **OR** nontemperature-controlled, **as directed**, spaces that have environmental controls to maintain ambient conditions of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
3. rms Real-Time Measurements:
a. Current: Each phase, neutral, average of three phases, percent unbalance.
b. Voltage: Line-to-line each phase, line-to-line average of three phases, line-to-neutral each phase, line-to-neutral average of three phases, line-to-neutral percent unbalance.
c. Power: Per phase and three-phase total.
d. Reactive Power: Per phase and three-phase total.
e. Apparent Power: Per phase and three-phase total.
f. Power Factor: Per phase and three-phase total.
g. Displacement Power Factor: Per phase and three-phase total.
h. Frequency.
i. THD: Current and voltage.
j. Accumulated Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
k. Incremental Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
l. Conditional Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
4. Demand Current Calculations, per Phase, Three-Phase Average and Neutral:
a. Present.
b. Running average.
c. Last completed interval.
d. Peak.
5. Demand Real Power Calculations, Three-Phase Total:

a. Present.
b. Running average.
c. Last completed interval.
d. Predicted.
e. Peak.
f. Coincident with peak kVA demand.
g. Coincident with kVAR demand.

6. Demand Reactive Power Calculations, Three-Phase Total:
    a. Present.
    b. Running average.
    c. Last completed interval.
    d. Predicted.
    e. Peak.
    f. Coincident with peak kVA demand.
    g. Coincident with kVAR demand.
7. Demand Apparent Power Calculations, Three-Phase Total:
    a. Present.
    b. Running average.
    c. Last completed interval.
    d. Predicted.
    e. Peak.
    f. Coincident with peak kVA demand.
    g. Coincident with kVAR demand.
8. Average Power Factor Calculations, Demand Coincident, Three-Phase Total:
    a. Last completed interval.
    b. Coincident with kW peak.
    c. Coincident with kVAR peak.
    d. Coincident with kVA peak.
9. Power Analysis Values:
    a. THD, Voltage and Current: Per phase, three phase, and neutral.
    b. Displacement Power Factor: Per phase, three phase.
    c. Fundamental Voltage, Magnitude and Angle: Per phase.
    d. Fundamental Currents, Magnitude and Angle: Per phase.
    e. Fundamental Real Power: Per phase, three phase.
    f. Fundamental Reactive Power: Per phase.
    g. Harmonic Power: Per phase, three phase.
    h. Phase rotation.
    i. Unbalance: Current and voltage.
    j. Harmonic Magnitudes and Angles for Current and Voltages: Per phase, up to 31st **OR** 63rd, **as directed**, harmonic.
10. Power Demand Calculations: According to one of the following calculation methods, selectable by the user:
    a. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
    b. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:
        1) Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
        2) Fixed block that calculates demand at end of the interval.
        3) Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.
    c. Demand Calculation Initiated by a Synchronization Signal:
        1) Signal is a pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.

2) Signal is a communication signal. Calculation shall be configurable as either a block or rolling block calculation.
3) Demand can be synchronized with clock in the power meter.

11. Sampling:
    a. Current and voltage shall be digitally sampled at a rate high enough to provide accuracy to 63rd harmonic of 60-Hz fundamental.
    b. Power monitor shall provide continuous sampling at a rate of 128 samples per cycle on all voltage and current channels in the meter.
12. Minimum and Maximum Values: Record monthly minimum and maximum values, including date and time of record. For three-phase measurements, identify phase of recorded value. Record the following parameters:
    a. Line-to-line voltage.
    b. Line-to-neutral voltage.
    c. Current per phase.
    d. Line-to-line voltage unbalance.
    e. Line-to-neutral voltage unbalance.
    f. Power factor.
    g. Displacement power factor.
    h. Total power.
    i. Total reactive power.
    j. Total apparent power.
    k. THD voltage L-L.
    l. THD voltage L-N.
    m. THD current.
    n. Frequency.
13. Harmonic Calculation: Display and record the following:
    a. Harmonic magnitudes and angles for each phase voltage and current through 31st **OR** 63rd, **as directed**, harmonic. Calculate for all three phases, current and voltage, and residual current. Current and voltage information for all phases shall be obtained simultaneously from same cycle.
    b. Harmonic magnitude reported as a percentage of the fundamental or as a percentage of rms values, as selected by user.
14. Current and Voltage Ratings:
    a. Designed for use with current inputs from standard instrument current transformers with 5-A secondary and shall have a metering range of 0-10 A.
    b. Withstand ratings shall be not less than 15 A, continuous; 50 A, lasting over 10 seconds, no more frequently than once per hour; 500 A, lasting 1 second, no more frequently than once per hour.
    c. Designed for use with voltage inputs from standard instrument potential transformers with a 120-V secondary.
15. Accuracy:
    a. Comply with ANSI C12.20, Class 0.5; and IEC 60687, Class 0.5 for revenue meters.
    b. Accuracy from Light to Full Rating:
        1) Power: Accurate to 0.25 percent of reading, plus 0.025 percent of full scale.
        2) Voltage and Current: Accurate to 0.075 percent of reading, plus 0.025 percent of full scale.
        3) Power Factor: Plus or minus 0.002, from 0.5 leading to 0.5 lagging.
        4) Frequency: Plus or minus 0.01 Hz at 45 to 67 Hz.
16. Waveform Capture:
    a. Capture and store steady-state waveforms of voltage and current channels; initiated manually. Each capture shall be for 3 cycles, 128 data points for each cycle, allowing resolution of harmonics to 31st harmonic of basic 60 Hz.
    b. Store captured waveforms in internal nonvolatile memory; available for PC display, archiving, and analysis.
17. Input: One digital input signal(s).

a. Normal mode for on/off signal.

b. Demand interval synchronization pulse, accepting a demand synchronization pulse from a utility demand meter.

c. Conditional energy signal to control conditional energy accumulation.

18. Outputs:

a. Operated either by user command sent via communication link, or set to operate in response to user-defined alarm or event.

b. Closed in either a momentary or latched mode as defined by user.

c. Each output relay used in a momentary contact mode shall have an independent timer that can be set by user.

d. One digital KY pulse to a user-definable increment of energy measurement. Output ratings shall be up to 120-V ac, 300-V dc, 50 mA, and provide 3500-V rms isolation.

e. One relay output module(s), providing a load voltage range from 20- to 240-V ac or from 20- to 30-V dc, supporting a load current of 2 A.

f. Output Relay Control:

1) Relay outputs shall operate either by user command sent via communication link or in response to user-defined alarm or event.

2) Normally open and normally closed contacts, field configured to operate as follows:

a) Normal contact closure where contacts change state for as long as signal exists.

b) Latched mode when contacts change state on receipts of a pickup signal; changed state is held until a dropout signal is received.

c) Timed mode when contacts change state on receipt of a pickup signal; changed state is held for a preprogrammed duration.

d) End of power demand interval when relay operates as synchronization pulse for other devices.

e) Energy Pulse Output: Relay pulses quantities used for absolute kWh, absolute kVARh, kVAh, kWh In, kVARh In, kWh Out, and kVARh Out.

f) Output controlled by multiple alarms using Boolean-type logic.

19. Onboard Data Logging:

a. Store logged data, alarms, events, and waveforms in 80 **OR** 800, **as directed**, KB of onboard nonvolatile memory.

b. Stored Data:

1) Billing Log: User configurable; data shall be recorded every 15 minutes, identified by month, day, and 15-minute interval. Accumulate 24 months of monthly data, 32 days of daily data, and between 2 to 52 days of 15-minute interval data, depending on number of quantities selected.

2) Custom Data Logs: One **OR** Three, **as directed**, user-defined log(s) holding up to 96 parameters. Date and time stamp each entry to the second and include the following user definitions:

a) Schedule interval.

b) Event definition.

c) Configured as "fill-and-hold" or "circular, first-in first-out."

3) Alarm Log: Include time, date, event information, and coincident information for each defined alarm or event.

4) Waveform Log: Store captured waveforms configured as "fill-and-hold" or "circular, first-in first-out."

c. Default values for all logs shall be initially set at factory, with logging to begin on device power up.

20. Alarms.

a. User Options:

1) Define pickup, dropout, and delay.

2) Assign one of four severity levels to make it easier for user to respond to the most important events first.

3) Allow for combining up to four alarms using Boolean-type logic statements for outputting a single alarm.

b. Alarm Events:
1) Over/undercurrent.
2) Over/undervoltage.
3) Current imbalance.
4) Phase loss, current.
5) Phase loss, voltage.
6) Voltage imbalance.
7) Over kW demand.
8) Phase reversal.
9) Digital input off/on.
10) End of incremental energy interval.
11) End of demand interval.

21. Control Power: 90- to 457-V ac or 100- to 300-V dc.
22. Communications:
a. Power monitor shall be permanently connected to communicate via Modbus TCP via a 100 Base-T Ethernet **OR** RS-485 Modbus TCP/IP, **as directed**.
b. Local plug-in connections shall be for RS-232 and 100 Base-T Ethernet.
23. Display Monitor:
a. Backlighted LCD to display metered data with touch-screen **OR** touch-pad, **as directed**, selecting device.
b. Touch-screen display shall be a minimum 12-inch diagonal, resolution of 800 by 600 RGB pixels, 256 colors; NEMA 250, Type 1 display enclosure.
c. Display four values on one screen at same time.
1) Current, per phase rms, three-phase average and neutral, **as directed**.
2) Voltage, phase to phase, phase to neutral, and three-phase averages of phase to phase and phase to neutral.
3) Real power, per phase and three-phase total.
4) Reactive power, per phase and three-phase total.
5) Apparent power, per phase and three-phase total.
6) Power factor, per phase and three-phase total.
7) Frequency.
8) Demand current, per phase and three-phase average.
9) Demand real power, three-phase total.
10) Demand apparent power, three-phase total.
11) Accumulated energy (MWh and MVARh).
12) THD, current and voltage, per phase.
d. Reset: Allow reset of the following parameters at the display:
1) Peak demand current.
2) Peak demand power (kW) and peak demand apparent power (kVA).
3) Energy (MWh) and reactive energy (MVARh).

G. Standalone, Web-Enabled Monitoring And Control Instrument
1. Separately mounted, permanently installed instrument for power monitoring and control.
a. Enclosure: NEMA 250, Type 1 **OR** 12, **as directed**.
2. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability.
a. Indoor installation in non-air-conditioned **OR** nontemperature-controlled, **as directed**, spaces that have environmental controls to maintain ambient conditions of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
3. Power-Distribution Equipment Monitor: Web enabled, with integral network port and embedded Web server with factory-configured firmware and HTML-formatted Web pages for viewing of power monitoring and equipment status information from connected devices equipped with digital communication ports.

4. LAN Connectivity: Multipoint, RS-485 Modbus serial communication network, interconnecting all breaker trip units, protective relays, drives, and metering devices equipped with communications. Serial communication network connected to Ethernet server that functions as a gateway and server, providing data access via 10 Base-T **OR** 100 Base-T **OR** 100 Base-FX, **as directed**, LAN.
5. Communication Devices within the Equipment: Addressed at factory and tested to verify reliable communication with network server.
6. Server Configuration:
   a. Initial network parameters set using a standard Web browser. Connect via a local operator interface, or an RJ-45 port accessible from front of equipment.
   b. Network server shall be factory programmed with embedded HTML-formatted Web pages that are user configurable and that provide detailed communication diagnostic information for serial and Ethernet ports as status of RS-485 network; with internal memory management information pages for viewing using a standard Web browser.
   c. Login: Password protected; password administration accessible from the LAN using a standard Web browser.
   d. Operating Software: Suitable for local access; firewall protected.
7. Data Access:
   a. Network server shall include embedded HTML pages providing real-time information from devices connected to RS-485 network ports via a standard Web browser.
8. Equipment Monitoring Options: Login shall be followed by a main menu for selecting summary Web pages that follow.
9. Summary Web pages shall be factory configured to display the following information for each communicating device within the power equipment lineup:
   a. User-Configured Custom Home Page: Provide for the lineup, showing status-at-a-glance of key operating values, **as directed**.
   b. Circuit Summary Page: Circuit name, three-phase average rms current, power (kW), power factor, and breaker status.
   c. Load Current Summary Page: Circuit name, Phase A, B, and C rms current values.
   d. Demand Current Summary Page: Circuit name, Phase A, B, and C average demand current values.
   e. Power Summary Page: Circuit name, present demand power (kW), peak demand power (kW), and recorded time and date.
   f. Energy Summary Page: Circuit name, energy (kWh), reactive energy (kVARh), and time/date of last reset.
   g. Transformer Status Page: Transformer tag, coil temperatures, and cooling fan status.
   h. Motor-Control Center Status Page: Circuit name, three-phase average rms current, thermal capacity (percentage), and drive output frequency (Hz) contactor status.
   i. Specific Device Pages: Each individual communicating device shall display detailed, real-time information, as appropriate for device type.
      1) Display historical energy data that shall be logged automatically for each device, as appropriate for device type.
      2) Display historical data logged from each device in graphical time-trend plots. Value to be displayed on time-trend plot shall be user selectable. Time interval to be displayed on scale shall be for previous day or week.
   j. Export historical energy data to a PC or workstation through network using FTP (File Transfer Protocol). Format exported data in a CSV (Comma Separated Variable) file format for importing into spreadsheet applications.
10. Communications:
   a. Power monitor: Permanently connected to communicate via RS-485 Modbus TCP/IP **OR** Modbus TCP via an 100 Base-T Ethernet, **as directed**.
   b. Local Plug-in Connections: RS-232 and 100 Base-T Ethernet.
   c. Monitor Display: Backlighted LCD to display metered data with touch-screen **OR** touch-pad, **as directed**, selecting device.

H. Workstation Hardware

1. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
   a. Indoor installation in spaces that have environmental controls to maintain ambient conditions of 36 to 122 deg F (2 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
2. Computer: Standard unmodified PC of modular design. CPU word size shall be 32 bytes or larger; CPU operating speed shall be at least 66 MHz **OR** GHz, **as directed**.
   a. Memory: 256 MB of usable installed memory, expandable to a minimum of 1024 MB without additional chassis or power supplies.
   b. Real-Time Clock:
      1) Accuracy: Plus or minus 1 minute per month.
      2) Time Keeping Format: 24-hour time format including seconds, minutes, hours, date, day, and month; automatic reset by software.
      3) Clock shall function for one year without power.
      4) Provide automatic time correction once every 24 hours by synchronizing clock with the Time Service Department of the U.S. Naval Observatory.
   c. Serial Ports: Two RS-232-F serial ports for general use, with additional ports as required. Data transmission rates shall be selectable under program control.
   d. Parallel Port: Enhanced.
   e. LAN Adapter Card: 10/100-Mbps PCI bus, internal network interface card.
   f. Sound Card: For playback and recording of digital WAV sound files associated with audible warning and alarm functions.
   g. Color Monitor: PC compatible, not less than 18 inches (455 mm), LCD type, with a minimum resolution of 1280 by 1024 pixels, noninterlaced, and a maximum dot pitch of 0.28 mm.
   h. Keyboard: Minimum of 64 characters, standard ASCII character set based on ANSI INCITS 154.
   i. Mouse: Standard, compatible with installed software.
   j. Disk Storage: Include the following, each with appropriate controller:
      1) Minimum 80-GB hard disk, maximum average access time of 10 ms.
      2) Floppy Disk Drive: High density, 3-1/2-inch (90-mm) size.
      3) PCMCIA slot with removable 500-MB media.
      4) 100-MB Iomega Zip drive.
      5) 250-MB Iomega Jaz drive.
   k. Magnetic Tape System, **as directed**: 4-mm cartridge magnetic tape system with minimum 2 **OR** 4 **OR** 12 **OR** 20, **as directed**,-GB formatted capacity per tape. Provide 10 tapes, each in a rigid cartridge with spring-loaded cover and operator-selectable write-protect feature.
   l. Modem: 56,600 bps, full duplex for asynchronous communications. With error detection, auto answer/autodial, and call-in-progress detection. Modem shall comply with requirements in ITU-T v.34, ITU-T v.42, ITU-T v.42 Appendix VI for error correction, and ITU-T v.42 BIS for data compression standards; and shall be suitable for operating on unconditioned voice-grade telephone lines complying with 47 CFR 68.
   m. Audible Alarm: Manufacturer's standard.
   n. CD-ROM Drive:
      1) Nominal Storage Capacity: 650 MB.
      2) Data Transfer Rate: 1.2 Mbps.
      3) Average Access Time: 150 ms.
      4) Cache Memory: 256 KB.
      5) Data Throughput: 1 MB/second, minimum.
   o. Report Printer: Minimum resolution 600 dpi laser printer.
      1) Connected to central station and designated workstations.
      2) RAM: 2 MB, minimum.
      3) Printing Speed: Minimum 12 pages per minute.

4) Paper Handling: Automatic sheet feeder with 250-sheet paper cassette and with automatic feed.

p. Interface: Bidirectional parallel and universal serial bus.

q. LAN Adapter Card: 10/100-Mbps internal network interface card.

3. Redundant Central Computer: Connected in a hot standby, peer configuration; automatically maintains copies of system software, application software, and data files. System transactions and other activities that alter system data files shall be updated to system files of redundant computer in near real-time. If central computer fails, redundant computer shall assume control immediately and automatically.

4. UPS: Self-contained; complying with requirements in Division 26 Section "Static Uninterruptible Power Supply".

a. Size: Provide a minimum of 6 hours of operation of workstation station equipment, including 2 hours of alarm printer operation, **as directed**.

b. Batteries: Sealed, valve regulated, recombinant, lead calcium.

c. Accessories:

1) Transient voltage suppression.
2) Input-harmonics reduction.
3) Rectifier/charger.
4) Battery disconnect device.
5) Static bypass transfer switch.
6) Internal maintenance bypass/isolation switch.
7) External maintenance bypass/isolation switch.
8) Output isolation transformer.
9) Remote UPS monitoring.
10) Battery monitoring.
11) Remote battery monitoring.

I. RS-232 ASCII Interface

1. ASCII interface shall allow RS-232 connections to be made between a meter or circuit monitor operating as the host PC and any equipment that will accept RS-232 ASCII command strings, such as local display panels **OR** dial-up modems **OR** alarm transmitters, **as directed**.

2. Pager System Interface: Alarms shall be able to activate a pager system with customized message for each input alarm.

a. RS-232 output shall be capable of connection to a pager interface that can be used to call a paging system or service and send a signal to a portable pager. System shall allow an individual alphanumeric message per alarm input to be sent to paging system. This interface shall support both numeric and alphanumeric pagers.

3. Alarm System Interface:

a. RS-232 output shall be capable of transmitting alarms from other monitoring and alarm systems to workstation software.

4. Cables:

a. PVC-Jacketed, RS-232 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; PVC jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.

1) NFPA 70, Type CM.
2) Flame Resistance: UL 1581, Vertical Tray.

b. Plenum-Type, RS-232 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; plastic jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.

1) NFPA 70, Type CMP.
2) Flame Resistance: NFPA 262, Flame Test.

J. LAN Cables

1. Comply with Division 27 Section "Communications Horizontal Cabling".

2. RS-485 Cable:
    a. PVC-Jacketed, RS-485 Cable: Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, PVC insulation, unshielded, PVC jacket, and NFPA 70, Type CMG.
    b. Plenum-Type, RS-485 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and fluorinated-ethylene-propylene jacket, and NFPA 70, Type CMP.
3. Unshielded Twisted Pair Cables: Category 5e **OR** 6, **as directed**, as specified for horizontal cable for data service in Division 27 Section "Communications Horizontal Cabling".

K. Low-Voltage Wiring
1. Low-Voltage Control Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.
    a. Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.
    b. Ordinary Switching Circuits: Three conductors, unless otherwise indicated.
    c. Switching Circuits with Pilot Lights or Locator Feature: Five conductors, unless otherwise indicated.

1.3 EXECUTION

A. Cabling
1. Comply with NECA 1.
2. Install cables and wiring according to requirements in Division 27 Section "Communications Horizontal Cabling".
3. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.
   OR
   Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use NRTL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
4. Install LAN cables using techniques, practices, and methods that are consistent with specified category rating of components and that ensure specified category performance of completed and linked signal paths, end to end.
5. Install cables without damaging conductors, shield, or jacket.

B. Identification
1. Identify components and power and control wiring according to Division 26 Section "Identification For Electrical Systems".
2. Label each power monitoring and control module with a unique designation.

C. Grounding
1. Comply with IEEE 1100, "Power and Grounding Sensitive Electronic Equipment."

D. Field Quality Control
1. Perform tests and inspections and prepare test reports.
    a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Tests and Inspections:
    a. Electrical Tests: Use caution when testing devices containing solid-state components.
    b. Continuity tests of circuits.
    c. Operational Tests: Set and operate controls at workstation and at monitored and controlled devices to demonstrate their functions and capabilities. Use a methodical sequence that cues and reproduces actual operating functions as recommended by

manufacturer. Submit sequences for approval. Note response to each test command and operation. Note time intervals between initiation of alarm conditions and registration of alarms at central-processing workstation.

1) Coordinate testing required by this Section with that required by Sections specifying equipment being monitored and controlled.
2) Test LANs according to requirements in Division 27 Section "Communications Horizontal Cabling".
3) System components with battery backup shall be operated on battery power for a period of not less than 10 percent of calculated battery operating time.
4) Verify accuracy of graphic screens and icons.
5) Metering Test: Load feeders, measure loads on feeder conductor with an rms reading clamp-on ammeter, and simultaneously read indicated current on the same phase at central-processing workstation. Record and compare values measured at the two locations. Resolve discrepancies greater than 5 percent and record resolution method and results.
6) Record metered values, control settings, operations, cues, time intervals, and functional observations and submit test reports printed by workstation printer.

3. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.
4. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.
5. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.
6. Remove and replace malfunctioning devices and circuits and retest as specified above.

E. Demonstration

1. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain systems.
   a. Train the Owner's management and maintenance personnel in interpreting and using monitoring displays and in configuring and using software and reports. Include troubleshooting, servicing, adjusting, and maintaining equipment. Provide a minimum of 12 hours' training.
   b. Training Aid: Use approved final versions of software and maintenance manuals as training aids.

END OF SECTION 26 09 23 00b

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SECTION 26 09 23 00c - MOTOR-CONTROL CENTERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for motor-control centers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes MCCs for use with ac circuits rated 600 V and less and having the following factory-installed components:
   a. Incoming main lugs and OCPDs.
   b. Full-voltage magnetic controllers.
   c. Reduced-voltage magnetic controllers.
   d. Reduced-voltage, solid-state controllers.
   e. Multispeed controllers.
   f. VFCs.
   g. Feeder-tap units.
   h. TVSS.
   i. Instrumentation.
   j. Auxiliary devices.

C. Definitions
1. BAS: Building automation system.
2. CE: Conformite Europeene (European Compliance).
3. CPT: Control power transformer.
4. EMI: Electromagnetic interference.
5. GFCI: Ground fault circuit interrupting.
6. IGBT: Insulated-gate bipolar transistor.
7. LAN: Local area network.
8. LED: Light-emitting diode.
9. MCC: Motor-control center.
10. MCCB: Molded-case circuit breaker.
11. MCP: Motor-circuit protector.
12. NC: Normally closed.
13. NO: Normally open.
14. OCPD: Overcurrent protective device.
15. PCC: Point of common coupling.
16. PID: Control action, proportional plus integral plus derivative.
17. PT: Potential transformer.
18. PWM: Pulse-width modulated.
19. RFI: Radio-frequency interference.
20. SCR: Silicon-controlled rectifier.
21. TDD: Total demand (harmonic current) distortion.
22. THD(V): Total harmonic voltage demand.
23. TVSS: Transient voltage surge suppressor.
24. VFC: Variable-frequency controller.

D. Performance Requirements
1. Seismic Performance: MCCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

E. Submittals

1. Product Data: For each type of controller and each type of MCC. Include shipping and operating weights, features, performance, electrical ratings, operating characteristics, and furnished specialties and accessories.
2. LEED Submittals:
   a. Product Data for Credit EA 5: For continuous metering equipment for energy consumption.
3. Shop Drawings: For each MCC, manufacturer's approval, custom and production drawings as defined in UL 845. In addition to requirements specified in UL 845, include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.
   a. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      1) Each installed unit's type and details.
      2) Factory-installed devices.
      3) Enclosure types and details.
      4) Nameplate legends.
      5) Short-circuit current (withstand) rating of complete MCC, and for bus structure and each unit.
      6) Features, characteristics, ratings, and factory settings of each installed controller and feeder device, and installed devices.
      7) Specified optional features and accessories.
   b. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring for each installed controller.
   c. Nameplate legends.
   d. Vertical and horizontal bus capacities.
   e. Features, characteristics, ratings, and factory settings of each installed unit.
4. Harmonic Analysis Study and Report: Comply with IEEE 399 and NETA Acceptance Testing Specification; identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze possible **OR** designated, **as directed**, operating scenarios, including recommendations for VFC input filtering to limit TDD and THD(V) at each VFC **OR** at the defined PCC, **as directed**, to specified levels.
5. Standard Drawings: For each MCC, as defined in UL 845.
6. Production Drawings: For each MCC, as defined in UL 845.
7. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around MCCs where pipe and ducts are prohibited. Show MCC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
8. Seismic Qualification Certificates: For MCCs, accessories, and components, from manufacturer.
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
9. Qualification Data: For qualified testing agency.
10. Product Certificates: For each MCC, from manufacturer.
11. Source quality-control reports.
12. Field quality-control reports.
13. Operation and Maintenance Data: For MCCs, all installed devices, and components to include in emergency, operation, and maintenance manuals. Include the following:

a. Manufacturer's Record Drawings: As defined in UL 845. In addition to requirements specified in UL 845, include field modifications and field-assigned wiring identification incorporated during construction by manufacturer, Contractor, or both.
b. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
c. Manufacturer's written instructions for setting field-adjustable overload relays.
d. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage, solid-state controllers.
e. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
f. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

14. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
15. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.
16. Warranty: Sample of special warranty.

F. Quality Assurance
1. Testing Agency Qualifications: Member company of NETA or an NRTL.
   a. Testing Agency's Field Supervisor: Currently certified by NETA **OR** one who meets the requirements necessary for certification, **as directed,** to supervise on-site testing.
2. Source Limitations: Obtain MCCs and controllers of a single type from single source from single manufacturer.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Comply with NFPA 70.
5. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".

G. Delivery, Storage, And Handling
1. Deliver MCCs in shipping splits of lengths that can be moved past obstructions in delivery paths.
2. Handle MCCs according to the following:
   a. NEMA ICS 2.3, "Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers Rated Not More Than 600 Volts."
   b. NECA 402, "Recommended Practice for Installing and Maintaining Motor Control Centers."
3. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside MCCs; install temporary electric heating, with at least 250 W per vertical section **OR** connect factory-installed space heaters to temporary electrical service, **as directed**.

H. Project Conditions
1. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   a. Ambient Temperature: Less than 0 deg F (minus 18 deg C) or exceeding 104 deg F (40 deg C), with an average value exceeding 95 deg F (35 deg C) over a 24-hour period.
   b. Ambient Storage Temperature: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C).
   c. Humidity: Less than 95 percent (noncondensing).
   d. Altitude: Exceeding 6600 feet (2000 m), or 3300 feet (1000 m) if MCC includes solid-state devices.
2. Interruption of Existing Electrical Service or Distribution Systems: Do not interrupt electrical service to, or distribution systems within, a facility occupied by the Owner or others unless

permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:

a. Notify the Owner no fewer than two days in advance of proposed interruption of electrical service.

b. Indicate method of providing temporary electrical service.

c. Do not proceed with interruption of electrical service without the Owner's written permission.

d. Comply with NFPA 70E.

3. Product Selection for Restricted Space: Drawings indicate maximum dimensions for MCCs, including clearances between MCCs and adjacent surfaces and other items.

I. Coordination

1. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases.
2. Coordinate features of MCCs, installed units, and accessory devices with remote pilot devices and control circuits to which they connect.
3. Coordinate features, accessories, and functions of each MCC, each controller, and each installed unit with ratings and characteristics of supply circuits, motors, required control sequences, and duty cycle of motors and loads.

J. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace TVSS **OR** VFCs, **as directed**, that fail in materials or workmanship within specified warranty period.
   a. Warranty Period: Five years from date of Final Completion.

1.2 PRODUCTS

A. Manufactured Units

1. General Requirements for MCCs: Comply with NEMA ICS 18 and UL 845, **as directed**.

B. Functional Features

1. Description: Modular arrangement of main units, controller units, control devices, feeder-tap units, instruments, metering, auxiliary devices, and other items mounted in vertical sections of MCC.
2. Controller Units: Combination controller units.
   a. Install units up to and including Size 3 on drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
   b. Equip units in Type B and Type C MCCs with pull-apart terminal strips for external control connections.
3. Feeder-Tap Units: Through 225-A rating shall have drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
4. Future Units: Compartments fully bused and equipped with guide rails or equivalent, ready for insertion of drawout units.
5. Spare Units: Installed in compartments indicated "spare."

C. Incoming Mains

1. Incoming Mains Location: Top and bottom, **as directed**.
2. Main Lugs Only: Conductor connectors suitable for use with conductor material and sizes.
   a. Material: Tin-plated aluminum **OR** Hard-drawn copper, 98 percent conductivity, **as directed**.
   b. Main and Neutral Lugs: Compression **OR** Mechanical, **as directed**, type.

3. MCCB: Comply with UL 489, with series-connected rating **OR** interrupting capacity, **as directed**, to meet available fault currents.
    a. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
    b. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
    c. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
        1) Instantaneous trip.
        2) Long- and short-time pickup levels.
        3) Long- and short-time time adjustments.
        4) Ground-fault pickup level, time delay, and I^2t response.
    d. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
    e. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
    f. MCCB Features and Accessories:
        1) Standard frame sizes, trip ratings, and number of poles.
        2) Lugs: Mechanical **OR** Compression, **as directed**, style, suitable for number, size, trip ratings, and conductor material.
        3) Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
        4) Ground-Fault Protection: Integrally mounted **OR** Remote-mounted, **as directed**, relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
        5) Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
        6) Communication Capability: Circuit-breaker-mounted **OR** Universal-mounted **OR** Integral **OR** Din-rail-mounted, **as directed**, communication module with functions and features compatible with power monitoring and control system specified in Division 16 Section "Electrical Power Monitoring and Control."
        7) Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 **OR** 75, **as directed**, percent of rated voltage.
        8) Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
        9) Auxiliary Contacts: One SPDT switch **OR** Two SPDT switches, **as directed**, with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
        10) Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
4. Insulated-Case Circuit Breaker: 80 **OR** 100, **as directed**, percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
    a. Fixed **OR** Drawout, **as directed**, circuit-breaker mounting.
    b. Two-step, stored-energy closing.
    c. Standard **OR** Full, **as directed**,-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
        1) Instantaneous trip.
        2) Long- and short-time time adjustments.
        3) Ground-fault pickup level, time delay, and I^2t response.
    d. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
    e. Remote trip indication and control.

f. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Division 16 Section "Electrical Power Monitoring and Control."

g. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

h. Control Voltage: 40-V dc **OR** 125-V dc **OR** 250-V dc **OR** 120-V ac, **as directed**.

D. Combination Controllers

1. Full-Voltage Controllers:
   a. General Requirements for Full-Voltage Enclosed Controllers: Comply with NEMA ICS 2, general purpose, Class A.
   b. Magnetic Controllers: Full voltage, across the line, electrically held.
      1) Configuration: Nonreversing and reversing.
2. Reduced-Voltage Magnetic Controllers:
   a. General Requirements for Reduced-Voltage Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A; closed transition; adjustable time delay on transition.
   b. Reduced-Voltage Magnetic Controllers: Reduced voltage, electrically held.
      1) Configuration:
         a) Wye-Delta Controller: Four contactors, with a three-phase starting resistor/reactor bank.
         b) Part-Winding Controller: Separate START and RUN contactors, field-selectable for one-half or two-thirds winding start mode, with either six- or nine-lead motors; with separate overload relays for starting and running sequences.
         c) Autotransformer Reduced-Voltage Controller: Medium-duty service, with integral overtemperature protection; taps for starting at 50, 65, and 80 percent of line voltage; two START and one RUN contactors.
3. Reduced-Voltage, Solid-State Controllers:
   a. General Requirements for Reduced-Voltage, Solid-State Controllers: Comply with UL 508.
   b. Reduced-Voltage, Solid-State Controllers: An integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and keypad, bypass contactor, and overload relay; suitable for use with NEMA MG 1, Design B, polyphase, medium-induction motors.
      1) Configuration: Standard duty **OR** Severe duty, **as directed**; nonreversible **OR** reversible, **as directed**.
      2) Starting Mode: Voltage ramping **OR** Current limit **OR** Torque control **OR** Torque control with voltage boost, **as directed**; field selectable, **as directed**.
      3) Stopping Mode: Coast to stop **OR** Adjustable torque deceleration **OR** Adjustable braking, **as directed**; field selectable, **as directed**.
      4) Shorting (Bypass) Contactor: Operates automatically when full voltage is applied to motor, and bypasses the SCRs. Solid-state controller protective features shall remain active when the shorting contactor is in the bypass mode.
      5) Shorting and Input Isolation, **as directed**, Contactor Coils: Pressure-encapsulated type; manufacturer's standard operating voltage, matching control power or line voltage, depending on contactor size and line-voltage rating. Provide coil transient suppressors, **as directed**.
      6) Logic Board: Identical for all ampere ratings and voltage classes, with environmental protective coating.
      7) Adjustable acceleration-rate control using voltage or current ramp, and adjustable starting torque control with up to 400 percent current limitation for 20 seconds.
      8) SCR bridge shall consist of at least two SCRs per phase, providing stable and smooth acceleration with **OR** without, **as directed**, external feedback from the motor or driven equipment.

9) Keypad, front accessible; for programming the controller parameters, functions, and features; shall be manufacturer's standard and include not less than the following functions:
   a) Adjusting motor full-load amperes, as a percentage of the controller's rating.
   b) Adjusting current limitation on starting, as a percentage of the motor full-load current rating.
   c) Adjusting linear acceleration and deceleration ramps, in seconds.
   d) Initial torque, as a percentage of the nominal motor torque.
   e) Adjusting torque limit, as a percentage of the nominal motor torque.
   f) Adjusting maximum start time, in seconds.
   g) Adjusting voltage boost, as a percentage of the nominal supply voltage.
   h) Selecting stopping mode, and adjusting parameters.
   i) Selecting motor thermal-overload protection class between 5 and 30.
   j) Activating and de-activating protection modes.
   k) Selecting or activating communications modes.
10) Digital display, front accessible; for showing motor, controller, and fault status; shall be manufacturer's standard and include not less than the following:
   a) Controller Condition: Ready, starting, running, stopping.
   b) Motor Condition: Amperes, voltage, power factor, power, and thermal state.
   c) Fault Conditions: Controller thermal fault, motor overload alarm and trip, motor underload, overcurrent, shorted SCRs, line or phase loss, phase reversal, and line frequency over or under normal.
11) Controller Diagnostics and Protection:
   a) Microprocessor-based thermal protection system for monitoring SCR and motor thermal characteristics, and providing controller overtemperature and motor overload alarm and trip; settings selectable via the keypad.
   b) Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and underload conditions; and line frequency over or under normal.
   c) Input isolation contactor that opens when the controller diagnostics detect a faulted solid-state component, or when the motor is stopped.
      OR
      Shunt trip that opens the disconnecting means when the controller diagnostics detect a faulted solid-state component.
12) Remote Output Features:
   a) All outputs prewired to terminal blocks.
   b) Form C status contacts that change state when controller is running.
   c) Form C alarm contacts that change state when a fault condition occurs.
13) Optional Features:
   a) Analog output for field-selectable assignment of motor operating characteristics; 0 to 10-V dc **OR** 4 to 20-mA dc, **as directed**.
   b) Additional field-assignable Form C contacts for alarm outputs.
   c) Surge suppressors in solid-state power circuits providing three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
   d) Full-voltage bypass contactor operating automatically **OR** manually, with NORMAL/BYPASS selector switch, **as directed**. Power contacts shall be totally enclosed, double break, and silver-cadmium oxide; and assembled to allow inspection and replacement without disturbing line or load wiring.

4. Multispeed Magnetic Controllers:
   a. General Requirements for Multispeed Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A.
   b. Multispeed Magnetic Controllers: Two speed, full voltage, across the line, electrically held. Compelling relay to ensure that motor will start only at low speed.
      1) Configuration: Nonreversing **OR** Reversing, **as directed**; consequent pole **OR** two winding, **as directed**.

2) Compelling relays shall ensure that motor starts only at low speed.
3) Accelerating timer relays shall ensure properly timed acceleration through speeds lower than that selected.
4) Decelerating timer relays shall ensure automatically timed deceleration through each speed.
5) Antiplugging timer relays shall ensure a time delay when transferring from FORWARD to REVERSE and back.

5. Disconnecting Means and OCPDs:
   a. Fusible Disconnecting Means:
      1) NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class J **OR** Class L, **as directed**, fuses.
      2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
      3) Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
   b. MCP Disconnecting Means:
      1) UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
      2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
      3) Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
      4) NC **OR** NO, **as directed**, alarm contact that operates only when MCP has tripped.
      5) Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.
   c. MCCB Disconnecting Means:
      1) UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
      2) Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
      3) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
      4) Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
      5) NC **OR** NO, **as directed**, alarm contact that operates only when MCCB has tripped.
   d. Molded-Case Switch Disconnecting Means:
      1) UL 489, NEMA AB 1, and NEMA AB 3, with in-line fuse block for Class J or L power fuses (depending on ampere rating), providing an interrupting capacity to comply with available fault currents; MCCB with fixed, high-set instantaneous trip only.
      2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
      3) Auxiliary contacts "a" and "b" arranged to activate with molded-case switch handle.
      4) NC **OR** NO, **as directed**, alarm contact that operates only when molded-case switch has tripped.
6. Overload Relays:
   a. Melting-Alloy Overload Relays:
      1) Inverse-time-current characteristic.
      2) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic.
      3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
   b. Bimetallic Overload Relays:
      1) Inverse-time-current characteristic.
      2) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic.
      3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
      4) Ambient compensated.

5) Automatic resetting.

c. Solid-State Overload Relays:

1) Switch or dial selectable for motor running overload protection.
2) Sensors in each phase.
3) Class 10 **OR** Class 20 **OR** Class 10/20 selectable, **as directed**, tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
    a) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
    b) Analog communication module.

d. NC **OR** NO, **as directed**, isolated overload alarm contact.

e. External overload reset push button.

7. Control Power:

a. Control Circuits: 24 **OR** 120, **as directed**,-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT **OR** control power source, **as directed**, of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.

1) CPT Spare Capacity: 50 **OR** 100 **OR** 200, **as directed**, VA.

E. VFCS

1. General Requirements for VFCs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C, **as directed**.
2. Application: Constant torque and variable torque, **as directed**.
3. VFC Description: Variable-frequency power converter (rectifier, dc bus, and IGBT PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
    a. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
    b. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
    c. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
    d. Listed and labeled for single-phase use by an NRTL acceptable to authorities having jurisdiction.
4. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
5. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range **OR** 66 Hz, with torque constant as speed changes, **as directed**; maximum voltage equals input voltage.
6. Unit Operating Requirements:
    a. Input AC Voltage Tolerance: Plus 10 and minus 10 **OR** 15, **as directed**, percent of VFC input voltage rating.
    b. Input AC Voltage Unbalance: Not exceeding 3 **OR** 5, **as directed**, percent.
    c. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
    d. Minimum Efficiency: 96 **OR** 97, **as directed**, percent at 60 Hz, full load.
    e. Minimum Displacement Primary-Side Power Factor: 96 **OR** 98, **as directed**, percent under any load or speed condition.
    f. Overload Capability: 1.1 **OR** 1.5, **as directed**, times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
    g. Starting Torque: Minimum of 100 percent of rated torque from 3 to 60 Hz.
    h. Speed Regulation: Plus or minus 5 **OR** 10, **as directed**, percent.
    i. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.

j. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

7. Inverter Logic: Microprocessor based, 16 **OR** 32, **as directed**, bit, isolated from all power circuits.
8. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
   a. Signal: Electrical.
   OR
   Signal: Pneumatic.
9. Internal Adjustability Capabilities:
   a. Minimum Speed: 5 to 25 percent of maximum rpm.
   b. Maximum Speed: 80 to 100 percent of maximum rpm.
   c. Acceleration: 0.1 to 999.9 seconds.
   d. Deceleration: 0.1 to 999.9 seconds.
   e. Current Limit: 30 to a minimum of 150 percent of maximum rating.
10. Self-Protection and Reliability Features:
   a. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
   b. Loss of Input Signal Protection: Selectable response strategy including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
   c. Under- and overvoltage trips.
   d. Inverter overcurrent trips.
   e. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
   f. Critical frequency rejection, with three selectable, adjustable deadbands.
   g. Instantaneous line-to-line and line-to-ground overcurrent trips.
   h. Loss-of-phase protection.
   i. Reverse-phase protection.
   j. Short-circuit protection.
   k. Motor overtemperature fault.
11. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
12. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.
13. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
14. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
15. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
16. Integral Input Disconnecting Means and OCPD: NEMA AB 1, instantaneous-trip circuit breaker **OR** NEMA AB 1, molded-case switch, with power fuse block and current-limiting fuses **OR** NEMA AB 1, thermal-magnetic circuit breaker **OR** NEMA KS 1, nonfusible switch, with power fuse block and current-limiting fuses **OR** NEMA KS 1, fusible switch, **as directed**, with pad-lockable, door-mounted handle mechanism.
   a. Disconnect Rating (for VFCs without bypass systems): Not less than 115 percent of VFC input current rating.
   b. Disconnect Rating (for VFCs with bypass systems): Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
   c. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.

d. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
e. NC **OR** NO, **as directed**, alarm contact that operates only when circuit breaker has tripped.

F. VFC Controls And Indication
1. Status Lights: Door-mounted LED indicators displaying the following conditions:
a. Power on.
b. Run.
c. Overvoltage.
d. Line fault.
e. Overcurrent.
f. External fault.
2. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
a. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
b. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
1) Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.
3. Historical Logging Information and Displays:
a. Running log of total power versus time.
b. Total run time.
c. Fault log, maintaining last four faults with time and date stamp for each.
4. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters, including, but not limited to:
a. Output frequency (Hz).
b. Motor speed (rpm).
c. Motor status (running, stop, fault).
d. Motor current (amperes).
e. Motor torque (percent).
f. Fault or alarming status (code).
g. PID feedback signal (percent).
h. DC-link voltage (V dc).
i. Set point frequency (Hz).
j. Motor output voltage (V ac).
5. Control Signal Interfaces:
a. Electric Input Signal Interface:
1) A minimum of two programmable analog inputs: 0- to 10-V dc **OR** 4- to 20-mA dc **OR** Operator-selectable "x"- to "y"-mA dc, **as directed**.
2) A minimum of six multifunction programmable digital inputs.
b. Pneumatic Input Signal Interface: 3 to 15 psig (20 to 104 kPa).
c. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:
1) 0- to 10-V dc.
2) 4- to 20-mA dc.
3) Potentiometer using up/down digital inputs.
4) Fixed frequencies using digital inputs.
d. Output Signal Interface: A minimum of one programmable analog output signal(s) (0- to 10-V dc **OR** 4- to 20-mA dc **OR** operator-selectable "x"- to "y"-mA dc, **as directed**), which can be configured for any of the following:
1) Output frequency (Hz).
2) Output current (load).

3) DC-link voltage (V dc).
4) Motor torque (percent).
5) Motor speed (rpm).
6) Set point frequency (Hz).

e. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
1) Motor running.
2) Set point speed reached.
3) Fault and warning indication (overtemperature or overcurrent).
4) PID high- or low-speed limits reached.

6. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.
a. Number of Loops: One **OR** Two, **as directed**.

7. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFC status and alarms and energy usage, **as directed**. Allows VFC to be used with an external system within a multidrop LAN configuration; settings retained within VFC's nonvolatile memory.
a. Network Communications Ports: Ethernet and RS-422/485.
b. Embedded BAS Protocols for Network Communications: ASHRAE 135 BACnet **OR** Echelon LonWorks **OR** Ethernet TCP/IP **OR** Johnson Metasys N2 **OR** Modbus/Memobus **OR** Siemens System 600 APOGEE **OR** an acceptable equivalent, **as directed**; protocols accessible via the communications ports.

G. VFC Line Conditioning And Filtering
1. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD at input terminals of VFCs to less than 5 **OR** 8, **as directed**, percent and THD(V) to 3 **OR** 5, **as directed**, percent.
2. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD and THD(V) at the defined PCC per IEEE 519.
3. Input Line Conditioning: <**Insert requirements**>.
4. VFC Output Filtering: <**Insert requirements**>.
5. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

H. VFC Bypass Systems
1. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes, and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.
2. Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.
OR
Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic control system feedback.
3. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode, **as directed**.
a. Bypass Contactor: Load-break, IEC **OR** NEMA, **as directed**,-rated contactor.
b. Output Isolating Contactor: Non-load-break, IEC **OR** NEMA, **as directed**,-rated contactor.
c. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

OR
Bypass Controller: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier, **as directed**, arranged to isolate the power converter input and output and permit safe testing and troubleshooting of the power converter, both energized and de-energized, while motor is operating in bypass mode.

a. Bypass Contactor: Load-break, IEC **OR** NEMA, **as directed**,-rated contactor.
b. Input and Output Isolating Contactors: Non-load-break, IEC **OR** NEMA, **as directed**,-rated contactors.
c. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

4. Bypass Contactor Configuration: Full-voltage (across-the-line) **OR** Reduced-voltage (autotransformer), **as directed**, type.
   a. NORMAL/BYPASS selector switch.
   b. HAND/OFF/AUTO selector switch.
   c. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
   d. Contactor Coils: Pressure-encapsulated type with coil transient suppressors, **as directed**.
      1) Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
      2) Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
   e. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses **as directed**, with CPT **OR** control power source, **as directed**, of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
   f. CPT Spare Capacity: 50 **OR** 100 **OR** 200, **as directed**, VA.
5. Overload Relays: NEMA ICS 2.
   a. Melting-Alloy Overload Relays:
      1) Inverse-time-current characteristic.
      2) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic.
      3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
   b. Bimetallic Overload Relays:
      1) Inverse-time-current characteristic.
      2) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic.
      3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
      4) Ambient compensated.
      5) Automatic resetting.
   c. Solid-State Overload Relays:
      1) Switch or dial selectable for motor-running overload protection.
      2) Sensors in each phase.
      3) Class 10 **OR** Class 20 **OR** Class 10/20 selectable, **as directed**, tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
      4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
      5) Analog communication module.
      6) NC **OR** NO, **as directed**, isolated overload alarm contact.
      7) External overload reset push button.

I. Optional VFC Features
1. Multiple-Motor Capability: VFC suitable for variable-speed service to multiple motors. Overload protection shuts down VFC and motors served by it, and generates fault indications, when overload protection activates.

a. Configure to allow two or more motors to operate simultaneously at the same speed; separate overload relay for each controlled motor.
b. Configure to allow two motors to operate separately; operator selectable via local or remote switch or contact closures; single overload relay for both motors; separate output magnetic contactors for each motor.
c. Configure to allow two motors to operate simultaneously and in a lead/lag mode, with one motor operated at variable speed via the power converter and the other at constant speed via the bypass controller; separate overload relay for each controlled motor.

2. Damper control circuit with end of travel feedback capability.
3. Sleep Function: Senses a minimal deviation of a feedback signal and stops the motor. On an increase in speed-command signal deviation, VFC resumes normal operation.
4. Motor Preheat Function: Preheats motor when idle to prevent moisture accumulation in the motor.
5. Firefighter's Override (Smoke Purge) Input: On a remote contact closure from the firefighter's control station **OR** smoke-control fan controller, **as directed**, this password-protected input:
   a. Overrides all other local and external inputs (analog/digital, serial communication, and all keypad commands).
   b. Forces VFC to operate motor, without any other run or speed command, at a field-adjustable, preset speed.
      OR
      Forces VFC to transfer to Bypass Mode and operate motor at full speed.
   c. Causes display of Override Mode on the VFC display.
   d. Reset VFC to normal operation on removal of override signal automatically **OR** manually, **as directed**.
6. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.
7. Remote digital operator kit.
8. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

J. Feeder-Tap Units
1. MCCB: Comply with UL 489, with series-connected rating **OR** interrupting capacity, **as directed**, to meet available fault currents.
   a. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   b. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
   c. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
      1) Instantaneous trip.
      2) Long- and short-time pickup levels.
      3) Long- and short-time time adjustments.
      4) Ground-fault pickup level, time delay, and I^2t response.
   d. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
   e. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
   f. MCCB Features and Accessories:
      1) Standard frame sizes, trip ratings, and number of poles.
      2) Lugs: Mechanical **OR** Compression, **as directed**, style, suitable for number, size, trip ratings, and conductor material.
      3) Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

4) Ground-Fault Protection: Integrally mounted **OR** Remote-mounted, **as directed**, relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
5) Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
6) Communication Capability: Circuit-breaker-mounted **OR** Universal-mounted **OR** Integral **OR** Din-rail-mounted, **as directed**, communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring And Control".
7) Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 **OR** 75, **as directed**, percent of rated voltage.
8) Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
9) Auxiliary Contacts: One SPDT switch **OR** Two SPDT switches, **as directed**, with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
10) Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

2. Fusible Switch: NEMA KS 1, Type HD, clips to accommodate specified fuses with lockable handle.
3. Fuses are specified in Division 26 Section "Fuses".

K. Transient Voltage Suppression Devices

1. Surge Protection Device Description: IEEE C62.41-compliant, integrally mounted, wired-in **OR** plug-in **OR** bolt-on, **as directed**, solid-state, parallel-connected, modular (with field-replaceable modules) **OR** non-modular, **as directed**, type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the MCC short-circuit rating, and with the following features and accessories:
   a. Fuses, rated at 200-kA interrupting capacity.
   b. Fabrication using bolted compression lugs for internal wiring.
   c. Integral disconnect switch.
   d. Redundant suppression circuits.
   e. Redundant replaceable modules.
   f. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
   g. LED indicator lights for power and protection status.
   h. Audible alarm, with silencing switch, to indicate when protection has failed.
   i. Form-C contacts rated at 5 A and 250-V ac, one NO and one NC, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
   j. Four **OR** Six, **as directed**,-digit, transient-event counter set to totalize transient surges.
2. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA per phase **OR** 120 kA per mode/240 kA per phase **OR** 80 kA per mode/160 kA per phase, **as directed**.
3. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
4. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 **OR** 208Y/120 **OR** 600Y/347, **as directed**,-V, three-phase, four-wire circuits shall be as follows:
   a. Line to Neutral: 800 V for 480Y/277 **OR** 400 V for 208Y/120 **OR** 1200 V for 600Y/347, **as directed**.
   b. Line to Ground: 800 V for 480Y/277 **OR** 400 V for 208Y/120 **OR** 1200 V for 600Y/347, **as directed**.
   c. Neutral to Ground: 800 V for 480Y/277 **OR** 400 V for 208Y/120 **OR** 1200 V for 600Y/347, **as directed**.

   OR

   Protection modes and UL 1449 SVR for 240/120-V, three-phase, four-wire circuits with high leg shall be as follows:

a. Line to Neutral: 400 V, 800 V from high leg.
b. Line to Ground: 400 V.
c. Neutral to Ground: 400 V.

OR

Protection modes and UL 1449 SVR for 240-, 480-, or 600-V, three-phase, three-wire, delta circuits shall be as follows:

a. Line to Line: 2000 V for 480 V **OR** 1000 V for 240 V **OR** 2500 V for 600 V, **as directed**.
b. Line to Ground: 1500 V for 480 V **OR** 800 V for 240 V **OR** 2500 V for 600 V, **as directed**.

L. Instrumentation
1. Instrument Transformers (for the Owner metering): IEEE C57.13, NEMA EI 21.1, and the following:
    a. PTs: IEEE C57.13; 120 V, 60 Hz, single **OR** tapped **OR** double, **as directed**, secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
    b. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; wound **OR** bushing **OR** bar or window, **as directed**, type; single **OR** double, **as directed**, secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
    c. CPTs: Dry type, mounted in separate compartments for units larger than 3 kVA.
    d. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.
2. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
    a. Listed or recognized by a nationally recognized testing laboratory.
    b. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
    c. Switch-selectable digital display of the following values with the indicated maximum accuracy tolerances:
        1) Phase Currents, Each Phase: Plus or minus 1 percent.
        2) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
        3) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
        4) Three-Phase Real Power (Megawatts): Plus or minus 2 percent.
        5) Three-Phase Reactive Power (Megavars): Plus or minus 2 percent.
        6) Power Factor: Plus or minus 2 percent.
        7) Frequency: Plus or minus 0.5 percent.
        8) Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
        9) Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
        10) Contact devices to operate remote impulse-totalizing demand meter.
    d. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
3. Ammeters, Voltmeters, and Power-Factor Meters: ANSI C39.1.
    a. Meters: 4-inch (100-mm) diameter or 6 inches (150 mm) square, flush or semiflush, with antiparallax 250-degree scale and external zero adjustment.
    b. Voltmeters: Cover an expanded-scale range of nominal voltage plus 10 percent.
4. Instrument Switches: Rotary type with off position.
    a. Voltmeter Switches: Permit reading of all phase-to-phase voltages and phase-to-neutral voltages where a neutral is included.
    b. Ammeter Switches: Permit reading of current in each phase and maintain current-transformer secondaries in a closed-circuit condition at all times.

5. Feeder Ammeters: 2-1/2-inch (64-mm) minimum size with 90- or 120-degree scale. Meter and transfer device with off position, located on overcurrent device door for feeder circuits, unless otherwise indicated.
6. Watt-Hour Meters and Wattmeters:
   a. Comply with ANSI C12.1.
   b. Three-phase induction type with two stators, each with current and potential coil, rated 5 A, 120 V, 60 Hz.
   c. Suitable for connection to three- and four-wire circuits.
   d. Potential indicating lamps.
   e. Adjustments for light and full load, phase balance, and power factor.
   f. Four-dial clock register.
   g. Integral demand indicator.
      OR
      Contact devices to operate remote impulse-totalizing demand meter.
   h. Ratchets to prevent reverse rotation.
   i. Removable meter with drawout test plug.
   j. Semiflush mounted case with matching cover.
   k. Appropriate multiplier tag.
7. Impulse-Totalizing Demand Meter:
   a. Comply with ANSI C12.1.
   b. Suitable for use with MCC watt-hour meter, including two-circuit totalizing relay.
   c. Cyclometer.
   d. Four-dial, totalizing kilowatt-hour register.
   e. Positive chart drive mechanism.
   f. Capillary pen holding a minimum of one month's ink supply.
   g. Roll chart with minimum 31-day capacity; appropriate multiplier tag.
   h. Capable of indicating and recording five **OR** 15 **OR** 30, **as directed**,-minute integrated demand of totalized system.

M. MCC Control Power
1. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from CPT.
   OR
   Control Circuits: 120-V ac, supplied from remote branch circuit.
2. Electrically Interlocked Main and Tie Circuit Breakers: Two CPTs in separate compartments, with interlocking relays, connected to the primary side of each CPT at the line side of the associated main circuit breaker. 120-V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.
3. Control Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
4. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

N. Enclosures
1. Indoor Enclosures: Freestanding steel cabinets unless otherwise indicated. NEMA 250, Type 1 **OR** Type 1A **OR** Type 2 **OR** Type 12, **as directed**, unless otherwise indicated to comply with environmental conditions at installed location.
2. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.
   a. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point **OR** Manual switching of branch-circuit protective device, **as directed**.
   b. Space-Heater Power Source: Transformer, factory installed in MCC **OR** 120-V external branch circuit, **as directed**.
3. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray **OR** custom color, **as directed**, finish over a rust-inhibiting primer on treated metal surface.

4. Outdoor Enclosures: Type 3R, non-walk-in aisle **OR** Type 3R, with interior-lighted walk-in aisle, **as directed**.
   a. Finish: Factory-applied finish in manufacturer's standard **OR** custom, **as directed**, color; undersurfaces treated with corrosion-resistant undercoating.
   b. Enclosure: Flat **OR** Downward, rearward sloping, **as directed**, roof; bolt-on rear covers **OR** rear hinged doors, **as directed**, for each section, with provisions for padlocking.
   c. Doors: Personnel door at each end of aisle, minimum width of 30 inches (762 mm); opening outwards; with panic hardware and provisions for padlocking **OR** cylinder lock, **as directed**.
   d. Accessories: Fluorescent lighting fixtures, ceiling mounted; wired to a three-way light switch at each end of aisle; GFCI duplex receptacle; emergency battery pack lighting fixture installed on wall of aisle midway between personnel doors.
   e. Walk-in Aisle Heating and Ventilating:
      1) Factory-installed electric unit heater(s), wall or ceiling mounted, with integral thermostat and disconnect and with capacities to maintain switchboard interior temperature of 40 deg F (5 deg C) with outside design temperature of 104 deg F (40 deg C).
      2) Factory-installed exhaust fan with capacities to maintain switchboard interior temperature of 100 deg F (38 deg C) with outside design temperature of 23 deg F (minus 5 deg C).
      3) Ventilating openings complete with replaceable fiberglass air filters, **as directed.**
      4) Thermostat: Single stage; wired to control heat and exhaust fan.
   f. Power for Space Heaters, Ventilation, Lighting, and Receptacle: Include a CPT within the switchboard. Supply voltage shall be 120 **OR** 120/240 **OR** 120/208, **as directed**,-V ac.
      OR
      Power for space heaters, ventilation, lighting, and receptacle provided by a remote source.
5. Compartments: Modular; individual lift-off, **as directed**, doors with concealed hinges and quick-captive screw fasteners. Interlocks on units requiring disconnecting means in off position before door can be opened or closed, except by operating a permissive release device.
6. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC; same size compartments to permit interchangeability and ready rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.
7. Wiring Spaces:
   a. Vertical wireways in each vertical section for vertical wiring to each unit compartment; supports to hold wiring in place.
   b. Horizontal wireways in bottom **OR** top **OR** bottom and top, **as directed**, of each vertical section for horizontal wiring between vertical sections; supports to hold wiring in place.

O. Auxiliary Devices
1. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
   a. Push Buttons, Pilot Lights, and Selector Switches: Heavy **OR** Standard, **as directed**,-duty, oiltight, **as directed**, type.
      1) Push Buttons: Covered **OR** Lockable **OR** Recessed **OR** Shielded **OR** Shrouded **OR** Unguarded, **as directed**, types; maintained **OR** momentary, **as directed**, contact unless otherwise indicated.
      2) Pilot Lights: Incandescent **OR** LED **OR** Neon **OR** Resistor **OR** Transformer, **as directed**, types; <**Insert color(s)**>; push to test, **as directed**.
      3) Selector Switches: Rotary type.
   b. Elapsed-Time Meters: Heavy duty with digital readout in hours; nonresettable **OR** resettable, **as directed**.
   c. Meters: Panel type, 2-1/2-inch (64-mm) minimum size with 90- or 120-degree scale and plus or minus 2 percent accuracy with selector switches having an off position.
2. NC **OR** NO **OR** Reversible NC/NO, **as directed**, contactor auxiliary contact(s).

3. Control Relays: Auxiliary and adjustable pneumatic **OR** solid-state, **as directed**, time-delay relays.
4. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
5. Space heaters, with NC auxiliary contacts, to mitigate condensation in enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
6. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
7. Cover gaskets for Type 1 enclosures.
8. Terminals for connecting power factor correction capacitors to the line **OR** load, **as directed**, side of overload relays.
9. Spare control-wiring terminal blocks; unwired **OR** wired, **as directed**.
10. Spare-Fuse Cabinet: Identified and compartmented steel box **OR** cabinet with hinged lockable door, **as directed**.

P. Characteristics And Ratings

1. Wiring: NEMA ICS 18, Class I **OR** Class I-S, **as directed**, Type A **OR** Type B, for starters above Size 3 **OR** Type B-D, for starter Size 3 and below **OR** Type B-T, for starter Size 3 and below **OR** Type C, **as directed**.
   OR
   Wiring: NEMA ICS 18, Class II **OR** Class II-S, **as directed**, Type B, for starters above Size 3 **OR** Type B-D, for starter Size 3 and below **OR** Type B-T, for starter Size 3 and below **OR** Type C, **as directed**.
2. Control and Load Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.
3. Nominal System Voltage: 480 V, three phase, three wire **OR** 480Y/277 V, three phase, four wire, **as directed**.
   OR
   Nominal System Voltage: 208 V, three phase, three wire **OR** 208/120 V, three phase, four wire, **as directed**.
4. Short-Circuit Current Rating for Each Unit: Combination series rated **OR** Fully rated, **as directed**; 22 **OR** 42 **OR** 65 **OR** 100, **as directed**, kA.
5. Short-Circuit Current Rating of MCC: Combination series rated **OR** Fully rated, **as directed**, with its main overcurrent device; 22 **OR** 42 **OR** 65 **OR** 100, **as directed**, kA.
6. Environmental Ratings:
   a. Ambient Temperature Rating: Not less than 0 deg F (minus 18 deg C) and not exceeding 104 deg F (40 deg C), with an average value not exceeding 95 deg F (35 deg C) over a 24-hour period.
   b. Ambient Storage Temperature Rating: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C)
   c. Humidity Rating: Less than 95 percent (noncondensing).
   d. Altitude Rating: Not exceeding 6600 feet (2000 m), or 3300 feet (1000 m) if MCC includes solid-state devices.
7. Main-Bus Continuous Rating: 600 **OR** 800 **OR** 1000 **OR** 1200 **OR** 1600 **OR** 2000, **as directed**, A.
8. Vertical-Bus Minimum, **as directed**, Continuous Rating: 300 **OR** 600 **OR** 1200, **as directed**, A.
9. Horizontal and Vertical Bus Bracing (Short-Circuit Current Rating): Match MCC short-circuit current rating.
10. Main Horizontal and Equipment Ground Buses: Uniform capacity for entire length of MCC's main and vertical sections. Provide for future extensions from both ends, **as directed**. Brace bus extensions for busway feeder bus, **as directed**.
11. Vertical Phase and Equipment Ground Buses: Uniform capacity for entire usable height of vertical sections, except for sections incorporating single units.

12. Phase- and Neutral-, **as directed**,Bus Material: Hard-drawn copper of 98 percent conductivity, silver **OR** tin, **as directed**, plated.
    OR
    Phase- and Neutral-, **as directed**,Bus Material: Tin-plated, high-strength, electrical-grade aluminum alloy.
13. Neutral Buses: 50 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical **OR** compression, **as directed**, connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus, **as directed**.
    OR
    Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical **OR** compression, **as directed**, connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus, **as directed**.
14. Ground Bus: Minimum size required by UL 845, hard-drawn copper of 98 percent conductivity, equipped with mechanical **OR** compression, **as directed**, connectors for feeder and branch-circuit equipment grounding conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run, **as directed**.
15. Front-Connected, Front-Accessible MCCs:
    a. Main Devices: Drawout **OR** Fixed, **as directed**, mounted.
    b. Controller Units: Drawout and fixed, **as directed**, mounted.
    c. Feeder-Tap Units: Drawout and fixed, **as directed**, mounted.
    d. Sections front and rear aligned.
16. Utility Metering Compartment: Fabricated, barrier compartment and section complying with utility company's requirements; hinged sealed door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic MCC. Provide service entrance label and necessary applicable service entrance features.
17. the Owner Metering Compartment: A separate customer metering compartment and section with front hinged door, metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks, **as directed**.
18. Bus Transition and Incoming Pull Sections: Matched and aligned with basic MCC.
19. Pull Box on Top of an MCC:
    a. Adequate ventilation to maintain temperature in pull box within same limits as MCC.
    b. Set back from front to clear circuit-breaker removal mechanism.
    c. Removable covers forming top, front, and sides. Top covers at rear easily removable for drilling and cutting.
    d. Insulated bottom of fire-resistive material with separate holes for cable drops into MCC.
    e. Cable supports arranged to facilitate cabling and adequate to support cables, including those for future installation.
    f. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
20. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of unit.
21. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.
22. Fungus Proofing: Permanent fungicidal treatment for OCPDs and other components including instruments and instrument transformers.

Q. Source Quality Control
1. MCC Testing: Inspect and test MCCs according to requirements in NEMA ICS 18.
2. VFC Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.
    a. Test each VFC while connected to its specified motor **OR** a motor that is comparable to that for which the VFC is rated, **as directed**.

b. Verification of Performance: Rate VFCs according to operation of functions and features specified.
3. MCCs will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

1.3 EXECUTION

A. Examination
1. Examine areas and surfaces to receive MCCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.
2. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Harmonic Analysis Study
1. Perform a harmonic analysis study to identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze possible **OR** designated, **as directed**, operating scenarios, including recommendations for VFC input filtering to limit TDD and THD(V) at the defined PCC to specified levels.
2. Prepare a harmonic analysis study report complying with IEEE 399 and NETA Acceptance Testing Specification.

C. Installation
1. Coordinate layout and installation of MCCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
2. Floor-Mounting Controllers: Install MCCs on 4-inch (100-mm) nominal thickness concrete base. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-place Concrete".
   a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   d. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Seismic Bracing: Comply with requirements specified in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
4. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
5. Install fuses in each fusible switch.
6. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses".
7. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
8. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
9. Install power factor correction capacitors. Connect to the line **OR** load, **as directed**, side of overload relays. If connected to the load side of overload relays, adjust overload heater sizes to accommodate the reduced motor full-load currents.
10. Comply with NECA 1.

D. Identification
1. Comply with requirements in Division 26 Section "Identification For Electrical Systems" for identification of MCC, MCC components, and control wiring.

a. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
b. Label MCC and each cubicle with engraved nameplate.
c. Label each enclosure-mounted control and pilot device.
d. Mark up a set of manufacturer's connection wiring diagrams with field-assigned wiring identifications and return to manufacturer for inclusion in Record Drawings.

2. Operating Instructions: Frame printed operating instructions for MCCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of MCCs.

E. Control Wiring Installation

1. Install wiring between enclosed controllers **OR** master terminal boards, **as directed**, and remote devices and facility's BAS **OR** and facility's central-control system, **as directed**. Comply with requirements in Division 26 Section "Control-voltage Electrical Power Cables".
2. Bundle, train, and support wiring in enclosures.
3. Connect selector switches and other automatic-control selection devices where applicable.
   a. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
   b. Connect selector switches within enclosed controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

F. Connections

1. Comply with requirements for installation of conduit in Division 26 Section "Raceway And Boxes For Electrical Systems". Drawings indicate general arrangement of conduit, fittings, and specialties.
2. Comply with requirements in Division 26 Section "Grounding And Bonding For Electrical Systems".

G. Field Quality Control

1. Perform tests and inspections.
2. Acceptance Testing Preparation:
   a. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
   b. Test continuity of each circuit.
3. Tests and Inspections:
   a. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
   b. Test insulation resistance for each enclosed controller element, component, connecting motor supply, feeder, and control circuits.
   c. Test continuity of each circuit.
   d. Verify that voltages at controller locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify the Owner before starting the motor(s).
   e. Test each motor for proper phase rotation.
   f. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   g. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   h. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
      1) Initial Infrared Scanning: After Final Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each multipole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.
      2) Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multipole enclosed controller 11 months after date of Final Completion.

3) Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

i. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

j. Mark up a set of manufacturer's drawings with all field modifications incorporated during construction and return to manufacturer for inclusion in Record Drawings.

4. Enclosed controllers will be considered defective if they do not pass tests and inspections.
5. Prepare test and inspection reports, including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

H. Startup Service
1. Perform startup service.
   a. Complete installation and startup checks according to manufacturer's written instructions.

I. Adjusting
1. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
2. Adjust overload relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
3. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify the Owner before increasing settings.
4. Set the taps on reduced-voltage autotransformer controllers at 50 **OR** 65 **OR** 80, **as directed**, percent.
5. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage, solid-state controllers.
6. Program microprocessors in VFCs for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Final Completion.
7. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study".

J. Protection
1. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.
2. Replace controllers whose interiors have been exposed to water or other liquids prior to Final Completion.

K. Demonstration
1. Train the Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers, and to use and reprogram microprocessor-based, reduced-voltage, solid-state controllers, **as directed**.

END OF SECTION 26 09 23 00c

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SECTION 26 09 23 00d - CENTRAL DIMMING CONTROLS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for central dimming controls. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes microprocessor-based central dimming controls with the following components:
a. Control network.
b. Master-control stations.
c. Partitioned-space master-control stations.
d. Wall stations.
e. Dimmer cabinets.
f. Manual switches and plates for controlling dimmers.

C. Definitions
1. Fade Override: The ability to temporarily set fade times to zero for all lighting scenes.
2. Fade Rate: The time it takes each zone to arrive at the next scene, dependent on the degree of change in lighting level.
3. Fade Time: The time it takes all zones to fade from one lighting scene to another, with all zones arriving at the next scene at the same time.
4. Low Voltage: As defined in NFPA 70, term for circuits and equipment operating at less than 50 V or for remote-control, signaling, and power-limited circuits.
5. Scene: The lighting effect created by adjusting several zones of lighting to the desired intensity.
6. SCR: Silicon-controlled rectifier.
7. Zone: A fixture or group of fixtures controlled simultaneously as a single entity. Also known as a "channel."

D. Submittals
1. Product Data: For each type of product indicated.
a. For central dimming controls; include elevation, features, characteristics, and labels.
b. For dimmer panels; include dimensions, features, dimmer characteristics, ratings, and directories.
c. Device plates, plate color, and material.
d. Ballasts and lamp combinations compatible with dimmer controls.
e. Sound data including results of operational tests of central dimming controls.
f. Operational documentation for software and firmware.
2. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on Project. Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
a. Include elevation views of front panels of control and indicating devices and control stations.
b. Wiring Diagrams: Power, signal, and control wiring.
3. Samples: For master-control stations, partitioned-space master-control stations, wall stations, dimmer cabinets, and faceplates with factory-applied color finishes and technical features.
a. Operation and Maintenance Data: For central dimming controls with remote-mounting dimmers to include in emergency, operation, and maintenance manuals.
4. Warranty: Special warranty specified in this Section.

E. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.
3. Comply with NFPA 70.

F. Warranty
1. Manufacturer's standard form in which manufacturer agrees to repair or replace components of central dimming controls that fail in materials or workmanship within specified warranty period.
    a. Failures include, but are not limited to, the following:
        1) Damage from transient voltage surges.
    b. Warranty Period: Cost to repair or replace any parts for two years from date of Final Completion.
    c. Extended Warranty Period: Cost of replacement parts (materials only, f.o.b. the nearest shipping point to Project site), for eight years, that failed in service due to transient voltage surges.

G. Software Service Agreement
1. Services in this Article may not be allowed for publicly funded projects.
2. Technical Support: Beginning with Final Completion, provide software support for two years.
3. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Final Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
    a. Provide 30 days' notice to the Owner to allow scheduling and access to system and to allow the Owner to upgrade computer equipment if necessary.

1.2 PRODUCTS

A. General System Requirements
1. Compatibility: Dimming control components shall be compatible with other elements of lighting fixtures, ballasts, transformers, and lighting controls.
2. Line-Voltage Surge Suppression: Factory installed as an integral part of 120- and 277-V ac, solid-state dimmers and control panels.
    a. Alternative Line-Voltage Surge Suppression: Comply with requirements in Division 26 Section "Transient-voltage Suppression For Low-voltage Electrical Power Circuits" for Category A **OR** B, **as directed**, locations.
3. Dimmers and Dimmer Modules: Comply with UL 508.
    a. Audible Noise and Radio-Frequency Interference Suppression: Solid-state dimmers shall operate smoothly over their operating ranges without audible lamp or dimmer noise or radio-frequency interference. Modules shall include integral or external filters to suppress audible noise and radio-frequency interference.
    b. Dimmer or Dimmer-Module Rating: Not less than 125 percent of connected load unless otherwise indicated.

B. System Description
1. Description: Microprocessor-based, solid-state controls consisting of control stations and a separately mounted dimmer cabinet.
    a. Operation: Change variable dimmer settings of indicated number of zones simultaneously from one preset scene to another when a rocker switch **OR** pushbutton **OR** slider, **as directed**, is operated.
    b. System control shall include master station(s), wall stations, and dimmer panels.
    c. Each zone shall be configurable to control the following light sources:

1) Fluorescent lamps with electronic **OR** magnetic, **as directed**, ballasts.
2) Line-voltage incandescent lamps.
3) Low-voltage incandescent lamps.
4) Cold cathode lamps.
5) Non-dimmed loads.
6) LED lamps.

d. Control of each zone shall interface with controls for the following accessory functions:
1) Curtains and drapes.
2) Blackout curtains.
3) Projector screens.
4) Motorized partitions.
5) Manually positioned partitions.

e. Memory: Retain preset scenes and fade settings through power failures for at least 90 days by retaining physical settings of controls or by an on-board, automatically recharged battery.

C. Control Network
1. Dimmers shall receive signals from control stations that are linked to dimmer cabinet with a common network data cable.
2. Functions of network control stations shall be set up at master station that include the number and arrangement of scene presets, zones, and fade times at wall stations.
a. Control Voltage: 24- or 10-V dc.
b. Comply with USITT AMX 192 **OR** USITT DMX 512, **as directed**, for data transmission.

D. Master-Control Stations
1. Functions and Features:
a. Control adjustment of the lighting level for each scene of each zone, and adjustment of fade-time setting for each scene change from one preset scene to another. Controls shall use analog manual sliders **OR** digital rocker switches with LCD graphic display of light level, **as directed**.
b. Master channel shall raise and lower lighting level of all zones.
c. Fade rate for each scene shall be adjustable from zero to 60 seconds.
d. Fade override control for each scene.
e. Recall each preset scene and allow adjustment of zone controls associated with that scene.
f. Lockout switch to prevent changes when set.
g. On and off scene controls for non-dim channel contactors.
h. Emergency-control pushbutton to bypass all controls, turning all dimmers to full bright and turning on non-dim channel contactors.
i. Master on and off switch; off position enables housekeeping controls.
j. Housekeeping controls to turn on selected lighting fixtures for housekeeping functions.
k. Pushbuttons for accessory functions.
l. Enable and disable wall stations.
m. Communications link to other master stations.
n. Provide for connecting a portable computer to program the master station.
o. Rear-illuminate all scene-select buttons.
p. Show lighting-level setting and fade-rate setting graphically using LEDs or backlighted bar-graph indicator.
2. Mounting: Single, flush wall box with manufacturer's standard faceplate with hinged transparent locking cover, **as directed**.

E. Partitioned-Space Master-Control Station
1. Functions and Features:
a. Automatically combine and separate lighting and accessory function controls as spaces are configured with movable partitions; with controls for adjustment of the lighting level for

each scene of each dimmer, and adjustment of fade-rate setting for each scene change from one preset scene to another.

b. Master controls shall accommodate partitioning the space into six adjacent rooms.
c. Manual controls to set up six scenes for each room. Include wall stations in each room to control scenes.
d. Master channel to raise and lower the lighting level of all zones.
e. Adjustable fade rate for each scene from zero to 60 seconds.
f. Fade override control for each scene.
g. On and off scene controls for non-dim channel contactors.
h. Emergency-control pushbutton to bypass all controls, turning all dimmers to full bright and turning on non-dim channel contactors.
i. Master on and off switch; off position enables housekeeping controls.
j. Housekeeping controls to turn on selected lighting fixtures for housekeeping functions.
k. Pushbuttons for accessory functions.
l. Provide for connecting a portable computer to program the master station.
m. Rear-illuminate all scene-select buttons.
n. Show lighting-level setting and fade-rate setting graphically using LEDs or backlighted bar-graph indicator.

2. Custom Graphics. Include a graphical display of room configurations and the names for each. Indicate the current spaces configuration with LCD graphic or LED-illuminated indicators, and show which wall stations are active. Inactive wall stations shall be automatically deactivated.
3. Mounting: Single, flush wall box with manufacturer's standard faceplate with hinged transparent locking cover, **as directed**.

F. Wall Stations

1. Functions and Features:
   a. Wall stations shall function as a submaster to a master station, containing limited control of selected scenes of the master station.
   b. Controls to adjust the lighting level of each dimmer for each scene, and the fade time setting for each scene change from one preset scene to another.
   c. Numbered pushbuttons to select scenes.
   d. Off switch to turn master station off. Operating the off switch at any remote station shall automatically turn on selected housekeeping lighting, **as directed**.
   e. On switch turns all scenes of master station to full bright.
   f. Pushbutton controls for accessory functions.
2. Mounting: Flush, wall box with manufacturer's standard faceplate.
3. Hand-held Cordless Control: Scene-select and accessory function pushbuttons using infrared **OR** radio-frequency, **as directed**, transmission.

G. Dimmer Cabinets

1. Factory wired, convection cooled without fans, with barriers to accommodate 120- and 277-V feeders and suitable to control designated lighting equipment or accessory functions.
2. Ambient Conditions:
   a. Temperature: 60 to 95 deg F (15 to 35 deg C).
   b. Relative Humidity: 10 to 90 percent, noncondensing.
   c. Filtered air supply.
3. Dimmer Cabinet Assembly: NRTL listed and labeled.
4. Cabinet Type: Plug in, modular, and accepting dimmers of each specified type in any plug-in position.
   a. Integrated Fault-Current Rating: 10,000-A RMS symmetrical.
5. Lighting Dimmers: Solid-state SCR dimmers.
   a. Primary Protection: Magnetic or thermal-magnetic circuit breaker, also serving as the disconnecting means.
   b. Dimmer response to control signal shall follow the "Square Law Dimming Curve" specified in IESNA's "IESNA Lighting Handbook."

c. Dimming Range: 0 to 100 percent, full output voltage not less than 98 percent of line voltage.
d. Dimmed circuits shall be filtered to provide a minimum 350-mic.sec. current-rise time at a 90-degree conduction angle and 50 percent of rated dimmer capacity. Rate of current rise shall not exceed 30 mA/mic.sec., measured from 10 to 90 percent of load-current waveform.
e. Protect controls of each dimmer with a fuse and transient voltage surge suppression, **as directed**.

6. Non-dim modules shall include relays with contacts rated to switch 20-A tungsten-filament load at 120-V ac and 20-A electronic ballast load at 277-V ac.
7. Accessory function control modules shall be compatible with requirement of the accessory being controlled.
8. Digital Control Network:
   a. Dimmers shall receive digital signals from digital network control stations that are linked to the dimmer cabinet with a common network data cable.
   b. Functions of digital network control stations shall be set up at the dimmer cabinet's electronic controls that include indicated number and arrangement of scene presets, channels, and fade times.
9. Emergency Power Transfer Switch: Comply with UL 1008; factory prewired and pretested to automatically transfer load circuits from normal to emergency power supply when normal supply fails.
   a. Transfer from normal to emergency supply when normal-supply voltage drops to 55 percent or less.
   b. Retransfer immediately to normal on failure of emergency supply and after an adjustable time-delay of 10 to 90 seconds on restoration of normal supply while emergency supply is available.
   c. Integrated Fault-Current Rating: Same value as listed for the panel.
   d. Test Switch: Simulate failure of normal supply to test controls associated with transfer scheme.
   e. Fabricate and test dimmer boards to withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".

H. Portable Computer
1. Description: As recommended by master-control station manufacturer, to program master station and associated wall stations, and all interconnected master stations, **as directed**. Portable computer shall be laptop style with a battery runtime of at least two hours. Display shall be an 11-inch (280-mm) interactive-matrix LCD and shall have required hardware, firmware, and software to program specified control functions of master-control stations.
2. Software shall be configured and customized by master-station manufacturer.

I. Manual Switches And Plates
1. Switches: Modular, momentary pushbutton, low-voltage type.
   a. Color: White unless otherwise indicated.
   b. Integral Pilot Light: Indicate when circuit is on. Use where indicated.
   c. Locator Light: Internal illumination.
   d. Wall Plates: Comply with requirements in Division 26 Section "Wiring Devices" for materials, finish, and color. Use multigang plates if more than one switch is indicated at a location.
   e. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

J. Conductors And Cables
1. Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

2. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 **OR** 22 **OR** 24, **as directed**, AWG. Comply with requirements in Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
3. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 **OR** 16 **OR** 18, **as directed**, AWG. Comply with requirements in Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
4. Unshielded, Twisted-Pair Data Cable: Category 5e **OR** 6, **as directed**. Comply with requirements in Division 27 Section "Communications Horizontal Cabling".

1.3 EXECUTION

A. Wiring Installation
1. Comply with NECA 1.
2. Wiring Method:
   a. Comply with requirements in Division 26 Section "Low-voltage Electrical Power Conductors And Cables"
   b. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Division 27 Section "Communications Horizontal Cabling".
   c. Minimum conduit size shall be 1/2 inch (13 mm).
3. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
4. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
5. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
6. Install dimmer cabinets for each zone.

B. Identification
1. Comply with requirements in Division 26 Section "Identification For Electrical Systems" for identifying components and power and control wiring.
2. Label each dimmer module with a unique designation.
3. Label each scene control button with approved scene description.

C. Field Quality Control
1. Perform tests and inspections and prepare test reports.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Tests and Inspections:
   a. Continuity tests of circuits.
   b. Operational Test: Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.
      1) Include testing of dimming control equipment under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.
   c. Emergency Power Transfer: Test listed functions.
3. Remove and replace malfunctioning dimming control components and retest as specified above.
4. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.
5. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

D. Demonstration

1. Engage a factory-authorized service representative to train **OR** Train, **as directed**, the Owner's maintenance personnel to adjust, operate, and maintain central dimming controls. Laptop portable computer shall be used in training, **as directed**.
2. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Network Lighting Controls".

END OF SECTION 26 09 23 00d

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SECTION 26 09 23 00e - MODULAR DIMMING CONTROLS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for modular dimming controls. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Manual modular dimming controls.
      b. Integrated, multipreset modular dimming controls.

C. Definitions
   1. Fade Rate: The time it takes each zone to arrive at the next scene, dependent on the degree of change in lighting level.
   2. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.
   3. Scene: The lighting effect created by adjusting several zones of lighting to the desired intensity.
   4. SCR: Silicon-controlled rectifier.
   5. Zone: A fixture or group of fixtures controlled simultaneously as a single entity. Also known as a "channel."

D. Submittals
   1. Product Data: For each type of product indicated.
      a. For modular dimming controls; include elevation, dimensions, features, characteristics, ratings, and labels.
      b. Device plates and plate color and material.
      c. Ballasts and lamp combinations compatible with dimmers.
      d. Wiring Diagrams: Power, signal, and control wiring.
   2. Samples: For master and remote-control stations, and faceplates with factory-applied color finishes and technical features.

E. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   2. Comply with NFPA 70.

1.2 PRODUCTS

A. General Dimming Device Requirements
   1. Compatibility: Dimming control components shall be compatible with other elements of lighting fixtures, ballasts, transformers, and lighting controls.
   2. Dimmers and Dimmer Modules: Comply with UL 508.
      a. Audible Noise and Radio-Frequency Interference Suppression: Solid-state dimmers shall operate smoothly over their operating ranges without audible lamp or dimmer noise or radio-frequency interference. Modules shall include integral or external filters to suppress audible noise and radio-frequency interference.
      b. Dimmer or Dimmer-Module Rating: Not less than 125 percent of connected load unless otherwise indicated.

B. Manual Modular Multiscene Dimming Controls
1. Description: Factory-fabricated equipment providing manual modular dimming control consisting of a wall-box-mounted, master-scene controller and indicated number of wall-box zone stations. Controls and dimmers shall be integrated for mounting in one-, two-, or three-gang wall box under a single wall plate. Each zone station shall be adjustable to indicated number of scenes, which shall be recorded on the zone controller.
2. Operation: Automatically change variable dimmer settings of indicated number of zones simultaneously from one preset scene to another when a push button is operated.
3. Each manual modular multiscene dimming controller shall include a master control and remote controls.
4. Each zone shall be configurable to control the following:
    a. Fluorescent lamps with electronic **OR** magnetic, **as directed**, ballasts.
    b. Incandescent lamps.
    c. Low-voltage incandescent lamps.
5. Memory: Retain preset scenes through power failures for at least seven days.
6. Device Plates: Style, material, and color shall comply with Division 26 Section "Wiring Devices".
7. Master-Scene Controller: Suitable for mounting in a single flush wall box.
    a. Switches: Master off, group dim, group bright, and selectors for each scene.
    b. LED indicator lights, one associated with each scene switch, and one for the master off switch.
8. Fluorescent Zone Dimmer: Suitable for operating lighting fixtures and ballasts specified in Division 26 Section "Interior Lighting", and arranged to dim number of scenes indicated for the master-scene controller. Scene selection is at the master-scene controller for setting light levels of each zone associated with scene.
    a. Switch: Rocker **OR** Slider, **as directed**, style for setting the light level for each scene.
    b. LED indicator lights, one associated with each scene.
    c. Electrical Rating: 1000 **OR** 2000, **as directed**, VA, 120 V.
9. Incandescent Zone Dimmer: Suitable for operating incandescent lamps at line-voltage or low-voltage lamps connected to a transformer and arranged to dim number of scenes indicated for the master-scene controller. Scene selection shall be at the master-scene controller for setting light levels of each zone associated with scene.
    a. Switch: Rocker **OR** Slider, **as directed**, style for setting the light level for each scene.
    b. LED indicator lights, one associated with each scene.
    c. Voltage Regulation: Dimmer shall maintain a constant light level, with no visible flicker, when the source voltage varies plus or minus 2 percent in RMS voltage.

C. Integrated, Multipreset Modular Dimming Controls
1. Indicate number of wall-box, remote-control stations.
2. Description: Factory-fabricated, microprocessor-based, solid-state controls providing manual dimming control consisting of a master station and multiple wall-box, remote-control stations.
3. Operation: Automatically changes variable dimmer settings of indicated number of zones simultaneously from one preset scene to another when a push button is operated.
4. Each zone shall be configurable to control the following:
    a. Fluorescent lamps with electronic **OR** magnetic, **as directed**, ballasts.
    b. Incandescent lamps.
    c. Low-voltage incandescent lamps.
5. Memory: Retain preset scenes and fade settings through power failures by retaining physical settings of controls.
6. Master Station:
    a. Contains control panel and multiple control and dimmer modules.
    b. Controls and commands adjustment of each dimmer-zone setting for each scene change from one preset scene to another.
        1) Master zone raises and lowers lighting level.
        2) Adjustable fade rate for each scene from 1 to 60 seconds.
    c. Rear-illuminated, scene-select buttons.

d. Lighting-level setting and fade-rate setting shall be graphically shown using LEDs or backlighted bar-graph indicator.
e. Mounting: Flush wall box with manufacturer's standard faceplate.

7. Remote-Control Stations:
   a. Numbered push buttons to select scenes.
   b. Off switch to turn master station off. Operating the off switch at any remote station shall automatically turn on selected housekeeping lighting, **as directed**.
   c. On switch turns all scenes of master station to full bright.
   d. Control Wiring: NFPA 70, Class 2.
   e. Mounting: Single flush wall box with manufacturer's standard faceplate.
8. Infrared Remote-Control Station: Same functions as for standard remote-control station, except that functions are input by a hand-held infrared transmitter.
9. Dimmers: Modular, plug-in type, with circuit breaker to protect the dimmer and branch circuit.
   a. Dimming Circuit: Two SCR dimmers, in inverse parallel configuration.
   b. Dimming Curve: Modified "square law" as specified in IESNA's "IESNA Lighting Handbook"; control voltage is 0- to 10-V dc.
   c. Dimming Range: 0 to 100 percent, full output voltage not less than 98 percent of line voltage.
   d. Voltage Regulation: Dimmer shall maintain a constant light level, with no visible flicker, when the source voltage varies plus or minus 2 percent in RMS voltage.
   e. Short-Circuit Rating: 10 kA for 120 V, 14 kA for 277 V.

D. Conductors And Cables
1. Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
2. Class 2 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 **OR** 22 **OR** 24, **as directed**, AWG. Comply with requirements in Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

1.3 EXECUTION

A. Wiring Installation
1. Comply with NECA 1.
2. Wiring Method: Comply with requirements in Division 26 Section "Low-voltage Electrical Power Conductors And Cables". Minimum conduit size shall be 1/2 inch (13 mm).
3. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
4. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
5. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

B. Identification
1. Comply with requirements in Division 26 Section "Identification For Electrical Systems" for identifying components and power and control wiring.
2. Label each dimmer module with a unique designation.
3. Label each scene control button with approved scene description.

C. Field Quality Control
1. Perform tests and inspections and prepare test reports.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

2. Tests and Inspections:
   a. Continuity tests of circuits.
   b. Operational Test: Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.
      1) Include testing of modular dimming control equipment under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.
3. Remove and replace malfunctioning modular dimming control components and retest as specified above.
4. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.
5. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

D. Demonstration
1. Engage a factory-authorized service representative to train **OR** Train, **as directed**, Owner's maintenance personnel to adjust, operate, and maintain modular dimming controls. Laptop portable computer shall be used in training, **as directed**.
2. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Network Lighting Controls".

END OF SECTION 26 09 23 00e

Task	Specification	Specification Description
26 09 23 00	02 84 16 00	Removal of Fluorescent Light Ballasts/Capacitors and Fluorescent Light Tubes
26 09 23 00	02 84 16 00a	Interior Lighting
26 09 23 00	02 84 16 00b	Exterior Lighting

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SECTION 26 11 13 00 - SECONDARY UNIT SUBSTATIONS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for secondary unit substations. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes indoor and outdoor secondary unit substations, each consisting of the following:
   a. Primary incoming section.
   b. Transformer.
   c. Secondary distribution section.

C. Definitions
1. NETA ATS: Acceptance Testing Specification.

D. Submittals
1. Product Data: Include rated capacities, furnished specialties, and accessories.
2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Time-Current Characteristic Curves: For overcurrent protective devices.
4. Primary Fuses: Submit recommendations and size calculations.
5. Manufacturer Seismic Qualification Certification: Submit certification that transformer assembly and components will withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
6. Field quality-control test reports.
7. Operation and Maintenance Data: For secondary unit substations and accessories to include in emergency, operation, and maintenance manuals.

E. Quality Assurance
1. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. Comply with IEEE C2.
3. Comply with IEEE C37.121.
4. Comply with NFPA 70.

F. Delivery, Storage, And Handling
1. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.
2. Coordinate delivery of secondary unit substations to allow movement into designated space.
3. Store secondary unit substation components protected from weather and so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.
4. Handle secondary unit substation components according to manufacturer's written instructions. Use factory-installed lifting provisions.

G. Project Conditions
1. Service Conditions: IEEE C37.121, usual service conditions, except for the following:
   a. Exposure to significant solar radiation.
   b. Altitudes above 3300 feet (1000 m).

c. Exposure to fumes, vapors, or dust.
d. Exposure to explosive environments.
e. Exposure to hot and humid climate or to excessive moisture, including steam, salt spray, and dripping water.
f. Exposure to seismic shock or to abnormal vibration, shock, or tilting.
g. Exposure to excessively high or low temperatures.
h. Unusual transportation or storage conditions.
i. Unusual grounding resistance conditions.
j. Unusual space limitations.

1.2 PRODUCTS

A. Manufactured Units
1. Indoor Unit Arrangement: Single assembly **OR** Separate secondary distribution equipment connected with busway, **as directed**.
2. Outdoor Unit Arrangement: Single assembly **OR** Separate secondary distribution equipment connected with busway, **as directed**.
   a. Weatherproof, listed for installation outdoors, complying with IEEE C37.20.1.
   b. Aisleless Construction: Full-height doors in front of basic weatherproof equipment.
3. Enclosure Finish: Factory-applied finish in manufacturer's standard color, including under surfaces treated with corrosion-resistant undercoating **OR** Factory-applied finish in manufacturer's standard gray over a rust-inhibiting primer on treated metal surface, **as directed**.

B. Incoming Section
1. Primary Incoming Section: Terminal assembly with adequate space for incoming-cable terminations and surge arresters.
   OR
   Transformer cover-mounted bushings.
   OR
   Enclosed, air-interrupter, dual primary **OR** primary, **as directed,** switch.
   a. Three pole, single throw, dead front, metal enclosed, with manual stored energy operator, with fuses mounted on a single frame **OR** without fuses, **as directed**, complying with IEEE C37.20.3.
   b. Key interlocking system to prevent fuse access door from being opened unless switch is open. Additionally, interlock air-interrupter switch with transformer secondary main circuit breaker, preventing switch from being opened or closed unless secondary main circuit breaker is open.
   c. Phase Barriers: Located between blades and fuses of each phase, designed for easy removal, allows visual inspection of switch components when barrier is in place.
   d. Window: Permits viewing switch-blade positions when door is closed.
   e. Accessory Set: Tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation. Include fuse-handling tool as recommended by switchgear manufacturer.
   f. Continuous-Current Rating: 600 A.
   g. Short-Circuit Rating:
      1) Short-time momentary asymmetrical fault rating of 40 kA.
      2) 3-second symmetrical rating of 25-kA RMS.
      3) Fault close asymmetrical rating of 40 kA.
   h. Fuses: Sizes recommended by secondary unit substation manufacturer, considering fan cooling, temperature-rise specification, and cycle loading. Comply with the following:
      1) Current-limiting type, rated for not less than 50-kA RMS symmetrical current-interrupting capacity.
      2) Indicator integral with each fuse to show when it has blown.

3) Spares: Include three fuses in use and three spare fuses in storage clips in each switch.

2. Surge Arresters: Comply with IEEE C62.11, Distribution class; metal-oxide-varistor type, with ratings as indicated, connected in each phase of incoming circuit and ahead of any disconnecting device.

C. Liquid-Filled Transformer Section

1. Description: IEEE C57.12.00 and UL 1062, liquid-filled, 2-winding, secondary unit substation transformer.
2. Insulating Liquid: Mineral oil complying with ASTM D 3487, Type II, and tested according to ASTM D 117.
   OR
   Insulating Liquid: Less flammable, edible-seed-oil based, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.
   OR
   Insulating Liquid: Less flammable, dielectric, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.
   OR
   Insulating Liquid: Less flammable, silicone-based dielectric, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall have low toxicity and be nonhazardous.
3. Insulation Temperature Rise: 65/55 deg C, based on an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C. Insulation system shall be rated to continuously allow an additional 12-percent kVA output, at 65 deg C temperature rise, without decreasing rated transformer life.
   OR
   Insulation Temperature Rise: 65 deg C, based on an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C.
4. Basic Impulse Level: Comply with UL 1062.
   OR
   Basic Impulse Level: 60 **OR** 75 **OR** 95 **OR** 110, **as directed,** kV.
5. Full-Capacity Voltage Taps: 4 nominal 2.5 percent taps, 2 above and 2 below rated primary voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
   OR
   Full-Capacity Voltage Taps: 4 nominal 2.5 percent taps below rated primary voltage, with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
6. Cooling System: Class OA, liquid cooled **OR** OA/FA, liquid cooled, and with forced-air rating **OR** OA/FFA, liquid cooled, and with provisions for future forced-air rating, **as directed**. Cooling systems shall include auxiliary cooling equipment, automatic controls, and status indicating lights.
7. Sound level may not exceed 58 dB, without fans.
8. Impedance: Percentage as directed.
9. Accessories: Grounding pads, lifting lugs, and provisions for jacking under base. Transformers shall have a steel base and frame allowing use of pipe rollers in any direction, and an insulated, low-voltage, neutral bushing with removable ground strap. Include the following additional accessories:
   a. Liquid-level gage.
   b. Pressure-vacuum gage.
   c. Liquid temperature indicator.
   d. Drain and filter valves.
   e. Pressure relief device.

D. Dry-Type Transformer Section

1. Description: IEEE C57.12.01, IEEE C57.12.50 for dry-type transformers rated up to 500 kVA, IEEE C57.12.51 for dry-type transformers rated 501 kVA and larger, or IEEE C57.12.52 for sealed dry-type transformers rated 501 kVA and larger, NEMA ST 20, and dry-type, 2-winding, secondary unit substation transformer.
2. Enclosure: Indoor, ventilated **OR** Outdoor, ventilated **OR** Totally enclosed, nonventilated, **as directed**, cast coil/encapsulated coil, with primary and secondary windings individually cast in epoxy; with insulation system rated at 185 deg C with an 80 deg C average winding temperature rise above a maximum ambient temperature of 40 deg C.
   OR
   Enclosure: Indoor, ventilated **OR** Outdoor, ventilated **OR** Totally enclosed, nonventilated, **as directed**, vacuum-pressure, impregnated type and with insulation system rated at 220 deg C with an 80 deg C average winding temperature rise above a maximum ambient temperature of 40 deg C.
3. Cooling System: Class AA, air cooled **OR** AA/FA, air cooled with forced-air rating **OR** AA/FFA, air cooled with provisions for future forced-air rating, **as directed**, complying with IEEE C57.12.01.
   a. Automatic forced-air cooling system controls, including thermal sensors, fans, control wiring, temperature controller with test switch, power panel with current-limiting fuses, indicating lights, alarm, and alarm silencing relay.
   b. Include mounting provision for fans.
4. Insulation Materials: IEEE C57.12.01, rated 220 deg C.
5. Insulation Temperature Rise: 80 **OR** 115 **OR** 150, **as directed,** deg C, maximum rise above 40 deg C.
6. Basic Impulse Level: 60 **OR** 75 **OR** 95 **OR** 110, **as directed,** kV.
7. Full-Capacity Voltage Taps: 4 nominal 2.5 percent taps, 2 above and 2 below rated primary voltage.
   OR
   Full-Capacity Voltage Taps: 4 nominal 2.5 percent taps below rated primary voltage.
8. Sound level may not exceed maximum dBA level **as directed**, without fans operating.
9. Impedance: Percentage **as directed**.
10. High-Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm.

E. Secondary Distribution Section
1. Secondary Terminal Compartment: Bus bars mounted on standoff insulators **OR** duct flange for close coupling with busway, **as directed**.
   OR
   Secondary Distribution: Low-voltage switchgear as specified in Division 26 Section "Low-voltage Switchgear".
   OR
   Secondary Distribution: Low-voltage switchboard as specified in Division 26 Section "Switchboards".
   OR
   Secondary Distribution: Motor-control center as specified in Division 26 Section "Motor-control Centers".
   OR
   Distribution Panelboard: Panelboards as specified in Division 26 Section "Panelboards".
2. Network Protectors:
   a. Rated for continuous service in an ambient temperature of up to 40 deg C, applied to 3-phase, 4-wire, solidly grounded wye secondary networks. Comply with IEEE C57.12.44.
   b. Dead-front, drawout design with externally mounted fuses, using hand-cranked rail system. Relay and control panel located on a separate drawout module.
   c. Protector Operator: Spring-close and/or stored-energy mechanism, rated to close on a 25,000 **OR** 40,000, **as directed,** RMS symmetrical load.
   d. Control Voltage: Not more than 125 V.

e. Control microprocessor-based, three-phase, tripping relay with features and functions as follows:
   1) Close protector if positive sequence power flows into the network. Adjustable closing range shall be from 0.5 to 3.5 V in phase difference between network and transformer voltages.
   2) Trip protector if there is a net, three-phase, reverse power flow through protector. Trip protectors shall be adjustable from 0.05 to 5 percent of continuous-current rating of current transformers within protector.
   3) Trip protector if there is a flow of reverse magnetizing current of its associated transformer.
   4) Field-adjustable relay parameters and watt or watt-var trip values.

f. Protector shall not open under any fault on network side of protector.

g. Current-limiting fuses shall have interrupting capacity of 150,000 A on network side of protector for protection against switchboard bus faults.

h. Mechanical interlocks shall prevent racking in and racking out when protector is closed.

i. Auxiliary contacts shall be remotely tripped and locked out by four-wire remote pilot devices.

j. Network protectors shall have not less than two spare auxiliary dry contacts.

k. Network Switchgear-Mounted Disconnect Switch: Supply each network-protector circuit with a switchgear-mounted fuse truck, with Class L fuses rated for 200-kA interrupting capacity, and key interlocked with each associated protector.

   OR

   Network Switchgear-Mounted Disconnect Switch: Supply each network-protector circuit with a switchgear-mounted main circuit breaker rated for fault current that can be delivered by the network transformers, less one. Use drawout type to provide a means of isolating the load side of each protector from the network bus.

F. Identification Devices
   1. Compartment Nameplates: Engraved, laminated-plastic or metal nameplate for each compartment, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification For Electrical Systems"**.**

G. Source Quality Control
   1. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to IEEE C57.12.90. Conduct switchgear and switchboard tests according to ANSI C37.51.

      OR

      Factory Tests: Perform the following factory-certified tests on each secondary unit substation:

      a. Resistance measurements of all windings on the rated voltage connection and on tap extreme connections.
      b. Ratios on the rated voltage connection and on tap extreme connections.
      c. Polarity and phase relation on the rated voltage connection.
      d. No-load loss at rated voltage on the rated voltage connection.
      e. Exciting current at rated voltage on the rated voltage connection.
      f. Impedance and load loss at rated current on the rated voltage connection and on tap extreme connections.
      g. Applied potential.
      h. Induced potential.
      i. Temperature Test: If a transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kilovolt-ampere Class OA or Class AA rating and highest kilovolt-ampere Class FA rating.
         1) Temperature test is not required if a record of a temperature test on an essentially duplicate unit is available.
      j. the Owner will witness all required factory tests. Notify the Owner at least 14 days before date of tests and indicate their approximate duration.

1.3 EXECUTION

A. Installation
1. Install secondary unit substations on concrete bases.
a. Anchor secondary unit substations to concrete bases according to manufacturer's written instructions, seismic codes at Project, and requirements in Division 26 Section "Hangers And Supports For Electrical Systems".
b. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit and 4 inches (100 mm) high.
c. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-place Concrete".
d. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
e. Install epoxy-coated anchor bolts for anchoring equipment to the concrete base.
f. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
g. Bolt transformers to channel-iron sills embedded in concrete bases. Install sills level and grout flush with floor or base.
2. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

B. Identification
1. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section "Identification For Electrical Systems".
2. Operating Instructions: Frame printed operating instructions for secondary unit substations, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of secondary unit substation.

C. Connections
1. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
2. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

D. Cleaning
1. After completing equipment installation and before energizing, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Vacuum interiors of secondary unit substation sections.

E. Field Quality Control
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
2. Perform the following field tests and inspections and prepare test reports:
a. Perform each visual and mechanical inspection and electrical test according to NETA ATS. Certify compliance with test parameters.
b. After installing secondary unit substation but before primary is energized, verify that grounding system at the substation tested at the specified value or less.
c. After installing secondary unit substation and after electrical circuitry has been energized, test for compliance with requirements.
d. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
1) Remove and replace malfunctioning units and retest as specified above.

F. Follow-Up Service
1. Voltage Monitoring and Adjusting: After Final Completion, if requested by the Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:
   a. During a period of normal load cycles as evaluated by the Owner, perform seven days of three-phase voltage recording at the outgoing section of each secondary unit substation. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards and with a chart speed of not less than 1 inch (25 mm) per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.
   b. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
      1) Adjust transformer taps.
      2) Rebalance loads.
      3) Prepare written request for voltage adjustment by electric utility.
   c. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained.
   d. Report: Prepare a written report covering monitoring performed and corrective action taken.
2. Infrared Scanning: Perform as specified in Division 26 Section "Medium-voltage Switchgear".

END OF SECTION 26 11 13 00

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SECTION 26 11 16 11 - SWITCHGEAR

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for switchgear. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes metal-enclosed, low-voltage power circuit-breaker switchgear rated 1000 V and less for use in ac systems.

C. Definitions
1. ATS: Acceptance Testing Service.
2. GFCI: Ground-fault circuit interrupter.

D. Submittals
1. Product Data: For each type of switchgear, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
2. Shop Drawings: For each type of switchgear and related equipment.
   a. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Include the following:
   b. Wiring Diagrams: Power, signal, and control wiring.
3. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where pipe and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
4. Samples: Representative portion of mimic bus with specified finish. Manufacturer's color charts showing colors available for mimic bus.
5. Manufacturer Seismic Qualification Certification: Submit certification that switchgear, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
6. Field quality-control test reports.
7. Updated mimic-bus diagram reflecting field changes after final switchgear load connections have been made, for record.
8. Operation and Maintenance Data: For switchgear and components to include in emergency, operation, and maintenance manuals. Include the following:
   a. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   b. Time-current curves, including selectable ranges for each type of overcurrent protective device.

E. Quality Assurance
1. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   a. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
3. Comply with NFPA 70.

F. Delivery, Storage, And Handling
1. Deliver switchgear in sections of lengths that can be moved past obstructions in delivery path.
2. Store switchgear indoors in clean dry space with uniform temperature to prevent condensation. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage.
3. If stored in areas subjected to weather, cover switchgear to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchgear; install electric heating (250 W per section) to prevent condensation.

G. Project Conditions
1. Installation Pathway: Remove and replace building components and structures to provide pathway for moving switchgear into place.
2. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service.
3. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchgear, including clearances between switchgear, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
4. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
   a. Ambient Temperature: Not exceeding 40 deg C.
   b. Altitude: Not exceeding 6600 feet (2010 m).

1.2 PRODUCTS

A. Ratings
1. Nominal System Voltage: 480 V, 3 wire **OR** 480/277 V, 4 wire **OR** 240 V, 3 wire **OR** 208/120 V, 4 wire, **as directed**, 60 Hz.
2. Main-Bus Continuous: 4000 **OR** 3200 **OR** 2000 **OR** 1600, **as directed,** A.
3. Short-Time and Short-Circuit Current: Match rating of highest-rated circuit breaker in switchgear assembly.

B. Fabrication
1. Factory assembled and tested and complying with IEEE C37.20.1.
2. Indoor Enclosure Material: Steel.
3. Outdoor Enclosure Material: Galvanized steel.
4. Outdoor Enclosure Fabrication Requirements: Weatherproof; integral structural-steel base frame with factory-applied asphaltic undercoating; and each compartment equipped with the following features:
   a. Structural design and anchorage adequate to resist loads imposed by 125-mph (200-km/h), **as directed**, wind.
   b. Space heater operating at one-half or less of rated voltage, sized to prevent condensation.
   c. Louvers equipped with insect and rodent screen and filter; arranged to permit air circulation while excluding insects, rodents, and exterior dust.
   d. Hinged front door with padlocking provisions.
   e. Interior light with switch.
   f. Weatherproof duplex receptacle.

g. Common internal aisle of sufficient width to permit protective-device withdrawal, disassembly, and servicing in aisle.
h. Aisle access doors with outside padlocking provisions and interior panic latches.
i. Aisle space heaters operating at one-half or less of rated voltage, thermostatically controlled.
j. Vaporproof fluorescent aisle lights with low-temperature ballasts, controlled by wall switch at each entrance.
k. GFCI duplex receptacles, a minimum of two, located in aisle.
l. Aisle ventilation louvers equipped with insect and rodent screen and filter and arranged to permit air circulation while excluding insects, rodents, and exterior dust.

5. Finish: IEEE C37.20.1, manufacturer's standard gray finish over a rust-inhibiting primer on phosphatizing-treated metal surfaces.
6. Section barriers between main and tie circuit-breaker compartments shall be extended to rear of section.
7. Bus isolation barriers shall be arranged to isolate line bus from load bus at each main and tie circuit breaker.
8. Circuit-breaker compartments shall be equipped to house drawout-type circuit breakers and shall be fitted with hinged outer doors.
9. Fabricate enclosure with removable, hinged, rear cover panels to allow access to rear interior of switchgear.
10. Auxiliary Compartments: Match and align with basic switchgear assembly. Include the following:
    a. Utility metering compartment that complies with utility company requirements.
    b. Bus transition sections.
    c. Incoming-line pull sections.
    d. Hinged front panels for access to metering, accessory, and blank compartments.
    e. Pull box on top of switchgear for extra room for pulling cable, with removable top, front, and side covers and ventilation provisions adequate to maintain air temperature in pull box within same limits as switchgear.
        1) Set pull box back from front to clear circuit-breaker lifting mechanism.
        2) Bottom: Insulating, fire-resistant material with separate holes for cable drops into switchgear.
        3) Cable Supports: Arranged to ease cabling and adequate to support cables indicated, including those for future installation.
11. Bus bars connect between vertical sections and between compartments. Cable connections are not permitted.
    a. Main Phase Bus: Uniform capacity the entire length of assembly.
    b. Neutral Bus: 50 **OR** 100, **as directed,** percent of phase-bus ampacity, except as indicated. Equip bus with pressure-connector terminations for outgoing circuit neutral conductors. Include braces for neutral-bus extensions for busway feeders.
    c. Vertical Section Bus Size: Comply with IEEE C37.20.1, including allowance for spare circuit breakers and spaces for future circuit breakers.
    d. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.
       OR
       Phase- and Neutral-Bus Material: Silver- or tin-plated, high-strength, electrical-grade aluminum alloy, with copper or tin-plated aluminum circuit-breaker line connections.
       OR
       Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent minimum conductivity or tin-plated, high-strength, electrical-grade aluminum alloy.
    e. Use silver-plated copper or tin-plated aluminum for connecting circuit-breaker line to aluminum bus.
    f. Use copper for connecting circuit-breaker line to copper bus.
    g. Contact Surfaces of Buses: Silver plated.
    h. Feeder Circuit-Breaker Load Terminals: Silver-plated copper bus extensions equipped with pressure connectors for outgoing circuit conductors.

i. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for feeder and branch-circuit ground conductors, minimum size 1/4 by 2 inches (6 by 50 mm).
j. Supports and Bracing for Buses: Adequate strength for indicated short-circuit currents.
k. Neutral bus equipped with pressure-connector terminations for outgoing circuit neutral conductors. Neutral-bus extensions for busway feeders are braced.
l. Neutral Disconnect Link: Bolted, uninsulated, 1/4-by-2-inch (6-by-50-mm) copper bus, arranged to connect neutral bus to ground bus.
m. Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.
n. Bus-Bar Insulation: Individual bus bars wrapped with factory-applied, flame-retardant tape or spray-applied, flame-retardant insulation.
    1) Sprayed Insulation Thickness: 3 mils (0.08 mm), minimum.
    2) Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.

C. Components
1. Instrument Transformers: Comply with IEEE C57.13.
    a. Potential Transformers: Secondary-voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
    b. Current Transformers: Ratios as indicated; burden and accuracy class suitable for connected relays, meters, and instruments.
2. Multifunction Digital-Metering Monitor: UL-listed or -recognized, microprocessor-based unit suitable for three- or four-wire systems and with the following features:
    a. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
    b. Switch-selectable digital display of the following:
        1) Phase Currents, Each Phase: Plus or minus 1 percent.
        2) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
        3) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
        4) Three-Phase Real Power: Plus or minus 2 percent.
        5) Three-Phase Reactive Power: Plus or minus 2 percent.
        6) Power Factor: Plus or minus 2 percent.
        7) Frequency: Plus or minus 0.5 percent.
        8) Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
        9) Accumulated energy, in megawatt hours (joules), plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.
    c. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
3. Analog Instruments: Rectangular, 4-1/2-inch (115-mm) square, accurate within 1 percent, semiflush mounting, with antiparallax 250-degree scale and external zero adjustment, complying with ANSI C39.1.
    a. Voltmeters: Cover an expanded scale range of normal voltage plus 10 percent.
    b. Voltmeter Selector Switch: Rotary type with off position to provide readings of phase-to-phase and phase-to-neutral voltages.
    c. Ammeters: Cover an expanded scale range of bus rating plus 10 percent.
    d. Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in off position.
    e. Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
    f. Watt-Hour Meters: Flush- or semiflush-mounting type, 5 A, 120 V, 3 phase, 3 wire; with 3 elements, 15-minute indicating demand register, and provision for testing and adding pulse initiation.

g. Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with 15-minute interval.
   1) Operation: Meter counts and records a succession of pulses entering two channels.
   2) Housing: Drawout, back-connected case arranged for semiflush mounting.
4. Relays: Comply with IEEE C37.90, types and settings as indicated; with test blocks and plugs.
5. Surge Arresters: Distribution class, metal-oxide-varistor type. Comply with IEEE C62.11 and NEMA LA 1.
   a. Install in cable termination compartments and connect in each phase of circuit.
   b. Coordinate rating with circuit voltage.
6. Provision for Future Devices: Equip compartments with rails, mounting brackets, supports, necessary appurtenances, and bus connections.
7. Fungus Proofing: Permanent fungicidal treatment for switchgear interior, including instruments and instrument transformers.
8. Control Power Supply: Control power transformer supplying 120-V control circuits through secondary disconnect devices. Include the following features:
   a. Dry-type transformers, in separate compartments for units larger than 3 kVA, including primary and secondary fuses.
   b. Two control power transformers in separate compartments with necessary interlocking relays; each transformer connected to line side of associated main circuit breaker.
      1) Secondary windings connected through a relay or relays to control bus to effect an automatic transfer scheme.
      2) Secondary windings connected through an internal automatic transfer switch to switchgear control power bus.
   c. Control Power Fuses: Primary and secondary fuses with current-limiting and overload protection.
   d. Fuses are specified in Division 26 Section "Fuses".
9. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:
   a. Flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
   b. Conductors sized according to NFPA 70 for duty required.

D. Circuit Breakers
1. Description: Comply with IEEE C37.13.
2. Ratings: As indicated for continuous, interrupting, and short-time current ratings for each circuit breaker; voltage and frequency ratings same as switchgear.
3. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:
   a. Normal Closing Speed: Independent of both control and operator.
   b. Slow Closing Speed: Optional with operator for inspection and adjustment.
   c. Stored-Energy Mechanism: Manually charged **OR** Electrically charged, with optional manual charging, **as directed**.
   d. Operation counter.
4. Trip Devices: Solid-state, overcurrent trip-device system consisting of one or two current transformers or sensors per phase, a release mechanism, and the following features:
   a. Functions: Long-time-delay, short-time-delay, and instantaneous-trip functions, independent of each other in both action and adjustment.
   b. Temperature Compensation: Ensures accuracy and calibration stability from minus 5 to plus 40 deg C.
   c. Field-adjustable, time-current characteristics.
   d. Current Adjustability: Dial settings and rating plugs on trip units or sensors on circuit breakers, or a combination of these methods.
   e. Three bands, minimum, for long-time- and short-time-delay functions; marked "minimum," "intermediate," and "maximum."
   f. Pickup Points: Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable I^2t operation.

g. Pickup Points: Five minimum, for instantaneous-trip functions.
h. Ground-fault protection with at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup. Arrange to provide protection for the following:
    1) Three-wire circuit or system.
    2) Four-wire circuit or system.
    3) Four-wire, double-ended substation.
i. Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.

5. Auxiliary Contacts: For interlocking or remote indication of circuit-breaker position, with spare auxiliary switches and other auxiliary switches required for normal circuit-breaker operation, quantity as indicated. Each consists of two Type "a" and two Type "b" stages (contacts) wired through secondary disconnect devices to a terminal block in stationary housing.
6. Drawout Features: Circuit-breaker mounting assembly equipped with a racking mechanism to position circuit breaker and hold it rigidly in connected, test, and disconnected positions. Include the following features:
    a. Interlocks: Prevent movement of circuit breaker to or from connected position when it is closed, and prevent closure of circuit breaker unless it is in connected, test, or disconnected position.
    b. Circuit-Breaker Positioning: An open circuit breaker may be racked to or from connected, test, and disconnected positions only with the associated compartment door closed unless live parts are covered by a full dead-front shield. An open circuit breaker may be manually withdrawn to a position for removal from the structure with the door open. Status for connection devices for different positions includes the following:
        1) Test Position: Primary disconnect devices disengaged, and secondary disconnect devices and ground contact engaged.
        2) Disconnected Position: Primary and secondary devices and ground contact disengaged.
7. Arc Chutes: Readily removable from associated circuit breaker when it is in disconnected position, and arranged to permit inspection of contacts without removing circuit breaker from switchgear.
8. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.
9. Operating Handle: One for each circuit breaker capable of manual operation.
10. Electric Close Button: One for each electrically operated circuit breaker.
11. Mechanical Interlocking of Circuit Breakers: Uses a mechanical tripping lever or equivalent design and electrical interlocks.
12. Key Interlocks: Arranged so keys are attached at devices indicated. Mountings and hardware are included where future installation of key-interlock devices is indicated.
13. Undervoltage Trip Devices: Instantaneous, with adjustable pickup voltage **OR** Adjustable time-delay and pickup voltage, **as directed**.
14. Shunt-Trip Devices: Where indicated.
15. Fused Circuit Breakers: Circuit breaker and fuse combinations complying with requirements for circuit breakers and trip devices and with the following:
    a. Fuses: NEMA FU 1, Class L current limiting, sized to coordinate with and protect associated circuit breaker.
    b. Circuit Breakers with Frame Size 1600 A and Smaller: Fuses on line side of associated circuit breaker, on a common drawout mounting, arranged so fuses are accessible only when circuit breaker is in disconnected position.
    c. Circuit Breakers with Frame Sizes More Than 1600 A: Fuses and circuit breakers may be installed in separate compartments on separate drawout mountings. Fuse drawout element is interlocked with associated power circuit breaker to prevent drawing out fuse element unless circuit breaker is in open position.
    d. Open-Fuse Trip Device: Positive means of tripping and holding circuit breaker in open position when a fuse opens. Open-fuse status is indicated at front of circuit breaker or fuse drawout element.

16. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices.

E. Accessories
1. Accessory Set: Furnish tools and miscellaneous items required for circuit-breaker and switchgear test, inspection, maintenance, and operation.
a. Racking handle to manually move circuit breaker between connected and disconnected positions.
b. Portable test set for testing all functions of circuit-breaker, solid-state trip devices without removal from switchgear.
c. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.
2. Circuit-Breaker Removal Apparatus: Portable, floor-supported, roller-base, elevating carriage arranged for moving circuit breakers in and out of compartments.
3. Circuit-Breaker Removal Apparatus: Overhead-circuit-breaker lifting device, track mounted at top front of switchgear and complete with hoist and lifting yokes matching each size of drawout circuit breaker installed.
4. Spare-Fuse Cabinet: Identified and compartmented steel box or cabinet with lockable door.
5. Storage for Manual: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

F. Identification
1. Mimic Bus: Continuous mimic bus, arranged in single-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.
a. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce a concise visual presentation of principal switchgear components and connections.
b. Medium: Painted graphics, as selected by Architect.
c. Color: Contrasting with factory-finish background; as selected by Architect from manufacturer's full range.
2. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads. Include as-built data for low-voltage power switchgear and connections as follows:
a. Frame size of each circuit breaker.
b. Trip rating for each circuit breaker.
c. Conduit and wire size for each feeder.

1.3 EXECUTION

A. Installation
1. Comply with applicable portions of NECA 400.
2. Anchor switchgear assembly to 4-inch (100-mm), channel-iron floor sill embedded in floor **OR** concrete base, **as directed,** and attach by bolting.
a. Sills: Select to suit switchgear; level and grout flush into floor **OR** concrete base, **as directed**.
b. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Division 26 Section "Hangers And Supports For Electrical Systems" for seismic-restraint requirements.
c. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 3 inches (75 mm) in all directions beyond the maximum dimensions of switchgear unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Division 26 Section "Hangers And Supports For Electrical Systems".
3. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, brackets, and temporary blocking of moving parts from switchgear units and components.

B. Identification
1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification For Electrical Systems".
2. Diagram and Instructions:
a. Frame and mount under clear acrylic plastic on the front of switchgear.
1) Operating Instructions: Printed basic instructions for switchgear, including control and key-interlock sequences and emergency procedures.
2) System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.
b. Storage for Maintenance: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

C. Connections
1. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
2. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

D. Field Quality Control
1. Prepare for acceptance tests as follows:
a. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
b. Test continuity of each circuit.
2. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
a. Inspect switchgear installation, including wiring, components, connections, and equipment. Test and adjust components and equipment.
b. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 22.
c. Complete installation and startup checks according to manufacturer's written instructions.
d. Assist in field testing of equipment including pretesting and adjusting of equipment and components.
e. Report results in writing.
3. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
a. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for each of the following NETA categories:
1) Switchgear.
2) Circuit breakers.
3) Protective relays.
4) Instrument transformers.
5) Metering and instrumentation.
6) Ground-fault systems.
7) Battery systems.
8) Surge arresters.
9) Capacitors.
b. Remove and replace malfunctioning units and retest as specified above.
4. Infrared Scanning: After Final Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner.
a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear 11 months after date of Final Completion.

b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

c. Record of Infrared Scanning: Prepare a certified report that identifies switchgear checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

E. Adjusting

1. Set field-adjustable, protective-relay trip characteristics according to results in Division 26 Section "Overcurrent Protective Device Coordination Study".
2. Set field-adjustable, protective-relay trip characteristics.

F. Cleaning

1. On completion of installation, inspect interior and exterior of switchgear. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

G. Protection

1. Temporary Heating: Apply temporary heat to switchgear, according to manufacturer's written instructions, throughout periods when switchgear environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

END OF SECTION 26 11 16 11

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Task	Specification	Specification Description
26 11 16 11	26 11 13 00	Secondary Unit Substations

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SECTION 26 12 13 00 - MEDIUM-VOLTAGE TRANSFORMERS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for medium-voltage transformers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following types of transformers with medium-voltage primaries:
      a. Liquid-filled distribution and power transformers.
      b. Dry-type distribution and power transformers.
      c. Pad-mounted, liquid-filled transformers.

C. Definitions
   1. NETA ATS: Acceptance Testing Specification.

D. Submittals
   1. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, location of each field connection, and performance for each type and size of transformer indicated.
   2. Shop Drawings: Diagram power signal and control wiring.
   3. Manufacturer Seismic Qualification Certification: Submit certification that transformer assembly and components will withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
   4. Field quality-control test reports.
   5. Follow-up service reports.
   6. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

E. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   2. Comply with IEEE C2.
   3. Comply with ANSI C57.12.10, ANSI C57.12.28, IEEE C57.12.70, and IEEE C57.12.80.
   4. Comply with NFPA 70.

F. Delivery, Storage, And Handling
   1. Store transformers protected from weather and so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.

G. Project Conditions
   1. Service Conditions: IEEE C37.121, usual service conditions except for the following:
      a. Exposure to significant solar radiation.
      b. Altitudes above 3300 feet (1000 m).
      c. Exposure to fumes, vapors, or dust.
      d. Exposure to explosive environments.
      e. Exposure to hot and humid climate or to excessive moisture, including steam, salt spray, and dripping water.
      f. Exposure to seismic shock or to abnormal vibration, shock, or tilting.
      g. Exposure to excessively high or low temperatures.

h. Unusual transportation or storage conditions.
i. Unusual grounding-resistance conditions.
j. Unusual space limitations.

1.2 PRODUCTS

A. Liquid-Filled Distribution And Power Transformers
1. Description: IEEE C57.12.00 and UL 1062, liquid-filled, 2-winding transformers.
2. Insulating Liquid: Mineral oil, complying with ASTM D 3487, Type II, and tested according to ASTM D 117.
OR
Insulating Liquid: Less flammable, edible-seed-oil based, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.
OR
Insulating Liquid: Less flammable, dielectric, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.
OR
Insulating Liquid: Less flammable, silicone-based dielectric, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall have low toxicity and be nonhazardous.
3. Insulation Temperature Rise: 65/55 deg C, based on an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C. Insulation system shall be rated to continuously allow an additional 12 percent kilovolt-ampere output, at 65 deg C temperature rise, without decreasing rated transformer life.
OR
Insulation Temperature Rise: 65 deg C, based on an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C.
4. Basic Impulse Level: Comply with UL 1062.
OR
Basic Impulse Level: 60 **OR** 75 **OR** 95 **OR** 110, **as directed** kV.
5. Full-Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated primary voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
OR
Full-Capacity Voltage Taps: Four nominal 2.5 percent taps below rated primary voltage, with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
6. Cooling System: Class OA, self-cooled **OR** OA/FA, self-cooled, and with forced-air-cooled rating **OR** OA/FFA, self-cooled, and with provisions for future forced-air-cooled rating, **as directed**. Cooling systems shall include auxiliary cooling equipment, automatic controls, and status indicating lights.
7. Sound level may not exceed sound levels listed in NEMA TR 1, without fans operating.
8. Accessories: Grounding pads, lifting lugs, and provisions for jacking under base. Transformers shall have a steel base and frame allowing use of pipe rollers in any direction, and an insulated, low-voltage, neutral bushing with removable ground strap. Include the following additional accessories:
a. Liquid-level gage.
b. Pressure-vacuum gage.
c. Liquid temperature indicator.
d. Drain and filter valves.
e. Pressure relief device.

B. Dry-Type Distribution And Power Transformers

1. Description: NEMA ST 20, IEEE C57.12.01, ANSI C57.12.50 for dry-type transformers rated up to 500 kVA, ANSI C57.12.51 for dry-type transformers rated 501 kVA and larger, or ANSI C57.12.52 for sealed dry-type transformers rated 501 kVA and larger, UL 1562 listed and labeled, dry-type, 2-winding transformers.
   a. Indoor, ventilated **OR** Outdoor, ventilated **OR** Totally enclosed, nonventilated, **as directed**, cast coil/encapsulated coil, with primary and secondary windings individually cast in epoxy; with insulation system rated at 185 deg C with an 80 deg C average winding temperature rise above a maximum ambient temperature of 40 deg C.
   b. Indoor, ventilated **OR** Outdoor, ventilated **OR** Totally enclosed, nonventilated, **as directed**, vacuum-pressure impregnated and with insulation system rated at 220 deg C with an 80 deg C average winding temperature rise above a maximum ambient temperature of 40 deg C.
2. Primary Connection: Air terminal compartment with removable **OR** hinged, **as directed,** door. Tin-plated copper bar for incoming line termination, predrilled to accept terminals for indicated conductors.
   OR
   Primary Connection: Transition terminal compartment with connection pattern to match switchgear.
3. Secondary Connection: Air terminal compartment with removable **OR** hinged, **as directed,** door. Tin-plated copper bar for incoming line termination, predrilled to accept terminals for indicated conductors.
   OR
   Secondary Connection: Transition terminal compartment with connection pattern to match switchgear **OR** bus duct, **as directed**.
4. Insulation Materials: IEEE C57.12.01, rated at 220 deg C.
5. Insulation Temperature Rise: 80 **OR** 115 **OR** 150, **as directed,** deg C, maximum rise above 40 deg C.
6. Basic Impulse Level: 60 **OR** 75 **OR** 95 **OR** 110, **as directed,** kV.
7. Full-Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated primary voltage.
   OR
   Full-Capacity Voltage Taps: Four nominal 2.5 percent taps below rated primary voltage.
8. Cooling System: Class AA, self-cooled **OR** AA/FA, self-cooled, and with forced-air-cooled rating **OR** AA/FFA, self-cooled, and with provisions for future forced-air-cooled rating, **as directed**, complying with IEEE C57.12.01.
   a. Automatic forced-air cooling system controls, including thermal sensors, fans, control wiring, temperature controller with test switch, power panel with current-limiting fuses, indicating lights, alarm, and alarm silencing relay.
   b. Include mounting provision for fans.
9. Sound level may not exceed sound levels listed in NEMA TR 1, without fans operating.
10. High-Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm.

C. Pad-Mounted, Liquid-Filled Transformers

1. Description: ANSI C57.12.13, ANSI C57.12.26 for pad-mounted transformers with dead-front, separable, insulated, high-voltage, load-break cable connectors, IEEE C57.12.00 IEEE C57.12.22 for pad-mounted transformers with live-front high-voltage bushings pad-mounted, 2-winding transformers. Stainless-steel tank base and cabinet, **OR** cabinet, and sills, **as directed**.
2. Insulating Liquid: Mineral oil, complying with ASTM D 3487, Type II, and tested according to ASTM D 117.
   OR
   Insulating Liquid: Less flammable, edible-seed-oil based, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.

OR
Insulating Liquid: Less flammable, dielectric, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.
OR
Insulating Liquid: Less flammable, silicone-based dielectric, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall have low toxicity and be nonhazardous.

3. Insulation Temperature Rise: 55 **OR** 65, **as directed,** deg C when operated at rated kVA output in a 40 deg C ambient temperature. Transformer shall be rated to operate at rated kilovolt ampere in an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C without loss of service life expectancy.
4. Basic Impulse Level: 30 **OR** 60 **OR** 95, **as directed,** kV.
5. Full-Capacity Voltage Taps: Four 2.5 percent taps, 2 above and 2 below rated high voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
6. High-Voltage Switch: 200 **OR** 300 **OR** 400, **as directed,** A, make-and-latch rating of 10-kA RMS, symmetrical, arranged for radial feed with 3-phase, 2-position, gang-operated, load-break switch that is oil immersed in transformer tank with hook-stick operating handle in primary compartment.
   OR
   High-Voltage Switch: 200 **OR** 300 **OR** 400, **as directed,** A, make-and-latch rating of 10-kA RMS, symmetrical, arranged for loop feed with 3-phase, 4-position, gang-operated, load-break switch that is oil immersed in transformer tank with hook-stick operating handle in primary compartment.
7. Primary Fuses: 150-kV fuse assembly with fuses complying with IEEE C37.47. Rating of current-limiting fuses shall be 50-kA RMS at specified system voltage.
   a. Current-limiting type in dry-fuse holder wells, mechanically interlocked with liquid-immersed switch in transformer tank to prevent disconnect under load.
   b. Internal liquid-immersed cartridge fuses.
   c. Bay-O-Net liquid-immersed fuses that are externally replaceable without opening transformer tank.
   d. Bay-O-Net liquid-immersed fuses in series with liquid-immersed current-limiting fuses. Bay-O-Net fuses shall be externally replaceable without opening transformer tank.
   e. Bay-O-Net liquid-immersed current-limiting fuses that are externally replaceable without opening transformer tank.
8. Surge Arresters: Distribution class, one for each primary phase; complying with IEEE C62.11 and NEMA LA 1; support from tank wall within high-voltage compartment. Transformers shall have three arresters for radial-feed **OR** three arresters for loop-feed **OR** six arresters for loop-feed, **as directed,** circuits.
9. High-Voltage Terminations and Equipment: Live front with externally clamped porcelain bushings and cable connectors suitable for terminating primary cable.
   OR
   High-Voltage Terminations and Equipment: Dead front with universal-type bushing wells for dead-front bushing-well inserts, complying with IEEE 386 and including the following:
   a. Bushing-Well Inserts: One for each high-voltage bushing well.
   b. Surge Arresters: Dead-front, elbow-type, metal-oxide-varistor units.
   c. Parking Stands: One for each high-voltage bushing well.
   d. Portable Insulated Bushings: Arranged for parking insulated, high-voltage, load-break cable terminators; one for each primary feeder conductor terminating at transformer.
10. Accessories:
    a. Drain Valve: 1 inch (25 mm), with sampling device.
    b. Dial-type thermometer.
    c. Liquid-level gage.
    d. Pressure-vacuum gage.
    e. Pressure Relief Device: Self-sealing with an indicator.
    f. Mounting provisions for low-voltage current transformers.

g. Mounting provisions for low-voltage potential transformers.
h. Busway terminal connection at low-voltage compartment.
i. Alarm contacts for gages and thermometer listed above.

D. Identification Devices
1. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification For Electrical Systems".

E. Source Quality Control
1. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to ANSI C57.12.50 for ventilated dry-type distribution transformers 1 to 500 kVA, single phase, and 15 to 500 kVA, 3 phase, with high voltage 601 to 34,500 V and low voltage 208Y/120 to 4160 V; ANSI C57.12.51 for ventilated dry-type power transformers 501 kVA and larger, 3 phase, with high voltage 601 to 34,500 V and low voltage 208Y/120 to 4160 V; IEEE C57.12.90 for liquid-filled transformers; and IEEE C57.12.91 for dry-type distribution and power transformers.
2. Factory Tests: Perform the following factory-certified tests on each transformer:
a. Resistance measurements of all windings on rated-voltage connection and on tap extreme connections.
b. Ratios on rated-voltage connection and on tap extreme connections.
c. Polarity and phase relation on rated-voltage connection.
d. No-load loss at rated voltage on rated-voltage connection.
e. Excitation current at rated voltage on rated-voltage connection.
f. Impedance and load loss at rated current on rated-voltage connection and on tap extreme connections.
g. Applied potential.
h. Induced potential.
i. Temperature Test: If transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kilovolt-ampere Class OA or Class AA rating and highest kilovolt-ampere Class OA/FA or Class AA/FA rating.
1) Temperature test is not required if record of temperature test on an essentially duplicate unit is available.

1.3 EXECUTION

A. Installation
1. Install transformers on concrete bases.
a. Anchor transformers to concrete bases according to manufacturer's written instructions, seismic codes at Project, and requirements in Division 26 Section "Hangers And Supports For Electrical Systems".
b. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit and 4 inches (100 mm) high.
c. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-place Concrete".
d. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
e. Install epoxy-coated anchor bolts, for supported equipment, that extend through concrete base and anchor into structural concrete floor.
f. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
g. Tack-weld or bolt transformers to channel-iron sills embedded in concrete bases. Install sills level and grout flush with floor or base.

2. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

B. Identification
1. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section "Identification For Electrical Systems", **as directed.**

C. Connections
1. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
2. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

D. Field Quality Control
1. Perform the following field tests and inspections and prepare test reports:
   a. After installing transformers but before primary is energized, verify that grounding system at substation is tested at specified value or less.
   b. After installing transformers and after electrical circuitry has been energized, test for compliance with requirements.
   c. Perform visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
   d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Remove and replace malfunctioning units and retest as specified above.
3. Test Reports: Prepare written reports to record the following:
   a. Test procedures used.
   b. Test results that comply with requirements.
   c. Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.

E. Follow-Up Service
1. Voltage Monitoring and Adjusting: If requested by the Owner, perform the following voltage monitoring after Final Completion but not more than six months after Final Acceptance:
   a. During a period of normal load cycles as evaluated by the Owner, perform seven days of three-phase voltage recording at secondary terminals of each transformer. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with a chart speed of not less than 1 inch (25 mm) per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.
   b. Corrective Actions: If test results are unacceptable, perform the following corrective actions, as appropriate:
      1) Adjust transformer taps.
      2) Prepare written request for voltage adjustment by electric utility.
   c. Retests: After corrective actions have been performed, repeat monitoring until satisfactory results are obtained.
   d. Report: Prepare written report covering monitoring and corrective actions performed.
2. Infrared Scanning: Perform as specified in Division 26 Section "Medium-voltage Switchgear".

END OF SECTION 26 12 13 00

SECTION 26 12 13 00a - LOW-VOLTAGE TRANSFORMERS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for low-voltage transformers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
      a. Distribution transformers.
      b. Buck-boost transformers.

C. Submittals
   1. Product Data: For each product indicated.
   2. Shop Drawings: Indicate dimensions and weights.
      a. Wiring Diagrams: Power, signal, and control wiring.
   3. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
   4. Field quality-control test reports.
   5. Operation and maintenance data.

D. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   2. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

E. Delivery, Storage, And Handling
   1. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.2 PRODUCTS

A. General Transformer Requirements
   1. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
   2. Cores: Grain-oriented, non-aging silicon steel.
   3. Coils: Continuous windings without splices except for taps.
      a. Internal Coil Connections: Brazed or pressure type.
      b. Coil Material: Aluminum **OR** Copper, **as directed**.

B. Distribution Transformers
   1. Comply with NEMA ST 20, and list and label as complying with UL 1561.
   2. Provide transformers that are constructed to withstand seismic forces specified in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
   3. Cores: One leg per phase.
   4. Enclosure: Ventilated **OR** Totally enclosed, nonventilated, **as directed**, NEMA 250, Type 2.

a. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

5. Enclosure: Ventilated **OR** Totally enclosed, nonventilated, **as directed**, NEMA 250, Type 3R **OR** Type 4X, stainless steel, **as directed**.
   a. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
6. Transformer Enclosure Finish: Comply with NEMA 250.
   a. Finish Color: Gray **OR** ANSI 49 gray **OR** ANSI 61 gray, **as directed**.
7. Taps for Transformers Smaller Than 3 kVA: None **OR** One 5 percent tap above normal full capacity, **as directed**.
8. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity **OR** Two 5 percent taps below rated voltage, **as directed**.
9. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity **OR** Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity, **as directed**.
10. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 **OR** 115 **OR** 80, **as directed**, deg C rise above 40 deg C ambient temperature.
11. Energy Efficiency for Transformers Rated 15 kVA and Larger:
    a. Complying with NEMA TP 1, Class 1 efficiency levels.
    b. Tested according to NEMA TP 2.
12. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
    a. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
    b. Indicate value of K-factor on transformer nameplate.
13. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
14. Wall Brackets: Manufacturer's standard brackets.
15. Fungus Proofing: Permanent fungicidal treatment for coil and core.
16. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

C. Buck-Boost Transformers
1. Description: Self-cooled, two-winding dry type, rated for continuous duty and with wiring terminals suitable for connection as autotransformer. Transformers shall comply with NEMA ST 1 and shall be listed and labeled as complying with UL 506 or UL 1561.
2. Enclosure: Ventilated, NEMA 250, Type 2.
   a. Finish Color: Gray **OR** ANSI 49 gray **OR** ANSI 61 gray, **as directed**.

D. Identification Devices
1. Nameplates: Engraved, laminated-plastic or metal nameplate. Nameplates are specified in Division 26 Section "Identification For Electrical Systems".

1.3 EXECUTION

A. Installation
1. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
   a. Brace wall-mounting transformers as specified in Division 26 Section "Hangers And Supports For Electrical Systems".
2. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project, **as directed**, and requirements in Division 26 Section "Hangers And Supports For Electrical Systems".

B. Field Quality Control

1. Perform tests and inspections.
2. Tests and Inspections:
   a. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   b. Infrared Scanning: Two months after Final Completion, perform an infrared scan of transformer connections.
      1) Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
      2) Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Final Completion.
      3) Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

C. Adjusting
1. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
2. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
3. Output Settings Report: Prepare a written report recording output voltages and tap settings.

D. Cleaning
1. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 26 12 13 00a

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Task	Specification	Specification Description
26 12 13 00	02 84 33 00	Overhead Electrical Distribution
26 12 16 00	26 12 13 00	Medium-Voltage Transformers
26 12 16 00	26 12 13 00a	Low-Voltage Transformers
26 12 19 00	26 12 13 00	Medium-Voltage Transformers
26 12 19 00	26 12 13 00a	Low-Voltage Transformers
26 13 16 00	26 11 13 00	Secondary Unit Substations
26 13 19 00	26 11 13 00	Secondary Unit Substations
26 13 29 00	26 11 13 00	Secondary Unit Substations
26 13 29 00	26 11 16 11	Switchgear
26 18 36 00	26 11 16 11	Switchgear
26 19 18 00	02 84 33 00	Overhead Electrical Distribution
26 19 80 60	02 84 33 00	Overhead Electrical Distribution
26 21 13 00	26 05 13 16	Conductors And Cables
26 21 13 00	26 05 13 16a	Undercarpet Cables
26 21 13 00	26 05 13 16b	Medium-Voltage Cables
26 21 13 00	02 84 33 00	Overhead Electrical Distribution
26 21 16 00	26 05 13 16	Conductors And Cables
26 21 16 00	26 05 13 16a	Undercarpet Cables
26 21 16 00	26 05 13 16b	Medium-Voltage Cables
26 22 13 00	26 12 13 00	Medium-Voltage Transformers
26 22 13 00	02 84 33 00	Overhead Electrical Distribution
26 22 13 00	26 12 13 00a	Low-Voltage Transformers

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SECTION 26 24 13 00 - ELECTRICITY METERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. [**Electricity metering**] [**Work to accommodate utility company revenue meters, and Owner's electricity meters used to manage electrical power system**].

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

A. KY or KYZ Pulse: Term used by metering industry to describe method of measuring consumption of electricity (kWh) that is based on relay opening and closing in response to rotation of disk in meter. Electronic meters generate pulses electronically.

1.3 COORDINATION

A. Electrical Service Connections:

1. Coordinate with utility companies and utility-furnished components.

   a. Comply with requirements of utility providing electrical power services.
   b. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

1.4 ACTION SUBMITTALS

A. Product Data:

1. For each type of meter.
2. For metering infrastructure components.
3. For metering software.

B. Shop Drawings: For electricity-metering equipment.

1. Include elevation views of front panels of control and indicating devices and control stations.
2. Include diagrams for power, signal, and control wiring.
3. Wire Termination Diagrams and Schedules: Include diagrams for power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation,

operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.

4. Include series-combination rating data for modular meter centers with main disconnect device.
5. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices used. Describe characteristics of network and other data communication lines.
6. Submit evidence that meters are compatible with connected monitoring and control devices and systems specified in [**Section 260913 "Electrical Power Monitoring and Control."**] <**Insert Section number and title.**>

   a. Show interconnecting signal and control wiring, and interface devices to show compatibility of meters.
   b. For reporting and billing interfaces and adapters, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of the protocol.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Installation of metering equipment.

B. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Software and firmware service agreement.

B. Warranty documentation.

1.7 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed metering equipment performs in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**] <**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that metering equipment performs in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. [**Initial**]Extended-Warranty Period: [**Three**] <**Insert number**> years from date of Substantial Completion; [**full**] [**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**] <**Insert number**> years from date of Substantial Completion; [**full**] [**prorated**] coverage for materials[**that failed because of transient voltage surges**] only, free on board [**origin**] [**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Comply with UL 916.

2.2 UTILITY METERING INFRASTRUCTURE

A. Install metering accessories furnished by utility company, complying with its requirements.

B. Utility-Furnished Meters: Connect data transmission facility of metering equipment installed by Utility.

1. Data Transmission: Transmit pulse data over control-circuit conductors, classified as Class 1 per NFPA 70, Article 725. Comply with Section 260523 "Control-Voltage Electrical Power Cables."

C. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.

D. Meter Sockets:

1. Comply with requirements of electrical-power utility company.
2. Meter Sockets: Steady-state and short-circuit current ratings must meet indicated circuit ratings.

E. Modular Meter Center: Factory-coordinated assembly of main service [**terminal box with lugs only**] [**disconnect device**], wireways, meter socket modules, and feeder circuit breakers arranged in adjacent vertical sections complete with interconnecting buses.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Comply with requirements of utility company for meter center.

    a. Comply with UL 67.

3. Housing: UL 50E, [**Type 1**] [**Type 3R**] [**Type 4X**] enclosure.
4. Meter Socket Rating: Coordinated with connected feeder circuit rating.
5. Minimum Short-Circuit Rating: [**22 000 A**] [**42 000 A**] [**65 000 A**] [**100 000 A**] <**Insert amperes**> symmetrical at rated voltage.
6. Steady-state and short-circuit current ratings must have ratings that match connected circuit ratings.
7. Main Disconnect Device:

    a. Circuit breaker, series-combination rated for use with downstream feeder and branch circuit breakers and having adjustable magnetic trip setting for circuit-breaker frame sizes of 250 A and larger. Comply with requirements in Section 262816 "Enclosed Switches and

Circuit Breakers." Circuit breakers must be operable from outside enclosure to disconnect unit. Configure cover so it can be opened only when disconnect switch is open.

b. Fusible switch, UL 98 Type GD, series-combination rated by fuse manufacturer to protect downstream feeder and branch circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers." Switch must be operable from outside enclosure to disconnect unit. Configure cover so that it can be opened only when disconnect switch is open.

8. Feeder Circuit Breakers: Series-combination-rated molded-case units, rated to protect downstream circuit breakers and to house load centers and panelboards that have [**10 000 A**] <**Insert amperes**> interrupting capacity.

   a. Identification: Complying with requirements in Section 260553 "Identification for Electrical Systems."
   b. Physical Protection: Tamper resistant, with hasp for padlock.

9. Surge Protection:

   a. Factory-installed in main disconnect, integrally mounted, UL 1449 Type 1. Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
   b. Field-mounted external to main disconnect, UL 1449 Type 2, with integral disconnect and overcurrent protective device. Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
   c. Factory-installed in main terminal box, integrally mounted, UL 1449 Type 1. Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
   d. Field-mounted external to main terminal box, UL 1449 Type 2, with integral disconnect and overcurrent protective device. Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

F. Arc-Flash Warning Labels;

1. Comply with requirements for "Arc-Flash Warning Labels" in Section 260573.19 "Arc-Flash Studies." Apply 3-1/2-by-5 inch (76-by-127 mm) thermal transfer label of high-adhesion polyester for each work location included in the analysis.
2. Comply with requirements for "Self-Adhesive Equipment Labels" and "Signs" in Section 260553 "Identification for Electrical Systems." Apply 3-1/2-by-5 inch (76-by-127 mm) thermal transfer label of high-adhesion polyester for each work location included in the analysis. Labels must be machine printed, with no field-applied markings.

   a. Label must have orange header with wording, "WARNING, ARC-FLASH HAZARD," and must include the following information taken directly from arc-flash hazard analysis:

      1) Location designation.
      2) Nominal voltage.
      3) Flash protection boundary.
      4) Hazard risk category.
      5) Incident energy.
      6) Working distance.
      7) Engineering report number, revision number, and issue date.

2.3 ELECTRICITY METERS

A. System Description: Able to meter designated activity loads, with or without external alarm, control, and communication capabilities, or other optional features.

B. <Double click here to find, evaluate, and insert list of manufacturers and products.>

C. General Requirements for Meters:

1. Comply with NEMA ANSI C12.1 and NEMA ANSI C12.20, [**0.1**] [**0.2**] [**0.5**] accuracy class.
2. Ambient Temperature: Minus 22 deg F to plus 158 deg F (Minus 30 deg C to plus 70 deg C).
3. Humidity: Zero to 95 percent, noncondensing.
4. Capacities and Characteristics:

    a. Circuit: 120/240 V(ac), 100 A.
    b. Measure: kWh, onboard LED display.
    c. Remote-Reading Options: None.

5. Billing Meters Accuracy: [**0.2**] [**0.5**] [**1.0**] percent of reading, complying with NEMA ANSI C12.20.
6. Meters Certification: Certified by [**California Type Evaluation Program**] <**Insert agency**> as complying with [**4 CCR 4027, Article 2.2**] <**Insert state or Federal regulatory requirement**>.
7. Certify that meters comply with NEMA ANSI C12.20 requirements by laboratory accredited by the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology (NIST). Laboratory must use test equipment that is certified annually and is traceable to NIST standards.
8. Enclosure: Supplied by meter manufacturer, UL 50E, [**Type 1**] [**Type 3R**] [**Type 4X**] minimum, with provisions for locking or sealing.
9. Identification: Comply with requirements in Section 260553 "Identification for Electrical Systems."
10. Onboard Nonvolatile Data Storage: kWh, until reset.
11. Sensors: Current-sensing type, supplied by electronic meter manufacturer, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.

    a. Type: [**Split**] [**and**] [**solid**] core, complying with recommendation of meter manufacturer.

D. kWh Meter: Electronic [**single-phase**] [**and**] [**three-phase**] meters, measuring electricity use.

1. Voltage and Phase Configuration: Meter must be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display:

    a. LCD with characters not less than 0.25 inch (6 mm) high, indicating accumulative kWh and current kilowatt load. Retain accumulated kWh in nonvolatile memory, until reset.
    b. Digital electromechanical counter, indicating accumulative kWh.

E. kWhd Meter: Electronic [**single-phase**] [**and**] [**three-phase**] meters, measuring electricity use and demand. Demand must be integrated over [**15-minute**] <**Insert time**> interval.

1. Voltage and Phase Configuration: Meter must be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than 0.25 inch (6 mm) high, indicating the following:

    a. Accumulative kWh.
    b. Current time and date.
    c. Current demand.
    d. Historic peak demand.
    e. Time and date of historic peak demand.

3. Retain accumulated kWh and historic peak demand in nonvolatile memory, until reset.

F. KY and KYZ Pulse Totalizer:

1. Pulse Totalizer: Instrument for demand and billing applications where one or more utility revenue meters stream KY or KYZ energy pulses. Instrument must totalize kWh accumulated over user-selected period and must log maximum and minimum kWhd for that period. Record each period with date/time stamp. Time period must be user selected from one to 60 minutes.

    a. Pulse Input: [**One**] <**Insert number**>, individually programmable, KYZ Form C (three-wire) contact pulse channels. Pulse interval, pulse rate, and minimum pulse width must be field adjustable, set for pulse stream provided by utility revenue meter.
    b. Data Totalizing Capacity of Each Channel: Not less than 149 days at 15-minute intervals.
    c. Instrument Power: User selectable, 120 V(ac) and 277 V(ac).
    d. Clock: Line frequency.

G. Remote Reading Options:

    1. Pulse Output: [**KY**] [**KYZ**], complete with optical sensor and interface devices.
    2. TIA-232 serial interface.
    3. TIA-485 serial interface, with [**Modbus RTU protocol**] <**Insert protocol name**>.
    4. USB interface.
    5. TCP/IP adapter.

H. Current-Transformer Cabinet: Size and configuration as recommended by metering equipment manufacturer for use with indicated connected feeder and sensors.

I. Uninterruptible Power Supply: Single phase, 120 V(ac), sized and rated to provide continuous power to meter for operations of [**48**] <**Insert number**> hours after interruption of normal power.

    1. Output: Sine wave, total harmonic distortion less than 5 percent at full load.
    2. Battery: Maintenance free, sealed, lead acid, and leakproof.
    3. Control Panel: LED status display of "on-battery," "replace battery," and "overload."

J. Data Transmission Cable: Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

K. Software: PC-based product [**of**] [**recommended by**] meter manufacturer, suitable for calculating utility cost allocation.

    1. Utility Cost Allocation: Automatically import electricity-usage records to allocate electricity costs for the following:

        a. At least [**15**] <**Insert number**> departments.
        b. At least [**30**] <**Insert number**> tenants or activities.
        c. At least [**five**] <**Insert number**> processes.
        d. At least [**five**] <**Insert number**> buildings.
        e. <**Insert entity**>.

    2. Activity Billing Software: Automatically import electricity-usage records to automatically compute and prepare electricity-use statements[**and invoices**] based on electricity use[**and peak demand**]. Maintain separate directory for each allocation. Prepare summary reports in user-defined formats and time intervals.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Install modular meter center according to switchboard installation requirements in NECA 400.
2. Install arc-flash labels as required by NFPA 70.

C. Special Techniques:

1. Install meters furnished by utility company. Install raceways and equipment according to utility company's published instructions. Provide empty conduits for metering leads and extend grounding connections as required by utility company.
2. Wiring Methods:

a. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
b. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Section 271513 "Communications Copper Horizontal Cabling."
c. Minimum conduit size is metric designator 16 (trade size 1/2).

3.2 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Series Combination Warning Label: Self-adhesive labels, with text as required by NFPA 70.
2. Equipment Identification Labels: Self-adhesive labels with clear protective overlay. For residential meters, provide additional card holder suitable for [**printed, weather-resistant card**] [**typewritten card**] with occupant's name.

3.3 FIELD QUALITY CONTROL

A. [**Acceptance**]Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**] [**Tenant**] [**authorities having jurisdiction**] <**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Equipment and Software Setup:

a. Set meter date and time clock.
b. Test, calibrate, and connect pulse metering system.
c. Set and verify billing demand interval for demand meters.
d. Report settings and calibration results.

e. Set up reporting and billing software, insert billing location names and initial constant values and variable needed for billing computations.

2. Connect load of known power rating, [**1.5 kW**] <**Insert kilowatts**> minimum, to circuit supplied by metered feeder.
3. Turn off circuits supplied by metered feeder and secure them in off condition.
4. Run test load continuously for eight hours minimum, or longer, to obtain measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
5. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.
6. Generate test report and billing for each tenant or activity from meter reading tests.

D. Nonconforming Work:

1. Electricity metering will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**] [**supervise**] field tests and inspections.

3.4 PROTECTION

A. After installation, protect metering equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.5 MAINTENANCE

A. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software and firmware support for [**two**] <**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software and firmware upgrades that become available within [**two**] <**Insert number**> years from date of Substantial Completion.[**Verify that upgrading software includes operating system and new or revised licenses for using software.**]

a. Upgrade Notice: No fewer than [**30**] <**Insert number**> days to allow Owner to schedule and access the system[**and to upgrade computer equipment if necessary.**]

3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION 26 24 13 00

SECTION 26 24 13 00a - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Receptacle switches.
4. Shunt trip switches.
5. Molded-case circuit breakers (MCCBs).
6. Molded-case switches.
7. Enclosures.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

A. GFEP: Ground-fault circuit-interrupter for equipment protection.

B. GFLS: Ground-fault circuit-interrupter for life safety.

C. SPDT: Single pole, double throw.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
2. Enclosure types and details for types other than UL 50E, Type 1.
3. Current and voltage ratings.
4. Short-circuit current ratings (interrupting and withstand, as appropriate).
5. Include evidence of qualified electrical testing laboratory listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
7. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in [**PDF**] [**and**] <**Insert calculation program format**> electronic format.

B. Shop Drawings: For enclosed switches and circuit breakers.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include wiring diagrams for power, signal, and control wiring.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts: Furnish to Owner spare parts, for repairing enclosed switches and circuit breakers, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Fuses: Equal to [**10**] <**Insert number**> percent of quantity installed for each size and type, but no fewer than [**three**] <**Insert number**> of each size and type.
2. Fuse Pullers: [**Two**] <**Insert number**> for each size and type.
3. <**Insert spare parts**>.

1.7 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed enclosed switches and circuit breakers perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**] <**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that enclosed switches and circuit breakers perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Three**] <**Insert number**> years from date of Substantial Completion; [**full**] [**prorated**] coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Source Limitations: Obtain products from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 FUSIBLE SWITCHES

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Type HD, Heavy Duty:

1. [**Single**] [**Double**] throw.
2. [**Three**] [**six**] pole.
3. [**240**] [**600**] V(ac).
4. [**1200 A and smaller**] [**200 A and smaller**].
5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate [**specified**] [**indicated**] fuses.
6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Service-Rated Switches: Labeled for use as service equipment.
6. Hookstick Handle: Allows use of hookstick to operate handle.
7. Auxiliary Contact Kit: [**One**] [**Two**] NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - [**24 V(ac)**] [**120 V(ac)**] [**208 V(ac)**] [**240 V(ac)**] [**6 V(dc)**] [**12 V(dc)**] [**24 V(dc)**].
8. Lugs: [**Mechanical**] [**Compression**] type, suitable for number, size, and conductor material.

2.3 NONFUSIBLE SWITCHES

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Type GD, General Duty, Three Pole, Single Throw, 240 V(ac), 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Three Pole, Single Throw, [**240**] [**600**] V(ac), 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Six Pole, Single Throw, [**240**] [**600**] V(ac), 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Type HD, Heavy Duty, Three Pole, Double Throw, [**240**] [**600**] V(ac), 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

F. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Service-Rated Switches: Labeled for use as service equipment.
6. Hookstick Handle: Allows use of hookstick to operate handle.
7. Auxiliary Contact Kit: [**One**] [**Two**] NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - [**24 V(ac)**] [**120 V(ac)**] [**208 V(ac)**] [**240 V(ac)**] [**6 V(dc)**] [**12 V(dc)**] [**24 V(dc)**].
8. Lugs: [**Mechanical**] [**Compression**] type, suitable for number, size, and conductor material.

2.4 RECEPTACLE SWITCHES

A. <u><Double click here to find, evaluate, and insert list of manufacturers and products.></u>

B. Type HD, Heavy-Duty, Three Pole, Single-Throw Fusible Switch: [**240**] [**600**] V(ac), [**30**] [**60**] [**100**] <**Insert number**> A; UL 98 and NEMA KS 1; horsepower rated, with clips or bolt pads to accommodate [**specified**] [**indicated**] fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

C. Type HD, Heavy-Duty, Three Pole, Single-Throw Nonfusible Switch: [**240**] [**600**] V(ac), [**30**] [**60**] [**100**] <**Insert number**> A; UL 98 and NEMA KS 1; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Interlocking Linkage: Provided between receptacle and switch mechanism to prevent inserting or removing plug while switch is in on position, inserting plug other than specified, and turning switch on if incorrect plug is inserted or correct plug has not been fully inserted into receptacle.

E. Receptacle: Polarized, three-phase, four-wire receptacle (fourth wire connected to enclosure ground lug).

F. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Service-Rated Switches: Labeled for use as service equipment.
6. Hookstick Handle: Allows use of hookstick to operate handle.
7. Auxiliary Contact Kit: [**One**] [**Two**] NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - [**24 V(ac)**] [**120 V(ac)**] [**208 V(ac)**] [**240 V(ac)**] [**6 V(dc)**] [**12 V(dc)**] [**24 V(dc)**].
8. Lugs: [**Mechanical**] [**Compression**] type, suitable for number, size, and conductor material.

2.5 SHUNT TRIP SWITCHES

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. General Requirements: Comply with[**ASME A17.1,**] UL 50, and UL 98, with Class J fuse block and 200 kA interrupting and short-circuit current rating.

C. Type HD, Heavy-Duty, Three Pole, Single-Throw Fusible Switch: [**240**] [**600**] V(ac), [**30**] [**60**] [**100**] <**Insert number**> A; UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, with clips or bolt pads to accommodate [**specified**] [**indicated**] fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Type HD, Heavy-Duty, Three Pole, Single-Throw Nonfusible Switch: [**240**] [**600**] V(ac), [**30**] [**60**] [**100**] <**Insert number**> A; UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

E. Control Circuit: 120 V(ac); obtained from [**integral control power transformer, with primary and secondary fuses,**] <**Insert source of control power**> with control power [**transformer**] [**source**] of enough capacity to operate shunt trip, pilot, indicating and control devices.

F. Accessories:

1. Oiltight key switch for key-to-test function.
2. Oiltight [**red**] [**green**] [**white**] [**yellow**] ON pilot light.
3. Isolated neutral lug; [**100**] [**200**] percent rating.
4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
5. Three-pole, double-throw, fire-safety and alarm relay; [**120 V(ac)**] [**24 V(dc)**] coil voltage.
6. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.
7. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
8. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
9. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
10. Service-Rated Switches: Labeled for use as service equipment.
11. Hookstick Handle: Allows use of hookstick to operate handle.
12. Form C alarm contacts that change state when switch is tripped.
13. Auxiliary Contact Kit: [**One**] [**Two**] NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - [**24 V(ac)**] [**120 V(ac)**] [**208 V(ac)**] [**240 V(ac)**] [**6 V(dc)**] [**12 V(dc)**] [**24 V(dc)**].
14. Lugs: [**Mechanical**] [**Compression**] type, suitable for number, size, and conductor material.

2.6 MOLDED-CASE CIRCUIT BREAKERS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Circuit breakers must be constructed using glass-reinforced insulating material. Current carrying components must be completely isolated from handle and accessory mounting area.

C. Circuit breakers must have toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. Circuit-breaker handle must be over center, be trip free, and reside in tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon must be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with push-to-trip button, located on face of circuit breaker to mechanically operate circuit-breaker tripping mechanism for maintenance and testing purposes.

D. Maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings must be clearly marked on face of circuit breaker. Circuit breakers must be [**100 percent rated**] [**series rated**] [**100 percent rated or series rated as indicated on Drawings**]. [**Circuit breaker/circuit breaker**] [**Fuse/circuit breaker**] combinations for series connected interrupting ratings must be listed by UL as recognized component combinations. Series rated combination used must be marked on end-use equipment along with statement "Caution - Series Rated System. _____ Amps Available. Identical Replacement Component Required."

E. MCCBs must be equipped with device for locking in isolated position.

F. Lugs must be suitable for [**60 deg C rated wire on 125 A circuit breakers and below**] [**75 deg C rated wire**] [**90 deg C rated wire, sized in accordance with 75 deg C temperature rating in NFPA 70**].

G. Standard: Comply with UL 489 with required interrupting capacity for available fault currents.

H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, RMS sensing, with the following field-adjustable settings:

1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and I-squared t response.

K. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

L. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

M. GFLS Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6 mA trip).

N. GFEP Circuit Breakers: With Class B ground-fault protection (30 mA trip).

O. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.

2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
3. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
4. Alarm Switch: One [**NO**] [**NC**] contact that operates only when circuit breaker has tripped.
5. Auxiliary Contacts: [**One SPDT switch**] [**Two SPDT switches**] with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
6. Lugs: [**Mechanical**] [**Compression**] type, suitable for number, size, trip ratings, and conductor material.
7. Ground-Fault Protection: Comply with UL 1053; [**integrally mounted, self-powered**] [**remote-mounted and powered**] type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
8. Communication Capability: [**Circuit-breaker-mounted**] [**Universal-mounted**] [**Integral**] [**Din-rail-mounted**] communication module with functions and features compatible with power monitoring and control system, specified in Section 260913 "Electrical Power Monitoring and Control."
9. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
10. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.
11. Zone-Selective Interlocking: Integral with [**electronic**] [**ground-fault**] trip unit; for interlocking ground-fault protection function.
12. Electrical Operator: Provide remote control for on, off, and reset operations.
13. Accessory Control Power: [**Integrally mounted, self-powered**] [**Remote mounted and powered**]; [**24 V(ac)**] [**120 V(ac)**] [**208 V(ac)**] [**240 V(ac)**] [**12 V(dc)**] [**24 V(dc)**] [**120 V(dc)**].

2.7 MOLDED-CASE SWITCHES

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

C. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.

D. Features and Accessories:

1. Standard frame sizes and number of poles.
2. Lugs:

    a. [**Mechanical**] [**Compression**] type, suitable for number, size, trip ratings, and conductor material.
    b. Lugs must be suitable for [**60 deg C rated wire on 125 A circuit breakers and below**] [**75 deg C rated wire**] [**90 deg C rated wire, sized in accordance with 75 deg C temperature rating in NFPA 70**].

3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
6. Auxiliary Contacts: [**One SPDT switch**] [**Two SPDT switches**] with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.

7. Alarm Switch: One [**NO**] [**NC**] contact that operates only when switch has tripped.
8. Key Interlock Kit: Externally mounted to prohibit switch operation; key must be removable only when switch is in off position.
9. Zone-Selective Interlocking: Integral with ground-fault shunt trip unit; for interlocking ground-fault protection function.
10. Electrical Operator: Provide remote control for on, off, and reset operations.
11. Accessory Control Power Voltage: [**Integrally mounted, self-powered**] [**Remote mounted and powered**]; [**24 V(ac)**] [**120 V(ac)**] [**208 V(ac)**] [**240 V(ac)**] [**12 V(dc)**] [**24 V(dc)**] [**120 V(dc)**].

2.8 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, UL 50E, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish: Enclosure must be [**finished with**] [**gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (UL 50E Type 1)**] [**gray baked enamel paint, electrodeposited on cleaned, phosphatized galvannealed steel (UL 50E Types 3R, 12)**] [**a brush finish on Type 304 stainless steel (UL 50E Type 4-4X stainless steel)**] [**copper-free cast aluminum alloy (UL 50E Types 7, 9)**].

C. Conduit Entry: UL 50E Types 4, 4X, and 12 enclosures may not contain knockouts. UL 50E Types 7 and 9 enclosures must be provided with threaded conduit openings in both endwalls.

D. Operating Mechanism: Circuit-breaker operating handle must be [**externally operable with operating mechanism being integral part of box, not cover**] [**directly operable through front cover of enclosure (UL 50E Type 1)**] [**directly operable through dead front trim of enclosure (UL 50E Type 3R)**] [**externally operable with operating mechanism being integral part of cover (UL 50E Types 7, 9)**]. Cover interlock mechanism must have externally operated override. Override may not permanently disable interlock mechanism, which must return to locked position once override is released. Tool used to override cover interlock mechanism must not be required to enter enclosure in order to override interlock.

E. Enclosures designated as UL 50E Type 4, 4X stainless steel, 12, or 12K must have dual cover interlock mechanism to prevent unintentional opening of enclosure cover when circuit breaker is ON and to prevent turning circuit breaker ON when enclosure cover is open.

F. UL 50E Type 7/9 enclosures must be furnished with breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Commencement of work will indicate Installer's acceptance of areas and conditions as satisfactory.

3.2 SELECTION OF ENCLOSURES

A. Indoor, Dry and Clean Locations: UL 50E, [**Type 1**] <**Insert type**>.

B. Outdoor Locations: UL 50E, [**Type 3R**] [**Type 4X**] <**Insert type**>.

C. [**Kitchen**] [**Wash-Down**] Areas: UL 50E, [**Type 4X**] <**Insert type**>, [**stainless steel**] <**Insert material**>.

D. Other Wet or Damp, Indoor Locations: UL 50E, [**Type 4**] <**Insert type**>.

E. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: UL 50E, Type 12.

F. Hazardous Areas Indicated on Drawings: UL 50E, [**Type 7**] [**Type 9**] <**Insert type**> [**with cover attached by Type 316 stainless steel bolts**].

3.3 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Special Techniques:

1. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
2. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
3. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
4. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
5. Install fuses in fusible devices.

3.4 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.5 FIELD QUALITY CONTROL

A. [**Acceptance**]Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**] [**Tenant**] [**authorities having jurisdiction**] <**Insert names or titles of witnesses**>.

C. Tests and Inspections for Switches:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and clearances.
c. Verify that unit is clean.
d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
e. Verify that fuse sizes and types match the Specifications and Drawings.
f. Verify that each fuse has adequate mechanical support and contact integrity.
g. Inspect bolted electrical connections for high resistance using one of the following methods:

1) Use low-resistance ohmmeter.

a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.

h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on Drawings.
i. Verify correct phase barrier installation.
j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
b. Measure contact resistance across each switchblade fuseholder. Drop values may not exceed high level of manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
e. Perform ground fault test in accordance with NETA ATS Section 7.14 "Ground Fault Protection Systems, Low-Voltage."

D. Tests and Inspections for Molded-Case Circuit Breakers:

1. Visual and Mechanical Inspection:

a. Verify that equipment nameplate data are as described in the Specifications and shown on Drawings.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, grounding, and clearances.

d. Verify that unit is clean.
e. Operate circuit breaker to ensure smooth operation.
f. Inspect bolted electrical connections for high resistance using one of the following methods:

1) Use low-resistance ohmmeter.

a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.

g. Inspect operating mechanism, contacts, and chutes in unsealed units.
h. Perform adjustments for final protective device settings in accordance with coordination study.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
c. Perform contact/pole resistance test. Drop values may not exceed high level of manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
d. Perform insulation resistance tests on control wiring with respect to ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values may be no less than 2 M Ω.
e. Determine the following by primary current injection:

1) Long-time pickup and delay. Pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
2) Short-time pickup and delay. Short-time pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
3) Ground-fault pickup and time delay. Ground-fault pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
4) Instantaneous pickup. Instantaneous pickup values must be as specified and within manufacturer's published tolerances.

f. Test functionality of trip unit by means of primary current injection. Pickup values and trip characteristics must be as specified and within manufacturer's published tolerances.
g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of shunt trip and close coils must be as indicated by manufacturer.
h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset trip logs and indicators. Investigate units that do not function as designed.
i. Verify operation of charging mechanism. Investigate units that do not function as designed.

3. Test and adjust controls, remote monitoring, and safeties.

E. Nonconforming Work:

1. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Collect, assemble, and submit test and inspection reports.

1. Test procedures used.
2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
3. List deficiencies detected, remedial action taken, and observations after remedial action.

G. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**] [**supervise**] field tests and inspections.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges[**as specified in Section 260573.16 "Coordination Studies."**] [**to values indicated on Drawings.**] [**to values indicated in attached schedule.**]

3.7 PROTECTION

A. After installation, protect enclosed switches and circuit breakers from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.8 MAINTENANCE

A. Infrared Scanning of Enclosed Switches and Breakers: Two months after Substantial Completion, perform infrared scan of joints and connections. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.

1. Instruments and Equipment: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Follow-up Infrared Scanning: Perform two follow-up infrared scans of enclosed switches and breakers, one at four months and another at 11 months after Substantial Completion.
3. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
4. Report: Prepare certified report that identifies units checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 26 24 13 00a

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SECTION 26 24 13 00b - SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Switchboards.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.

B. Related Requirements

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 260573.19 "Arc-Flash Hazard Analysis" for arc-flash analysis and arc-flash label requirements.

1.2 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Switchboards.
2. Overcurrent protective devices.
3. Surge protection devices.
4. Groud-fault protection devices.
5. Accessories.
6. Other components.
7. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than UL 50E, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Detail utility company's metering provisions with indication of approval by utility company.
7. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series rating of installed devices.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
10. Include diagram and details of proposed mimic bus.
11. Include schematic and wiring diagrams for power, signal, and control wiring.

C. Samples: Representative portion of mimic bus with specified material and finish, for color selection.

D. Field Quality-Control Submittals:

1. Field Quality-Control Reports:

a. Test procedures used.
b. Test results that comply with requirements.
c. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Handling, storing, and providing temporary heat.
2. Mounting accessories and anchoring devices.
3. Testing and adjusting overcurrent protective devices.

B. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts: Furnish to Owner spare parts, for repairing switchboards, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type but no fewer than two of each size and type.
2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type but no less than one of each size and type.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to switchboards, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
2. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.
3. Portable Circuit-Breaker Lifting Device: Floor-supported, roller-based, elevating carriage arranged for movement of circuit breakers in and out of compartments for present and future circuit breakers.
4. Overhead Circuit-Breaker Lifting Device: Mounted at top front of switchboard, with hoist and lifting yokes matching each drawout circuit breaker.
5. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and [**install temporary electric heating (250 W per section)**] [**connect factory-installed space heaters to temporary electrical service**] to prevent condensation.

C. Handle and prepare switchboards for installation in accordance with [**NECA 400**] [**NEMA PB 2.1**].

1.8 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed switchboard perform in accordance with specified requirements and agrees to repair or replace components that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**] <**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that switchboard performs in accordance with specified requirements and agrees to provide repair or replacement of components that fail to perform as specified within extended-warranty period.

1. [**Initial**]Extended-Warranty Period: [**Three**] <**Insert number**> years from date of Substantial Completion; [**full**] [**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Five**] <**Insert number**> years from date of Substantial Completion; [**full**] [**prorated**] coverage for materials[**that failed because of transient voltage surges**] only, free on board [**origin**] [**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 SWITCHBOARDS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

E. Comply with NEMA PB 2.

F. Comply with NFPA 70.

G. Comply with UL 891.

H. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: [**Panel**] [**Fixed, individually**] mounted.
2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.

I. Front- and Side-Accessible Switchboards:

1. Main Devices: Fixed, individually mounted.
2. Branch Devices: Panel mounted.
3. Section Alignment: [**Front**] [**and**] [**Rear**] aligned.

J. Front- and Rear-Accessible Switchboards:

1. Main Devices: [**Fixed, individually**] [**Drawout**] mounted.
2. Branch Devices: [**Panel**] [**Fixed, individually**] [**Panel and fixed, individually**] [**Fixed and individually compartmented**] [**Individually compartmented and drawout**] mounted.
3. Sections [**front and rear**] [**rear**] aligned.

K. Nominal System Voltage: [**480Y/277 V**] [**208Y/120 V**] <**Insert system voltage**>.

L. Main-Bus Continuous: [**5000**] [**4000**] [**3000**] [**2500**] [**2000**] [**1600**] [**1200**] <**Insert ampere rating**> A.

M. Indoor Enclosures: Steel, UL 50E, [**Type 1**] [**Type 2**].

N. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's [**standard gray**] [**custom color**] finish over rust-inhibiting primer on treated metal surface.

O. Outdoor Enclosures: [**Type 3R**] [**Type 3R, with interior-lighted walk-in aisle**].

1. Finish: Factory-applied finish in manufacturer's [**standard**] [**custom**] color; undersurfaces treated with corrosion-resistant undercoating.
2. Enclosure: [**Flat**] [**Downward, rearward sloping**] roof; [**bolt-on rear covers**] [**rear hinged doors**] for each section, with provisions for padlocking.
3. Doors: Personnel door at each end of aisle, minimum width of [**30 inch (762 mm)**] <**Insert value**>; opening outwards; with panic hardware and provisions for [**padlocking**] [**cylinder lock**]. At least one door must be sized to permit largest single switchboard section to pass through without disassembling doors, hinges, or switchboard section.
4. Accessories: LED luminaires, ceiling mounted; wired to three-way light switch at each end of aisle; ground-fault circuit interrupter (GFCI) duplex receptacle; emergency battery pack luminaire installed on wall of aisle midway between personnel doors.
5. Walk-in Aisle Heating and Ventilating:

    a. Factory-installed electric unit heater(s), wall or ceiling mounted, with integral thermostat and disconnect and with capacities to maintain switchboard interior temperature of [**40 deg F (5 deg C)**] <**Insert temperature**> with outside design temperature of [**0 deg F (minus 18 deg C)**] <**Insert temperature**>.
    b. Factory-installed exhaust fan with capacities to maintain switchboard interior temperature of [**100 deg F (38 deg C)**] <**Insert temperature**> with outside design temperature of [**90 deg F (32 deg C)**] <**Insert temperature**>.
    c. Ventilating openings[**complete with replaceable fiberglass air filters**].
    d. Thermostat: Single stage; wired to control heat and exhaust fan.

6. Power for Space Heaters, Ventilation, Lighting, and Receptacle: Include control-power transformer, with spare capacity of 25 percent, within switchboard. Supply voltage must be [**120 V(ac)**] [**120/240 V(ac)**] [**120/208 V(ac)**].
7. Power for space heaters, ventilation, lighting, and receptacle provided by remote source.

P. Barriers: Between adjacent switchboard sections.

Q. Insulation and isolation for[**main bus of main section and**] main and vertical buses of feeder sections.

R. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.

1. Space-Heater Control: [**Thermostats to maintain temperature of each section above expected dew point**] [**Manual switching of branch-circuit protective device**].
2. Space-Heater Power Source: [**Transformer, factory installed in switchboard**] [**120 V external branch circuit**].

S. Service Entrance Rating: Switchboards intended for use as service entrance equipment may contain from one to six service disconnecting means with overcurrent protection, neutral bus with disconnecting link, grounding electrode conductor terminal, and main bonding jumper.

T. Utility Metering Compartment: Barrier compartment and section complying with utility company's requirements; hinged sealable door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

U. Customer Metering Compartment: Separate customer metering compartment[**and section with front hinged door,**] and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring must be terminated on shorting-type terminal blocks.[**Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.**]

V. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

W. Removable, Hinged Rear Doors and Compartment Covers: Secured by [**captive thumb screws**] [**standard bolts**], for access to rear interior of switchboard.

X. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

Y. Pull Box on Top of Switchboard:

1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
2. Set back from front to clear circuit-breaker removal mechanism.
3. Removable covers may form top, front, and sides. Top covers at rear must be easily removable for drilling and cutting.
4. Bottom must be insulating, fire-resistive material with separate holes for cable drops into switchboard.
5. Cable supports must be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

Z. Buses and Connections: Three phase, four wire unless otherwise indicated.

1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from front of switchboard.
2. Phase- and Neutral-Bus Material:

   a. Hard-drawn copper of 98 percent conductivity[**, silver-plated**].
   b. Tin-plated, high-strength, electrical-grade aluminum alloy with tin-plated aluminum circuit-breaker line connections.

3. Copper feeder circuit-breaker line connections.
4. Tin-plated aluminum feeder circuit-breaker line connections.
5. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with [**mechanical**] [**compression**] connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
6. Ground Bus: [**1/4 by 2 inch (6 by 50 mm-)**] [**1/4 by 1 inch (6 by 25 mm-)**] [**Minimum-size required by UL 891,**] hard-drawn copper of 98 percent conductivity, equipped with [**mechanical**] [**compression**] connectors for feeder and branch-circuit ground conductors.
7. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
8. Disconnect Links:

   a. Isolate neutral bus from incoming neutral conductors.
   b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.

9. Neutral Buses: [**50**] [**100**] percent of ampacity of phase buses unless otherwise indicated, equipped with [**mechanical**] [**compression**] connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
10. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

AA. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

BB. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

CC. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components including instruments and instrument transformers.

2.2 SURGE PROTECTION DEVICES

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. SPDs: Listed and labeled in accordance with UL 1449, [**Type 1**] [**Type 2**].

C. Features and Accessories:

1. Integral disconnect switch.
2. Internal thermal protection that disconnects SPD before damaging internal suppressor components.
3. Indicator light display for protection status.
4. Form-C contacts rated at [**5 A and 250 V(ac)**] [**2 A and 24 V(ac)**] <**Insert values**>, one normally open and one normally closed, for remote monitoring of protection status.[**Contacts must reverse on failure of surge diversion module or on opening of current-limiting device. Coordinate with building power monitoring and control system.**]
5. Surge counter.

D. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase may not be less than [**200 kA**] [**250 kA**] [**300 kA**] <**Insert amperes**>. Peak surge current rating must be arithmetic sum of ratings of individual MOVs in each mode.

E. Protection modes and UL 1449 VPR for grounded wye circuits with [**480Y/277 V**] [**208Y/120 V**], three-phase, four-wire circuits may not exceed the following:

1. Line to Neutral: [**1200 V for 480Y/277 V**] [**700 V for 208Y/120 V**].
2. Line to Ground: [**1200 V for 480Y/277 V**] [**1200 V for 208Y/120 V**].
3. Line to Line: [**2000 V for 480Y/277 V**] [**1000 V for 208Y/120 V**].

F. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits may not exceed the following:

1. Line to Neutral: 700 V.
2. Line to Ground: [**700 V**] [**1000 V**].
3. Line to Line: 1000 V.

G. SCCR: Equal or exceed [**100 kA**] [**200 kA**] <**Insert amperes**>.

H. Nominal Rating: 20 kA.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with [**series-connected rating**] [**interrupting capacity**] to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with RMS sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long and short time adjustments.
    d. Ground-fault pickup level, time delay, and I squared t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
6. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6 mA trip).
7. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30 mA trip).
8. MCCB Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: [**Mechanical**] [**Compression**] style, suitable for number, size, trip ratings, and conductor material.
    c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    d. Ground-Fault Protection: [**Integrally mounted**] [**Remote-mounted**] relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
    f. Communication Capability: [**Circuit-breaker-mounted**] [**Universal-mounted**] [**Integral**] [**Din-rail-mounted**] communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
    g. Shunt Trip: 120 V trip coil energized from separate circuit, set to trip at [**55**] [**75**] percent of rated voltage.
    h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
    i. Auxiliary Contacts: [**One SPDT switch**] [**Two SPDT switches**] with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
    j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.

B. Insulated-Case Circuit Breaker (ICCB): [**80**] [**100**] percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.

1. [**Fixed**] [**Drawout**] circuit-breaker mounting.
2. Two-step, stored-energy closing.
3. [**Standard**] [**Full**]-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:

a. Instantaneous trip.
b. Time adjustments for long- and short-time pickup.
c. Ground-fault pickup level, time delay, and I squared t response.
d. <**Insert settings**>.

4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
5. Remote trip indication and control.
6. Communication Capability: Web enabled integral Ethernet communication module and embedded Web server with factory-configured Web pages (HTML file format). Provide functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.
8. Control Voltage: [**40 V(dc)**] [**125 V(dc)**] [**250 V(dc)**] [**120 V(ac)**].

C. Bolted-Pressure Contact Switch: Operating mechanism uses rotary-mechanical-bolting action to produce and maintain high clamping pressure on switch blade after it engages stationary contacts.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Main-Contact Interrupting Capability: Minimum of 12 times switch current rating.
3. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.

a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
b. Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.

4. Auxiliary Switches: Factory installed, SPDT, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
5. Service-Rated Switches: Labeled for use as service equipment.
6. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.

a. Configuration: [**Integrally mounted**] [**Remote-mounted**] relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
b. Internal Memory: Integrates cumulative value of intermittent arcing ground-fault currents and uses effect to initiate tripping.
c. No-Trip Relay Test: Permits ground-fault simulation test without tripping switch.
d. Test Control: Simulates ground fault to test relay and switch (or relay only if "no-trip" mode is selected).

7. Open-Fuse Trip Device: Arranged to trip switch open if phase fuse opens.

D. High-Pressure, Butt-Type Contact Switch: Operating mechanism uses butt-type contacts and spring-charged mechanism to produce and maintain high-pressure contact when switch is closed.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Main-Contact Interrupting Capability: Minimum of 12 times switch current rating.
3. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.

a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.

b. Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.

4. Auxiliary Switches: Factory installed, SPDT, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
5. Service-Rated Switches: Labeled for use as service equipment.
6. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.

   a. Configuration: [**Integrally mounted**] [**Remote-mounted**] relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
   b. Internal Memory: Integrates cumulative value of intermittent arcing ground-fault currents and uses effect to initiate tripping.
   c. No-Trip Relay Test: Permits ground-fault simulation test without tripping switch.
   d. Test Control: Simulates ground fault to test relay and switch (or relay only if "no-trip" mode is selected).

7. Open-Fuse Trip Device: Arranged to trip switch open if phase fuse opens.

E. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

F. Fuses are specified in Section 262813 "Fuses."

2.4 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, and the following:

1. Potential Transformers: NEMA EI 21.1; 120 V, 60 Hz, [**single**] [**tapped**] [**double**] secondary; disconnecting type with integral fuse mountings. Burden and accuracy must be consistent with connected metering and relay devices.
2. Current Transformers: NEMA EI 21.1; 5 A, 60 Hz, secondary; [**wound**] [**bushing**] [**bar or window**] type; [**single**] [**double**] secondary winding and secondary shorting device. Burden and accuracy must be consistent with connected metering and relay devices.
3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

   a. Phase Currents, Each Phase: Plus or minus 0.5 percent.
   b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
   c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
   d. Megawatts: Plus or minus 1 percent.
   e. Megavars: Plus or minus 1 percent.
   f. Power Factor: Plus or minus 1 percent.
   g. Frequency: Plus or minus 0.1 percent.

h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
i. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.
j. Contact devices to operate remote impulse-totalizing demand meter.

2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

C. Analog Meters:

1. Meters: 4 inch (100 mm) diameter or 6 inch (150 mm) square, flush or semiflush, with anti-parallax 250-degree scales and external zero adjustment.

D. Voltmeters: Cover expanded-scale range of nominal voltage plus 10 percent.

E. Instrument Switches: Rotary type with off position.

1. Voltmeter Switches: Permit reading of phase-to-phase voltages and, where neutral is indicated, phase-to-neutral voltages.
2. Ammeter Switches: Permit reading of current in each phase and maintain current-transformer secondaries in closed-circuit condition at all times.

F. Ammeters: 2-1/2 inch (64 mm) minimum size with 90- or 120-degree scale. Meter and transfer device with off position, located on overcurrent device door for indicated feeder circuits only.

G. Watt-Hour Meters and Wattmeters:

1. Comply with ANSI C12.1.
2. Three-phase induction type with two stators, each with current and potential coil, rated 5 A, 120 V, 60 Hz.
3. Suitable for connection to three- and four-wire circuits.
4. Potential indicating lamps.
5. Adjustments for light and full load, phase balance, and power factor.
6. Four-dial clock register.
7. Integral demand indicator.
8. Contact devices to operate remote impulse-totalizing demand meter.
9. Ratchets to prevent reverse rotation.
10. Removable meter with drawout test plug.
11. Semiflush mounted case with matching cover.
12. Appropriate multiplier tag.

H. Impulse-Totalizing Demand Meter:

1. Comply with ANSI C12.1.
2. Suitable for use with switchboard watt-hour meter, including two-circuit totalizing relay.
3. Cyclometer.
4. Four-dial, totalizing kilowatt-hour register.
5. Positive chart drive mechanism.
6. Capillary pen holding minimum of one month's ink supply.
7. Roll chart with minimum 31-day capacity; appropriate multiplier tag.
8. Capable of indicating and recording [**five**] [**15**] [**30**] <**Insert time period**>-minute integrated demand of totalized system.

2.5 CONTROL POWER

A. Control Circuits:

1. 120 V(ac), supplied through secondary disconnecting devices from control-power transformer.
2. 120 V(ac), supplied from remote branch circuit.
3. <**Insert control voltage**> V(dc).

B. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to primary side of each control-power transformer at line side of associated main circuit breaker. 120 V secondaries connected through automatic transfer relays to ensure fail-safe automatic transfer scheme.

C. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

D. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Mounting Accessories: For anchors, mounting channels, bolts, washers, and other mounting accessories, comply with requirements in Section 260548.16 "Seismic Controls for Electrical Systems" or manufacturer's instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards in accordance with [**NECA 400**] [**NEMA PB 2.1**].

1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's published instructions.
2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
3. Protect from moisture, dust, dirt, and debris during storage and installation.
4. Install temporary heating during storage in accordance with manufacturer's published instructions.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect performance of equipment.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

3.3 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Switchboards and Accessories: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with [**NECA 400**] [**NEMA PB 2.1**].
2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Equipment Mounting: Install switchboards on concrete base, 4 inch (100 mm) nominal thickness. Comply with requirements for concrete base specified in Section 260529 "Hangers and Supports for Electrical Systems."

    a. Install conduits entering underneath switchboard, entering under vertical section where conductors will terminate. Install with couplings flush with concrete base. Extend 2 inch (50 mm) above concrete base after switchboard is anchored in place.
    b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18 inch (450 mm) centers around full perimeter of concrete base.
    c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
    d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, published instructions, and directions furnished with items to be embedded.
    e. Install anchor bolts to elevations required for proper attachment to switchboards.
    f. Anchor switchboard to building structure at top of switchboard if required or recommended by manufacturer.

2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.
3. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
4. Operating Instructions: Frame and mount printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
5. Install filler plates in unused spaces of panel-mounted sections.
6. Install overcurrent protective devices, surge protection devices, and instrumentation.

    a. Set field-adjustable switches and circuit-breaker trip ranges.

7. Install spare-fuse cabinet.

3.4 CONNECTIONS

A. Comply with requirements for terminating feeder bus specified in Section 262500 "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.

B. Comply with requirements for terminating cable trays specified in Section 260536 "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.

C. Bond conduits entering underneath switchboard to equipment ground bus with bonding conductor sized in accordance with NFPA 70.

D. Support and secure conductors within switchboard in accordance with NFPA 70.

E. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.5 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Mimic Bus:

1. Entire single-line switchboard bus work, as depicted on factory record drawing, on minimum 0.032 inch (0.813 mm) thick anodized aluminum photoengraved nameplate, located at eye level on front cover of switchboard incoming service section.
2. Entire single-line switchboard bus work, as depicted on factory record drawing, on engraved minimum 0.0625 inch (1.588 mm) thick laminated-plastic (Gravoply) nameplate, located at eye level on front cover of switchboard incoming service section.
3. Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single-line diagram format, using symbols and letter designations consistent with final mimic-bus diagram.
4. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce concise visual presentation of principal switchboard components and connections.
5. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.

E. Service Equipment Label: Labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

3.6 FIELD QUALITY CONTROL

A. [**Acceptance**]Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**] [**Tenant**] [**authorities having jurisdiction**] <**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Acceptance Testing:

a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
b. Test continuity of each circuit.

2. Test ground-fault protection of equipment for service equipment in accordance with NFPA 70.
3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
5. Perform the following infrared scan tests and inspections, and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each switchboard. Remove [**front**] [**front and rear**] panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
c. Instruments and Equipment:

1) Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Nonconforming Work:

1. Switchboard will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Collect, assemble, and submit test and inspection reports, including certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

F. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**] [**supervise**] field tests and inspections.

3.7 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges [**as indicated.**] [**as specified in Section 260573.16 "Coordination Studies."**]

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature in accordance with manufacturer's published instructions, until switchboard is ready to be energized and placed into service.

END OF SECTION 26 24 13 00b

Task	Specification	Specification Description
26 24 16 00	01 51 13 00	Panelboards

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SECTION 26 24 19 00 - POWER DISTRIBUTION UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manufactured power distribution units.
2. Input-output, circuit-breaker section.
3. Isolation transformer section.
4. SPD system.
5. Output panelboards.
6. Power distribution unit controls.
7. Monitoring, status, and alarm annunciation.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

A. EPO: Emergency power-off.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Coordination Meeting(s): For power distribution units. Conduct meeting(s) [**as videoconference**] [**or**] [**at Project site**] <**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, representatives of Owner, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**] [**, and Owner's Commissioning Authority**] of scheduled meeting dates.
2. Coordinate layout and installation of power distribution units with Owner's equipment.
3. Record agreements reached in meetings and distribute record to other participants.
4. Adjust arrangements and locations of power distribution units to accommodate and optimize arrangement and space requirements of equipment.

1.4 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.
2. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for power distribution units.

3. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and [**mounting**] [**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Certificates: For each type of power distribution unit, signed by product manufacturer.

D. Field Quality-Control Submittals:

1. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Installation and startup checks.

B. Source quality-control reports.

1. For each factory test of power distribution units.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment in fully enclosed vehicles after specified environmental conditions have been permanently established in spaces where equipment is to be placed.

B. Store equipment in spaces with environments controlled within manufacturer's ambient temperature and humidity tolerances for non-operating equipment.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS[**TO BE MODIFIED**] [**TO BE REMOVED AND RE-INSTALLED**]

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.2 MANUFACTURERS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain products from single manufacturer.

2.3 MANUFACTURED POWER DISTRIBUTION UNITS

A. Description: Integrated and coordinated assembly of power-line-conditioning and distribution components packaged in single cabinet or modular assembly of cabinets[**each with full-swivel casters mounted to bottom frame**]. Include the following components:

1. Input-power, circuit-breaker section.
2. Isolation transformer.
3. SPD system.
4. Output panelboard(s).
5. Alarm, monitoring, and control system.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

C. Constructed to withstand seismic forces specified in Section 260011 "Facility Performance Requirements for Electrical."

D. Wiring Access: [**Top**] [**and**] [**bottom**] wiring access.

E. Unit Capacity Rating: Carry indicated RMS kilovolt-ampere load continuously without affecting normal operation of circuit breakers, monitoring system, or unit controls and without exceeding rated insulation temperature for the following input voltage and load current:

1. Input Voltage: Within rated input-voltage tolerance band of unit.
2. Load Current: Minimum of 3.0 crest factor and 85 percent total harmonic distortion.

2.4 INPUT-POWER, CIRCUIT-BREAKER SECTION

A. Description: Three-pole, [**shunt-tripped,**]thermal-magnetic-type circuit breaker, rated for indicated interrupting capacity and 125 percent of input current of unit at 100 percent rated load at unit capacity rating.

1. Dual-Input Units:

   a. Two input circuit breakers arranged to provide transfer between two input-power sources.
   b. Controls and interfaces to allow selecting either open- or closed-transition transfer between two input-power sources.
   c. Use 120 V permissive signal from both upstream voltage sources to indicate acceptable conditions for closed-transition transfer.
   d. Open second circuit breaker automatically after closed-transition transfer is completed.

2. Static Transfer Switch: Three-pole, double-throw; solid-state, automatic transfer switch.

2.5 ISOLATION TRANSFORMER SECTION

A. Description: Dry-type, electrostatically shielded, three-phase, common-core, convection-air-cooled isolation transformer.

1. Comply with UL 1561[**including requirements for nonsinusoidal load-current-handling capability defined by designated K-factor**].
2. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses, one leg per phase.
3. Coil Material and Insulation: [**Aluminum**] [**Copper**] windings, 220 deg C insulation class.
4. Temperature Rise: Designed for [**80**] [**115**] [**150**] deg C rise above 40 deg C ambient.
5. Output Impedance: 3.5 plus or minus 0.5 percent.
6. Regulation: 2 to 4 percent maximum, at full-resistive load; 5 percent maximum, at rated nonlinear load.
7. Taps: Six full-capacity compensation taps at 2.5 percent increments; two above and four below nominal voltage.
8. Full-Load Efficiency: Minimum 96 percent at rated[**nonlinear**] load.
9. Magnetic-Field Strength External to Transformer Enclosure: Less than 0.1 G at 18 inch (450 mm).
10. K-Factor Rating: Transformers indicated to be K-factor rated must comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.

    a. Unit may not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
    b. Indicate value of K-factor on transformer nameplate.

11. Electrostatic Shielding: Independently shield each winding with full-width, [**single**] [**double**], copper, electrostatic shield arranged to minimize interwinding capacitance.

    a. Coil leads and terminal trips must be arranged to minimize capacitive coupling between input and output connections.
    b. Shield Terminal: Separate, and marked "Shield" for grounding connection. Shield must be connected to reference ground point for distribution panels.
    c. Capacitance: Limit capacitance between primary and secondary windings to maximum of 33 pF over frequency range of 20 Hz to 1 MHz.
    d. Common-Mode Noise Attenuation: 120 dB minimum, 0.5 to 1.5 kHz; minus 65 dB minimum, 1.5 to 100 kHz.
    e. Normal-Mode Noise Attenuation: 52 dB minimum, 1.5 to 10 kHz.

12. Neutral Rating: [**1.732 times**] [**200 percent of**] system full-load ampere rating.
13. Shipping Restraints: Paint or otherwise color code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside transformer enclosure.

2.6 SPD SYSTEM

A. Description: Integrated SPD system, complying with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits," to protect unit panelboard, and having the following features:

1. Disconnect Device: Manual, three-pole, fused disconnect switch to de-energize SPD system while permitting power distribution units to continue operation. Fuses must be rated for 200 kA interrupting capacity.
2. Nonlinear Loading: System must accommodate rated-load current with minimum 3.0 crest factor and 85 percent total harmonic distortion.

2.7 OUTPUT PANELBOARDS

A. Description: Panelboards complying with Section 262416 "Panelboards" except for mounting provisions. Mount [**single**] [**double**] panelboards on power distribution unit behind flush doors. Include the following features:

1. Construction: [**30**] [**42**] pole, [**208 V**] [**240 V**], three phase; capable of accepting branch circuit breakers rated up to 100 A.
2. Panelboard Rating: [**225 A**] <**Insert value**>, with main circuit breaker.
3. Panelboard Phase, Neutral, and Ground Buses: Copper, with neutral bus at least [**1.732**] [**two**] times nominal phase bus rating.
4. Isolated Ground Bus: Copper, adequate for branch-circuit equipment ground conductors; insulated from supports.
5. Branch Circuit Breakers: [**Bolt**] [**Plug**] on.
6. Cable Racks: Removable and arranged for supporting and routing cables for panelboard entrance.
7. Access Panels: Arranged so additional branch-circuit wiring can be installed and connected in future.

2.8 POWER DISTRIBUTION UNIT CONTROLS

A. Include the following control features:

1. EPO switch integral with power distribution unit.
2. Power-off input terminals for connection to remote EPO switch.
3. Shutdown with automatic unit disconnection for the following alarm conditions:

   a. High temperature in transformer coil.
   b. High or low input or output voltage.
   c. Phase loss.
   d. Ground fault.
   e. Reverse-phase rotation.

4. Alarm Contacts: Electrically isolated, Form C (one normally open and one normally closed), summary alarm; contact set must change state if monitored function goes into alarm mode.
5. Auxiliary Control Outputs: <**Insert control function outputs**>.

2.9 MONITORING, STATUS, AND ALARM ANNUNCIATION

A. Description: Microprocessor-based monitoring, status, and alarm annunciation panel mounted flush in front of power distribution unit to provide status display and failure-indicating interface for the following:

1. Power Monitoring:

   a. Input Voltage: Line-to-line, RMS.
   b. Output Voltage: Line-to-line and line-to-neutral, RMS.
   c. Output current.

2. Status Indication: Unit on.
3. Alarm Annunciation:

   a. High temperature in transformer coil.
   b. High and low input voltage.
   c. High and low output voltage.

d. Phase loss.
e. Ground fault.
f. Frequency.
g. Phase rotation.
h. SPD module failure.

4. Audible Alarm and Silencing Switch: Alarm sounds when alarm indication occurs. Silencing switch must silence audible alarm but leave visual indication active until alarm condition is corrected.

2.10 SOUND LEVEL

A. Fully assembled products must have average audible sound levels[**more than 3 dB**] below the following maximum sound levels, without fans running, when factory tested in accordance with IEEE C57.12.91:

1. 9 kVA and Smaller: [**40**] <**Insert number**> dB(A-weighted).
2. 9.01 to 30 kVA: [**45**] <**Insert number**> dB(A-weighted).
3. 30.01 to 50 kVA: [**45**] [**48**] <**Insert number**> dB(A-weighted).
4. 50.01 to 150 kVA: [**50**] [**53**] <**Insert number**> dB(A-weighted).
5. 150.01 to 300 kVA: [**55**] [**58**] <**Insert number**> dB(A-weighted).
6. 300.01 to 500 kVA: [**60**] [**63**] <**Insert number**> dB(A-weighted).
7. 500.01 to 700 kVA: [**62**] [**65**] <**Insert number**> dB(A-weighted).
8. 700.01 to 1000 kVA: [**64**] [**67**] <**Insert number**> dB(A-weighted).

B. Mount transformer on rubber isolation pads.

2.11 ENCLOSURE REQUIREMENTS

A. Single, freestanding, galvanized steel, UL 50E Type 1 enclosure. Opening of exterior door may not provide access to live parts. Panels and covers that expose hazardous voltages must require tools to remove.

B. Access from front, top, and side only for installation, operations, and normal maintenance, including infrared scanning of bus and breakers. Normal operating controls and instrumentation must be located on front of enclosure.

C. Arrange enclosure to allow lifting and moving via forklift.

2.12 FINISHES

A. Manufacturer's standard finish over corrosion-resistant pretreatment and primer.

2.13 SOURCE QUALITY CONTROL

A. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

B. Testing Administrant: [**Owner will engage**] [**Engage**] qualified electrical testing agency to evaluate power distribution units.

C. [**Factory**]Tests and Inspections: Test and inspect power distribution units, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with referenced before delivering to site. Affix label with name and date of [**manufacturer's**] [**qualified electrical testing laboratory's**] certification of system compliance.

1. Conduct factory sound-level tests.

D. Nonconforming Work:

1. Equipment that does not pass tests and inspections will be considered defective.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Connections to Connectors and Terminals: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with torque-tightening values in UL 486A-486B.
2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Arrange power distribution units to provide adequate access to equipment and circulation of cooling air. Locate transformers away from corners and not parallel to adjacent wall surface.
2. Coordinate size and location of [**concrete bases**] [**access flooring support**] with actual power distribution unit provided.
3. Equipment Mounting:

a. Install power distribution units on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 260529 "Hangers and Supports for Electrical Systems."
b. Comply with requirements for vibration isolation and seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
c. Supports must penetrate and be independent of access flooring.

D. Interfaces with Other Work:

1. Identify equipment and install warning signs in accordance with Section 260553 "Identification for Electrical Systems."
2. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
3. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
4. Install flexible connections at conduit and conductor terminations and supports to eliminate sound and vibration transmission to building structure.

3.2 FIELD QUALITY CONTROL

A. [**Acceptance**]Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**] [**Tenant**] [**authorities having jurisdiction**] <**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Perform each visual and mechanical inspection and electrical test stated in NETA ATS for circuit breakers, molded case; and for transformers, dry type, air cooled, low voltage. Certify compliance with test parameters.
3. Perform functional tests of power distribution units throughout their operating ranges. Test each monitoring, status, and alarm function.
4. Test Labeling: On completion of satisfactory testing of each unit, attach dated and signed "Satisfactory Test" label to tested component.

D. Nonconforming Work:

1. Power distribution unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**] [**supervise**] field tests and inspections.

3.3 SYSTEM STARTUP

A. [**Engage factory-authorized service representative to perform**] [**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. Verify that power distribution units are installed and connected in accordance with Contract Documents.
3. Verify that electrical wiring installation complies with manufacturer's submittal and with published installation requirements in other electrical Sections.

3.4 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

B. Adjust power distribution units to provide optimal voltage to equipment served throughout normal operating cycle of loads served. Record input and output voltages and adjustment settings, and incorporate into test results.

3.5 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.6 PROTECTION

A. After installation, protect power distribution units from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.7 MAINTENANCE

A. Infrared Scanning of Power Distribution Units: Two months after Substantial Completion, perform infrared scan of conductor and bus joints and connections. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.

1. Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
2. Follow-up Infrared Scanning: Perform two follow-up infrared scans of power distribution units, one at four months and another at 11 months after Substantial Completion.
3. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
4. Report: Prepare certified report that identifies joints and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 26 24 19 00

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Task	Specification	Specification Description
26 24 19 00	01 22 16 00	No Specification Required
26 24 19 00	26 09 23 00b	Electrical Power Monitoring And Control
26 24 19 00	23 09 23 53	Enclosed Controllers
26 24 19 00	26 11 16 11	Switchgear
26 24 19 00	26 09 23 00c	Motor-Control Centers

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SECTION 26 25 13 00 - ENCLOSED BUS ASSEMBLIES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for enclosed bus assemblies. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Feeder-bus assemblies.
b. Plug-in bus assemblies.
c. Bus plug-in devices.

C. Definitions
1. TVSS: Transient voltage surge suppressor.

D. Submittals
1. Shop Drawings: For each type of bus assembly **OR** bus assembly and plug-in device, **as directed**.
a. Show fabrication and installation details for enclosed bus assemblies. Include plans, elevations, and sections of components. Designate components and accessories, including clamps, brackets, hanger rods, connectors, straight lengths, and fittings.
b. Show fittings, materials, fabrication, and installation methods for listed fire-stop barriers and weather barriers.
c. Indicate required clearances, method of field assembly, and location and size of each field connection.
d. Detail connections to switchgear, switchboards, transformers, and panelboards.
e. Wiring Diagrams: Power and signal **OR** and control, **OR** signal, and control, **as directed**, wiring.
f. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer.
1) Design Calculations: Calculate requirements for selecting seismic restraints.
2) Detail fabrication, including anchorages and attachments to structure and to supported equipment.
2. Coordination Drawings: Floor plans and sections, drawn to scale. Include scaled bus-assembly layouts and relationships between components and adjacent structural, mechanical, and electrical elements. Show the following:
a. Vertical and horizontal enclosed bus-assembly runs, offsets, and transitions.
b. Clearances for access above and to the side of enclosed bus assemblies.
c. Vertical elevation of enclosed bus assemblies above the floor or bottom of structure.
d. Support locations, type of support, and weight on each support.
3. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.
4. Product Certificates: For each type of enclosed bus assembly, signed by product manufacturer.
5. Manufacturer Seismic Qualification Certification: Submit certification that enclosed bus assemblies, plug-in devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems" Include the following:
a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
1) The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2) The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

6. Qualification Data: For professional engineer and testing agency.
7. Field quality-control test reports.
8. Operation and Maintenance Data: For enclosed bus assemblies to include in emergency, operation, and maintenance manuals.

E. Quality Assurance

1. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   a. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 1.3.
2. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
3. Source Limitations: Obtain enclosed bus assemblies and plug-in devices through one source from a single manufacturer.
4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
5. Comply with NEMA BU 1, "Busways."
6. Comply with NFPA 70.

F. Delivery, Storage, And Handling

1. Deliver, store, and handle enclosed bus assemblies according to NEMA BU 1.1, "General Instructions for Proper Handling, Installation, Operation and Maintenance of Busway Rated 600 Volts or Less."

G. Project Conditions

1. Derate enclosed bus assemblies for continuous operation at indicated ampere ratings for ambient temperature not exceeding 122 deg F (50 deg C) **OR** 140 deg F (60 deg C), **as directed**.

H. Coordination

1. Coordinate layout and installation of enclosed bus assemblies and suspension system with other construction that penetrates ceilings or floors or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
2. Coordinate size and location of concrete curbs around openings for vertical bus. Concrete, reinforcement, and formwork requirements are specified in Division 31.

1.2 PRODUCTS

A. Enclosed Bus Assemblies

1. Feeder-Bus Assemblies: NEMA BU 1, low-impedance bus assemblies in nonventilated housing; single-bolt joints; ratings as indicated.
   a. Seismic Fabrication Requirements: Fabricate mounting provisions and attachments for feeder-bus assemblies with reinforcement strong enough to withstand seismic forces

defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems" when mounting provisions and attachments are anchored to building structure

b. Voltage: 120/208 **OR** 240 **OR** 480 **OR** 277/480, **as directed**, V; 3 phase; 100 **OR** 200 **OR** percent neutral capacity, **as directed**.

c. Temperature Rise: 55 deg C above 40 deg C ambient maximum for continuous rated current.

d. Bus Materials: Current-carrying copper **OR** aluminum, **as directed**, conductors, fully insulated with Class 130C insulation except at joints; plated surface at joints.

e. Ground:
   1) 50 percent capacity integral with housing.
   2) 50 percent capacity internal bus bars of material matching bus material.
   3) 50 percent capacity isolated, internal bus bar of material matching bus material.

f. Enclosure: Steel with manufacturer's standard finish **OR** Aluminum with manufacturer's standard finish **OR** Weatherproof, steel or aluminum with manufacturer's standard finish, sealed seams, drains, and removable closures, **as directed**.

g. Fittings and Accessories: Manufacturer's standard.

h. Mounting: Arranged flat, edgewise, or vertically without derating.

2. Plug-in Bus Assemblies: NEMA BU 1, low-impedance bus assemblies in nonventilated housing; single-bolt joints; ratings as indicated.

a. Seismic Fabrication Requirements: Fabricate mounting provisions and attachments for switchboards with reinforcement strong enough to withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems" when mounting provisions and attachments are anchored to building structure.

b. Voltage: 120/208 **OR** 240 **OR** 480 **OR** 277/480, **as directed**, V; 3 phase; 100 **OR** 200 **OR** percent neutral capacity, **as directed**.

c. Temperature Rise: 55 deg C above 40 deg C ambient maximum for continuous rated current.

d. Bus Materials: Current-carrying copper **OR** aluminum, **as directed**, conductors, fully insulated with Class 130C insulation except at stabs and joints; plated surface at stabs and joints.

e. Ground:
   1) 50 percent capacity integral with housing.
   2) 50 percent capacity internal bus bar of material matching bus material.
   3) 50 percent capacity isolated, internal bus bar of material matching bus material.

f. Enclosure: Steel, with manufacturer's standard finish, plug-in openings 24 inches (610 mm) o.c., and hinged covers over unused openings **OR** Aluminum, with manufacturer's standard finish, plug-in openings 24 inches (610 mm) o.c., and hinged covers over unused openings, **as directed**.

g. Fittings and Accessories: Manufacturer's standard.

h. Mounting: Arranged flat, edgewise, or vertically without derating.

B. Plug-In Devices

1. Fusible Switches: NEMA KS 1, heavy duty; with R-type rejection **OR** J-type **OR** L-type, **as directed**, fuse clips to accommodate specified fuses; hookstick-operated handle, lockable with two padlocks, and interlocked with cover in closed position. See Division 16 Section "Fuses" for fuses and fuse installation requirements.

2. Molded-Case Circuit Breakers: NEMA AB 1; hookstick-operated handle, lockable with two padlocks, and interlocked with cover in closed position.

3. TVSS: NEMA 250, Type 1 enclosure with NEMA KS 1, fusible, disconnect switch and external handle to isolate TVSS from busway. TVSS product and installation requirements are specified in Division 16 Section "Transient Voltage Suppression."

4. Motor Controllers: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.

a. Control Circuit: 120 V; obtained from integral control power transformer, **as directed**, with a control power transformer **OR** source, **as directed**, of enough capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.

b. Combination Controller: Factory-assembled combination controller and disconnect switch with or without overcurrent protection as indicated.
   1) Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with R-type rejection **OR** J-type, **as directed**, fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by a nationally recognized testing laboratory (NRTL) acceptable to authorities having jurisdiction. See Division 26 Section "Fuses" for fuses and fuse installation requirements.
   OR
   Nonfusible Disconnecting Means: NEMA KS 1, heavy-duty, nonfusible switch.
   OR
   Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
c. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic. Overload relays shall have heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
d. Adjustable Overload Relay: Dipswitch selected for motor running overload protection with NEMA ICS 2, Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Adjustable overload relays shall have Class II ground-fault protection with start and run delays to prevent nuisance trip on starting.

5. Multispeed Motor Controllers: Match controller to motor type, application, and number of speeds; include the following accessories:
   a. Compelling relay ensures motor starts only at low speed.
   b. Accelerating relay ensures properly timed acceleration through speeds lower than that selected.
   c. Decelerating relay ensures automatically timed deceleration through each speed.
6. Accessories: Hookstick operator, adjustable to maximum extension of 14 feet (4.3 m), **as directed**.

1.3 EXECUTION

A. Installation
1. Support bus assemblies independent of supports for other elements such as equipment enclosures at connections to panelboards and switchboards, pipes, conduits, ceilings, and ducts.
   a. Design each fastener and support to carry load indicated by seismic requirements and to comply with seismic-restraint details according to Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
   b. Design each fastener and support to carry 200 lb (90 kg) or 4 times the weight of bus assembly, whichever is greater.
   c. Support bus assembly to prevent twisting from eccentric loading.
   d. Support bus assembly with not less than 3/8-inch (10-mm) steel rods. Install side bracing to prevent swaying or movement of bus assembly. Modify supports after completion to eliminate strains and stresses on bus bars and housings.
   e. Fasten supports securely to building structure according to Division 26 Section "Hangers And Supports For Electrical Systems".
2. Install expansion fittings at locations where bus assemblies cross building expansion joints. Install at other locations so distance between expansion fittings does not exceed manufacturer's recommended distance between fittings.
3. Construct rated fire-stop assemblies where bus assemblies penetrate fire-rated elements such as walls, floors, and ceilings. Seal around penetrations according to Division 07 Section "Penetration Firestopping".

4. Install weatherseal fittings and flanges where bus assemblies penetrate exterior elements such as walls or roofs. Seal around openings to make weathertight. See Division 07 Section "Joint Sealants" for materials and application.
5. Install a concrete curb at least 4 inches (100 mm) high around bus-assembly floor penetrations.
6. Coordinate bus-assembly terminations to equipment enclosures to ensure proper phasing, connection, and closure.
7. Tighten bus-assembly joints with torque wrench or similar tool recommended by bus-assembly manufacturer. Tighten joints again after bus assemblies have been energized for 30 days.
8. Install bus-assembly, plug-in units. Support connecting conduit independent of plug-in unit.

B. Connections
1. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
2. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Field Quality Control
1. Perform tests and inspections and prepare test reports.
2. Tests and Inspections:
   a. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Remove and replace units that do not pass tests and inspections and retest as specified above.
4. Infrared Scanning: Two months after Final Completion, perform an infrared scan of bus assembly including joints and plug-in units.
   a. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
   b. Perform 2 follow-up infrared scans of bus assembly, one at 4 months and the other at 11 months after Final Completion.
   c. Prepare a certified report identifying bus assembly checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
5. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

D. Adjusting
1. Set field-adjustable, circuit-breaker trip ranges and overload relay trip settings, **as directed**, as indicated.

E. Cleaning
1. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

F. Protection
1. Provide final protection to ensure that moisture does not enter bus assembly.

END OF SECTION 26 25 13 00

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Task	Specification	Specification Description
26 25 16 00	26 25 13 00	Enclosed Bus Assemblies
26 27 13 00	02 84 33 00	Overhead Electrical Distribution
26 27 16 00	01 22 16 00	No Specification Required
26 27 16 00	26 05 33 16	Raceways And Boxes
26 27 16 00	26 09 23 00b	Electrical Power Monitoring And Control
26 27 16 00	26 09 23 00c	Motor-Control Centers
26 27 19 00	26 05 19 13	Underfloor Raceways For Electrical Systems
26 27 23 00	26 05 33 16a	Wiring Devices
26 27 26 00	01 22 16 00	No Specification Required
26 27 26 00	26 05 33 16	Raceways And Boxes
26 27 26 00	26 05 33 16a	Wiring Devices
26 27 26 00	26 09 23 00b	Electrical Power Monitoring And Control
26 27 26 00	23 09 23 53	Enclosed Controllers
26 27 33 00	26 24 19 00	Power Distribution Units
26 27 73 00	26 05 33 16a	Wiring Devices

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SECTION 26 28 13 00 - FUSES

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for fuses. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
    a. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, panelboards, switchboards, enclosed controllers, and motor-control centers.
    b. Plug fuses rated 125-V ac and less for use in plug-fuse-type enclosed switches, fuseholders, and panelboards.
    c. Plug-fuse adapters for use in Edison-base, plug-fuse sockets.
    d. Spare-fuse cabinets.

C. Submittals

1. Product Data: For each type of product indicated.
2. Operation and maintenance data.

D. Quality Assurance

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA FU 1 for cartridge fuses.
3. Comply with NFPA 70.
4. Comply with UL 248-11 for plug fuses.

E. Project Conditions

1. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.2 PRODUCTS

A. Cartridge Fuses

1. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

B. Plug Fuses

1. Characteristics: UL 248-11, nonrenewable plug fuses; 125-V ac.

C. Plug-Fuse Adapters

1. Characteristics: Adapters for using Type S, rejection-base plug fuses in Edison-base fuseholders or sockets; ampere ratings matching fuse ratings; irremovable once installed.

D. Spare-Fuse Cabinet

1. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
    a. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.

b. Finish: Gray, baked enamel.
c. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
d. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

1.3 EXECUTION

A. Fuse Applications
1. Cartridge Fuses:
a. Service Entrance: Class L, fast acting **OR** Class L, time delay **OR** Class RK1, fast acting **OR** Class RK1, time delay **OR** Class J, fast acting **OR** Class J, time delay **OR** Class T, fast acting, **as directed**.
b. Feeders: Class L, fast acting **OR** Class L, time delay **OR** Class RK1, fast acting **OR** Class RK1, time delay **OR** Class RK5, fast acting **OR** Class RK5, time delay **OR** Class J, fast acting **OR** Class J, time delay, **as directed**.
c. Motor Branch Circuits: Class RK1 **OR** Class RK5, **as directed**, time delay.
d. Other Branch Circuits: Class RK1, time delay **OR** Class RK5, time delay **OR** Class J, fast acting **OR** Class J, time delay, **as directed**.
e. Control Circuits: Class CC, fast acting **OR** time delay, **as directed**.
2. Plug Fuses:
a. Motor Branch Circuits: Edison-base type, dual **OR** Edison-base type, single **OR** Type S, dual **OR** Type S, single, **as directed**,-element time delay.
b. Other Branch Circuits: Edison-base type, single-element fast acting **OR** Edison-base type, dual-element time delay **OR** Edison-base type, single-element time delay **OR** Type S, dual-element time delay **OR** Type S, single-element time delay, **as directed**.

B. Installation
1. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
2. Install plug-fuse adapters in Edison-base fuseholders and sockets. Ensure that adapters are irremovable once installed.
3. Install spare-fuse cabinet(s).

C. Identification
1. Install labels complying with requirements for identification specified in Division 26 Section "Identification For Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 28 13 00

Task	Specification	Specification Description
26 28 13 00	26 11 16 11	Switchgear
26 28 16 13	01 51 13 00	Panelboards
26 29 13 13	01 22 16 00	No Specification Required
26 29 13 13	23 09 23 53	Enclosed Controllers

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SECTION 26 29 23 00 - VARIABLE FREQUENCY CONTROLLERS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for variable frequency controllers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section includes separately enclosed, pre-assembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

C. Definitions

1. BAS: Building automation system.
2. CE: Conformite Europeene (European Compliance).
3. CPT: Control power transformer.
4. EMI: Electromagnetic interference.
5. IGBT: Insulated-gate bipolar transistor.
6. LAN: Local area network.
7. LED: Light-emitting diode.
8. MCP: Motor-circuit protector.
9. NC: Normally closed.
10. NO: Normally open.
11. OCPD: Overcurrent protective device.
12. PCC: Point of common coupling.
13. PID: Control action, proportional plus integral plus derivative.
14. PWM: Pulse-width modulated.
15. RFI: Radio-frequency interference.
16. TDD: Total demand (harmonic current) distortion.
17. THD(V): Total harmonic voltage demand.
18. VFC: Variable-frequency motor controller.

D. Performance Requirements

1. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

E. Submittals

1. Product Data: For each type and rating of VFC indicated. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.
2. LEED Submittals:
   a. Product Data for Credit EA 5: For continuous metering equipment for energy consumption.
3. Shop Drawings: For each VFC indicated. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.
   a. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      1) Each installed unit's type and details.
      2) Factory-installed devices.

3) Enclosure types and details.
4) Nameplate legends.
5) Short-circuit current (withstand) rating of enclosed unit.
6) Features, characteristics, ratings, and factory settings of each VFC and installed devices.
7) Specified modifications.

b. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring.

4. Harmonic Analysis Study and Report: Comply with IEEE 399 and NETA Acceptance Testing Specification; identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze possible **OR** designated, **as directed**, operating scenarios, including recommendations for VFC input filtering to limit TDD and THD(V) at each VFC **OR** at the defined PCC, **as directed**, to specified levels.
5. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFCs. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
6. Qualification Data: For qualified testing agency.
7. Seismic Qualification Certificates: For VFCs, accessories, and components, from manufacturer.
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   c. Detailed description of equipment anchorage devices on which the certification is based, and their installation requirements.
8. Product Certificates: For each VFC, from manufacturer.
9. Source quality-control reports.
10. Field quality-control reports.
11. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals. Include the following:
    a. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and MCP trip settings.
    b. Manufacturer's written instructions for setting field-adjustable overload relays.
    c. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
    d. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
12. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.
13. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

F. Quality Assurance
1. Testing Agency Qualifications: Member company of NETA or an NRTL.
   a. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Comply with NFPA 70.
4. IEEE Compliance: Fabricate and test VFC according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".

G. Delivery, Storage, And Handling

1. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller **OR** connect factory-installed space heaters to temporary electrical service, **as directed**.

H. Project Conditions
   1. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions unless otherwise indicated:
      a. Ambient Temperature: Not less than 14 deg F (minus 10 deg C) and not exceeding 104 deg F (40 deg C).
      b. Ambient Storage Temperature: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C)
      c. Humidity: Less than 95 percent (noncondensing).
      d. Altitude: Not exceeding 3300 feet (1005 m).
   2. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
      a. Notify Owner no fewer than two days in advance of proposed interruption of electrical systems.
      b. Indicate method of providing temporary electrical service.
      c. Do not proceed with interruption of electrical systems without Owner's written permission.
      d. Comply with NFPA 70E.
   3. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

I. Coordination
   1. Coordinate features of motors, load characteristics, installed units, and accessory devices to be compatible with the following:
      a. Torque, speed, and horsepower requirements of the load.
      b. Ratings and characteristics of supply circuit and required control sequence.
      c. Ambient and environmental conditions of installation location.
   2. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.
   3. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

J. Warranty
   1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
      a. Warranty Period: Five years from date of Final Completion.

1.2 PRODUCTS

A. Manufactured Units
   1. General Requirements for VFCs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.
   2. Application: Constant torque and variable torque.
   3. VFC Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
      a. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."

b. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
c. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

4. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
5. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range **OR** 66 Hz, with torque constant as speed changes, **as directed**; maximum voltage equals input voltage.
6. Unit Operating Requirements:
   a. Input AC Voltage Tolerance: Plus 10 and minus 10 **OR** 15, **as directed**, percent of VFC input voltage rating.
   b. Input AC Voltage Unbalance: Not exceeding 3 **OR** 5, **as directed**, percent.
   c. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
   d. Minimum Efficiency: 96 **OR** 97, **as directed**, percent at 60 Hz, full load.
   e. Minimum Displacement Primary-Side Power Factor: 96 **OR** 98, **as directed**, percent under any load or speed condition.
   f. Minimum Short-Circuit Current (Withstand) Rating: 10 **OR** 22 **OR** 65 **OR** 100, **as directed**, kA.
   g. Ambient Temperature Rating: Not less than 14 deg F (minus 10 deg C) and not exceeding 104 deg F (40 deg C).
   h. Ambient Storage Temperature Rating: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C)
   i. Humidity Rating: Less than 95 percent (noncondensing).
   j. Altitude Rating: Not exceeding 3300 feet (1005 m).
   k. Vibration Withstand: Comply with IEC 60068-2-6.
   l. Overload Capability: 1.1 **OR** 1.5, **as directed**, times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
   m. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
   n. Speed Regulation: Plus or minus 5 **OR** 10, **as directed**, percent.
   o. Output Carrier Frequency: Selectable; 0.5 to 15, **as directed**, kHz.
   p. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
7. Inverter Logic: Microprocessor based, 16 **OR** 32, **as directed**, bit, isolated from all power circuits.
8. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
   a. Signal: Electrical.
   b. Signal: Pneumatic.
9. Internal Adjustability Capabilities:
   a. Minimum Speed: 5 to 25 percent of maximum rpm.
   b. Maximum Speed: 80 to 100 percent of maximum rpm.
   c. Acceleration: 0.1 to 999.9 seconds.
   d. Deceleration: 0.1 to 999.9 seconds.
   e. Current Limit: 30 to minimum of 150 percent of maximum rating.
10. Self-Protection and Reliability Features:
   a. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
   b. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
   c. Under- and overvoltage trips.
   d. Inverter overcurrent trips.
   e. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing

VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.

f. Critical frequency rejection, with three selectable, adjustable deadbands.

g. Instantaneous line-to-line and line-to-ground overcurrent trips.

h. Loss-of-phase protection.

i. Reverse-phase protection.

j. Short-circuit protection.

k. Motor overtemperature fault.

11. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

12. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

13. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

14. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

15. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

16. Integral Input Disconnecting Means and OCPD: NEMA AB 1, instantaneous-trip circuit breaker **OR** NEMA AB 1, molded-case switch, with power fuse block and current-limiting fuses **OR** NEMA AB 1, thermal-magnetic circuit breaker **OR** NEMA KS 1, nonfusible switch, with power fuse block and current-limiting fuses **OR** NEMA KS 1, fusible switch, **as directed**, with pad-lockable, door-mounted handle mechanism.

a. Disconnect Rating: Not less than 115 percent of VFC input current rating.

b. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.

c. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.

d. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.

e. NC **OR** NO, **as directed**, alarm contact that operates only when circuit breaker has tripped.

B. Controls And Indication

1. Status Lights: Door-mounted LED indicators displaying the following conditions:

a. Power on.

b. Run.

c. Overvoltage.

d. Line fault.

e. Overcurrent.

f. External fault.

2. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

a. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.

b. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

1) Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

3. Historical Logging Information and Displays:

a. Real-time clock with current time and date.

b. Running log of total power versus time.

c. Total run time.
d. Fault log, maintaining last four faults with time and date stamp for each.

4. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters including, but not limited to:
   a. Output frequency (Hz).
   b. Motor speed (rpm).
   c. Motor status (running, stop, fault).
   d. Motor current (amperes).
   e. Motor torque (percent).
   f. Fault or alarming status (code).
   g. PID feedback signal (percent).
   h. DC-link voltage (V dc).
   i. Set point frequency (Hz).
   j. Motor output voltage (V ac).
5. Control Signal Interfaces:
   a. Electric Input Signal Interface:
      1) A minimum of two programmable analog inputs: 0- to 10-V dc **OR** 4- to 20-mA dc **OR** Operator-selectable "x"- to "y"-mA dc, **as directed**.
      2) A minimum of six multifunction programmable digital inputs.
   b. Pneumatic Input Signal Interface: 3 to 15 psig (20 to 104 kPa).
   c. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:
      1) 0- to 10-V dc.
      2) 4- to 20-mA dc.
      3) Potentiometer using up/down digital inputs.
      4) Fixed frequencies using digital inputs.
   d. Output Signal Interface: A minimum of one programmable analog output signal(s) (0- to 10-V dc **OR** 4- to 20-mA dc **OR** operator-selectable "x"- to "y"-mA dc, **as directed**), which can be configured for any of the following:
      1) Output frequency (Hz).
      2) Output current (load).
      3) DC-link voltage (V dc).
      4) Motor torque (percent).
      5) Motor speed (rpm).
      6) Set point frequency (Hz).
   e. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
      1) Motor running.
      2) Set point speed reached.
      3) Fault and warning indication (overtemperature or overcurrent).
      4) PID high- or low-speed limits reached.
6. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.
   a. Number of Loops: One **OR** Two, **as directed**.
7. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFC status and alarms and energy usage. Allows VFC to be used with an external system within a multidrop LAN configuration; settings retained within VFC's nonvolatile memory.
   a. Network Communications Ports: Ethernet and RS-422/485.
   b. Embedded BAS Protocols for Network Communications: ASHRAE 135 BACnet **OR** Echelon LonWorks **OR** Johnson Metasys N2 **OR** Modbus/Memobus **OR** Siemens System 600 APOGEE, **as directed**; protocols accessible via the communications ports.

C. Line Conditioning And Filtering

1. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD at input terminals of all **OR** indicated, **as directed**, VFCs to less than 5 **OR** 8, **as directed**, percent and THD(V) to 3 **OR** 5, **as directed**, percent.
   OR
   Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD and THD(V) at the defined PCC per IEEE 519.
2. Output Filtering: <**Insert requirements**>.
3. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

D. Bypass Systems
1. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.
2. Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.
   OR
   Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic control system feedback.
3. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.
   a. Bypass Contactor: Load-break, IEC **OR** NEMA **as directed**,-rated contactor.
   b. Output Isolating Contactor: Non-load-break, IEC **OR** NEMA, **as directed**,-rated contactor.
   c. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

   OR
   Bypass Controller: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter input and output and permit safe testing and troubleshooting of the power converter, both energized and de-energized, while motor is operating in bypass mode.
   a. Bypass Contactor: Load-break, IEC **OR** NEMA, **as directed**,-rated contactor.
   b. Input and Output Isolating Contactors: Non-load-break, IEC **OR** NEMA, **as directed**,-rated contactors.
   c. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.
4. Bypass Contactor Configuration: Full-voltage (across-the-line) **OR** Reduced-voltage (autotransformer), **as directed**, type.
   a. NORMAL/BYPASS selector switch.
   b. HAND/OFF/AUTO selector switch.
   c. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
   d. Contactor Coils: Pressure-encapsulated type with coil transient suppressors, **as directed**.
      1) Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
      2) Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
   e. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT **OR** control power source, **as directed**, of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
      1) CPT Spare Capacity: 50 **OR** 100 **OR** 200, **as directed**, VA.

f. Overload Relays: NEMA ICS 2.
 1) Melting-Alloy Overload Relays:
  a) Inverse-time-current characteristic.
  b) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic.
  c) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 2) Bimetallic Overload Relays:
  a) Inverse-time-current characteristic.
  b) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic.
  c) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
  d) Ambient compensated.
  e) Automatic resetting.
 3) Solid-State Overload Relays:
  a) Switch or dial selectable for motor-running overload protection.
  b) Sensors in each phase.
  c) Class 10 **OR** Class 20 **OR** Class 10/20 selectable, **as directed**, tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
  d) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
  e) Analog communication module.
 4) NC **OR** NO, **as directed**, isolated overload alarm contact.
 5) External overload reset push button.

E. Optional Features
 1. Multiple-Motor Capability: VFC suitable for variable-speed service to multiple motors. Overload protection shuts down VFC and motors served by it, and generates fault indications, when overload protection activates.
  a. Configure to allow two or more motors to operate simultaneously at the same speed; separate overload relay for each controlled motor.
  OR
  Configure to allow two motors to operate separately; operator selectable via local or remote switch or contact closures; single overload relay for both motors; separate output magnetic contactors for each motor.
  OR
  Configure to allow two motors to operate simultaneously and in a lead/lag mode, with one motor operated at variable speed via the power converter and the other at constant speed via the bypass controller; separate overload relay for each controlled motor.
 2. Damper control circuit with end of travel feedback capability.
 3. Sleep Function: Senses a minimal deviation of a feedback signal and stops the motor. On an increase in speed-command signal deviation, VFC resumes normal operation.
 4. Motor Preheat Function: Preheats motor when idle to prevent moisture accumulation in the motor.
 5. Firefighter's Override (Smoke Purge) Input: On a remote contact closure from the firefighter's control station **OR** smoke-control fan controller, **as directed**, this password-protected input:
  a. Overrides all other local and external inputs (analog/digital, serial communication, and all keypad commands).
  b. Forces VFC to operate motor, without any other run or speed command, at a field-adjustable, preset speed.
  OR
  Forces VFC to transfer to Bypass Mode and operate motor at full speed.
  c. Causes display of Override Mode on the VFC display.
  d. Reset VFC to normal operation on removal of override signal automatically **OR** manually, **as directed**.

6. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.
7. Remote digital operator kit.
8. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

F. Enclosures
1. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
   a. Dry and Clean Indoor Locations: Type 1.
   b. Outdoor Locations: Type 3R **OR** Type 4X, **as directed**.
   c. Kitchen **OR** Wash-Down, **as directed**, Areas: Type 4X, stainless steel.
   d. Other Wet or Damp Indoor Locations: Type 4.
   e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.
2. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

G. Accessories
1. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.
   a. Push Buttons, Pilot Lights, and Selector Switches: Heavy **OR** Standard, **as directed**,-duty, oiltight, **as directed**, type.
      1) Push Buttons: Covered **OR** Lockable **OR** Recessed **OR** Shielded **OR** Shrouded **OR** Unguarded, **as directed**, types; maintained **OR** momentary, **as directed**.
      2) Pilot Lights: Incandescent **OR** LED **OR** Neon **OR** Resistor **OR** Transformer, **as directed**, types; push to test.
      3) Selector Switches: Rotary type.
      4) Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
2. NC **OR** NO **OR** Reversible NC/NO, **as directed**, bypass contactor auxiliary contact(s).
3. Control Relays: Auxiliary and adjustable pneumatic **OR** solid-state, **as directed**, time-delay relays.
4. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
   a. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.
5. Supplemental Analog **OR** Digital, **as directed**, Meters:
   a. Elapsed-time meter.
   b. Kilowatt meter.
   c. Kilowatt-hour meter.
6. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4 **OR** Type 4X **OR** Type 12, **as directed**, enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
7. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 3R **OR** Type 4X **OR** Type 12, **as directed**, enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
8. Cooling Fan and Exhaust System: For NEMA 250, Type 1 **OR** Type 12, **as directed**; UL 508 component recognized: Supply fan, with composite **OR** stainless steel, **as directed**, intake and exhaust grills and filters, **as directed**; 120-V ac; obtained from integral CPT.
9. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
10. Spare control-wiring terminal blocks; unwired **OR** wired, **as directed**.

H. Source Quality Control

1. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.
   a. Test each VFC while connected to its specified motor **OR** a motor that is comparable to that for which the VFC is rated, **as directed**.
   b. Verification of Performance: Rate VFCs according to operation of functions and features specified.
2. VFCs will be considered defective if they do not pass tests and inspections.
3. Prepare test and inspection reports.

1.3 EXECUTION

A. Examination
1. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
2. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.
3. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.
4. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Harmonic Analysis Study
1. Perform a harmonic analysis study to identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze possible **OR** designated, **as directed**, operating scenarios, including recommendations for VFC input filtering to limit TDD and THD(V) at each VFC **OR** at the defined PCC, **as directed**, to specified levels.
2. Prepare a harmonic analysis study and report complying with IEEE 399 and NETA Acceptance Testing Specification.

C. Installation
1. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
2. Wall-Mounting Controllers: Install VFCs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches (2000 mm) above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Division 26 Section "Hangers And Supports For Electrical Systems".
3. Floor-Mounting Controllers: Install VFCs on 4-inch (100-mm) nominal thickness concrete base. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-place Concrete".
   a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   d. Install anchor bolts to elevations required for proper attachment to supported equipment.
4. Roof-Mounting Controllers: Install VFC on roofs with tops at uniform height and with disconnect operating handles not higher than 79 inches (2000 mm) above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.
   a. Curbs and roof penetrations are specified in Division 07 Section "Roof Accessories".
   b. Structural-steel channels are specified in Division 26 Section "Hangers And Supports For Electrical Systems".

5. Seismic Bracing: Comply with requirements specified in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
6. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
7. Install fuses in each fusible-switch VFC.
8. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses".
9. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
10. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
11. Comply with NECA 1.

D. Identification
1. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".
    a. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
    b. Label each VFC with engraved nameplate.
    c. Label each enclosure-mounted control and pilot device.
2. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

E. Control Wiring Installation
1. Install wiring between VFCs and remote devices and facility's central-control system, **as directed**. Comply with requirements in Division 26 Section "Control-voltage Electrical Power Cables"
2. Bundle, train, and support wiring in enclosures.
3. Connect selector switches and other automatic control devices where applicable.
    a. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.
    b. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

F. Field Quality Control
1. Perform tests and inspections.
2. Acceptance Testing Preparation:
    a. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
    b. Test continuity of each circuit.
3. Tests and Inspections:
    a. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
    b. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
    c. Test continuity of each circuit.
    d. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Owner before starting the motor(s).
    e. Test each motor for proper phase rotation.
    f. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
    g. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

h. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
   1) Initial Infrared Scanning: After Final Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
   2) Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Final Completion.
   3) Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

i. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

4. VFCs will be considered defective if they do not pass tests and inspections.
5. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

G. Startup Service
   1. Perform startup service.
      a. Complete installation and startup checks according to manufacturer's written instructions.

H. Adjusting
   1. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Final Completion.
   2. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
   3. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Owner before increasing settings.
   4. Set the taps on reduced-voltage autotransformer controllers.
   5. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study".
   6. Set field-adjustable pressure switches.

I. Protection
   1. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.
   2. Replace VFCs whose interiors have been exposed to water or other liquids prior to Final Completion.

J. Demonstration
   1. Train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION 26 29 23 00

Task	Specification	Specification Description
26 29 33 13	21 30 00 00a	Diesel-Drive, Centrifugal Fire Pumps
26 29 33 13	21 31 13 00	Pressure-Maintenance Pumps
26 29 33 13	21 31 13 00a	Controllers for Fire-Pump Drivers

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SECTION 26 31 00 00 - PHOTOVOLTAIC ENERGY EQUIPMENT

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for Photovoltaic Energy Equipment. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
    a. PV laminates (cells laminated into rigid sheets, with connecting cables).
    b. PV modules (laminates in mounting frames).
    c. Charge controllers.
    d. Inverters.
    e. Mounting structures.

C. Definitions
1. CEC: California Energy Commission.
2. ETFE: Ethylene tetrafluoroethylene.
3. FEP: Fluorinated ethylene propylene.
4. IP Code: Required ingress protection to comply with IEC 60529.
5. MPPT: Maximum power point tracking.
6. PTC: USA standard conditions for PV.
7. PV: Photovoltaic.
8. STC: Standard Test Conditions defined in IEC 61215.

D. Action Submittals
1. Product Data: For each type of product.
    a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for PV panels.
    b. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Shop Drawings: For PV modules.
    a. Include plans, elevations, sections, and mounting details.
    b. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
    c. Detail fabrication and assembly.
    d. Include diagrams for power, signal, and control wiring.

E. Informational Submittals
1. Field quality-control reports.
2. Sample Warranty: For manufacturer's special materials and workmanship warranty and minimum power output warranty.

F. Closeout Submittals
1. Operation and Maintenance Data: For PV modules to include in operation and maintenance manuals.

G. Warranty

1. Manufacturer's Special Materials and Workmanship Warranty: Manufacturer agrees to repair or replace components of PV modules that fail in materials or workmanship within specified warranty period.
   a. Manufacturer's materials and workmanship warranties include, but are not limited to, the following:
      1) Faulty operation of PV modules.
   b. Warranty Period: Two **OR** Five years from date of Final Completion.
2. Manufacturer's Special Minimum Power Output Warranty: Manufacturer agrees to repair or replace components of PV modules that fail to exhibit the minimum power output within specified warranty period. Special warranty, applying to modules only, applies to materials only, on a prorated basis, for period specified.
   a. Manufacturer's minimum power output warranties include, but are not limited to, the following warranty periods, from date of Final Completion:
      1) Specified minimum power output to 80 percent or more, for a period of 25 years.

1.2 PRODUCTS

A. Performance Requirements
1. NRTL (Nationally Recognized Testing Laboratory) Listing: Entire assembly shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for electrical and fire safety, Class A **OR** Class C, according to UL 1703.
2. FM approved for NFPA 70, Class 1, Division 2, Group C and Group D hazardous locations.

B. System Description
1. Grid-Tied PV System:
   a. Connected via a utility meter to the electrical utility.
   b. An array of six modules to generate a total nominal 1000 rated W.
   c. System Components:
      1) Cell materials.
      2) PV modules.
      3) Array frame.
      4) Charge controller.
      5) Inverter.
      6) Overcurrent protection/combiner box.
      7) Mounting structure.
      8) Utility meter.
2. Battery-Storage PV System:
   a. Connected to a battery bank to provide electricity to Project.
   b. An array of six modules to generate a total nominal 1000 rated W.
   c. System Components:
      1) Cell materials.
      2) PV modules.
      3) Array frame.
      4) Charge controller.
      5) Inverter.
      6) Overcurrent protection/combiner box.
      7) Mounting structure.
      8) Battery charge controller(s).
      9) Batteries.
      10) Battery-storage structure.

C. Manufactured Units
1. Cell Materials: Amorphous silicon (a-Si) **OR** Cell Materials: Copper indium (di)selenide (CIS) **OR** Cell Materials: Copper indium gallium (di)selenide (CIGS) **OR** Cadmium telluride (CdTe) **OR**

Cadmium sulfide **OR** Polycrystalline (c-Si) **OR** Polycrystalline (Gallium arsenide (GaAs) **OR** Monocrystalline (c-Si) **OR** Monocrystalline (Gallium arsenide (GaAs), **as directed.**

2. Module Construction:
   a. Nominal Size: 32 inches (800 mm) wide by 64 inches (1600 mm) long.
   b. Weight: 42.8 lb (19.4 kg).
3. Insulating Substrate Film: Flexible **OR** Rigid, polyester **OR** polyimide, **as directed.**
4. Conducting Substrate Film: Flexible **OR** Rigid **OR** luoropolymer, ETFE **OR** FEP, **as directed**.
5. Encapsulant: Ethyl vinyl acetate.
6. Front Panel: Fully tempered glass.
7. Front Panel: 0.125-inch- (3.2-mm-) thick glass.
8. Front Panel: Low iron glass.
9. Front Panel: Antireflective coating glass.
10. Front Panel: Laminating film.
11. Front Panel: Laminating material.
12. Backing Material: Tempered glass.
13. Backing Material: 0.125-inch- (3.2-mm-) thick glass; color **as directed.**
14. Backing Material: Polyester film.
    a. Layers: **as directed.**
    b. Color: White **OR as directed.**
15. Backing Material: PVC film.
    a. Layers: **as directed.**
    b. Color: White **OR as directed.**
16. Bypass Diode Protection: Internal.
17. Junction Box:
    a. Size: 1.56 by 3.96 by 0.52 inch (39.6 by 100.6 by 13.2 mm).
    b. Fully potted, vandal resistant.
    c. IP Code: IP65 **OR** IP66 **OR** IP67, **as directed**.
    d. Flammability Test: UL 1703.
18. Output Cabling:
    a. **0.158 inch (4 mm)**.
    b. Quick, multiconnect, polarized connectors.
    c. Two-Conductor Harness: No traditional return wire is needed from the end of a row back to the source combiner.
19. Series Fuse Rating: **as directed**.

D. Capacities And Characteristics
1. Minimum Electrical Characteristics:
   a. Rated Open Circuit Voltage (V_{oc}): **as directed.**
   b. Maximum System Voltage: **as directed.**
   c. Maximum Power at Voltage (V_{pm}): **as directed.**
   d. Short-Circuit Temperature Coefficient: **as directed.**
   e. Rated Short-Circuit Current (I_{sc}): **as directed.**
   f. Maximum System: **as directed.**
   g. Rated Operation Current (I_{mp}): **as directed.**
   h. Maximum Power at STC (P_{max}): **as directed.**
2. Additional Electrical Characteristics:
   a. PTC Rating: **as directed.**
   b. Peak Power per Unit Area: **as directed.**
   c. Tolerance of Pmax: **as directed.**
   d. Minimum Peak Power: **as directed.**
   e. Series Fuse Rating: **as directed.**
   f. Module Efficiency: **as directed.**
   g. Temperature Cycling Range: **as directed.**
   h. Humidity, Freeze, Damp Heat Condition: **as directed.**
   i. Wind Loading or Surface Pressure: **as directed.**
   j. Maximum Distortion Angle: **as directed.**

k. Hailstone Impact Withstand: **as directed.**
l. Series Fuse Rating: **as directed.**
3. Normal Operating Temperature Characteristics (NOTC):
a. Temperature at Nominal Operating Cell Temperature: **as directed.**
b. Temperature Coefficient (NOTC P_{max}): **as directed.**
c. Temperature Coefficient (NOTC V_{oc}): **as directed.**.
d. Temperature Coefficient (NOTC I_{sc}): **as directed.**
e. Temperature Coefficient (NOTC V_{mp}): **as directed.**
f. Temperature Coefficient (NOTC I_{mp}): **as directed.**

E. Module Framing
1. PV laminates mounted in anodized extruded-aluminum frames.
a. Entire assembly UL listed for electrical and fire safety, Class A **OR** Class C, according to UL 1703, complying with IEC 61215.
b. Frame strength exceeding requirements of certifying agencies in subparagraph above.
c. Finish: Anodized aluminum.
1) Alloy and temper recommended by framing manufacturer for strength, corrosion resistance, and application of required finish.
2) Color: As indicated by manufacturer's designations.
d. Finish: High-performance organic finish.
1) Fluoropolymer Two-Coat System: Manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent PVC resin by weight.
2) Color: As indicated by manufacturer's designations.
e. Finish: Baked-enamel finish.
1) Color: As indicated by manufacturer's designations.

F. Array Construction
1. Framing:
a. Material: Extruded aluminum **OR** Galvanized steel **OR** Coated steel, **as directed**.
b. Maximum System Weight: Less than 4 lb/sq. ft. (19.53 kg/sq. m).
c. Minimum Distance to Connectors: **as directed**.
d. Raceway Cover Plates: Plastic **OR** Aluminum **OR** Galvanized steel, **as directed**.
2. Flat-Roof Mounting:
a. No roof penetrations.
b. Self-ballasting.
c. Wind-tunnel tested to 110-mph (160-km/h) wind.
d. Service Life: **25** years.
e. Freestanding system.

G. Charge Controller
1. Charge Controller Electrical Characteristics:
a. Output Current Rating: **as directed**.
b. Nominal Battery Voltage: **as directed**.
c. PV Maximum Open Circuit Voltage: **as directed**.
d. Equalization Voltage: **as directed**.
e. Voltage Step-Down Capability: **as directed**.
f. Power Conversion Efficiency: **as directed**.
2. Charge controllers shall have the following:
a. Digital display.
b. Data logging.
c. Remote interface.
d. External sensors.
e. Temperature compensation.

H. Inverter
  1. Control Type: Pulse width modulation control.
  2. Control Type: Maximum power point tracker control.
  3. Inverter Electrical Characteristics:
     a. Maximum Recommended PV Input Power: **as directed**.
     b. Maximum Voc: **as directed**.
     c. PV Start Voltage: **as directed**.
     d. MPPT Voltage Range: **as directed**.
     e. Maximum Input Current: **as directed**.
     f. Number of String Inputs: **as directed**.
     g. Number of Independent MPPT Circuits: **as directed**.
     h. Nominal Output Voltage: **as directed**.
     i. CEC Rated Power: **as directed**.
     j. Nominal Output Voltage: **as directed**.
     k. Maximum Output Current: **as directed**.
     l. Peak Efficiency: **as directed**.
     m. CEC Weighted Efficiency: **as directed**.
     n. CEC Night Tare Loss: **as directed**.
     o. DC/AC Terminal Range (AWG): **as directed**.
     p. NEMA 250 Enclosure Rating: **as directed**.
  4. Operating Conditions:
     a. Operating Ambient Temperatures: Minus 4 to plus 122 deg F (20 to plus 50 deg C).
     b. Storage Temperature: Minus 40 to plus 122 deg F (minus 40 to plus 50 deg C).
     c. Relative Humidity: 0 to 95 percent, noncondensing.
  5. Charge controllers shall have the following:
     a. Overcurrent protection.
     b. Generator input breaker box.
     c. Automatic transfer relay.
     d. Digital display.
     e. Transformer.
     f. Disconnect switch.
     g. Shunt controller.
     h. Shunt regulator.
     i. Surge overload protection.
  6. Enclosure:
     a. NEMA 250, Type 3R.
     b. Enclosure Material: Galvanized steel **OR** Steel, **as directed**.
     c. Cooling Methods:
        1) Fan convection cooling.
        2) Passive cooling.
     d. Protective Functions:
        1) AC over/under voltage.
        2) AC over/under frequency.
        3) Ground over current.
        4) Overtemperature.
        5) AC and dc overcurrent.
        6) DC over voltage.
     e. Standard liquid crystal display, four lines, 20 characters, with user display and on/off toggle switch.
     f. Weight: 260 lb (118 kg).
     g. Dimensions: 54 by 36 by 19 inches (137 by 91 by 48 cm).
  7. Disconnects:
     a. Low-voltage disconnect.
     b. Low-voltage reconnect.
     c. High-temperature disconnect.
     d. High-temperature reconnect.

8. Regulatory Approvals:
   a. IEEE 1547.1.
   b. IEEE 1547.3.
   c. UL 1741.
9. Characteristics:
   a. Inverter Dimensions: **as directed**.
   b. Inverter Weight: **as directed**.

I. System Overcurrent Protection
1. Combiner Box:
   a. Fuses: **as directed**.
   b. Circuit Breakers: **as directed**.

J. Mounting Structures
1. Roof Mount: Extruded aluminum, two **OR** four rails, **as directed**, tilt legs, and roof standoffs.
2. Pole Mount: Top **OR** Panel tops **OR** Side, **as directed**.
3. Tracking Mounts: One **OR** Two axis, **as directed**.

1.3 EXECUTION

A. Examination
1. Examine substrate areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
2. Do not begin installation until mounting surfaces have been properly prepared.
3. If preparation of mounting surfaces is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
4. Examine modules and array frame before installation. Reject modules and arrays that are wet, moisture damaged, or mold damaged.
5. Examine roofs, supports, and supporting structures for suitable conditions where PV system will be installed.
6. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Field Quality Control
1. Perform tests and inspections **with the assistance of a factory-authorized service representative**.
2. PV module will be considered defective if it does not pass tests and inspections.
3. Prepare test and inspection reports.

END OF SECTION 26 31 00 00

Task	Specification	Specification Description
26 31 00 00	01 22 16 00	No Specification Required

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SECTION 26 32 13 13 - PACKAGED ENGINE GENERATORS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for packaged engine generators. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes packaged engine-generator sets for emergency **OR** standby, **as directed**, power supply with the following features:
      a. Gas and Diesel engine.
      b. Unit-mounted and Remote-mounting cooling system.
      c. Unit-mounted and Remote-mounting control and monitoring.
      d. Performance requirements for sensitive loads.
      e. Load banks.
      f. Outdoor enclosure.

C. Definitions
   1. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.
   2. LP: Liquid petroleum.

D. Submittals
   1. Product Data: For each type of packaged engine generator and accessory indicated.
   2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Manufacturer Seismic Qualification Certification: Submit certification that day tank, engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
   4. Source quality-control test reports.
   5. Field quality-control test reports.
   6. Operation and maintenance data.
   7. Warranty: Special warranty specified in this Section.

E. Quality Assurance
   1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
   2. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles (321 km) of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
   3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   4. Comply with ASME B15.1.
   5. Comply with NFPA 37.
   6. Comply with NFPA 70.
   7. Comply with NFPA 99 for healthcare facilities.
   8. Comply with NFPA 110 requirements for Level 1 **OR** 2, **as directed,** emergency power supply system.

9. Comply with UL 2200.
10. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
11. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

F. Project Conditions
1. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
    a. Ambient Temperature: 5 to 40 deg C **OR** Minus 15 to plus 40 deg C, **as directed**.
    b. Relative Humidity: 0 to 95 percent for outdoor units.
    c. Altitude: Sea level to 1000 feet (300 m).
2. Unusual Service Conditions: Engine-generator equipment and installation are required to operate under the following conditions:
    a. High salt-dust content in the air due to sea-spray evaporation.

1.2 PRODUCTS

A. Engine-Generator Set
1. Factory-assembled and -tested, engine-generator set.
2. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
    a. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.
3. Capacities and Characteristics:
    a. Power Output Ratings: Nominal ratings as indicated, with capacity as required to operate as a unit as evidenced by records of prototype testing.
    b. Output Connections: Three-phase, three **OR** four, **as directed,** wire.
    c. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
4. Generator-Set Performance:
    a. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
    b. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
    c. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
    d. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
    e. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
    f. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
    g. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
    h. Start Time: Comply with NFPA 110, Type 10, system requirements.

5. Generator-Set Performance for Sensitive Loads:
   a. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.
      1) Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
   b. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
   c. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
   d. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
   e. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
   f. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
   g. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
   h. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
   i. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.
      1) Provide permanent magnet excitation for power source to voltage regulator.
   j. Start Time: Comply with NFPA 110, Type 10, system requirements.

B. Engine
1. Fuel: Fuel oil, Grade DF-2 **OR** Natural gas with automatic LP-gas standby **OR** Natural gas, **as directed**.
2. Rated Engine Speed: 1800 rpm.
3. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm (11.4 m/s).
4. Lubrication System: The following items are mounted on engine or skid:
   a. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
   b. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
   c. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
5. Engine Fuel System:
   a. Main Fuel Pump For Diesel-Fueled Engine: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
   b. Relief-Bypass Valve For Diesel-Fueled Engine: Automatically regulates pressure in fuel line and returns excess fuel to source.
   c. Dual Natural Gas with LP-Gas Backup (Vapor-Withdrawal) System:
      1) Carburetor.
      2) Secondary Gas Regulators: One for each fuel type.
      3) Fuel-Shutoff Solenoid Valves: One for each fuel source.
      4) Flexible Fuel Connectors: One for each fuel source.
6. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.
7. Governor: Adjustable isochronous, with speed sensing.

8. Cooling System:
   a. Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
      1) Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
      2) Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
      3) Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
      4) Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
      5) Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
         a) Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
         b) End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
   b. Closed loop, liquid cooled, with remote radiator and integral engine-driven coolant pump.
      1) Configuration: Vertical **OR** Horizontal, **as directed,** air discharge.
      2) Radiator Core Tubes: Aluminum **OR** Nonferrous-metal construction other than aluminum, **as directed**.
      3) Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
      4) Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
      5) Fan: Driven by multiple belts from engine shaft **OR** totally enclosed electric motor with sealed bearings, **as directed**.
      6) Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
      7) Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
9. Muffler/Silencer:
   a. Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
      1) Minimum sound attenuation of 25 dB at 500 Hz.
      2) Sound level measured at a distance of 10 feet (3 m) from exhaust discharge after installation is complete shall be 85 dBA or less.
   b. Residential type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
      1) Minimum sound attenuation of 18 dB at 500 Hz.
      2) Sound level measured at a distance of 10 feet (3 m) from exhaust discharge after installation is complete shall be 95 dBA or less.
   c. Industrial type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
      1) Minimum sound attenuation of 12 dB at 500 Hz.
      2) Sound level measured at a distance of 25 feet (8 m) from exhaust discharge after installation is complete shall be 87 dBA or less.
10. Air-Intake Filter: Standard **OR** Heavy, **as directed,**-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
11. Starting System: 12 **OR** 24, **as directed,**-V electric, with negative ground.

a. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
b. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
c. Cranking Cycle: As required by NFPA 110 for system level specified **OR** 60 seconds, **as directed**.
d. Battery: Adequate capacity within ambient temperature range specified in Part 1.1 "Project Conditions" Article to provide specified cranking cycle at least twice **OR** three times, **as directed**, without recharging.
e. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
f. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1.1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
g. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
h. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236.
   1) Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
   2) Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
   3) Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
   4) Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
   5) Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
   6) Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

C. Fuel Oil Storage
1. Comply with NFPA 30.
2. Day Tank: Comply with UL 142, freestanding, factory-fabricated fuel tank assembly, with integral, float-controlled transfer pump and the following features:
   a. Containment: Integral rupture basin with a capacity of 150 percent of nominal capacity of day tank.
      1) Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.
   b. Tank Capacity: As recommended by engine manufacturer for an uninterrupted period of 4 hours' operation at 100 percent of rated power output of engine-generator system without being refilled.
   c. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine.
   d. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
   e. High-Level Alarm Sensor: Liquid-level device operates alarm and redundant fuel shutoff contacts at midpoint between overflow level and 100 percent of normal fuel level.

f. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.
g. Redundant High-Level Fuel Shutoff: Actuated by high-level alarm sensor in day tank to operate a separate motor device that disconnects day-tank pump motor. Sensor shall signal solenoid valve, located in fuel suction line between fuel storage tank and day tank, to close. Both actions shall remain in shutoff state until manually reset. Shutoff action shall initiate an alarm signal to control panel but shall not shut down engine-generator set.

3. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:
   a. Tank level indicator.
   b. Capacity: Fuel for eight hours' continuous operation at 100 percent rated power output.
   c. Vandal-resistant fill cap.
   d. Containment Provisions: Comply with requirements of authorities having jurisdiction.

D. Control And Monitoring
1. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.
2. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.
3. Configuration:
   a. Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.
   b. Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common wall-mounted control and monitoring panel.
   c. Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator disconnect switch or circuit breaker, and other indicated components shall be grouped in a combination control and power panel. Control and monitoring section of panel shall be isolated from power sections by steel barriers. Panel features shall include the following:
      1) Wall-Mounting Cabinet Construction: Rigid, self-supporting steel unit complying with NEMA ICS 6. Power bus shall be copper. Bus, bus supports, control wiring, and temperature rise shall comply with UL 891.
      2) Switchboard Construction: Freestanding unit complying with Division 26 Section "Switchboards".
      3) Switchgear Construction: Freestanding unit complying with Division 26 Section "Low-voltage Switchgear".
      4) Current and Potential Transformers: Instrument accuracy class.
4. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 **OR** 2, **as directed,** system, and the following:
   a. AC voltmeter.
   b. AC ammeter.
   c. AC frequency meter.
   d. DC voltmeter (alternator battery charging).
   e. Engine-coolant temperature gage.
   f. Engine lubricating-oil pressure gage.
   g. Running-time meter.
   h. Ammeter-voltmeter, phase-selector switch(es).

i. Generator-voltage adjusting rheostat.
j. Fuel tank derangement alarm.
k. Fuel tank high-level shutdown of fuel supply alarm.
l. Generator overload.

5. Indicating and Protective Devices and Controls:
   a. AC voltmeter.
   b. AC ammeter.
   c. AC frequency meter.
   d. DC voltmeter (alternator battery charging).
   e. Engine-coolant temperature gage.
   f. Engine lubricating-oil pressure gage.
   g. Running-time meter.
   h. Ammeter-voltmeter, phase-selector switch(es).
   i. Generator-voltage adjusting rheostat.
   j. Start-stop switch.
   k. Overspeed shutdown device.
   l. Coolant high-temperature shutdown device.
   m. Coolant low-level shutdown device.
   n. Oil low-pressure shutdown device.
   o. Fuel tank derangement alarm.
   p. Fuel tank high-level shutdown of fuel supply alarm.
   q. Generator overload.
6. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.
7. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals are covered in Division 26 Section "Electrical Power Monitoring And Control".
8. Common Remote Audible Alarm:
   a. Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.
      1) Overcrank shutdown.
      2) Coolant low-temperature alarm.
      3) Control switch not in auto position.
      4) Battery-charger malfunction alarm.
      5) Battery low-voltage alarm.
   b. Common Remote Audible Alarm for manually starting systems or for automatically starting systems not specified to comply with NFPA 110, Level 1, but where some remote alarm functions are needed. Signal the occurrence of any events listed below without differentiating between event types. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.
      1) Engine high-temperature shutdown.
      2) Lube-oil, low-pressure shutdown.
      3) Overspeed shutdown.
      4) Remote emergency-stop shutdown.
      5) Engine high-temperature prealarm.
      6) Lube-oil, low-pressure prealarm.
      7) Fuel tank, low-fuel level.
      8) Low coolant level.
9. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

10. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

E. Generator Overcurrent And Fault Protection

1. Generator Circuit Breaker:
    a. Molded-case, thermal-magnetic type; 100 percent rated; complying with NEMA AB 1 and UL 489.
        1) Tripping Characteristic: Designed specifically for generator protection.
        2) Trip Rating: Matched to generator rating.
        3) Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
        4) Mounting: Adjacent to or integrated with control and monitoring panel.
    b. Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.
        1) Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
        2) Trip Settings: Selected to coordinate with generator thermal damage curve.
        3) Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
        4) Mounting: Adjacent to or integrated with control and monitoring panel.
    c. Insulated-case, electronic-trip type; 100 percent rated; complying with UL 489.
    d. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
    e. Trip Settings: Selected to coordinate with generator thermal damage curve.
    f. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
    g. Mounting: Adjacent to or integrated with control and monitoring panel.
2. Generator Disconnect Switch: Molded-case type, 100 percent rated.
    a. Rating: Matched to generator output rating.
    b. Shunt Trip: Connected to trip switch when signaled by generator protector or by other protective devices.
3. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:
    a. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
    b. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
    c. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
    d. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.
    e. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

F. Generator, Exciter, And Voltage Regulator

1. Comply with NEMA MG 1.
2. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
3. Electrical Insulation: Class H or Class F.
4. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

5. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
6. Enclosure: Dripproof.
7. Instrument Transformers: Mounted within generator enclosure.
8. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
    a. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.
9. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
10. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
11. Subtransient Reactance: 12 percent, maximum.

G. Load Bank
1. Description: Permanent, outdoor, weatherproof, remote-controlled, forced-air-cooled, resistive **OR** resistive and reactive, **as directed,** unit capable of providing a balanced 3-phase, delta-connected load to generator set at 100 percent rated-system capacity, at 80 percent power factor, lagging. Unit may be composed of separate resistive and reactive load banks controlled by a common control panel. Unit shall be capable of selective control of load in 25 percent steps and with minimum step changes of approximately 5 and 10 percent available.
2. Resistive Load Elements: Corrosion-resistant chromium alloy with ceramic and steel supports. Elements shall be double insulated and designed for repetitive on-off cycling. Elements shall be mounted in removable aluminized-steel heater cases.
3. Reactive Load Elements: Epoxy-encapsulated reactor coils.
4. Load-Bank Heat Dissipation: Integral fan with totally enclosed motor shall provide uniform cooling airflow through load elements. Airflow and coil operating current shall be such that, at maximum load, with ambient temperature at the upper end of specified range, load-bank elements operate at not more than 50 percent of maximum continuous temperature rating of resistance elements.
5. Load Element Switching: Remote-controlled contactors switch groups of load elements. Contactor coils are rated 120 V. Contactors shall be located in a separate NEMA 250, Type 3R enclosure within load-bank enclosure, accessible from exterior through hinged doors with tumbler locks.
6. Contactor Enclosures: Heated by thermostatically controlled strip heaters to prevent condensation.
7. Load-Bank Enclosures: NEMA 250, Type 3R, complying with NEMA ICS 6. Louvers at cooling-air intake and discharge openings shall prevent entry of rain and snow. Openings for airflow shall be screened with 1/2-inch- (13-mm-) square, galvanized-steel mesh. Reactive load bank shall include automatic shutters at air intake and discharge.
8. Protective Devices: Power input circuits to load banks shall be fused, and fuses shall be selected to coordinate with generator circuit breaker. Fuse blocks shall be located in contactor enclosure. Cooling airflow and overtemperature sensors shall automatically shut down and lock out load bank until manually reset. Safety interlocks on access panels and doors shall disconnect load power, control, and heater circuits. Fan motor shall be separately protected by overload and short-circuit devices. Short-circuit devices shall be noninterchangeable fuses with 200,000-A interrupting capacity.
9. Remote-Control Panel: Separate from load bank in NEMA 250, Type 1 enclosure with a control power switch and pilot light, and switches controlling groups of load elements.
10. Control Sequence: Control panel may be preset for adjustable single-step loading of generator during automatic exercising.

H. Outdoor Generator-Set Enclosure
1. Description:
    a. Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph (160 km/h). Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

b. Prefabricated or preengineered walk-in enclosure with the following features:
1) Construction: Galvanized-steel, metal-clad, integral structural-steel-framed building erected on concrete foundation.
2) Structural Design and Anchorage: Comply with ASCE 7 for wind loads.
3) Space Heater: Thermostatically controlled and sized to prevent condensation.
4) Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents.
5) Hinged Doors: With padlocking provisions.
6) Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents.
7) Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components.
8) Muffler Location: Within **OR** External to, **as directed,** enclosure.

2. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
a. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
b. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

3. Interior Lights with Switch: Factory-wired, vaporproof-type fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.
a. AC lighting system and connection point for operation when remote source is available.
b. DC lighting system for operation when remote source and generator are both unavailable.

4. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.

I. Motors
1. General requirements for motors are specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
b. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 22.

J. Vibration Isolation Devices
1. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
a. Material: Standard neoprene **OR** Natural rubber **OR** Bridge-bearing neoprene, complying with AASHTO M 251, **as directed**.
b. Durometer Rating: 30 **OR** 40 **OR** 45 **OR** 50 **OR** 60 **OR** 65 **OR** 70, **as directed**.
c. Number of Layers: One **OR** Two **OR** Three **OR** Four, **as directed**.

2. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
a. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
b. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
c. Minimum Additional Travel: 50 percent of required deflection at rated load.
d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

K. Finishes
1. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

L. Source Quality Control
1. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
   a. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.
   b. Report factory test results within 10 days of completion of test.

1.3 EXECUTION

A. Installation
1. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.
2. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
3. Install packaged engine generator with elastomeric isolator pads **OR** restrained spring isolators, **as directed,** having a minimum deflection of 1 inch (25 mm) on 4-inch- (100-mm-) high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
4. Install remote radiator with elastomeric isolator pads **OR** restrained spring isolators, **as directed,** having a minimum deflection of 1 inch (25 mm) on concrete base on grade **OR** roof equipment supports on roof, **as directed**.
5. Install Schedule 40, black steel piping with welded joints for cooling water piping between engine-generator set and heat exchanger **OR** remote radiator, **as directed**. Piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping".
6. Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet. Flexible connectors and steel piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping".
   a. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints. Flexible connectors and piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping".
7. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.
8. Piping installation requirements are specified in Division 21. Drawings indicate general arrangement of piping and specialties.
9. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.
10. Connect cooling-system water piping to engine-generator set and remote radiator **OR** heat exchanger, **as directed** with flexible connectors.
11. Connect engine exhaust pipe to engine with flexible connector.
12. Connect fuel piping to engines with a gate valve and union and flexible connector.
   a. Natural-gas piping, valves, and specialties for gas distribution are specified in Division 23 Section "Facility Natural-gas Piping".
   b. LP-gas piping, valves, and specialties for gas piping are specified in Division 23 Section "Facility Liquefied-petroleum Gas Piping".
13. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
14. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
15. Identify system components according to Division 23 Section "Identification For Hvac Piping And Equipment" and Division 26 Section "Identification For Electrical Systems".

B. Field Quality Control
1. Perform tests and inspections and prepare test reports.
    a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Tests and Inspections:
    a. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection (except those indicated to be optional) for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
    b. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
    c. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
        1) Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
        2) Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
        3) Verify acceptance of charge for each element of the battery after discharge.
        4) Verify that measurements are within manufacturer's specifications.
    d. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
    e. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
    f. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg (120 kPa). Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
    g. Exhaust Emissions Test: Comply with applicable government test criteria.
    h. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
    i. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
    j. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.
3. Coordinate tests with tests for transfer switches and run them concurrently.
4. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
5. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
6. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
7. Remove and replace malfunctioning units and retest **OR** reinspect, **as directed,** as specified above.
8. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
9. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

C. Demonstration

1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

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Task	Specification	Specification Description
26 32 13 19	26 32 13 13	Packaged Engine Generators
26 32 29 00	26 32 13 13	Packaged Engine Generators

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SECTION 26 33 43 00 - CENTRAL BATTERY INVERTERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for central battery inverters. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes slow-transfer, fast-transfer, and UPS central battery inverters with the following features:
a. Output distribution section.
b. Internal maintenance bypass/isolation switch.
c. External maintenance bypass/isolation switch.
d. Multiple output voltages.
e. Emergency-only circuits.
f. Remote monitoring provisions.

C. Definitions
1. LCD: Liquid-crystal display.
2. LED: Light-emitting diode.
3. THD: Total harmonic distortion.
4. UPS: Uninterruptible power supply.

D. Submittals
1. Product Data: For the following:
a. Electrical ratings, including the following:
1) Capacity to provide power during failure of normal ac.
2) Inverter voltage regulation and THD of output current.
3) Rectifier data.
4) Transfer time of transfer switch.
5) Data for specified optional features.
b. Transfer switch.
c. Inverter.
d. Battery charger.
e. Batteries.
f. Battery monitoring.
g. Battery-cycle warranty monitor.
2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, components, and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
a. Wiring Diagrams: Detail internal and interconnecting wiring; and power, signal, and control wiring.
b. Elevation and details of control and indication displays.
c. Output distribution section.
3. Manufacturer Seismic Qualification Certification: Submit certification that central battery inverter equipment will withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
4. Operation and Maintenance Data.

E. Quality Assurance

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. Central Battery Inverter System: UL 924 and UL 1778, **as directed**, listed.
3. Comply with NFPA 70 and NFPA 101.

F. Delivery, Storage, And Handling
1. Deliver equipment in fully enclosed vehicles.
2. Store equipment in spaces having environments controlled within manufacturers' written instructions for ambient temperature and humidity conditions for non-operating equipment.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace batteries that fail in materials or workmanship within specified warranty period. Special warranty, applying to batteries only, applies to materials only, on a prorated basis, for period specified.
   a. Warranty Period: Include the following warranty periods, from date of Final Completion:
      1) Premium, Valve-Regulated, Recombinant, Lead-Calcium Batteries:
         a) Full Warranty: One year.
         b) Pro Rata: 19 years.
      2) Standard, Valve-Regulated, Recombinant, Lead-Calcium Batteries:
         a) Full Warranty: One year.
         b) Pro Rata: Nine years.
      3) Nickel-Cadmium, Wet-Cell Batteries:
         a) Full Warranty: Five years.
         b) Pro Rata: 15 years.
      4) Lead-Calcium, Wet-Cell Batteries:
         a) Full Warranty: One year.
         b) Pro Rata: Nine years.
      5) Lead-Antimony, Wet-Cell Batteries:
         a) Full Warranty: One year.
         b) Pro Rata: Nine years.

1.2 PRODUCTS

A. Inverter Performance Requirements
1. Slow-Transfer Central Battery Inverters: Automatically sense loss of normal ac supply and use an electromechanical switch to transfer loads. Transfer in one second or less from normal supply to battery-inverter supply.
   a. Operation: Unit supplies power to output circuits from a single, external, normal supply source. Unit automatically transfers load from normal source to internal battery/inverter source. Retransfer to normal is automatic when normal power is restored.
2. Fast-Transfer Central Battery Inverters: Automatically sense loss of normal ac supply and use a solid-state switch to transfer loads. Transfer in 0.004 second or less from normal supply to battery-inverter supply.
   a. Operation: Unit supplies power to output circuits from a single, external, normal supply source. Unit automatically transfers load from normal source to internal battery/inverter source. Retransfer to normal is automatic when normal power is restored.
3. UPS-Type Central Battery Inverters: Continuously provide ac power to connected electrical system.
   a. Automatic Operation:
      1) Normal Conditions: Supply the load with ac power flowing from normal ac power input terminals, through rectifier-charger and inverter, with battery connected in parallel with rectifier-charger output.

2) Abnormal Supply Conditions: If normal ac supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, battery supplies constant, regulated, inverter ac power output to the load without switching or disturbance.
3) If normal power fails, battery continues supply-regulated ac power through the inverter to the load without switching or disturbance.
4) When power is restored at normal supply terminals of system, controls automatically synchronize inverter with the external source before transferring the load. Rectifier-charger then supplies power to the load through the inverter and simultaneously recharges battery.
5) If battery becomes discharged and normal supply is available, rectifier-charger charges battery. When battery is fully charged, rectifier-charger automatically shifts to float-charge mode.
6) If any element of central battery inverter system fails and power is available at normal supply terminals of system, static bypass transfer switch transfers the load to normal ac supply circuit without disturbance or interruption of supply.
7) If a fault occurs in system supplied by central battery inverter and current flows in excess of the overload rating of central battery inverter system, static bypass transfer switch operates to bypass fault current to normal ac supply circuit for fault clearing.
8) When fault has cleared, static bypass transfer switch returns the load to central battery inverter system.
9) If battery is disconnected, central battery inverter continues to supply power to the load with no degradation of its regulation of voltage and frequency of output bus.

b. Manual Operation:
1) Turning inverter off causes static bypass transfer switch to transfer the load directly to normal ac supply circuit without disturbance or interruption.
2) Turning inverter on causes static bypass transfer switch to transfer the load to inverter.

4. Maximum Acoustical Noise: <**Insert value**> dB, "A" weighting, emanating from any UPS component under any condition of normal operation, measured 39 inches (990 mm) from nearest surface of component enclosure.

B. Service Conditions
1. Environmental Conditions: Inverter system shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
a. Ambient Temperature for Electronic Components: 32 to 98 deg F (0 to 37 deg C).
b. Relative Humidity: 0 to 95 percent, noncondensing.
c. Altitude: Sea level to 4000 feet (1220 m).

C. Inverters
1. Description: Solid-state type, with the following operational features:
a. Automatically regulate output voltage to within plus or minus 5 percent.
b. Automatically regulate output frequency to within plus or minus 1 Hz, from no load to full load at unit power factor over the operating range of battery voltage.
c. Output Voltage Waveform of Unit: Sine wave with maximum 10 percent THD throughout battery operating-voltage range, from no load to full load.
1) THD may not exceed 5 percent when serving a resistive load of 100 percent of unit rating.
d. Output Protection: Current-limiting and short-circuit protection.
OR
Output Protection: Ferroresonant transformer to provide inherent overload and short-circuit protection.
e. Surge Protection: Panelboard **OR** Auxiliary panel, **as directed**, suppressors specified in Division 26 Section "Transient-voltage Suppression For Low-voltage Electrical Power Circuits".

f. Overload Capability: 125 percent for 10 minutes; 150 percent surge.
g. Brownout Protection: Produces rated power without draining batteries when input voltage is down to 75 percent of normal.

D. Battery Charger
1. Description: Solid-state, automatically maintaining batteries in fully charged condition when normal power is available. With LED indicators for "float" and "high-charge" modes.

E. Batteries
1. Description: Premium, valve-regulated, recombinant, lead-calcium **OR** Standard, valve-regulated, recombinant, lead-calcium **OR** Nickel-cadmium, wet-cell **OR** Lead-calcium, wet-cell **OR** Lead-antimony, wet-cell, **as directed**, batteries.
a. Capable of sustaining full-capacity output of inverter unit for minimum of 90 minutes.

F. Enclosures
1. NEMA 250, Type 1 steel cabinets with access to components through hinged doors with flush tumbler lock and latch.
2. Finish: Manufacturer's standard baked-enamel finish over corrosion-resistant prime treatment.

G. Seismic Requirements
1. Central battery inverter assemblies, subassemblies, components, fastenings, supports, and mounting and anchorage devices shall be designed and fabricated to withstand seismic forces, **as directed**. The term "withstand" is defined in the "Manufacturer Seismic Qualification Certification" Paragraph in Part 1.1 "Submittals" Article.

H. Control And Indication
1. Description: Group displays, indications, and basic system controls on common control panel on front of central battery inverter enclosure.
2. Minimum displays, indicating devices, and controls shall include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms shall include an audible signal and a visual display.
3. Indications: Labeled LED **OR** Plain-language messages on a digital LCD or LED, **as directed**.
a. Quantitative Indications:
1) Input voltage, each phase, line to line.
2) Input current, each phase, line to line.
3) System output voltage, each phase, line to line.
4) System output current, each phase.
5) System output frequency.
6) DC bus voltage.
7) Battery current and direction (charge/discharge).
8) Elapsed time-discharging battery.
b. Basic Status Condition Indications:
1) Normal operation.
2) Load-on bypass.
3) Load-on battery.
4) Inverter off.
5) Alarm condition exists.
c. Alarm Indications:
1) Battery system alarm.
2) Control power failure.
3) Fan failure.
4) Overload.
5) Battery-charging control faulty.
6) Input overvoltage or undervoltage.
7) Approaching end of battery operation.

8) Battery undervoltage shutdown.
9) Inverter fuse blown.
10) Inverter transformer overtemperature.
11) Inverter overtemperature.
12) Static bypass transfer switch overtemperature.
13) Inverter power supply fault.
14) Inverter output overvoltage or undervoltage.
15) System overload shutdown.
16) Inverter output contactor open.
17) Inverter current limit.

d. Controls:
1) Inverter on-off.
2) Start.
3) Battery test.
4) Alarm silence/reset.
5) Output-voltage adjustment.

4. Dry-form "C" contacts shall be available for remote indication of the following conditions:
a. Inverter on battery.
b. Inverter on-line.
c. Inverter load-on bypass.
d. Inverter in alarm condition.
e. Inverter off (maintenance bypass closed).

5. Include the following minimum array:
a. Ready, normal-power on light.
b. Charge light.
c. Inverter supply load light.
d. Battery voltmeter.
e. AC output voltmeter with minimum accuracy of 2 percent of full scale.
f. Load ammeter.
g. Test switch to simulate ac failure.

6. Enclosure: Steel, with hinged lockable doors, suitable for wall **OR** floor, **as directed**, mounting. Manufacturer's standard corrosion-resistant finish.

I. Optional Features
1. Multiple Output Voltages: Supply unit branch circuits at different voltage levels if required. Transform voltages internally as required to produce indicated output voltages.
2. Emergency-Only Circuits: Automatically energize only when normal supply has failed. Disconnect emergency-only circuits when normal power is restored.
3. Maintenance Bypass/Isolation Switch: Load is supplied, bypassing central battery inverter system. Normal supply, electromechanical transfer switch, and system load terminals are completely disconnected from external circuits.
4. Maintenance Bypass/Isolation Switch: Switch is interlocked so it cannot be operated unless static bypass transfer switch is in bypass mode. Switch provides manual selection among the following three conditions without interrupting supply to the load during switching:
a. Full Isolation: Load is supplied, bypassing central battery inverter system. Normal ac input circuit, static bypass transfer switch, and central battery inverter load terminals are completely disconnected from external circuits.
b. Maintenance Bypass: Load is supplied, bypassing central battery inverter system. Central battery inverter ac supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.
c. Normal: Normal central battery inverter ac supply terminals are energized and the load is supplied either through static bypass transfer switch and central battery inverter rectifier-charger and inverter or through battery and inverter.

J. Output Distribution Section

1. Panelboard: Comply with Division 26 Section "Panelboards" except provide assembly integral to equipment cabinet.

K. System Monitoring And Alarms
1. Remote Status and Alarm Panel: Labeled LEDs on panel faceplate shall indicate five basic status conditions. Audible signal indicates alarm conditions. Silencing switch in face of panel silences signal without altering visual indication.
    a. Cabinet and Faceplate: Surface or flush mounted to suit mounting conditions indicated.
2. Provisions for Remote Computer Monitoring: Communication module in unit control panel provides capability for remote monitoring of status, parameters, and alarms specified in Part 1.2 "Control and Indication" Article. Remote computer and connecting signal wiring will be provided by the Owner. Include the following features:
    a. Connectors and network interface units or modems for data transmission via RS-232 link.
    b. Software shall be designed to control and monitor inverter system functions and to provide on-screen explanations, interpretations, diagnosis, action guidance, and instructions for use of monitoring indications and development of reports. Include capability for storage and analysis of power-line transient records. Software shall be compatible with requirements in Division 26 Section "Electrical Power Monitoring And Control" and the operating system and configuration of the Owner-furnished computers.
3. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 ohms.
    a. Annunciation of Alarms: At inverter system control panel.
4. Battery-Cycle Warranty Monitoring: Electronic device, acceptable to battery manufacturer as a basis for warranty action, for monitoring charge-discharge cycle history of batteries covered by cycle-life warranty.
    a. Basic Functional Performance: Automatically measures and records each discharge event, classifies it according to duration category, and totals discharges according to warranty criteria, displaying remaining warranted battery life on integral LCD.
    b. Additional monitoring functions and features shall include the following:
        1) Measuring and recording of total voltage at battery terminals; providing alarm for excursions outside proper float voltage level.
        2) Monitoring of ambient temperature at battery and initiating an alarm if temperature deviates from normally acceptable range.
        3) Keypad on device front panel provides access to monitored data using front panel display.
        4) Alarm contacts arranged to provide local **OR** remote, **as directed**, alarm for battery discharge events **OR** abnormal temperature **OR** abnormal battery voltage or temperature, **as directed**.
        5) Memory device to store recorded data in nonvolatile electronic memory.
        6) RS-232 port to permit downloading of data to a portable personal computer.
        7) Modem to make measurements and recorded data accessible to remote personal computer via telephone line. Computer will be provided by the Owner.

L. Source Quality Control
1. Factory test complete inverter system, including battery, before shipment. Include the following:
    a. Functional test and demonstration of all functions, controls, indicators, sensors, and protective devices.
    b. Full-load test.
    c. Transient-load response test.
    d. Overload test.
    e. Power failure test.
2. Observation of Test: Give 14 days' advance notice of tests and provide access for the Owner's representative to observe tests at the Owner's option.
3. Report test results. Include the following data:

a. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
b. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
c. List of instruments and equipment used in factory tests.

1.3 EXECUTION

A. Installation
1. Install system components on floor **OR** concrete base, **as directed**, and attach by bolting.
   a. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Division 26 Section "Vibration And Seismic Controls For Electrical Systems" for seismic-restraint requirements.
   b. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 3 inches (75 mm) in all directions beyond the maximum dimensions of switchgear unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Division 26 Section "Hangers And Supports For Electrical Systems".
   c. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   d. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   e. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-place Concrete".
2. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

B. Connections
1. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams, unless otherwise indicated.
2. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
   a. Separately Derived Systems: Make grounding connections to grounding electrodes and bonding connections to metallic piping systems as indicated; comply with NFPA 70.
3. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Identification
1. Identify equipment and components according to Division 26 Section "Identification For Electrical Systems".

D. Field Quality Control
1. Perform tests and inspections and prepare test reports.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Tests and Inspections:
   a. Inspect interiors of enclosures for integrity of mechanical and electrical connections, component type and labeling verification, and ratings of installed components.
   b. Test manual and automatic operational features and system protective and alarm functions.
   c. Test communication of status and alarms to remote monitoring equipment.
   d. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specifications. Certify compliance with test parameters.

e. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Remove and replace malfunctioning units and retest as specified above.

E. Startup Service
1. Engage a factory-authorized service representative to perform startup service.
2. Verify that central battery inverter is installed and connected according to the Contract Documents.
3. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 22.
4. Complete installation and startup checks according to manufacturer's written instructions.

F. Adjusting And Cleaning
1. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
2. Install new filters in each equipment cabinet within 14 days from date of Final Completion.

END OF SECTION 26 33 43 00

SECTION 26 33 43 00a - PUBLIC ADDRESS AND MASS NOTIFICATION SYSTEMS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of public address and mass notification systems. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Preamplifiers.
      b. Power amplifiers.
      c. Transfer to standby amplifier.
      d. Microphones.
      e. Volume limiter/compressors.
      f. Control console.
      g. Equipment cabinet.
      h. Equipment rack.
      i. Telephone paging adapters.
      j. Tone generator.
      k. Monitor panel.
      l. Loudspeakers.
      m. Noise-operated gain controllers.
      n. Microphone and headphone outlets.
      o. Battery backup power unit.
      p. Conductors and cables.
      q. Raceways.

C. Definitions
   1. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.
   2. VU: Volume unit.
   3. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

D. Performance Requirements
   1. Delegated Design: Design supports and seismic restraints for control consoles, equipment cabinets and racks, and components, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
   2. Seismic Performance: Supports and seismic restraints for control consoles, equipment cabinets and racks, and components shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

E. Submittals
   1. Product Data: For each type of product indicated.
   2. Shop Drawings: For supports and seismic restraints for control consoles, equipment cabinets and racks, and components. Include plans, elevations, sections, details, and attachments to other work.

a. Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.
b. Console layouts.
c. Control panels.
d. Rack arrangements.
e. Calculations: For sizing backup battery.
f. Wiring Diagrams: For power, signal, and control wiring.
1) Identify terminals to facilitate installation, operation, and maintenance.
2) Single-line diagram showing interconnection of components.
3) Cabling diagram showing cable routing.

3. Delegated-Design Submittal: For supports and seismic restraints for control consoles, equipment cabinets and racks, and components indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
a. Detail fabrication and assembly of supports and seismic restraints for control consoles, equipment cabinets and racks, and components.
4. Seismic Qualification Certificates: For control consoles, equipment cabinets and racks, accessories, and components, from manufacturer.
a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
5. Field quality-control reports.
6. Operation and maintenance data.

F. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NFPA 70.

1.2 PRODUCTS

A. Functional Description Of System
1. System Functions:
a. Selectively connect any zone to any available signal channel.
b. Selectively control sound from microphone outlets and other inputs.
c. "All-call" feature shall connect the all-call sound signal simultaneously to all zones regardless of zone or channel switch settings.
d. Telephone paging adapter shall allow paging by dialing an extension from any local telephone instrument and speaking into the telephone.
e. Produce a program-signal tone that is amplified and sounded over all speakers, overriding signals currently being distributed.
f. Reproduce high-quality sound that is free of noise and distortion at all loudspeakers at all times during equipment operation including standby mode with inputs off; output free of non-uniform coverage of amplified sound.

B. General Equipment And Material Requirements
1. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.
2. Equipment: Comply with UL 813. Equipment shall be modular, using solid-state components, and fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.

3. Equipment Mounting: Where rack, cabinet, or console mounting is indicated, equipment shall be designed to mount in a 19-inch (483-mm) housing complying with TIA/EIA-310-D.
4. Weather-Resistant Equipment: Listed and labeled by a qualified testing agency for duty outdoors or in damp locations.

C. Preamplifiers
1. Preamplifier: Separately mounted.
2. Preamplifier: Integral to power amplifier.
3. Output Power: Plus 4 dB above 1 mW at matched power-amplifier load.
4. Total Harmonic Distortion: Less than 1 percent.
5. Frequency Response: Within plus or minus 2 dB from 20 to 20,000 Hz.
6. Input Jacks: Minimum of two. One matched for low-impedance microphone; the other matchable to cassette deck, CD player, or radio tuner signals without external adapters.
7. Minimum Noise Level: Minus 55 dB below rated output.
8. Controls: On-off, input levels, and master gain.

D. Power Amplifiers
1. Mounting: Console **OR** Rack, **as directed**.
2. Output Power: 70-V balanced line. 80 percent of the sum of wattage settings of connected for each station and speaker connected in all-call mode of operation, plus an allowance for future stations.
3. Total Harmonic Distortion: Less than 3 percent at rated power output from 50 to 12,000 Hz.
4. Minimum Signal-to-Noise Ratio: 60 dB, at rated output.
5. Frequency Response: Within plus or minus 2 dB from 50 to 12,000 Hz.
6. Output Regulation: Less than 2 dB from full to no load.
7. Controls: On-off, input levels, and low-cut filter.
8. Input Sensitivity: Matched to preamplifier and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphone or handset transmitter.

E. Transfer To Standby Amplifier
1. Monitoring Circuit and Sensing Relay: Detect reduction in output of power amplifier of 40 percent or more and, in such event, transfer load and signal automatically to standby amplifier.

F. Microphones
1. Paging Microphone:
   a. Type: Dynamic, with cardioid **OR** omni, **as directed**, polar characteristic.
   b. Impedance: 150 ohms.
   c. Frequency Response: Uniform, 50 to 14,000 Hz.
   d. Output Level: Minus 58 dB, minimum.
   e. Finish: Satin chrome.
   f. Cable: C25J.
   g. Mounting: Desk stand with integral-locking, press-to-talk switch.

G. Volume Limiter/Compressor
1. Minimum Performance Requirements:
   a. Frequency Response: 45 to 15,000 Hz, plus or minus 1 dB minimum.
   b. Signal Reduction Ratio: At least a 10:1 and 5:1 selectable capability.
   c. Distortion: 1 percent, maximum.
   d. Rated Output: Minimum of plus 14 dB.
   e. Inputs: Minimum of two inputs with variable front-panel gain controls and VU or decibel meter for input adjustment.
   f. Rack mounting.

H. Control Console
1. Cabinet: Modular, desktop **OR** desk style, **as directed**; complying with TIA/EIA-310-D.

2. Housing: Steel, 0.0478 inch (1.2 mm) minimum, with removable front and rear panels. Side panels are removable for interconnecting side-by-side mounting.
3. Panel for Equipment and Controls: Rack mounted.
4. Controls:
   a. Switching devices to select signal sources for distribution channels.
   b. Program selector switch to select source for each program channel.
   c. Switching devices to select zones for paging.
   d. All-call selector switch.
5. Indicators: A visual annunciation for each distribution channel to indicate source being used.
6. Self-Contained Power and Control Unit: A single assembly of basic control, electronics, and power supply necessary to accomplish specified functions.
7. Spare Positions: 20 percent spare zone control and annunciation positions on console.
8. Microphone jack.

I. Equipment Cabinet
1. Comply with TIA/EIA-310-D.
2. House amplifiers and auxiliary equipment at each location.
3. Cabinet Housing:
   a. Constructed of 0.0478-inch (1.2-mm) steel, minimum, with front- and rear-locking doors and standard TIA/EIA-310-D-compliant, 19-inch (483-mm) racks.
   b. Arranged for floor or wall mounting as indicated.
   c. Sized to house all equipment indicated, plus spare capacity.
   d. Include 20 percent minimum spare capacity for future equipment in addition to space required for future cassette deck and CD player.
4. Power Provisions: A single switch in cabinet shall disconnect cabinet power distribution system and electrical outlets, which shall be uniformly spaced to accommodate ac-power cords for each item of equipment.
5. Ventilation: A low-noise fan for forced-air cabinet ventilation. Fan shall be equipped with a filtered input vent and shall be connected to operate from 105- to 130-V ac, 60 Hz; separately fused and switched; arranged to be powered when main cabinet power switch is on.

J. Equipment Rack
1. Racks: 19 inches (483 mm) standard, complying with TIA/EIA-310-D.
2. Power-Supply Connections: Compatible plugs and receptacles.
3. Enclosure Panels: Ventilated rear and sides and solid top. Use louvers in panels to ensure adequate ventilation.
4. Finish: Uniform, baked-enamel factory finish over rust-inhibiting primer.
5. Power-Control Panel: On front of equipment housing, with master power on-off switch and pilot light; and with socket for 5-A cartridge fuse for rack equipment power.
6. Service Light: At top rear of rack with an adjacent control switch.
7. Vertical Plug Strip: Grounded receptacles, 12 inches (300 mm) o.c.; the full height of rack.
8. Maintenance Receptacles: Duplex convenience outlets supplied independent of vertical plug strip and located in front and bottom rear of rack.
9. Spare Capacity: 20 percent in rack for future equipment.

K. Telephone Paging Adapter
1. Adapters shall accept voice signals from telephone extension dialing access and automatically provide amplifier input and program override for preselected zones.
   a. Minimum Frequency Response: Flat, 200 to 2500 Hz.
   b. Impedance Matching: Adapter matches telephone line to public address equipment input.
   c. Rack mounting.

L. Tone Generator
1. Generator shall provide clock and program interface with public address and mass notification system.

2. Signals: Minimum of seven distinct, audible signal types including wail, warble, high/low, alarm, repeating and single-stroke chimes, and tone.
3. Pitch Control: Chimes and tone.
4. Volume Control: All outputs.
5. Activation-Switch Network: Establishes priority and hierarchy of output signals produced by different activation setups.
6. Mounting: Rack.

M. Monitor Panel
1. Monitor power amplifiers.
2. Components: VU or dB meter, speaker with volume control, and multiple-position rotary selector switch.
3. Selector Switch and Volume Control: Selective monitoring of output of each separate power amplifier via VU or dB meter and speaker.
4. Mounting: Rack.

N. Loudspeakers
1. Cone-Type Loudspeakers:
    a. Minimum Axial Sensitivity: 91 dB at one meter, with 1-W input.
    b. Frequency Response: Within plus or minus 3 dB from 50 to 15,000 Hz.
    c. Size: 8 inches (200 mm) with 1-inch (25-mm) voice coil and minimum 5-oz. (140-g) ceramic magnet.
    d. Minimum Dispersion Angle: 100 degrees.
    e. Rated Output Level: 10 W.
    f. Matching Transformer: Full-power rated with four taps. Maximum insertion loss of 0.5 dB.
    g. Surface-Mounting Units: Ceiling, wall, or pendant mounting, as indicated, in steel back boxes, acoustically dampened. Front face of at least 0.0478-inch (1.2-mm) steel and whole assembly rust proofed and shop primed for field painting.
    h. Flush-Ceiling-Mounting Units: In steel back boxes, acoustically dampened. Metal ceiling grille with white baked enamel.
2. Horn-Type Loudspeakers:
    a. Type: Single-horn units, double-reentrant design, with minimum full-range power rating of 15 W.
    b. Matching Transformer: Full-power rated with four standard taps. Maximum insertion loss of 0.5 dB.
    c. Frequency Response: Within plus or minus 3 dB from 250 to 12,000 Hz.
    d. Dispersion Angle: 130 by 110 degrees.
    e. Mounting: Integral bracket.
    f. Units in Hazardous (Classified) Locations: Listed and labeled for environment in which they are located.

O. Noise-Operated Gain Controller
1. Gain controller shall be designed to continuously sense space noise level and automatically adjust signal level to local speakers.
2. Frequency Response: 20 to 20,000 Hz, plus or minus 1 dB.
3. Level Adjustment Range: 20 dB minimum.
4. Maximum Distortion: 1 percent.
5. Control: Permits adjustment of sensing level of device.

P. Outlets
1. Volume Attenuator Station: Wall-plate-mounted autotransformer type with paging priority feature.
    a. Wattage Rating: 10 W unless otherwise indicated.
    b. Attenuation per Step: 3 dB, with positive off position.
    c. Insertion Loss: 0.4 dB maximum.

d. Attenuation Bypass Relay: Single pole, double throw. Connected to operate and bypass attenuation when all-call, paging, program signal, or prerecorded message features are used. Relay returns to normal position at end of priority transmission.
e. Label: "PA Volume."

2. Microphone Outlet: Three-pole, polarized, locking-type, microphone receptacles in single-gang boxes. Equip wall outlets with brushed stainless-steel device plates. Equip floor outlets with gray tapered rubber or plastic cable nozzles and fixed outlet covers.
3. Headphone Outlet (for the Hearing Impaired): Microphone receptacles in single-gang boxes. Equip wall outlets with brushed stainless-steel device plates. Equip floor outlets with gray tapered rubber or plastic cable nozzles and fixed-outlet covers.

Q. Battery Backup Power Unit

1. Unit shall be rack mounted, consisting of time-delay relay, sealed lead-calcium battery, battery charger, on-off switch, "normal" and "emergency" indicating lights, and adequate capacity to supply maximum equipment power requirements for one hour of continuous full operation.
2. Unit shall supply public address equipment with 12- to 15-V dc power automatically during an outage of normal 120-V ac power.
3. Battery shall be on float charge when not supplying system and to transfer automatically to supply system after three to five seconds of continuous outage of normal power, as sensed by time-delay relay.
4. Unit shall automatically retransfer system to normal supply when normal power has been reestablished for three to five seconds continuously.

R. Conductors And Cables

1. Jacketed, twisted pair and twisted multipair, untinned solid copper.
   a. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inch (0.8 mm) thick.
   b. Microphone Cables: Neoprene jacketed, not less than 2/64 inch (0.8 mm) thick, over shield with filled interstices. Shield No. 34 AWG, tinned, soft-copper strands formed into a braid or approved equivalent foil. Shielding coverage on conductors is not less than 60 percent.
   c. Plenum Cable: Listed and labeled for plenum installation.

S. Raceways

1. Conduit and Boxes: Comply with Division 26 Section "Raceway And Boxes For Electrical Systems". Flexible metal conduit shall not be used, unless directed otherwise.
   a. Outlet boxes shall be not less than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

1.3 EXECUTION

A. Wiring Methods

1. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used, **as directed**. Conceal raceway and cables except in unfinished spaces.
   a. Install plenum cable in environmental air spaces, including plenum ceilings.
   b. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway And Boxes For Electrical Systems".
2. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
3. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

B. Installation Of Raceways
   1. Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems" for installation of conduits and wireways.
   2. Install manufactured conduit sweeps and long-radius elbows whenever possible.

C. Installation Of Cables
   1. Comply with NECA 1.
   2. General Cable Installation Requirements:
      a. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
      b. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
      c. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
      d. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
      e. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
      f. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.
   3. Open-Cable Installation:
      a. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
      b. Suspend speaker cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceiling by cable supports not more than 60 inches (1524 mm) apart.
      c. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.
   4. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches (300 mm) apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

D. Installation
   1. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.
   2. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.
   3. Equipment Cabinets and Racks:
      a. Group items of same function together, either vertically or side by side, and arrange controls symmetrically. Mount monitor panel above the amplifiers.
      b. Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
      c. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by panels.
   4. Volume Limiter/Compressor: Equip each zone with a volume limiter/compressor. Install in central equipment cabinet. Arrange to provide a constant input to power amplifiers.
   5. Wall-Mounted Outlets: Flush mounted.
   6. Floor-Mounted Outlets: Conceal in floor and install cable nozzles through outlet covers. Secure outlet covers in place. Trim with carpet in carpeted areas.

7. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.
8. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.
9. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.
10. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

E. Grounding
1. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
2. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.
3. Install grounding electrodes as specified in Division 26 Section "Grounding And Bonding For Electrical Systems".

F. Field Quality Control
1. Perform tests and inspections.
    a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Tests and Inspections:
    a. Schedule tests with at least seven days' advance notice of test performance.
    b. After installing public address and mass notification systems and after electrical circuitry has been energized, test for compliance with requirements.
    c. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.
    d. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:
        1) Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000-Hz signal. Replace all other microphones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure signal-to-noise ratio.
        2) Repeat test for each separately controlled zone of loudspeakers.
        3) Minimum acceptance ratio is 50 dB.
    e. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12,000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.
    f. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.
    g. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12,000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.
    h. Signal Ground Test: Measure and report ground resistance at pubic address equipment signal ground. Comply with testing requirements specified in Division 26 Section "Grounding And Bonding For Electrical Systems".

3. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.
4. Public address and mass notification systems will be considered defective if they do not pass tests and inspections.
5. Prepare test and inspection reports.
   a. Include a record of final speaker-line matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.

END OF SECTION 26 33 43 00a

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Task	Specification	Specification Description
26 33 43 00	27 52 23 00	Nurse Call

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SECTION 26 33 53 00 - STATIC UNINTERRUPTIBLE POWER SUPPLY

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for static uninterruptible power supply. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Three-phase, on-line, double-conversion, static-type, UPS units with the following features:
         1) Surge suppression.
         2) Input harmonics reduction.
         3) Rectifier-charger.
         4) Inverter.
         5) Static bypass transfer switch.
         6) Battery and battery disconnect device.
         7) Internal and External maintenance bypass/isolation switch.
         8) Output isolation transformer.
         9) Remote UPS monitoring provisions.
         10) Battery monitoring.
         11) Remote monitoring.

C. Definitions
   1. EMI: Electromagnetic interference.
   2. LCD: Liquid-crystal display.
   3. LED: Light-emitting diode.
   4. PC: Personal computer.
   5. THD: Total harmonic distortion.
   6. UPS: Uninterruptible power supply.

D. Performance Requirements
   1. Seismic Performance: UPS shall withstand the effects of earthquake motions determined according to ASCE/SEI 7, **as directed**.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

E. Submittals
   1. Product Data: For each type of product indicated. Include data on features, components, ratings, and performance.
   2. Shop Drawings: For UPS. Include plans, elevations, sections, details, and attachments to other work.
      a. Detail equipment assemblies and indicate dimensions, weights, components, and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
      b. Wiring Diagrams: For power, signal, and control wiring.
   3. Seismic Qualification Certificates: For UPS equipment, from manufacturer.
      a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Factory Test Reports: Comply with specified requirements.
5. Field quality-control reports.
6. Operation and maintenance data.
7. Warranties: Sample of special warranties.

F. Quality Assurance
1. Testing Agency Qualifications: Member company of NETA or an NRTL **OR** one who meets the requirements necessary for certification, **as directed**.
   a. Testing Agency's Field Supervisor: Currently certified by NETA **OR** one who meets the requirements necessary for certification, **as directed,** to supervise on-site testing.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. UL Compliance: Listed and labeled under UL 1778 by an NRTL.
4. NFPA Compliance: Mark UPS components as suitable for installation in computer rooms according to NFPA 75.

G. Warranty
1. Special Battery Warranties: Specified form in which manufacturer and Installer agree to repair or replace UPS system storage batteries that fail in materials or workmanship within specified warranty period.
   a. Warranted Cycle Life for Valve-Regulated, Lead-Calcium Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F (25 deg C):

Discharge Rate	Discharge Duration	Discharge End Voltage	Cycle Life
8 hours	8 hours	1.67	6 cycles
30 minutes	30 minutes	1.67	20 cycles
15 minutes	45 seconds	1.67	120 cycles

OR
Warranted Cycle Life for Premium Valve-Regulated, Lead-calcium Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F (25 deg C):

Discharge Rate	Discharge Duration	Discharge End Voltage	Cycle Life
8 hours	8 hours	1.67	40 cycles
30 minutes	30 minutes	1.67	125 cycles
15 minutes	1.5 minutes	1.67	750 cycles

OR
Warranted Cycle Life for Flooded Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F (25 deg C):

Discharge Rate	Discharge Duration	Discharge End Voltage	Cycle Life
8 hours	8 hours	1.75	40 cycles
1 hour	1 hour	1.75	80 cycles
15 minutes	45 seconds	1.67	2700 cycles

2. Special UPS Warranties: Specified form in which manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within Two **OR** Three, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Operational Requirements
1. Automatic operation includes the following:
   a. Normal Conditions: Load is supplied with power flowing from the normal power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output.
   b. Abnormal Supply Conditions: If normal supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the battery supplies energy to maintain constant, regulated inverter power output to the load without switching or disturbance.
   c. If normal power fails, energy supplied by the battery through the inverter continues supply-regulated power to the load without switching or disturbance.
   d. When power is restored at the normal supply terminals of the system, controls automatically synchronize the inverter with the external source before transferring the load. The rectifier-charger then supplies power to the load through the inverter and simultaneously recharges the battery.
   e. If the battery becomes discharged and normal supply is available, the rectifier-charger charges the battery. On reaching full charge, the rectifier-charger automatically shifts to float-charge mode.
   f. If any element of the UPS system fails and power is available at the normal supply terminals of the system, the static bypass transfer switch switches the load to the normal ac supply circuit without disturbance or interruption.
   g. If a fault occurs in the system supplied by the UPS, and current flows in excess of the overload rating of the UPS system, the static bypass transfer switch operates to bypass the fault current to the normal ac supply circuit for fault clearing.
   h. When the fault has cleared, the static bypass transfer switch returns the load to the UPS system.
   i. If the battery is disconnected, the UPS continues to supply power to the load with no degradation of its regulation of voltage and frequency of the output bus.
2. Manual operation includes the following:
   a. Turning the inverter off causes the static bypass transfer switch to transfer the load directly to the normal ac supply circuit without disturbance or interruption.
   b. Turning the inverter on causes the static bypass transfer switch to transfer the load to the inverter.
3. Maintenance Bypass/Isolation Switch Operation: Switch is interlocked so it cannot be operated unless the static bypass transfer switch is in the bypass mode. Device provides manual selection among the three conditions in subparagraphs below without interrupting supply to the load during switching:
   a. Full Isolation: Load is supplied, bypassing the UPS. Normal UPS ac input circuit, static bypass transfer switch, and UPS load terminals are completely disconnected from external circuits.
   b. Maintenance Bypass: Load is supplied, bypassing the UPS. UPS ac supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.
   c. Normal: Normal UPS ac supply terminals are energized and the load is supplied through either the static bypass transfer switch and the UPS rectifier-charger and inverter, or the battery and the inverter.
4. Environmental Conditions: The UPS shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability, except battery performance.
   a. Ambient Temperature for Electronic Components: 32 to 104 deg F (0 to 40 deg C).

b. Ambient Temperature for Battery: 41 to 95 deg F (5 to 35 deg C).
c. Relative Humidity: 0 to 95 percent, noncondensing.
d. Altitude: Sea level to 4000 feet (1220 m).

B. Performance Requirements

1. The UPS shall perform as specified in this article while supplying rated full-load current, composed of any combination of linear and nonlinear load, up to 100 percent nonlinear load with a load crest factor of 3.0, under the following conditions or combinations of the following conditions:
   a. Inverter is switched to battery source.
   b. Steady-state ac input voltage deviates up to plus or minus 10 percent from nominal voltage.
   c. Steady-state input frequency deviates up to plus or minus 5 percent from nominal frequency.
   d. THD of input voltage is 15 percent or more with a minimum crest factor of 3.0, and the largest single harmonic component is a minimum of 5 percent of the fundamental value.
   e. Load is 30 **OR** 50 **OR** 100, **as directed**, percent unbalanced continuously.
2. Minimum Duration of Supply: If battery is sole energy source supplying rated full UPS load current at 80 percent power factor, duration of supply is five **OR** 10 **OR** 15, **as directed**, minutes.
3. Input Voltage Tolerance: System steady-state and transient output performance remains within specified tolerances when steady-state ac input voltage varies plus 10, minus 15 **OR** 20 **OR** 30, **as directed**, percent from nominal voltage.
4. Overall UPS Efficiency:

NOMINAL OVERALL UPS EFFICIENCY RATINGS

SIZE RANGE OF UPS UNITS	EFFICIENCY AT 100% RATED LOAD	EFFICIENCY AT 75% RATED LOAD	EFFICIENCY AT 50% RATED LOAD
30 kVA and Smaller	86	85	84
37.5 to 74 kVA	89	88	87
75 to 124 kVA	90	88	87
125 to 224 kVA	90	89	88
225 kVA and Larger	90	89	88

5. Maximum Acoustical Noise:

NOMINAL OVERALL UPS AUDIBLE NOISE RATINGS

SIZE RANGE OF UPS UNITS	MAXIMUM NOISE VALUE	DISTANCE AT WHICH MEASURED
10 kVA and Smaller	58 dB	36 inches (900 mm)
20 to 125 kVA	60 dB	48 inches (1200 mm)
150 to 300 kVA	78 dB	48 inches (1200 mm)
300 kVA and Larger	83 dB	48 inches (1200 mm)

6. Maximum Energizing Inrush Current: Six **OR** Eight, **as directed**, times the full-load current.
7. Maximum AC Output-Voltage Regulation for Loads up to 50 Percent Unbalanced: Plus or minus 2 percent over the full range of battery voltage.
8. Output Frequency: 60 Hz, plus or minus 0.5 percent over the full range of input voltage, load, and battery voltage.
9. Limitation of harmonic distortion of input current to the UPS shall be as follows:

a. Description: Either a tuned harmonic filter or an arrangement of rectifier-charger circuits shall limit THD to 5 **OR** 10, **as directed**, percent, maximum, at rated full UPS load current, for power sources with X/R ratio between 2 and 30.
OR
Description: THD is limited to a maximum of 32 percent, at rated full UPS load current, for power sources with X/R ratio between 2 and 30.

10. Maximum Harmonic Content of Output-Voltage Waveform: 5 percent rms total and 3 percent rms for any single harmonic, for 100 percent rated nonlinear load current with a load crest factor of 3.0.
OR
Maximum Harmonic Content of Output-Voltage Waveform: 5 percent rms total and 3 percent rms for any single harmonic, for rated full load with THD up to 50 percent, with a load crest factor of 3.0.
11. Minimum Overload Capacity of UPS at Rated Voltage: 125 percent of rated full load for 10 minutes, and 150 percent for 30 seconds in all operating modes.
12. Maximum Output-Voltage Transient Excursions from Rated Value: For the following instantaneous load changes, stated as percentages of rated full UPS load, voltage shall remain within stated percentages of rated value and recover to, and remain within, plus or minus 2 percent of that value within 100 ms:
    a. 50 Percent: Plus or minus 5 percent.
    b. 100 Percent: Plus or minus 5 percent.
    c. Loss of AC Input Power: Plus or minus 1 percent.
    d. Restoration of AC Input Power: Plus or minus 1 percent.
13. Input Power Factor: A minimum of 0.70 **OR** 0.85, **as directed**, lagging when supply voltage and current are at nominal rated values and the UPS is supplying rated full-load current.
14. EMI Emissions: Comply with FCC Rules and Regulations and with 47 CFR 15 for Class A equipment.

C. UPS Systems
1. Electronic Equipment: Solid-state devices using hermetically sealed, semiconductor elements. Devices include rectifier-charger, inverter, static bypass transfer switch, and system controls.
2. Enclosures: Comply with NEMA 250, Type 1, unless otherwise indicated.
3. Control Assemblies: Mount on modular plug-ins, readily accessible for maintenance.
4. Surge Suppression: Protect internal UPS components from surges that enter at each ac power input connection including main disconnect switch, static bypass transfer switch, and maintenance bypass/isolation switch, **as directed**. Protect rectifier-charger, inverter, controls, and output components.
    a. Use factory-installed surge suppressors tested according to IEEE C62.41.1 and IEEE C62.41.2, Category B **OR** Category C, **as directed**.
    b. Additional Surge Protection: Protect internal UPS components from low-frequency, high-energy voltage surges described in IEEE C62.41.1 and IEEE C62.41.2. Design the circuits connecting with external power sources and select circuit elements, conductors, conventional surge suppressors, and rectifier components and controls so input assemblies will have adequate mechanical strength and thermal and current-carrying capacity to withstand stresses imposed by 40-Hz, 180 percent voltage surges described in IEEE C62.41.1 and IEEE C62.41.2.
5. Maintainability Features (for units rated more than approximately 100 kVA): Mount rectifier-charger and inverter sections and the static bypass transfer switch on modular plug-ins, readily accessible for maintenance.
6. Capacity Upgrade Capability: Arrange wiring, controls, and modular component plug-in provisions to permit future 25 percent increase in UPS capacity.
7. Seismic-Restraint Design: UPS assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) shall be designed and fabricated to withstand static and seismic forces.
8. UPS Cabinet Ventilation: Redundant fans or blowers draw in ambient air near the bottom of cabinet and discharge it near the top rear.

9. Output Circuit Neutral Bus, Conductor, and Terminal Ampacity (for a UPS with heavy nonlinear loading): Rated phase current times a multiple of 1.73, minimum.

D. Rectifier-Charger
1. Capacity: Adequate to supply the inverter during rated full output load conditions and simultaneously recharge the battery from fully discharged condition to 95 percent of full charge within 10 times the rated discharge time for duration of supply under battery power at full load.
2. Output Ripple: Limited by output filtration to less than 0.5 percent of rated current, peak to peak.
3. Control Circuits: Immune to frequency variations within rated frequency ranges of normal and emergency power sources.
   a. Response Time: Field adjustable for maximum compatibility with local generator-set power source.
4. Battery Float-Charging Conditions: Comply with battery manufacturer's written instructions for battery terminal voltage and charging current required for maximum battery life.

E. Inverter
1. Description: Pulse-width modulated, with sinusoidal output.
OR
Description (if the UPS may be supplied power from a standby engine-generator set): Pulse-width modulated, with sinusoidal output. Include a bypass phase synchronization window adjustment to optimize compatibility with local engine-generator-set power source.

F. Static Bypass Transfer Switch
1. Description: Solid-state switching device providing uninterrupted transfer. A contactor or electrically operated circuit breaker automatically provides electrical isolation for the switch.
2. Switch Rating: Continuous duty at the rated full UPS load current, minimum.

G. Battery

ALTERNATIVE BATTERY TYPES FOR UPS SYSTEMS

TYPE	NOMINAL LIFE EXPECTANCY (YEARS)*	TYPICAL WARRANTY (YEARS)*		MINIMUM NOMINAL MAINTENANCE INTERVAL	APPROX. INITIAL COST FACTOR**	SPECIAL FEATURES
		FULL	PRO RATA			
Premium quality, valve regulated, recombinant, lead calcium	20	1	19	1 year	2.5	Spill proof.
Standard quality, valve regulated, recombinant, lead calcium	10	1	9	1 year	1.0	Spill proof.
Nickel cadmium, flooded	25	5	15	3 years	4.0	Can operate in high ambient tempera-tures. Can be com-pletely discharged without damage.
Lead calcium, flooded	20	1	9	6 months	2.5	-
*Life expectancy and warranty data apply to installations where batteries are considered to be in a "float-service"						

application. Use the data only as a general guide because UPS batteries are typically considered to be in a separate service application category that accounts for the numerous discharges of varying duration they experience.

**Cost includes an allowance for space requirements and environmental control.

1. Description: Valve-regulated, recombinant, lead-calcium units, factory assembled in an isolated compartment of UPS cabinet, complete with battery disconnect switch.
   a. Arrange for drawout removal of battery assembly from cabinet for testing and inspecting.
   OR
   Description: Valve-regulated, premium, heavy-duty, recombinant, lead-calcium units, factory assembled in an isolated compartment or in a separate matching cabinet, complete with battery disconnect switch.
   a. Arrange for drawout removal of battery assembly from cabinet for testing and inspecting.
   OR
   Description: Flooded, lead-calcium, heavy-duty industrial units in styrene acrylonitrile containers mounted on three-tier, **as directed**, acid-resistant, painted steel racks. Assembly includes battery disconnect switch, intercell connectors, hydrometer syringe, and thermometer with specific gravity-correction scales.
2. Seismic-Restraint Design: Battery racks, cabinets, assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) shall be designed and fabricated to withstand static and seismic forces.

H. Controls And Indications
1. Description: Group displays, indications, and basic system controls on a common control panel on front of UPS enclosure.
2. Minimum displays, indicating devices, and controls include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms include audible signals and visual displays.
3. Indications: Labeled LED **OR** Plain-language messages on a digital LCD or LED, **as directed**.
   a. Quantitative indications shall include the following:
      1) Input voltage, each phase, line to line.
      2) Input current, each phase, line to line.
      3) Bypass input voltage, each phase, line to line.
      4) Bypass input frequency.
      5) System output voltage, each phase, line to line.
      6) System output current, each phase.
      7) System output frequency.
      8) DC bus voltage.
      9) Battery current and direction (charge/discharge).
      10) Elapsed time discharging battery.
   b. Basic status condition indications shall include the following:
      1) Normal operation.
      2) Load-on bypass.
      3) Load-on battery.
      4) Inverter off.
      5) Alarm condition.
   c. Alarm indications shall include the following:
      1) Bypass ac input overvoltage or undervoltage.
      2) Bypass ac input overfrequency or underfrequency.
      3) Bypass ac input and inverter out of synchronization.
      4) Bypass ac input wrong-phase rotation.
      5) Bypass ac input single-phase condition.
      6) Bypass ac input filter fuse blown.
      7) Internal frequency standard in use.
      8) Battery system alarm.
      9) Control power failure.
      10) Fan failure.

11) UPS overload.
12) Battery-charging control faulty.
13) Input overvoltage or undervoltage.
14) Input transformer overtemperature.
15) Input circuit breaker tripped.
16) Input wrong-phase rotation.
17) Input single-phase condition.
18) Approaching end of battery operation.
19) Battery undervoltage shutdown.
20) Maximum battery voltage.
21) Inverter fuse blown.
22) Inverter transformer overtemperature.
23) Inverter overtemperature.
24) Static bypass transfer switch overtemperature.
25) Inverter power supply fault.
26) Inverter transistors out of saturation.
27) Identification of faulty inverter section/leg.
28) Inverter output overvoltage or undervoltage.
29) UPS overload shutdown.
30) Inverter current sensor fault.
31) Inverter output contactor open.
32) Inverter current limit.

d. Controls shall include the following:
1) Inverter on-off.
2) UPS start.
3) Battery test.
4) Alarm silence/reset.
5) Output-voltage adjustment.

4. Dry-form "C" contacts shall be available for remote indication of the following conditions:
a. UPS on battery.
b. UPS on-line.
c. UPS load-on bypass.
d. UPS in alarm condition.
e. UPS off (maintenance bypass closed).

5. Emergency Power Off Switch: Capable of local operation and operation by means of activation by external dry contacts.

I. Maintenance Bypass/Isolation Switch

1. Description: Manually operated switch or arrangement of switching devices with mechanically actuated contact mechanism arranged to route the flow of power to the load around the rectifier-charger, inverter, and static bypass transfer switch.
a. Switch shall be electrically and mechanically interlocked to prevent interrupting power to the load when switching to bypass mode.
b. Switch shall electrically isolate other UPS components to permit safe servicing.

2. Comply with NEMA PB 2 and UL 891.

3. Switch Rating: Continuous duty at rated full UPS load current.

4. Mounting Provisions: Internal to system cabinet **OR** Separate wall- or floor-mounted unit, **as directed**.

5. Key interlock requires unlocking maintenance bypass/isolation switch before switching from normal position with key that is released only when the UPS is bypassed by the static bypass transfer switch. Lock is designed specifically for mechanical and electrical component interlocking.

J. Output Isolation Transformer

1. Description: Shielded unit **OR** Unit, **as directed**, with low forward transfer impedance up to 3 kHz, minimum. Include the following features:
   a. Comply with applicable portions of UL 1561, including requirements for nonlinear load current-handling capability for a K-factor of approximately 4 **OR** 9 **OR** 13 **OR** 20, **as directed**.
   b. Output Impedance at Fundamental Frequency: Between 3 and 4 percent.
   c. Regulation: 5 percent, maximum, at rated nonlinear load current.
   d. Full-Load Efficiency at Rated Nonlinear Load Current: 96 percent, minimum.
   e. Electrostatic Shielding of Windings: Independent for each winding.
   f. Coil Leads: Physically arranged for minimum interlead capacitance.
   g. Shield Grounding Terminal: Separately mounted; labeled "Shield Ground."
   h. Capacitive Coupling between Primary and Secondary: 33 picofarads, maximum, over a frequency range of 20 Hz to 1 MHz.

K. Output Distribution Section
1. Panelboards: Comply with Division 26 Section "Panelboards" except provide assembly integral to UPS cabinet.

L. Monitoring By Remote Status And Alarm Panel
1. Description: Labeled LEDs on panel faceplate indicate five basic status conditions. Audible signal indicates alarm conditions. Silencing switch in face of panel silences signal without altering visual indication.
   a. Cabinet and Faceplate: Surface or flush mounted to suit mounting conditions indicated.

M. Monitoring By Remote Computer
1. Description: Communication module in unit control panel provides capability for remote monitoring of status, parameters, and alarms specified in "Controls and Indications" Article. The remote computer and the connecting signal wiring are not included in this Section. Include the following features:
   a. Connectors and network interface units or modems for data transmission via RS-232 link.
   b. Software designed for control and monitoring of UPS functions and to provide on-screen explanations, interpretations, diagnosis, action guidance, and instructions for use of monitoring indications and development of meaningful reports. Permit storage and analysis of power-line transient records. Designs for Windows applications, software, and computer are not included in this Section.
   c. Software and Hardware: Compatible with that specified in Division 26 Section "Electrical Power Monitoring And Control".

N. Basic Battery Monitoring
1. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 ohms.
2. Battery compartment smoke/high-temperature detector initiates an alarm when smoke or a temperature greater than 75 deg C occurs within the compartment.
3. Annunciation of Alarms: At UPS control panel.

O. Additional Battery Monitoring
1. Monitoring features and components shall include the following:
   a. Factory-wired sensing leads to cell and battery terminals and cell temperature sensors.
   b. Connections for data transmission via RS-232 link, network interface and, **as directed**, modem and, **as directed**, external signal wiring to computer **OR** electrical power monitoring and control equipment, **as directed**. External signal wiring and computer are not specified in this Section.
   c. PC-based software designed to store and analyze battery data. Software compiles reports on individual-cell parameters and total battery performance trends, and provides data for scheduling and prioritizing battery maintenance.

2. Performance: Automatically measures and electronically records the following parameters on a routine schedule and during battery discharge events. During discharge events, records measurements timed to nearest second; includes measurements of the following parameters:
   a. Total battery voltage and ambient temperature.
   b. Individual-cell voltage, impedance, and temperature. During battery-discharging events such as utility outages, measures battery and cell voltages timed to nearest second.
   c. Individual-cell electrolyte levels.

P. Battery-Cycle Warranty Monitoring
1. Description: Electronic device, acceptable to battery manufacturer as a basis for warranty action, for monitoring of charge-discharge cycle history of batteries covered by cycle-life warranties.
2. Performance: Automatically measures and records each discharge event, classifies it according to duration category, and totals discharges according to warranty criteria, displaying remaining warranted battery life on front panel display.
3. Additional monitoring functions and features shall include the following:
   a. Measuring and Recording: Total voltage at battery terminals; initiates alarm for excursions outside the proper float-voltage level.
   b. Monitors: Ambient temperature at battery; initiates alarm if temperature deviates from normally acceptable range.
   c. Keypad on Device Front Panel: Provides access to monitored data using front panel display.
   d. Alarm Contacts: Arranged to initiate local **OR** remote, **as directed**, alarm for battery discharge events **OR** abnormal temperature **OR** abnormal battery voltage or temperature, **as directed**.
   e. Memory: Stores recorded data in nonvolatile electronic memory.
   f. RS-232 Port: Permits downloading of data to a portable PC.
   g. Modem: Makes measurements and recorded data accessible to a remote PC via telephone line. Computer is not specified in this Section.

Q. Source Quality Control
1. Factory test complete UPS system before shipment. Use actual batteries that are part of final installation **OR** simulated battery testing, **as directed**. Include the following:
   a. Test and demonstration of all functions, controls, indicators, sensors, and protective devices.
   b. Full-load test.
   c. Transient-load response test.
   d. Overload test.
   e. Power failure test.
2. Observation of Test: Give 14 days' advance notice of tests and provide opportunity for Owner's representative to observe tests at Owner's choice.
3. Report test results. Include the following data:
   a. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
   b. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
   c. List of instruments and equipment used in factory tests.

1.3 EXECUTION

A. Installation
1. Equipment Mounting: Install UPS on concrete base. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-place Concrete".
   a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.

b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
d. Install anchor bolts to elevations required for proper attachment to supported equipment.

2. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
3. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams unless otherwise indicated.

B. Grounding
1. Separately Derived Systems: If not part of a listed power supply for a data-processing room, comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer.

C. Identification
1. Identify components and wiring according to Division 26 Section "Identification For Electrical Systems".
   a. Identify each battery cell individually.

D. Battery Equalization
1. Equalize charging of battery cells according to manufacturer's written instructions. Record individual-cell voltages.

E. Field Quality Control
1. Perform tests and inspections.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Tests and Inspections:
   a. Comply with manufacturer's written instructions.
   b. Inspect interiors of enclosures, including the following:
      1) Integrity of mechanical and electrical connections.
      2) Component type and labeling verification.
      3) Ratings of installed components.
   c. Inspect batteries and chargers according to requirements in NETA Acceptance Testing Specifications.
   d. Test manual and automatic operational features and system protective and alarm functions.
   e. Test communication of status and alarms to remote monitoring equipment.
   f. Load the system using a variable-load bank to simulate kilovolt amperes, kilowatts, and power factor of loads for unit's rating. Use instruments calibrated within the previous six months according to NIST standards.
      1) Simulate malfunctions to verify protective device operation.
      2) Test duration of supply on emergency, low-battery voltage shutdown, and transfers and restoration due to normal source failure.
      3) Test harmonic content of input and output current less than 25, 50, and 100 percent of rated loads.
      4) Test output voltage under specified transient-load conditions.
      5) Test efficiency at 50, 75, and 100 percent of rated loads.
      6) Test remote status and alarm panel functions.
      7) Test battery-monitoring system functions.
3. Seismic-restraint tests and inspections shall include the following:
   a. Inspect type, size, quantity, arrangement, and proper installation of mounting or anchorage devices.

b. Test mounting and anchorage devices according to requirements in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".

4. The UPS system will be considered defective if it does not pass tests and inspections.
5. Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, inspections, and retests.
6. Prepare test and inspection reports.

F. Demonstration

1. Train Owner's maintenance personnel to adjust, operate, and maintain the UPS.

END OF SECTION 26 33 53 00

Task	Specification	Specification Description
26 33 53 00	26 33 43 00	Central Battery Inverters

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SECTION 26 35 33 16 - POWER FACTOR CORRECTION CAPACITORS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for power factor correction capacitors. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes power and automatic power factor correction equipment rated 600 V and less.

C. Performance Requirements
1. Seismic Performance: Power factor correction equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

D. Submittals
1. Product Data: For each type of product indicated. Include dimensions, operating characteristics of multiple capacitor cells or elements, and data on features, ratings, and performance.
2. Shop Drawings: For automatic power factor correction units.
   a. Detail equipment assemblies and indicate dimensions, weights, method of field assembly, components, and location and size of each field connection. Show access and workspace requirements and required clearances.
   b. Wiring Diagrams: For power, signal, and control wiring.
3. Qualification Data: For qualified testing agency.
4. Seismic Qualification Certificates: For capacitors, accessories, and components, from manufacturer.
   a. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   b. Dimensioned Outline Drawings of Equipment: Identify center of gravity and locate and describe mounting and anchorage provisions.
   c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
5. Field quality-control reports.
6. Operation and Maintenance Data: For equipment to include in emergency, operation, and maintenance manuals. Include the following:
   a. Lists of spare parts and replacement components recommended for storage at Project site.
   b. Detailed instructions covering operation under both normal and abnormal conditions.
7. Warranty: Sample of special warranty.

E. Quality Assurance
1. Testing Agency Qualifications: Member company of NETA or an NRTL **OR** one who meets the requirements necessary for certification, **as directed**.
   a. Testing Agency's Field Supervisor: Currently certified by NETA **OR** one who meets the requirements necessary for certification, **as directed,** to supervise on-site testing.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Comply with IEEE 18 and NEMA CP 1.
4. Comply with NFPA 70.

F. Coordination
1. Coordinate sensor-communication module package with data network and with monitoring equipment specified in Division 26 Section "Electrical Power Monitoring And Control" for successful transmission and remote readout of remote monitoring data specified in this Section.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace capacitor-bank components that fail in materials or workmanship within five years from date of Final Completion.

1.2 PRODUCTS

A. Capacitors, General
1. Comply with UL 810.
2. Service Conditions: Capacitor equipment suitable for the following conditions:
   a. Operating Temperature: Minus 40 to plus 115 deg F (Minus 40 to plus 46 deg C).
   b. Maximum Altitude: 6000 feet (1800 m).
   c. Humidity: 0 to 95 percent, noncondensing.
3. Construction: Multiple capacitor cells or elements, factory wired in three-phase groups and mounted in metal enclosures.
4. Cells: Dry metallized-dielectric, self-healing type. Each cell shall be encapsulated in thermosetting resin inside plastic container.
5. Rupture Protection: Pressure-sensitive circuit interrupter for each cell.

B. Fixed Capacitors
1. Description: Factory wired, ready for field connection to external circuits at a single set of pressure terminals. Comply with UL 810.
2. Fuses: Current-limiting, noninterchangeable type; factory installed in each phase and located within the equipment enclosure. Features include the following:
   a. Interrupting Capacity: 100,000 **OR** 200,000, **as directed**, A
   b. Fuse Ratings and Characteristics: As recommended by capacitor manufacturer.
   c. Neon Indicator Lamp for Each Fuse: Connect to illuminate when fuse has opened, but is still in place, and locate so it is visible from outside the enclosure.
3. Discharge Resistors: Factory installed and wired.
4. Enclosure: NEMA 250, steel **OR** aluminum, **as directed**, arranged to contain the fluid leakage from capacitor cells; factory equipped with mounting brackets suitable for type of mounting indicated.
   a. Indoor Enclosures: NEMA 250, Type 12 or as indicated.
      OR
      Outdoor Enclosures: NEMA 250, Type 3R or as indicated.
      OR
      Outdoor Enclosures: NEMA 250, Type 4, equipped with watertight conduit connections.

C. Automatic Power Factor Correction Units
1. Description: Capacitors, contactors, controls, and accessories factory installed in independent enclosures **OR** motor-control center, with a connection to motor-control center bus, **as directed**, complying with NEMA ICS 2. Comply with UL 810.
2. Performance Requirements: Controls permit selection of a target power factor, adjustable to any value between unity and 0.80 lagging. Controls continuously sense the power factor on circuits being corrected and, when the power factor differs from the target setting for more than 10 seconds, operate a contractor to switch a capacitor bank into or out of the circuit. Contactors are opened or closed as required to bring the corrected circuit power factor closer to the target setting. Provide number of switching steps indicated on the Three-Phase Capacitor-Bank Schedule.

3. Current Transformer: Type, configuration, and ratio to suit sensing and mounting conditions.
4. Main Circuit Breaker: Thermal-magnetic, inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger. Operable from outside the enclosure to disconnect the unit.
5. Controls: Solid-state, microprocessor-based controls, including the following:
    a. Undervoltage relay that interrupts capacitor switching and disconnects capacitors for power-supply interruptions longer than 15 minutes.
    b. "Advance" and "Retard" push buttons on the control panel to permit manually controlled capacitor-bank switching.
6. Contactors: Three pole; rated for the repetitive high-inrush-switching duty in the capacitor application.
7. Fuses for Protection of Capacitor Banks: Rated to protect contactor, interconnecting wiring, and capacitors.
    a. Spare-Fuse Cabinet: Identified and compartmented steel box **OR** cabinet with hinged lockable door, **as directed**.
8. Discharge Resistors: Factory installed and wired.
   OR
   Inductors: Air-core type, connected in capacitor circuits; rated to limit switching surges to within contactor ratings.
9. Precharge Capacitor Circuit: Resistive, precharge circuit to charge capacitors prior to switching and to limit switching surges to within contactor ratings.
10. Enclosure: NEMA 250, Type 1 **OR** Type 3R **OR** Type 12, **as directed**, steel or aluminum, with hinged door and hand-operated catch. Door shall be interlocked with controls or main circuit breaker to de-energize capacitors when door is opened.
    a. Factory Finish: Manufacturer's standard enamel over corrosion-resistant treatment or primer coat.
11. Local Display: LED or liquid-crystal digital type, mounted in door of enclosure, indicating the following:
    a. Target and actual power factors accurate to plus or minus 1 percent of reading.
    b. Steps energized.
    c. Step reconnection delay.
    d. Real and reactive currents.
    e. Voltage total harmonic distortion.
    f. Alarm codes.
12. System Alarms: Alarm relay and local display indication of the following conditions:
    a. Low power factor.
    b. Leading power factor.
    c. Frequency not detected.
    d. Overcurrent.
    e. Overvoltage.
    f. Overtemperature.
    g. Excessive voltage total harmonic distortion.
    h. Capacitor overload.
    i. Loss of capacitance.
13. Remote Monitoring Components: Sensors, associated communication modules, and network interface units, matched to and compatible with electrical power monitoring and control network. Communication module shall have capability to transmit the following data to remote monitoring devices:
    a. System in alarm.
    b. Power factor set point.
    c. Corrected power factor.
    d. Number of capacitor steps activated.

D. Source Quality Control

1. Factory test power factor correction equipment before shipment. Comply with NEMA CP 1. Include the following:
   a. Routine capacitor production tests, including short-time overvoltage, capacitance, leak, and dissipation-factor tests.
   b. Functional test of all operations, controls, indicators, sensors, and protective devices.

1.3 EXECUTION

A. Installation
   1. Install freestanding equipment on concrete bases. Cast-in-place concrete is specified in Division 3.
   2. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
   3. Maintain minimum workspace according to manufacturer's written instructions.
   4. Connect remote monitoring communication module to electrical power monitoring and control data network through appropriate network interface unit.
   5. Identify components according to Division 26 Section "Identification For Electrical Systems".

B. Field Quality Control
   1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
   2. Perform tests and inspections.
   3. Tests and Inspections: Perform each visual and mechanical inspection and electrical test stated in the following Sections, except optional tests, in NETA Acceptance Testing Specification. Certify compliance with test parameters.
      a. Current Transformers.
      b. Capacitors and Reactors, Capacitors.

C. Startup Service
   1. Perform startup service.
      a. Complete installation and startup checks according to manufacturer's written instructions.
      b. Connect and run installed motors and equipment to verify the automatic switching of the capacitors. Verification shall include automatic switching of the total capacity of installed capacitors.
         1) Provide sufficient inductive/reactive load banks, in combination with resistive load banks, for the test.

D. Demonstration
   1. Train Owner's maintenance personnel to adjust, operate, and maintain automatic power factor correction units.

END OF SECTION 26 35 33 16

Task	Specification	Specification Description
26 35 33 16	26 09 23 00b	Electrical Power Monitoring And Control
26 35 53 00	26 32 13 13	Packaged Engine Generators

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SECTION 26 36 13 00 - TRANSFER SWITCHES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for transfer switches. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes transfer switches rated 600 V and less, including the following:
a. Automatic transfer switches.
b. Bypass/isolation switches.
c. Nonautomatic transfer switches.
d. Remote annunciation systems.
e. Remote annunciation and control systems.

C. Submittals
1. Product Data: Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.
2. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
3. Manufacturer Seismic Qualification Certification: Submit certification that transfer switches accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems". Include the following:
4. Field quality-control test reports.
5. Operation and maintenance data.

D. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. Comply with NEMA ICS 1.
3. Comply with NFPA 70.
4. Comply with NFPA 99.
5. Comply with NFPA 110.
6. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.2 PRODUCTS

A. General Transfer-Switch Product Requirements
1. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
2. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
a. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
3. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

4. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
5. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
6. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
   a. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
   b. Switch Action: Double throw; mechanically held in both directions.
   c. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.
7. Neutral Switching. Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles **OR** overlapping neutral contacts, **as directed**.
8. Neutral Terminal: Solid and fully rated, unless otherwise indicated.
9. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.
10. Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.
11. Battery Charger: For generator starting batteries.
   a. Float type rated 2 **OR** 10, **as directed,** A.
   b. Ammeter to display charging current.
   c. Fused ac inputs and dc outputs.
12. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.
13. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Identification For Electrical Systems".
   a. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
   b. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
   c. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
14. Enclosures: General-purpose NEMA 250, Type 1 **OR** 3R **OR** 12, **as directed**, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

B. Automatic Transfer Switches
1. Comply with Level 1 equipment according to NFPA 110.
2. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
3. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.
4. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.
5. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.
6. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.
7. Transfer Switches Based on Molded-Case-Switch Components: Comply with NEMA AB 1, UL 489, and UL 869A.
8. Automatic Closed-Transition Transfer Switches: Include the following functions and characteristics:

a. Fully automatic make-before-break operation.
b. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.
c. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.
   1) Initiation occurs without active control of generator.
   2) Controls ensure that closed-transition load transfer closure occurs only when the 2 sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.
d. Failure of power source serving load initiates automatic break-before-make transfer.

9. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
10. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit inrush and seal currents are rated for actual currents to be encountered.
11. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.
12. Automatic Transfer-Switch Features:
    a. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
    b. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
    c. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
    d. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
    e. Test Switch: Simulate normal-source failure.
    f. Switch-Position Pilot Lights: Indicate source to which load is connected.
    g. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
       1) Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
       2) Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
    h. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
    i. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.

j. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
k. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
l. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
m. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
    1) Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    2) Push-button programming control with digital display of settings.
    3) Integral battery operation of time switch when normal control power is not available.

C. Bypass/Isolation Switches
1. Comply with requirements for Level 1 equipment according to NFPA 110.
2. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:
    a. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. While isolated, interlocks prevent transfer-switch operation, except for testing or maintenance.
    b. Drawout Arrangement for Transfer Switch: Provide physical separation from live parts and accessibility for testing and maintenance operations.
    c. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.
    d. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.
    e. Operability: Constructed so load bypass and transfer-switch isolation can be performed by 1 person in no more than 2 operations in 15 seconds or less.
    f. Legend: Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.
    g. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.
3. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed copper bus bars; plated at connection points and braced for the indicated available short-circuit current.

D. Nonautomatic Transfer Switches
1. Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternate Source." Switch shall be capable of transferring load in either direction with either or both sources energized.
2. Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternate Source." In addition, removable manual handle provides quick-make, quick-break manual-switching action. Switch shall be capable of electrically or manually transferring load in either direction with either or both sources energized. Control circuit disconnects from electrical operator during manual operation.
3. Double-Throw Switching Arrangement: Incapable of pauses or intermediate position stops during switching sequence.

4. Nonautomatic Transfer-Switch Accessories:
    a. Pilot Lights: Indicate source to which load is connected.
    b. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and alternate-source sensing circuits.
        1) Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
        2) Emergency Power Supervision: Red light with nameplate engraved "Alternate Source Available."
    c. Unassigned Auxiliary Contacts: One set of normally closed contacts for each switch position, rated 10 A at 240-V ac.

E. Remote Annunciator System
1. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches. Annunciation shall include the following:
    a. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
    b. Switch position.
    c. Switch in test mode.
    d. Failure of communication link.
2. Annunciator Panel: LED-lamp type with audible signal and silencing switch.
    a. Indicating Lights: Grouped for each transfer switch monitored.
    b. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
    c. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
    d. Lamp Test: Push-to-test or lamp-test switch on front panel.

F. Remote Annunciator And Control System
1. Functional Description: Include the following functions for indicated transfer switches:
    a. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
    b. Indication of switch position.
    c. Indication of switch in test mode.
    d. Indication of failure of digital communication link.
    e. Key-switch or user-code access to control functions of panel.
    f. Control of switch-test initiation.
    g. Control of switch operation in either direction.
    h. Control of time-delay bypass for transfer to normal source.
2. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically reverts to stand-alone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.
3. Remote Annunciation and Control Panel: Solid-state components. Include the following features:
    a. Controls and indicating lights grouped together for each transfer switch.
    b. Label each indicating light control group. Indicate transfer switch it controls, location of switch, and load it serves.
    c. Digital Communication Capability: Matched to that of transfer switches supervised.
    d. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.

G. Source Quality Control
1. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

1.3 EXECUTION

A. Installation
1. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Division 26 Section "Hangers And Supports For Electrical Systems".
2. Floor-Mounting Switch: Anchor to floor by bolting.
   a. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 4 inches (100 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Division 26 Section "Hangers And Supports For Electrical Systems".
3. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.
4. Identify components according to Division 26 Section "Identification For Electrical Systems".
5. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

B. Connections
1. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to the Owner if necessary to accommodate required wiring.
2. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
3. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Field Quality Control
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
2. Perform tests and inspections and prepare test reports.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
   b. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
   c. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   d. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
      1) Check for electrical continuity of circuits and for short circuits.
      2) Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
      3) Verify that manual transfer warnings are properly placed.
      4) Perform manual transfer operation.
   e. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
      1) Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
      2) Simulate loss of phase-to-ground voltage for each phase of normal source.
      3) Verify time-delay settings.
      4) Verify pickup and dropout voltages by data readout or inspection of control settings.
      5) Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.

6) Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

f. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

1) Verify grounding connections and locations and ratings of sensors.

3. Coordinate tests with tests of generator and run them concurrently.
4. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
5. Remove and replace malfunctioning units and retest as specified above.
6. Infrared Scanning: After Final Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
   a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Final Completion.
   b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   c. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

D. Demonstration

1. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below.
2. Coordinate this training with that for generator equipment.

END OF SECTION 26 36 13 00

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Task	Specification	Specification Description
26 36 13 00	26 24 13 00a	Enclosed Switches And Circuit Breakers
26 36 23 00	26 24 13 00a	Enclosed Switches And Circuit Breakers
26 36 23 00	26 36 13 00	Transfer Switches

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SECTION 26 43 13 00 - TRANSIENT VOLTAGE SUPPRESSION

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for transient voltage suppression. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section includes field-mounted TVSS for low-voltage (120 to 600 V) power distribution and control equipment.

C. Definitions
   1. ATS: Acceptance Testing Specifications.
   2. SVR: Suppressed voltage rating.
   3. TVSS: Transient voltage surge suppressor(s), both singular and plural; also, transient voltage surge suppression.

D. Submittals
   1. Product Data: For each type of product indicated. Include rated capacities, operating weights, electrical characteristics, furnished specialties, and accessories.
   2. Field quality-control reports.
   3. Operation and maintenance data.
   4. Warranties: Sample of special warranties.

E. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended location and application.
   2. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.
   3. Comply with NEMA LS 1.
   4. Comply with UL 1283, **as directed**, and UL 1449.
   5. Comply with NFPA 70.

F. Project Conditions
   1. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
      a. Notify Owner no fewer than two days in advance of proposed electrical service interruptions.
      b. Do not proceed with interruption of electrical service without Owner's written permission.
   2. Service Conditions: Rate TVSS devices for continuous operation under the following conditions unless otherwise indicated:
      a. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
      b. Operating Temperature: 30 to 120 deg F (0 to 50 deg C).
      c. Humidity: 0 to 85 percent, noncondensing.
      d. Altitude: Less than 20,000 feet (6090 m) above sea level.

G. Warranty
   1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within Five years from date of Final Completion.

2. Special Warranty for Cord-Connected, Plug-in Surge Suppressors: Manufacturer's standard form in which manufacturer agrees to repair or replace electronic equipment connected to circuits protected by surge suppressors.

1.2 PRODUCTS

A. Service Entrance Suppressors
1. Surge Protection Devices:
a. Non-modular.
b. LED indicator lights for power and protection status.
c. Audible alarm, with silencing switch, to indicate when protection has failed.
d. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.

OR

Surge Protection Devices:
e. Comply with UL 1449.
f. Modular design (with field-replaceable modules) **OR** Non-modular design, **as directed**.
g. Fuses, rated at 200-kA interrupting capacity.
h. Fabrication using bolted compression lugs for internal wiring.
i. Integral disconnect switch (if a fused switch or circuit breaker is not provided for the TVSS in the panelboard and the TVSS will not have a direct bus bar connection).
j. Redundant suppression circuits.
k. Redundant replaceable modules.
l. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
OR
Arrangement with wire connections to phase buses, neutral bus, and ground bus.
m. LED indicator lights for power and protection status.
n. Audible alarm, with silencing switch, to indicate when protection has failed.
o. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
p. Four **OR** Six, **as directed**,-digit transient-event counter set to totalize transient surges.
2. Peak Single-Impulse Surge Current Rating: 320 kA per mode/640 kA **OR** 240 kA per mode/480 kA **OR** 160 kA per mode/320 kA, **as directed**, per phase.
3. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2
a. Line to Neutral: 70,000 A.
b. Line to Ground: 70,000 A.
c. Neutral to Ground: 50,000 A.
4. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 V **OR** 208Y/120 V **OR** 600Y/347 V, **as directed**, 3-phase, 4-wire circuits shall be as follows:
a. Line to Neutral: 800 V for 480Y/277 V **OR** 400 V for 208Y/120 V **OR** 1200 V for 600Y/347 V, **as directed**.
b. Line to Ground: 800 V for 480Y/277 V **OR** 400 V for 208Y/120 V **OR** 1200 V for 600Y/347 V, **as directed**.
c. Neutral to Ground: 800 V for 480Y/277 V **OR** 400 V for 208Y/120 V **OR** 1200 V for 600Y/347 V, **as directed**.

OR

Protection modes and UL 1449 SVR for 240/120 V, single-phase, 3-wire circuits shall be as follows:

a. Line to Neutral: 400 V.
b. Line to Ground: 400 V.
c. Neutral to Ground: 400 V.

OR

Protection modes and UL 1449 SVR for 240/120-V, 3-phase, 4-wire circuits with high leg shall be as follows:

a. Line to Neutral: 400 V, 800 V from high leg.
b. Line to Ground: 400 V.
c. Neutral to Ground: 400 V.

OR

Protection modes and UL 1449 SVR for 240 V, 480 V, or 600 V, 3-phase, 3-wire, delta circuits shall be as follows:

a. Line to Line: 2000 V for 480 V **OR** 1000 V for 240 V **OR** 2500 V for 600 V, **as directed**.
b. Line to Ground: 2000 V for 480 V **OR** 1000 V for 240 V **OR** 2500 V for 600 V, **as directed**.

B. Panelboard Suppressors
1. Surge Protection Devices:
a. Non-modular.
b. LED indicator lights for power and protection status.
c. Audible alarm, with silencing switch, to indicate when protection has failed.
d. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.

OR

Surge Protection Devices:

a. Comply with UL 1449.
b. Modular design (with field-replaceable modules) **OR** Non-modular design, **as directed**.
c. Short-circuit current rating complying with UL 1449, and matching or exceeding the panelboard short-circuit rating and redundant suppression circuits; with individually fused metal-oxide varistors.
d. Fuses, rated at 200-kA interrupting capacity.
e. Fabrication using bolted compression lugs for internal wiring.
f. Integral disconnect switch (if a fused switch or circuit breaker is not provided for the TVSS in the panelboard and the TVSS will not have a direct bus bar connection).
g. Redundant suppression circuits.
h. Redundant replaceable modules.
i. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
j. LED indicator lights for power and protection status.
k. Audible alarm, with silencing switch, to indicate when protection has failed.
l. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
m. Four **OR** Six, **as directed**,-digit transient-event counter set to totalize transient surges.

2. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA **OR** 120 kA per mode/240 kA **OR** 80 kA per mode/160 kA, **as directed**, per phase.
3. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2:
a. Line to Neutral: 70,000 A.
b. Line to Ground: 70,000 A.
c. Neutral to Ground: 50,000 A.
4. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 V **OR** 208Y/120 V **OR** 600Y/347 V, **as directed**, 3-phase, 4-wire circuits shall be as follows:
a. Line to Neutral: 800 V for 480Y/277 V **OR** 400 V for 208Y/120 V **OR** 1200 V for 600Y/347 V, **as directed**.

b. Line to Ground: 800 V for 480Y/277 V **OR** 400 V for 208Y/120 V **OR** 1200 V for 600Y/347 V, **as directed**.
c. Neutral to Ground: 800 V for 480Y/277 V **OR** 400 V for 208Y/120 V **OR** 1200 V for 600Y/347 V, **as directed**.

OR

Protection modes and UL 1449 SVR for 240/120-V, single-phase, 3-wire circuits shall be as follows:

a. Line to Neutral: 400 V.
b. Line to Ground: 400 V.
c. Neutral to Ground: 400 V.

OR

Protection modes and UL 1449 SVR for 240/120-V, 3-phase, 4-wire circuits with high leg shall be as follows:

a. Line to Neutral: 400 V, 800 V from high leg.
b. Line to Ground: 400 V.
c. Neutral to Ground: 400 V.

OR

Protection modes and UL 1449 SVR for 240 V, 480 V, or 600 V, 3-phase, 3-wire, delta circuits shall be as follows:

a. Line to Line: 2000 V for 480 V **OR** 1000 V for 240 V **OR** 2500 V for 600 V, **as directed**.
b. Line to Ground: 1500 V for 480 V **OR** 800 V for 240 V **OR** 2500 V for 600 V, **as directed**.

C. Enclosures

1. Indoor Enclosures: NEMA 250 Type 1 **OR** Type 12, **as directed**.
2. Outdoor Enclosures: NEMA 250 Type 3R **OR** Type 4 **OR** Type 4X, **as directed**.

1.3 EXECUTION

A. Installation

1. Install TVSS devices at service entrance on load side, with ground lead bonded to service entrance ground.
2. Install TVSS devices for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
   a. Provide multiple, 30 **OR** 60 **OR** 100, **as directed**,-A circuit breaker as a dedicated disconnecting means for TVSS unless otherwise indicated.

B. Field Quality Control

1. Perform tests and inspections.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Tests and Inspections:
   a. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
   b. After installing TVSS devices but before electrical circuitry has been energized, test for compliance with requirements.
   c. Complete startup checks according to manufacturer's written instructions.
3. TVSS device will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

C. Startup Service

a. Do not energize or connect service entrance equipment **OR** panelboards **OR** control terminals **OR** data terminals, **as directed**, to their sources until TVSS devices are installed and connected.

b. Do not perform insulation resistance tests of the distribution wiring equipment with the TVSS installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.

D. Demonstration

a. Train Owner's maintenance personnel to maintain TVSS devices.

END OF SECTION 26 43 13 00

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Task	Specification	Specification Description
26 51 13 00	02 84 16 00a	Interior Lighting
26 51 16 00	02 84 16 00a	Interior Lighting
26 51 19 00	02 84 16 00a	Interior Lighting
26 51 23 00	02 84 16 00a	Interior Lighting
26 51 33 00	02 84 16 00	Removal of Fluorescent Light Ballasts/Capacitors and Fluorescent Light Tubes
26 51 33 00	02 84 16 00a	Interior Lighting
26 51 33 00	02 84 16 00b	Exterior Lighting
26 52 13 16	02 84 16 00a	Interior Lighting
26 55 13 00	01 22 16 00	No Specification Required
26 55 13 00	02 84 16 00b	Exterior Lighting
26 55 16 00	02 84 16 00a	Interior Lighting
26 55 16 00	02 84 16 00b	Exterior Lighting
26 55 29 00	02 84 16 00b	Exterior Lighting
26 55 53 11	02 84 16 00b	Exterior Lighting

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SECTION 26 55 61 00 - STAGE LIGHTING

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for stage lighting. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Dimmer racks.
   b. Control console and control devices.
   c. Lighting fixtures and accessories.
   d. Distribution components.

C. Performance Requirements

1. Seismic Performance: Dimmer racks shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event," **as directed**.

D. Submittals

1. Product Data: For each type of product indicated.
2. Seismic Qualification Certificates: For <**Insert equipment,**> accessories, and components, from manufacturer.
3. Field quality-control reports.
4. Operation and maintenance data.
5. Software and Firmware Operational Documentation.

E. Quality Assurance

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NECA 1.
3. Comply with NFPA 70.

F. Software Service Agreement (if allowed)

1. Technical Support: Beginning with Final Completion, provide software support for two years.
2. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Final Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
   a. Provide 30 days' notice to the Owner to allow scheduling and access to system and to allow the Owner to upgrade computer equipment if necessary.

1.2 PRODUCTS

A. Plug Connectors

1. Pin Type: USITT S3, two-pole, three-wire, 20-A.
2. Twist-Locking Type: NEMA WD 6, two-pole, three-wire, 20-A.

B. Lighting Fixtures And Accessories
1. General:
    a. Comply with UL 1573 and listed and labeled by an NRTL.
    b. Fixtures: Equipped with pigtail, yoke with pipe clamp, safety cable for batten mounting, and filter holder.
    c. Metal Parts: Free of burrs, sharp corners, and edges.
    d. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
    e. Fixture Doors and Their Internal Access: Smooth operating, free of light leakage under operating conditions, and arranged to permit relamping without use of tools. Doors, lenses, diffusers, and other pieces arranged to prevent accidental falling during relamping and when secured in operating position.
    f. Pigtail: Factory wired, 36-inch- (900-mm-) long, three-wire cord and plug connector assembly with cord encased in woven fiberglass or silicone tubing.
    g. Lamp Sockets: Relampable without disturbing alignment or focus adjustment.
    h. Fixture Ventilation Openings: Baffled against light leaks.
    i. Fixture Operating Controls and Handles: Thermally insulated.
    j. Lenses: Borosilicate glass in silicone mountings.
    k. Framing Shutters: Stainless steel, four way; with each blade in a separate plane under adjustable tension mounting. Blades adjust plus or minus 30 degrees of rotation in gate, for 120-degree-minimum total angular rotation between adjacent blades.
    l. Color Filter Frame Holder: Attached to front of fixture.
    m. Fixture Yoke: Rigid metal, arranged for vertical aiming of unit and equipped with T-bolt or hand screw to lock alignment.
2. Ellipsoidal Spotlights: Fixtures with an elliptical reflector mounted in a fixed relationship to the lamp. Light shall be projected through a gate where the beam is shaped by using shutters, a gobo, or an iris. The shaped beam shall then be focused by a system of lenses.
    a. Tag: ES-1:
        1) Lamp: 1000 W Q1000/4CL, ANSI FEL.
        2) Pattern Holders: Three for each fixture, with framing shutters.
        3) Color Frame: Black, metal.
        4) Minimum Cosine Illumination Performance Ratings When Operated with ANSI C78 Series, FEL Lamp:
            a) 171,000 beam candlepower at 20-degree field angle.
            b) 48,000 beam candlepower at 40-degree field angle.
3. Zoom Ellipsoidal Spotlights: Fixtures with an elliptical reflector mounted in an adjustable relationship to the lamp. Light shall be projected through a gate where the beam is shaped by using shutters, a gobo, or an iris. The shaped beam shall then be focused by a system of lenses.
    a. Tag: ZES-1:
        1) Lamp: 1000 W Q1000/4CL, ANSI FEL.
        2) Pattern Holders: Three for each fixture, with framing shutters.
        3) Operator adjustable from 25- to 50-degree field angle.
        4) Field-angle adjustment scale label on instrument housing for field reference.
        5) Minimum Cosine Illumination Performance Rating When Operated with ANSI C78 Series, FEL Lamp: 82,000 beam candlepower at 35-degree field angle.
4. Fresnel Lens Spotlights:
    a. Die-cast extruded-aluminum housing, with hinged front for relamping.
    b. Tag: FLS-1.
        1) Lamp: 1000 W Q1000T7/4CL, ANSI EGT.
        2) Lens: 6 inches (152 mm).
        3) Illumination Performance Rating When Operated with ANSI C78 Series, EGT Lamp:
            a) 175,000 beam candlepower at 12.5-degree field angle in spot focus.
            b) 12,000 beam candlepower at 74.6-degree field angle in flood focus.
        4) Barn Doors: Two 4-leaf rotatable metal flaps for every three fixtures.
5. Follow Spotlights:

a. Tag: FS-1:
   1) Lamp: Metal halide, G22 medium bi-post, CRI: 90, color: 6000 K, life: 750 hours, HMI 575 W/GS 95 V.
   2) Adjustable lenses in metal housing.
   3) Lamp: Quartz-projector type, Adjustable, underslung base stand mounted on 3-inch (75-mm), locking-type, rubber-tired, ball-bearing casters.
   4) Adjustable lamp holder and socket assembly with precision tuning adjustment; relampable without tools.
   5) Three-leaf, full-range mechanical dimmer.
   6) Adjustable iris and framing shutters.
   7) Automatic color boom.
   8) Removable power cable, 25 feet (8 m) long.
   9) Iris Open, Spot-Focus Performance: 800,000, **as directed**, beam candlepower at 7.2, **as directed**,-degree field angle.
   10) Iris Open, Flood-Focus Performance: 330,000, **as directed**, beam candlepower at 12.2, **as directed**,-degree field angle.

6. PAR Lamp Holders:
   a. Tag: PLH-1:
      1) Lamp: 300 W PAR 38.
      2) Housing: Steel or aluminum, flat black color, **as directed**, with porcelain-plated shell socket.
      3) Barn Doors: Two 4-leaf rotatable metal flaps for every three fixtures.
   b. Tag: <**Insert drawing designation**>.
      1) Lamp: 575 W tungsten halogen, 90 GLA 575 W, 230 V, color: 3200 K, ANSI GKV.
      2) Housing: Steel or aluminum, with porcelain-plated shell socket and color frame, **as directed**.
      3) Barn Doors: Two 4-leaf rotatable metal flaps for every three fixtures.
      4) With Lens Holder and Replaceable Lenses:
         a) <Insert drawing designation>: Very narrow spot.
         b) <Insert drawing designation>: Narrow spot.
         c) <Insert drawing designation>: Medium flood.
         d) <Insert drawing designation>: Wide flood.
         e) <Insert drawing designation>: Very wide.
      5) Motorized **OR** Manual, **as directed**, color wheel.

7. Borderlight Units: Compartmented, three-circuit striplight with nine 150-W, PAR 38/SP **OR** 150-W, PAR 38/FL **OR** 250-W, PAR 38/SP **OR** 150-W, R40/FL, **as directed**, lamps in porcelain sockets and steel sheet housing, 90 inches (2286 mm) long. Compartments shall be in line and wired on two **OR** three **OR** four, **as directed**, alternate circuits, each producing a different color.
   a. Front Door: Spring loaded; designed to hold either filter frames or color roundels.
   b. Color Roundels: One for each lamp; alternating red, blue, and clear, **as directed**.
      1) Additional Roundels: <**Insert number**> amber and <**Insert number**> green.
   c. Hanger: Adjustable, steel-strap type equipped at each end with pipe clamp and safety cable for suspension from a batten.

8. Cyclorama Lights: Suitable for lighting cycloramas from above.
   a. Tag: CL-1:
      1) Lamp: 1000 W Q1000T3/1CL, ANSI FFT.
      2) Housing: Aluminum or steel, **as directed**, flat black color, **as directed**, with color frame, **as directed**.

9. Black Lights: Portable, producing a wash of UV light for special effects.
   a. Tag: BL-1:
      1) Lamp: 250 W blacklight flood, H37KB-250, with integral filter to eliminate far-UV effect while maximizing the near-UV effect.
      2) Housing: Steel or aluminum, **as directed**, flat black color, **as directed**, with carry handle.
      3) C-clamp for using on light pipe.

10. Moving Lights:

a. Tag: ML-1:
   1) General: 700-W, 120-V, metal halide, motorized remote-controlled lighting instrument; NRTL listed.
   2) Lamp: Short-arc metal halide, 14,500 lumens; color temperature of 5600 K, CRI of 80.
   3) Color System: Three-filter CYM (cyan, yellow, magenta) cross-fading mechanism, and 11 standard colors on a fixed wheel.
   4) Optics: Zoom optics with continuously variable field angle from 18.5 to 42 degrees, programmable over a timed range of 2 seconds to 20 minutes; with a mechanical iris for beam-size control. Variable beam focus to soften the edges of gobos and light beams. Zoom combined with iris can project a beam with a field angle of 8 degrees.
   5) Dimming: Coated glass dimmer wheel, with controls to provide smooth timed fades.
   6) Strobe for strobe lighting effects.
   7) Gobo: One rotating wheel with five rotatable wheel positions and one open position. One fixed gobo wheel with 11 pattern positions and one open position.
   8) Beam Orientation Control: Smooth pan and tilt using a three-phase stepper motor system. Pan, 540 degrees; tilt, 270 degrees at 0.3-degree repeatability on either axis.
   9) Control: ANSI E1.11 (USITT DMX512-A) protocol using five pin connectors.

C. Distribution Components
1. Connector Strip: Listed and labeled by an NRTL; factory-wired wireway and receptacle assembly.
   a. Wireway: Steel or extruded aluminum, with removable cover and nominal cross-section dimensions of 3 by 4-1/2 inches (75 by 115 mm).
   b. Accessories: Cable clamps, support cradles, and cable strain relief grips for each cable.
   c. Receptacles: Pigtail mounted, 18 inches (450 mm) long, with strain relief at wireway wall penetration.
      OR
      Receptacles: Flush mounted in wireway cover.
   d. Receptacle Wiring: For connecting to terminal blocks; with 125 deg C, crosslinked, PE-insulated, identification-labeled wire.
   e. Terminal Blocks: Molded-barrier type with screw lugs to suit supply conductors.
   f. Mounting Hardware: Furnished with each unit; permits surface, single-pipe-bracket, or double-pipe-bracket mounting.
   g. Finish: Semigloss or matte black.
2. Plug-in Boxes: Listed and labeled by an NRTL; factory-wired wireway and receptacle assembly, 24 inches (600 mm) long unless otherwise indicated; with the following features:
   a. Wireway: Steel or extruded aluminum, with removable cover and nominal cross-section dimensions of 3 by 4-1/2 inches (75 by 115 mm).
   b. Accessories: Cable clamps, support cradles, and cable strain relief grips for each cable.
   c. Receptacles: Pigtail mounted, 18 inches (450 mm) long, with strain relief at wireway wall penetration.
      OR
      Receptacles: Flush mounted in wireway cover.
   d. Receptacle Wiring: For connecting to terminal blocks; with 125 deg C, crosslinked, PE-insulated, identification-labeled wire.
   e. Terminal Blocks: Molded-barrier type with screw lugs to suit supply conductors.
   f. Surface or Grid Mounting: With accessories for surface mounting or with pipe-mounting accessory bracket.
   g. Recessed Mounting: With flanged cover suitable for recessed mounting in wall.
   h. Finish: Semigloss or matte black.
3. Gridiron Junction Boxes: Listed and labeled by an NRTL; factory wired with terminal strips and concentric knockouts on all sides.
   a. Terminal Blocks: Molded-barrier type with screw lugs to suit supply conductors.

b. Accessories: Cable clamps, support cradles, and cable strain relief grips for each cable, and brackets for surface or pipe mounting.
c. Finish: Semigloss or matte black.
4. Floor Pockets: Listed and labeled by an NRTL; flush-mounted, receptacle outlet assembly.
a. Box: 0.0598-inch (1.5-mm) steel sheet, 10 inches (250 mm) deep.
b. Cover Plate: Steel, cast iron, or cast aluminum with nonskid safety tread surface and self-closing, hinged door with cable notches.
c. Barrier for allowing installation of low-voltage control receptacle for console input or handheld remotes.

D. Wire And Cable
1. Building Wire in Raceways: Comply with requirements specified in Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
2. Portable Power Cable: Listed and labeled by an NRTL; flexible stage and lighting power cable; Type SC, SCE, or SCT; 600 V; multiconductor; 60 deg C temperature rating.
3. Ethernet Cabling: Comply with requirements specified in Division 26 Section "Control-voltage Electrical Power Cables".
a. For 10/100BaseT, comply with provisions for UTP cable and hardware.
b. For 10Base-FL, comply with provisions for 50/125 **OR** 62.5/125, **as directed**,-micrometer, multimode, optical-fiber cable and hardware.
4. ANSI E1.11 (USITT DMX512-A) Control Cabling: Comply with requirements specified in Division 26 Section "Control-voltage Electrical Power Cables".
a. Standard Cable: NFPA 70, Type CM **OR** Type CMG, **as directed**.
1) Paired, low-capacitance computer cable for ANSI E1.11 (USITT DMX512-A) applications. Two pairs, twisted, No. 22 AWG **OR** No. 24 AWG, **as directed**, stranded, tinned-copper conductors.
2) PE insulation.
3) Inner Shield: 100 percent coverage, aluminum foil-polyester tape.
4) Outer Shield: 90 percent coverage, tinned-copper braid.
5) Outer Shield Drain Wire: Stranded, tinned copper.
6) PVC jacket.
7) Flame Resistance: Comply with UL 1581.
b. Plenum-Rated Cable: NFPA 70, Type CMP.
1) Paired, low-capacitance computer cable for ANSI E1.11 (USITT DMX512-A) applications. Two pairs, twisted, No. 22 AWG **OR** No. 24 AWG, **as directed**, stranded, tinned-copper conductors.
2) Insulation: Foam fluoridated ethylene propylene.
3) Inner Shield: 100 percent coverage, aluminum foil-polyester tape.
4) Outer Shield: 90 percent coverage, tinned-copper braid.
5) Outer Shield Drain Wire: Stranded, tinned copper.
6) Low-smoke PVC jacket.
7) Flame Resistance: Comply with NFPA 262.
5. Low-Voltage Control Cabling:
a. Control-Cable Conductors:
1) Class 1 Control Circuits: Stranded copper, Type THHN-THWN, in raceway; complying with UL 83.
OR
Class 1 Control Circuits: Stranded copper, Type THHN, in raceway; complying with UL 44.
2) Class 2 Control Circuits: Stranded copper, Type THHN-THWN, in raceway **OR** power-limited cable, concealed in building finishes **OR** power-limited tray cable, in cable tray, **as directed**; complying with UL 83.
OR
Class 2 Control Circuits: Stranded copper, Type THHN, in raceway **OR** power-limited cable, concealed in building finishes **OR** power-limited tray cable, in cable tray, **as directed**; complying with UL 44.

3) Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or Type TF; complying with UL 83.

b. Paired Cable: NFPA 70, Type CMG.
   1) One pair, twisted, No. 16 AWG, stranded, tinned-copper conductors.
   2) PVC insulation.
   3) Unshielded.
   4) PVC jacket.
   5) Flame Resistance: Comply with UL 1581.
c. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
   1) One pair, twisted, No. 16 AWG, stranded (19x29), tinned-copper conductors.
   2) PVC insulation.
   3) Unshielded.
   4) PVC jacket.
   5) Flame Resistance: Comply with NFPA 262.
d. Paired Cable: NFPA 70, Type CMG.
   1) One pair, twisted, No. 18 AWG, stranded (19x30), tinned-copper conductors.
   2) PVC insulation.
   3) Unshielded.
   4) PVC jacket.
   5) Flame Resistance: Comply with UL 1581.
e. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
   1) One pair, twisted, No. 18 AWG, stranded (19x30), tinned-copper conductors.
   2) Fluorinated ethylene propylene insulation.
   3) Unshielded.
   4) Plastic jacket.
   5) Flame Resistance: Comply with NFPA 262.

E. Lighting Control System

1. Description: Microprocessor-based modular system consisting of dimmer and control modules operated from remote-control stations and a control console.
   a. Comply with UL 508.
   b. Comply with USITT AMX192 **OR** ANSI E1.11 (USITT DMX512-A), **as directed**, for data transmission.
2. Dimmer Racks: Listed and labeled by an NRTL; dead-front, front-access, wall-mounted **OR** freestanding, **as directed**, rack for mounting modular dimmers; formed-steel or extruded-aluminum structural members; completely enclosed with steel or aluminum panels. Painted with manufacturer's standard corrosion-resistant primer and finish coats, and having the following features:
   a. Primary Circuit Breaker: Fault-current withstand rating of the rack; not less than 10,000 **OR** 50,000, **as directed**, A, symmetrical.
   b. Hinged, locking front door, with openings to allow air intake across the face of all dimmer modules.
   c. Individual rack sections shall not exceed 84 inches high by 25 inches deep by 30 inches wide (2134 mm high by 635 mm deep by 762 mm wide). Multisection racks shall be interconnected with busbars.
   d. For each module position, provide support rails and control-pin configurations, constructed for precise alignment of dimmer modules into power and signal connector sockets.
   e. Forced-air cooling of each rack for maintaining operating temperature at each dimmer, assuming full load, in ambient temperature not to exceed 40 deg C. Exhaust rates shall be variable, using temperature sensors and fan-speed control electronics. Individual control of multiple fans is acceptable in lieu of fan-speed control. Fan(s) shall start and stop automatically. Fan noise at full load shall be less than 3.1 sones.
   f. Each rack shall have an automatic air-temperature sensor to shut off all dimmers in the rack should the internal temperature rise above maximum safe operating limits. In an

overheat condition, the fan shall continue operating. When a safe operating temperature is restored, the system shall automatically reset to allow normal user control.

g. Fabricate and test dimmer racks to withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".

3. Dimmers: Modular solid-state units that operate smoothly over their operating ranges without audible lamp noise or radio-frequency interference at any setting. Modules shall be dead-front, draw-out type with floating line, load, and control sockets for smooth insertion and withdrawal; with load-side thermal-magnetic circuit breaker, speed-controlled cooling fan, and overtemperature sensor.
   a. Non-Dim Units: On-off relay control only. Capable of serving inductive loads such as motors or high-intensity-discharge fixtures.
   b. Surge Protection: Modules shall withstand power-line surges of 6000 V/3000 A according to IEEE C62.41.1 and IEEE C62.41.2.
   c. Filter each dimmed circuit to provide a minimum 350-mic.sec., current-rise time at a 90-degree conduction angle at 50 percent of rated dimmer capacity. At any load within rating, rate of current rise shall not exceed 30 mA/mic.sec., measured from 10 to 90 percent of load current waveform.

4. Control System: Microprocessor-based control system, ANSI E1.11 (USITT DMX512-A) protocol, with a nonvolatile system memory to adjust dimmer channel settings for different scenes, to patch dimmers to channels, and to manually or automatically change dimmer settings from one preset scene to another.
   a. Control shall support Ethernet-based LAN at every control device.
   b. Provide means to create and monitor show data on a PC using software by console manufacturer. Software shall be capable of the following:
      1) Creating show and providing for use of USITT show files.
      2) Playing back show in a console-simulation mode.
      3) Accessing all remote-control stations associated with the console and control system.
      4) Providing standard Ethernet connection between the console control system and the PC.
   c. Display the following system status information on a color, 17-inch (430-mm) LCD monitor associated with the control console:
      1) Current channel intensities.
      2) Cue information.
      3) Monitor.
   d. Moving Lights: Include a standard control library, a program patch specific to fixture(s) provided, and selective programming with ANSI E1-11 (USITT DMX512-A) addressing of fade, focus points, beam, image, color, <**Insert attributes**> and position.

5. Control Console: Tabletop unit with manual and computer-based programming controls, memory units, indicating devices, and the following features:
   a. Servicing access through hinged top panel.
   b. Grand-master level control.
   c. Blackout switch.
   d. 12 submaster level controls with overlapping pile-on performance.
      OR
      24 submaster level controls with overlapping pile-on performance.
   e. Bump buttons for momentary control of channels or submasters, one for each submaster level control.
   f. Two cross-fade controls for split dipless fade between scenes, each with its own fade progress indicator.
   g. One set of scene level controls for each scene when used in two-scene preset mode. Second set of scene level controls to allow setting levels into memory for expanded single scenes when used in multiple single-channel scene mode. Each set shall have same quantity of scene level controls as is used for submaster level controls.
   h. Multibutton keypad for programming in multiscene memory mode.

i. Fade time control for assigning fade time to cues, with individual cue adjustment from one second to five minutes, minimum.
j. Light-emitting diode **OR** LCD **OR** Computer monitor cathode-ray tube, **as directed**, with associated display controls, for displaying operating menus and memory readout.
k. Controls for setting levels into memory.
l. Cord and connector for connecting console to outlets for console power and control.

6. System Operation: Selectable between multichannel two-scene preset and four-channel single-scene memory. Console features include electronic patching of control signals for up to 512 dimmers and off-line data storage using internal, 3-1/2-inch (90-mm) disk-drive unit. Operational capability includes the following:
   a. Live and blind programming.
   b. Special effects programmability for automatic operation of lights in pulsating, sequential dimming and brightening, and other special operating modes. Special effects menu displays operator guidance for programming and individual step levels.
   c. Signal from fire-alarm control panel that automatically brings selected circuits to fully on or fully bright condition, overriding normal dimming and on-off controls.
   d. Inserting cues between designated cues without renumbering.
   e. Out-of-sequence playback of cues.
   f. Controlling houselights and stage lights from console by assigning their dimmers or non-dim on-off controls to a channel.
   g. Retaining programmed cues in memory for minimum of one year after power outage.
   h. Automatic sequential execution of programmed cues.
   i. Printing cues using parallel or serial printer port, cable, and printer. Cable and printer are not included with this system.
7. PC: Standard, unmodified, with accessories and peripherals that are configured to install and run control-console manufacturer's written requirements, but not less than the following:
   a. CPU operating speed shall be at least 1.6 GHz.
   b. Memory: 1024 MB.
   c. Serial Ports: Provide two for general use.
   d. Parallel Port: Enhanced.
   e. LAN Adapter: 10/100/1000 Mbps, internal network interface card.
   f. Three USB 2.0 ports.
   g. Sound Card: For playback and recording of digital WAV sound files that are associated with audible warning and alarm functions.
   h. Color Monitor: Not less than 17 inches (430 mm), with a minimum resolution of 1280 by 1024 pixels, noninterlaced, and a maximum dot pitch of 0.28 mm. Video card shall support at least 256 colors at a resolution of 1280 by 1024 pixels at a minimum refresh rate of 70 Hz.
   i. Keyboard: With a minimum of 64 characters; standard ASCII character set based on ANSI INCITS 154 (formerly ANSI X3.154).
   j. Mouse: Standard, compatible with installed software.
   k. Disk storage shall include the following, each with appropriate controller:
      1) Minimum 60 GB hard disk, 5400 rpm.
      2) Floppy Disk Drive: High density, 3-1/2-inch (90-mm) size.
      3) <**Insert disk drives**>.
   l. CD-ROM Drive: 24x/10x/24x CD-RW/8x DVD combination.
8. Console Power and Control Outlets: Multiple receptacles matched to connector on console connector cord.
9. House Lighting Control Station: Architectural-type, multichannel, remote-dimmer-control station with the following features:
   a. System controls designated houselights, stage lights, and other lights.
   b. Stage lighting controls compatible with dimming and control system.
   c. Flush mounting.
   d. Brushed-aluminum wall plate.
   e. Five **OR** Six, **as directed**, channels, each with slider potentiometer control.

f. Master-slider potentiometer that controls lights on all channels proportionally from completely dimmed to degree of brightness that corresponds to individual slider positions.
g. Fully on switch that turns all channels on at full brightness regardless of slider position.
h. Take-control/off switch that places station in control of channels and sets lighting to levels dictated by channel and master-slider controls.
i. Legend on face of wall plate that identifies items as "House Lighting Control Station" and identifies functions of each slider and switch position, with slider positions individually graduated from zero to 10.
j. Illuminated push buttons for activating preset scenes of house lighting and labeled "Entry" **OR** "Panic" **OR** "Entry" and "Panic," **as directed**.
k. Flush wall mounted unless otherwise indicated.

10. Entry Station: Push button activates or deactivates indicating light and presets scene of house lighting control system.
a. Light-emitting-diode indicating light illuminates when preset command is executed.
b. Labeled "Entry."
c. Flush wall mounted unless otherwise indicated.

11. Key-Entry Station: Key-operated switch controls station to activate or deactivate indicating light and presets scene of lighting control system.
a. Light-emitting-diode indicating light illuminates when preset command is executed.
b. Labeled "Entry."
c. Flush wall mounted unless otherwise indicated.

12. Emergency Lighting Control Station: Key-operated, **as directed**, push button activates indicating light and brings selected dimmers to fully bright condition, i.e., the "Panic" preset. Operating push button a second time returns dimmers to previous setting.
a. Emergency mode indicating light.
b. Labeled "Emergency Lights."
c. Flush wall mounted unless otherwise indicated.

F. Rigging Components
1. Pipe Clamps: Malleable iron, suitable for clamping fixtures or items to pipe from 3/4 to 2 inches (20 to 51 mm) in OD. Arranged for horizontal rotation of yoke for aiming; equipped with T-bolt to lock alignment.
2. Safety Cables: Heavy-duty, flexible steel; 30-inch (762-mm) nominal length, with spring clip at one end and steel ring at the other end.
3. Cable Grips: Stainless **OR** Galvanized, **as directed**, steel; basket-weave type for supporting stage cables.

1.3 EXECUTION

A. Installation
1. Set permanently mounted items level, plumb, and square with ceilings and walls.
2. Indicated mounting heights are to bottom of unit for suspended items and to center of unit for wall-mounted items.
3. Mount and connect fixtures, and install and connect distribution devices.
a. If arrangement is not indicated, install so each fixture, dimmer, house lighting circuit, control channel, and outlet circuit can be operated, and complete system demonstrated, in all operating modes.
b. Install safety cables secured to stage rigging or gridiron for all pipe-mounted electrical fixtures and equipment.
4. Dimmer Rack Mounting: Install and anchor dimmer racks level on 4-inch- (100-mm-) high concrete base. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-place Concrete".
a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.

b. For dimmer racks, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
d. Install anchor bolts to elevations required for proper attachment to dimmer racks.

5. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".

B. Wiring

1. Power Wiring:
   a. Install wiring as specified in Division 26 Section "Low-voltage Electrical Power Conductors And Cables" for hardwired connections. Install wiring in raceways except cable and plug connections.
   b. Install power wiring with a separate neutral for each output circuit from main dimmer and for each house and stage lighting circuit.
2. Signaling, Remote-Control, and Power-Limited Circuits:
   a. Comply with requirements specified in Division 26 Section "Control-voltage Electrical Power Cables" for installation of wiring. Install wiring in raceways except cable and plug connections.
   b. Comply with the following unless otherwise indicated:
      1) Size conductors according to lighting control device manufacturer's written instructions.
      2) Select cable insulation, shielding, drain wire, and jacket complying with lighting control device manufacturer's written instructions.
      3) Install circuits to eliminate radio-frequency interference and electromagnetic interference.
   c. Remote-control circuits associated with emergency lighting control shall be installed complying with Class 1 Circuit standards in NFPA 70.
3. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points.
4. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes and in terminal cabinets and equipment enclosures.
5. Remove wall plates and protect devices and assemblies during painting.
6. Support lighting fixtures, distribution components, and accessories as specified in Division 26 Section "Hangers And Supports For Electrical Systems". Equip all pipe-mounted equipment with safety cables that are secured to supporting pipe.
7. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".

C. Identification

1. Identify components, power, and control wiring according to Division 26 Section "Identification For Electrical Systems".
2. Label each fixture, lighting outlet, distribution device, and dimmer module with unique designation. Labels on elevated components shall be readable from the floor.

D. Field Quality Control

1. Perform tests and inspections.
2. Tests and Inspections:
   a. Schedule visual and mechanical inspections and electrical tests with at least seven days' advance notice.
   b. Visual and Mechanical Tests and Inspections:
      1) Inspect each fixture, outlet, module, control, and device for defects, finish failure, corrosion, physical damage, labeling by an NRTL, and nameplate.
      2) Exercise and perform operational tests on mechanical parts and operable devices according to manufacturer's written instructions.
      3) Check tightness of electrical connections with torque wrench.

4) Verify proper protective device settings, fuse types, and ratings.
5) Record results of tests and inspections.

c. Electrical Tests: Perform tests according to manufacturer's written instructions.
1) Continuity tests of circuits.
2) Operational Tests: Connect each outlet to a fixture and a dimmer output circuit so each dimmer module, dimmer control and output circuit, outlet, and fixture in a typical operating mode will be sequentially tested. Set and operate controls to demonstrate fixtures, outlets, dimmers, and controls in a sequence that cues and reproduces actual operating functions for a typical system of the size and scope installed. Include operation and control of houselights and stage lights from each control location and station including optional plug-in, control-console outlet locations. Record fixture and outlet assignments, control settings, operations, cues, and observations of performance.

d. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible organization and individual.

3. Stage lighting will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.
a. Prepare a schedule of lighting outlets by number; indicate circuits, dimmers, connected fixtures, and control-channel assignments. Prepare a schedule of control settings and circuit assignments for house control channels. Prepare written reports of tests and observations. Report defective materials, workmanship, and unsatisfactory test results. Include records of repairs and adjustments made.

E. Adjusting
1. Occupancy Adjustments: When requested within 12 months of date of Final Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

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SECTION 26 55 68 00 - SPORTS LIGHTING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for exterior athletic lighting. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes lighting for the following outdoor sports venues:
a. Baseball fields.
b. Softball fields.
c. Football fields.
d. Soccer fields.
e. Outdoor tennis courts.

C. Definitions
1. CV: Coefficient of variation; a statistical measure of the weighted average of all relevant illumination values for the playing area, expressed as the ratio of the standard deviation for all illuminance values to the mean illuminance value.
2. Delegated-Design Submittals: Documents, including drawings, calculations, and material and product specifications prepared as a responsibility of Contractor to obtain acceptance by the Owner and authorities having jurisdiction.
3. Illuminance: The metric most commonly used to evaluate lighting systems. It is the density of luminous flux, or flow of light, reaching a surface divided by the area of that surface.
a. Horizontal Illuminance: Measurement in foot-candles (lux), on a horizontal surface 36 inches (914 mm) above ground unless otherwise indicated.
b. Target Illuminance: Average maintained illuminance level, calculated by multiplying initial illuminance by LLF.
c. Vertical Illuminance: Measurement in foot-candles (lux), in two **OR** four, **as directed**, directions on a vertical surface, at an elevation coinciding with plane height of horizontal measurements.
4. LC: Lighting Certified.
5. Light Trespass: Light spill into areas and properties outside the playing areas, which is either annoying or unwanted.
6. LLD: Lamp lumen depreciation, which is the decrease in lamp output as the lamp ages.
7. LLF: Light loss factor, which is the product of all factors that contribute to light loss in the system.
8. Luminaire: Complete lighting fixture, including ballast housing if integral.
9. UG: Uniformity gradient; the rate of change of illuminance on the playing field, expressed as a ratio between the illuminances of adjacent measuring points on a uniform grid.

D. Performance Requirements
1. Facility Type: Professional **OR** College **OR** Semiprofessional **OR** Sports club **OR** Amateur league **OR** High school **OR** Training facility **OR** Elementary school **OR** Recreational or social facility, **as directed**.
2. Illumination Criteria:
a. Minimum average target illuminance level for each lighted area for each sports venue and for the indicated class of play according to IESNA RP-6.
b. CV and maximum-to-minimum uniformity ratios for each lighted area equal to or less than those listed in IESNA RP-6 for the indicated class of play.
c. UG levels within each lighted area equal to or less than those listed in IESNA RP-6 for the indicated speed of sport.

3. Illumination Criteria:
   a. Minimum Average Target Illumination: <**Insert value**>.
   b. CV: <**Insert value**>.
   c. Maximum-to-Minimum Uniformity Ratio: <**Insert value**>.
   d. UG Level: <**Insert value**>.
4. Illumination Calculations: Computer-analyzed point method complying with IESNA RP-6 to optimize selection, location, and aiming of luminaires.
   a. Grid Pattern Dimensions: For playing areas of each sport and areas of concern for spill-light control, correlate and reference calculated parameters to the grid areas. Each grid point represents the center of the grid area defined by the length and width of the grid spacing.
   b. Spill-Light Control: Minimize spill light for each playing area on adjacent and nearby areas.
      1) Prevent light trespass on properties near Project as defined by <**Insert name(s) of authorities having jurisdiction**>.
      2) For areas indicated on Drawings as "spill-light critical," limit the level of illuminance directed into the area from any luminaire or group of luminaires, and measured 36 inches (914 mm) above grade to the following:
         a) Maximum Horizontal Illuminance: 0.25 fc (2.7 lux) **OR** 0.5 fc (5.4 lux) **OR** 0.75 fc (8.1 lux), **as directed**.
         b) Maximum Vertical Illuminance from the Direction of the Greatest Contribution of Light: 1.0 fc (10.8 lux) **OR** 2.0 fc (21.5 lux) **OR** 3.0 fc (32.3 lux), **as directed**.
      3) Calculate the horizontal and vertical illuminance due to spill light for points spaced 20 feet (6 m) apart in areas indicated on Drawings as "spill-light critical," to ensure that design meets the above limits.
   c. Glare Control: Design illumination for each playing area to minimize direct glare in adjacent and nearby areas.
      1) Design source intensity of luminaires that may be observed at an elevation of 60 inches (1524 mm) above finished grade from nearby properties to be less than 12,000 **OR** 20,000 **OR** 30,000, **as directed**, candela when so observed.
      2) Design source intensity of luminaires that may be observed at an elevation of 60 inches (1524 mm) above finished grade from designated "spill-light critical" areas to be less than 12,000 **OR** 20,000 **OR** 30,000, **as directed**, candela when so observed.
   d. Determine LLF according to IESNA RP-6 and manufacturer's test data.
      1) Use LLD at 100 percent of rated lamp life. LLF shall be applied to initial illumination to ensure that target illumination is achieved at 100 percent of lamp life and shall include consideration of field factor.
      2) LLF shall not be higher than 70 percent, and may be lower when determined by manufacturer after application of the ballast output and optical system output according to IESNA RP-6.
   e. Luminaire Mounting Height: Comply with IESNA RP-6, with consideration for requirements to minimize spill light and glare.
   f. Luminaire Placement: Luminaire clusters shall be outside the glare zones defined by IESNA RP-6.
5. Baseball Fields:
   a. IESNA RP-6, Class of Play: I **OR** II **OR** III **OR** IV, **as directed**.
   b. Speed of Sport: Fast **OR** Moderate **OR** Slow, **as directed**.
   c. Grid Pattern Dimensions: 30 by 30 feet (9 by 9 m).
6. Softball Fields:
   a. IESNA RP-6, Class of Play: I **OR** II **OR** III **OR** IV, **as directed**.
   b. Speed of Sport: Fast **OR** Moderate **OR** Slow, **as directed**.
   c. Grid Pattern Dimensions: 20 by 20 feet (6 by 6 m).
7. Football Fields:
   a. IESNA RP-6, Class of Play: I **OR** II **OR** III **OR** IV, **as directed**.

b. Speed of Sport: Fast **OR** Moderate **OR** Slow, **as directed**.
c. Grid Pattern Dimensions: 30 by 30 feet (9 by 9 m).

8. Soccer Fields:
   a. IESNA RP-6, Class of Play: I **OR** II **OR** III **OR** IV, **as directed**.
   b. Speed of Sport: Fast **OR** Moderate **OR** Slow, **as directed**.
   c. Grid Pattern Dimensions: 30 by 30 feet (9 by 9 m).
9. Outdoor Tennis Courts:
   a. IESNA RP-6, Class of Play: I **OR** II **OR** III **OR** IV, **as directed**.
   b. Speed of Sport: Fast **OR** Moderate **OR** Slow, **as directed**.
   c. Grid Pattern Dimensions: 10 by 10 feet (3 by 3 m).
10. Egress Lighting: In case of power failure, provide a minimum of 1.0-fc (10.8-lux) illumination, within 30 seconds, measured at grade in spectator and spectator egress areas.
    a. Duration of emergency illumination shall be not less than 15 minutes.
    b. Momentary Power Interruptions: Provide emergency illumination immediately following restoration of power to the lighting circuits. Emergency illumination shall automatically extinguish after 15 minutes.
11. Lighting Control: Manual, low voltage, or digital; providing the following functions, integrated into a single control station, with multiple subcontrol stations as indicated:
    a. Control Station: Key-operated master switch, manual push-button controls, and system status indicator lights. Test switch of egress lighting system, **as directed**.
    b. Light Levels: Two levels of control - 100/50 percent of minimum target illumination.
12. Electric Power Distribution Requirements:
    a. Electric Power: 208 **OR** 230 **OR** 480, **as directed**, V; three phase.
       1) Include roughing-in of service indicated for nonsports improvements on Project site.
       2) Balance load between phases. Install wiring to balance three phases at each support structure.
       3) Include required overcurrent protective devices and individual lighting control for each sports field or venue.
       4) Include indicated feeder capacity and panelboard provisions for future lighted sports field construction.
13. Maximum Total Load: <**Insert number**> A.
    a. Maximum Total Voltage Drop from Source to Load: 5 percent, including voltage drops in branch circuit, subfeeder, and feeder.
14. Seismic Performance: Luminaires, ballasts, and support structures shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
15. Life-Cycle Cost Criteria:
    a. Estimated life-cycle cost of lighting system for period of <**Insert number**> years based on the parameters below:
       1) Energy Cost: <**Insert value**> {Calculate energy costs by multiplying (number of luminaires) x (kilowatt demand per luminaire) x (power cost at $/kilowatts) x (number of annual usage hours) x (number of years)}.
       2) Lamp Replacement Cost: <**Insert value**> (Calculate replacement costs by multiplying (cost to replace a lamp) x (number of luminaires) x (number of relamps over the period of years used in calculating the energy cost)).
       3) General Maintenance: <**Insert value**> (Calculate maintenance costs by multiplying (number of repairs) x (cost per repair) over the life cycle).

       OR

       Life-Cycle Cost Criteria: <**Insert value**> (Calculate according to Federal Energy Management Program's "Building Life-Cycle Cost").

E. Submittals
   1. Product Data: For each type of lighting product indicated. Include the following:

a. Lamp life, output, and energy-efficiency data. Lamp data certified by NVLAP or NRTL; comply with IESNA LM-47.
b. Photometric data based on laboratory tests of each luminaire type, complete with lamps, ballasts, and accessories; comply with IESNA LM-5.
1) Photometric data shall be certified by a qualified independent testing agency.
OR
Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
2. Delegated-Design Submittal: For exterior athletic lighting indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
a. Drawings and specifications for construction of lighting system.
b. Manufacturer's determination of LLF used in design calculations.
c. Lighting system design calculations for the following:
1) Target illuminance.
2) Point calculations of horizontal and vertical illuminance, CV, and UG at minimum grid size and area.
3) Point calculations of horizontal and vertical illuminance in indicated areas of concern for spill light.
4) Calculations of source intensity of luminaires observed at eye level from indicated properties near the playing fields.
d. Electrical system design calculations for the following:
1) Short-circuit current calculations for rating of panelboards.
2) Total connected and estimated peak-demand electrical load, in kilowatts, of lighting system.
3) Capacity of feeder **OR** service, **as directed**, required to supply lighting system.
e. Wiring requirements, including required conductors and cables and wiring methods.
f. Structural analysis data and calculations used for pole selection.
1) Manufacturer Wind-Load Strength Certification: Submit certification that selected total support system, including poles, complies with AASHTO LTS-4-M for location of Project.
3. Qualification Data: For qualified Installer, manufacturer, professional engineer, luminaire photometric data testing laboratory and field testing agency.
4. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
5. Manufacturer Certificates: For support structures, including brackets, arms, appurtenances, bases, anchorages, and foundations, from manufacturer.
6. Welding certificates.
7. Field quality-control reports.
8. Operation and Maintenance Data: For sports lighting system components to include in emergency, operation, and maintenance manuals.
9. Warranty: Sample of special warranty.

F. Quality Assurance
1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Manufacturer Qualifications: Manufacturer's responsibilities include fabricating sports lighting and providing professional engineering services needed to assume engineering responsibility.

a. Engineering Responsibility: Preparation of delegated-design submittals and comprehensive engineering analysis by a qualified professional engineer who is additionally LC by the National Council on Qualifications for the Lighting Professions, **as directed**.

3. Luminaire Photometric Data Testing Laboratory: By manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
4. Luminaire Photometric Data Testing Laboratory: By an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL.
5. Field Testing Agency Qualifications: An independent testing agency that is accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products, or an NRTL as defined in 29 CFR 1910, with the experience and capability to conduct field testing according to IESNA LM-5.

   OR

   Field Testing Agency Qualifications: A qualified independent professional engineer not associated with Contractor or lighting equipment manufacturer, who is additionally LC by the National Council on Qualifications for the Lighting Professions, **as directed**.
6. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel" and AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
7. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of luminaires, lamps, and luminaire alignment products and to correct misalignment that occurs subsequent to successful acceptance tests. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, and unauthorized repairs and alterations from special warranty coverage.
   a. Luminaire Warranty: Luminaire and luminaire assembly (excluding fuses and lamps) shall be free from defects in materials and workmanship for a period of five years from date of Final Completion.
   b. Lamp Warranty:
      1) Replace lamps and fuses that fail within 12 months from date of Final Completion.
      2) Provide replacement lamps for lamps that fail within the second 12 months from date of Final Completion.
   c. Alignment Warranty: Accuracy of alignment of luminaires shall remain within specified illuminance uniformity ratios for a period of five years from date of successful completion of acceptance tests.
      1) Realign luminaires that become misaligned during the warranty period.
      2) Replace alignment products that fail within the warranty period.
      3) Verify successful realignment of luminaires by retesting as specified in "Field Quality Control" Article.

1.2 PRODUCTS

A. Luminaires, Lamps, And Ballasts

1. Luminaires: Listed and labeled, by an NRTL acceptable to authorities having jurisdiction, for compliance with UL 1598 for installation in wet locations.
   a. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without using tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent their accidental falling during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lens.
   b. Exposed Hardware: Stainless-steel latches, fasteners, and hinges.

c. Spill-Light Control Devices: Internal louvers and external baffles furnished by manufacturer and designed for secure attachment to specific luminaire.
d. Luminaires for tennis courts shall be bracket-mounted, full-cutoff type with integral ballasts.
e. Lamps for Tennis Court Luminaires: Metal halide, rated 1000 W.

2. Ballast Mounting: Grouped in cabinets, remote from **OR** At, **as directed**, location of associated luminaires unless otherwise indicated.

B. Support Structures

1. Support-Structure Wind-Load Strength: Poles and other support structures, brackets, arms, appurtenances, bases, anchorages, and foundations shall comply with AASHTO LTS-4-M and shall be certified by manufacturers to withstand winds up to 100 mph (160 km/h) without permanent deflection or whipping.
2. Support-Structure Seismic Strength: Poles or other support structures, brackets, arms, appurtenances, bases, anchorages, and foundations shall be designed to prevent separation of components or fracture of poles, luminaire supports, or pole foundations during a seismic event.
3. Mountings, Fasteners, and Appurtenances:
   a. Corrosion resistant, compatible with support components, and which shall not cause galvanic action at contact points.
      1) Steel Components: Hot-dip galvanized after fabrication, complying with ASTM A 123/A 123M.
      2) Mounting Hardware Fasteners: Hot-dip galvanized, complying with ASTM A 153/A 153M, or minimum 18-8 grade stainless steel.
   b. Accommodate attachments and wiring of other indicated systems.
4. Concrete for Pole Foundations: 3000-psi (20.7-MPa), 28-day minimum compressive strength. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-place Concrete".
5. Direct-buried steel structures or poles shall not be used.

C. Power Distribution And Control

1. Wiring Method for Feeders, Subfeeders, Branch Circuits, and Control Wiring: Underground nonmetallic raceway; No. 10 AWG minimum conductor size for power wiring.
2. Overhead-, pole-, or structure-supported wiring and transformers are **OR** are not, **as directed**, permitted.
3. Electrical Enclosures Exposed to Weather: NEMA 250, Type 3R enclosure constructed from stainless steel **OR** corrosion-resistant material, **as directed**, with hinged doors fitted with padlock hasps or lockable latches.

D. Surge Protection

1. Surge Protection: Comply with requirements in Division 26 Section "Transient-voltage Suppression For Low-voltage Electrical Power Circuits" and include surge suppressors with the following requirements:
   a. Panelboard type.
   b. Nonmodular, with digital indicator lights and one set of dry contacts, **as directed**.
   c. Peak Single-Impulse Surge Current Rating: <**Insert number**> kA per phase.

E. Pole And Base Protection

1. Pole Pads: Wraparound pad, with 4 inches (100 mm) of extra-firm polyfoam, 360-degree coverage of ground-mounted poles and supports, continuous hook-and-loop fastening, and not less than 72 inches (1820 mm) high.

1.3 EXECUTION

A. Installation

1. Use web fabric slings (not chain or cable) to raise and set structural members. Protect equipment during installation to prevent corrosion.
2. Install poles and other structural units level, plumb, and square.
3. Except for embedded structural members, grout void between pole base and foundation. Use nonshrinking or expanding concrete grout firmly packed in entire void space. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole. Nonshrink grout is specified in Division 05 Section "Metal Fabrications".
4. Install pole pads at all poles inside playing field boundaries and when located within 20 feet (6 m) of the field boundary.
5. Extend cast-in-place bolted base foundations 36 inches (914 mm) above grade, minimum.
6. Install protective pipe bollards on two **OR** three, **as directed**, sides of each embedded pole installed in paved areas. See Division 05 Section "Metal Fabrications" for pipe bollards.
7. Install controls and ballast housings in cabinets mounted on support structure at least 10 feet (3 m) above finished grade.

B. Field Quality Control
1. Perform tests, inspections, and analysis according to IESNA RP-6 and IESNA LM-5 where applicable.
2. Tests and Inspections:
   a. After installing sports lighting system and after electrical circuits have been energized, perform proof-of-performance field measurements and analysis for compliance with requirements.
   b. Playing and Other Designated Areas: Make field measurements at intersections of grids, dimensioned and located as specified in "Performance Requirements" Article and as described below:
      1) Baseball Fields: Measure at least 25 points of the infield and 87 points of the outfield. Extend the grid 15 feet (5 m) outside the foul lines, extending to outfield boundary or fence.
      2) Softball Fields: Measure at least 16 points of the infield and 48 points of the outfield. Extend the grid 15 feet (5 m) outside the foul lines, extending to outfield boundary.
      3) Football Fields: Lighted area is 180 by 360 feet (55 by 110 m). Measure at least 91 points.
      4) Soccer Fields: Lighted area is 210 by 370 feet (64 by 113 m). Measure at least 91 points.
      5) Tennis Courts: Measure at least 30 points for a double court.
   c. Make field measurements at established test points in areas of concern for spill light and glare.
   d. Perform analysis to demonstrate correlation of field measurements with specified illumination quality and quantity values and corresponding computer-generated values that were submitted with engineered design documents. Submit a report of the analysis. For computer-generated values, use manufacturer's lamp lumens that are adjusted to lamp age at time of field testing.
3. Correction of Illumination Deficiencies for Playing Areas: Make corrections to illumination quality or quantity, measured in field quality-control tests, that varies from specified illumination criteria by plus or minus 10 percent.
   a. Add or replace luminaires, or change mounting height, revise aiming, or install louvers, shields, or baffles.
   b. If luminaires are added or mounting height is changed, revise aiming and recalculate and modify or replace support structures if indicated.
   c. Do not replace luminaires with units of higher or lower wattage without the Owner's approval.
   d. Retest as specified above after repairs, adjustments, or replacements are made.
   e. Report results in writing.

4. Correction of Excessive Illumination in Spill-Light-Critical Areas: If measurements indicate that specified limits for spill light are exceeded, make corrections to illumination quantity, measured in field quality-control tests, that reduce levels to within specified maximum values.
    a. Replace luminaires, or change mounting heights, revise aiming, or install louvers, shields, or baffles.
    b. Obtain the Owner's approval to replace luminaires with units of higher or lower wattage.
    c. If mounting height is changed, revise aiming and recalculate and modify or replace support structures if indicated.
    d. Retest as specified above after repairs, adjustments, or replacements are made.
    e. Report results in writing.
5. Sports lighting will be considered defective if it does not pass tests and inspections.
6. Prepare test and inspection reports.

C. Demonstration
1. Train the Owner's maintenance personnel to adjust, operate, and maintain exterior athletic lighting.

END OF SECTION 26 55 68 00

Task	Specification	Specification Description
26 55 70 00	02 84 16 00a	Interior Lighting
26 56 13 00	01 22 16 00	No Specification Required
26 56 13 00	02 41 13 13	Selective Demolition
26 56 13 00	02 84 33 00	Overhead Electrical Distribution
26 56 13 00	02 84 16 00b	Exterior Lighting
26 56 18 00	02 84 16 00b	Exterior Lighting
26 56 19 00	02 84 16 00a	Interior Lighting
26 56 19 00	02 84 16 00b	Exterior Lighting
26 56 21 00	01 22 16 00	No Specification Required
26 56 21 00	02 84 33 00	Overhead Electrical Distribution
26 56 21 00	02 84 16 00b	Exterior Lighting

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Task	Specification	Specification Description
27 05 26 00	26 05 53 00a	Intercommunications and Program Systems
27 11 16 00	26 05 53 00a	Intercommunications and Program Systems

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SECTION 27 11 19 00 - LOOSE-TUBE GEL-FILLED FIBER OPTIC CABLES

GENERAL

Description Of Work

1. This specification covers the furnishing and installation of loose-tube gel-filled fiber optic cables. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

Shop Drawings And Samples

2. The following shall be submitted:
   a. Complete bill of materials.
   b. Drawings indicating the locations of all pull boxes with station numbers.
   c. Catalog data on all testing devices proposed for use plus certifications of accuracy, calibration, and traceability to standards of the National Institute for Standards and Testing.
   d. Cable pulling calculations for all conduit runs. Indicate on the submittal any additional pull boxes that are required, including station number and a written description, of the location.
   e. A cable pulling and splicing work plan shall be submitted a minimum of 45 days prior to the planned initiation of cable pulling. The pulling plan and pull tension calculations may be prepared by using a software program such as Pull-Planner 2000 by American Polywater Corporation. The cable pulling and splicing work plan must be approved a minimum of 15 days prior to pulling cable. Work plan shall include the following:
      1) Pull tension calculations
      2) Calculated amount of lubrication required
      3) Detailed description of pull operation methods for all conduit runs

Quality Assurance

3. All work described in this section shall meet or exceed the applicable provisions of the following documents:
   a. ANSI C8.471983, American National Standard for Polyolefin Insulated Thermoplastic Jacketed Communication Cables.
   b. EIA-455 (addendum 1 through 5) Standard Test Procedures for Fiber Optics, Cables, Transducers, Connecting and Terminating Devices.
   c. EIA-455-27A, Method of Measuring (Uncoated) Diameter of Optical Waveguide Fibers.
   d. EIA-455-28A, Method For Measuring Tensile Failure Point of Optical Waveguide Fibers.
   e. EIA-455-34, Interconnection Device Insertion Loss Test.
   f. EIA-455-89, Fiber Optic Cable Jacket Elongation and Tensile Strength.

Warranty

4. The Contractor shall provide an unconditional warranty on all installed cable for a minimum period of two (2) years.

PRODUCTS

Materials

5. Fiber Optic Cable - 24 strand
   a. Cable type: Outdoor Plant Stranded Loose-Tube, Gel-Filled Fiber Optic Cable, Corning Altos 024RW4-14101A20 or Lucent Lightpack 7D1X-024-BXD.
   b. Number of fibers: 24 fibers.
   c. Buffer Tubes: All optical fibers shall be placed inside a loose buffer tube. The optical cable shall contain three buffer tubes, numbered 1, 2, and 3. The tubes shall be color coded according to the table below:

Buffer Tube Number	Buffer Tube Color
1	Blue
2	Orange
3	Green

d. Each buffer tube shall contain 8 singlemode fibers. Each fiber shall be numbered and distinguishable by means of the color coding established in the main body of the specification.
e. The colors of the individual fibers shall be stable across the specified storage and operating temperature range and not subject to fading or smearing onto each other or into the gel filling material. Colors shall not cause fibers to stick together.
f. The fibers shall not adhere to the inside walls of the loose buffer tube. Buffer tubes shall be kink resistant within the specified minimum bend radius.
g. Filler may be included in the cable core composition to lend symmetry to the cable cross-section where needed.
h. A central anti-buckling member shall be included into the cable to prevent buckling of the cable. The anti-buckling member shall be composed of a glass reinforced plastic rod.
i. Each buffer tube shall be filled with a non-hygroscopic, non-nutritive to fungus, electrically non-conductive, homogenous gel. The gel shall be free from dirt and foreign matter. The gel shall be readily removable with conventional nontoxic solvents.
j. Buffer tubes shall be stranded around a central member using the reverse oscillation, or "S-Z", stranding process.
k. The cable core shall contain a water-blocking material. The water blocking material shall be non-nutritive to fungus, electrically non-conductive and homogenous. It shall also be free from dirt and foreign matter and shall be readily removable with conventional nontoxic solvents.
l. Binders shall be applied with sufficient tension to secure the buffer tubes to the member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking and dialectic with low shrinkage.
m. Tensile strength shall be provided by a combination of high tensile strength dielectric yarns. The high tensile strength dielectric yarns shall be helically stranded evenly around the cable core.
n. The all-dielectric cable shall be sheathed with medium density polyethylene (MDPE). The minimum nominal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members and water blocking material. The jacket or sheath shall be free of holes, splits, and blisters. The cable jacket shall contain no metallic elements and shall be of a consistent thickness.
o. The cable shall contain at least one ripcord under the sheath for easy sheath removal.

6. Fiber Optic Cable - 36 Strand
a. Cable type: Outdoor Plant Stranded Loose-Tube, Gel-Filled Fiber Optic Cable, Corning Altos 036RW4-14101A20 or Lucent Lightpack 7D1X-036-BXD.
b. Number of fibers: 36 fibers.
c. Buffer Tubes: All optical fibers shall be placed inside a loose buffer tube. The optical cable shall contain three buffer tubes, numbered 1, 2, and 3. The tubes shall be color coded according to the table below:

Buffer Tube Number	Buffer Tube Color
1	Blue
2	Orange
3	Green

d. Each buffer tube shall contain 12 single mode fibers. Each fiber shall be numbered and distinguishable by means of the color coding established in the main body of the specification.

e. The colors of the individual fibers shall be stable across the specified storage and operating temperature range and not subject to fading or smearing onto each other or into the gel filling material. Colors shall not cause fibers to stick together.
f. The fibers shall not adhere to the inside walls of the loose buffer tube. Buffer tubes shall be kink resistant within the specified minimum bend radius.
g. Filler may be included in the cable core composition to lend symmetry to the cable cross-section where needed.
h. A central anti-buckling member shall be included into the cable to prevent buckling of the cable. The anti-buckling member shall be composed of a glass reinforced plastic rod.
i. Each buffer tube shall be filled with a non-hygroscopic, non-nutritive to fungus, electrically non-conductive, homogenous gel. The gel shall be free from dirt and foreign matter. The gel shall be readily removable with conventional nontoxic solvents.
j. Buffer tubes shall be stranded around a central member using the reverse oscillation, or "S-Z", stranding process.
k. The cable core shall contain a water-blocking material. The water blocking material shall be non-nutritive to fungus, electrically non-conductive and homogenous. It shall also be free from dirt arid foreign matter and shall be readily removable with conventional nontoxic solvents.
l. Binders shall be applied with sufficient tension to secure the buffer tubes to the member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking and dialectic with low shrinkage.
m. Tensile strength shall be provided by a combination of high tensile strength dielectric yarns. The high tensile strength dielectric yarns shall be helically stranded evenly around the cable core.
n. The all-dielectric cable shall be sheathed with medium density polyethylene (MDPE). The minimum nominal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members and water blocking material. The jacket or sheath shall be free of holes, splits, and blisters. The cable jacket shall contain no metallic elements and shall be of a consistent thickness.
o. The cable shall contain at least one ripcord under the sheath for easy sheath removal.

7. Fan-Out Termination for Loose Tube Cables
a. Individual fibers within the loose tube cable require handling protection inside the termination cabinets. Fan-out kits shall be installed in the patch panel enclosures to transition the loose tube fibers to ruggedized tight-buffered fiber pigtail cables. Fan-out tubes or furcation kits shall not be used. Optical fusion splices shall connect the loose tube fibers to the tight-buffered pigtail cables. The optical splice loss shall comply with the specifications for optical splices. Splice protection sleeves shall be employed on all splices to protect the splices. A wall-mountable splice center shall house the splices and serve to fully protect excess lengths of loose tube fibers from exposure.
b. The tight-buffered pigtails shall be terminated with ST connectors as specified.

8. Fan-out Pigtail Cable Specifications
a. Singlemode fiber (Corning SMF-28) shall be used in the pigtails. Optical characteristics shall comply with the optical fiber performance specifications.

Buffer material	Thermoplastic
Buffer O.D.	900 um
Strength Member	Kevlar
Jacket Material	PVC
Jacket O.D.	3.0 mm
Temperature Range	-20 to +70 C

9. Fiber Optic Termination Patch Panels:
a. Where shown on the plans or in the Appendix, the fiber optic cable shall terminate inside a communications cabinet on a termination patch panel. All fiber sub-cables within the cable shall be terminated with "ST™ compatible" connectors. The patch panel shall have a 24-fiber capacity, and shall facilitate fiber-optic cable cross-connection between outside plant

cables and opto-electronic interface equipment cabling. The patch panel shall contain "ST™" type bayonet couplings. All unused couplings shall have protective dust covers. Factory-terminated, tight-buffered, aramid-reinforced fiber optic jumper assemblies or interconnect cables, standard 3.0-mm O.D., shall connect the optical cable terminations to the patch panel couplings.

b. The termination panel shall be equipped with a suitable means for routing and securing of cables and shall provide a suitable means of protection for the mounted fiber connectors, to prevent damage to fibers arid connectors during all regular operation and maintenance functions. Bend diameters on cable fibers and jumpers must be greater than four (4) inches at all times to ensure optical and mechanical integrity of the optical fibers.

10. Optical Connectors

a. All connectors shall be field-installable and perfectly matched to the cable used. The connectors shall provide tight fitting termination, to the cladding and buffer coating. Epoxy-based or "hot melt " adhesives shall be used to bond the fiber and buffer to the connector ferrule and body prior to polishing the end face. No dry-termination or "quick crimp" connectors are allowed.

b. After termination with connectors, the fiber ends must be visually inspected at a magnification of not less than 100 power to check for cracks or pits in the end face of the fiber. If any irregularities found cannot be removed by further polishing, the entire process must be redone by cutting off and disposing the connector body.

c. Connectors shall have a maximum allowable connection loss of 0.3 dB per mated pair, as measured per EIA-455-34. No index-matching gel is to be used, dry interfaces only. Singlemode connectors shall be capable of field installation on 9/125 micron fibers with 900 micron buffers (OD).

d. Each connector shall be of the industry standard ST type compatible, designed for singlemode tolerances, and shall meet or exceed the applicable provisions of EIA-455-5, 455-2A, and 455-34, and shall be capable of 100 repeated matings with a maximum loss increase of 0.1 dB. Connectors shall incorporate a key-way design and shall have a zirconia ceramic ferrule. Connector bodies and couplings shall be made of corrosion-resistant and oxidation-resistant materials, such as nickel plated zinc, designed to operate in humid environments without degradation of surface finishes.

11. Splice Closures:

a. Splice closures shall be of the re-enterable type, with an external moisture-proof shell, inner closure and encapsulant.

b. Closure shall have removable interior splice trays.

c. Closures shall be Corning Cable Systems (Siecor) type SCN or equal.

EXECUTION

Fiber Optic Cable Installation

12. General:

a. The Contractor shall determine a suitable cable installation method to ensure that all cable installation requirements shall be met in all conduit sections. All work shall be carried out in accordance and consistent with the highest standards of quality and craftsmanship in the communication industry with regard to the electrical and mechanical integrity of the connections; the finished appearance of the installation; as well as the accuracy and completeness of the documentation.

b. The Contractor shall make a physical survey of the project site for the purpose of establishing the exact cable routing and cutting lengths prior to the commencement of any work or committing any materials.

c. The cable shall be carefully inspected for jacket defects as it is removed from the reel. If defects are noticed, the pulling operation shall be terminated immediately and the the Owner notified.

d. Precautions shall be taken during installation to prevent the cable from being kinked or crushed. Crushed or kinked cable shall be replaced with new cable. As the cable is pulled into the conduit system, it shall be sufficiently lubricated with a lubricant that shall be the water-based type and approved by the cable manufacturer. Lubricant shall be applied at a rate to provide a continuous 10-mil coating, as recommended by the manufacturer. Lubricant shall be Polywater F® manufactured by American Polywater, or approved equivalent.
e. The mechanical stress placed upon the cable during installation shall not be such that the cable is twisted and stretched or exceeds manufacturer's specifications.
f. The pulling of the cable shall be hand assisted at each handhole or pullbox. When pulling through intermediate pullboxes, the cable shall be placed on the ground near the pullbox and care taken to prevent damage by vehicles or other objects. The cable shall not be crushed, kinked or forced around a sharp corner. A minimum of 3 foot slack shall be left in each pullbox and enough left at each end of the cable to allow proper cable termination.

13. Fiber optic cables shall be installed in continuous lengths without intermediate splices throughout the project. Cable installation personnel shall be familiar with the manufacturer's recommended procedures including, but not limited to the following:
    a. Proper attachment to the cable strength elements for pulling during installation. Depending on cable design, this will involve direct attachment to internal strength members or attaching an external "Kellums" or split mesh grip using a 600 lb breakaway swivel.
    b. Cable tensile limitations and tension monitoring procedures.
    c. Cable bending radius limitations.
    d. Cable twisting limitations.
14. The Contractor shall comply with the cable manufacturer's recommended installation procedures at all times. Cable installation procedures shall conform to Belcore guidelines.
15. To accommodate long continuous installation lengths, bi-directional "center pull" techniques for pulling of the fiber optic cable is acceptable and shall be implemented as follows:
    a. From the midpoint, pull the fiber optic cable into the conduit from the shipping reel in accordance with the manufacturer's specifications.
    b. When this portion of the pull is complete, the remainder of the cable must be removed from the reel to make the inside end available for pulling in the opposite direction.
    c. This is accomplished by hand pulling the cable from the reel and laying into large "figure eight" loops on the ground.
    d. The purpose of the figure eight pattern is to avoid cable tangling and kinking.
    e. The loops shall be laid carefully one upon the other (to prevent subsequent tangling) and shall be in a protected area.
    f. The inside reel end of the cable is then available for installation.
    g. In some cases, it may be necessary to set up a winch at an intermediate cable vault.
    h. The required length of cable shall be pulled to that point, and brought out of the cable vault and coiled into a figure eight.
    i. The figure eight is then turned over to gain access to the free cable end. This can then be reinserted into the duct system for installation into the next section.
16. At pullboxes, the Contractor shall provide 30 feet of cable slack. The fiber optic cable shall be coiled and secured with cable ties in the pullbox. The Contractor shall ensure that the minimum bending radius of the fiber optic cable is not compromised when preparing this stored cable slack.
17. The pulling eye/sheath termination hardware on the fiber optic cables shall not be pulled over any sheave blocks.
18. When power equipment is used to install fiber optic cabling, the pulling speed shall not exceed 30 meters per minute. The pulling tension, bending radius and twist limitation for fiber optic cable shall not be exceeded under any circumstances.
19. Large diameter wheels, pulling sheaves, and cable guides shall be used to maintain the appropriate bending radius. Tension monitoring shall be accomplished using commercial dynamometers or loadcell instruments.
    a. All pulls shall be documented by a graph which is annotated with the following information:
        1) Reel number
        2) Station from and station to

3) Date and tune
4) Explanations of abnormalities in readings or interruptions
5) Sign-off by Contractor and the Owner

b. Under no conditions shall the FOC be left exposed or unattended.

20. Repairs: Repair of cable jacket will not be permitted. Jacket damage will require removal and re-installation of a new cable run at the Contractor's expense.
21. Splicing:
    a. Splicing of fiber optic cable shall not be permitted except in emergency conditions or as specified on the plans or in the special conditions for a specified project. Fiber optic cable runs and required looping of the cable shall be provided in one continuous length. When splicing is authorized by the the Owner, splicing shall be by trained, authorized persons only. Any allowed splicing of fiber optic cable shall be by fusion splice only, no mechanical splices are permitted.
    b. All fusion splicing equipment shall be in good working order, properly calibrated, and meeting all industry standards and safety regulations. Cable preparation, closure installation and splicing shall be accomplished in accordance with accepted and approved industry standards.
    c. Spices shall be made in pullboxes and shall use re-enterable splice closures.
    d. The average splice loss shall be 0.1 dB or less per splice. The average splice loss is defined as the summation of the loss as measured in both directions using an optical time domain reflectometer (OTDR) through the fusion splice, divided by two. No individual splice loss measured in a single direction shall exceed 0.15 dB.
    e. Upon completion of the splicing operation, all waste material shall be deposited in suitable containers, removed from the job site, arid disposed of in an environmentally acceptable manner.
22. After the cables are installed and spliced, they shall be racked and all conduits sealed. A minimum of 30 feet of FOC shall be stored at each end of one splice. Racking shall conform to the following:
    a. Cables shall be loosely secured in racked position with Ty-Raps or equal.
    b. Imprinted plastic coated cloth identification/warning tags shall be securely attached to the cables in at least two locations in each handhole. Tags shall be by Brady or Thomas & Betts.
    c. All coiled cable shall be suitably protected to prevent damage to the cable and fibers. Racking shall include securing cables to brackets and racking hardware that extend from the sidewalls of the handhole.
    d. When all cables at each handhole are securely racked, unused conduits and void areas around conduit containing cables shall be sealed.

Cable Protection During Installation

23. All fiber optic cable shall be pulled in conduit except as specified on the plans. Care shall be exercised during cable pulls through conduit bends and looping in pull boxes.
24. To reduce the possibility of damage to the outer jacket of the fiber optic cable, protective measures shall be used when the cable is installed. The requirements herein shall be followed, but does not limit the installation to only those identified. The purpose of the installation specifications is to ensure protection, of the fiber optic cable when it is installed. Other protective measures not specified herein may be taken during installation if it will ensure protection of the cable.
25. A cable feeder guide shall be used between the cable reel and the face of the duct and conduit to protect the cable and guide it off the reel and into the duct. The cable shall be carefully inspected for jacket defects as it is removed from the reel. If defects are noticed, the pulling operation shall be terminated immediately and the the Owner notified.
26. Precautions shall be taken during installation to prevent the cable from being kinked, crushed or twisted. A pulling eye shall be attached to the cable end and be used to pull the cable through the duct and conduit system. As the cable is pulled off the reel and into the cable feeder guide, it shall

be sufficiently lubricated with a lubricant that shall be of the water based type and approved by the cable manufacturer.

27. Dynamometers or break away pulling swings shall be used to ensure the pulling line tension does not exceed the installation tension values specified by the cable manufacturer. The mechanical stress placed upon the cable during installation shall not be such that the cable is twisted and stretched. Maximum allowable cable strain during installation shall be less than 0.75%.
28. The pulling of the cable shall be hand assisted at each handhole or pullbox. The cable shall not be crushed, kinked or forced around a sharp corner. Sufficient slack shall be left at each end of the cable to allow proper cable termination.
29. The cable shall be looped in all pull boxes as noted on the plans to provide approximately thirty (30) feet of extra cable in the pull box. At termination points, such as at cabinets or computers, a thirty (30) foot loop shall also be provided wherever space permits.
30. Cable Marking: At each pullbox and at each cabinet, the cable shall be visibly marked with yellow warning tape as follows:

"CAUTION - FIBER OPTIC CABLE"

Fiber Optic Cable Testing

31. General: The Contractor shall perform pre-installation and post-installation FOC tests. The the Owner shall be notified a minimum of 10 days in advance so that these tests are witnessed. All test equipment shall be traceable to NIST standards.
32. Test equipment: The Contractor, shall use the following to perform pre-installation and post-installation FOC tests:
    a. Optical time domain reflectometer (OTDR). The OTDR shall be laser precision, ALT Inc. MODEL 5200 LRFL, or equal.
33. Pre-installation tests
    a. The purpose of these tests is to perform acceptance tests on the cable prior to installation to verify that the cable conforms to the manufacturer's specifications, and is free of defects, breaks and damages by transportation and manufacturing processes.
    b. Prior to removal of each cable from the delivery reel, all optical fibers within the cables shall be tested by the Contractor using an OTDR. The OTDR tests shall consist of end-to-end length and fiber attenuation (dB/km) measurements to ensure proper performance of the fiber optic cable. The tests shall be performed from both ends of each fiber to ensure complete fiber continuity within the cable structure.
    c. Pre-installation, "on-reel" test results shall be compared with the manufacturer's test report delivered with the cable. Gross dissimilarities shall be noted and remedied between the Contractor and manufacturer. In all cases, all fibers must meet the optical attenuation specifications prior to cable installation.
    d. The Contractor shall perform tests on all reels of cable. The the Owner shall be notified a minimum of 15 days prior to any test.
    e. The Contractor shall document each test and submit the report to the the Owner for review. Documentation shall consist of both hard copy and 3-1/2 inch electronic disk complete with all application software.
    f. Cable shall not be installed until the the Owner has reviewed the test report.
    g. Maximum allowable attenuation is 0.5 dB/km at 1310 and 1550 nm.
34. Post-installation tests: After FOC has been installed the following tests shall be performed:
    a. A recording OTDR shall be used to test for end-to-end continuity and attenuation of each optical fiber. The OTDR shall be equipped with a 1310 nm and 1550 nm light source for the single mode fiber (SMF). The OTDR shall have an X-Y plotter to provide a hard copy record of each trace of each fiber: The OTDR shall be equipped with sufficient internal masking to allow the entire cable section to be tested. This may be achieved by using an optical fiber pigtail of 30 feet or more to display the required cable section.
    b. The OTDR shall be calibrated for the correct index of refraction to provide proper length measurement for the known length of reference fiber.

c. A transmission test shall be performed with the use of a 1310 and 1550 nm stabilized light sources and 1310 nm/1550 nm power meters for SMF. This test shall be conducted in both directions on each fiber of each cable.

d. Hard and electronic copy of test documentation shall be submitted to the the Owner. The documentation shall include the trace plot, index, dB/km loss, cable length, date and time of test, wavelength, pulse width, the test site, cable ID, fiber number and type, and operator's initials. The Contractor shall compare the pre-installation test results to the post-installation results. If a deviation of greater than one dB occurs, the the Owner shall be notified in writing by the Contractor, and the cable shall be removed and replaced at no additional cost to the Owner.

e. Upon completion of the previous tests all FOC coils shall be secured with ends capped to prevent intrusion of dirt and water.

35. Required OTDR Trace Information:

a. All traces shall display the entire length of cable under test, highlighting any localized loss discontinuities (installation-induced losses and/or connector losses). The trace shall display fiber length (in kilofeet), fiber loss (dB), and average fiber attenuation (in dB/km) as measured between two markers placed as near to the opposite ends of the fiber under test as is possible while still allowing an accurate reading. Care shall be taken to ensure that the markers are placed in the linear region of the trace: away from the front-end response and far-end Fresnel reflection spike. Time averaging shall be used to improve the display signal to noise ratio. The pulse width of the OTDR shall be set to a sufficient width to provide adequate injected power to measure the entire length the fiber under test.

b. If connectors exist in the cable under test, then two traces shall be recorded. One trace shall record the fiber loss (dB) and average attenuation (dB/km) of the entire cable segment under test, including connectors. The second trace shall display a magnified view of the connector regions, revealing the connector losses (dB). All connector losses shall be measured using the 5-point splice loss measurement technique.

c. The OTDR trace shall also include the following information:

1) The date and time of the test
2) The cable ID number
3) The cable segment ID number
4) The fiber color or sub-cable number
5) Launch point connector number
6) The optical wavelength used for the test
7) The refractive index setting of the OTDR
8) The pulse width setting of the OTDR
9) The averaging interval of the test

END OF SECTION 27 11 19 00

Task	Specification	Specification Description
27 11 19 00	26 05 53 00a	Intercommunications and Program Systems
27 11 23 00	26 05 53 00a	Intercommunications and Program Systems
27 13 13 13	26 05 13 16	Conductors And Cables
27 13 13 13	26 05 13 16a	Undercarpet Cables
27 13 13 13	26 05 13 16b	Medium-Voltage Cables
27 13 13 13	26 05 53 00a	Intercommunications and Program Systems
27 13 23 13	27 11 19 00	Loose-Tube Gel-Filled Fiber Optic Cables
27 15 13 00	26 05 13 16	Conductors And Cables
27 15 13 00	26 05 13 16a	Undercarpet Cables
27 15 13 00	26 05 19 16c	Control-Voltage Electrical Power Cables
27 15 13 00	26 05 13 16b	Medium-Voltage Cables
27 15 33 00	26 05 13 16	Conductors And Cables
27 15 33 00	26 05 13 16a	Undercarpet Cables
27 15 33 00	26 05 19 16c	Control-Voltage Electrical Power Cables
27 15 33 00	26 05 13 16b	Medium-Voltage Cables
27 15 43 00	26 05 53 00a	Intercommunications and Program Systems
27 15 53 00	27 11 19 00	Loose-Tube Gel-Filled Fiber Optic Cables
27 16 16 00	27 11 19 00	Loose-Tube Gel-Filled Fiber Optic Cables
27 16 19 00	26 05 13 16	Conductors And Cables
27 16 19 00	27 11 19 00	Loose-Tube Gel-Filled Fiber Optic Cables
27 21 16 00	27 11 19 00	Loose-Tube Gel-Filled Fiber Optic Cables
27 21 16 00	26 05 53 00a	Intercommunications and Program Systems
27 31 13 00	26 05 53 00a	Intercommunications and Program Systems
27 32 13 00	26 05 33 16a	Wiring Devices
27 32 13 00	26 05 53 00a	Intercommunications and Program Systems
27 32 26 00	26 05 53 00a	Intercommunications and Program Systems

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SECTION 27 51 43 00 - EDUCATIONAL INTERCOMMUNICATIONS AND PROGRAM SYSTEMS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for educational intercommunications and program systems. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes: Manually switched intercommunications, Microprocessor-switched intercommunications, Microprocessor-switched telephone/intercommunications and program systems with the following components:
      a. Master stations.
      b. Call control console.
      c. Speaker-microphone stations.
      d. Call-switch unit.
      e. All-call amplifier.
      f. Intercommunication amplifier.
      g. Paging amplifier.
      h. Loudspeakers/speaker microphones.
      i. Conductors and cables.
      j. Raceways.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. Shop Drawings: For educational intercommunications and program systems. Include plans, elevations, sections, details, and attachments to other work.
      a. Wiring Diagrams: For power, signal, and control wiring.
         1) Identify terminals to facilitate installation, operation, and maintenance.
         2) Single-line diagram showing interconnection of components.
         3) Cabling diagram showing cable routing.
   3. Field quality-control reports.
   4. Operation and maintenance data.

D. Quality Assurance
   1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
   2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for location and application.
   3. Comply with NFPA 70.

1.2 PRODUCTS

A. Functional Description Of Manually Switched Systems
   1. Master Station:
      a. Communicating selectively with other master and speaker-microphone stations by actuating selector switches.
      b. Communicating simultaneously with all other stations by actuating a single all-call switch.
      c. Communicating with individual stations in privacy.
      d. Including other master-station connections in a multiple-station conference call.

e. Accessing separate paging speakers or groups of paging speakers by actuating selector switches.
f. Overriding any conversation by a designated master station.

2. Speaker-Microphone Station:
   a. Having privacy from remote monitoring without a warning tone signal at monitored station. Designated speaker-microphone stations have a privacy switch to prevent another station from listening and to permit incoming calls.
   b. Communicating hands free.
   c. Calling master station by actuating call switch.
   d. Returning a busy signal to indicate that station is already in use.
   e. Being free of noise and distortion during operation and when in standby mode.
3. Speakers: Free of noise and distortion during operation and when in standby mode.

B. Functional Description Of Microprocessor-Switched Systems
1. Master Station:
   a. Communicating selectively with other master and speaker-microphone stations by dialing station's number on a 12-digit keypad.
   b. Communicating with individual stations in privacy.
   c. Communicating on a minimum of three voice channels with up to two simultaneous conversations between master stations and one conversation between a master station and a speaker-microphone station.
   d. Increasing the number of conversation channels by adding a module in central-control cabinet.
   e. Including up to three other station connections in a conference call.
   f. Accessing separate paging speakers or groups of paging speakers by dialing designated numbers on a 12-digit keypad.
   g. Overriding any conversation by a designated master station.
   h. Displaying selected station.
   i. Communicating simultaneously with all other stations by dialing a designated number on a 12-digit keypad.
   j. Automatically controlling gain to ensure constant intercom speech level.
   k. Controlling the simultaneous distribution of program material to various combinations of speaker-microphone stations or groups over two program channels by using keypad to control sources and distribute programs.
   l. Operating and correcting secondary clocks and controlling class-change signals to speakers and bells by using keypad.
   m. User-programmable features include the following:
      1) Station calling by room number.
      2) Room station call-in priority levels.
      3) Clock signal schedule functions.
      4) Schedule characteristics of audible signals.
      5) Call-in tone characteristic.
      6) Precedence among master stations as destinations for incoming calls from room stations.
      7) Grouping of rooms and speakers into zones for paging and program distribution purposes.
2. Speaker-Microphone Station:
   a. Having privacy from remote monitoring without a warning tone signal at monitored station. Designated speaker-microphone stations have a privacy switch to prevent another station from listening and to permit incoming calls.
   b. Communicating hands free.
   c. Calling master station by actuating call switch.
   d. Returning a busy signal to indicate that station is already in use.
3. Speakers: Free of noise and distortion during operation and when in standby mode.

C. Functional Description Of Telephone/Intercommunication Systems

1. Integrated central system with the following:
    a. Direct-dial, full duplex private telephone communications between all locations equipped with telephones. Call initiation among master stations and between master and remote stations by dialing station's number on a 12-digit keypad.
    b. 16 channels for unrestricted simultaneous communications.
    c. Initial system operation with <**Insert number**> master and remote stations, expandable to 360 stations.
    d. Direct-dial, two-way amplified voice intercommunication between master telephones and remote stations without use of press-to-talk or talk-listen switches.
    e. Automatic queuing for intercommunication channels, with automatic call waiting.
    f. Call transfer among master stations.
    g. Display of selected station and answering calling station by pressing a single "response button."
    h. Simultaneous communication with other stations on system by dialing a designated number on a 12-digit keypad.
    i. Automatic gain control to ensure constant intercom speech level.
    j. Simultaneous distribution of emergency announcements to all locations equipped with speakers by dialing a predetermined code number.
    k. User-selectable facility for providing selected telephones with dial tone.
    l. User-selectable facility for permitting linkage of selected stations to media retrieval center and for permitting on- and off-premise computer linkage.
    m. Assignment of speaker locations within any one or more of eight zones for zone paging or time signal reception.
    n. Digital readout displays on which up to three incoming calls are displayed with additional calls stored for subsequent display.
    o. Off-site diagnostics through a serial data port on central-control station.
    p. Control of simultaneous distribution of program material to various combinations of remote stations or groups by using keypad to control sources and distribute programs.
    q. Operation and correction of secondary clocks and control of class-change signals to speakers and bells by using keypad.
    r. User-programmable features include the following:
        1) Station calling by room number.
        2) Room station call-in priority levels.
        3) Clock signal schedule functions.
        4) Schedule characteristics of audible signals.
        5) Call-in tone characteristic.
        6) Precedence among master stations as destinations for incoming calls from room stations.
        7) Grouping rooms and speakers into zones for paging and program distribution purposes.
    s. Telephone interconnect features include the following:
        1) Direct connection to central office trunk lines with initial system wiring for <**Insert number**> trunk lines.
        2) Routing of outside trunk lines for "attendant answer incoming" and "direct inward line" functions.
        3) Station programming for access to outside trunk lines to be any of the following:
            a) Totally unrestricted access.
            b) Restricted access.
            c) No access.
        4) System programming to allow or disallow local prefixes, and to authorize access for as many as three area codes.
        5) Discriminating ringing for identifying internal and outside calls.
        6) Circular hunting for outside trunks to prevent excess usage of any one trunk.
        7) Direct connection of a single trunk to designated telephone with transfer to attendant if unanswered.

8) Call parking allowing paged party to remotely pick up outside call from any master station.
9) Night-answer mode to allow one or all of the following:
   a) Incoming call transferred to predetermined extension.
   b) Tone transmitted to speakers to notify key personnel to answer telephone.
   c) Dial tone to remote stations to allow answering call from all locations.
10) Call control console to do as follows:
   a) Identify, answer, and route incoming outside calls, with reminder and recall features.
   b) Directly access outside trunk lines.
   c) Hold, park, and transfer calls.
   d) Screen outside calls.

2. Remote Stations:
   a. Speaker-Microphone Station:
      1) Having privacy from remote monitoring without a warning tone signal at monitored station. Designated speaker-microphone stations have a privacy switch to prevent another station from listening and to permit incoming calls.
      2) Communicating hands free.
      3) Calling master station by actuating call switch.
      4) Returning a busy signal to indicate that station is already in use.
3. Speakers: Free of noise and distortion during operation and when in standby mode.

D. General Requirements For Equipment And Materials
1. Coordinate features and select components to form an integrated system. Match components and interconnections for optimum performance of specified functions.
2. Expansion Capability: Increase number of stations in the future by 25 percent above those indicated without adding any internal or external components or main trunk cable conductors.
3. Equipment: Modular type using solid-state components, fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz. Comply with UL 813.
4. Weather-Resistant Equipment: Listed and labeled by an NRTL for duty outdoors or in damp locations.

E. Master Station For Manually Switched Systems
1. Station-Selector and Talk-Listen Switches: Heavy-duty type with gold-plated contacts rated for five million operations.
2. Volume Control: Regulates incoming-call volume.
3. LED Annunciation: Identifies calling stations and stations in use. LED remains on until call is answered.
4. Tone Annunciation: Momentary audible tone signal announces incoming calls.
5. Speaker Microphone: Transmits and receives calls.
   a. Minimum Speaker Sensitivity: 91 dB at one meter, with 1-W input.
6. Handset with Hook Switch: Telephone type with 18-inch- (450-mm-) long, permanently coiled cord. Arrange to disconnect speaker when handset is lifted.
7. Central-Equipment Cabinet: Comply with TIA/EIA-310-D. Lockable, ventilated metal cabinet houses terminal strips, power supplies, amplifiers, system volume control, and auxiliary equipment.

F. Master Station For Microprocessor-Switched Systems
1. 12-Digit Keypad Selector: Transmits calls to other stations and initiates commands for programming and operation.
2. Volume Control: Regulates incoming-call volume.
3. Tone Annunciation: Momentary audible tone signal announces incoming calls.
4. Lamp Annunciation: Identifies calling stations and stations in use. Lamp remains on until call is answered.

5. Speaker Microphone: Transmits intercom voice signals when used via a voice-operated switch.
    a. Minimum Speaker Sensitivity: 91 dB at one meter, with 1-W input.
6. Link Button: To transfer calls.
7. Reset Control: Cancels call and resets system for next call.
8. Digital Display: 16-digit alphanumeric LCD readout to register up to four three-digit station numbers.
9. Central-Equipment Cabinet: Comply with TIA/EIA-310-D. Lockable, ventilated metal cabinet houses terminal strips, power supplies, amplifiers, system volume control, and other switching and control devices required for conversation channels and control functions.

G. Call Control Console
1. Microprocessor-based instrument to process outside and internal calls with a 12-digit keypad selector.
2. 20-character alphanumeric display for the following:
    a. Simultaneous display of up to three calling stations plus last station dialed.
    b. Display of calls in order received with emergency calls taking precedence on the display.
    c. Review of calls stored in groups of four.
    d. Display of prompt messages to assist in system operation.
3. Programmable Keys: Minimum of 20 with LED indicators for ringing/busy status; programmable for trunk and operator functions.
4. Transfer Button: Calls to busy extensions and unanswered calls automatically returned to call control console.
5. Hold Button: With reminder feature every 30 seconds for parked calls or calls placed on hold.
6. Release Button: For use with parked calls or calls placed on hold.
7. Page Button: For engaging system paging functions.
8. Programmable for night answer, remote answer, and remote pickup features.
9. Programmable for distribution of emergency announcements, all-page announcements, zone-page announcements, and emergency/evacuation alert.
10. Central-Control Cabinet Equipment: Central switching equipment, central office adapter module, line link modules, power supplies, chassis adapters, and other switching and control devices required for trunk and internal conversation channels and control functions.

H. Speaker-Microphone Stations
1. Mounting: Flush unless otherwise indicated, and suitable for mounting conditions indicated.
2. Faceplate: Stainless steel or anodized aluminum with tamperproof mounting screws.
3. Back Box: Two-gang galvanized steel with 2-1/2-inch (64-mm) minimum depth.
4. Speaker: Minimum axial sensitivity shall be 91 dB at one meter, with 1-W input. Voice coil shall be not less than 3 inches (76 mm), 2.3 oz. (65 g) minimum; permanent magnet.
5. Tone Annunciation: Recurring momentary tone indicates incoming calls.
6. Call Switch: Mount on faceplate. Permits calls to master station.
7. Privacy Switch: Mount on faceplate. When in on position, switch prevents transmission of sound from remote station to system; when in off position, without further switch manipulation, response can be made to incoming calls.

I. Call-Switch Unit
1. Enclosure: Single-gang box with stainless-steel faceplate.
2. Call Switch: Momentary contact signals system that a call has been placed.
3. Privacy Switch: Prevents transmission of sound signals from station to system.
4. Volume Control: Operated by screwdriver blade through a hole in faceplate to adjust output level of associated speaker.

J. All-Call Amplifier
1. Output Power: 70-V balanced line. 80 percent of the sum of wattage settings of connected for each station and speaker connected in all-call mode of operation, plus an allowance for future stations.

2. Total Harmonic Distortion: Less than 5 percent at rated output power with load equivalent to quantity of stations connected in all-call mode of operation.
3. Minimum Signal-to-Noise Ratio: 60 dB, at rated output.
4. Frequency Response: Within plus or minus 2 dB from 50 to 12,000 Hz.
5. Output Regulation: Maintains output level within 2 dB from full to no load.
6. Input Sensitivity: Compatible with master stations and central equipment so amplifier delivers full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on master stations, speaker microphones, or handset transmitters.
7. Amplifier Protection: Prevents damage from shorted or open output.

K. Intercommunication Amplifier
1. Minimum Output Power: 15 W; adequate for all functions.
2. Total Harmonic Distortion: Less than 5 percent at rated output power with load equivalent to one station connected to output terminals.
3. Minimum Signal-to-Noise Ratio: 50 dB, at rated output.
4. Frequency Response: Within plus or minus 3 dB from 70 to 10,000 Hz.
5. Output Regulation: Maintains output level within 2 dB from full to no load.
6. Input Sensitivity: Matched to input circuit and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on microphones in master stations, speaker microphones, or handset transmitters.
7. Amplifier Protection: Prevents damage from shorted or open output.

L. Paging Amplifier
1. Input Voltage: 120-V ac, 60 Hz.
2. Frequency Response: Within plus or minus 3 dB from 60 to 10,000 Hz.
3. Minimum Signal-to-Noise Ratio: 60 dB, at rated output.
4. Total Harmonic Distortion: Less than 3 percent at rated output power from 70 to 12,000 Hz.
5. Output Regulation: Less than 2 dB from full to no load.
6. Controls: On-off, input levels, and low-cut filter.
7. Input Sensitivity: Matched to input circuit and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphones or handset transmitters.
8. Amplifier Protection: Prevents damage from shorted or open output.

M. Cone-Type Loudspeakers/Speaker Microphones
1. Minimum Axial Sensitivity: 91 dB at one meter, with 1-W input.
2. Frequency Response: Within plus or minus 3 dB from 70 to 15,000 Hz.
3. Minimum Dispersion Angle: 100 degrees.
4. Line Transformer: Maximum insertion loss of 0.5 dB, power rating equal to speaker's, and at least four level taps.
5. Enclosures: Steel housings or back boxes, acoustically dampened, with front face of at least 0.0478-inch (1.2-mm) steel and whole assembly rust proofed and factory primed; complete with mounting assembly and suitable for surface ceiling, flush ceiling, pendant or wall mounting; with relief of back pressure.
6. Baffle: For flush speakers, minimum thickness of 0.032-inch (0.8-mm) aluminum brushed to a satin sheen and lacquered **OR** with textured white finish, **as directed**.
7. Vandal-Proof, High-Strength Baffle: For flush **OR** surface, **as directed**,-mounted speakers, self-aging cast aluminum with tensile strength of 44,000 psi (303 MN/sq. m), 0.025-inch (0.65-mm) minimum thickness; countersunk heat-treated alloy mounting screws; and textured white epoxy finish.
8. Size: 8 inches (200 mm) with 1-inch (25-mm) voice coil and minimum 5-oz. (140-g) ceramic magnet.

N. Horn-Type Loudspeakers/Speaker Microphones
1. Speakers shall be all-metal, weatherproof construction; complete with universal mounting brackets.

2. Frequency Response: Within plus or minus 3 dB from 275 to 14,000 Hz.
3. Minimum Power Rating of Driver: 15 W, continuous.
4. Minimum Dispersion Angle: 110 degrees.
5. Line Transformer: Maximum insertion loss of 0.5 dB, power rating equal to speaker's, and at least four level taps.

O. Conductors And Cables
1. Conductors: Jacketed, twisted pair and twisted multipair, untinned solid copper. Sizes as recommended by system manufacturer, but no smaller than No. 22 AWG.
2. Insulation: Thermoplastic, not less than 1/32 inch (0.8 mm) thick.
3. Shielding: For speaker-microphone leads and elsewhere where recommended by manufacturer; No. 34 AWG, tinned, soft-copper strands formed into a braid or equivalent foil.
   a. Minimum Shielding Coverage on Conductors: 60 percent.
4. Plenum Cable: Listed and labeled for plenum installation.

P. Raceways
1. Educational Intercommunication and Program System Raceways and Boxes: Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems".
2. Educational Intercommunication and Program System Raceways and Boxes: Same as required for electrical branch circuits specified in Division 26 Section "Raceway And Boxes For Electrical Systems".
3. Educational Intercommunication and Program System Raceways and Boxes: EMT **OR** ENT **OR** RNC **OR** Optical-fiber/communication raceways and fittings **OR** Metal wireways **OR** Nonmetal wireways **OR** Surface metal raceways **OR** Surface nonmetal raceways, **as directed**.
4. Outlet boxes shall be not less than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.
5. Flexible metal conduit is prohibited.

1.3 EXECUTION

A. Wiring Methods
1. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used, **as directed**. Conceal raceway and cables except in unfinished spaces.
   a. Install plenum cable in environmental air spaces, including plenum ceilings.
   b. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway And Boxes For Electrical Systems".
2. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
3. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

B. Installation Of Raceways
1. Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems" for installation of conduits and wireways.
2. Install manufactured conduit sweeps and long-radius elbows whenever possible.

C. Installation Of Cables
1. Comply with NECA 1.
2. General Requirements:
   a. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.

b. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
c. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
d. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
e. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
f. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.

3. Open-Cable Installation:
   a. Install cabling with horizontal and vertical cable guides in telecommunication spaces with terminating hardware and interconnection equipment.
   b. Suspend speaker cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceiling by cable supports not more than 60 inches (1524 mm) apart.
   c. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.
4. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches (300 mm) apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

D. Installation
1. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.
2. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.
3. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.
4. Connect wiring according to Division 26 Section "Grounding And Bonding For Electrical Systems".

E. Grounding
1. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
2. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.
3. Install grounding electrodes as specified in Division 26 Section "Grounding And Bonding For Electrical Systems".

F. System Programming
1. Programming: Fully brief the Owner on available programming options. Record the Owner's decisions and set up initial system program. Prepare a written record of decisions, implementation methodology, and final results.

G. Field Quality Control
1. Perform tests and inspections.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

2. Tests and Inspections:
   a. Schedule tests with at least seven days' advance notice of test performance.
   b. After installing educational intercommunications and program systems and after electrical circuitry has been energized, test for compliance with requirements.
   c. Operational Test: Test originating station-to-station **OR** originating station-to-station, all-call, and page, **as directed**, messages at each intercommunication station. Verify proper routing and volume levels and that system is free of noise and distortion. Test each available message path from each station on system.
   d. Frequency Response Test: Determine frequency response of two transmission paths, including all-call and paging, **as directed**, by transmitting and recording audio tones. Minimum acceptable performance is within 3 dB from 150 to 2500 Hz.
   e. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:
      1) Disconnect speaker microphone and replace it in the circuit with a signal generator using a 1000-Hz signal. Measure signal-to-noise ratio at paging, **as directed**, speakers.
      2) Repeat test for three speaker microphones, one master station microphone, and for each separately controlled zone of paging loudspeakers.
      3) Minimum acceptable ratio is 45 dB.
   f. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 150, 200, 400, 1000, and 2500 Hz into each intercom **OR** intercom, paging, and all-call amplifier, **as directed**. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 5 percent total harmonics.
   g. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each paging zone. Maximum permissible variation in level is plus or minus 3 dB; in levels between adjacent zones, plus or minus 5 dB.
   h. Power Output Test: Measure electrical power output of each paging amplifier at normal gain settings of 150, 1000, and 2500 Hz. Maximum variation in power output at these frequencies is plus or minus 3 dB.
   i. Signal Ground Test: Measure and report ground resistance at system signal ground. Comply with testing requirements in Division 26 Section "Grounding And Bonding For Electrical Systems".
3. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging and independent room speaker-line matching transformers.
4. Educational intercommunications and program systems will be considered defective if they do not pass tests and inspections.
5. Prepare test and inspection reports.

END OF SECTION 27 51 43 00

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Task	Specification	Specification Description
27 51 43 00	26 33 43 00a	Public Address and Mass Notification Systems

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SECTION 27 52 23 00 - NURSE CALL

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for nurse call. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section includes visual/tone and audiovisual/voice nurse-call system.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
      a. Detail equipment cabinets and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      b. Cabling Diagrams: Single-line block diagrams showing cabling interconnection of all components for this specific equipment. Include cable type for each interconnection.
      c. Station Installation Details: For built-in equipment, dimensioned and to scale.
   3. Qualification Data: For qualified Installer.
   4. Field quality-control reports.
   5. Operation and Maintenance Data: For nurse-call equipment to include in emergency, operation, and maintenance manuals.
   6. Warranty: Sample of special warranty.

D. Quality Assurance
   1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
   2. Compatibility: System shall be capable of integration with any brand of phone system (wired or wireless), staff locating system, CCTV, and fire-alarm system.
   3. Electrical Components, Devices, and Accessories: Listed and labeled according to UL 1069 as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Warranty
   1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace batteries that fail in materials or workmanship within specified warranty period. Special warranty for batteries applies to materials only, on a prorated basis for specified period.
      a. Warranty Period: Include the following warranty periods, from date of Final Completion:
         1) Nickel-Cadmium Batteries, Lithium Batteries, and Wet-Cell Batteries:
            a) Full Warranty: Five years.
            b) Pro Rata: 15 years.

1.2 PRODUCTS

A. Nurse-Call System General Requirements
   1. Station Zones: Able to program 256 station zones for each master station in the network with eight priority levels and addressable visual and audible annunciation of audible devices such as smoke detectors and door contacts.
   2. System shall provide integrated and centralized "Code Blue" and "Staff Emergency" calls.

3. Expansion Capability: Equipment ratings, housing volume, spare keys, switches, relays, annunciator modules, terminals, and cable conductor quantities adequate to increase the number of stations in the future by 25 percent above those indicated without adding internal or external components or main trunk cable conductors.
4. Existing System Compatibility: Functionally and electrically compatible with existing system so components and wiring operate as an extension or upgrade of the existing system and existing or upgraded functional performance of the existing system applies to the entire final system. Colors, tones, types, and durations of signal manifestation shall be common among new and existing systems.
5. Resistance to Electrostatic Discharge: System, components, and cabling, and the selection, arrangement, and connection of materials and circuits, shall be protected against damage or diminished performance when subjected to electrostatic discharges of up to 25,000 V in an environment with a relative humidity of 20 percent or less.
6. Equipment: Microprocessor, electronic, modular.
7. Master Nurse-Call Station: Programmed via a PC.
8. Wall-Mounted Component Connection Method: Components connect to system wiring in back boxes with factory-wired plug connectors.
9. Telephone Interface: Permit use of wired and wireless telephones to execute nurse-call master station functions.
10. Third-Party Pager Interface: Programmable to send tone, numeric, and alphanumeric message to pocket pagers or personal digital assistants and to use industry standard-protocol, RS-485 interface.

B. Visual/Tone Nurse-Call System
1. Operational Requirements:
   a. Patient Station Call: Lights a steady call-placed lamp on the station, steady lamps in the zone light and corridor dome light associated with the patient's room, and steady lamps at the central annunciator and other system display devices and displays message on master and staff/duty stations. At the same time, it sounds a programmed tone at intervals, at the respective annunciator and master and staff/duty stations. Legends at the central annunciator and master station identify the calling station.
   b. Pull-Cord-Call Station Call: Flashes a call-placed lamp on the station and distinctive-color lamps in the zone light and corridor dome light and at the central annunciator and staff/duty stations. At the same time, it sounds a programmed tone at intervals, at the central annunciator and master and staff/duty stations. A legend at the master station identifies the calling station, priority as programmed, and bed identification.
   c. Emergency-Call Station Call: Produces the same responses as pull-cord-call station calls except rapidly flashing red emergency digital display and tone repetition rates are more frequent, tone frequency is higher, and lamps in the zone light and corridor dome light are a different color. Indicator lamps may be extinguished and the system reset only at the calling station. Displays message on pocket pagers, sounds programmed tone on phones, and displays message on display equipped phones.
   d. System Reset: Operating reset button at the originating station cancels signals associated with the call. Illuminates a green digital display on the patient station and log presence on the master station.
   e. Cord-Set Removal: Initiates a patient station call when the cord set is removed from the jack in the patient station faceplate. Displays location and "cord removed" message on master station, pocket pagers, and display equipped phones. Inserting a cord-set plug or a dummy plug into the jack and operating the station reset button resets the call.
   f. Patient Control Unit: Controls entertainment volume and channel selection. Nurse button on the unit initiates a patient station call. Integral speaker reproduces entertainment sound.
   g. Emergency Bath Station Call: Illuminates the digital display on the emergency bath station; rapidly flashes white dome lamp; displays location, priority, and bath on master

station; and sounds programmed tone on master station display equipped phones and pocket pagers.

h. Staff/Duty Station Operation: Operation shall be identified to patient station except the message staff shall display on all devices when the staff call button is activated.

i. Privacy Key Activation: When privacy key is activated on patient station, the system shall disconnect the patient station microphone and slowly flash yellow privacy digital display on the patient station. Displays "privacy" on master station when selecting this room/bed.

2. Central Annunciator:
   a. Lamp type.
   b. Lamp Legends: Machine lettered and legible from a distance of at least 48 inches (1200 mm) when a call is present. Legend shall identify initiating station and priority of call.
   c. Power-on Indicator: Digital, or push-to-test switch.
   d. Audible Signal: Electronic tone.
3. Central Equipment Cabinet:
   a. Lockable metal.
   b. Houses power supplies, controls, terminal strips, and other components.
   c. Power-on indicator lamp.
   d. Battery Backup Unit: Sealed nickel-cadmium, wet-cell battery supplies power through an automatic switch when normal power fails, for a period of not less than six minutes at rated output. System shall lose no unanswered calls or calls in progress during the transfer operation.
      1) Automatic retransfer to normal power, after a 15-minute time delay.
      2) Two-rate battery charger with an automatic trickle rate and a recharge rate.
4. Single-Patient Station: Call-placed lamp, reset push button, and polarized receptacle matching cord-set plug; mounted in a single faceplate.
5. Dual-Patient Station: Single call-placed lamp, single reset push button, and two polarized receptacles matching cord-set plug; mounted in a single faceplate.
6. Ambulatory-Patient Station: Call push-button switch, call-placed lamp, and reset push button; mounted in a single faceplate.
7. Staff/Duty Stations: A minimum of two call lamps, one for routine calls and one for emergency calls; and an audible tone signal device.

C. Audiovisual/Voice Nurse-Call System
1. Operational Requirements:
   a. Station Selection from Master Station: Capable of selectively communicating with other stations or groups of stations on its system by touch screen, mouse click, or manual switch; and capable of programming up to 256 stations for each master station in the network.
   b. Master Station Privacy: Capable of conversing with individual stations in complete privacy.
   c. Called Station:
      1) Capable of hands-free and two-way conversation.
      2) Pressing "talk/listen" key shall cause the annunciation tone to cease.
      3) Pressing "cancel" key terminates normal calls and conversations.
      4) Terminating of high-priority level 1 **OR** 2 **OR** 3 **OR** 4, **as directed**, shall not be allowed except at calling station location and shall send "remind" message if the call is not acknowledged at point of origin in programmed time frame.
   d. Annunciation:
      1) At the master station, a programmable tone announces an incoming call; an annunciator light or digital display identifies the calling station and indicates the priority of the call.
      2) Call type indications include alarm assist, bath, bed, code, communication fault, cord out, door, emergency, and fire.
      3) Memory lamps or lighted displays identify stations selected for outgoing calls.
   e. System Reset at Master Station: A normal, incoming call can be canceled, associated lights and audible tones extinguished, and the system reset when the station switch is returned to the normal position.

f. Patient Station Calls:
   1) Lights the call-placed lamp at patient station, zone, and corridor dome lights.
   2) Sounds a tone and lights the call lights at staff/duty stations and actuates annunciation at the master station.
   3) When the calling station is selected at the master station, the patient can converse with the master station without moving and without raising or directing the voice.
   4) During voice communications, entertainment audio at the calling station is automatically muted.
g. Pull-Cord-Call Station Calls and Emergency-Call Station Calls:
   1) Lights call-placed lamp and corridor dome light and flashes zone light.
   2) Master station tone pulses and annunciator light for that room flashes.
   3) When master station acknowledges the call by touch screen or switch, the tone stops but lights continue to flash until the call is canceled at the initiating point.
h. Code Blue and Staff/Duty Station Calls:
   1) Lights the call-placed lamp at the station and actuates annunciation at the master station.
   2) When the called station is selected at the master station, the caller and the master station operator can converse.
   3) Code Blue: Unique sound and light pattern indicating the highest priority emergency.
   4) Staff Station: Unique sound and light pattern indicating an emergency.
   5) Duty Station: Sound and light pattern indicating a call to the nurse station.
i. Handset Operation: Lifting the handset on master station disconnects speaker/microphone and transfers conversation to the handset.
j. Station Privacy: No patient or staff/duty station can be remotely monitored without lighting a warning lamp at the monitored station.
k. Patient Station Cord-Set Removal:
   1) A patient station call is initiated as described above when a patient station cord-set plug is removed from the jack in the station faceplate.
   2) Tone stops but lights continue to flash until the call is canceled at the initiating point or the plug is reinserted or replaced with a dummy plug when the master station call button for the station is pressed.
l. Patient Control Unit:
   1) Controls entertainment volume and channel selection.
   2) Speaker is used for both nurse communication and entertainment sound.
   3) Entertainment sound is automatically muted when station is communicating with master station.
   4) Nurse button on the unit initiates a patient station call.
m. Selective Paging: Master station is capable of initiating a message to selected groups of stations or speakers simultaneously by using station group switches.
n. Staff Reminder:
   1) Master station can initiate a staff reminder that a patient requires direct staff response by operating a reminder control while in contact with the patient station.
   2) This reminder will light a distinctive-color lamp in the corridor dome light at the patient's room and in the appropriate zone lights.
   3) Reminder calls are canceled by operating a staff reminder cancel switch in the patient's room.
o. Call Priority Indication:
   1) Capable of eight call priority levels in addition to normal.
   2) Call priority switch near each patient station, or integral with the master station, shall control priority status of the call transmitted by individual stations.
   3) Switch selects one of the following status levels:
      a) Normal: No change to the normal call initiation and canceling sequence.

b) Emergency: Call initiation produces signals and indications identical to those of emergency-call stations. Indicator lamps are extinguished and the system is reset only at the originating station.
c) Priority: System response is the same for emergency status except voice communication between the master station and the calling station is locked in from the time of call initiation until the system is reset at the originating station.

p. Additional Call:
1) Waiting display window on the master station similar to current call window displays incoming calls.
2) Master station shall have a call-overflow indicator when incoming calls exceed <**Insert number**> calls.
3) System shall store unlimited number of incoming calls.
4) System shall be capable of automatically answering incoming calls in order of priority.

q. Calling Intercom Stations:
1) Master station shall be capable of calling any intercom station using the handset or the hands-free speaker/microphone.
2) Receipt of a call at the intercom station shall be preceded by an optional pre-announce tone.
3) If there is a call in process, system shall place the active call on automatic hold while the new call is placed, then reestablish the previous call when the new call has ended.

r. Privacy Override:
1) Temporarily deactivates the "Privacy" mode of a called station by calling the station and instructing the called party to press the call-cord button.
2) On completion of the conversation, the called station shall automatically return to the "Privacy" mode.
3) When in "Privacy" mode, a called station shall be capable of hearing the master station; however, the master station shall not be capable of hearing the called station; a privacy message shall be indicated on the master station display.

s. Master-Station-to-Master-Station Calls:
1) Master stations shall be capable of calling other master stations using the handset.
2) Calls from master stations shall be answered using the handset only.
3) Busy master stations shall be indicated by a master station intercom busy tone.

t. Voice Paging:
1) Capable of voice paging to all stations using a single "All Call" key. The page shall be preceded by an optional pre-announce tone, **as directed**.
2) Capable of voice paging to eight user-defined groups of stations by selecting the group and then the "All Call" key. The page shall be proceeded by a pre-announce tone, **as directed**.
3) Capable of voice paging to all staff/duty stations and all patient stations where staff has registered presence using a single "Public Address (PA)/Staff" key. The page shall be proceeded by a pre-announce tone, **as directed**.
4) Capable of voice paging through a third-party PA system.
5) Capable of including or excluding any station from the voice paging function(s).
6) Automatically places an active station call on hold during any page and reestablishes the connection at the end of the page.
7) Automatically cancels a page if the talk mode is inactive for more than 15 seconds.

u. Station Monitor:
1) An audio monitor feature shall allow a user to sequentially or simultaneously listen to one or all stations that are included in the user-created list.
2) Master station display shall indicate which station is being monitored when in sequential mode.
3) The dwell time each station is monitored shall be user programmable.
4) The user shall be able to stop the monitoring sequence by activating a "pause" key.

5) The user shall be able to manually sequence through stations using a "next" key.

v. Night Service:
   1) Functions shall be adaptable for nighttime staffing levels, patient traffic, and day/night operations.
   2) Staff Follow:
      a) Capable of locating roving staff; forwarding visual and audible annunciation of incoming calls to station(s) where personnel have registered presence.
      b) Master station shall display locations where staff have registered presence.
      c) Incorporates a programmable timer that automatically cancels a forgotten staff presence registration.
   3) Tones:
      a) Deactivates audio signals from a duty station and mini-master display telephones.
      b) Capable of changing the tone volume at the master and duty stations.
      c) Satellite function shall permit the user to deactivate audio signals from duty stations and other remote annunciator devices.
   4) Transfer:
      a) Permits one nurse station to take control of all or individually selected bed call cords from another nurse station. It shall be possible to view transfer status of a nurse station.
      b) Includes a minimum of three transfer modes to allow one nurse station to take control or share calls and operations from another nurse station.
         i. Parallel Transfer Mode: Permits both nurse stations to share all calls and operations.
         ii. Supervised Transfer Mode: Permits the transferred nurse station to share all calls and operations with the controlling nurse station; however, the controlling nurse station calls are not shared with the transferring station.
         iii. Capture Transfer Mode: Transfers all calls and operations from the transferred nurse station to the controlling nurse station.
         iv. Transferred station shall have no control over calls, and its display shall indicate calls have been transferred to another station.
      c) Includes two "patient swing" modes to allow one nurse station to take control or share calls from one or many calls from another nurse station.
         i. Supervised Transfer Mode: Permits the transferred calls to be shared with the controlling nurse station.
         ii. Capture Transfer Mode: Transfers all calls from the call cord from the transferred nurse station to the controlling nurse station.
         iii. Transferred station has no control over those transferred calls.

w. Service Request:
   1) Permits users to assign a service request to a substation, at programmable priority level.
   2) Displays service request on the nurse station display and light the green flashing corridor lamp at the respective substation and automatically generate a service reminder request.
   3) Cancels service requests only at the initiating point.
   4) Recall calls shall sound and be displayed at the master station if the service request has not been cancelled at the initiating point within the programmed period of time.

x. Call Reminder Function:
   1) Automatically generates a reminder call for a patient- or staff-initiated, high-priority 2 **OR** 3 **OR** 4, **as directed**, request that has had the call tones silenced, allowing time to physically attend to the request and cancel the call at the initiating point.
   2) Regenerated calls shall display the same tones and visual indications and priority as the original call and shall also display a "regenerated call" message.
   3) Capable of manually adding low-priority calls to the reminder list.

4) "Call Reminder" function and reminder timer shall be programmable by call priority.

y. Hide Function: Prevents a selected station from displaying calls or generating tones on the nurse station.

z. Door Control Function: Capable of being programmed to enable the user to remotely activate electric door locks.

aa. Test and Diagnostics Feature:
1) Able to automatically diagnose system faults and categorize them as warnings, communication errors, or fatal errors.
2) Warnings shall indicate possible system problems.
3) Communication errors shall indicate the inability of the master station to communicate with a substation or another nurse-call station.
4) Fatal errors shall indicate a major hardware or software failure.

bb. User-Configured System Programming - Access Code Not Required:
1) Patient call-cord priority levels.
2) Monitor list.
3) "All Call" list.
4) Master station communication parameters (volume, filtering, talk/listen, sensitivity).
5) Master and duty station call annunciation tone volume.
6) Date/time.
7) Staff-follow operating mode.
8) Transfer type.
9) Pocket pager list assignment.
10) Presence mode.

cc. User-Configured System Programming - Access Code Required:
1) Master station number.
2) Room device type.
3) Room number.
4) Bed number.
5) Bed alpha or numeric.
6) Reminder duration.
7) Staff presence registration cancel duration.
8) Display language.
9) Paging group assignment(s).
10) Zone group assignments.
11) Monitoring duration.
12) Pocket pager number.
13) Call tone assignment by priority.
14) Pretone activation.
15) Call tones minimum volume.
16) Clock mode (12 h/24 h).

2. Master Station:
a. Speaker/microphone unit with operating controls.
b. Indicator lamps with legends or by digital display designate identification and priority of calling stations and called stations.
c. Pulse rate of incoming-call lights denotes priority of calls awaiting response.
d. Station Selection Controls: Touchpad select stations for two-way voice communications.
e. Signal Tones: Programmable to announce incoming calls.
f. Pulse rate and frequency of tone identify the highest priority call awaiting response at one time.
g. Volume Control: Regulates incoming-call volume.
h. Privacy Handset with Hook Switch: Of the type that does not require push-to-talk switch attached to each station unless otherwise indicated.
i. Staff Reminder Control: Initiates flashing of corresponding corridor dome lights for patients requiring service. Permits scanning equipment to indicate which patients are currently in reminder status.

j. Call Priority Selection: Controls associated with patient-station selection switches determine the priority displayed when a call is initiated at a patient station.

3. Central Equipment Cabinet:
   a. Lockable metal.
   b. Houses amplifiers, tone generators, power supplies, controls, terminal strips, and other components.
   c. Amplifier: With fidelity and overall gain necessary to achieve the sound-transmission and reproduction characteristics specified, considering interoperability with the installed speakers/microphones and wiring.
      1) Power Output: Not less than 3 W at a total harmonic distortion not exceeding 5 percent.
      2) Hum and Noise: 60 dB below full output with normal input open.
      3) Volume Control: Concealed within the amplifier unit to control the volume of sound reproduced at all stations.
      4) Protection: Circuit to prevent damage to the amplifier in case of shorted or open circuit.
   d. Selective Paging Amplifiers: Plug-in card mounted in central equipment cabinet, rated 15 W.
   e. System Power Supply:
      1) 24-V dc for operation of the call system.
      2) Equipment Rating: Suitable for continuous operation between 32 and 120 deg F (0 and 49 deg C), from a primary line voltage between 105- to 125-V ac, 60 Hz.
      3) Output: Regulated 24-V dc with protection against overloads. Line-to-load regulation shall not exceed 2-1/2 percent with ripple and noise remaining below the 10-mV, rms level.
      4) Overload Protection: Electronic fold-back circuit set to limit the volt-ampere output to less than 100 VA during overloaded or shorted output. Restore power output automatically on removal of overload without resetting circuit breakers or replacing fuses.
   f. Power-on indicator lamp.
   g. Surge Protector Device: Comply with Division 26 Section "Transient-voltage Suppression For Low-voltage Electrical Power Circuits" for auxiliary panel suppressors, with digital indicator lights for power and protection status.
   h. Battery Backup Unit: Sealed nickel-cadmium, wet-cell battery supplies power through an automatic switch when normal power fails, for a period of not less than six minutes at rated output.
      1) Automatic retransfer to normal power, after a 15-minute time delay.
      2) Two-rate battery charger with an automatic trickle rate and a recharge rate.
4. Speaker/Microphones:
   a. Type: Permanent-magnet, dynamic or ceramic, protected against dust and humidity.
   b. Sound Reproduction: Sound level of 90 dB plus or minus 3 dB at a distance of 48 inches (1220 mm) on the axis without overdriving or distorting any frequencies between 300 and 3000 Hz when installed in an enclosure or in the pillow speaker.
   c. Power Handling Capacity: Not susceptible to damage from overdriving within the range of power available from the amplifier.
   d. Impedance Matching: Coordinated and matched to the input and output circuits of the amplifier, both for single connection and for group monitoring, to provide the sound reproduction specified. Subsystems or components shall not be combined, which could cause unacceptable distortion such as feedback between pillow speakers and unmuted room speaker/microphone combinations. This protection shall extend throughout the entire range of operation (volume control) of all components.
5. Single-Patient Station: Speaker/microphone with 2-inch (50-mm) dynamic cone, a polarized receptacle to match the cord-set plug, monitor lamp, reset switch, and call-placed lamp; assembled under a single faceplate.
6. Dual-Patient Station:

a. Speaker/microphone with 2-inch (50-mm) dynamic cone, two polarized receptacles to match cord-set plugs, monitor lamp, and reset switch; assembled under a single faceplate.
b. Single call-placed lamp serves both beds.
OR
Dual call-placed lamps, one for each bed.

7. Staff/Duty Stations: Audible call-tone signal device, speaker/microphone with 2-inch (50-mm) dynamic cone, monitor lamp, reset switch, routine-call lamp, emergency-call lamp, and call push button; assembled under a single faceplate.
8. Code Blue Station: Audible call-tone signal device, speaker/microphone with 2-inch (50-mm) dynamic cone, monitor lamp, reset switch, Code Blue emergency-call lamp, and call push button; assembled under a single faceplate.
9. Ambulatory-Patient Station: Speaker/microphone with 2-inch (50-mm) dynamic cone, monitor lamp, reset switch, call-placed lamp, and call push button; assembled under a single faceplate.
10. Selective Paging Speakers: 8-inch (200-mm) cone type with 1-inch (25-mm) voice coil and minimum 5-oz. (140-g) ceramic magnet, multitap matching transformer, flush-mounted steel back-box, and white enamel-finished metal ceiling grille.
11. Call Priority Switch Station: Three-position, tamper-resistant priority selection switch. Positions designated by labeling "Normal," "Emergency," and "Priority."
12. Staff Reminder Cancel Switch Station: Momentary contact.

D. System Components

1. Emergency-Call Station: Locking-type push button, labeled "Push to Call Help"; reset trigger to release push button and cancel call; and call-placed lamp, mounted in a single faceplate.
2. Emergency-Bath Station:
   a. Consists of a sliding, chemical-resistant, ABS red fascia marked with the word "URGENT" in bold letters.
   b. Capable of being activated with nylon pull cord or by sliding the face of the unit downwards.
   c. Activation of the station shall illuminate a reassurance digital display on the face of the unit in addition to notifying the master station.
   d. Water resistant and able to withstand routine cleaning and chemical disinfectants.
   e. Uses magnetic reed switch technology for reliability and corrosion resistance.
   f. Mounts on a single-gang electrical box wire to the respective patient station or input controller.
3. Code Blue Station:
   a. Consists of a sliding, chemical-resistant, ABS blue fascia marked with the word "CODE" in bold letters.
   b. Capable of being activated with nylon pull cord or by sliding the face of the unit downwards.
   c. Activation of the station shall illuminate a reassurance digital display on the face of the unit in addition to notifying the master station.
   d. Water resistant and able to withstand routine cleaning and chemical disinfectants.
   e. Uses magnetic reed switch technology for reliability and corrosion resistance.
   f. Mounts on a single-gang electrical box wire to the respective patient station or input controller.
4. Staff, Emergency Station:
   a. Consists of a sliding, chemical-resistant, ABS red fascia marked with the word "EMERGENCY" in bold letters.
   b. Capable of being activated with nylon pull cord or by sliding the face of the unit downwards.
   c. Activation of the station shall illuminate a reassurance digital display on the face of the unit in addition to notifying the master station.
   d. Mounts on a single-gang electrical box wire to the input controller.
5. Pull-Cord-Call Station:
   a. Pull-Down Switch: Lever-locking type, labeled "Pull Down to Call Help."
   b. Reset trigger.

c. Call-placed lamp.
d. Water-resistant construction.
6. Patient Control Unit:
a. Equipped with plug and 96-inch- (2400-mm-) long white cord.
b. Ethylene oxide, sterilizable.
c. Light-Control Switch: Arranged for independent on-off control of patient's up and down light.
d. Integral Speaker: 2 inches (50 mm), with 0.35-oz. (9.9-g) magnet, rated 0.2 W.
e. Controls: Speaker volume, TV control, and nurse call.
f. Housing: High-impact white plastic.
g. Attachment: Stainless-steel bed clamp with permanently attached polyester film strap.
h. Quantity: 12 units for every 10 patient beds.
7. Call-Button Cord Set:
a. Plug and 72-inch (1800-mm) white cord; cord set shall be resistant to medical gas environment equipped with momentary-action, call-button switch.
b. Ethylene oxide, sterilizable.
c. Washable cord.
d. Palladium switch contacts in high-impact white housing with cord-set strain relief.
e. Attachment: Stainless-steel bed clamp with permanently attached polyester film strap.
f. Quantity: Three cord sets for every 10 patient beds.
8. Geriatric Call-Button Cord Set:
a. Plug and 72-inch (1800-mm) white cord.
b. Resistant to medical gas environment equipped with momentary-action, light-pressure switch in soft outer jacket.
c. Ethylene oxide, sterilizable.
d. Washable cord.
e. Palladium switch contacts in high-impact white housing with cord-set strain relief.
f. Attachment: Stainless-steel bed clamp with permanently attached polyester film strap.
g. Quantity: Two cord sets for every 10 patient beds.
9. Squeeze-Bulb Switch Cord Set:
a. Plug and 72-inch (1800-mm) washable tube with white cord set.
b. Resistant to medical gas environment; washable; equipped with neoprene squeeze-bulb activator, and plug-mounted, momentary contact switch.
c. Ethylene oxide, sterilizable.
d. Attachment: Stainless-steel bed clamp with permanently attached polyester film strap.
e. Quantity: Two cord sets for every 10 patient beds.
10. Breath Call Cord:
a. Flexible PVC jacketed cable and a momentary contact air-pressure sensitive switch.
b. Cord: 108 inches (2700 mm) long.
c. Include an adjustable arm for clamping and suitable for use in oxygen atmospheres.
d. Include 12 replacement straws.
11. Pillow Speakers:
a. Eight-conductor, DIN, flexible PVC jacketed cable.
b. Contain nurse-call button, volume control, speaker, and channel control in molded flame-retardant ABS housing.
c. Cord: 96 inches (2400 mm) long with sheet clip.
12. Call-Button Plug:
a. Designed to plug into patient station cord-set receptacle.
b. Button switches call circuit.
c. Two plugs for every 10 patient beds.
13. Dummy Plugs:
a. Designed to plug into patient station cord-set receptacle when call-button plug or patient cord set is not used.
b. Three plugs for every 10 patient beds.
14. Indicator Lamps: Digital type with rated life of 20 years unless otherwise indicated.

15. Station Faceplates:
    a. Stainless steel, a minimum of 0.0375 inch (0.95 mm) thick.
    b. Finish: Brushed.
    c. Machine-engraved labeling identifies indicator lamps and controls.

    OR

    Station Faceplates:
    a. High-impact plastic.
    b. Color: Beige.
    c. Molded or machine-engraved labeling identifies indicator lamps and controls.
16. Corridor Dome Lights and Zone Lights:
    a. Three-lamp signal lights.
    b. Lamps: Front replaceable without tools, low voltage with rated life of 7500 hours. Barriers are such that only one color is displayed at a time.
    c. Lenses: Heat-resistant, shatterproof, translucent polymer that will not deform, discolor, or craze when exposed to hospital cleaning agents.
    d. Filters: Two per unit, amber and red.
17. Cable:
    a. Conductors: Jacketed single and multiple, twisted-pair copper cables.
    b. Sizes and Types: As recommended by equipment manufacturer.
    c. Cable for Use in Plenums: Listed and labeled for plenum installation.
18. Grounding Components: Comply with requirements in Division 26 Section "Grounding And Bonding For Electrical Systems".

E. Software Requirements
1. Telephone System Interface:
    a. Permits use of wired and/or wireless telephones to execute nurse-call master station.
    b. Two-way communication with patient and staff stations.
    c. Two-way communication with the master nurse station.
    d. "All Call," group call, and staff call paging.
    e. Capable of being programmed to forward calls destined for a master nurse station to any connected telephone.
    f. Telephones connected to the telephone interface shall have the same call tone ring patterns as those generated at the master nurse station.
    g. Telephones having a display shall indicate the call type, priority code, and the calling station number of incoming calls.
    h. Telephones shall be capable of initiating a service request for a particular patient station, logging calls on the master station's reminder list, and activating door lock mechanisms associated with a call station.
    i. Capable of routine setup and configuration changes using the keypads on display telephone and/or the master station.
2. Display Telephones:
    a. Digital telephones for use as mini-master nurse-call stations.
    b. Digital display shall indicate the call type, priority code, and calling station number of incoming calls.
    c. Ring patterns shall be identical to those generated at the master station.
    d. Capable of two-way communication with patient and staff stations and the master station, and other telephones interfaced with the system.
    e. Capable of placing or answering outside calls when interfaced with the facility telephone system.
    f. Capable of "All Call," group call, and staff call paging and of initiating service requests, logging calls to the reminder list, and activating optional door controls.
3. Third-Party Pocket Pager Interface:
    a. Equipped with a standalone pocket pager interface.
    b. Connects with the facility paging system and transmit alphanumeric messages to the pocket pagers as preprogrammed in the system.
4. Statistical Software:

a. Includes a data statistical software package that stores, sorts, and analyzes activities occurring on the nurse-call system network.
b. Windows based and operated on a PC that is connected to the nurse-call system network.
c. Stores events on the PC's hard disk. Accumulation of these stored events shall make up the database that is used to generate reports and statistics.
d. Events stored by the software shall include date, day of week, time, ward, priority, and room number.
e. Capable of assigning a patient name to bed number.
f. Stored events shall include, but not be limited to, calls placed, call priority, calls cancelled at the nurse station, calls cancelled at the point of origin, regenerated calls, calls answered, calls sent to pager interface, staff presence registration, staff presence cancellation, service request, service cancellation, and system and network error messages.

5. Data Analysis Software:
a. Capable of analyzing the stored information and generating computed analysis.
b. Analysis of the database can be conducted by specifying one, many, or all of the following parameters of the database: date, day of week, time, wards, priority, and room number.
c. Analysis shall include, but not be limited to, total number of calls placed, average call response time (from call placed to call cancellation), total number of presence registrations, average presence time in a room, total number of service requests, average response time (from audio answer to call cancellation), and average ring time (from call placed to audio answer).

6. Statistical Software Package:
a. Capable of displaying multiple calls/events on a PC monitor or on a RS-485 data-bus-driven digital display panel.
b. Calls from patient or staff stations and associated devices shall be displayed by priority. Display shall be customizable as follows:
1) Choice of color by type of call.
2) Choice of display size (character size).
3) Choice of priority levels, type of events, points of origin.
4) Identification of facility.
5) Identification of ward.
6) Identification of patient with specific patient information.

F. Conductors And Cables
1. Audio Cables:
a. Conductors: Jacketed, twisted-pair and twisted-multipair, untinned solid copper. Sizes as recommended by system manufacturer, but no smaller than No. 22 AWG.
b. Insulation: Thermoplastic, not less than 1/32 inch (0.8 mm) thick.
c. Shielding: For speaker/microphone leads and elsewhere where recommended by manufacturer; No. 34 AWG, tinned, soft-copper strands formed into a braid or equivalent foil.
d. Minimum Shielding Coverage on Conductors: 60 percent.
e. Plenum Cable: Listed and labeled for plenum installation.
2. Data Cable and Hardware: Category 5e **OR** Category 6, **as directed**, UTP and UTP hardware. Comply with requirements in Division 27 Section "Communications Horizontal Cabling".
3. Power Conductors and Cables: Copper, solid, No. 20 AWG. Comply with requirements in Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
4. Grounding Conductors and Cables: Copper, stranded, No. 16 AWG. Comply with requirements in Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

1.3 EXECUTION

A. Installation
1. Wiring Method:

a. Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used, **as directed**.
   1) Install plenum cable in environmental air spaces, including plenum ceilings.
   2) Conceal raceway and cables except in unfinished spaces.
b. Cable Trays: Comply with requirements in Division 27 Section "Communications Horizontal Cabling".
c. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems". Flexible metal conduit shall not be used, **as directed**.
   1) Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

2. Install cables without damaging conductors, shield, or jacket.
3. Do not bend cables, while handling or installing, to radii smaller than as recommended by manufacturer.
4. Pull cables without exceeding cable manufacturer's recommended pulling tensions.
   a. Pull cables simultaneously if more than one is being installed in same raceway.
   b. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
   c. Use pulling means, including fish tape, cable, rope, and basket-weave wire or cable grips, that will not damage media or raceway.
5. Install exposed raceways and cables parallel and perpendicular to surfaces or exposed structural members, and follow surface contours. Secure and support cables by straps, staples, or similar fittings designed and installed so as not to damage cables. Secure cable at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, or fittings.
6. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
7. Separation of Wires: Separate speaker/microphone, line-level, speaker-level, and power-wiring runs. Run in separate raceways or, if exposed or in same enclosure, provide 12-inch (300-mm) minimum separation between conductors to speaker/microphones and adjacent parallel power and telephone wiring. Provide separation as recommended by equipment manufacturer for other conductors.
8. Splices, Taps, and Terminations: Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Install terminal cabinets where there are splices, taps, or terminations for eight or more conductors.
9. Impedance and Level Matching: Carefully match input and output impedances and signal levels at signal interfaces. Provide matching networks if required.
10. Identification of Conductors and Cables: Comply with requirements in Division 27 Section "Communications Horizontal Cabling" for cable administration, cable schedule, and cable and wire identification.
11. Equipment Identification:
    a. Comply with requirements in Division 26 Section "Identification For Electrical Systems" for equipment labels and signs and labeling installation requirements.
    b. Label stations, controls, and indications using approved consistent nomenclature.

B. Existing Systems
1. Examine existing systems for proper operation, compatibility with new equipment, and deficiencies. If discrepancies or impairments to successful connection and operation of interconnected equipment are found, report them and do not proceed with installation until directed. Schedule existing systems' examination so there is reasonable time to resolve problems without delaying construction.

C. Grounding
1. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other signal impairments.

2. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding except at connection to main building ground bus.
3. Grounding Provisions: Comply with requirements in Division 26 Section "Grounding And Bonding For Electrical Systems".

D. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
    a. Schedule tests a minimum of seven days in advance.
    b. Report: Submit a written record of test results.
    c. Operational Test: Perform an operational system test and demonstrate proper operations, adjustment, and sensitivity of each station. Perform tests that include originating station-to-station and "All Call" messages and pages at each nurse-call station. Verify proper routing, volume levels, and freedom from noise and distortion. Test each available message path from each station on the system. Meet the following criteria:
        1) Speaker Output: 90 dB plus or minus 3 dB, 300 to 3000 Hz, reference level threshold of audibility 0 dB at 0.02 mPa of sound pressure.
        2) Gain from patient's bedside station to nurse station, with distortion less than 65 dB (plus or minus 3 dB, 300 to 3000 Hz).
        3) Signal-to-Noise Ratio: Hum and noise level at least 45 dB below full output.
    d. Test Procedure:
        1) Frequency Response: Determine frequency response of two transmission paths by transmitting and recording audio tones.
        2) Signal-to-Noise Ratio: Measure the ratio of signal to noise of the complete system at normal gain settings using the following procedure: Disconnect a speaker/microphone and replace it in the circuit with a signal generator using a 1000-Hz signal. Measure the ratio of signal to noise and repeat the test for four speaker microphones.
        3) Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 300, 400, 1000, and 3000 Hz into each nurse-call equipment amplifier, and measure the distortion in the amplifier output.
3. Retesting: Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense. Verify, by the system test, that the total system meets these Specifications and complies with applicable standards. Report results in writing.
4. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
5. Prepare test and inspection reports.

E. Adjusting
1. Occupancy Adjustments: When requested within 12 months of date of Final Completion, provide on-site assistance in adjusting sound levels and controls to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal operating hours for this purpose.

F. Demonstration
1. Train Owner's maintenance personnel and caregiver staff to adjust, operate, and maintain nurse-call equipment.

END OF SECTION 27 52 23 00

SECTION 27 53 13 13 - CLOCK AND PROGRAM CONTROL

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for clock and program control. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
2. Master clock and program control unit.
3. Secondary indicating clocks.
4. Program signal devices.
5. Clock circuit power boosters.
6. Interface with intercom and public-address system.
7. System wire and cable.

C. Definitions
1. NIST: The National Institute of Science and Technology.
2. PC: Personal computer.
3. UTC: Universal time coordinated. The precisely measured time at zero degrees longitude; a worldwide standard for time synchronization.

D. Performance Requirements
1. Seismic Performance: Master clock and housing shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

E. Submittals
1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes (including available colors) for each product indicated and describe features and operating sequences, both automatic and manual.
2. Shop Drawings: For clock systems. Include plans, elevations, sections, details, and attachments to other work.
   a. Wiring Diagrams: For power, signal, and control wiring and correction circuits.
      1) Identify terminals and wiring color codes to facilitate installation, operation, and maintenance.
      2) Indicate recommended wire types and sizes, and circuiting arrangements for field-installed system wiring. Show protection from overcurrent, static discharge, and voltage surge.
   b. Details of seismic restraints including mounting, anchoring, and fastening devices for the following system components:
      1) Surface-mounted and semirecessed secondary indicating clocks.
      2) Master clock enclosures **OR** mounting racks, **as directed**.
      3) Clock circuit power boosters.
   c. Details of seismic strengthening of master clock enclosures **OR** mounting racks, **as directed**.

d. Dimensioned Outline Drawings of the Mounting Rack for the Master Clock: Show internal seismic bracing, and locate center of gravity of fully equipped and assembled unit. Locate and describe mounting and anchorage provisions.

3. Delegated-Design Submittal: For the master clock and housing indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   a. Detail fabrication and assembly of the master clock and housing.
   b. Design Calculations: Calculate requirements for selecting seismic restraints.
4. Seismic Qualification Certificates: For the master clock, accessories, and components, from manufacturer.
5. Field quality-control reports.
6. Operation and maintenance data.

F. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NFPA 70.

1.2 PRODUCTS

A. Master And Secondary Clock System
1. System Functions and Features:
   a. Supply power to remote indicating clocks except those indicated to have correction signals applied through a data circuit.
   b. Maintain correct synchronized time and transmit time-correction signals over dedicated system wiring from a master clock to any one **OR** two, **as directed**, type(s) of secondary indicating clocks, including the following:
      1) Analog Synchronous Clocks: Correct for minute- and second-hand synchronization at least once each hour and for hour-hand synchronization at least once each day.
      2) Digital Clocks: Test clocks automatically for synchronization with master time control at least once every hour and automatically correct those not synchronized with the time reference unit. Automatically correct clocks immediately when power is restored after an outage of power to the master clock.
   c. Initiate and execute programs for scheduled automatic operation of remote devices. Include audible signal devices and visual signal devices, **as directed**, and on and off switching of equipment and circuits, **as directed**.
   d. Provide for manual control of programmed signal and equipment-switching circuits.
   e. Communicate with remote PC for access to UTC time base and to permit programming from remote location, **as directed**.
   f. Maintain system access security with a minimum of one level **OR** two levels **OR** three levels, **as directed**, of user-access control to restrict use of system controls to authorized personnel. Levels of access apply to both local access and access from a remote computer, **as directed**. Access to user programming and control functions is accomplished by entering a minimum three-digit code. Access levels include the following:
      1) Access to review existing programs only.
      2) Access to normal system operating controls.
      3) Access to all user-programming and control functions.
   g. Regulate system timing functions using power-line frequency, backed up for power outages by an internal battery-powered, crystal-controlled oscillator.
      OR
      Regulate system timing functions using power-line frequency, backed up for power outages by an internal battery-powered, crystal-controlled oscillator, and automated periodic reference to NIST or UTC time signals via internal telephone modem and automatic dialup connection **OR** internal modem and network or microcomputer Internet

access **OR** dedicated internal radio receiver tuned to NIST time signal broadcasts, **as directed**. Reference time signals shall be automatically accessed at programmable intervals.

h. Provide for programming multiple independent event schedules into memory and running them simultaneously for different output circuits.
   1) Quantity of Programmable Schedules: Three **OR** Four **OR** Eight **OR** 18 **OR** 250, **as directed**, minimum.
   2) Number of Weekly Events That Can Be Programmed for Each Schedule: 64 **OR** 128 **OR** 300 **OR** 600 **OR** 2500, **as directed**, minimum.
   3) Simultaneous operation of independent schedules shall be limited only by the number of signal-device and equipment-switching output circuits.
   4) Advance Programming for Automatic Holiday Schedule Changes: Number of schedule changes that can be programmed to suit holidays and vacations shall be 10 **OR** 16 **OR** 50 **OR** 100, **as directed**, and each change may be programmed up to a year in advance to occur on any day of the calendar year.

i. Automatically check functioning of LEDs, switches, input keys, central processor, read-only memory, random access memory, and output circuits. A display on the control panel or a remote computer with the proper access code, **as directed**, shall indicate failure by identifying faulty component or circuit and shall recommend corrective action.

j. Provide manually initiated **OR** programming for automatic, **as directed**, daylight savings time correction.

k. Provide for adjustments to master clock output signals. Duration of momentary signal shall be individually programmable for each signal and equipment-control output circuit from 1 to 99 seconds. Signals shall be programmable for either on or off switching to suit equipment-operation scheduling.

B. Master Clock

1. Description: Microprocessor-based, software-controlled unit complying with Class A device requirements in 47 CFR 15.
   a. Programming and control switches.
   b. Informational Display: LED or backlit LCD type.
      1) Normally shows current time, date, and day of week, **as directed**, display.
      2) Provides programming cues when system is being programmed.
   c. Output Circuits for Power and Correction of Secondary Indicating Clocks:
      1) Wired Synchronous Clock Power-and-Correction Circuits: For analog and digital, **as directed**, clocks; a minimum of one **OR** two, **as directed**, required. Relay controlled.

         OR

         Wired Synchronous Digital Clock Power-and-Correction Circuits: One, **as directed**, required.
      2) Existing Clock Power-and-Correction Circuit: An output circuit suitable for the of existing power-and-correction circuit and number of clocks to be connected.
   d. Data Output Port for Digital, **as directed**, Secondary Clock Correction Circuit: RS485 or similar circuit for scheduled periodic correction signals.
   e. Modem and PC interface software suitable for remote programming and automatic NIST or UTC synchronization, **as directed**.
   f. Circuits for Audible and Visual, **as directed**, Signal Devices: Relay controlled, manually switchable, using controls on the master clock. Rated 120-V ac, five **OR** 10, **as directed,** A minimum. A minimum of two **OR** four **OR** six **OR** eight, **as directed**, circuits.
   g. Circuits for Programmable Switching of Remote Equipment and Circuits: Relay controlled, manually switchable, using controls on the master clock. Rated 120-V ac, 5 **OR** 10, **as directed**, A minimum. A minimum of two **OR** four **OR** six **OR** eight, **as directed**, circuits.
   h. Power Supplies: Capacity for internal loads and power-and correction circuits of connected clocks.

i. Enclosure: Metal cabinet with locking front panel. When cabinet is locked, display indication shall be visible on or through front panel face. Arrange cabinet for surface, semirecessed, or flush mounting as indicated.
OR
Housing: Rack-mounting metal enclosure with display indication visible on front panel face.
1) Reinforce mounting and attachment capable of resisting seismic forces described in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".

j. Battery Backup for Time Base: Lithium battery to maintain the timekeeping function and retain the programs in memory during outage of normal ac power supply for up to 10 years.

k. Electrostatic Discharge Resistance: Master clock and secondary indicating clocks, **as directed**, shall be tested and certified according to IEC 61000-4-2 in both human-discharge and direct-injection modes.

C. Secondary Indicating Clocks

1. Analog Clock: Equipped with a sweep second hand. Movement shall be driven by self-starting, permanently lubricated, sealed synchronous motor equipped with a correcting solenoid actuator, or be a microprocessor-based, second impulse unit, compatible with the master clock.

2. Digital Clock: Microprocessor-controlled unit complying with Class A device requirements in 47 CFR 15, with red LED digital time display of hours and minutes **OR**, minutes, and seconds, **as directed**.
   a. Display Height: 2-1/2-Inch (64-mm) Clock: Hour and minute numerals readable at 50 feet (15 m).
   OR
   Display Height: 4-Inch (102-mm) Clock: Hour and minute numerals readable at 100 feet (30 m).
   b. Display Format: Selectable between 12-hour with "PM" LED display and 24-hour formats.
   c. Connections for Power and Correction:
      1) Wired synchronous connection to the master clock for both operating power and correction.
         a) Time-Base Backup: Internal alkaline battery shall back up internal time base to maintain timekeeping during power outages of up to six days' duration.
         OR
         Time-Base Backup: Internal capacitor shall back up internal time base to maintain timekeeping during power outages of up to 12 hours' duration.
         b) Correction by RS485, Ethernet, or similar data line with operating power supplied over a separate connection.
         c) Power Connection for Secondary Indicating Clocks: Plug connector **OR** Wire pigtail or compression splice, **as directed**.

3. Interval-Timer Clock: Digital microprocessor-controlled, 4-inch (102-mm) unit with 2-1/2-inch (64-mm), red LED digital display for hours and minutes and 1-5/16-inch (33-mm) display for seconds; a separately mounted, mode-control switch; and the following features:
   a. Display Visibility: Hour and minute numerals readable at 30 feet (10 m) in normal ambient light.
   b. Operating Modes:
      1) Normal: Clock operates as a regular secondary system clock, displaying corrected time in normal display configuration, selectable between 12- and 24-hour formats, with "PM" digital display for 12-hour format.
      2) Count-Down or Count-Up Timer: Selected by mode-control switch count-up and count-down positions, and capable of being preset at the mode-control station.
      3) Code Blue: Automatically selected by a signal through a wiring connection from the code-blue system. This signal captures control of the clock regardless of current mode or correction status and instantly initiates count-up operation, starting at time 00:00:00. While in this mode, other clock functions, including correction, shall run in

the background. Clock shall revert to normal operating mode when the initiating-signal system is reset.

c. Mode-Selector Switch: Push-button or rotary, multiposition type, flush mounted; with start, stop, and reset capability in both count-up and count-down modes.
d. Audible tone signal: Housed in clock or mode-selector-switch box. Sounds at end of preset up or down count.

4. Provision for Modular Panel Installation: Equip designated clock for panel mounting. Mount flush or semirecessed with arrangement and trim as indicated. Coordinate wiring with other modular panel components, including room lighting switches **OR** intercom devices **OR** convenience outlets **OR** data outlets **OR** speaker **OR** other similar devices, **as directed**.
5. Provision for Time-Tone-Unit Installation: Equip indicated clocks for housing or mounting in an acoustically treated and baffled speaker compartment specified in Division 27 Section "Public Address And Mass Notification Systems".

D. Secondary Indicating Clock Characteristics:
a. Clock Type: Analog **OR** Digital, **as directed**.
b. Face Configuration: Single **OR** Double, **as directed**.
c. Mounting: Recessed **OR** Semirecessed **OR** Pendant **OR** Surface **OR** Suspended **OR** Within time-tone unit **OR** Within modular panel, **as directed**.
d. Nominal Dimensions: as directed by the Owner.
e. Casing Finish: Types and colors, as directed by the Owner.
f. Special Environmental Conditions: Describe conditions such as corrosive, damp, or wet locations, as directed by the Owner.
g. For analog clocks.
1) Dial Face Color: as directed by the Owner.
2) Analog Clock Crystal: Clear glass **OR** acrylic **OR** polycarbonate, **as directed**.
h. For digital clocks.
1) Face Color: as directed by the Owner.
2) Display Height: as directed by the Owner.
3) Seconds Display: Yes **OR** No, **as directed**.
4) Digital Clock Lens: Antiglare acrylic material.
5) Battery Backup: Yes **OR** No, **as directed**.
6) Interval-Timer Display: Yes **OR** No, **as directed**.

E. Program Signal Devices
1. Bells: Heavy-duty, modular, vibrating type with the following sound-output ratings measured at 10 feet (3 m):
a. 4-Inch (100-mm) Bell: 90 dB.
b. 6-Inch (150-mm) Bell: 95 dB.
c. 10-Inch (250-mm) Bell: 104 dB.
2. Chimes: Heavy-duty, modular, vibrating chimes with polished-chrome tone bar and enamel-finished housing. Minimum sound-output rating measured at 10 feet (3 m) shall be 75 dB.
3. Clock Buzzers: Adjustable output signal device designed for mounting within clock housing or outlet box.
a. Sound-Output Rating Measured at 3 Feet (1 m): 75 dB.
b. Audible Tone Frequency: Manufacturer's standard between 120 Hz and 2 kHz.
4. Horns: Modular, adjustable-output, vibrating type with minimum full-intensity-rated sound output of 103 dB measured at 10 feet (3 m).
5. Projector Horns: Adjustable-output, vibrating type with single **OR** double, **as directed**, projector arranged to channel sound in the direction of the projector axis, and with minimum full-intensity-rated sound output of 104 dB measured at 10 feet (3 m).
6. Loudspeakers for Audible Tones: See Division 27 Section "Public Address And Mass Notification Systems".
7. Visible Signal Devices: Strobe lights with blue **OR** yellow, **as directed**, polycarbonate lens and xenon flash tube, with lens mounted on an aluminum faceplate and the word "Program" engraved

in letters at least 1 inch (25 mm) high on lens. Lamp unit shall have a minimum rated light output of 75 candela.

8. Combination Audible and Visible Signal Devices: Factory-integrated horn and strobe light in a single mounting assembly.
9. Outdoor Signal Equipment: Weatherproof models listed for outdoor use.
10. Mounting Arrangement for Signal Devices: Designed for attachment with screws on the mounting plate of a flush-mounted back box unless otherwise indicated.
11. Enclosures for Flush-Mounting Bells and Horns: Enclosure, mounting plate, and grille assembly shall be furnished by device manufacturer to match features of the device to be mounted. Enclosure shall be recessed in wall, completely enclosing the device, with grille mounting over the open side of the enclosure and flush with the wall.
12. Connection Provision for Signal-Indicating Devices: Plug connector **OR** Wire pigtail or compression splice, **as directed**.

F. Clock Circuit Power Booster
1. Description: Transformer power supply, mounted in steel cabinet with hinged door, and having fuse-protected input and output circuits.

G. Back Boxes For Secondary Indicating Clocks And Program Devices
1. Description: Box and cover-plate assembly shall be furnished by device manufacturer and be suitable for device to be mounted. Back boxes shall be equipped with knockouts and hanger straps or mounting adapters arranged for flush mounting the device unless otherwise indicated.

H. Guards
1. Description: Formed-steel wire, shaped to fit around guarded device, with 1-inch (25-mm) maximum clearance.
   a. Mounting Provisions: Fixed tabs, welded to guard and arranged for screw attachment to mounting surface.
   b. Finish for Indoor Devices: Clear epoxy lacquer over zinc plating.
   c. Finish for Outdoor Devices: Black powder coat over zinc plating and primer.

I. Rack-Mounting Provision For Master Clock
1. Equipment Cabinet: Floor **OR** Wall, **as directed**,-mounted, rack type. Comply with EIA-310-D and the following:
   a. Cabinet Housing: Constructed of steel, with front and rear, **as directed**, doors; with manufacturer's standard tumbler locks, keyed alike.
      1) Front door shall have a clear panel in front of the master clock display.
      2) Housing shall enclose master clock and auxiliary clock system components, plus a minimum of 20 percent spare capacity for future equipment.
   b. Forced Ventilation: Internal low-noise fan with a filtered intake vent, connected to operate from 105- to 130-V ac, 60 Hz; separately fused and switchable and arranged to be powered when main cabinet power switch is on.
      OR
      Natural Ventilation: Ventilated rear and sides with louvers and solid top.
   c. For freestanding, floor-mounting cabinet, arrange inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
   d. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by equipment or panels.
   e. Finish: Uniform, baked-enamel, manufacturer's standard color finish over rust-inhibiting primer.
   f. Power-Control Panel: On front of equipment housing; with master power on-off switch and pilot light, and socket for a 5-A, indicating, cartridge fuse for rack equipment power.
   g. Vertical Plug Strip: Grounded receptacles, 12 inches (300 mm) o.c. the full height of rack, to supply rack-mounting equipment.

h. Maintenance Receptacles: Duplex convenience outlet with supply terminals separate from equipment plug strip and located in front of rack.

J. Conductors And Cables
1. Conductors: Jacketed, twisted pair and twisted multipair, untinned solid copper. Sizes as recommended by system manufacturer, but not smaller than No. 22 AWG. Voltage drop for signal, control, and clock correction circuits shall not exceed 10 percent under peak load conditions. Comply with requirements in Division 27 Section "Communications Horizontal Cabling".
2. 120-V AC and Class 1 Signal and Control Circuits: Stranded, single conductors of size and type recommended by system manufacturer. Materials and installation requirements are specified in Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
3. Class 2 and Class 3 Signal and Control Circuits: Single conductor or twisted-pair cable, unshielded, unless manufacturer recommends shielded cable.
4. Data Circuits: Category 6 minimum, unshielded, twisted-pair cable, unless manufacturer recommends shielded cable.
5. Insulation: Thermoplastic, not less than 1/32 inch (0.8 mm) thick.
6. Plenum Cable: Listed and labeled for plenum installation.
7. Conductor Color-Coding: Uniformly identified and coordinated with wiring diagrams.
8. Shielding: For speaker-microphone leads and at other locations recommended by manufacturer; No. 34 AWG tinned, soft-copper strands formed into a braid or equivalent foil.
   a. Minimum Shielding Coverage on Conductors: 60 percent.

K. Pathways
1. Intercommunication and Program System Raceways and Boxes: Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems".
   OR
   Intercommunication and Program System Raceways and Boxes: Same as required for electrical branch circuits specified in Division 26 Section "Raceway And Boxes For Electrical Systems".
   OR
   Intercommunication and Program System Raceways and Boxes: Optical fiber/communications raceway and fittings **OR** Metal wireways **OR** Nonmetal wireways **OR** Surface metal raceways **OR** Surface nonmetal raceways, **as directed**.
2. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.
3. Flexible metal conduit is prohibited.

1.3 EXECUTION

A. Installation
1. Mount system components with fastening methods and devices designed to resist the seismic forces indicated in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".

B. Wiring Methods
1. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
   a. Install plenum cable in environmental air spaces, including plenum ceilings.
   b. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway And Boxes For Electrical Systems".
   OR
   Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

2. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
3. Support cables not enclosed in raceways on J-Hooks. Install, size, and space J-Hooks to comply with TIA/EIA-568-B.

C. Electrical Connections
  1. Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
  2. Use plug connectors **OR** splices, **as directed**, for connections to clocks and signal devices.
  3. Ground clocks, programming equipment, and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

D. Identification
  1. Comply with Division 26 Section "Identification For Electrical Systems".
  2. Color-code wires, and apply wire and cable marking tape to designate wires and cables so they are uniformly identified and coordinated with wiring diagrams throughout the system.

E. Field Quality Control
  1. Perform tests and inspections.
     a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
  2. Tests and Inspections:
     a. Perform operational-system tests to verify compliance with the Specifications and make adjustments to bring system into compliance. Include operation of all modes of clock correction and all programming and manually programmed signal and relay operating functions.
     b. Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
  3. Clock system will be considered defective if it does not pass tests and inspections.
  4. Prepare test and inspection reports.

F. Adjusting
  1. Program system according to the Owner's requirements. Set system so signal devices operate on the Owner-required schedules and are activated for durations selected by the Owner. Program equipment-control output circuits to suit the Owner's operating schedule for equipment controlled.
  2. Adjust sound-output level of adjustable signal devices to suit the Owner's requirements.
  3. Occupancy Adjustments: When requested within 12 months of date of Final Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

G. Demonstration
  1. Train the Owner's maintenance personnel to adjust, operate, and maintain clock-and-program-control system components.

END OF SECTION 27 53 13 13

Task	Specification	Specification Description
27 53 13 16	27 53 13 13	Clock And Program Control

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SECTION 28 16 11 00 - PERIMETER SECURITY

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for perimeter security. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
    a. Perimeter detection and alarm system.
    b. Integration of other electronic and electrical systems and equipment.

C. Definitions

1. CCTV: Closed-circuit television.
2. EMI: Electromagnetic interference.
3. PIR: Passive infrared.
4. RFI: Radio-frequency interference.
5. UPS: Uninterruptible power supply.
6. Control Unit: System component that monitors inputs and controls outputs through various circuits.
7. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.
8. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.
9. Protected Zone: A protected premises or an area within a protected premise that is provided with means to prevent an unwanted event.
10. Standard Intruder: A person who weighs 100 lb (45 kg) or less and whose height is 60 inches (1525 mm) or less; dressed in a long-sleeved shirt, slacks, and shoes unless environmental conditions at the site require protective clothing.
11. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.
12. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.
13. Zone. A defined area within a protected premise. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

D. Action Submittals

1. Product Data: Components for sensing, detecting, systems integration, and control, including dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
2. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.
    a. Functional Block Diagram: Show single-line interconnections between components including interconnections between components specified in this Section and those furnished under other Sections. Indicate methods used to achieve systems integration. Indicate control, signal, and data communication paths and identify programmable logic controllers **OR** networks, **as directed,** and control interface devices and media to be used. Describe characteristics of network and other data communication lines.

1) Indicate methods used to achieve systems integration.
2) Indicate control, signal, and data communication paths and identify PLCs, networks, control interface devices, and media to be used.
3) Describe characteristics of network and other data communication lines.
4) Describe methods used to protect against power outages and transient voltages including types and ratings of isolation and surge suppression devices used in data, communication, signal, control, and ac and dc power circuits.

b. Raceway Riser Diagrams: Detail raceway runs required for perimeter security and for systems integration. Include designation of devices connected by raceway, raceway type, and size, and type and size of wire and cable fill for each raceway run.
c. UPS: Sizing calculations.
d. Site and Floor Plans: Indicate final outlet and device locations, routing of raceways, and cables inside and outside the building. Include room layout for central-station control-unit console, terminal cabinet, racks, and UPS.
e. Master Control Unit Console Layout: Show required artwork and device identification.
f. Device Address List: Coordinate with final system programming.
g. System Wiring Diagrams: Include system diagrams unique to Project. Show connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.
h. Details of surge-protection devices and their installation.
i. Sensor detection patterns and adjustment ranges.

3. Equipment and System Operation Description: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are not acceptable.
4. Samples for Initial Selection: For units with factory-applied color finishes.
5. Samples for Verification: For each type of exposed finish required.

E. Informational Submittals
1. Qualification Data: For Installer, security systems integrator, and testing agency.
2. Field quality-control test reports.
3. Warranty: Sample of special warranty.
4. Other Information Submittals:
a. Test Plan and Schedule: Test plan defining all tests required to ensure that system meets technical, operational, and performance specifications within 60 days of date of Contract award.
b. Examination reports documenting inspections of substrates, areas, and conditions.
c. Anchor inspection reports documenting inspections of built-in and cast-in anchors.

F. Closeout Submittals
1. Operation and Maintenance Data: For perimeter security system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation And Maintenance Data", include the following:
a. Data for each type of product, including features and operating sequences, both automatic and manual.
b. Master control-unit hardware and software data.

G. Maintenance Material Submittals
1. One spare control-unit board(s) for strain-sensitive cable system and one cable repair and splice kit(s).
2. One of each type of microwave sensor and one of each type of power supply for microwave perimeter security system.
3. One of each spare sensor and PIR unit and one alignment telescope(s) for long-range PIR system.
4. One spare control-unit board(s) for electrostatic-field system.

5. One spare control-unit board(s) for buried, ported coaxial cable system, 10 feet (3 m) of cable; and one cable repair and splice kit(s).
6. Fuses: Three of each kind and size.
7. Tool Kit: Provide six sets of tools for use with security fasteners, each packaged in a compartmented kit configured for easy handling and storage.
8. Security Fasteners: Furnish no fewer than 1 box for every 50 boxes or fraction thereof, of each type and size of security fastener installed.

H. Quality Assurance
1. Installer Qualifications:
    a. An employer of workers, at least one of whom is a technician certified by the National Burglar & Fire Alarm Association.
    b. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Security Systems Integrator Qualifications: An experienced perimeter security equipment supplier and Installer who has completed systems integration work for installations similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
3. Testing Agency Qualifications: Member company of NETA or an NRTL.
    a. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. FMG Compliance: FMG-approved and -labeled perimeter security devices and equipment.
6. Comply with NFPA 70.

I. Project Conditions
1. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
    a. Altitude: Sea level to 4000 feet (1220 m).
    b. Master Control Unit: Rated for continuous operation in an ambient of 60 to 85 deg F (16 to 29 deg C) and a relative humidity of 20 to 80 percent, noncondensing.
    c. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambients of minus 30 to plus 122 deg F (minus 34 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, condensing. Comply with UL 294 and UL 639 for outdoor-use equipment. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h) and snow cover up to 24 inches (610 mm) thick.
    d. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings shall be rated, listed, and installed according to NFPA 70.

J. Warranty:
1. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of perimeter security devices and equipment that fail in materials or workmanship within specified warranty period.
    a. Warranty Period: Two years from date of Final Completion.

1.2 PRODUCTS

A. Functional Description Of System
1. Description: Perimeter protection system with fence-mounted systems **OR** buried sensors **OR** volumetric detectors, **as directed,** integrated into a single perimeter detection and alarm system.
2. Supervision: System components shall be continuously monitored for normal, alarm, supervisory and trouble conditions. Indicate deviations from normal conditions at any location in

system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.

a. Alarm Signal: Display at central-station control unit and actuate audible and visual alarm devices.
b. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal shall indicate system problems such as battery failure, open or shorted transmission line conductors, or controller failure.
c. Supervisory Condition Signal: Distinct from other signals, indicating an abnormal condition as specified for the particular device or controller.

3. System Control: Central-station control unit shall directly monitor gate detection devices, perimeter detection units, and connecting wiring.
OR
System Control: One or more remote, addressable controllers operate under control of a central-station control-unit microcomputer in a multiplexed distributed control system or as part of a network. Controllers shall receive programming by multiplexed signal transmission from a central-station control-unit microprocessor or microcomputer and hold data in nonvolatile memory. System shall automatically reboot program without error or loss of status or alarm data after any system disturbance, **as directed**.
4. Operator Commands:
a. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, shall produce a short explanation of the purpose, use, and system reaction to that command.
b. Acknowledge Alarm: To indicate that alarm message has been observed by operator.
c. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.
d. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.
e. Protected Zone Test: Initiate operational test of a specific protected zone.
f. System Test: Initiate system-wide operational test.
g. Print Reports.
5. Timed Control at Central-Station Control Unit: Allow automatically timed "secure" and "access" functions of selected protected zones.
6. Automatic Control of Related Systems: Alarm or supervisory signals from certain perimeter security devices control the following functions in related systems:
a. Switch selected lights.
b. Open a signal path between certain intercommunication stations.
c. Shift sound system to "listening mode" and open a signal path to certain system speakers.
d. Switch signal to selected monitor from closed-circuit television camera in vicinity of sensor signaling an alarm.
7. Printed Record of Events: Print a record of alarm, supervisory, and trouble events on system printer. Sort and report by protected zone, device, and function. When central-station control unit receives a signal, print a report of alarm, supervisory, or trouble condition. Report type of signal (alarm, supervisory, or trouble), protected zone description, date, and time of occurrence. Differentiate alarm signals from other indications. When system is reset, report reset event with the same information concerning device, location, date, and time. Commands shall initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.
8. Response Time: Two seconds between actuation of any alarm and its indication at central-station control unit.
9. Circuit Supervision: Supervise all signal and data transmission lines, links with other systems, controllers, and sensors from central-station control unit. Indicate circuit and detection device faults with both protected zone and trouble signals, sound a distinctive audible tone, and illuminate an LED. Maximum permissible elapsed time between occurrence of a trouble condition and indication at central-station control unit is 20 seconds. Initiate an alarm in response to opening, closing, shorting, or grounding of a signal or data transmission line.

10. Programmed Secure-Access Control: System shall be programmable to automatically change status of various combinations of protected zones between secure and access conditions at scheduled times. Status changes may be preset for repetitive, daily, and weekly; specially scheduled operations may be preset up to a year in advance. Manual secure-access control stations shall override programmed settings.
11. Manual Secure-Access Control: Coded entries at manual stations shall change status of associated protected zone between secure and access conditions.

B. System Component Requirements
1. Compatibility: Detection devices and their communication features, connecting wiring, and master control unit shall be selected and configured with accessories for full compatibility with the existing equipment.
2. Perimeter Security Units: Listed and labeled by a qualified testing agency for compliance with UL 639.
3. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.
   a. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Division 26 Section "Transient-voltage Suppression For Low-voltage Electrical Power Circuits".
   b. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Comply with requirements in Division 26 Section "Transient-voltage Suppression For Low-voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.
4. Interference Protection: Components shall be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10,000 MHz and conducted interference signals up to 0.25-V RMS injected into power supply lines at 10 to 10,000 MHz.
5. Tamper Protection: Tamper switches on detection devices, controllers, annunciators, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled and when entering conductors are cut or disconnected. Central-station control-unit alarm display shall identify tamper alarms and indicate locations.
6. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Devices transmit test failure to central-station control unit.
7. Antimasking Devices: Automatically check operation continuously or at intervals of a minute or less, and use signal-processing logic to detect blocking, masking, jamming, tampering, or other operational dysfunction. Devices transmit detection of operational dysfunction to central-station control unit as an alarm signal.
8. Addressable Devices: Transmitter and receivers shall communicate unique device identification and status reports to central-station control unit.
9. Remote-Controlled Devices: Individually and remotely adjustable for sensitivity and individually monitored at central-station control unit for calibration, sensitivity, and alarm condition.

C. Enclosures
1. Interior Sensors: Enclosures that protect against dust, falling dirt, and dripping noncorrosive liquids.
2. Interior Electronics: NEMA 250, Type 12.
3. Exterior Electronics: NEMA 250, Type 4X fiberglass **OR** stainless steel, **as directed**.
4. Corrosion Resistant: NEMA 250, Type 4X PVC **OR** stainless steel, **as directed**.
5. Terminal cabinets in handholes and manholes shall be NEMA 250, Type 6 **OR** 6P, **as directed**.
6. Screw Covers: Where enclosures are accessible to inmates, secure with security fasteners of type appropriate for enclosure.

D. Secure And Access Devices
1. Keypad and Display Module: Arranged for entering and executing commands for system-status changes and for displaying system-status and command-related data.

2. Key-Operated Switch: Change protected zone between secure and access conditions.

E. Strain-Sensitive Cable
1. Description: Strain-sensitive, coaxial transducer cable shall monitor chain-link-type and welded-mesh-type fence and generate an alarm when a standard intruder attempts to climb over, cut through, or lift fence fabric.
2. Environment: Suitable for exterior installation and the following conditions:
   a. Ambient Temperatures: Ranging from minus 22 to plus 158 deg F (minus 30 to plus 70 deg C).
3. Transducer Cable:
   a. Ultraviolet-resistant cable furnished by system manufacturer.
   b. Suitable for up to 1000 feet (300 m) of sensor cable per single-zone controller and up to 2000 feet (600 m) of sensor cable per dual-zone processor.
   c. Sensitivity shall be uniform throughout its entire length, requiring only one variable sensitivity adjustment throughout its entire length.
4. Control Unit:
   a. Field mounted, with tamper switch at controller board.
   b. Electronic circuitry shall discriminate between acceptable fence movement and intrusion-related disturbances.
   c. Sensitivity, count control, and climb-over processors shall be adjustable with a minimum of five individual count-control and climb-over adjustments.
   d. Controller output shall have adjustable pulse width to adjust the time the alarm relay will activate per detected intrusion attempt.
5. System Performance:
   a. Immune to RFI and EMI environments; interference shall have no effect on normal operational characteristics.
   b. Trouble and Tamper: Entire sensor system shall be fully supervised with individually monitored tamper and supervision alarms. Disconnecting, cutting, or shorting of strain-sensitive cable results in supervisory alarm.
   c. Intrusion Simulation: Each zone shall have a self-test feature that, when activated by a signal from central-station control unit, will produce an intrusion alarm and verify operation of sensor.

F. Microwave Intrusion Detectors
1. Description: Volumetric microwave detection system.
2. Device Performance: Microwave transmitter establishes an electromagnetic field in an adjustable detection pattern and detects intrusion by monitoring changes in that pattern.
   a. Movement Sensitivity: Adjustable, able to detect standard-intruder movement within sensor's detection pattern at any speed between 0.1 to 50 fps (0.03 to 15.2 m/s). Sensor sensitivity adjustments shall be accessible only when sensor housing is removed, and sensors shall comply with 47 CFR 15.
   b. Detection range: 15 to 600 feet (5 to 180 m).
   c. Range Sensitivity: Adjustable for setting area of protection between 15 to 500 feet (5 to 152 m) in range and from 2 to 40 feet (0.6 to 12 m) in beam diameter.
   d. Trouble and Tamper: Fully supervised with individually monitored tamper and supervision alarms. System failure shall result in tamper alarm. System jamming or wrong modulation shall result in supervisory alarm.
   e. Activation Indicator: LED indicator shall not be visible during normal operation. Indicator shall light when sensor detects a standard intruder. Locate test-enabling switch under sensor housing cover.
   f. Remote Test: When initiated by central-station control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.
3. Environment: Suitable for exterior installation and the following conditions:

a. Ambient Temperatures: Ranging from minus 30 to plus 158 deg F (minus 34 to plus 70 deg C) and in rainfall up to 4 inches (100 mm).

G. Electrostatic Field
1. Description: Electronically balanced phase electrostatic-field detection system consisting of a field generator that generates an electrical field in one or more field wires and that has two or more sensing wires, a sense filter, amplifier, and a controller. Detection fields shall have a minimum of four different frequencies so adjacent zones cannot interfere with each other.
2. Environment: Suitable for exterior installation and the following conditions:
   a. Ambient Temperatures: Ranging from minus 22 to plus 158 deg F (minus 30 to plus 70 deg C).
3. System Performance:
   a. Detect, via sense wires, a compound signal form consisting of amplitude change, rate of change, and pre-set time disturbance that forms a "signature" of human movement. Generate an alarm when all exist simultaneously. Provide detection fields of not less than four different frequencies so adjacent zones do not interfere with each other.
   b. Control Units: Single or multiple zone, with sense filter. Front panel with calibration meter, status of alarm transmitter, sensitivity selector, test point selector, power indicator, and power control. Control unit shall reject signals due to wind and small objects striking the wires.
   c. Motion Detection: Sense standard-intruder movement at rates from 0.15 to 26 fps (0.045 to 8.0 m/s).
   d. Zone Length: Not to exceed 500 feet (152 m) **OR** 325 feet (100 m), **as directed**.
   e. Supervision: Generate trouble signal if field or sense wires are cut or shorted to ground or to each other. Generate supervisory alarm if received signal is substantially reduced.
4. Insulators, Wire-Tensioning Devices, and Brackets: Manufacturer's standard for mounting and tensioning of wires.
5. Field and Sensing Wires: Stainless steel.

H. Buried, Ported Coaxial Cable
1. Description: Buried electrostatic-field detection system consisting of parallel, ported coaxial cables that generate a detection field between cables.
2. Environment: Suitable for exterior installation and the following conditions:
   a. Ambient Temperatures: Ranging from minus 22 to plus 158 deg F (minus 30 to plus 70 deg C).
3. System Performance: One of two parallel cables receives a continuous wave signal from a transmitter module. Second cable, connected to a sensor module, detects, preamplifies, and analyzes variations in signal. When system senses "signature" of a standard intruder in the detection zone, based on mass, motion, and time of day, it generates an alarm.
   a. Transmitter: Locate at one end of zone, with standby battery.
   b. Preamplifier-Sensor: Locate at opposite end from transmitter, with standby battery.
   c. Front panel with sensitivity calibration meter, calibrated self-test potentiometer, power switch, and LED normal and malfunction indicators.
   d. Electromagnetic Radiation: Less than 50 mV per meter at 30 m.
   e. Motion Detection: Sense standard-intruder movement at rates from 0.17 to 26 fps (0.05 to 8.0 m/s).
   f. Zone Length: Not to exceed 500 feet (152 m) **OR** 325 feet (100 m), **as directed**.
   g. Zone Width: Not to exceed 15 feet (4.6 m), with an average width of 12 feet (3.7 m).
   h. Zone Height: Approximately 3.3 feet (1.0 m), depending on sensitivity setting.
   i. Supervision: Generate trouble signal if cable is cut or shorted to ground. Generate supervisory alarm if cabinets are tampered with.
4. Enclosures: Hinged cover with tamper switch and security fasteners.
5. Buried, Ported Coaxial Cable: Approximately 1/2-inch (1.3-mm) diameter, minimum 10 AWG center conductor, foam polyethylene dielectric, braided copper outer conductor, and polyethylene jacket.

I. Long-Range PIR Detectors
1. Description: Volumetric passive infrared detection system.
2. Listed and labeled by a qualified testing agency for compliance with SIA PIR-01.
3. Environment: Suitable for exterior installation and the following conditions:
   a. Ambient Temperatures: Ranging from minus 30 to plus 150 deg F (minus 34 to plus 65 deg C).
4. System Performance: Detect an interruption of dual-infrared light beams that link transmitters and receivers. Generate an alarm when signal is interrupted due to presence of an object that interrupts both beams.
   a. Sensitivity: Field adjustable to allow adjustment of range from 25 to 500 feet (7.6 to 152 m), generating an alarm within 20 to 50 ms when both beams are interrupted.
   b. Detection system shall adjust automatically to compensate for weather, including fog, rain, snow, blowing dust, and rapid temperature changes.
   c. Motion Detection: Detect standard-intruder movement at rates from 0.1 to 50 fps (0.03 to 15.2 m/s).
   d. Supervision: Generate supervisory alarm if any portion of system is tampered with.
   e. Remote Test: When initiated by central-station control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

J. Geophone Fence Detection
1. Description: Fence-mounted system to detect attempts to cut or climb the protected fence, using geophone sensors that respond to specific shock or vibrations.
2. Environment: Suitable for exterior installation and the following conditions:
   a. Ambient Temperatures: Ranging from minus 30 to plus 150 deg F (minus 34 to plus 65 deg C).
3. System Performance:
   a. Controller: 10 zone capacity for processing geophone generated analog signals. Each zone shall consist of not more than 10 sensors.
      1) Adjustments: For each zone provide stepped gain control for sensitivity, and switches for geophone signal filters to minimize nuisance alarms. System shall adjust automatically to compensate for weather, including fog, rain, snow, blowing dust, and rapid temperature changes.
      2) Trouble Condition Signal: Generate when any zone fails.
      3) Supervisory Condition Signal: Generate on interference with controller operation or when detecting a break-in into a enclosure housing electronics.
   b. Sensors: Fence mounted 20 feet (6 m) o.c.
   c. Cable for Interconnection of System Components: Shielded, PVC jacketed and armored, as supplied by system manufacturer.
   d. Test each zone simulating an alarm condition. Test by command from central-station control **OR** test switch at controller inside the enclosure, **as directed**.

K. Video Motion Sensor
1. Description: Video-surveillance based detection system.
2. Device Performance: Detect changes in video signal within a user-defined protected zone. Provide an alarm output for each video input.
   a. Detect movement within protected zone of standard intruders wearing clothing with a reflectivity that differs from that of background scene by a factor of 2. Reject all other changes in video signal.
   b. Modular design that allows for expansion or modification of number of inputs.
   c. Adjustable Controls:
      1) Number of detection zones.
      2) Size of detection zones.
      3) Sensitivity of detection of each protected zone.
   d. Mounting: Standard 19-inch (480-mm) rack as described in EIA 310.

3. Environment: Suitable for installation in interior air-conditioned spaces.

L. Gate Units
1. Description: Fence mounted gate-movement detector, blanced-magnetic type, UL listed for outdoor locations. Units shall be designed for mounting on single- or double-leaf swinging or rolling gates and have armored jumper cables between switch and stationary junction box for wiring to central-station control unit and tamper switches in junction box.
2. Device Performance: Bias magnet and at least three encapsulated-reed switches that resist compromise from introduction of foreign magnetic fields, with integral overcurrent protective device to limit current to 80 percent of switch capacity.
3. Remote Test: Simulate movement of actuating magnet from central-station control unit.

M. Field-Mounted Control Units
1. Field-mounted control units shall include the power supply and detector specific functions, and provide for communications with the master control unit. Control unit shall include read-only resident software needed for startup, a time clock, and all automatic operations. Software shall be downloaded from the master control unit.
2. Battery Backup: UPS, providing 6 hours of run time during a power outage, with 2-rate automatic battery charger to fully recharge batteries within 12 hours after normal power is restored.
   a. Batteries: Rechargeable, valve-regulated, recombinant, sealed, lead-acid type with nominal 10-year life expectancy.
   b. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Charger shall recharge fully discharged battery within 24 hours.
3. Annunciation: Indicate a change in system condition and switching of system or component to backup power.

N. Master Control Unit
1. Description: Supervise sensors and detection subsystems and their connecting communication links, status control (secure or access) of sensors and detector subsystems, activation of alarms and supervisory and trouble signals, and other indicated functions.
   a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
   b. Include a real-time clock for time annotation of events on the event recorder and printer.
   c. Addressable initiation devices that communicate device identity and status.
   d. Control circuits for operation of mechanical equipment in response to an alarm.
2. Construction: Freestanding equipment rack **OR** Desk-mounted console, **as directed,** modular, with separate and independent alarm and supervisory system modules. Alarm-initiating protected zone boards shall be plug-in cards. Arrangements that require removal of field wiring for module replacement are unacceptable.
3. Comply with UL 609 **OR** UL 681 **OR** UL 1076, **as directed**.
4. Console Controls and Displays: Arranged for interface between human operator at master control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
   a. Annunciator and Display: LCD type, one **OR** two **OR** three line(s) of 40 **OR** 80 characters, minimum, **as directed**.
   b. Keypad: Arranged to permit entry and execution of programming, display, and control commands
   c. Control-Unit Network: Automatic communication of alarm, status changes, commands, and other communications required for system operation. Communication shall return to normal after partial or total network interruption such as power loss or transient event. Total or partial signaling network failures shall identify the failure and record the failure at the annunciator display and at the system printer.
   d. Field Device Network: Communicate between the control unit and field devices of the system. Communications shall consist of alarm, network status, and status and control of

field-mounted processors. Each field-mounted device shall be interrogated during each interrogation cycle.

e. Operator Controls: Manual switches and push-to-test buttons that do not require a key to operate. Prevent resetting of alarm, supervisory, or trouble signals while alarm or trouble condition persists. Include the following:
   1) Acknowledge alarm.
   2) Silence alarm.
   3) System reset.
   4) LED test.

f. Timing Unit: Solid state, programmable, 365 days.

g. Confirmation: Relays, contactors, and other control devices shall have auxiliary contacts that provide confirmation signals to system for their on or off status. Software shall interpret such signals, display equipment status, and initiate failure signals.

h. Alarm Indication: An audible signal sounds and an LED lights at master control unit identifying the protected zone **OR** addressable detector, **as directed,** originating the alarm. Annunciator panel displays a common alarm light and sounds an audible tone.

i. Alarm Indication: An audible signal sounds and a plain-language identification of the protected zone **OR** addressable detector, **as directed** originating the alarm appears on LED or LCDdisplay at master control unit. Annunciator panel displays a common alarm light and sounds an audible tone.

j. Alarm Indication: An audible signal sounds and a plain-language identification of the protected zone **OR** addressable detector, **as directed** originating the alarm appears on LED, LCD or cathode-ray-tube display, **as directed** at master control unit. Annunciator panel alarm light and audible tone identify protected zone signaling an alarm.

k. Alarm activation sounds a bell **OR** siren **OR** strobe **OR** bell or siren and strobe, **as directed**.

5. Protected Zones: Quantity of alarm and supervisory zones as indicated, with capacity for expanding number of protected zones by a minimum of 25 percent.
6. Power Supply Circuits: Master control units shall provide power for remote power-consuming detection devices. Circuit capacity shall be adequate for at least a 25 percent increase in load.
7. UPS: Comply with Division 26 Section "Static Uninterruptible Power Supply". UPS shall be sized to provide a minimum of six hours of master control-unit operation.
8. Cabinet: Lockable, steel enclosure arranged so operations required for testing, normal operation, and maintenance are performed from front of enclosure. If more than a single cabinet is required to form a complete control unit, provide exactly matching modular enclosures. Accommodate all components and allow ample gutter space for field wiring. Identify each enclosure by an engraved, laminated, phenolic-resin nameplate. Lettering on enclosure nameplate shall not be less than 1 inch (25 mm) high. Identify, with permanent labels, individual components and modules within cabinets.
9. Transmission to Monitoring Station: A communications device to automatically transmit alarm, supervisory, and trouble signals to the monitoring station, operating over a standard voice grade telephone leased line. Comply with UL 1635.
10. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

O. Audible And Visual Alarm Devices

1. Bell: UL listed, 10 inches (254 mm) in diameter, rated to produce a minimum sound output of 84 dB at 10 feet (3 m) from central-station control unit.
   a. Enclosure: Weather-resistant steel box equipped with tamper switches on cover and on back of box.

2. Klaxon Weatherproof Motor-Driven Hooter: UL listed, rated to produce a minimum sound output of 120 dB at 3 feet (1 m), plus or minus 3 dB, at a frequency of 470 Hz. Rated for intermittent use - two minutes on, five minutes off.
   a. Designed for use in industrial areas and in high noise, severe weather marine environments.
3. Siren: 30-W speaker with siren driver, rated to produce a minimum sound output of 103 dB at 10 feet (3 m) from central-station control unit.
   a. Enclosure: Weather-resistant steel box with tamper switches on cover and on back of box.
4. Strobe: Xenon light complying with UL 1638, with a clear polycarbonate lens.
   a. Light Output: 115 cd, minimum.
   b. Flash Rate: 60 per minute.

P. Security Fasteners
1. Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive system type, head style, material, and protective coating as required for assembly, installation, and strength.
2. Drive System Types: Pinned Torx-Plus, pinned Torx, or pinned hex (Allen).
3. Socket Flat Countersunk Head Fasteners:
   a. Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
   b. Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.
4. Socket Button Head Fasteners:
   a. Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
   b. Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.
5. Socket Head Cap Fasteners:
   a. Heat-treated alloy steel, ASTM A 574 (ASTM A 574M).
   b. Stainless steel, ASTM F 837 (ASTM F 837M), Group 1 CW.
6. Protective Coatings for Heat-Treated Alloy Steel:
   a. Zinc chromate, ASTM F 1135, Grade 3 or 4; for exterior applications and interior applications where indicated.
   b. Zinc phosphate with oil, ASTM F 1137, Grade I, or black oxide, unless otherwise indicated.

Q. Source Quality Control
1. Electrostatic-Field and Buried, Ported Coaxial Cable Systems Electronics: Precondition at factory by subjecting modules to at least 4 days' operational burn-in at temperatures not less than 140 deg F (60 deg C).

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of perimeter security.
2. Examine roughing-in for embedded and built-in anchors to verify actual locations of perimeter security connections before perimeter security installation.
3. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of perimeter security.
4. Inspect built-in and cast-in anchor installations, before installing perimeter security, to verify that anchor installations comply with requirements. Prepare inspection reports.
   a. Remove and replace anchors where inspections indicate that they do not comply with requirements. Reinspect after repairs or replacements are made.
   b. Perform additional inspections to determine compliance of replaced or additional anchor installations. Prepare inspection reports.
5. For material whose orientation is critical for its performance as a ballistic barrier, verify installation orientation.
6. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Systems Integration
1. Integrate perimeter security system with the following systems and equipment:
a. Electronic door hardware.
b. Elevators.
c. Network lighting controls.
d. Intercommunications and program systems.
e. Public address and mass notification systems.
f. Access control.
g. Fire-alarm system.
h. Intrusion detection system.
i. Video surveillance.

C. System Installation
1. Comply with UL 681 and NFPA 731.
2. Equipment Mounting: Install master control unit on finished floor with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.
a. Comply with requirements for seismic-restraint devices specified in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
3. Install wall-mounted equipment, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.
a. Comply with requirements for seismic-restraint devices specified in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
4. Connecting to Existing Equipment: Verify that existing perimeter security system is operational before making changes or connections.
a. Connect new equipment to existing control panel in existing part of the building.
b. Connect new equipment to existing monitoring equipment at the Supervising Station.
c. Expand, modify, and supplement existing **control** or **monitoring** equipment as necessary to extend existing **control** or **monitoring**] functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.
5. Security Fasteners: Where accessible to inmates, install perimeter security components using security fasteners with head style appropriate for fabrication requirements, strength, and finish of adjacent materials except that a maximum of two different sets of tools shall be required to operate security fasteners for Project. Provide stainless-steel security fasteners in stainless-steel materials.
6. Wiring Method: Install power, signal, and data transmission wire and cable in raceways according to Division 26 Section(s) "Underground Ducts And Raceways For Electrical Systems" AND "Raceway And Boxes For Electrical Systems". Minimum conduit size shall be 1/2 inch (13 mm). Control and data transmission wiring shall not share raceways with any other system.
7. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with perimeter security system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
8. Wires and Cables:
a. Conductors: Size as recommended in writing by system manufacturer, unless otherwise indicated.
b. 120-V Power Wiring: Install according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables", unless otherwise indicated.
c. Cable for Low-Voltage Control and Signal Circuits: Install unshielded, twisted-pair cable, unless otherwise indicated or if manufacturer recommends shielded cable, according to Division 28 Section "Conductors And Cables For Electronic Safety And Security".

d. Data and Television Signal Transmission Cables: Install according to Division 28 Section "Conductors And Cables For Electronic Safety And Security"

9. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
10. Install power supplies and other auxiliary components for detection devices at controllers, unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.
11. Stain-Sensitive Transducer Cable: Attached to fence at 12-inch (300-mm) intervals with tie wraps.
12. Electrostatic-Field System: Install field and sense wires on insulators and standoffs on a fence, wall, or roof. Provide intermediate supports recommended in writing by manufacturer as needed for specified performance.
13. Buried, Ported Coaxial Cable: Transmitters may be located at one end of parallel coaxial cables, and preamplifier-sensor module may be located at opposite end. Install cable so shield is uniform throughout the length, without twisting or distorting cable during installation. Field-cut cables to exact zone length at the site. To attach data transmission cable to sensing cable, use heat-shrink splice kits approved by manufacturer. Provide sufficient overlap of detector cables to eliminate the possibility of entry between zones.

D. Identification

1. Indentify system components wiring, cabling, and terminals. Comply with identification requirements in Division 26 Section "Identification For Electrical Systems".
2. Install instructions frame in a location visible from master control unit.

E. Grounding

1. Ground the master control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to master control unit.
2. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
3. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding. Provide 5-ohm ground. Measure, record, and report ground resistance.
4. Install grounding electrodes of type, size, location, and quantity indicated. Comply with installation requirements in Division 26 Section "Grounding And Bonding For Electrical Systems".

F. Field Quality Control

1. Pretesting: After installation, align, adjust, and balance system and perform complete pretesting to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.
   a. Report of Pretesting: After pretesting is complete, provide a letter certifying that installation is complete and fully operable; include names and titles of witnesses to preliminary tests.
2. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections.
3. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components and equipment installations, including connections.
4. Tests and Inspections: Comply with provisions in NFPA 731, Ch.9, “Testing and Insptections.”
   a. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
   b. Operational Tests: Schedule tests after pretesting has been successfully completed. Test all modes of system operation and perimeter security at each detection device. Test for detection of intrusion and for false alarms in each protected zone. Test for false alarms by simulating activities outside indicated detection patterns.
   c. Electrical Tests: Comply with NFPA 72, Section A-7. Minimum required tests are as follows:

1) Verify the absence of unwanted voltages between circuit conductors and ground.
2) Test all conductors for short circuits using an insulation-testing device.
3) With each circuit pair, short circuit at the far end of circuit and measure circuit resistance with an ohmmeter. Record circuit resistance of each circuit on Record Drawings.
4) Verify that each controller is in normal condition as detailed in manufacturer's operation and maintenance manual.
5) Test signal and data transmission circuits complying with requirements in Division 28 Section "Conductors And Cables For Electronic Safety And Security" for proper signal transmission under open-circuit conditions. One connection each should be opened at not less than 10 percent of initiating and indicating devices. Observe proper signal transmission according to class of wiring used.
6) Verify that transient surge-protection devices are installed according to manufacturer's written instructions.
7) Test each initiating and indicating device for alarm operation and proper response at central-station control unit.
8) Test both primary and secondary power. Verify, by test, that UPS is capable of operating the system for period and in manner specified.

d. Geophone System Tests: Test each zone at a minimum of two different locations. Test each zone as follows:
1) Horizontal Movement: Adjust sensitivity to screen out alarms from wind.
2) Vertical Climb: 100 percent detection required. Set count at 3 occurrences within 90-second window.
3) Cut Test: 100 percent detection required. Set count at 2 occurrences within 120-second window.
4) Set sensitivity to value as low as possible, consistent with reliable detection.
5) If performance tests fail, make adjustments to sensors to comply with requirements. Retest failing and adjacent zones to comply with test.

e. Strain-Sensitive Cable System Tests: Adjust sensitivity and count control to value as low as possible, consistent with reliable detection.

f. Microwave Perimeter Security System Tests: Adjust sensitivity to value as low as possible, consistent with reliable detection.

g. Long-Range PIR System Tests: Adjust sensitivity and hold time between activity duration to value as low as possible, consistent with reliable detection.

5. Report of Tests and Inspections: Prepare a written record of tests, inspections, and detailed test results in the form of a test log.
6. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.

G. Demonstration
1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain perimeter security.

H. Adjusting
1. Occupancy Adjustments: When requested within 12 months of date of Final Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose. Visits for this purpose shall be in addition to any required by warranty.

END OF SECTION 28 16 11 00

SECTION 28 16 11 00a - INTRUSION DETECTION

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for intrusion detection. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section includes:
   a. Intrusion detection with communication links to perform monitoring, alarm, and control functions.
2. Integration of other electronic and electrical systems and equipment.

C. Definitions

1. CCTV: Closed-circuit television.
2. PIR: Passive infrared.
3. RFI: Radio-frequency interference.
4. UPS: Uninterruptible power supply.
5. Control Unit: System component that monitors inputs and controls outputs through various circuits.
6. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.
7. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.
8. Protected Zone: A protected premises or an area within a protected premises that is provided with means to prevent an unwanted event.
9. Standard Intruder: A person who weighs 100 lb (45 kg) or less and whose height is 60 inches (1525 mm) or less; dressed in a long-sleeved shirt, slacks, and shoes unless environmental conditions at the site require protective clothing.
10. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.
11. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.
12. Zone. A defined area within a protected premises. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

D. Action Submittals

1. Product Data: Components for sensing, detecting, systems integration, and control, including dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
2. Show Drawings: Detail assemblies of standard components that are custom assembled for specific application on the Project.
   a. Functional Block Diagram: Show single-line interconnections between components including interconnections between components specified in this Section and those furnished under other Sections. Indicate methods used to achieve systems integration. Indicate control, signal, and data communication paths and identify programmable logic controllers **OR** networks, **as directed** and control interface devices and media to be used. Describe characteristics of network and other data communication lines.

1) Indicate methods used to achieve systems integration.
2) Indicate control, signal, and data communication paths and identify PLCs, networks, control interface devices, and media to be used.
3) Describe characteristics of network and other data communication lines.
4) Describe methods used to protect against power outages and transient voltages including types and ratings of isolation and surge suppression devices used in data, communication, signal, control, and ac and dc power circuits.

b. Raceway Riser Diagrams: Detail raceway runs required for intrusion detection and for systems integration. Include designation of devices connected by raceway, raceway type and size, and type and size of wire and cable fill for each raceway run.
c. UPS: Sizing calculations.
d. Site and Floor Plans: Indicate final outlet and device locations, routing of raceways, and cables inside and outside the building. Include room layout for master control-unit console, terminal cabinet, racks, and UPS.
e. Master Control-Unit Console Layout: Show required artwork and device identification.
f. Device Address List: Coordinate with final system programming.
g. System Wiring Diagrams: Include system diagrams unique to Project. Show connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.
h. Details of surge-protection devices and their installation.
i. Sensor detection patterns and adjustment ranges.

3. Equipment and System Operation Description: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are unacceptable.
4. Samples for Initial Selection: For units with factory-applied color finishes.
5. Samples for Verification: For each type of exposed finish required.

E. Information Submittals
1. Qualification Data: For Installer **OR** intrusion detection systems integrator **OR** testing agency, **as directed**.
2. Field quality-control reports.
3. Warranty: Sample of special warranty.
4. Other Information Submittals:
a. Test Plan and Schedule: Test plan defining all tests required to ensure that system meets technical, operational, and performance specifications within 60 days of date of Contract award.
b. Examination reports documenting inspections of substrates, areas, and conditions.
c. Anchor inspection reports documenting inspections of built-in and cast-in anchors.

F. Closeout Submittals
1. Operation and Maintenance Data: For intrusion detection system to include in emergency, operation, and maintenance manuals," include the following:
a. Data for each type of product, including features and operating sequences, both automatic and manual.
b. Master control-unit hardware and software data.

G. Quality Assurance
1. Installer Qualifications:
a. An employer of workers, at least one of whom is a technician certified by the National Burglar & Fire Alarm Association **OR** possess the standards and experience for certification, **as directed**.
b. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

2. Intrusion Detection Systems Integrator Qualifications: An experienced intrusion detection equipment supplier and Installer who has completed systems integration work for installations similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
3. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the National Burglar & Fire Alarm Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to Owner's insurance underwriter.
   a. Testing Agency's Field Supervisor: Person currently certified as an advanced alarm technician by the National Burglar & Fire Alarm Association **OR** possess the standards and experience for certification, **as directed,** to supervise on-site testing specified in Part 3.
4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
5. Control Units, Devices, and Communications with Monitoring Station: Listed and labeled by a qualified testing agency for compliance with SIA CP-01.
6. FM Global Compliance: FMG-Approved and -labeled intrusion detection devices and equipment.
7. Comply with NFPA 70.

H. Project Conditions
1. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
   a. Altitude: Sea level to 4000 feet (1220 m).
   b. Master Control Unit: Rated for continuous operation in an ambient of 60 to 85 deg F (16 to 29 deg C) and a relative humidity of 20 to 80 percent, noncondensing.
   c. Interior, Controlled Environment: System components, except master station control unit, installed in air-conditioned **OR** temperature-controlled, **as directed,** interior environments shall be rated for continuous operation in ambients of 36 to 122 deg F (2 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
   d. Interior, Uncontrolled Environment: System components installed in non-air-conditioned **OR** non-temperature-controlled, **as directed,** interior environments shall be rated for continuous operation in ambients of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
   e. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambients of minus 30 to plus 122 deg F (minus 34 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, condensing. Comply with UL 294 and UL 639 for outdoor-use equipment. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h) and snow cover up to 24 inches (610 mm) thick.
   f. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings shall be rated, listed, and installed according to NFPA 70.

I. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of intrusion detection devices and equipment that fail in materials or workmanship within specified warranty period.
2. Warranty Period: Two years from date of Final Completion.

1.2 PRODUCTS

A. Functional Description Of System
1. Description: Hard-wired **OR** Multiplexed, modular, microprocessor-based controls, intrusion sensors and detection devices, and communication links to perform monitoring, alarm, and control functions.

2. Supervision: System components shall be continuously monitored for normal, alarm, supervisory, and trouble conditions. Indicate deviations from normal conditions at any location in system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.
   a. Alarm Signal: Display at master station control unit and actuate audible and visual alarm devices.
   b. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal shall indicate system problems such as battery failure, open or shorted transmission line conductors, or controller failure.
   c. Supervisory Condition Signal: Distinct from other signals, indicating an abnormal condition as specified for the particular device or controller.
3. System Control: Master station control unit shall directly monitor intrusion detection units and connecting wiring.
   OR
   System Control: Master station control unit shall directly monitor intrusion detection devices, perimeter detection units **OR** controllers associated with perimeter detection units, **as directed,** and connecting wiring in a multiplexed distributed control system or as part of a network.
4. System shall automatically reboot program without error or loss of status or alarm data after any system disturbance.
5. Operator Commands:
   a. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, shall produce a short explanation of the purpose, use, and system reaction to that command.
   b. Acknowledge Alarm: To indicate that alarm message has been observed by operator.
   c. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.
   d. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.
   e. Protected Zone Test: Initiate operational test of a specific protected zone.
   f. System Test: Initiate system-wide operational test.
   g. Print Reports.
6. Timed Control at Master station control unit: Allow automatically timed "secure" and "access" functions of selected protected zones.
7. Automatic Control of Related Systems: Alarm or supervisory signals from certain intrusion detection devices control the following functions in related systems:
   a. Switch selected lights.
   b. Shift elevator control to a different mode.
   c. Open a signal path between certain intercommunication stations.
   d. Shift sound system to "listening mode" and open a signal path to certain system speakers.
   e. Switch signal to selected monitor from closed-circuit television camera in vicinity of sensor signaling an alarm.
8. Printed Record of Events: Print a record of alarm, supervisory, and trouble events on system printer. Sort and report by protected zone, device, and function. When master station control unit receives a signal, print a report of alarm, supervisory, or trouble condition. Report type of signal (alarm, supervisory, or trouble), protected zone description, date, and time of occurrence. Differentiate alarm signals from other indications. When system is reset, report reset event with the same information concerning device, location, date, and time. Commands shall initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.
9. Response Time: Two seconds between actuation of any alarm and its indication at master station control unit.
10. Circuit Supervision: Supervise all signal and data transmission lines, links with other systems, and sensors from master station control unit. Indicate circuit and detection device faults with both protected zone and trouble signals, sound a distinctive audible tone, and illuminate an LED. Maximum permissible elapsed time between occurrence of a trouble condition and indication at

master station control unit is 20 seconds. Initiate an alarm in response to opening, closing, shorting, or grounding of a signal or data transmission line.

11. Programmed Secure-Access Control: System shall be programmable to automatically change status of various combinations of protected zones between secure and access conditions at scheduled times. Status changes may be preset for repetitive, daily, and weekly; specially scheduled operations may be preset up to a year in advance. Manual secure-access control stations shall override programmed settings.
12. Manual Secure-Access Control: Coded entries at manual stations shall change status of associated protected zone between secure and access conditions.

B. System Component Requirements
1. Compatibility: Detection devices and their communication features, connecting wiring, and master station control unit shall be selected and configured with accessories for full compatibility with existing equipment:
2. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.
   a. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Division 26 Section "Transient-voltage Suppression For Low-voltage Electrical Power Circuits".
   b. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Comply with requirements in Division 26 Section "Transient-voltage Suppression For Low-voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.
3. Intrusion Detection Units: Listed and labeled by a qualified testing agency for compliance with UL 639.
4. Interference Protection: Components shall be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10,000 MHz and conducted interference signals up to 0.25-V RMS injected into power supply lines at 10 to 10,000 MHz.
5. Tamper Protection: Tamper switches on detection devices, controllers, annunciators, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled and when entering conductors are cut or disconnected. Central-station control-unit alarm display shall identify tamper alarms and indicate locations.
6. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Devices transmit test failure to master station control unit.
7. Antimasking Devices: Automatically check operation continuously or at intervals of a minute or less, and use signal-processing logic to detect blocking, masking, jamming, tampering, or other operational dysfunction. Devices transmit detection of operational dysfunction to master station control unit as an alarm signal.
8. Addressable Devices: Transmitter and receivers shall communicate unique device identification and status reports to master station control unit.
9. Remote-Controlled Devices: Individually and remotely adjustable for sensitivity and individually monitored at master station control unit for calibration, sensitivity, and alarm condition.

C. Enclosures
1. Interior Sensors: Enclosures that protect against dust, falling dirt, and dripping noncorrosive liquids.
2. Interior Electronics: NEMA 250, Type 12.
3. Exterior Electronics: NEMA 250, Type 4X fiberglass **OR** stainless steel, **as directed**.
4. Corrosion Resistant: NEMA 250, Type 4X PVC **OR** stainless steel, **as directed**.
5. Screw Covers: Where enclosures are accessible to inmates, secure with security fasteners of type appropriate for enclosure.

D. Secure And Access Devices

1. Keypad and Display Module: Arranged for entering and executing commands for system-status changes and for displaying system-status and command-related data.
2. Key-Operated Switch: Change protected zone between secure and access conditions.

E. Door And Window Switches
1. Description: Balanced-magnetic switch, complying with UL 634, installed on frame with integral overcurrent device to limit current to 80 percent of switch capacity. Bias magnet and minimum of two **OR** three, **as directed,** encapsulated reed switches shall resist compromise from introduction of foreign magnetic fields.
2. Flush-Mounted Switches: Unobtrusive and flush with surface of door and window frame.
3. Overhead Door Switch: Balanced-magnetic type, listed for outdoor locations, and having door-mounting magnet and floor-mounting switch unit.
4. Remote Test: Simulate movement of actuating magnet from master station control unit.

F. PIR Sensors
1. Listed and labeled by a qualified testing agency for compliance with SIA PIR-01.
2. Description: Sensors detect intrusion by monitoring infrared wavelengths emitted from a human body within their protected zone and by being insensitive to general thermal variations.
   a. Wall-Mounting Unit Maximum Detection Range: 125 percent of indicated distance for individual units and not less than 50 feet (15 m). Provide adjustable coverage pattern as indicated.
   b. Ceiling-Mounting Unit Spot-Detection Pattern: Full 360-degree conical.
   c. Ceiling-Mounting Unit Pattern Size: 84-inch (2135-mm) diameter at floor level for units mounted 96 inches (2440 mm) above floor; 18-foot (5.5-m) diameter at floor level for units mounted 25 feet (7.6 m) above floor.
3. Device Performance:
   a. Sensitivity: Adjustable pattern coverage to detect a change in temperature of 2 deg F (1deg C) or less, and standard-intruder movement within sensor's detection patterns at any speed between 0.3 to 7.5 fps (0.09 to 2.3 m/s) across 2 adjacent segments of detector's field of view.
   b. Test Indicator: LED test indicator that is not visible during normal operation. When visible, indicator shall light when sensor detects an intruder. Locate test enabling switch under sensor housing cover.
   c. Remote Test: When initiated by master station control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

G. Microwave Intrusion Detectors (Interior)
1. Device Performance: Microwave transmitter establishes an electromagnetic field in an adjustable detection pattern and detects intrusion by monitoring changes in that pattern.
   a. Sensitivity: Adjustable, able to detect standard-intruder movement within sensor's detection pattern at any speed between 0.3 to 7.5 fps (0.09 to 2.3 m/s). Sensor sensitivity adjustments shall be accessible only when sensor housing is removed, and sensors shall comply with 47 CFR 15.
   b. Activation Indicator: LED indicator shall not be visible during normal operation. Indicator shall light when sensor detects a standard intruder. Locate test-enabling switch under sensor housing cover.
   c. Remote Test: When initiated by master station control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

H. Acoustic-Type, Glass-Break Sensors
1. Listed and labeled by a qualified testing agency for compliance with SIA GB-01.
2. Device Performance: Detect unique, airborne acoustic energy spectrum caused by breaking glass.

a. Sensor Element: Microprocessor-based, digital device to detect breakage of plate, laminate, tempered, and wired glass while rejecting common causes of false alarms. Detection pattern shall be at least a 20-foot (6-m) range.
b. Hookup Cable: Factory installed, not less than 72 inches (1830 mm).
c. Activation Indicator: LED on sensor housing that lights when responding to vibrations, remaining on until manually reset at sensor controller or at master station control unit.
d. Controller: Integral with sensor housing or in a separate assembly, locally adjustable by control under housing cover.
e. Glass-Break Simulator: A device to induce frequencies into protected glass pane that simulate breaking glass without causing damage to glass.

I. Piezoelectric-Type, Glass-Break Sensors
1. Listed and labeled by a qualified testing agency for compliance with SIA GB-01.
2. Device Performance: Detect unique, high-frequency vibrations caused by breaking glass.
a. Sensor Element: Piezoelectric crystals in a housing designed to mount directly to glass surface with adhesive provided by element manufacturer. Circular detection pattern, with at least a 60-inch (1525-mm) radius on a continuous glass pane. Sensor element shall not be larger than 4 sq. in. (25.80 sq. cm).
b. Hookup Cable: Factory installed, not less than 72 inches (1830 mm).
c. Activation Indicator: LED on sensor housing that lights when responding to vibrations, remaining on until manually reset at sensor controller or at master station control unit.
d. Controller: Integral with sensor housing or in a separate assembly, locally adjustable by control under housing cover.
e. Glass-Break Simulator: A device to induce frequencies into protected glass pane that simulate breaking glass without causing damage to glass.

J. Vibration Sensors
1. Listed and labeled by a qualified testing agency for compliance with SIA GB-01.
2. Description: A sensor controller and piezoelectric crystal sensor elements that are designed to be rigidly mounted to structure being protected.
3. Device Performance: Detects high-frequency vibrations generated by use of such tools as oxyacetylene torches, oxygen lances, high-speed drills and saws, and explosives that penetrate a structure while not responding to any other mechanical vibration.
a. Circular detection pattern, with at least a 72-inch (1830-mm) radius on protected structure.
b. Hookup Cable: Factory installed, not less than 72 inches (1830 mm).
c. Controller: Integral with sensor housing or in a separate assembly, locally adjustable by control under housing cover.
d. Glass-Break Simulator: A device to induce frequencies to protected glass pane that simulate breaking glass without causing damage to glass.

K. Photoelectric Sensors
1. Device Performance: Detect an interruption of a pulsed, infrared, light beam that links transmitter and receiver.
a. Sensitivity: Detect standard-intruder movement within sensor's detection patterns at any speed of less than 7.5 fps (2.3 m/s) though the beam. Allow installation of multiple sensors within same protected zone that will not interfere with each other.
b. Activation Indicator: LED indicator shall not be visible during normal operation. Indicator shall light when sensor detects a standard intruder. Locate test enabling switch under sensor housing cover.
c. Remote Test: When initiated by master station control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

L. Microwave-PIR Dual-Technology Motion Sensors

1. Description: Single unit combining a sensor that detects changes in microwave signals and a PIR sensor that detects changes in ambient level of infrared emissions caused by standard-intruder movement within detection pattern.
2. Device Performance: An alarm is transmitted when either sensor detects a standard intruder within a period of three to eight seconds from when the other sensor detects a standard intruder.
   a. Minimum Detection Pattern: A room 20 by 30 feet (6 by 9 m).
   b. PIR Sensor Sensitivity: Adjustable pattern coverage to detect a change in temperature of 2 deg F (1 deg C) or less, and standard-intruder movement within sensor's detection patterns at any speed between 0.3 to 7.5 fps (0.09 to 2.3 m/s) across 2 adjacent segments of detector's field of view.
   c. Microwave Sensor Sensitivity: Adjustable, able to detect standard-intruder movement within sensor's detection pattern at any speed between 0.3 to 7.5 fps (0.09 to 2.3 m/s). Sensor sensitivity adjustments shall be accessible only when sensor housing is removed, and sensors shall comply with 47 CFR 15.
   d. Activation Indicator: LED indicator shall not be visible during normal operation. Indicator shall light when sensor detects a standard intruder. Locate test enabling switch under sensor housing cover.
   e. Remote Test: When initiated by master station control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

M. Duress-Alarm Switches
1. Description: A switch with a shroud over the activating lever that allows an individual to covertly send a duress signal to master station control unit, with no visible or audible indication when activated. Switch shall lock in activated position until reset with a key.
   a. Minimum Switch Rating: 50,000 operations.
   b. Foot Rail: Foot activated, floor mounting.
   c. Push Button: Finger activated, suitable for mounting on horizontal or vertical surface.

N. Video Motion Sensor (Interior)
1. Device Performance: Detect changes in video signal within a user-defined protected zone. Video inputs shall be composite video as defined in EIA 170. Provide an alarm output for each video input.
   a. Detect movement within protected zone of standard intruders wearing clothing with a reflectivity that differs from that of background scene by a factor of 2. Reject all other changes in video signal.
   b. Modular design that allows for expansion or modification of number of inputs.
   c. Controls:
      1) Number of detection zones.
      2) Size of detection zones.
      3) Sensitivity of detection of each protected zone.
   d. Mounting: Standard 19-inch (480-mm) rack as described in EIA 310.

O. Master Control Units
1. Description: Supervise sensors and detection subsystems and their connecting communication links, status control (secure or access) of sensors and detector subsystems, activation of alarms and supervisory and trouble signals, and other indicated functions.
   a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
   b. Include a real-time clock for time annotation of events on the event recorder and printer.
   c. Addressable initiation devices that communicate device identity and status.
   d. Control circuits for operation of mechanical equipment in response to an alarm.
2. Construction: Freestanding equipment rack **OR** Desk-mounted console, **as directed** modular, with separate and independent alarm and supervisory system modules. Alarm-initiating protected

zone boards shall be plug-in cards. Arrangements that require removal of field wiring for module replacement are unacceptable.

3. Comply with UL 609 **OR** UL 1023 **OR** UL 1076, **as directed**.
4. Console Controls and Displays: Arranged for interface between human operator at master control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
   a. Annunciator and Display: LCD, one **OR** two **OR** three line(s), as directed of 40 **OR** 80 characters, as directed, minimum.
   b. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
   c. Control-Unit Network: Automatic communication of alarm, status changes, commands, and other communications required for system operation. Communication shall return to normal after partial or total network interruption such as power loss or transient event. Total or partial signaling network failures shall identify the failure and record the failure at the annunciator display and at the system printer.
   d. Field Device Network: Communicate between the control unit and field devices of the system. Communications shall consist of alarm, network status, and status and control of field-mounted processors. Each field-mounted device shall be interrogated during each interrogation cycle.
   e. Operator Controls: Manual switches and push-to-test buttons that do not require a key to operate. Prevent resetting of alarm, supervisory, or trouble signals while alarm or trouble condition persists. Include the following:
      1) Acknowledge alarm.
      2) Silence alarm.
      3) System reset.
      4) LED test.
   f. Timing Unit: Solid state, programmable, 365 days.
   g. Confirmation: Relays, contactors, and other control devices shall have auxiliary contacts that provide confirmation signals to system for their on or off status. Software shall interpret such signals, display equipment status, and initiate failure signals.
   h. Alarm Indication: Audible signal sounds and a plain-language identification **OR** LED **OR** LCD OR cathode ray-tube display at master control unit identifying the protected zone **OR** addressable detector, **as directed** originating the alarm. Annunciator panel displays a common alarm light and sounds an audible tone.
   i. Alarm activation sounds a bell or siren or strobe **OR** bell or siren and strobe**, as directed**.
5. Protected Zones: Quantity of alarm and supervisory zones as indicated, with capacity for expanding number of protected zones by a minimum of 25 percent.
6. Power Supply Circuits: Master station control units shall provide power for remote power-consuming detection devices. Circuit capacity shall be adequate for at least a 25 percent increase in load.
7. UPS: Comply with Division 26 Section "Static Uninterruptible Power Supply". UPS shall be sized to provide a minimum of six hours of central-station control-unit operation.
8. Cabinet: Lockable, steel enclosure arranged so operations required for testing, normal operation, and maintenance are performed from front of enclosure. If more than a single cabinet is required to form a complete control unit, provide exactly matching modular enclosures. Accommodate all components and allow ample gutter space for field wiring. Identify each enclosure by an engraved, laminated, phenolic-resin nameplate. Lettering on enclosure nameplate shall not be less than 1 inch (25 mm) high. Identify, with permanent labels, individual components and modules within cabinets.
9. Transmission to Monitoring Station: A communications device to automatically transmit alarm, supervisory, and trouble signals to the monitoring station, operating over a standard voice grade telephone leased line. Comply with UL 1635.
10. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print

system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

P. Audible And Visual Alarm Devices
1. Bell: 10 inches (254 mm) in diameter, rated to produce a minimum sound output of 84 dB at 10 feet (3 m) from master control unit.
    a. Enclosure: Weather-resistant steel box equipped with tamper switches on cover and on back of box.
2. Klaxon Weatherproof Motor-Driven Hooter: UL listed, rated to produce a minimum sound output of 120 dB at 3 feet (1 m), plus or minus 3 dB, at a frequency of 470 Hz. Rated for intermittent use: two minutes on and five minutes off.
    a. Designed for use in industrial areas and in high-noise, severe-weather marine environments.
3. Siren: 30-W speaker with siren driver, rated to produce a minimum sound output of 103 dB at 10 feet (3 m) from master control unit.
    a. Enclosure: Weather-resistant steel box with tamper switches on cover and on back of box.
4. Strobe: Xenon light complying with UL 1638, with a clear polycarbonate lens.
    a. Light Output: 115 cd, minimum.
    b. Flash Rate: 60 per minute.

Q. Security Fasteners
1. Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive system type, head style, material, and protective coating as required for assembly, installation, and strength.
2. Drive System Types: Pinned Torx-Plus **OR** pinned Torx **OR** pinned hex (Allen)**, as directed**.
3. Socket Flat Countersunk Head Fasteners:
    a. Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
    b. Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.
4. Socket Button Head Fasteners:
    a. Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
    b. Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.
5. Socket Head Cap Fasteners:
    a. Heat-treated alloy steel, ASTM A 574 (ASTM A 574M).
    b. Stainless steel, ASTM F 837 (ASTM F 837M), Group 1 CW.
6. Protective Coatings for Heat-Treated Alloy Steel:
    a. Zinc chromate, ASTM F 1135, Grade 3 or Grade 4, for exterior applications and interior applications where indicated.
    b. Zinc phosphate with oil, ASTM F 1137, Grade I, or black oxide unless otherwise indicated.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of intrusion detection.
2. Examine roughing-in for embedded and built-in anchors to verify actual locations of intrusion detection connections before intrusion detection installation.
3. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of intrusion detection.
4. Inspect built-in and cast-in anchor installations, before installing intrusion detection, to verify that anchor installations comply with requirements. Prepare inspection reports.
    a. Remove and replace anchors where inspections indicate that they do not comply with requirements. Reinspect after repairs or replacements are made.

b. Perform additional inspections to determine compliance of replaced or additional anchor installations. Prepare inspection reports.
5. For material whose orientation is critical for its performance as a ballistic barrier, verify installation orientation.
6. Proceed with installation only after unsatisfactory conditions have been corrected.

B. System Integration
1. Electronic door hardware.
2. Elevators.
3. Network lighting controls.
4. Intercommunications and program systems.
5. Public address and mass notification systems.
6. Access control.
7. Fire-alarm system.
8. Perimeter security system.
9. Video surveillance.

C. System Installation
1. Comply with UL 681 and NFPA 731.
2. Equipment Mounting: Install master control unit on finished floor with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.
   a. Comply with requirements for seismic-restraint devices specified in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
3. Install wall-mounted equipment, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.
   a. Comply with requirements for seismic-restraint devices specified in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
4. Connecting to Existing Equipment: Verify that existing perimeter security system is operational before making changes or connections.
   a. Connect new equipment to existing control panel in existing part of the building.
   b. Connect new equipment to existing monitoring equipment at the Supervising Station.
   c. Expand, modify, and supplement existing control **OR** monitoring equipment**, as directed** as necessary to extend existing control **OR** monitoring functions**, as directed** to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.
5. Security Fasteners: Where accessible to inmates, install intrusion detection components using security fasteners with head style appropriate for fabrication requirements, strength, and finish of adjacent materials except that a maximum of two different sets of tools shall be required to operate security fasteners for Project. Provide stainless-steel security fasteners in stainless-steel materials.

D. Wiring Installation
1. Wiring Method: Install wiring in metal raceways according to Division 26 Section "Raceway And Boxes For Electrical Systems". Conceal raceway except in unfinished spaces and as indicated. Minimum conduit size shall be 1/2 inch (13 mm). Control and data transmission wiring shall not share conduit with other building wiring systems.
2. Wiring Method: Install wiring in raceways except in accessible indoor ceiling spaces and in interior hollow gypsum board partitions where cable may be used. Conceal raceways and wiring except in unfinished spaces and as indicated. Minimum conduit size shall be 1/2 inch (13 mm). Control and data transmission wiring shall not share conduit with other building wiring systems.
3. Wiring Method: Cable, concealed in accessible ceilings, walls, and floors when possible.
4. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according

to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

5. Wires and Cables:
   a. Conductors: Size as recommended in writing by system manufacturer, unless otherwise indicated.
   b. 120-V Power Wiring: Install according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables", unless otherwise indicated.
   c. Control and Signal Transmission Conductors: Install unshielded, twisted-pair cable, unless otherwise indicated or if manufacturer recommends shielded cable, according to Division 28 Section "Conductors And Cables For Electronic Safety And Security".
   d. Data and Television Signal Transmission Cables: Install according to Division 28 Section "Conductors And Cables For Electronic Safety And Security".
6. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
7. Install power supplies and other auxiliary components for detection devices at controllers, unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.
8. Identify components with engraved, laminated-plastic or metal nameplate for master station control unit and each terminal cabinet, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification For Electrical Systems".

E. Identification
1. Identify system components, wiring, cabling, and terminals. Comply with identification requirements as specified in Division 26 Section "Identification For Electrical Systems".
2. Install instructions frame in a location visible from master control unit.

F. Grounding
1. Ground the master control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to master control unit.
2. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
3. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding. Provide 5-ohm ground. Measure, record, and report ground resistance.
4. Install grounding electrodes of type, size, location, and quantity indicated. Comply with installation requirements in Division 26 Section "Grounding And Bonding For Electrical Systems".

G. Field Quality Control
1. Pretesting: After installation, align, adjust, and balance system and perform complete pretesting to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.
   a. Report of Pretesting: After pretesting is complete, provide a letter certifying that installation is complete and fully operable; include names and titles of witnesses to preliminary tests.
2. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections.
3. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect test, and adjust components, assemblies, and equipment installations connections.
4. Perform tests and inspections.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
5. Test and Inspections: Comply with provisions in NFPA 731, Ch.9, “Testing and Inspections.”

a. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.

b. Test Methods: Intrusion detection systems and other systems and equipment that are associated with detection and accessory equipment shall be tested according to Table "Test Methods" and Table "Test Methods of Initiating Devices."

6. Documentation: Comply with provisions in NFPA 731, Ch. 4, "Documentation."
7. Tag all equipment, stations, and other components for which tests have been satisfactorily completed.
8.

H. Adjusting

1. Occupancy Adjustments: When requested within 12 months of Final Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose. Visits for this purpose shall be in addition to any required by warranty.

I. Demonstration

1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain intrusion detection system. Comply with documentation provisions in NFPA 731, Ch.4, “Documentation and User Training.”

END OF SECTION 28 16 11 00a

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SECTION 28 16 11 00b - SECURITY ACCESS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for security access. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
    a. Security access central-control station.
    b. One or more security access networked workstations.
    c. Security access operating system and application software.
    d. Security access controllers connected to high-speed electronic-data transmission network.

C. Definitions

1. CCTV: Closed-circuit television.
2. CPU: Central processing unit.
3. Credential: Data assigned to an entity and used to identify that entity.
4. dpi: Dots per inch.
5. DTS: Digital Termination Service. A microwave-based, line-of-sight communication provided directly to the end user.
6. GFI: Ground fault interrupter.
7. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.
8. I/O: Input/Output.
9. LAN: Local area network.
10. Location: A Location on the network having a PC-to-controller communications link, with additional controllers at the Location connected to the PC-to-controller link with a TIA 485-A communications loop. Where this term is presented with an initial capital letter, this definition applies.
11. PC: Personal computer. Applies to the central station, workstations, and file servers.
12. PCI Bus: Peripheral Component Interconnect. A peripheral bus providing a high-speed data path between the CPU and the peripheral devices such as a monitor, disk drive, or network.
13. PDF: Portable Document Format. The file format used by the Acrobat document-exchange-system software from Adobe.
14. RAS: Remote access services.
15. RF: Radio frequency.
16. ROM: Read-only memory. ROM data are maintained through losses of power.
17. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.
18. TWAIN: Technology without an Interesting Name. A programming interface that lets a graphics application, such as an image editing program or desktop publishing program, activate a scanner, frame grabber, or other image-capturing device.
19. UPS: Uninterruptible power supply.
20. USB: Universal serial bus.
21. WAN: Wide area network.
22. WAV: The digital audio format used in Microsoft Windows.
23. WMP: Windows media player.
24. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.

25. Windows: Operating system by Microsoft Corporation.
26. Workstation: A PC with software that is configured for specific, limited security-system functions.
27. WYSIWYG: What You See Is What You Get. Text and graphics appear on the screen the same as they will in print.

D. Submittals
1. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.
2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   a. Diagrams for cable management system.
   b. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 1.2 and 1.3.
   c. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:
      1) Workstation outlets, jacks, and jack assemblies.
      2) Patch cords.
      3) Patch panels.
   d. Cable Administration Drawings: As specified in Part 1.3 "Identification" Article.
   e. Battery and charger calculations for Central Station, workstations, and Controllers.
3. Samples: For workstation outlets, jacks, jack assemblies, and faceplates. For each exposed product and for each color and texture specified.
4. Other Action Submittals:
   a. Project planning documents as specified in Part 1.3.
5. Field quality-control test reports.
6. Operation and Maintenance Data: For security system to include in emergency, operation, and maintenance manuals. Include the following:
   a. Microsoft Windows software documentation.
   b. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware. Provide separately for each PC.
   c. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy submittal.
   d. System installation and setup guides, with data forms to plan and record options and setup decisions.

E. Quality Assurance
1. Installer Qualifications: An employer of workers trained and approved by manufacturer.
   a. Cable installer must have on staff a registered communication distribution designer certified by Building Industry Consulting Service International.
2. Source Limitations: Obtain Central Station, workstations, Controllers, Identifier readers, and all software through one source from a single manufacturer.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 by a qualified testing agency, and marked for intended use.
4. Comply with NFPA 70, "National Electrical Code."
5. Comply with SIA DC-01 and SIA DC-03 and SIA DC-07, **as directed**.

F. Delivery, Storage, And Handling
1. Central Station, Workstations, and Controllers:
   a. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F (10 and 30 deg C), and not more than 80 percent relative humidity, noncondensing.
   b. Open each container; verify contents against packing list, and file copy of packing list, complete with container identification for inclusion in operation and maintenance data.

c. Mark packing list with designations that have been assigned to materials and equipment for recording in the system labeling schedules that are generated by cable and asset management system specified in Part 2.
d. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

G. Project Conditions
1. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
a. Control Station: Rated for continuous operation in ambient conditions of 60 to 85 deg F (16 to 30 deg C) and a relative humidity of 20 to 80 percent, noncondensing.
b. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except central-station control unit, installed in air-conditioned **OR** temperature-controlled, **as directed**, indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F (2 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
c. Indoor, Uncontrolled Environment: NEMA 250, Type 3R **OR** 4 **OR** 12 **OR** 12K, **as directed**, enclosures. System components installed in non-air-conditioned **OR** non-temperature-controlled, **as directed**, interior environments shall be rated for continuous operation in ambient conditions of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
d. Outdoor Environment: NEMA 250, Type 3 **OR** 3R **OR** 3S **OR** 4 **OR** 4X, **as directed**, enclosures. System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of minus 30 to plus 122 deg F (minus 34 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h) and snow cover up to 24 inches (610 mm) thick.
e. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
f. Corrosive Environment: For system components subjected to corrosive fumes, vapors, and wind-driven salt spray in coastal zones, provide NEMA 250, Type 4X **OR** 6P, **as directed**, enclosures.

1.2 PRODUCTS

A. Description
1. Security Access System: PC-based central station, one or more networked PC-based workstations, and field-installed controllers, connected by a high-speed electronic-data transmission network.
2. System Software: Based on 32-bit, central-station, workstation operating system, server operating system, and application software. Software shall have the following capabilities:
a. Multiuser and multitasking to allow for independent activities and monitoring to occur simultaneously at different workstations.
b. Graphical user interface to show pull-down menus and a menu-tree format that complies with interface guidelines of Microsoft Windows.
c. System license for the entire system including capability for future additions that are within the indicated system size limits specified in this Section.
d. Open-architecture system that allows importing and exporting of data and interfacing with other systems that are compatible with Microsoft Windows.
e. Password-protected operator login and access.
f. Open-database-connectivity compliant.
3. Network connecting the central station and workstations shall be a LAN **OR** WAN, **as directed,** using Microsoft Windows-based TCP/IP with a capacity of connecting up to 99 workstations.

System shall be portable across multiple communication platforms without changing system software.

4. Network(s) connecting PCs and controllers shall consist of one or more of the following:
   a. Local area, IEEE 802.3 Fast Ethernet Gigabit-Ethernet **OR** 100 BASE-TX, **as directed**, star topology network based on TCP/IP.
   b. Direct-connected, RS-232 cable from the COM port of the central station to the first controller, then RS-485 cable to interconnect the remaining controllers at that Location.
   c. Dial-up and cable modem connection using a standard cable or dial-up telephone line.

B. Operation

1. Security access system shall use a single database for access-control and credential-creation functions.
2. Distributed Processing: A fully distributed processing system.
   a. Access-control information, including time, date, valid codes, access levels, and similar data, shall be downloaded to controllers so each controller can make access-control decisions.
   b. Intermediate controllers for access control are prohibited.
   c. In the event that communications with the central controller are lost, controllers shall automatically buffer event transactions until communications are restored, at which time buffered events shall be uploaded to the central station.
3. Number of Locations:
   a. Support at least 32,000 separate Locations using a single PC with combinations of direct-connect, dial-up, or TCP/IP LAN connections to each Location.
   b. Each Location shall have its own database and history in the central station.
   c. Locations may be combined to share a common database.
4. Data Capacity:
   a. 130 different card-reader formats.
   b. 999 comments.
   c. 48 graphic file types for importing maps.
5. Location Capacity:
   a. 128 reader-controlled doors.
   b. 50,000 total-access credentials.
   c. 2048 supervised alarm inputs.
   d. 2048 programmable outputs.
   e. 32,000 custom action messages per Location to instruct operator on action required when alarm is received.
6. System Network Requirements:
   a. System components shall be interconnected and shall provide automatic communication of status changes, commands, field-initiated interrupts, and other communications required for proper system operation.
   b. Communication shall not require operator initiation or response and shall return to normal after partial- or total-network interruption such as power loss or transient upset.
   c. System shall automatically annunciate communication failures to the operator and shall identify the communications link that has experienced a partial or total failure.
   d. Communications controller may be used as an interface between the central-station display systems and the field device network. Communications controller shall provide functions required to attain the specified network communications performance.
7. Central station shall provide operator interface, interaction, display, control, and dynamic and real-time monitoring. Central station shall control system networks to interconnect all system components, including workstations and field-installed controllers.
8. Field equipment shall include controllers, sensors, and controls.
   a. Controllers shall serve as an interface between the central station and sensors and controls.
   b. Data exchange between the central station and the controllers shall include down-line transmission of commands, software, and databases to controllers.

c. The up-line data exchange from the controller to the central station shall include status data such as intrusion alarms, status reports, and entry-control records.
d. Controllers are classified as alarm-annunciation or entry-control type.

9. System Response to Alarms:
a. Field device network shall provide a system end-to-end response time of one second(s) or less for every device connected to the system.
b. Alarms shall be annunciated at the central station within one second of the alarm occurring at a controller or at a device controlled by a local controller, and within 100 ms if the alarm occurs at the central station.
c. Alarm and status changes shall be displayed within 100 ms after receipt of data by the central station.
d. All graphics shall be displayed, including graphics-generated map displays, on the console monitor within five seconds of alarm receipt at the security console.
e. This response time shall be maintained during system heavy load.

10. False-Alarm Reduction: The design of the central station and controllers shall contain features to reduce false alarms. Equipment and software shall comply with SIA CP-01.

11. Error Detection:
a. Use a cyclic code method to detect single- and double-bit errors, burst errors of eight bits or fewer, and at least 99 percent of all other multibit and burst errors between controllers and the central station.
b. Interactive or product error-detection codes alone will not be acceptable.
c. A message shall be in error if one bit is received incorrectly.
d. Retransmit messages with detected errors.
e. Allow for an operator-assigned two-digit decimal number to each communications link representing the number of retransmission attempts.
f. Central station shall print a communication failure alarm message when the number of consecutive retransmission attempts equals the assigned quantity.
g. Monitor the frequency of data transmission failure for display and logging.

12. Data Line Supervision: System shall initiate an alarm in response to opening, closing, shorting, or grounding of data transmission lines.

13. Door Hardware Interface:
a. Comply with requirements in Division 8 Sections for door hardware required to be monitored or controlled by the security access system.
b. Electrical characteristics of controllers shall match the signal and power requirements of door hardware.

C. Application Software

1. System Software: Based on 32-bit, Microsoft Windows central-station and workstation operating system and application software.
a. Multiuser multitasking shall allow independent activities and monitoring to occur simultaneously at different workstations.
b. Graphical user interface shall show pull-down menus and a menu-tree format.
c. Capability for future additions within the indicated system size limits.
d. Open architecture that allows importing and exporting of data and interfacing with other systems that are compatible with operating system.
e. Password-protected operator login and access.

2. Peer Computer Control Software: Detect a failure of a central computer and cause the other central computer to assume control of all system functions without interruption of operation. Both central computers shall have drivers to support this mode of operation.

3. Application Software: Interface between the alarm annunciation and entry-control controllers to monitor sensors and DTS links, operate displays, report alarms, generate reports, and help train system operators.
a. Reside at the central station, workstations, and controllers as required to perform specified functions.
b. Operate and manage peripheral devices.

c. Manage files for disk I/O, including creating, deleting, and copying files; and automatically maintain a directory of all files, including size and location of each sequential and random-ordered record.
d. Import custom icons into graphics to represent alarms and I/O devices.
e. Globally link I/O so that any I/O can link to any other I/O within the same Location without requiring interaction with the host PC. This operation shall be at the controller.
f. Globally code I/O links so that any access-granted event can link to any I/O with the same Location without requiring interaction with the host PC. This operation shall be at the controller.
g. Messages from PC to controllers and controllers to controllers shall be on a polled network that utilizes check summing and acknowledgment of each message. Communication shall be automatically verified, buffered, and retransmitted if message is not acknowledged.
h. Selectable poll frequency and message time-out settings shall handle bandwidth and latency issues for TCP/IP, RF, and other PC-to-controller communications methods by changing the polling frequency and the amount of time the system waits for a response.
i. Automatic and encrypted backups for database and history backups shall be automatically stored at the central-control PC **OR** a selected workstation, **as directed**, and encrypted with a nine-character alphanumeric password that must be used to restore or read data contained in backup.
j. Operator audit trail for recording and reporting all changes made to database and system software.
k. Support network protocol and topology, TCP/IP, Novel Netware, Digital Pathworks, Banyan Vines, LAN/WAN, and RAS.

4. Workstation Software:
a. Password levels shall be individually customized at each workstation to allow or disallow operator access to program functions for each Location.
b. Workstation event filtering shall allow user to define events and alarms that will be displayed at each workstation. If an alarm is unacknowledged (not handled by another workstation) for a preset amount of time, the alarm will automatically appear on the filtered workstation.

5. Controller Software:
a. Controllers shall operate as autonomous, intelligent processing units.
1) Controllers shall make decisions about access control, alarm monitoring, linking functions, and door-locking schedules for their operation, independent of other system components.
2) Controllers shall be part of a fully distributed processing-control network.
3) The portion of the database associated with a controller, and consisting of parameters, constraints, and the latest value or status of points connected to that controller, shall be maintained in the controller.
b. The following functions shall be fully implemented and operational within each controller:
1) Monitoring inputs.
2) Controlling outputs.
3) Automatically reporting alarms to the central station.
4) Reporting of sensor and output status to the central station on request.
5) Maintaining real time, automatically updated by the central station at least once a day.
6) Communicating with the central station.
7) Executing controller resident programs.
8) Diagnosing.
9) Downloading and uploading data to and from the central station.
c. Controller Operations at a Location:
1) Up to 64 controllers connected to TIA 485-A communications loop. Globally operating I/O linking and anti-passback functions between controllers within the same Location without central-station or workstation intervention. Linking and anti-

passback shall remain fully functional within the same Location even when the central station or workstations are off-line.

2) In the event of communication failure between the central station and a Location, there shall be no degradation in operations at the controllers at that Location. Controllers at each Location shall be connected to a memory buffer with a capacity to store up to 10,000 events; there shall be no loss of transactions in system history files until the buffer overflows.

3) Buffered events shall be handled in a first-in-first-out mode of operation.

d. Individual Controller Operation:

1) Controllers shall transmit alarms, status changes, and other data to the central station when communications circuits are operable. If communications are not available, controllers shall function in a stand-alone mode; operational data, including the status and alarm data normally transmitted to the central station, shall be stored for later transmission to the central station. Storage capacity for the latest 1024 events shall be provided at each controller.

2) Card-reader ports of a controller shall be custom configurable for at least 120 different card-reader or keypad formats. Multiple reader or keypad formats may be used simultaneously at different controllers or within the same controller.

3) Controllers shall provide a response to card readers or keypad entries in less than 0.25 seconds, regardless of system size.

4) Controllers that are reset, or powered up from a nonpowered state, shall automatically request a parameter download and reboot to their proper working state. This shall happen without any operator intervention.

5) Initial Startup: When controllers are brought on-line, database parameters shall be automatically downloaded to them. After initial download is completed, only database changes shall be downloaded to each controller.

6) On failure for any reason, controllers shall perform an orderly shutdown and force controller outputs to a predetermined failure-mode state, consistent with the failure modes shown and the associated control device.

7) After power is restored, following a power failure, startup software shall initiate self-test diagnostic routines, after which controllers shall resume normal operation.

8) After controller failure, if the database and application software are no longer resident, controllers shall not restart but shall remain in the failure mode until repaired. If database and application programs are resident, controllers shall immediately resume operation. If not, software shall be restored automatically from the central station.

e. Communications Monitoring:

1) System shall monitor and report status of TIA 485-A communications loop of each Location.

2) Communication status window shall display which controllers are currently communicating, a total count of missed polls since midnight, and which controller last missed a poll.

3) Communication status window shall show the type of CPU, the type of I/O board, and the amount of RAM for each controller.

f. Operating systems shall include a real-time clock function that maintains seconds, minutes, hours, day, date, and month. The real-time clock shall be automatically synchronized with the central station at least once a day to plus or minus 10 seconds. The time synchronization shall be automatic, without operator action and without requiring system shutdown.

6. PC-to-Controller Communications:

a. Central-station or workstation communications shall use the following:

1) Direct connection using serial ports of the PC.
2) TCP/IP LAN interface cards.
3) Dial-up or cable modems for connections to Locations.

b. Each serial port used for communications shall be individually configurable for "direct communications," "modem communications incoming and outgoing," or "modem communications incoming only," or as an ASCII output port. Serial ports shall have adjustable data transmission rates and shall be selectable under program control.

c. Use multiport communications board if more than two serial ports are needed.
   1) Use a 4-, 8-, or 16-serial port configuration that is expandable to 32- or 64-serial ports.
   2) Connect the first board to an internal PCI bus adapter card.

d. Direct serial, TCP/IP, and dial-up, cable, or satellite communications shall be alike in the monitoring or control of the system except for the connection that must first be made to a dial-up or voice-over IP Location.

e. TCP/IP network interface card (NIV) shall have an option to set the poll-frequency and message-response time-out settings.

f. PC-to-controller and controller-to-controller communications (direct, dial-up, or TCP/IP) shall use a polled-communication protocol that checks sum and acknowledges each message. All communications in this subparagraph shall be verified and buffered, and retransmitted if not acknowledged.

7. Direct Serial or TCP/IP PC-to-Controller Communications:
   a. Communication software on the PC shall supervise the PC-to-controller communications link.
   b. Loss of communications to any controller shall result in an alarm at all PCs running the communication software.
   c. When communications are restored, all buffered events shall automatically upload to the PC, and any database changes shall be automatically sent to the controller.

8. Dial-up Modem or Cable Modem PC-to-Controller Communications:
   a. Communication software on the PC shall supervise the PC-to-controller communications link during dial-up modem connect times.
   b. Communication software shall be programmable to routinely poll each of the remote dial-up or cable modem Locations, collecting event logs and verifying phone lines at operator-selectable time intervals for each Location.
   c. System shall be programmable for dialing and connecting to all dial-up or cable modem Locations and for retrieving the accrued history transactions on an automatic basis as often as once every 10 minutes and up to once every 9999 minutes.
   d. Failure to communicate to a dial-up Location three times in a row shall result in an alarm at the PC.
   e. Time offset capabilities shall be present so that Locations in a different geographical time zone than the host PC will be set to, and maintained at, the proper local time. This feature shall allow for geographical time zones that are ahead of or behind the host PC.
   f. The controller connected to a dial-up or cable modem shall automatically buffer all normal transactions until its buffer reaches 80 percent of capacity. When the transaction buffer reaches 80 percent, the controller shall automatically initiate a call to the central station and upload all transactions.
   g. Alarms shall be reported immediately.
   h. Dial-up or cable modems shall be provided by manufacturer of the system. Modems used at the controller shall be powered by the controller. Power to the modem shall include battery backup if the controller is so equipped.

9. Controller-to-Controller Communications:
   a. TIA 485-A, four-wire, point-to-point, regenerative (repeater) communications network methodology.
   b. TIA 485-A communications signal shall be regenerated at each controller.

10. Database Downloads:
   a. All data transmissions from PCs to a Location, and between controllers at a Location, shall include a complete database checksum to check the integrity of the transmission. If the data checksum does not match, a full data download shall be automatically retransmitted.
   b. If a controller is reset for any reason, it shall automatically request and receive a database download from the PC. The download shall restore data stored at the controller to their normal working state and shall take place with no operator intervention.

c. Software shall provide for setting downloads via dial-up connection to once per 24-hour period, with time selected by the operator.
d. Software shall provide for setting delays of database downloads for dial-up connections. Delays change the download from immediately to a delay ranging from one to 999 minutes.

11. Operator Interface:
a. Inputs in system shall have two icon representations, one for the normal state and one for the abnormal state.
b. When viewing and controlling inputs, displayed icons shall automatically change to the proper icon to display the current system state in real time. Icons shall also display the input's state, whether armed or bypassed, and if the input is in the armed or bypassed state due to a time zone or a manual command.
c. Outputs in system shall have two icon representations, one for the secure (locked) state and one for the open (unlocked) state.
d. Icons displaying status of the I/O points shall be constantly updated to show their current real-time condition without prompting by the operator.
e. The operator shall be able to scroll the list of I/Os and press the appropriate toolbar button, or right click, to command the system to perform the desired function.
f. Graphic maps or drawings containing inputs, outputs, and override groups shall include the following:
1) Database to import and store full-color maps or drawings and allow for input, output, and override group icons to be placed on maps.
2) Maps to provide real-time display animation and allow for control of points assigned to them.
3) System to allow inputs, outputs, and override groups to be placed on different maps.
4) Software to allow changing the order or priority in which maps will be displayed.
g. Override Groups Containing I/Os:
1) System shall incorporate override groups that provide the operator with the status and control over user-defined "sets" of I/Os with a single icon.
2) Icon shall change automatically to show the live summary status of points in that group.
3) Override group icon shall provide a method to manually control or set to time-zone points in the group.
4) Override group icon shall allow the expanding of the group to show icons representing the live status for each point in the group, individual control over each point, and the ability to compress the individual icons back into one summary icon.
h. Schedule Overrides of I/Os and Override Groups:
1) To accommodate temporary schedule changes that do not fall within the holiday parameters, the operator shall have the ability to override schedules individually for each input, output, or override group.
2) Each schedule shall be composed of a minimum of two dates with separate times for each date.
3) The first time and date shall be assigned the override state that the point shall advance to when the time and date become current.
4) The second time and date shall be assigned the state that the point shall return to when the time and date become current.
i. Copy command in database shall allow for like data to be copied and then edited for specific requirements, to reduce redundant data entry.

12. Operator Access Control:
a. Control operator access to system controls through three password-protected operator levels. System operators and managers with appropriate password clearances shall be able to change operator levels for operators.
b. Three successive attempts by an operator to execute functions beyond their defined level during a 24-hour period shall initiate a software tamper alarm.
c. A minimum of 32 passwords shall be available with the system software. System shall display the operator's name or initials in the console's first field. System shall print the operator's name or initials, action, date, and time on the system printer at login and logoff.

d. The password shall not be displayed or printed.
e. Each password shall be definable and assignable for the following:
    1) Selected commands to be usable.
    2) Access to system software.
    3) Access to application software.
    4) Individual zones that are to be accessed.
    5) Access to database.

13. Operator Commands:
    a. Command Input: Plain-language words and acronyms shall allow operators to use the system without extensive training or data-processing backgrounds. System prompts shall be a word, a phrase, or an acronym.
    b. Command inputs shall be acknowledged and processing shall start in not less than one second(s).
    c. Tasks that are executed by operator's commands shall include the following:
        1) Acknowledge Alarms: Used to acknowledge that the operator has observed the alarm message.
        2) Place Zone in Access: Used to remotely disable intrusion-alarm circuits emanating from a specific zone. System shall be structured so that console operator cannot disable tamper circuits.
        3) Place Zone in Secure: Used to remotely activate intrusion-alarm circuits emanating from a specific zone.
        4) System Test: Allows the operator to initiate a system-wide operational test.
        5) Zone Test: Allows the operator to initiate an operational test for a specific zone.
        6) Print reports.
        7) Change Operator: Used for changing operators.
        8) Security Lighting Controls: Allows the operator to remotely turn on or turn off security lights.
        9) Display Graphics: Used to show any graphic displays implemented in the system. Graphic displays shall be completed within 20 seconds from time of operator command.
        10) Run system tests.
        11) Generate and format reports.
        12) Request help with the system operation.
            a) Include in main menus.
            b) Provide unique, descriptive, context-sensitive help for selections and functions with the press of one function key.
            c) Provide navigation to specific topic from within the first help window.
            d) Help shall be accessible outside the application program.
        13) Entry-Control Commands:
            a) Lock (secure) or unlock (open) each controlled entry and exit up to four times a day through time-zone programming.
            b) Arm or disarm each monitored input up to four times a day through time-zone programming.
            c) Enable or disable readers or keypads up to two times a day through time-zone programming.
            d) Enable or disable cards or codes up to four times a day per entry point through access-level programming.
    d. Command Input Errors: Show operator input assistance when a command cannot be executed because of operator input errors. Assistance screen shall use plain-language words and phrases to explain why the command cannot be executed. Error responses that require an operator to look up a code in a manual or other document are not acceptable. Conditions causing operator assistance messages include the following:
        1) Command entered is incorrect or incomplete.
        2) Operator is restricted from using that command.
        3) Command addresses a point that is disabled or out of service.

4) Command addresses a point that does not exist.
5) Command is outside the system's capacity.

14. Alarms:
 a. System Setup:
  1) Assign manual and automatic responses to incoming-point status change or alarms.
  2) Automatically respond to input with a link to other inputs, outputs, or operator-response plans; unique sound with use of WAV files; and maps or images that graphically represent the point location.
  3) Sixty-character message field for each alarm.
  4) Operator-response-action messages shall allow message length of at least 65,000 characters, with database storage capacity of up to 32,000 messages. Setup shall assign messages to access point **OR** zone **OR** sensor**, as directed**.
  5) Secondary messages shall be assignable by the operator for printing to provide further information and shall be editable by the operator.
  6) Allow 25 secondary messages with a field of four lines of 60 characters each.
  7) Store the most recent 1000 alarms for recall by the operator using the report generator.
 b. Software Tamper:
  1) Annunciate a tamper alarm when unauthorized changes to system database files are attempted. Three consecutive unsuccessful attempts to log onto system shall generate a software tamper alarm.
  2) Annunciate a software tamper alarm when an operator or other individual makes three consecutive unsuccessful attempts to invoke functions beyond the authorization level.
  3) Maintain a transcript file of the last 5000 commands entered at each central station to serve as an audit trail. System shall not allow write access to system transcript files by any person, regardless of their authorization level.
  4) Allow only acknowledgment of software tamper alarms.
 c. Read access to system transcript files shall be reserved for operators with the highest password authorization level available in system.
 d. Animated Response Graphics: Highlight alarms with flashing icons on graphic maps; display and constantly update the current status of alarm inputs and outputs in real time through animated icons.
 e. Multimedia Alarm Annunciation: WAV files to be associated with alarm events for audio annunciation or instructions.
 f. Alarm Handling: Each input may be configured so that an alarm cannot be cleared unless it has returned to normal, with options of requiring the operator to enter a comment about disposition of alarm. Allow operator to silence alarm sound when alarm is acknowledged.
 g. Alarm Automation Interface: High-level interface to central-station alarm automation software systems. Allows input alarms to be passed to and handled by automation systems in the same manner as burglar alarms, using a TIA 232-F ASCII interface.
 h. CCTV Alarm Interface: Allow commands to be sent to CCTV systems during alarms (or input change of state) through serial ports.
 i. Camera Control: Provides operator ability to select and control cameras from graphic maps.

15. Alarm Monitoring: Monitor sensors, controllers, and DTS circuits and notify operators of an alarm condition. Display higher-priority alarms first and, within alarm priorities, display the oldest unacknowledged alarm first. Operator acknowledgment of one alarm shall not be considered acknowledgment of other alarms nor shall it inhibit reporting of subsequent alarms.
 a. Displayed alarm data shall include type of alarm, location of alarm, and secondary alarm messages.
 b. Printed alarm data shall include type of alarm, location of alarm, date and time (to nearest second) of occurrence, and operator responses.
 c. Maps shall automatically display the alarm condition for each input assigned to that map if that option is selected for that input location.

d. Alarms initiate a status of "pending" and require the following two handling steps by operators:
   1) First Operator Step: "Acknowledged." This action shall silence sounds associated with the alarm. The alarm remains in the system "Acknowledged" but "Un-Resolved."
   2) Second Operator Step: Operators enter the resolution or operator comment, giving the disposition of the alarm event. The alarm shall then clear.
e. Each workstation shall display the total pending alarms and total unresolved alarms.
f. Each alarm point shall be programmable to disallow the resolution of alarms until the alarm point has returned to its normal state.
g. Alarms shall transmit to the central station in real time except for allowing connection time for dial-up locations.
h. Alarms shall be displayed and managed from a minimum of four different windows.
   1) Input Status Window: Overlay status icon with a large red blinking icon. Selecting the icon will acknowledge the alarm.
   2) History Log Transaction Window: Display name, time, and date in red text. Selecting red text will acknowledge the alarm.
   3) Alarm Log Transaction Window: Display name, time, and date in red. Selecting red text will acknowledge the alarm.
   4) Graphic Map Display: Display a steady colored icon representing each alarm input location. Change icon to flashing red when the alarm occurs. Change icon from flashing red to steady red when the alarm is acknowledged.
i. Once an alarm is acknowledged, the operator shall be prompted to enter comments about the nature of the alarm and actions taken. Operator's comments may be manually entered or selected from a programmed predefined list, or a combination of both.
j. For locations where there are regular alarm occurrences, provide programmed comments. Selecting that comment shall clear the alarm.
k. The time and name of the operator who acknowledged and resolved the alarm shall be recorded in the database.
l. Identical alarms from the same alarm point shall be acknowledged at the same time the operator acknowledges the first alarm. Identical alarms shall be resolved when the first alarm is resolved.
m. Alarm functions shall have priority over downloading, retrieving, and updating database from workstations and controllers.
n. When a reader-controlled output (relay) is opened, the corresponding alarm point shall be automatically bypassed.

16. Monitor Display: Display text and graphic maps that include zone status integrated into the display. Colors are used for the various components and current data. Colors shall be uniform throughout the system.
a. Color Code:
   1) FLASHING RED: Alerts operator that a zone has gone into an alarm or that primary power has failed.
   2) STEADY RED: Alerts operator that a zone is in alarm and alarm has been acknowledged.
   3) YELLOW: Advises operator that a zone is in access.
   4) GREEN: Indicates that a zone is secure and that power is on.
b. Graphics:
   1) Support 32,000 graphic display maps and allow import of maps from a minimum of 16 standard formats from another drawing or graphics program.
   2) Allow I/O to be placed on graphic maps by the drag-and-drop method.
   3) Operators shall be able to view the inputs, outputs, and the point's name by moving the mouse cursor over the point on the graphic map.
   4) Inputs or outputs may be placed on multiple graphic maps. The operator shall be able to toggle to view graphic maps associated with I/Os.

5) Each graphic map shall have a display-order sequence number associated with it to provide a predetermined order when toggled to different views.
6) Camera icons shall have the ability to be placed on graphic maps that, when selected by an operator, will open a video window, display the camera associated with that icon, and provide pan-tilt-zoom control.
7) Input, output, or camera placed on a map shall allow the ability to arm or bypass an input, open or secure an output, or control the pan-tilt-zoom function of the selected camera.

17. System test software enables operators to initiate a test of the entire system or of a particular portion of the system.
    a. Test Report: The results of each test shall be stored for future display or printout. The report shall document the operational status of system components.

18. Report-Generator Software: Include commands to generate reports for displaying, printing, and storing on disk and tape. Reports shall be stored by type, date, and time. Report printing shall be the lowest-priority activity. Report-generation mode shall be operator selectable but set up initially as periodic, automatic, or on request. Include time and date printed and the name of operator generating the report. Report formats may be configured by operators.
    a. Automatic Printing: Setup shall specify, modify, or inhibit the report to be generated; the time the initial report is to be generated; the time interval between reports; the end of the period; and the default printer.
    b. Printing on Request: An operator may request a printout of any report.
    c. Alarm Reports: Reporting shall be automatic as initially set up. Include alarms recorded by system over the selected time and information about the type of alarm such as door alarm, intrusion alarm, tamper alarm, etc, the type of sensor, the location, the time, and the action taken.
    d. Access and Secure Reports: Document zones placed in access, the time placed in access, and the time placed in secure mode.
    e. Custom Reports: Reports tailored to exact requirements of who, what, when, and where. As an option, custom report formats may be stored for future printing.
    f. Automatic History Reports: Named, saved, and scheduled for automatic generation.
    g. Cardholder Reports: Include data, or selected parts of the data, as well as the ability to be sorted by name, card number, imprinted number, or by any of the user-defined fields.
    h. Cardholder by Reader Reports: Based on who has access to a specific reader or group of readers by selecting the readers from a list.
    i. Cardholder by Access-Level Reports: Display everyone that has been assigned to the specified access level.
    j. Who Is "In" (Muster) Report:
        1) Emergency Muster Report: One-click operation on toolbar launches report.
        2) Cardholder Report. Contain a count of persons who are "In" at a selected Location and a detailed listing of name, date, and time of last use, sorted by the last reader used or by the group assignment.
    k. Panel Labels Reports: Printout of control-panel field documentation including the actual location of equipment, programming parameters, and wiring identification. Maintain system installation data within system database so that data are available on-site at all times.
    l. Activity and Alarm On-Line Printing: Activity printers for use at workstations; prints all events, or alarms only.
    m. History Reports: Custom reports that allow the operator to select any date, time, event type, device, output, input, operator, Location, name, or cardholder to be included or excluded from the report.
        1) Initially store history on the hard disk of the host PC.
        2) Permit viewing of the history on workstations or print history to any system printer.
        3) The report shall be definable by a range of dates and times with the ability to have a daily start and stop time over a given date range.
        4) Each report shall depict the date, time, event type, event description, and device; or I/O name, cardholder group assignment, and cardholder name or code number.

5) Each line of a printed report shall be numbered to ensure that the integrity of the report has not been compromised.
6) Total number of lines of the report shall be given at the end of the report. If the report is run for a single event such as "Alarms," the total shall reflect how many alarms occurred during that period.

n. Reports shall have the following four options:
1) View on screen.
2) Print to system printer. Include automatic print spooling and "Print To" options if more than one printer is connected to the system.
3) "Save to File" with full path statement.
4) System shall have the ability to produce a report indicating status of system inputs and outputs or of inputs and outputs that are abnormal, out of time zone, manually overridden, not reporting, or in alarm.

o. Custom Code List Subroutine: Allow the access codes of system to be sorted and printed according to the following criteria:
1) Active, inactive, or future activate or deactivate.
2) Code number, name, or imprinted card number.
3) Group, Location access levels.
4) Start and stop code range.
5) Codes that have not been used since a selectable number of days.
6) In, out, or either status.
7) Codes with trace designation.

p. The reports of system database shall allow options so that every data field may be printed.

q. The reports of system database shall be constructed so that the actual position of the printed data shall closely match the position of the data on the data-entry windows.

19. Anti-Passback:

a. System shall have global and local anti-passback features, selectable by Location. System shall support hard and soft anti-passback.

b. Hard Anti-Passback: Once a credential holder is granted access through a reader with one type of designation (IN or OUT), the credential holder may not pass through that type of reader designation until the credential holder passes through a reader of opposite designation.

c. Soft Anti-Passback: Should a violation of the proper IN or OUT sequence occur, access shall be granted, but a unique alarm shall be transmitted to the control station, reporting the credential holder and the door involved in the violation. A separate report may be run on this event.

d. Timed Anti-Passback: A controller capability that prevents an access code from being used twice at the same device (door) within a user-defined amount of time.

e. Provide four separate zones per Location that can operate without requiring interaction with the host PC (done at controller). Each reader shall be assignable to one or all four anti-passback zones. In addition, each anti-passback reader can be further designated as "Hard," "Soft," or "Timed" in each of the four anti-passback zones. The four anti-passback zones shall operate independently.

f. The anti-passback schemes shall be definable for each individual door.

g. The Master Access Level shall override anti-passback.

h. System shall have the ability to forgive (or reset) an individual credential holder or the entire credential-holder population anti-passback status to a neutral status.

20. Visitor Assignment:

a. Provide for and allow an operator to be restricted to only working with visitors. The visitor badging subsystem shall assign credentials and enroll visitors. Allow only those access levels that have been designated as approved for visitors.

b. Provide an automated log of visitor name, time and doors accessed, and name of person contacted.

c. Allow a visitor designation to be assigned to a credential holder.

d. Security access system shall be able to restrict the access levels that may be assigned to credentials issued to visitors.

e. Allow operator to recall visitors' credential-holder file once a visitor is enrolled in the system.

f. The operator may designate any reader as one that deactivates the credential after use at that reader. The history log shall show the return of the credential.

g. System shall have the ability to use the visitor designation in searches and reports. Reports shall be able to print all or any visitor activity.

21. Time and Attendance:

a. Time and attendance reporting shall be provided to match IN and OUT reads and display cumulative time in for each day and cumulative time in for length designated in the report.

b. Shall be provided to match IN and OUT reads and display cumulative time in for each day and cumulative time in for length designated in the report.

c. System software setup shall allow designation of selected access-control readers as time and attendance hardware to gather the clock-in and clock-out times of the users at these readers.

1) Reports shall show in and out times for each day, total time in for each day, and a total time in for period specified by the user.

2) Allow the operator to view and print the reports, or save the reports to a file.

3) Alphabetically sort reports on the person's last name, by Location or location group. Include all credential holders or optionally select individual credential holders for the report.

22. Training Software: Enables operators to practice system operation, including alarm acknowledgment, alarm assessment, response force deployment, and response force communications. System shall continue normal operation during training exercises and shall terminate exercises when an alarm signal is received at the console.

23. Entry-Control Enrollment Software: Database management functions that allow operators to add, delete, and modify access data as needed.

a. The enrollment station shall not have alarm response or acknowledgment functions.

b. Provide multiple, password-protected access levels. Database management and modification functions shall require a higher operator access level than personnel enrollment functions.

c. The program shall provide means to disable the enrollment station when it is unattended, to prevent unauthorized use.

d. The program shall provide a method to enter personnel identifying information into the entry-control database files through enrollment stations. In the case of personnel identity-verification subsystems, this shall include biometric data. Allow entry of personnel identifying information into the system database using menu selections and data fields. The data field names shall be customized during setup to suit user and site needs. Personnel identity-verification subsystems selected for use with the system shall fully support the enrollment function and shall be compatible with the entry-control database files.

e. Cardholder Data: Provide 99 user-defined fields. System shall have the ability to run searches and reports using any combination of these fields. Each user-defined field shall be configurable, using any combination of the following features:

1) MASK: Determines a specific format with which data must comply.

2) REQUIRED: Operator is required to enter data into field before saving.

3) UNIQUE: Data entered must be unique.

4) DEACTIVATE DATE: Data entered will be evaluated as an additional deactivate date for all cards assigned to this cardholder.

5) NAME ID: Data entered will be considered a unique ID for the cardholder.

f. Personnel Search Engine: A report generator with capabilities such as search by last name, first name, group, or any predetermined user-defined data field; by codes not used in definable number of days; by skills; or by seven other methods.

g. Multiple Deactivate Dates for Cards: User-defined fields to be configured as additional stop dates to deactivate any cards assigned to the cardholder.

h. Batch card printing.
i. Default card data can be programmed to speed data entry for sites where most card data are similar.
j. Enhanced ASCII File Import Utility: Allows the importing of cardholder data and images.
k. Card Expire Function: Allows readers to be configured to deactivate cards when a card is used at selected devices.

D. System Database
1. Database and database management software shall define and modify each point in database using operator commands. Definition shall include parameters and constraints associated with each system device.
2. Database Operations:
   a. System data management shall be in a hierarchical menu tree format, with navigation through expandable menu branches and manipulated with use of menus and icons in a main menu and system toolbar.
   b. Navigational Aids:
      1) Toolbar icons for add, delete, copy, print, capture image, activate, deactivate, and muster report.
      2) Point and click feature to facilitate data manipulation.
      3) Next and previous command buttons visible when editing database fields to facilitate navigation from one record to the next.
      4) Copy command and copy tool in the toolbar to copy data from one record to create a new similar record.
   c. Data entry shall be automatically checked for duplicate and illegal data and shall verify that data are in a valid format.
   d. System shall generate a memo or note field for each item that is stored in database, allowing the storing of information about any defining characteristics of the item. Memo field is used for noting the purpose the item was entered for, reasons for changes that were made, and the like.
3. File Management:
   a. File management shall include backup and restoration system, allowing selection of storage media, including 3.5-inch floppy disk, Zip and Jaz drives, and designated network resources.
   b. Operations shall be both manual and automatic mode. The number of automatic sequential backups before the oldest backup becomes overwritten; FIFO mode shall be operator selectable.
   c. Backup program shall provide manual operation from any PC on the LAN and shall operate while system remains operational.
4. Operator Passwords:
   a. Software shall support up to 32,000 individual system operators, each with a unique password.
   b. One to eight alphanumeric characters.
   c. Allow passwords to be case sensitive.
   d. Passwords shall not be displayed when entered.
   e. Passwords shall have unique and customizable password profile, and allow several operators to share a password profile. Include the following features in the password profile:
      1) Allow for at least 32,000 operator password profiles.
      2) Predetermine the highest-level password profile for access to all functions and areas of program.
      3) Allow or disallow operator access to any program operation, including the functions of View, Add, Edit, and Delete.
      4) Restrict which doors an operator can assign access to.

f. Operators shall use a user name and password to log on to system. This user name and password shall be used to access database areas and programs as determined by the associated profile.
g. Make provision to allow the operator to log off without fully exiting program. User may be logged off but program will remain running while displaying the login window for the next operator.

5. Access Card/Code Operation and Management: Access authorization shall be by card, by a manually entered code (PIN), or by a combination of both (card plus PIN).
a. Access authorization shall verify the facility code first, the card or card-and-PIN validation second, and the access level (time of day, day of week, date), anti-passback status, and number of uses last.
b. Use data-entry windows to view, edit, and issue access levels. Access authorization entry management system shall maintain and coordinate all access levels to prevent duplication or the incorrect creation of levels.
c. Allow assignment of multiple cards/codes to a cardholder.
d. Allow assignment of up to four access levels for each Location to a cardholder. Each access level may contain any combination of doors.
e. Each door may be assigned four time zones.
f. Access codes may be up to 11 digits in length.
g. Software shall allow the grouping of locations so cardholder data can be shared by all locations in the group.
h. Visitor Access: Issue a visitor badge for data tracking or photo ID purposes without assigning that person a card or code.
i. Cardholder Tracing: Allow for selection of cardholder for tracing. Make a special audible and visual annunciation at control station when a selected card or code is used at a designated code reader. Annunciation shall include an automatic display of the cardholder image.
j. Allow each cardholder to be given either an unlimited number of uses or a number from 1 to 9998 that regulates the number of times the card can be used before it is automatically deactivated.
k. Provide for cards and codes to be activated and deactivated manually or automatically by date. Provide for multiple deactivate dates to be preprogrammed.

6. Security Access Integration:
a. Photo ID badging and photo verification shall use same database as the security access and may query data from cardholder, group, and other personal information to build a custom ID badge.
b. Automatic or manual image recall and manual access based on photo verification shall also be a means of access verification and entry.
c. System shall allow sorting of cardholders together by group or other characteristic for a fast and efficient method of reporting on, and enabling or disabling, cards or codes.

7. Key control and tracking shall be an integrated function of cardholder data.
a. Provide the ability to store information about which conventional metal keys are issued and to whom, along with key construction information.
b. Reports shall be designed to list everyone that has possession of a specified key.

8. Facility Codes: System shall accommodate up to 2048 facility codes per Location, with the option of allowing facility codes to work at all doors or only particular doors.

9. Operator Comments:
a. With the press of one appropriate button on toolbar, the user shall be permitted to make operator comments into history at anytime.
b. Automatic prompting of operator comment shall occur before the resolution of each alarm.
c. Operator comments shall be recorded by time, date, and operator number.
d. Comments shall be sorted and viewed through reports and history.
e. The operator may enter comments in two ways; either or both may be used:
   1) Manually entered through keyboard data entry (typed), up to 65,000 characters per each alarm.
   2) Predefined and stored in database for retrieval on request.

f. System shall have a minimum of 999 predefined operator comments with up to 30 characters per comment.

10. Group:
    a. Group names may be used to sort cardholders into groups that allow the operator to determine the tenant, vendor, contractor, department, division, or any other designation of a group to which the person belongs.
    b. System software shall have the capacity to assign 1 of 32,000 group names to an access authorization.
    c. Make provision in software to deactivate and reactivate all access authorizations assigned to a particular group.
    d. Allow sorting of history reports and code list printouts by group name.
11. Time Zones:
    a. Each zone consists of a start and stop time for 7 days of the week and three holiday schedules. A time zone is assigned to inputs, outputs, or access levels to determine when an input shall automatically arm or disarm, when an output automatically opens or secures, or when access authorization assigned to an access level will be denied or granted.
    b. Up to four time zones may be assigned to inputs and outputs to allow up to four arm or disarm periods per day or four lock or unlock periods per day; up to three holiday override schedules may be assigned to a time zone.
    c. Data-entry window shall display a dynamically linked bar graph showing active and inactive times for each day and holiday, as start and stop times are entered or edited.
    d. System shall have the capacity for 2048 time zones for each Location.
12. Holidays:
    a. Three different holiday schedules may be assigned to a time zone. Holiday schedule consists of date in format MM/DD/YEAR and a description. When the holiday date matches the current date of the time zone, the holiday schedule replaces the time zone schedule for that 24-hour period.
    b. System shall have the capacity for 32,000 holidays.
    c. Three separate holiday schedules may be applied to a time zone.
    d. Holidays have an option to be designated as occurring on the designated date each year. These holidays remain in system and will not be purged.
    e. Holidays not designated to occur each year shall be automatically purged from database after the date expires.
13. Access Levels:
    a. System shall allow for the creation up to 32,000 access levels.
    b. One level shall be predefined as the Master Access Level. The Master Access Level shall work at all doors at all times and override any anti-passback.
    c. System shall allow for access to be restricted to any area by reader and by time. Access levels shall determine when and where an Identifier is authorized.
    d. System shall be able to create multiple door and time zone combinations under same access level so that an Identifier may be valid during different time periods at different readers even if the readers are on the same Controller.
14. User-Defined Fields:
    a. System shall provide a minimum of 99 user-defined fields, each with up to 50 characters, for specific information about each credential holder.
    b. System shall accommodate a title for each field; field length shall be 20 characters.
    c. A "Required" option may be applied to each user-defined field that, when selected, forces the operator to enter data in the user-defined field before the credential can be saved.
    d. A "Unique" option may be applied to each user-defined field that, when selected, will not allow duplicate data from different credential holders to be entered.
    e. Data format option may be assigned to each user-defined field that will require the data to be entered with certain character types in specific spots in the field entry window.
    f. A user-defined field, if selected, will define the field as a deactivate date. The selection shall automatically cause the data to be formatted with the windows MM/DD/YEAR date format. The credential of the holder will be deactivated on that date.

g. A search function shall allow any one user-defined field or combination of user-defined fields to be searched to find the appropriate cardholder. The search function shall include search for a character string.
h. System shall have the ability to print cardholders based on and organized by the user-defined fields.

15. Code Tracing:
a. System shall perform code tracing selectable by cardholder and by reader.
b. Any code may be designated as a "traced code" with no limit to how many codes can be traced.
c. Any reader may be designated as a "trace reader" with no limit to which or how many readers can be used for code tracing.
d. When a traced code is used at a trace reader, the access-granted message that usually appears on the monitor window of the Central Station shall be highlighted with a different color than regular messages. A short singular beep shall occur at the same time the highlighted message is displayed on the window.
e. The traced cardholder image (if image exists) shall appear on workstations when used at a trace reader.

E. Surge And Tamper Protection
1. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor-entry connection to components.
a. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Division 26 Section "Transient-voltage Suppression For Low-voltage Electrical Power Circuits".
b. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Division 26 Section "Transient-voltage Suppression For Low-voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.
2. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station control-unit alarm display shall identify tamper alarms and indicate locations.

F. Central-Station Hardware
1. Central-Station Computer: Standard unmodified PC of modular design. The CPU word size shall be 32 bytes or larger; the CPU operating speed shall be at least 66 MHz **OR** GHz, **as directed**.
a. Memory: 256 MB of usable installed memory, expandable to a minimum of 1024 MB without additional chassis or power supplies.
b. Power Supply: Minimum capacity of 250 W.
c. Real-Time Clock:
1) Accuracy: Plus or minus 1 minute per month.
2) Time Keeping Format: 24-hour time format including seconds, minutes, hours, date, day, and month; resettable by software.
3) Clock shall function for 1 year without power.
4) Provide automatic time correction once every 24 hours by synchronizing clock with the Time Service Department of the U.S. Naval Observatory.
d. Serial Ports: Provide two TIA 232-F serial ports for general use, with additional ports as required. Data transmission rates shall be selectable under program control.
e. Parallel Port: An enhanced parallel port.
f. LAN Adapter Card: 10/100 Mbps PCI bus, internal network interface card.
g. Sound Card: For playback and recording of digital WAV sound files that are associated with audible warning and alarm functions.
h. Color Monitor: Not less than 17 inches (430 mm), with a minimum resolution of 1280 by 1024 pixels, noninterlaced, and a maximum dot pitch of 0.28 mm. The video card shall

support at least 256 colors at a resolution of 1280 by 1024 at a minimum refresh rate of 70 Hz.

i. Keyboard: With a minimum of 64 characters, standard ASCII character set based on ANSI INCITS 154.
j. Mouse: Standard, compatible with the installed software.
k. Special function keyboard attachments or special function keys to facilitate data input of the following operator tasks:
   1) Help.
   2) Alarm Acknowledge.
   3) Place Zone in Access.
   4) Place Zone in Secure.
   5) System Test.
   6) Print Reports.
   7) Change Operator.
l. Disk storage shall include the following, each with appropriate controller:
   1) Minimum 10 GB hard disk, maximum average access time of 10 ms.
   2) Floppy Disk Drive: High density, 3-1/2-inch (90-mm) size.
   3) PCMCIA slot with removable 500 MB media.
   4) 100 MB Iomega Zip drive.
   5) 250 MB Iomega Jaz drive.
m. Magnetic Tape System: 4-mm cartridge magnetic tape system with minimum 2 **OR** 4 **OR** 12 **OR** 20, **as directed**, GB formatted capacity per tape. Provide 10 tapes, each in a rigid cartridge with spring-loaded cover and operator-settable write-protect feature.
n. Modem: 56,600 bps, full duplex for asynchronous communications. With error detection, auto answer/autodial, and call-in-progress detection. Modem shall comply with requirements in ITU-T v.34, ITU-T v.42 for error correction, and ITU-T v.42 BIS for data compression standards; and shall be suitable for operating on unconditioned voice-grade telephone lines complying with 47 CFR 68.
o. Audible Alarm: Manufacturer's standard.
p. CD-ROM Drive:
   1) Nominal storage capacity of 650 MB.
   2) Data Transfer Rate: 1.2 Mbps.
   3) Average Access Time: 150 ms.
   4) Cache Memory: 256 KB.
   5) Data Throughput: 1 MB/second, minimum.
q. Dot Matrix Alarm Printer:
   1) Connected to the Central Station.
   2) Minimum of 96 characters, standard ASCII character set based on ANSI INCITS 154, and with graphics capability and programmable control of top-of-form.
   3) Prints in both red and black without ribbon change.
   4) Adjustable sprockets for paper width up to 11 inches.
   5) 80 columns per line, minimum speed of 200 characters per second.
   6) Character Spacing: Selectable at 10, 12, or 17 characters per inch.
   7) Paper: Sprocket-fed fan fold paper.
r. Report Printer:
   1) Connected to the Central Station and designated workstations.
   2) Laser printer with minimum resolution of 600 dpi.
   3) RAM: 2 MB, minimum.
   4) Printing Speed: Minimum 12 pages per minute.
   5) Paper Handling: Automatic sheet feeder with 250-sheet paper cassette and with automatic feed.
s. Interface: Bidirectional parallel and universal serial bus.
t. LAN Adapter Card: 10/100 Mbps internal network interface card.

2. Redundant Central Computer: One identical redundant central computer, connected in a hot standby, peer configuration. This computer shall automatically maintain its own copies of system

software, application software, and data files. System transactions and other activities that alter system data files shall be updated to system files of redundant computer in near real-time. If central computer fails, redundant computer shall assume control immediately and automatically.

3. UPS: Self-contained; complying with requirements in Division 26 Section "Static Uninterruptible Power Supply".
   a. Size: Provide a minimum of 6 hours of operation of the central-station equipment, including 2 hours of alarm printer operation.
   b. Batteries: Sealed, valve regulated, recombinant, lead calcium.
   c. Accessories:
      1) Transient voltage suppression.
      2) Input-harmonics reduction.
      3) Rectifier/charger.
      4) Battery disconnect device.
      5) Static bypass transfer switch.
      6) Internal maintenance bypass/isolation switch.
      7) External maintenance bypass/isolation switch.
      8) Output isolation transformer.
      9) Remote UPS monitoring.
      10) Battery monitoring.
      11) Remote battery monitoring.

G. Standard Workstation Hardware
1. Workstation shall consist of a standard unmodified PC, with accessories and peripherals that configure the workstation for a specific duty.
2. Workstation Computer: Standard unmodified PC of modular design. The CPU word size shall be 32 bytes or larger; the CPU operating speed shall be at least 66 MHz **OR** GH, **as directed**.
   a. Memory: 512 MB of usable installed memory, expandable to a minimum of 8 GB without additional chassis or power supplies.
   b. Power Supply: Minimum capacity of 250 W.
   c. Real-Time Clock:
      1) Accuracy: Plus or minus 1 minute per month.
      2) Time Keeping Format: 24-hour time format including seconds, minutes, hours, date, day, and month; resettable by software.
      3) Provide automatic time correction once every 24 hours by synchronizing clock with the Central Station.
   d. Serial Ports: Provide two TIA 232-F USB serial ports for general use, with additional ports as required. Data transmission rates shall be selectable under program control.
   e. Parallel Port: An enhanced parallel port.
   f. Sound Card: For playback and recording of digital WMP sound files that are associated with audible warning and alarm functions.
   g. Color Monitor: Not less than 17 inches (430 mm), with a minimum resolution of 1280 by 1024 pixels, noninterlaced, and a maximum dot pitch of 0.28 mm. The video card shall support at least 256 colors at a resolution of 1280 by 1024 at a minimum refresh rate of 70 Hz.
   h. Keyboard: With a minimum of 64 characters, standard ASCII character set based on ANSI INCITS 154.
   i. Mouse: Standard, compatible with the installed software. Minimum resolution shall be 400 dpi.
   j. Disk storage shall include the following, each with appropriate controller:
      1) Minimum 20 GB hard disk, maximum average access time of 10 ms.
      2) Floppy Disk Drive: High density, 3-1/2-inch (90-mm) size.
   k. CD-ROM Drive:
      1) Nominal storage capacity of 700 MB.
      2) Data Transfer Rate: 3.6 Mbps.
      3) Average Access Time: 150 ms.
      4) Cache Memory: 512 KB.

5) Data Throughput: 3.6 MB/second, minimum.
6) Read Speed: 48x.
7) Write Speed: 32x.

l. DVD/DVD-RW Drive:
1) Nominal Storage Capacity: 4.7 GB.
2) Data Transfer Rate: 3.6 Mbps.
3) Cache Memory: 512 KB.
4) Read Speed: 24x.
5) Write Speed: 6x.

m. Printer:
1) Connected to the Central Station and designated workstations.
2) Laser printer with minimum resolution of 600 dpi.
3) RAM: 8 MB, minimum.
4) Printing Speed: Minimum 12 pages per minute.
5) Paper Handling: Automatic sheet feeder with 250-sheet paper cassette and with automatic feed.

n. Interface: Bidirectional parallel, and universal serial bus.

o. LAN Adapter Card: 10/100 Mbps internal network interface card.

3. Redundant Workstation: One identical redundant workstation, connected in a hot standby, peer configuration. This workstation shall automatically maintain its own copies of system software, application software, and data files. System transactions and other activities that alter system data files shall be updated to system files of redundant workstation in near real time. If its associated workstation fails, redundant workstation shall assume control immediately and automatically.

4. UPS: Self-contained, complying with requirements in Division 26 Section "Static Uninterruptible Power Supply".
a. Size: Provide a minimum of 6 hours of operation of the central-station equipment, including 2 hours of alarm printer operation.
b. Batteries: Sealed, valve regulated, recombinant, lead calcium.
c. Accessories:
1) Transient voltage suppression.
2) Input-harmonics reduction.
3) Rectifier/charger.
4) Battery disconnect device.
5) Static bypass transfer switch.
6) Internal maintenance bypass/isolation switch.
7) External maintenance bypass/isolation switch.
8) Output isolation transformer.
9) Remote UPS monitoring.
10) Battery monitoring.
11) UPS operation monitoring.
12) Abnormal operation. Visible and audible indication.
13) Remote battery monitoring.

H. Communications Workstation
1. Standard workstation, modified as follows:
a. Additional TIA 232-F serial ports. The CPU word size shall be 32 bytes or larger; the CPU operating speed shall be at least 66 MHz. Multiplexed serial ports shall be expandable with 8 character transmit and receive buffers for each port. Total buffer size shall be a minimum of 1 MB.
b. Redundant workstation is not required.
c. Printer is not required.

I. Fixed Map Display: A fixed map display shall show layout of the protected facilities. Zones corresponding to those monitored by system shall be highlighted on the display. Status of each zone shall be displayed using LEDs as required within each designated zone. An LED test switch shall be provided on the map display.

J. Controllers
1. Controllers: Intelligent peripheral control unit, complying with UL 294, that stores time, date, valid codes, access levels, and similar data downloaded from the Central Station or workstation for controlling its operation.
2. Subject to compliance with requirements in this Article, manufacturers may use multipurpose Controllers.
3. Battery Backup: Sealed, lead acid; sized to provide run time during a power outage of 90 minutes, complying with UL 924.
4. Alarm Annunciation Controller:
a. The Controller shall automatically restore communication within 10 seconds after an interruption with the field device network with dc line supervision on each of its alarm inputs.
1) Inputs: Monitor dry contacts for changes of state that reflect alarm conditions. Provides at least eight alarm inputs, which are suitable for wiring as normally open or normally closed contacts for alarm conditions.
2) Alarm-Line Supervision:
a) Supervise the alarm lines by monitoring each circuit for changes or disturbances in the signal, and for conditions as described in UL 1076 for line security equipment **OR** by monitoring for abnormal open, grounded, or shorted conditions, **as directed**, using dc change measurements. System shall initiate an alarm in response to an abnormal current, which is a dc change of 5 **OR** 10, **as directed**, percent or more for longer than 500 ms.
b) Transmit alarm-line-supervision alarm to the Central Station during the next interrogation cycle after the abnormal current condition.
3) Outputs: Managed by Central Station software.
b. Auxiliary Equipment Power: A GFI service outlet inside the Controller enclosure.
5. Entry-Control Controller:
a. Function: Provide local entry-control functions including one- and two-way communications with access-control devices such as card readers, keypads, biometric personal identity verification devices, door strikes, magnetic latches, gate and door operators, and exit push-buttons.
1) Operate as a stand-alone portal Controller using the downloaded database during periods of communication loss between the Controller and the field-device network.
2) Accept information generated by the entry-control devices; automatically process this information to determine valid identification of the individual present at the portal:
a) On authentication of the credentials or information presented, check privileges of the identified individual, allowing only those actions granted as privileges.
b) Privileges shall include, but not be limited to, time of day control, day of week control, group control, and visitor escort control.
3) Maintain a date-, time-, and Location-stamped record of each transaction. A transaction is defined as any successful or unsuccessful attempt to gain access through a controlled portal by the presentation of credentials or other identifying information.
b. Inputs:
1) Data from entry-control devices; use this input to change modes between access and secure.
2) Database downloads and updates from the Central Station that include enrollment and privilege information.
c. Outputs:
1) Indicate success or failure of attempts to use entry-control devices and make comparisons of presented information with stored identification information.
2) Grant or deny entry by sending control signals to portal-control devices and mask intrusion alarm annunciation from sensors stimulated by authorized entries.

3) Maintain a date-, time-, and Location-stamped record of each transaction and transmit transaction records to the Central Station.
4) Door Prop Alarm: If a portal is held open for longer than 20 seconds **OR** time listed in a schedule, **as directed**, alarm sounds.

d. With power supplies sufficient to power at voltage and frequency required for field devices and portal-control devices.

e. Data Line Problems: For periods of loss of communications with Central Station, or when data transmission is degraded and generating continuous checksum errors, the Controller shall continue to control entry by accepting identifying information, making authentication decisions, checking privileges, and controlling portal-control devices.
1) Store up to 1000 transactions during periods of communication loss between the Controller and access-control devices for subsequent upload to the Central Station on restoration of communication.

f. Controller Power: NFPA 70, Class II power supply transformer, with 12- or 24-V ac secondary, backup battery and charger.
1) Backup Battery: Premium, valve-regulated, recombinant-sealed, lead-calcium battery; spill proof; with a full 1-year warranty and a pro rata 19-year warranty. With single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery terminal voltage and charging current recommendations for maximum battery life.
2) Backup Battery: Valve-regulated, recombinant-sealed, lead-acid battery; spill proof. With single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery terminal voltage and charging current recommendations for maximum battery life.
3) Backup Power Supply Capacity: 5 **OR** 90, **as directed**, minutes of battery supply. Submit battery and charger calculations.
4) Power Monitoring: Provide manual dynamic battery load test, initiated and monitored at the control center; with automatic disconnection of the Controller when battery voltage drops below Controller limits. Report by using local Controller-mounted LEDs and by communicating status to Central Station. Indicate and report the following:
a) Trouble Alarm: Normal power off load assumed by battery.
b) Trouble Alarm: Low battery.
c) Alarm: Power off.

K. Secondary Alarm Annunciator

1. Secondary Alarm Annunciation Site: A workstation with limited I/O capacity, consisting of a secondary alarm annunciation workstation to allow the operator to duplicate functions of the main operator interface, and to show system status changes **OR** to display alarms or system status changes only, **as directed**.

L. Card Readers, Credential Cards, And Keypads

1. Card-Reader Power: Powered from its associated controller, including its standby power source, and shall not dissipate more than 5 W.
2. Response Time: Card reader shall respond to passage requests by generating a signal that is sent to the controller. Response time shall be 800 ms or less, from the time the card reader finishes reading the credential card until a response signal is generated.
3. Enclosure: Suitable for surface, semi-flush, pedestal, or weatherproof mounting. Mounting types shall additionally be suitable for installation in the following locations:
a. Indoors, controlled environment.
b. Indoors, uncontrolled environment.
c. Outdoors, with built-in heaters or other cold-weather equipment to extend the operating temperature range as needed for operation at the site.

4. Display: Digital visual indicator shall provide visible and audible status indications and user prompts. Indicate power on or off, whether user passage requests have been accepted or rejected, and whether the door is locked or unlocked.
5. Stripe Swipe Readers: Bidirectional, reading cards swiped in both directions, powered by the controller. Reader shall be set up for ABA Track.
   a. ABA Track: Magnetic stripe that is encoded on track 2, at 75-bpi density in binary-coded decimal format; for example, 5-bit, 16-character set.
   b. Readers for outdoors shall be in a polymeric plastic enclosure with all electronics potted in plastic. Rated for operation in ambient conditions of minus 40 to plus 160 deg F (minus 40 to plus 70 deg C) in a humidity range of 10 to 90 percent.
6. Wiegand Swipe Reader: Set up for 33 **OR** 26-bit data cards, **as directed.** Comply with SIA AC-01.
7. Wiegand Key-Insert Reader: Set up for 33 **OR** 26-bit data cards, **as directed.**
8. Bar-Code Reader: Set up for Code 39 **OR** 93 **OR** 128**, as directed.**
9. Insert Readers: Requiring the card to be inserted from the bottom **OR** side, **as directed,** powered by the controller.
10. Touch-Plate and Proximity Readers:
    a. Active-detection proximity card readers shall provide power to compatible credential cards through magnetic induction, and shall receive and decode a unique identification code number transmitted from the credential card.
    b. Passive-detection proximity card readers shall use a swept-frequency, RF field generator to read the resonant frequencies of tuned circuits laminated into compatible credential cards. The resonant frequencies read shall constitute a unique identification code number.
    c. The card reader shall read proximity cards in a range from direct contact to at least 6 inches (150 mm) from the reader.
11. Keypads:
    a. Entry-control keypads shall use a unique combination of alphanumeric and other symbols as an Identifier.
    b. Keypads shall contain an integral alphanumeric/special symbols keyboard with symbols arranged in ascending ASCII-code ordinal sequence **OR** random scrambled order, **as directed.**.
    c. Communication protocol shall be compatible with the local processor.
12. Keypad Display:
    a. Keypads shall include a digital visual indicator and shall provide visible **OR** visible and audible status indications and user prompts, **as directed.**
    b. Display shall indicate power on or off and whether user passage requests have been accepted or rejected.
    c. Design of the keypad display or keypad enclosure shall limit viewing angles of the keypad as follows:
       1) Maximum Horizontal Viewing Angle: Plus or minus 5 degrees or less off a vertical plane perpendicular to the plane of the face of the keypad display.
       2) Maximum Vertical Viewing Angle: Plus or minus 15 degrees or less off a horizontal plane perpendicular to the plane of the face of the keypad display.
13. Keypad Response Time:
    a. The keypad shall respond to passage requests by generating a signal to the local processor. The response time shall be 800 ms or less from the time the last alphanumeric symbol is entered until a response signal is generated.
14. Keypad Power:
    a. The keypad shall be powered from the source as shown and shall not dissipate more than 150 W.
15. Keypad Mounting Method:
    a. Keypads shall be suitable for surface, semi-flush, pedestal, or weatherproof mounting as required.
16. Keypad Duress Codes:
    a. Keypads shall provide a means for users to indicate a duress situation by entering a special code.

17. Keypad and Wiegand-Swipe-Reader Combination: Designed to require an entry on the keypad before presenting the credential card.
    a. Keypad: Allow the entry of four numeric digits **OR** alphanumeric characters, **as directed,** that are associated with a specific credential. Keypads shall contain an integral alphanumeric/special symbol keyboard with symbols arranged in ascending ASCII-code ordinal sequence **OR** random scrambled order, **as directed**. Keypad display or enclosure shall limit viewing angles of the keypad as follows:
        1) Maximum Horizontal Viewing Angle: Plus or minus 5 degrees or less off a vertical plane perpendicular to the plane of the face of the keypad display.
        2) Maximum Vertical Viewing Angle: Plus or minus 15 degrees or less off a horizontal plane perpendicular to the plane of the face of the keypad display.
    b. Wiegand Swipe Reader: Set up for 33 OR 26-bit data cards, **as directed**, to generate a unique card identification code. Comply with SIA AC-01.
18. Communication Protocol: Compatible with local processor.
19. Touch-Plate and Contactless Card Reader: The reader shall have "flash" download capability to accommodate card format changes. The card reader shall have capability of transmitting data to security control panel and shall comply with ISO/IEC 7816.
20. Credential Card Modification: Entry-control cards shall be able to be modified by lamination direct print process during the enrollment process without reduction of readability. The design of the credential cards shall allow for the addition of at least one slot or hole to accommodate the attachment of a clip for affixing the credential card to the badge holder used at the site.
21. Specify the standard card size of 2-1/8 by 3-3/8 inches (54 by 85 mm) unless a different size card is needed. If a nonstandard size card is specified, verify that the card size will work with the photo badging system and the card reader specified.
22. Card Size and Dimensional Stability: Credential cards shall be **2-1/8 by 3-3/8 inches (54 by 86 mm)**. The credential card material shall be dimensionally stable so that an undamaged card with deformations resulting from normal use shall be readable by the card reader.
23. Card Material: Abrasion resistant, nonflammable, nontoxic, and impervious to solar radiation and effects of ultraviolet light.
24. Insert additional security enhancements in paragraph below if needed. Retain card lamination and assembly equipment if needed at the site.
25. Card Construction:
    a. Core and laminate or monolithic construction.
    b. Lettering, logos, and other markings shall be hot stamped into the credential material or direct printed.
    c. Incorporate holographic images **OR** phosphorous ink**, as directed,** as a security enhancement.
    d. Furnish equipment for on-site assembly and lamination of credential cards.

M. Biometric Identity Verification Equipment
1. Biometric identity verification templates shall be stored as part of system database files and used as a comparative base by the identity verification equipment to generate an appropriate signal to the associated Controller.
2. Eye Retina Scanner: Designed to incorporate positive measures to establish that the eye retina being scanned by the device belongs to a living human being.
    a. Scanner shall not require eye contact with the retina scan equipment. Scan initiation shall be manual.
    b. The efficiency and accuracy of scanner shall not be affected by contact lenses.
    c. Storage space of each eye template shall not exceed 512 8-bit bytes.
    d. Light-emitting source used for retina scans may not use light levels exceeding 20 percent of the maximum safe level established in the American Conference of Governmental Industrial Hygienists limit values.
    e. Template Update: Eye scanner shall not automatically update a user's template. Significant changes in an individual's eye shall require re-enrollment.

f. Scan acceptance tolerance or template match criteria shall be under system manager/operator control. Eye scanner shall determine automatically when multiple attempts are needed to verify the eye being scanned, prompting automatically for additional attempts, up to a maximum of three. Three failed attempts shall generate an entry-control alarm.

g. Time of Verification: Eye scanner shall respond to passage requests by generating an entry request signal to the Controller. The verification time shall be 1.5 seconds or less from the moment eye scanner initiates the scan process until eye scanner generates a response signal.

h. Modes: Eye scanner shall provide an enrollment mode, a recognition mode, and a code/credential verification mode.
   1) In the enrollment mode, eye scanner shall create an eye template for new personnel and enter the template into system database file created for that person. Template information shall be compatible with system application software.
   2) In the recognition mode, eye scanner shall allow passage when the eye scan data from the verification attempt match an eye template stored in database files.
   3) In the code/credential verification mode, eye scanner shall allow passage when the eye scan data from the verification attempt match the eye scan template associated with the identification code entered into a keypad, or they match the eye scan template associated with credential card data read by a card reader.

i. Reports: Eye scanner shall create and store template match scores for all transactions involving eye retinal scans. Template match scores shall be stored in the matching personnel data file used for report generation.

j. Power: Scanner shall be powered from its associated Controller, requiring not more than 45 W.

k. Enclosure: Eye scanners shall be available with enclosures that are suitable for surface, semiflush, or pedestal mounting. Mounting types shall additionally be suitable for installation in the following locations:
   1) Indoors, controlled environment.
   2) Indoors, uncontrolled environment.

l. Display: LED or other type of visual indicator display shall provide visual and audible status indications and user prompts. Indicate power on/off, and whether user passage requests have been accepted or rejected.

3. Hand Geometry: Use unique human hand measurements to identify authorized, enrolled personnel. The design of this device shall incorporate positive measures to establish that the hand being measured by the device belongs to a living human being.

   a. The user's hand shall remain in full view of the user at all times. The scan process of the hand geometry device shall make three-dimensional measurements of the size and shape of the subject's hand. Scanning shall start automatically once the user's hand is properly positioned by the alignment system.

   b. Hand geometry device shall be able to use either left or right hand for enrollment and verification.

   c. Storage space of each eye template shall not exceed 50 8-bit bytes.

   d. Template Update and Acceptance Tolerances: Hand geometry devices shall not automatically update a user's profile. Significant changes in an individual's hand geometry shall require re-enrollment. Hand geometry devices shall provide an adjustable acceptance tolerance or template match criteria under system manager/operator control. Hand geometry device shall determine when multiple attempts are needed for hand geometry verification and shall automatically prompt the user for additional attempts up to a maximum of three. Three failed attempts shall generate an entry-control alarm.

   e. Average Verification Time: Hand geometry device shall respond to passage requests by generating an entry request signal to the Controller. The verification time shall be 1.5 seconds or less from the moment hand geometry device initiates the scan process until hand geometry device generates a response signal.

   f. Modes: Hand geometry device shall provide an enrollment mode, a recognition mode, and a code/credential verification mode.

1) In the enrollment mode, hand geometry device shall create a hand template for new personnel and enter the template into system database file created for that person. Template information shall be compatible with system application software.
2) In the recognition mode, hand geometry device shall allow passage when the hand scan data from the verification attempt match a hand geometry template stored in database files.
3) In the code/credential verification mode, hand geometry device shall allow passage when the hand scan data from the verification attempt match the hand geometry template associated with the identification code entered into a keypad, or they match the hand geometry template associated with credential card data read by a card reader.

g. Reports: Hand geometry device shall create and store template match scores for all transactions involving hand geometry scans. Template match scores shall be stored in the matching personnel data file used for report generation.
h. Power: Hand geometry device shall be powered from its associated Controller, requiring not more than 45 W.
i. Enclosure: Geometry readers shall be available with enclosures that are suitable for surface, semiflush, or pedestal mounting. Mounting types shall additionally be suitable for installation in the following locations:
1) Indoors, controlled environment.
2) Indoors, uncontrolled environment.
3) Outdoors.
j. Display: LED or other type of visual indicator display shall provide visual and audible status indications and user prompts. Indicate power on/off, and whether user passage requests have been accepted or rejected.

4. Fingerprint Analysis Scanner: Use a unique human fingerprint pattern to identify authorized, enrolled personnel. The design of this device shall incorporate positive measures to establish that the hand or fingers being scanned by the device belong to a living human being.
a. The user's hand shall remain in full view of the user at all times. The scan process of the fingerprint analysis scanner shall perform an optical or other type of scan of the enrollee's fingers. Scanning shall start automatically when the user's fingers are properly positioned.
b. Storage space for each fingerprint template shall not require more than 1250 8-bit bytes.
c. Template Update and Acceptance Tolerances: Fingerprint analysis scanners shall not automatically update a user's profile. Significant changes in an individual's fingerprints shall require re-enrollment. Fingerprint analysis scanners shall provide an adjustable acceptance tolerance or template match criteria under system manager/operator control. Fingerprint analysis scanner shall determine when multiple attempts are needed for fingerprint verification and shall automatically prompt the enrollee for additional attempts up to a maximum of three. Three failed attempts shall generate an entry-control alarm.
d. Average Verification Time: Fingerprint analysis scanner shall respond to passage requests by generating an entry request signal to the Controller. The verification time shall be 2 seconds or less from the moment fingerprint analysis scanner initiates the scan process until fingerprint analysis scanner generates a response signal.
e. Modes: Fingerprint analysis scanner shall provide an enrollment mode, a recognition mode, and a code/credential verification mode.
1) In the enrollment mode, fingerprint analysis scanner shall create a fingerprint template for new personnel and enter the template into the system database file created for that person.
2) In the recognition mode, fingerprint analysis scanner shall allow passage when the fingerprint data from the verification attempt match a fingerprint template stored in database files.
3) In the code/credential verification mode, fingerprint analysis scanner shall allow passage when the fingerprint data from the verification attempt match the fingerprint template associated with the identification code entered into a keypad, or they match the fingerprint template associated with credential card data read by a card reader.

f. Reports: Fingerprint analysis device shall create and store pattern match scores for all transactions involving fingerprint scans. Template match scores shall be stored in the matching personnel data file used for report generation.
g. Power: Fingerprint analysis scanner shall be powered from its associated Controller, requiring not more than 45 W.
h. Enclosure: Scanners shall be available with enclosures that are suitable for surface, semiflush, or pedestal mounting. Mounting types shall additionally be suitable for installation in the following locations:
   1) Indoors, controlled environment.
   2) Indoors, uncontrolled environment.
   3) Outdoors.
i. Display: LED or other type of visual indicator display shall provide visual and audible status indications and user prompts. Indicate power on/off, and whether user passage requests have been accepted or rejected.

5. Iris Scan Device: Use the unique patterns found in the iris of the human eye to identify authorized, enrolled personnel. The device shall use ambient light to capture an image of the iris of a person for identification. The resulting video image shall be compared against a stored template that was captured during the enrollment process. When the presented image is sufficiently similar to the stored image template, then the device shall authenticate the presenting individual as identified. The threshold of similarity shall be adjustable.
   a. Enrollees who wear contact lenses or eyeglasses shall not adversely affect the efficiency and accuracy of the device.
   b. Iris scan device shall provide a means for enrollees to align their eye for identification that does not require facial contact with the device. A manual push-button shall be provided to initiate the scan process when the enrollee's eye is aligned in front of the device.
   c. The device shall include adjustments to accommodate differences in enrollee height.
   d. Template Update: Iris scanners shall not automatically update an enrollee's template. Significant changes in an individual's eye shall require re-enrollment.
   e. Scan acceptance tolerance or template match criteria shall be under system manager/operator control. Iris scanner shall determine when multiple attempts are needed to verify the iris being scanned and shall automatically prompt the enrollee for additional attempts up to three. Three failed attempts shall generate an entry-control alarm.
   f. Average Verification Time: Iris scanner shall respond to passage requests by generating an entry request signal to the Controller. The verification time shall be 1.5 seconds or less from the moment iris scanner initiates the scan process until iris scanner generates a response signal.
   g. Modes: Iris scanner shall provide an enrollment mode, a recognition mode, and a code/credential verification mode.
      1) In the enrollment mode, iris scanner shall create an iris template for new personnel and enter the template into system database file created for that person. Template information shall be compatible with system application software.
      2) In the recognition mode, iris scanner shall allow passage when the iris scan data from the verification attempt match an iris template stored in database files.
      3) In the code/credential verification mode, iris scanner shall allow passage when the iris scan data from the verification attempt match the iris scan template associated with the identification code entered into a keypad, or they match the iris scan template associated with credential card data read by a card reader.
   h. Reports: Iris imaging shall create and store template match scores for all transactions involving iris scans. Template match scores shall be stored in the matching personnel data file used for report generation.
   i. Power: Iris scanner shall be powered from its associated Controller, requiring not more than 45 W.
   j. Enclosure: Eye scanners shall be available with enclosures that are suitable for surface, semiflush, or pedestal mounting. Mounting types shall additionally be suitable for installation in the following locations:
      1) Indoors, controlled environment.

        2) Indoors, uncontrolled environment.
    k. Display: LED or other type of visual indicator display shall provide visual and audible status indications and user prompts. Indicate power on/off, and whether user passage requests have been accepted or rejected.

N. Enrollment Center
  1. Equipment for enrolling personnel into, and removing personnel from, system database, using a dedicated workstation PC **OR** central-station equipment, **as directed**.
    a. Include equipment to enroll selected biometric credentials.
  2. Enrollment equipment shall support encoding of credential cards including cryptographic and other internal security checks as required for system.
    a. Allow only authorized entry-control enrollment personnel to access the enrollment equipment using passwords.
    b. Include enrollment subsystem configuration controls and electronic diagnostic aids for subsystem setup and troubleshooting with the Central Station.
    c. Enrollment station records printer shall meet requirements of the report printer.
  3. Entry-Control Enrollment Software:
    a. Shall include database management functions for the system, and shall allow an operator to change and modify the data entered in the system as needed.
    b. Software shall not have alarm response or acknowledgment functions as a programmable function.
    c. Multiple, password-protected access levels shall be provided at the enrollment station.
    d. Database management and modification functions shall require a higher operator-access level than personnel enrollment functions.
    e. Software shall provide a means for disabling the enrollment station when it is unattended, to prevent unauthorized use.
    f. Software shall provide a method to enter personnel identifying information into the entry-control database files through enrollment stations to include a credential unit in use at the installation.
    g. In the case of personnel identity-verification subsystems, this data shall include biometric data.
    h. Software shall allow entry of this data into the system database files through the use of simple menu selections and data fields. The data field names shall be customized to suit user and site needs.
    i. Personnel identity-verification subsystems selected for use with the system shall fully support the enrollment function and shall be compatible with the entry-control database files.
  4. Accessories:
    a. Steel desk-type console, swivel chair on casters, and equipment racks.
    b. Console and Equipment Racks: Comply with EIA-310-D.
    c. Equipment, with the exception of the printers, shall be rack mounted in the console and equipment racks.
    d. Storage Cabinet: Locking cabinet approximately 72 inches (1830 mm) high, 36 inches (915 mm) wide, and 24 inches (610 mm) deep, with 3 adjustable shelves and 2 storage racks for storage of disks, tapes, printouts, printer paper, ribbons, manuals, and other documentation.
  5. System Capacity: Number of badges shall be limited only by hard disk space. Badge templates and images shall be in color, supporting the maximum color capability of Microsoft Windows operating system.
  6. Badge Configuration:
    a. Software for badge template creation shall include a template consisting of background and predetermined locations of photographs, text objects and data fields for text, and bar-code and biometric information. Include automatic sizing of data fields placed on a badge to compensate for names, which may otherwise be too large to fit in the area designated.
    b. Allow different badge templates to be used for each department, tenant, or visitor.

c. As a setup option, templates shall be automatically selected for the badge, based on the group the credential holder is assigned to. Allow the operator to override the automatic template selection and use a template chosen by the operator for creating a badge.
d. Setup shall determine which graphics and credential holder information will be displayed and where on the card it will be placed. All data in the security access system such as name, code, group, access level, and any of the 99 user-defined fields shall be selectable, with the ability to place them anywhere on the card.
e. System shall include an importing, filing, and recall system of stored images and shapes that can be placed on the badge.
f. Allow multiple images on same badge, including, but not be limited to, bar codes, digital photos, and signatures.
g. Support transparent backgrounds so that image is only surrounded by the intended background, but not its immediate background.

7. Photo Imaging: Integral to security access.
   a. Import images from bitmap file formats, digital cameras, TWAIN cameras, or scanners. Allow image cropping and editing, WYSIWYG badge building application, and badge print preview and printing capabilities.
   b. System shall support multiple images stored for each credential holder, including signatures, portrait views, and profile views.
8. Text Objects: Badge configuration shall provide for creation of custom text as an object, allowing font selection, typing, scaling, and formatting of the text object. Formatting options shall include changing font, font size, text flow, and text alignment; bending or curving the text object into a circle or semicircle; applying 3-D effects; and applying predefined effects such as tilt, extrusion, or beveling. Text shall be placed and optionally automatically centered within any region of the badge layout.
9. Badges and Credential Cards:
   a. Badges are credential cards that do not contain data to be read by card readers.
   b. Credential cards shall store uniquely coded data used by card readers as an Identifier.
      1) Magnetic-Stripe Cards: Comply with ISO 7810, ISO 7811-1, ISO 7811-2, ISO 7811-3, and ISO 7811-6. Use single-layer magnetic tape material that is coated with a plastic slick protective coat and affixed to the back of the credential card near the top.
      2) Wiegand Wire Effect Cards: Ferromagnetic wires laminated into the credential card using binary digits specified for Wiegand readers to generate a unique credential card identification code.
      3) Proximity Cards **OR** Key Fobs, **as directed**: Use proximity detection without physical contact with the proximity reader for proper operation.
   c. Allow entry-control card to be modified by lamination or direct print process during the enrollment process for use as a picture and identification badge without reduction of readability. The design shall allow for the addition of at least one slot or hole to accommodate the attachment of a clip for affixing the credential card to the type of badge holder used at the site.
      1) Card Size and Dimensional Stability: Standard size, 2-1/8 by 3-3/8 inches (54 by 85 mm); dimensionally stable so that an undamaged card with deformations resulting from normal use is readable by the card reader.
      2) Card Material: Abrasion resistant, nonflammable, and nontoxic; and impervious to solar radiation and effects of ultraviolet light.
      3) Card Construction: Core and laminate or monolithic construction. Lettering, logos, and other markings shall be hot stamped into the credential material or direct printed.
         a) With holographic images **OR** phosphorous ink, **as directed**, as a security enhancement.
         b) Furnish equipment for on-site assembly and lamination of credential cards.
      4) Card Durability and Maintainability: Designed and constructed to yield a useful lifetime of at least 5 years or 5000 insertions or swipes, whichever results in a longer

period of time. Allow credential cards to be cleaned by wiping with a sponge or cloth wetted with soap and water.

10. Card-Making Equipment: Consisting of a workstation, video camera, video-imaging equipment, and a printer.
    a. Camera: NTSC color standard, RGB video output, 470 lines minimum horizontal resolution, and automatic white balance with full rated output under illumination of 0.5 fc (5 lx).
    b. Video Imaging: Live-image capture software and hardware and a digital signature capture pad.
    c. Standard workstation, modified as follows:
        1) Redundant workstation is not required.
        2) Printer is not required.
        3) UPS is not required.
        4) Sound card is not required.
    d. Printer: Dye-sublimation resin thermal transfer, 300 dpi resolution, 16.7 million colors, accepting cards ranging in size from 2.1 by 3 inches to 2.6 by 3.7 inches (53 by 76 mm to 66 by 94 mm) and having card thickness ranging from 0.020 to 0.060 inch (0.5 to 1.5 mm). Printer shall have options for encoding magnetic stripe using tracks 1, 2, and 3. Throughput shall be not less than 60 seconds per card.

O. Push-Button Switches
1. Push-Button Switches: Momentary-contact back-lighted push buttons, with stainless-steel switch enclosures.
    a. Electrical Ratings:
        1) Minimum continuous current rating of 10 A at 120 V ac or 5 A at 240-V ac.
        2) Contacts that will make 720 VA at 60 A and that will break at 720 VA at 10 A.
    b. Enclosures: Flush or surface mounting. Push buttons shall be suitable for flush mounting in the switch enclosures.
    c. Enclosures shall additionally be suitable for installation in the following locations:
        1) Indoors, controlled environment.
        2) Indoors, uncontrolled environment.
        3) Outdoors.
    d. Power: Push-button switches shall be powered from their associated Controller, using dc control.

P. Door And Gate Hardware Interface
1. Exit Device with Alarm: Operation of the exit device shall generate an alarm and annunciate a local alarm. Exit device and alarm contacts are specified in Division 08 Section "Door Hardware".
2. Exit Alarm: Operation of a monitored door shall generate an alarm. Exit devices and alarm contacts are specified in Division 08 Section "Door Hardware".
3. Electric Door Strikes: Use end-of-line resistors to provide power line supervision. Signal switches shall transmit data to Controller to indicate when the bolt is not engaged and the strike mechanism is unlocked, and shall report a forced entry. Power and signal shall be from the Controller. Electric strikes are specified in Division 08 Section "Door Hardware".
4. Electromagnetic Locks: End-of-line resistors shall provide power line supervision. Lock status sensing signal shall positively indicate door is secure. Power and signal shall be from the Controller. Electromagnetic locks are specified in Division 08 Section "Door Hardware".
5. Vehicle Gate Operator: Interface electrical operation of gate with controls of this Section. Vehicle gate operators shall be connected, monitored, and controlled, by the security access Controllers. Vehicle gate and accessories are specified in Division 32 Section "Chain Link Fences And Gates".

Q. Field-Processing Software
1. Operating System:

a. Local processors shall contain an operating system that controls and schedules that local processor's activities in real time.
b. Local processor shall maintain a point database in its memory that includes parameters, constraints, and the latest value or status of all points connected to that local processor.
c. Execution of local processor application programs shall utilize the data in memory resident files.
d. Operating system shall include a real-time clock function that maintains the seconds, minutes, hours, date, and month, including day of the week.
e. Local processor real-time clock shall be automatically synchronized with the central station at least once per day to plus or minus 10 seconds (the time synchronization shall be accomplished automatically, without operator action and without requiring system shutdown).

2. Startup Software:
   a. Causes automatic commencement of operation without human intervention, including startup of all connected I/O functions.
   b. Local processor restart program based on detection of power failure at the local processor shall be included in the local processor software.
   c. Initiates operation of self-test diagnostic routines.
   d. Upon failure of the local processor, if the database and application software are no longer resident, the local processor shall not restart and systems shall remain in the failure mode indicated until the necessary repairs are made.
   e. If the database and application programs are resident, the local processor shall immediately resume operation.
3. Operating Mode:
   a. Local processors shall control and monitor inputs and outputs as specified, independent of communications with the central station or designated workstations.
   b. Alarms, status changes, and other data shall be transmitted to the central station or designated workstations when communications circuits are operable.
   c. If communications are not available, each local processor shall function in a stand-alone mode and operational data, including the status and alarm data normally transmitted to the central station or designated workstations, shall be stored for later transmission to the central station or designated workstations.
   d. Storage for the latest 4000 events shall be provided at local processors, as a minimum.
   e. Local processors shall accept software downloaded from the central station.
   f. Panel shall support flash ROM technology to accomplish firmware downloads from a central location.
4. Failure Mode: Upon failure for any reason, each local processor shall perform an orderly shutdown and force all local processor outputs to a predetermined (failure-mode) state, consistent with the failure modes shown and the associated control device.
5. Functions:
   a. Monitoring of inputs.
   b. Control of outputs.
   c. Reporting of alarms automatically to the central station.
   d. Reporting of sensor and output status to central station upon request.
   e. Maintenance of real time, automatically updated by the central station at least once a day.
   f. Communication with the central station.
   g. Execution of local processor resident programs.
   h. Diagnostics.
   i. Download and upload data to and from the central station.

R. Field-Processing Hardware
   1. Alarm Annunciation Local Processor:
      a. Respond to interrogations from the field device network, recognize and store alarm status inputs until they are transmitted to the central station, and change outputs based on commands received from the central station.

b. Local processor shall also automatically restore communication within 10 seconds after an interruption with the field device network and provide dc line supervision on each of its alarm inputs.
c. Local processor inputs shall monitor dry contacts for changes of state that reflect alarm conditions.
d. Local processor shall have at least eight alarm inputs which allow wiring contacts as normally open or normally closed for alarm conditions; and shall provide line supervision for each input by monitoring each input for abnormal open, grounded, or shorted conditions using dc current change measurements.
e. Local processor shall report line supervision alarms to the central station.
f. Alarms shall be reported for any condition that remains abnormal at an input for longer than 500 milliseconds.
g. Alarm condition shall be transmitted to the central computer during the next interrogation cycle.
h. Local processor outputs shall reflect the state of commands issued by the central station.
i. Outputs shall be a form C contact and shall include normally open and normally closed contacts.
j. Local processor shall have at least four command outputs.
k. Local processor shall be able to communicate with the central station via RS-485 or TCP/IP as a minimum.

2. Processor Power Supply:
   a. Local processor and sensors shall be powered from an uninterruptible power source.
   b. Uninterruptible power source shall provide eight hours of battery back-up power in the event of primary power failure and shall automatically fully recharge the batteries within 12 hours after primary power is restored.
   c. If the facility is without an emergency generator, the uninterruptible power source shall provide 24 hours of battery backup power.
   d. There shall be no equipment malfunctions or perturbations or loss of data during the switch from primary to battery power and vice versa.
   e. Batteries shall be sealed, non-outgassing type.
   f. Power supply shall be equipped with an indicator for ac input power and an indicator for dc output power.
   g. Loss of primary power shall be reported to the central station as an alarm.
3. Auxiliary Equipment Power: A GFI service outlet shall be furnished inside the local processor's enclosure.
4. Entry-Control Local Processor:
   a. Entry-control local processor shall respond to interrogations from the field device network, recognize and store alarm status inputs until they are transmitted to the central station, and change outputs based on commands received from the central station.
   b. Local processor shall also automatically restore communication within 10 seconds after an interruption with the field device network and provide dc line supervision on each of its alarm inputs.
   c. Entry-control local processor shall provide local entry-control functions including communicating with field devices such as card readers, keypads, biometric personnel identity-verification devices, door strikes, magnetic latches, gate and door operators, and exit push buttons.
   d. Processor shall also accept data from entry-control field devices as well as database downloads and updates from the central station that include enrollment and privilege information.
   e. Processor shall send indications of successful or failed attempts to use entry-control field devices and shall make comparisons of presented information with stored identification information.
   f. Processor shall grant or deny entry by sending control signals to portal-control devices and mask intrusion-alarm annunciation from sensors stimulated by authorized entries.

g. Entry-control local processor shall use inputs from entry-control devices to change modes between access and secure.
h. Local processor shall maintain a date-time- and location-stamped record of each transaction and transmit transaction records to the central station.
i. Processor shall operate as a stand-alone portal controller using the downloaded database during periods of communication loss between the local processor and the central station.
j. Processor shall store a minimum of 4000 transactions during periods of communication loss between the local processor and the central station for subsequent upload to the central station upon restoration of communication.
k. Local processor inputs shall monitor dry contacts for changes of state that reflect alarm conditions.
l. Local processor shall have at least eight alarm inputs which allow wiring contacts as normally open or normally closed for alarm conditions; and shall also provide line supervision for each input by monitoring each input for abnormal open, grounded, or shorted conditions using dc current change measurements.
m. Local processor shall report line supervision alarms to the central station.
n. Alarms shall be reported for any condition that remains abnormal at an input for longer than 500 ms.
o. Alarm condition shall be transmitted to the central station during the next interrogation cycle.
p. Entry-control local processor shall include the necessary software drivers to communicate with entry-control field devices. Information generated by the entry-control field devices shall be accepted by the local processor and automatically processed to determine valid identification of the individual present at the portal.
q. Upon authentication of the credentials or information presented, the local processor shall automatically check privileges of the identified individual, allowing only those actions granted as privileges.
r. Privileges shall include, but are not limited to, time of day control, day of week control, group control, and visitor escort control. The local processor shall maintain a date-time- and location-stamped record of each transaction.
s. Transaction is defined as any successful or unsuccessful attempt to gain access through a controlled portal by the presentation of credentials or other identifying information.
t. Local processor outputs shall reflect the state of commands issued by the central station.
u. Outputs shall be a form C contact and shall include normally open and normally closed contacts.
v. Local processor shall have at least four addressable outputs.
w. The entry-control local processor shall also provide control outputs to portal-control devices.
x. Local processor shall be able to communicate with the central station via RS-485 or TCP/IP as a minimum.
y. The system manufacturer shall provide strategies for downloading database information for panel configurations and cardholder data to minimize the required download time when using IP connectivity.

S. Tia 232-F Ascii Interface Specifications
1. ASCII interface shall allow TIA 232-F connections to be made between the control station operating as the host PC and any equipment that will accept TIA 232-F ASCII command strings, such as CCTV switches, intercoms, and paging systems.
a. Alarm inputs in system shall allow for individual programming to output up to four unique ASCII character strings through two different COM ports on the host PC.
b. Inputs shall have the ability to be defined to transmit a unique ASCII string for alarm and one for restore through one COM port, and a unique ASCII string for a nonalarm, abnormal condition and one for a normal condition through the same or different COM port.
c. Predefined ASCII character strings shall have the ability to be up to 420 characters long with full use of all the ASCII control characters, such as return or line feed. Character

strings shall be defined in the system database and then assigned to the appropriate inputs.

d. COM ports of the host PC used to interface with external equipment shall be defined in the setup portion of the software. COM port's baud rate, word length, stop bits, and parity shall be definable in the software to match that of the external equipment.

2. Pager-System Interface: Alarms shall be able to activate a pager system with customized message for each input alarm.
   a. TIA 232-F output shall be capable of connection to a pager interface that can be used to call a paging system or service and send a signal to a portable pager. System shall allow an individual alphanumeric message per alarm input to be sent to the paging system. This interface shall support both numeric and alphanumeric pagers.
3. Alarm-System Interface:
   a. TIA 232-F output shall be capable of transmitting alarms from other monitoring and alarm systems to central-station automation software.
   b. Alternatively, alarms that are received by this access-control system are to be transferred to the alarm automation system as if they were sent through a digital alarm receiver.
      1) System shall be able to transmit an individual message from any alarm input to a burglar-alarm automation monitoring system.
      2) System shall be able to append to each message a predefined set of character strings as a prefix and a suffix.

T. Floor Select Elevator Control
1. Elevator access control shall be integral to security access.
   a. System shall be capable of providing full elevator security and control through dedicated Controllers without relying on the control-station host PC for elevator control decisions.
   b. Access-control system shall enable and disable car calls on each floor and floor select buttons in each elevator car, restricting passengers' access to the floors where they have been given access.
   c. System setup shall, through programming, automatically secure and unsecure each floor select button of a car individually by time and day. Each floor select button within a car shall be separately controlled so that some floors may be secure while others remain unsecure.
   d. When a floor select button is secure, it shall require the passenger to use his/her access code and have access to that floor before the floor select button will operate. The passenger's credential shall determine which car call and floor select buttons are to be enabled, restricting access to floors unless authorized by system's access code database. Floor select button shall be enabled only in the car where the credential holder is the passenger.
2. Security access system shall record which call button is pressed, along with credential and time information.
   a. System Controller shall record elevator access data.
   b. The Controller shall reset all additional call buttons that may have been enabled by the user's credential.
   c. The floor select elevator control shall allow for manual override either individually by floor or by cab as a group from a workstation PC.

U. Real-Time Guard Tour
1. Guard tour module shall provide the ability to plan, track, and route tours. Module shall input an alarm during tour if guard fails to make a station. Tours can be programmed for sequential or random tour-station order.
   a. Guard tour setup shall define specific routes or tours for the guard to take, with time restrictions in which to reach every predefined tour station.
   b. Guard tour activity shall be automatically logged to the central-station PC's hard drive.
   c. If the guard is early or late to a tour station, a unique alarm per station shall appear at the Central Station to indicate the time and station.

d. Guard tour setup shall allow the tours to be executed sequentially or in a random order with an overall time limit set for the entire tour instead of individual times for each tour station.
e. Setup shall allow recording of predefined responses that will display for the operator at the control station should a "Failed to Check-in" alarm occur.

2. Guard tour module shall allow proprietary direct-connected systems to use security access-control hardware to perform guard tour management in real time.
3. A tour station is a physical location a guard shall reach and perform an action indicating that the guard has arrived. This action, performed at the tour station, shall be 1 of 13 different events with any combination of station types within the same tour. A tour station shall be one of the following event types:
   a. Access Granted.
   b. Access Denied Code.
   c. Access Denied Card plus PIN.
   d. Access Denied Time Zone.
   e. Access Denied Level.
   f. Access Denied Facility.
   g. Access Denied Code Timer.
   h. Access Denied Anti-Passback.
   i. Access Granted Passback Violation.
   j. Alarm.
   k. Restored.
   l. Input Normal.
   m. Input Abnormal.
4. Guard tour and other system features shall operate simultaneously with no interference.
5. Guard Tour Module Capacity: 999 possible guard tour definitions with each tour having up to 99 tour stations. System shall allow all 999 tours to be running at same time.

V. Video And Camera Control

1. Control station or designated workstation displays live video from a CCTV source.
   a. Control Buttons: On the display window, with separate control buttons to represent Left, Right, Up, Down, Zoom In, Zoom Out, Scan, and a minimum of two custom command auxiliary controls.
   b. Provide at least seven icons to represent different types of cameras, with ability to import custom icons. Provide option for display of icons on graphic maps to represent their physical location.
   c. Provide the alarm-handling window with a command button that will display the camera associated with the alarm point.
2. Display mouse-selectable icons representing each camera source, to select source to be displayed. For CCTV sources that are connected to a video switcher, control station shall automatically send control commands through a COM port to display the requested camera when the camera icon is selected.
3. Allow cameras with preset positioning to be defined by displaying a different icon for each of the presets. Provide control with Next and Previous buttons to allow operator to cycle quickly through the preset positions.

W. Cables

1. General Cable Requirements: Comply with requirements in Division 28 Section "Conductors And Cables For Electronic Safety And Security" and as recommended by system manufacturer for integration requirement.
2. PVC-Jacketed, TIA 232-F Cables:
   a. Two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, and individual aluminum-foil/polyester-tape shielded pairs with 100 percent shield coverage; PVC jacket.
   b. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.

c. NFPA 70, Type CM.
d. Flame Resistance: UL 1581 vertical tray.

3. Plenum-Type, TIA 232-F Cables:
   a. Two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, and individual aluminum-foil/polyester-tape shielded pairs with 100 percent shield coverage; plastic jacket.
   b. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
   c. NFPA 70, Type CMP.
   d. Flame Resistance: NFPA 262 flame test.
4. PVC-Jacketed, TIA 485-A Cables: Two pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, PVC insulation, unshielded, PVC jacket, and NFPA 70, Type CMG.
5. Plenum-Type, TIA 485-A Cables:
   a. Two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and fluorinated-ethylene-propylene jacket.
   b. NFPA 70, Type CMP.
   c. Flame Resistance: NFPA 262 flame test.
6. Multiconductor, PVC Readers and Wiegand Keypads Cables:
   a. No. 22 AWG, paired and twisted multiple conductors, stranded (7x30) tinned copper conductors, semirigid PVC insulation, overall aluminum foil-polyester tape shield with 100 percent shield coverage, plus tinned copper braid shield with 65 percent shield coverage, and PVC jacket.
   b. NFPA 70, Type CMG.
   c. Flame Resistance: UL 1581 Vertical Tray.
   d. For TIA 232-F applications.
7. Paired PVC Readers and Wiegand Keypad Cables:
   a. Three pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, individual aluminum foil-polyester tape shielded pairs each with No. 22 AWG, stranded tinned copper drain wire, 100 percent shield coverage, and PVC jacket.
   b. NFPA 70, Type CM.
   c. Flame Resistance: UL 1581 Vertical Tray.
8. Paired PVC Readers and Wiegand Keypads Cable:
   a. Three 3 pairs, twisted, No. 20 AWG, stranded (7x28) tinned copper conductors, polyethylene (polyolefin) insulation, individual aluminum foil-polyester tape shielded pairs each with No. 22 AWG, stranded (19x34) tinned copper drain wire, 100 percent shield coverage, and PVC jacket.
   b. NFPA 70, Type CM.
   c. Flame Resistance: UL 1581 Vertical Tray.
9. Paired, Plenum-Type, Reader and Wiegand Keypad Cable:
   a. Three pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, individual aluminum foil-polypropylene tape shielded pairs each with No. 22 AWG, stranded tinned copper drain wire, 100 percent shield coverage, and fluorinated-ethylene-propylene jacket.
   b. NFPA 70, Type CMP.
   c. Flame Resistance: NFPA 262 Flame Test.
10. Multiconductor, Plenum-Type, Reader and Wiegand Keypad Cable:
    a. Six conductors, No. 20 AWG, stranded (7x28) tinned copper conductors, fluorinated-ethylene-propylene insulation, overall aluminum foil-polyester tape shield with 100 percent shield coverage plus tinned copper braid shield with 85 percent shield coverage, and fluorinated-ethylene-propylene jacket.
    b. NFPA 70, Type CMP.
    c. Flame Resistance: NFPA 262 Flame Test.
11. Paired Lock Cable:

a. One pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.
b. NFPA 70, Type CMG.
c. Flame Resistance: UL 1581 Vertical Tray.

12. Paired, Plenum-Type, Lock Cable:
a. One pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.
b. NFPA 70, Type CMP.
c. Flame Resistance: NFPA 262 Flame Test.

13. Paired Lock Cable:
a. One pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.
b. NFPA 70, Type CMG.
c. Flame Resistance: UL 1581 Vertical Tray.

14. Paired, Plenum-Type, Lock Cable:
a. One pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and plastic jacket.
b. NFPA 70, Type CMP.
c. Flame Resistance: NFPA 262 Flame Test.

15. Paired Input Cable:
a. One pair, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, overall aluminum foil-polyester tape shield with No. 22 AWG, stranded (7x30) tinned copper drain wire, 100 percent shield coverage, and PVC jacket.
b. NFPA 70, Type CMR.
c. Flame Resistance: UL 1666 Riser Flame Test.

16. Paired, Plenum-Type, Input Cable:
a. One pair, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, aluminum foil-polyester tape shield (foil side out), with No. 22 AWG drain wire, 100 percent shield coverage, and plastic jacket.
b. NFPA 70, Type CMP.
c. Flame Resistance: NFPA 262 Flame Test.

17. Paired AC Transformer Cable:
a. One pair, twisted, No. 18 AWG, stranded (7x26) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.
b. NFPA 70, Type CMG.

18. Paired, Plenum-Type, AC Transformer Cable:
a. One pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and plastic jacket.
b. NFPA 70, Type CMP.
c. Flame Resistance: NFPA 262 Flame Test.

19. Elevator Travel Cable:
a. Steel center core, with shielded, twisted pairs, No. 20 AWG conductor size.
b. Steel center support shall be preformed, flexible, low-torsion, zinc-coated, steel wire rope; insulated with 60 deg C flame-resistant PVC and covered with a nylon or cotton braid.
c. Shielded Pairs: Insulated copper conductors; color-coded, insulated with 60 deg C flame-resistant PVC; each pair shielded with bare copper braid for 85 percent coverage.
d. Electrical grade, dry jute filler
e. Helically wound synthetic fiber binder
f. Rayon or cotton braid applied with 95 percent coverage.
g. 60 deg C PVC jacket specifically compounded for flexibility and abrasion resistance and complying with UL VW-1 and CSA FT1 flame rated.

20. LAN Cabling:
a. Comply with requirements in Division 28 Section "Conductors And Cables For Electronic Safety And Security".
b. NFPA 262.

X. Transformers: NFPA 70, Class II control transformers, NRTL listed. Transformers for security access-control system shall not be shared with any other system.

Y. Cable And Asset Management Software
   1. Computer-based cable and asset management system, with fully integrated database and graphic capabilities, complying with requirements in TIA/EIA-606.
      a. Document physical characteristics by recording the network, asset, user, TIA/EAI details, device configurations, and exact connections between equipment and cabling.
         1) Manage the physical layer of security system.
         2) List device configurations.
         3) List and display circuit connections.
         4) Record firestopping data.
         5) Record grounding and bonding connections and test data.
      b. Information shall be presented in database view, schematic plans, or technical drawings.
         1) Microsoft Visio Technical Drawing shall be used as drawing and schematic plans software. Drawing symbols, system layout, and design shall comply with SIA/IAPSC AG-01.
      c. System shall interface with the following testing and recording devices:
         1) Direct upload tests from circuit testing instrument into the PC.
         2) Direct download circuit labeling into labeling printer.
   2. Software shall be designed for Microsoft Windows of same version as security access system's Central Station and workstations and shall be installed on the designated PC, using a hard drive dedicated only to this management function. Hard-drive capacity shall be not less than 50 GB.

1.3 EXECUTION

A. Examination
   1. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
   2. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
   1. Comply with recommendations in SIA CP-01.
   2. Comply with TIA/EIA 606-A, "Administration Standard for Commercial Telecommunications Infrastructure."
   3. Obtain detailed Project planning forms from manufacturer of access-control system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval.
      a. Record setup data for control station and workstations.
      b. For each Location, record setup of controller features and access requirements.
      c. Propose start and stop times for time zones and holidays, and match up access levels for doors.
      d. Set up groups, facility codes, linking, and list inputs and outputs for each controller.
      e. Assign action message names and compose messages.
      f. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
      g. Prepare and install alarm graphic maps.
      h. Develop user-defined fields.
      i. Develop screen layout formats.
      j. Propose setups for guard tours and key control.

k. Discuss badge layout options; design badges.
l. Complete system diagnostics and operation verification.
m. Prepare a specific plan for system testing, startup, and demonstration.
n. Develop acceptance test concept and, on approval, develop specifics of the test.
4. Develop cable and asset-management system details; input data from construction documents. Include system schematics and Visio Technical Drawings in electronic format.
5. In meetings with the Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

C. Cabling
1. Comply with NECA 1, "Good Workmanship in Electrical Contracting."
2. Install cables and wiring according to requirements in Division 28 Section "Conductors And Cables For Electronic Safety And Security".
3. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.
4. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use NRTL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
5. Install LAN cables using techniques, practices, and methods that are consistent with Category 5E rating of components and fiber-optic rating of components, and that ensure Category 6 performance and fiber-optic performance of completed and linked signal paths, end to end.
6. Boxes and enclosures containing security system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered to be accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.
7. Install end-of-line resistors at the field device location and not at the Controller or panel location.

D. Cable Application
1. Comply with TIA-569-B, "Commercial Building Standard for Telecommunications Pathways and Spaces."
2. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.
3. TIA 232-F Cabling: Install at a maximum distance of 50 feet (15 m).
4. TIA 485-A Cabling: Install at a maximum distance of 4000 feet (1220 m).
5. Card Readers and Keypads:
a. Install number of conductor pairs recommended by manufacturer for the functions specified.
b. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from Controller to the reader is 250 feet (75 m), and install No. 20 AWG wire if maximum distance is 500 feet (150 m).
c. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the Controller.
d. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.
6. Install minimum No. 16 AWG cable from Controller to electrically powered locks. Do not exceed 250 feet (75 m) **OR** 500 feet (150 m), **as directed**.
7. Install minimum No. 18 AWG ac power wire from transformer to Controller, with a maximum distance of 25 feet (8 m).

E. Grounding
1. Comply with Division 26 Section "Grounding And Bonding For Electrical Systems".
2. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

3. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
4. Bond shields and drain conductors to ground at only one point in each circuit.
5. Signal Ground:
   a. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
   b. Bus: Mount on wall of main equipment room with standoff insulators.
   c. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

F. Installation
1. Push Buttons: Where multiple push buttons are housed within a single switch enclosure, they shall be stacked vertically with each push-button switch labeled with 1/4-inch- (6.4-mm-) high text and symbols as required. Push-button switches shall be connected to the Controller associated with the portal to which they are applied, and shall operate the appropriate electric strike, electric bolt, or other facility release device.
2. Install card readers, keypads, push buttons, and biometric readers.

G. Identification
1. In addition to requirements in this Article, comply with applicable requirements in Division 26 Section "Identification For Electrical Systems" and with TIA/EIA-606.
2. Using software specified in "Cable and Asset Management Software" Article, develop cable administration drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.
3. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
   a. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
   b. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.
4. At completion, cable and asset management software shall reflect as-built conditions.

H. System Software and Hardware
1. Develop, install, and test software and hardware, and perform database test for the complete and proper operation of systems involved. Assign software license to the Owner.

I. Field Quality Control
1. Perform tests and inspections.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist testing.
2. Testing and Inspections:
   a. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use Class 2, bidirectional, Category 5 tester. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA-568-B.1, "Commercial Building Telecommunications Cabling Standards - Part 1 General Requirements." Link performance for UTP cables must comply with minimum criteria in TIA/EIA-568-B.
   b. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery

operating time. Provide special equipment and software if testing requires special or dedicated equipment.

c. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

3. Devices and circuits will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

J. Startup Service
1. Engage a factory-authorized service representative to supervise and assist with startup service.
    a. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
    b. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

K. Protection
1. Maintain strict security during the installation of equipment and software. Rooms housing the control station, and workstations that have been powered up shall be locked and secured, with an activated burglar alarm and access-control system reporting to a Central Station complying with UL 1610, "Central-Station Burglar-Alarm Units," during periods when a qualified operator in the employ of Contractor is not present.

END OF SECTION 28 16 11 00b

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Task	Specification	Specification Description
28 16 11 00	27 51 43 00	Educational Intercommunications and Program Systems
28 16 11 00	26 33 43 00a	Public Address and Mass Notification Systems

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SECTION 28 21 31 00 - VIDEO SURVEILLANCE

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for video surveillance. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section includes a video surveillance system consisting of cameras, digital video recorder, data transmission wiring, and a control station with its associated equipment.
2. Video surveillance system shall be integrated with monitoring and control system specified in Division 13 Section "Perimeter Security”, “Intrusion Detection”, “Security Access”, and PLC Electronic Detention Monitoring and Control Systems", which specifies systems integration.

C. Definitions

1. AGC: Automatic gain control.
2. BNC: Bayonet Neill-Concelman - type of connector.
3. B/W: Black and white.
4. CCD: Charge-coupled device.
5. FTP: File transfer protocol.
6. IP: Internet protocol.
7. LAN: Local area network.
8. MPEG: Moving picture experts group.
9. NTSC: National Television System Committee.
10. PC: Personal computer.
11. PTZ: Pan-tilt-zoom.
12. RAID: Redundant array of independent disks.
13. TCP: Transmission control protocol - connects hosts on the Internet.
14. UPS: Uninterruptible power supply.
15. WAN: Wide area network.

D. Performance Requirements

1. Seismic Performance: Video surveillance system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

E. Submittals

1. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
2. Shop Drawings: For video surveillance. Include plans, elevations, sections, details, and attachments to other work.
    a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
    b. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
    c. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
    d. UPS: Sizing calculations.
    e. Wiring Diagrams: For power, signal, and control wiring.

3. Equipment List: Include every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.
4. Seismic Qualification Certificates: For video surveillance, cameras, camera-supporting equipment, accessories, and components, from manufacturer.
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
   d. Field quality-control reports.
   e. Operation and Maintenance Data: For cameras, power supplies, infrared illuminators, monitors, videotape recorders, digital video recorders, video switches, and control-station components to include in emergency, operation, and maintenance manuals. Include the following:
      1) Lists of spare parts and replacement components recommended to be stored at the site for ready access.
5. Warranty: Sample of special warranty.

F. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NECA 1.
3. Comply with NFPA 70.
4. Electronic data exchange between video surveillance system with an access-control system shall comply with SIA TVAC.

G. Project Conditions
1. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
   a. Control Station: Rated for continuous operation in ambient temperatures of 60 to 85 deg F (16 to 29 deg C) and a relative humidity of 20 to 80 percent, noncondensing.
   b. Interior, Controlled Environment: System components, except central-station control unit, installed in air-conditioned **OR** temperature-controlled, **as directed**, interior environments shall be rated for continuous operation in ambient temperatures of 36 to 122 deg F (2 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 1 enclosures.
   c. Interior, Uncontrolled Environment: System components installed in non-air-conditioned **OR** non-temperature-controlled, **as directed**, interior environments shall be rated for continuous operation in ambient temperatures of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 3R **OR** Type 4 **OR** Type 12 **OR** Type 12K, **as directed**, enclosures.
   d. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 deg F (minus 34 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h) and snow cover up to 24 inches (610 mm) thick, **as directed**. Use NEMA 250, Type 3 **OR** Type 3R **OR** Type 3S **OR** Type 4 **OR** Type 4X, **as directed**, enclosures.
   e. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.

f. Corrosive Environment: System components subject to corrosive fumes, vapors, and wind-driven salt spray in coastal zones. Use NEMA 250, Type 4X **OR** Type 6P, **as directed**, enclosures.
g. Security Environment: Camera housing for use in high-risk areas where surveillance equipment may be subject to physical violence.

H. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fail in materials or workmanship within specified warranty period.
a. Warranty Period: Three years from date of Final Completion.

1.2 PRODUCTS

A. System Requirements
1. Video-signal format shall comply with NTSC standard, composite interlaced video. Composite video-signal termination shall be 75 ohms.
2. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.
a. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Division 16 Section "Transient Voltage Suppression."
b. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Division 16 Section "Transient Voltage Suppression" as recommended by manufacturer for type of line being protected.
3. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station, control-unit alarm display shall identify tamper alarms and indicate locations.

B. Standard Cameras
1. B/W Camera:
a. Comply with UL 639.
b. Pickup Device: CCD interline transfer, 252,000 512(H) by 492(V) pixels, **unless directed otherwise**.
c. Horizontal Resolution: 380 lines.
d. Signal-to-Noise Ratio: Not less than 46 dB.
e. With AGC, manually selectable on or off.
f. Sensitivity: Camera shall provide usable images in low-light conditions, delivering an image at a scene illumination, as directed by the Owner, with camera AGC off, **as directed**.
OR
Sensitivity: Camera shall deliver 1-V peak-to-peak video signal at the minimum specified light level. Illumination for the test shall be with lamps rated at approximately 2200-K color temperature, and with camera AGC off.
g. Manually selectable modes for backlight compensation or normal lighting.
h. Scanning Synchronization: Determined by external synch over the coaxial cable. Camera shall revert to internally generated synchronization on loss of external synch signal.
i. Motion Detector: Built-in digital.
2. Color Camera:
a. Comply with UL 639.
b. Pickup Device: CCD interline transfer, 380,000 771(H) by 492(V) pixels, **unless directed otherwise**.
c. Horizontal Resolution: 480 lines.
d. Signal-to-Noise Ratio: Not less than 50 dB, with camera AGC off.

e. With AGC, manually selectable on or off.
f. Sensitivity: Camera shall provide usable images in low-light conditions, delivering an image at a scene illumination, as directed by the Owner, with camera AGC off, **as directed**.
OR
Sensitivity: Camera shall deliver 1-V peak-to-peak video signal at the minimum specified light level. Illumination for the test shall be with lamps rated at approximately 2200-K color temperature, and with camera AGC off.
g. Manually selectable modes for backlight compensation or normal lighting.
h. Scanning Synchronization: Determined by external synch over the coaxial cable. Camera shall revert to internally generated synchronization on loss of external synch signal.
i. White Balance: Auto-tracing white balance, with manually settable fixed balance option.
j. Motion Detector: Built-in digital.

3. Automatic Color Dome Camera: Assembled and tested as a manufactured unit, containing dome assembly, color camera, motorized pan and tilt, zoom lens, and receiver/driver.
a. Comply with UL 639.
b. Pickup Device: CCD interline transfer, 380,000 768(H) by 494(V) pixels, **unless directed otherwise**.
c. Horizontal Resolution: 480 lines.
d. Signal-to-Noise Ratio: Not less than 50 dB, with camera AGC off.
e. With AGC, manually selectable on or off.
f. Sensitivity: Camera shall provide usable images in low-light conditions, delivering an image at a scene illumination, as directed by the Owner, with camera AGC off, **as directed**.
OR
Sensitivity: Camera shall deliver 1-V peak-to-peak video signal at the minimum specified light level. Illumination for the test shall be with lamps rated at approximately 2200-K color temperature, and with camera AGC off.
g. Manually selectable modes for backlight compensation or normal lighting.
h. Pan and Tilt: Direct-drive motor, 360-degree rotation angle, and 180-degree tilt angle. Pan-and-tilt speed shall be controlled by operator. Movement from preset positions shall be not less than 300 degrees per second.
i. Preset Positioning: Eight user-definable scenes, each allowing 16-character titles. Controls shall include the following:
1) In "sequence mode," camera shall continuously sequence through preset positions, with dwell time and sequencing under operator control.
2) Motion detection shall be available at each camera position.
3) Up to four preset positions may be selected to be activated by an alarm. Each of the alarm positions may be programmed to output a response signal.
j. Scanning Synchronization: Determined by external synch over the coaxial cable. Camera shall revert to internally generated synchronization on loss of external synch signal.
k. White Balance: Auto-tracing white balance, with manually settable fixed balance option.
l. Motion Detector: Built-in digital.
m. Dome shall support multiplexed control communications using coaxial cable recommended by manufacturer.

C. Submersible Cameras
1. Camera: Color, designed for underwater monitoring and for inspecting pipes and storm drains. Attributes as follows:
a. Infrared LEDs to provide illumination in zero-light conditions.
b. 60-foot (18.3-m) factory-installed cable with BNC connector for video and a 2.1-mm jack for 12-V dc power supply.
c. An adjustable swivel mount and attachment base.
d. Pickup Device: CCD interline transfer, 290,000 500(H) by 580(V) pixels, **unless directed otherwise**.

e. Horizontal Resolution: 380 lines.
f. Signal-to-Noise Ratio: Not less than 50 dB.
g. With AGC, from 4 to 39 dB.
h. Sensitivity: Camera shall provide usable images in low-light conditions, delivering an image at a scene illumination of 0.1 lux at f/2.0.
i. Scanning Synchronization: Internal.
j. White Balance: Auto-tracing white balance, for colors ranging from 2800 to 8200 deg K.

D. Reinforced Dome Cameras
1. Camera: Designed for high-abuse locations, with a weathertight semirecessed **OR** surface, **as directed**, mounting, impact-resistance polycarbonate dome, and heavy-gage, 6061 T6 aluminum body.
a. Suitable for exterior environment, rated for continuous operation in ambient temperatures of minus 40 to plus 122 deg F (minus 40 to plus 50 deg C) dry bulb and up to 85 percent relative humidity.
b. Pickup Device: CCD interline transfer, 290,000 510(H) by 492(V) pixels, **unless directed otherwise**.
c. Horizontal Resolution: 350 lines.
d. Signal-to-Noise Ratio: Not less than 46 dB.
e. With AGC and automatic backlight compensation.
f. Sensitivity: Camera shall provide usable images in low-light conditions, delivering an image at a scene illumination of 6 lux at f/2.0.
g. Scanning Synchronization: Determined by external synch over the coaxial cable. Camera shall revert to internally generated synchronization on loss of external synch signal.
h. White Balance: Auto-tracing white balance.

E. Lenses
1. Description: Optical-quality coated lens, designed specifically for video-surveillance applications and matched to specified camera. Provide color-corrected lenses with color cameras.
a. Auto-Iris Lens: Electrically controlled iris with circuit set to maintain a constant video level in varying lighting conditions.
b. Fixed Lens: With calibrated focus ring.
c. Zoom Lens: Motorized, remote-controlled unit, rated as "quiet operating." Features include the following:
1) Electrical Leads: Filtered to minimize video signal interference.
2) Motor Speed: Variable.
3) Lens shall be available with preset positioning capability to recall the position of specific scenes.

F. Power Supplies
1. Low-voltage power supplies matched for voltage and current requirements of cameras and accessories, and of type as recommended by manufacturer of camera, infrared illuminator, **as directed**, and lens.
a. Enclosure: NEMA 250, Type 1 **OR** Type 3 **OR** Type 4X, **as directed**.

G. Infrared Illuminators
1. Description: Lighting fixtures that emit light only in the infrared spectrum, suitable for use with cameras indicated, for nighttime surveillance, without emitting visible light.
a. Field-Selectable Beam Patterns: Narrow, medium, and wide.
b. Rated Lamp Life: More than 8000 hours.
c. Power Supply: 12-V ac/dc **OR** 120-V ac, **as directed**.
2. Area Coverage: Illumination to 150 feet (50 m) in a narrow beam pattern.
3. Exterior housings shall be suitable for same environmental conditions as the associated camera.

H. Camera-Supporting Equipment

1. Minimum Load Rating: Rated for load in excess of the total weight supported times a minimum safety factor of two.
2. Pan Units: Motorized automatic-scanning units arranged to provide remote-controlled manual and automatic camera panning action, and equipped with matching mounting brackets.
   a. Scanning Operation: Silent, smooth, and positive.
   b. Stops: Adjustable without disassembly, to limit the scanning arc.
3. Pan-and-Tilt Units: Motorized units arranged to provide remote-controlled aiming of cameras with smooth and silent operation, and equipped with matching mounting brackets.
   a. Panning Rotation: 0 to 355 degrees, with adjustable stops.
   b. Tilt Movement: 90 degrees, plus or minus 5 degrees, with adjustable stops.
   c. Speed: 12 degrees per second in both horizontal and vertical planes.
   d. Wiring: Factory prewired for camera and zoom lens functions and pan-and-tilt power and control.
   e. Built-in encoders or potentiometers for position feedback, and thermostat-controlled heater, **as directed**.
   f. Pan-and-tilt unit shall be available with preset positioning capability to recall the position of a specific scene.
4. Mounting Brackets for Fixed Cameras: Type matched to items supported and mounting conditions. Include manual pan-and-tilt adjustment.
5. Protective Housings for Fixed and Movable Cameras: Steel or 6061 T6 aluminum, **as directed**, enclosures with internal camera mounting and connecting provisions that are matched to camera/lens combination and mounting and installing arrangement of camera to be housed.
   a. Tamper switch on access cover sounds an alarm signal when unit is opened or partially disassembled. Central-control unit shall identify tamper alarms and indicate location in alarm display. Tamper switches and central-control unit are specified in Division 13 Section "Intrusion Detection."
   b. Camera Viewing Window: Polycarbonate **OR** Lexan, **as directed**, window, aligned with camera lens.
   c. Duplex Receptacle: Internally mounted.
   d. Alignment Provisions: Camera mounting shall provide for field aiming of camera and permit removal and reinstallation of camera lens without disturbing camera alignment.
   e. Built-in, thermostat-activated heater and blower units. Units shall be automatically controlled so the environmental limits of the camera equipment are not exceeded.
   f. Sun shield shall not interfere with normal airflow around the housing.
   g. Mounting bracket and hardware for wall or ceiling mounting of the housing. Bracket shall be of same material as the housing; mounting hardware shall be stainless steel.
   h. Finish: Housing and mounting bracket shall be factory finished using manufacturer's standard finishing process suitable for the environment.
   i. Enclosure Rating: as directed by the Owner.

I. Monitors
1. Monochrome:
   a. Metal cabinet units designed for continuous operation.
   b. Screen Size (Diagonal Dimension): as directed by the Owner.
   c. Horizontal Resolution: 600 lines, minimum, at center.
   d. Minimum Front Panel Devices and Controls: Power switch; power-on indicator; and brightness, horizontal-hold, vertical-hold, and contrast controls.
   e. Mounting: Adjustable tilting and training.
   f. Mounting: Single, 14-inch (356-mm) **OR** Dual, 9-inch (229-mm), **as directed**, vertical, EIA 19-inch (483-mm) electronic equipment rack or cabinet complying with CEA 310-E.
   g. Electrical: 120-V ac, 60 Hz.
2. Color:
   a. Metal cabinet units designed for continuous operation.
   b. Screen Size (Diagonal Dimension): as directed by the Owner.
   c. Horizontal Resolution: 300 lines.

d. Minimum Front Panel Devices and Controls: Power switch; power-on indicator; and brightness, contrast, color, and tint controls.
e. Degaussing: Automatic.
f. Mounting: Single, 14-inch (356-mm) **OR** Dual, 9-inch (229-mm), **as directed**, vertical, EIA 19-inch (483-mm) electronic equipment rack or cabinet complying with CEA 310-E.
g. Electrical: 120-V ac, 60 Hz.

J. Videotape Recorders
1. Description: Industrial, time-lapse type recorder, designed for continuous operation. Tape format is 1/2 inch (13 mm) using industrial-grade, T-120 cassettes.
a. Horizontal Resolution: 400 lines, minimum.
b. Recording Heads: Rotary-scan type.
c. Integral Timer: Permits programming of recording operation for adjustable daily and weekly periods.
d. Time-Lapse Operating Modes: Multiple, covering 24 to 240 hours, minimum.
e. Other Operating Modes:
1) Manual play and recording at two- and six-hour speeds.
2) Forward and reverse high-speed search.
3) Reverse, slow, and single-frame play.
f. Alarm Recording: Operating mode is automatically switched from time-lapse to two- or six-hour recording mode when an externally generated alarm signal is received.
g. Audio Recording: 70 to 7000 Hz. Phono and microphone input; phono output.
h. Time and Date Generator: Records time and date legend in corner of recorded scenes.
i. Tape Counter: Displays tape position.
j. Manual Recording Lock: Key or keypad operated. Prevents unauthorized tampering or control changes during preset operation.
k. Signal-to-Noise Ratio: 45 dB for video output in standard play mode.
l. Mounting: Standard 19-inch (483-mm) rack complying with CEA 310-E, or freestanding desktop.

K. Digital Video Recorders
1. Description: Digital, time-lapse type, full-frame and motion recorder, with removable hard drive.
a. Recording Time: 400 hours minimum.
b. Resolution: 720 by 480 lines, minimum.
c. Programming shall be from trackball and push buttons on face of the recorder, settings shall be displayed on any video monitor connected to the recorder. Programming shall include the following:
1) Motion analysis graph.
2) Password protection.
3) Alarm and timer controls.
4) Continuous recording option.
5) Time-lapse operating modes.
6) Search video by time, event, or motion.
d. Programming: SmartMedia card for software updating, image archiving, and image transfer to a PC.
e. Storage: 80-GB, **unless directed otherwise**, removable hard drive. Software shall permit hot-swapping drives.
f. Compression: MPEG-2.
g. Time and Date Generator: Records time (hr:min:sec) and date legend of each frame.
h. Audio Recording: 70 to 7000 Hz. Phono and microphone input; phono output.
i. Mounting: Standard 19-inch (483-mm) rack complying with CEA 310-E, or freestanding desktop.

L. Network Video Recorders
1. External storage or internal 250-1, 500-GB hard disk drive.
a. Video and audio recording over TCP/IP network.

b. Video recording of MPEG-2 and MPEG-4 streams.
c. Video recording up to 48 Mbps for internal storage and up to 100 Mbps for external storage.
d. Duplex Operation: Simultaneous recording and playback.
e. Continuous and alarm-based recording.
f. Full-Featured Search Capabilities: Search based on camera, time, or date.
g. Automatic data replenishment to ensure recording even if network is down.
h. Digital certification by watermarking.
i. Internal RAID storage or non-RAID storage of up to 1500 GB.
j. Capable of adding external RAID storage up to 7000 GB for models with no internal storage.
k. Full integration with LAN, Intranet, or Internet through standard Web browser or video management software.
l. Integrated Web server FTP server functionality.
m. Supports up to 16, 32, or 64 devices.

M. Digital Switchers
1. Quad Switch: For displaying images from four cameras on a single monitor. Provide color switcher if one or more cameras or monitors are in color.
   a. Controls: Unit-mounted front panel.
   b. Resolution: 720 by 480 lines, **unless directed otherwise**.
   c. Modes: Auto, manual, and alarm. In manual mode, each channel can also be viewed in single display mode. In the event of an alarm, alarming channel shall automatically switch to full screen. If several alarms are activated, channels in alarm shall be in auto-switching mode.
   d. Channel Loss Alarm: Audible buzzer; occurrence details shall be recorded.
   e. Time: Indicate date and time.
   f. Timing of Auto-Switcher: 1 to 30 seconds, selectable.
   g. Mounting: Standard 19-inch (483-mm) rack complying with CEA 310-E, or freestanding desktop.
2. Manual Switch Bank: Low-loss, high-isolation, multiple-video switch to allow manual switching of multiple quad switches and cameras to a single output. Switches shall be illuminated.
3. Sequential Switchers: Automatically sequence outputs of multiple cameras to single monitor and videotape recorder.
   a. Switching Time Interval: Continuously adjustable, 5 to 20 seconds minimum, with manual override.
   b. Skip-Sequential-Hold Switch: One for each camera, with LED to indicate active camera.
   c. Camera Identification Legend: Either on-screen message or label at skip-sequential switch.
   d. Alarm Switching: In the event of an alarm, alarming channel shall automatically switch the monitor to full screen.
   e. Mounting: Standard 19-inch (483-mm) rack complying with CEA 310-E.
4. PTZ Controls: Arranged for multiple-camera control, with switches to select camera to be controlled.
   a. Pan-and-Tilt Control: Joystick type.
   b. Zoom Control: Momentary-contact, "in-out" push button.
   c. Automatic-Scan Control: A push button for each camera with pan capability that places camera in automatic-scanning mode.

N. IP Video Systems
1. Description:
   a. System shall provide high-quality delivery and processing of IP-based video, audio, and control data using standard Ethernet-based networks.
   b. System shall have seamless integration of all video surveillance and control functions.

c. Graphical user interface software shall manage all IP-based video matrix switching and camera control functions, two-way audio communication, alarm monitoring and control, and recording and archive/retrieval management. IP system shall also be capable of integrating into larger system environments.
d. System design shall include all necessary compression software for high-performance, dual-stream, MPEG-2/MPEG-4 video. Unit shall provide connections for all video cameras, camera PTZ control data, bidirectional audio, discreet sensor inputs, and control system outputs.
e. All camera signals shall be compressed, encoded, and delivered onto the network for processing and control by the IP video-management software.
f. Camera system units shall be ruggedly built and designed for extreme adverse environments, complying with NEMA Type environmental standards.
g. Encoder/decoder combinations shall place video, audio, and data network stream that can be managed from multiple workstations on the user's LAN or WAN.
h. All system interconnect cables, workstation PCs, PTZ joysticks, and network intermediate devices shall be provided for full performance of specified system.

O. Video Motion Sensors (Interior)
1. Device Performance: Detect changes in video signal within a user-defined protected zone. Video inputs shall be composite video as defined in SMPTE 170M. Provide an alarm output for each video input.
a. Detect movement within protected zone of intruders wearing clothing with a reflectivity that differs from that of background scene by a factor of two. Reject all other changes in video signal.
b. Modular design that allows for expansion or modification of number of inputs.
c. Controls:
1) Size of detection zones.
2) Sensitivity of detection of each protected zone.
d. Mounting: Standard 19-inch (483-mm) rack complying with CEA 310-E.

P. Control Stations
1. Description: Heavy-duty, freestanding, modular, metal furniture units arranged to house electronic equipment. Coordinate component arrangement and wiring with components and wiring of other systems.
2. Equipment Mounting: Standard 19-inch (483-mm) rack complying with CEA 310-E.
3. Normal System Power Supply: 120 V, 60 Hz, through a locked disconnect device and an isolation transformer in central-station control unit. Central-station control unit shall supply power to all components connected to it unless otherwise indicated.
4. Power Continuity for Control Station: Batteries in power supplies of central-station control units and individual system components shall maintain continuous system operation during outages of both normal and backup ac system supply.
a. Batteries: Rechargeable, valve-regulated, recombinant, sealed, lead-acid type with nominal 10-year life expectancy. Capacity adequate to operate portions of system served including audible trouble signal devices for up to four hours and audible and visual alarm devices under alarm conditions for an additional 10 minutes.
b. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Charger shall recharge fully discharged battery within 24 hours.
5. Annunciation: Indicate change in system condition and switching of system or component to backup power.

Q. Signal Transmission Components
1. Cable: Coaxial cable elements have 75-ohm nominal impedance. Comply with requirements in Division 16 Section "Conductors and Cables for Electronic Safety and Security."
2. Video Surveillance Coaxial Cable Connectors: BNC type, 75 ohms. Comply with requirements in Division 16 Section "Conductors and Cables for Electronic Safety and Security."

1.3 EXECUTION

A. Examination
1. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.
2. Examine roughing-in for LAN, WAN, and IP network before device installation.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Wiring
1. Comply with requirements in Division 16 Section "Raceways and Boxes."
OR
Wiring Method: Install cables in raceways unless otherwise indicated.
a. Except raceways are not required in accessible indoor ceiling spaces and attics.
OR
Except raceways are not required in hollow gypsum board partitions.
b. Conceal raceways and wiring except in unfinished spaces.
2. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
3. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
4. For LAN connection and fiber-optic and copper communication wiring, comply with Division 16 Sections "Communications Backbone Cabling" and "Communications Horizontal Cabling."
5. Grounding: Provide independent-signal circuit grounding recommended in writing by manufacturer.

C. Video Surveillance System Installation
1. Install cameras and infrared illuminators level and plumb.
2. Install cameras with 84-inch- (2134-mm-) minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.
3. Set pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms, and adjust.
4. Install power supplies and other auxiliary components at control stations unless otherwise indicated.
5. Install tamper switches on components indicated to receive tamper switches, arranged to detect unauthorized entry into system-component enclosures and mounted in self-protected, inconspicuous positions.
6. Avoid ground loops by making ground connections only at the control station.
a. For 12- and 24-V dc cameras, connect the coaxial cable shields only at the monitor end.
7. Identify system components, wiring, cabling, and terminals according to Division 16 Section "Electrical Identification."

D. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
a. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
b. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:
1) Prepare equipment list described in "Submittals" Article.

2) Verify operation of auto-iris lenses.
3) Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
4) Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet (17 to 23 m) away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
5) Set and name all preset positions; consult Owner's personnel.
6) Set sensitivity of motion detection.
7) Connect and verify responses to alarms.
8) Verify operation of control-station equipment.

c. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
d. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

3. Video surveillance system will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

E. Adjusting
1. Occupancy Adjustments: When requested within 12 months of date of Final Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:
a. Check cable connections.
b. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
c. Adjust all preset positions; consult Owner's personnel.
d. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.
e. Provide a written report of adjustments and recommendations.

F. Cleaning
1. Clean installed items using methods and materials recommended in writing by manufacturer.
2. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

G. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain video-surveillance equipment.

END OF SECTION 28 21 31 00

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Task	Specification	Specification Description
28 21 31 00	01 22 16 00	No Specification Required
28 21 31 00	28 16 11 00a	Intrusion Detection
28 21 31 00	28 16 11 00b	Security Access
28 21 31 00	26 09 23 00b	Electrical Power Monitoring And Control
28 42 11 00	22 12 23 26	Underground Storage Tanks

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SECTION 28 46 00 00 - OIL/WATER SEPARATOR

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for oil/water separator. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Scope

1. The separator shall be designed for gravity separation of sand, grit, settleable solids, or semisolids, and free oils (hydrocarbons and other petroleum products) from wastewater. Separator shall be installed belowground with top access at or above grade level. The source of the influent to the separator shall be gravity flow from storm water runoff, hydrocarbon spills, and/or cleaning/maintenance operations.

C. Performance

1. Influent Characteristics
   a. Provide separator designed for intermittent and variable flows of water, oil, or any combination of non-emulsified oil-water mixtures. Minimum separator retention time shall be 10 minutes. Operating temperatures of the influent oil in water mixture shall range from 40 degrees F. to 80 degrees F. The specific gravity of the oils at operating temperatures shall range from 0.71 to 0.92. The specific gravity of the fresh water at operating temperatures shall range from 1.00 to 1.03.
2. Effluent Characteristics
   a. The free oil and grease concentration in the effluent from the separator shall not exceed 10 mg/l (10 PPM) to satisfy requirements of the NPDES stormwater discharge permit. To achieve this goal, it will be necessary to remove all free oil droplets equal to and greater than 20 microns.

D. Design Criteria

1. The separator shall be listed to Underwriters' Laboratories UL-SU2215. Construction and performance of the oil/water separators shall be in accordance with UL-SU2215. Provide certification documentation detailing criteria under which the system was tested. UL-SU2215 label shall be prominently displayed on manway covers.
2. Separator shall be designed in accordance with Stokes Law and the American Petroleum Institute Publication 421, "Monographs on Refinery Environmental Control - Management of Water Discharges; Design and Operation of Oil/Water Separators." Effective surface area calculations, signed and stamped by a Registered Professional Engineer shall be submitted to document specified effluent quality based on complete removal of the specified oil globule at design flow. A separator with lower effective surface area than required is not permissible.
3. Separator capacities, dimensions, construction, and thickness shall be in strict accordance with Underwriters' Laboratories, Subject UL-58 Standard for Safety, Steel Underground Tanks for Flammable and Combustible Liquids, September 30, 1997, Double Wall construction with 360 degree Steel Secondary Containment. The inner steel tank shall be completely contained within the outer steel tank, enclosing 100% of the tank volume. The tank shall have a double steel shell with a space between the layers. The space between the inner and outer steel walls shall be monitored with an approved electronic leak detection device through a pipe that extends vertically to the top of the tank from a small sump at the bottom. Tank construction using thin walled primary tank with external fiberglass jacket shall not be permissible.
4. Separator Corrosion Control System shall be in strict accordance with Underwriters' Laboratories Inc. Subject UL-1746 Standard for External Corrosion Protection Systems for Steel Underground Storage Tanks and the HighGuard® External Corrosion Protection Specifications.

5. Oil/water separator shall comply with National Fire Protection Association NFPA 30 Flammable and Combustible Liquids Code, 2003 Edition.
6. Separator vessel volume shall allow for a hydraulic retention time of ten (10) minutes to ensure laminar flow conditions which result in hydraulic uniformity and high effluent quality. Volume reduction will adversely affect separator performance by increasing horizontal velocity and turbulence, therefore a separator of smaller volume is not permissible.
7. Separator shall be the standard patented product of a steel tank manufacturer regularly engaged in the production of such equipment. Manufacturer shall have at least 20 years experience in manufacturing similar units for identical applications. No subcontracting of tank fabrication shall be permitted.
8. Separator shall be fabricated, inspected, and tested for leakage before shipment from the factory by manufacturer as a completely assembled vessel ready for installation.
9. Separator shall be cylindrical, horizontal, atmospheric-type steel vessel intended for the separation and storage of flammable and combustible liquids. The separator shall have the structural strength to withstand static and dynamic hydraulic loading while empty and during operating conditions. The Oil/Water Separator's dimensions and thickness shall be in strict compliance with Roark's Formulas for Stress and Strain as presented in UL 58, September 30, 1997. Calculations, signed and stamped by a Registered Professional Engineer shall be submitted to document structural strength under specified overbearing or external pressure. A separator with a reduced shell thickness is not permissible.
10. Separator shall have an oil storage capacity equal to about 43% of the total vessel volume and an emergency oil spill capacity equal to 80% of the total vessel volume.
11. To prevent extensive shutdown and maintenance, the separator design must allow solids to fall unhindered by turbulence, and oil droplets to rise without risk of re-emulsifying due to collisions with interfering solids. The use of plastic perforated tubes, spherical balls, or irregular shaped media will increase the facility's maintenance costs and shall not be permitted.
12. Separator shall consist of inlet and outlet connections, integral sand interceptor compartment, non-clogging flow distributor and energy dissipater device, stationary under flow baffle, presettling chamber for solids, sludge baffle, oil coalescing chamber with removable parallel flat/corrugated plate coalescer, with removable plates, and sectionalized removable polypropylene impingement coalescers to optimize separation of free oil from water, effluent downcomer positioned to prevent discharge of free oil that has been separated from the water, access ways for coalescers and each chamber, fittings for vent, oil pump-out, sampling, gauging, leak detection, and lifting lugs.

E. Submittals:
1. Shop Drawings: shop drawings for oil water separators shall show principal dimensions and location of all fittings.
2. Instructions: provide three complete sets of installation, operation, and maintenance instructions with separator.
3. Quality Control: Quality control, inspection procedures, and reports shall be considered part of the submittal package.

F. Warranty
1. The manufacturer shall warrant its products to be free from defects in material and workmanship for a period of one year from the date of shipment. The warranty shall be limited to repair or replacement of the defective part(s).
2. The manufacturer's warranty shall be standard limited warranty in effect at time of purchase.

1.2 PRODUCTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Highland Tank, One Highland Road, Box 338, Stoystown, PA 15563, Phone 814-893-5701, FAX 893-6126, E-mail ows.info@highlandtank.com, Website http://www.highlandtank.com

B. Product

1. Provide and install Highland Tank Model HTC Series "G" UL-SU2215 approved Belowground Double Wall Parallel Flat/Corrugated Plate Gravity Displacement Oil/Water Separator with Integral Sand Interceptor Compartment. Separator shall be furnished with oil level alarm and leak detection systems. Oil/Water Separator shall be of capacity to comply with Spill Prevention Control and Countermeasures (SPCC) plan requirements at the facility. The sizing of this oil/water separator is consistent with industry protocols for complying with the minimum federal spill and discharge regulations therefore a separator of smaller volume is not permissible.
2. Separator shall be furnished with a Corella™ inclined parallel flat/corrugated plate coalescer to simultaneously separate free oil droplets and settleable or suspended solids particles from water without clogging of the coalescer.

C. Description

1. Separator shall be standard prefabricated inclined parallel flat/corrugated plate, gravity displacement type unit.
2. Separator shall be cylindrical with capacities, dimensions, construction, and thickness in strict accordance with Underwriters' Laboratories Subject 58, Double Wall construction using flat-flanged heads. Separator shall comply with National Fire Protection Association NFPA 30 Flammable and Combustible Liquids Code, 2003 Edition.
3. The separator shall be a pre-packaged, pre-engineered, ready to install unit consisting of:
   a. An influent connection, flanged. An internal influent nozzle at the inlet end of the separator. Nozzle discharge to be located at the furthest diagonal point from the effluent discharge opening.
   b. An integral sand interceptor compartment containing one (1) manhole, UL approved, complete with extension, cover, gasket, and bolts. A heavy-duty bulkhead shall retain sand, grit, settleable solids or semisolids and prevent them from entering the separation chamber. Bulkhead shall have a transfer pipe.
   c. A velocity head diffusion baffle at the inlet to:
      1) reduce horizontal velocity and flow turbulence.
      2) distribute the flow equally over the separators cross sectional area.
      3) direct the flow in a serpentine path in order to enhance hydraulic characteristics and fully utilize all separator volume.
      4) completely isolate all inlet turbulence from the separation chamber.
   d. A sediment chamber to disperse flow and collect oily solids and sediments.
   e. A sludge baffle to retain settleable solids and sediment and prevent them from entering the separation chamber.
   f. An Oil/Water Separation Chamber containing a removable Corella™ inclined parallel flat/corrugated plate coalescer. The coalescer shall have individual removable plates, sloped towards the sediment chamber. Each coalescing polate shall be flat on the top and corrugated on the bottom. The flat top plate shall resist clogging and clotting with solids. The corrugations of each of the plate bottoms shall be shaped and positioned to enhance collisions between the rising oil droplets and coalesce between them thereby improving separator efficiency. The coalescer shall:
      1) effect separation of oil and solids from all strata of the wastewater stream.
      2) shorten the vertical distance that an oil globule or solid particle has to rise or sink, respectively, for effective removal. Minimum plate gap to be 3/4".
      3) enhance coalescence and agglomeration by causing the smaller globules and particles (those possessing smaller rising/settling rates) to coalesce and collect on the plates thereby forming larger globules and particles that separate rapidly in water.
      4) direct the flow paths of the separated oil to the surface of the separator and separated solids to the bottom of the separator.
      5) allow solids to fall unhindered by turbulence, and oil droplets to rise without risk of re-emulsifying due to collisions with interfering solids.
   g. The Oil/Water Separation Chamber shall also contain a sectionalized removable "Petro-Screen"™ polypropylene impingement coalescer designed to intercept oil globules of less

than 20 microns in diameter. Heavy, one-piece impingement coalescers are not permissible.

h. An internal effluent downcomer at the outlet end of the separator, to allow for discharge from the bottom of the separation chamber only.
i. An effluent connection, flanged.
j. Fittings for vent, interface/level sensor, leak detection, waste oil pump-out, sampling, and gauge.
k. Two (2) manholes, UL approved, complete with extension, cover, gasket, and bolts. One manway shall be placed between the inlet and the parallel flat/corrugated plate coalescer to facilitate access into sediment chamber for solids removal. One manway shall be placed between the parallel flat/corrugated plate coalescer and outlet to facilitate access into the oil water separation chamber for oil removal.
l. Lifting lugs at balancing points for handling and installation.
m. Identification plates: Plates shall be affixed in prominent location and be durable and legible throughout equipment life.
n. HighGuard® Corrosion Protection System consisting of:
    1) Isolation Spool Pieces
    2) Dielectric Isolation Gaskets and Bushings
    3) External surfaces commercial grit blast, coated 75 mils DFT Self-Reinforcing Polyurethane.
o. Internal surfaces commercial grit blast and coated with 10 mils DFT heavy duty Polyurethane.

D. Accessories

1. Separator shall be supplied with an audible and visual alarm system that indicates hi oil level (visual only) and hi hi oil level (audible and visual) of oil storage in the oil/water separator and an audible and visual leak detection alarm system that indicates hydrocarbon and/or water in the interstice. A silence control shall be provided for the audible alarms. Level sensor(s) shall be intrinsically safe. Level sensor floats shall be made of stainless steel. The control panel shall contain both level sensor and detection control. The control panel shall be NEMA 4. Power to the control panel shall be as directed by the Owner.
2. Separator shall be supplied with Polyester Hold-down straps.
3. Separator shall be supplied with prefabricated Concrete Deadman Anchors.
4. Separator shall be supplied with cylindrical and/or rectangular steel Grade Level Manways designed to AASHTO H20 requirements.

1.3 EXECUTION

A. Installation

1. Installation shall be in strict compliance with manufacturer's instructions and shall comply with all applicable local, state, and federal requirements.

END OF SECTION 28 46 00 00

SECTION 28 46 13 31 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for digital, addressable fire alarm system. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Fire-alarm control unit.
b. Manual fire-alarm boxes.
c. System smoke detectors.
d. Nonsystem smoke detectors.
e. Heat detectors.
f. Notification appliances.
g. Firefighters' two-way telephone communication service.
h. Magnetic door holders.
i. Remote annunciator.
j. Addressable interface device.
k. Digital alarm communicator transmitter.
l. Radio alarm transmitter.
m. System printer.

C. Definitions
1. LED: Light-emitting diode.
2. NICET: National Institute for Certification in Engineering Technologies.

D. System Description
1. Noncoded, UL-certified **OR** FMG-placarded, **as directed**, addressable system, with multiplexed signal transmission, dedicated to fire-alarm service only.
2. Noncoded addressable system, with automatic sensitivity control of certain smoke detectors and multiplexed signal transmission, dedicated to fire-alarm service only.

E. Performance Requirements
1. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event," **as directed.**

F. Submittals
1. General Submittal Requirements:
a. Submittals shall be approved by authorities having jurisdiction prior to submitting them to the Owner.
b. Shop Drawings shall be prepared by persons with the following qualifications:
1) Trained and certified by manufacturer in fire-alarm system design.
2) NICET-certified fire-alarm technician, Level III **OR** Level IV, **as directed**, minimum.
3) Licensed or certified by authorities having jurisdiction.
2. Product Data: For each type of product indicated.
3. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.

a. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
b. Include voltage drop calculations for notification appliance circuits.
c. Include battery-size calculations.
d. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
e. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
f. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
g. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

4. Delegated-Design Submittal: For smoke and heat detectors indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   a. Drawings showing the location of each smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the detector.
   b. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72.
5. Qualification Data: For qualified Installer.
6. Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
7. Field quality-control reports.
8. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. Deliver copies to authorities having jurisdiction and include the following:
   a. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
   b. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
   c. Record copy of site-specific software.
   d. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
      1) Frequency of testing of installed components.
      2) Frequency of inspection of installed components.
      3) Requirements and recommendations related to results of maintenance.
      4) Manufacturer's user training manuals.
   e. Manufacturer's required maintenance related to system warranty requirements.
   f. Abbreviated operating instructions for mounting at fire-alarm control unit.
   g. Copy of NFPA 25.
9. Software and Firmware Operational Documentation:
   a. Software operating and upgrade manuals.
   b. Program Software Backup: On magnetic media or compact disk, complete with data files.
   c. Device address list.
   d. Printout of software application and graphic screens.

G. Quality Assurance
1. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
2. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II **OR** Level III **OR** Level IV, **as directed**, technician.
3. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.
4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL.
6. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.
7. NFPA Certification: Obtain certification according to NFPA 72 in the form of a placard by an FMG-approved alarm company.
8. NFPA Certification: Obtain certification according to NFPA 72 by agency having jurisdiction.

H. Project Conditions
1. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
   a. Notify the Owner no fewer than two days in advance of proposed interruption of fire-alarm service.
   b. Do not proceed with interruption of fire-alarm service without the Owner written permission.

I. Sequencing And Scheduling
1. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.
2. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

J. Software Service Agreement
1. Comply with UL 864.
2. Technical Support: Beginning with Final Completion, provide software support for two years.
3. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Final Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
   a. Provide 30 days' notice to the Owner to allow scheduling and access to system and to allow the Owner to upgrade computer equipment if necessary.

1.2 PRODUCTS

A. Systems Operational Description
1. Fire-alarm signal initiation shall be by one or more of the following devices and systems, **as directed**:
   a. Manual stations.
   b. Heat detectors.
   c. Flame detectors.
   d. Smoke detectors.
   e. Duct smoke detectors.
   f. Verified automatic alarm operation of smoke detectors.
   g. Automatic sprinkler system water flow.
   h. Heat detectors in elevator shaft and pit.

i. Fire-extinguishing system operation.
j. Fire standpipe system.

2. Fire-alarm signal shall initiate the following actions:
   a. Continuously operate alarm notification appliances.
   b. Identify alarm at fire-alarm control unit and remote annunciators, **as directed**.
   c. Transmit an alarm signal to the remote alarm receiving station.
   d. Unlock electric door locks in designated egress paths.
   e. Release fire and smoke doors held open by magnetic door holders.
   f. Activate voice/alarm communication system.
   g. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
   h. Activate smoke-control system (smoke management) at firefighter smoke-control system panel.
   i. Activate stairwell and elevator-shaft pressurization systems.
   j. Close smoke dampers in air ducts of designated air-conditioning duct systems.
   k. Recall elevators to primary or alternate recall floors.
   l. Activate emergency lighting control.
   m. Activate emergency shutoffs for gas and fuel supplies.
   n. Record events in the system memory.
   o. Record events by the system printer.
3. Supervisory signal initiation shall be by one or more of the following devices and actions:
   a. Valve supervisory switch.
   b. Low-air-pressure switch of a dry-pipe sprinkler system.
   c. Elevator shunt-trip supervision.
4. System trouble signal initiation shall be by one or more of the following devices and actions:
   a. Open circuits, shorts, and grounds in designated circuits.
   b. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
   c. Loss of primary power at fire-alarm control unit.
   d. Ground or a single break in fire-alarm control unit internal circuits.
   e. Abnormal ac voltage at fire-alarm control unit.
   f. Break in standby battery circuitry.
   g. Failure of battery charging.
   h. Abnormal position of any switch at fire-alarm control unit or annunciator.
   i. Fire-pump power failure, including a dead-phase or phase-reversal condition.
   j. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.
5. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators, **as directed**. Record the event on system printer.

B. Fire-Alarm Control Unit
1. General Requirements for Fire-Alarm Control Unit:
   a. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.
      1) System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
      2) Include a real-time clock for time annotation of events on the event recorder and printer.
   b. Addressable initiation devices that communicate device identity and status.
      1) Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit, **as directed**.
      2) Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
   c. Addressable control circuits for operation of mechanical equipment.

2. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
   a. Annunciator and Display: Liquid-crystal type, 1 **OR** 2 **OR** 3, **as directed**, line(s) of 40 **OR** 80, **as directed**, characters, minimum.
   b. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters, **as directed**.
3. Circuits:
   a. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class A.
      1) Initiating Device Circuits: Style D **OR** Style E, **as directed**.
      2) Notification Appliance Circuits: Style Z.
      3) Signaling Line Circuits: Style 2 **OR** Style 5 **OR** Style 6 **OR** Style 7, **as directed**.
      4) Install no more than 50 addressable devices on each signaling line circuit.
   b. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class B.
      1) Initiating Device Circuits: Style A **OR** Style B **OR** Style C, **as directed**.
      2) Notification Appliance Circuits: Style W **OR** Style X **OR** Style Y, **as directed**.
      3) Signaling Line Circuits: Style 0.5 **OR** Style 1 **OR** Style 3 **OR** Style 3.5 **OR** Style 4 **OR** Style 4.5, **as directed**.
      4) Install no more than 50 addressable devices on each signaling line circuit.
   c. Serial Interfaces: Two RS-232 ports for printers.
4. Stairwell Pressurization: Provide an output signal using an addressable relay to start the stairwell pressurization system. Signal shall remain on until alarm conditions are cleared and fire-alarm system is reset. Signal shall not stop in response to alarm acknowledge or signal silence commands.
   a. Pressurization starts when any alarm is received at fire-alarm control unit.
   b. Alarm signals from smoke detectors at pressurization air supplies have a higher priority than other alarm signals that start the system.
5. Smoke-Alarm Verification:
   a. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
   b. Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.
   c. Record events by the system printer.
   d. Sound general alarm if the alarm is verified.
   e. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.
6. Notification Appliance Circuit: Operation shall sound in a <**Insert pattern**>.
7. Elevator Recall:
   a. Smoke detectors at the following locations shall initiate automatic elevator recall. Alarm-initiating devices, except those listed, shall not start elevator recall, **as directed**.
      1) Elevator lobby detectors except the lobby detector on the designated floor.
      2) Smoke detector in elevator machine room.
      3) Smoke detectors in elevator hoistway.
   b. Elevator lobby detectors located on the designated recall floors shall be programmed to move the cars to the alternate recall floor.
   c. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
      1) Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.
8. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be **OR** not be, **as directed**, connected to fire-alarm system.
9. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-

adjustment schedule changes in system memory, and print out the final adjusted values on system printer.

10. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
11. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided in a separate cabinet located in the fire command center **OR** as a special module that is part of fire-alarm control unit, **as directed**.
    a. Indicated number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711 and be listed by an NRTL.
        1) Allow the application of and evacuation signal to indicated number of zones and, at same time, allow voice paging to the other zones selectively or in any combination.
        2) Programmable tone and message sequence selection.
        3) Standard digitally recorded messages for "Evacuation" and "All Clear."
        4) Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification appliance circuits of fire-alarm control unit.
    b. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
    c. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.
12. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.
13. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals **OR** supervisory and digital alarm communicator transmitters **OR** digital alarm radio transmitters, **as directed**, shall be powered by 24-V dc source.
    a. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
14. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
    a. Batteries: Sealed lead calcium **OR** Sealed, valve-regulated, recombinant lead acid **OR** Vented, wet-cell pocket, plate nickel cadmium, **as directed**.
15. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

C. Manual Fire-Alarm Boxes

1. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
    a. Single-action mechanism, breaking-glass or plastic-rod **OR** pull-lever, **as directed**, type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
    b. Double-action mechanism requiring two actions to initiate an alarm, breaking-glass or plastic-rod **OR** pull-lever, **as directed**, type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.

c. Station Reset: Key- or wrench-operated switch.
d. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
e. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

D. System Smoke Detectors
1. General Requirements for System Smoke Detectors:
a. Comply with UL 268; operating at 24-V dc, nominal.
b. Detectors shall be four **OR** two, **as directed**,-wire type.
c. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
d. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
e. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
f. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status, **as directed**.
g. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
1) Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F (8 or 11 deg C) per minute.
2) Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F (57 or 68 deg C).
3) Provide multiple levels of detection sensitivity for each sensor.
2. Photoelectric Smoke Detectors:
a. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
b. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
1) Primary status.
2) Device type.
3) Present average value.
4) Present sensitivity selected.
5) Sensor range (normal, dirty, etc.).
3. Ionization Smoke Detector:
a. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
b. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
1) Primary status.
2) Device type.
3) Present average value.
4) Present sensitivity selected.
5) Sensor range (normal, dirty, etc.).
4. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
a. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
b. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
1) Primary status.
2) Device type.
3) Present average value.

4) Present sensitivity selected.
5) Sensor range (normal, dirty, etc.).

c. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
d. Each sensor shall have multiple levels of detection sensitivity.
e. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
f. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

E. Nonsystem Smoke Detectors

1. Single-Station Smoke Detectors:
   a. Comply with UL 217; suitable for NFPA 101, residential occupancies; operating at 120-V ac with 9-V dc battery as the secondary power source. Provide with "low" or "missing" battery chirping-sound device, **as directed**.
   b. Auxiliary Relays: One Form C rated at 0.5 A **OR** Form A and one Form C, both rated at 0.5 A, **as directed**.
   c. Audible Notification Appliance: Piezoelectric sounder rated at 90 dBA at 10 feet (3 m) according to UL 464.
   d. Visible Notification Appliance: 177-cd strobe.
   e. Heat sensor, 135 deg F (57 deg C) combination rate-of-rise, **as directed**, and fixed temperature.
   f. Test Switch: Push to test; simulates smoke at rated obscuration.
   g. Tandem Connection: Allow tandem connection of number of indicated detectors; alarm on one detector shall actuate notification on all connected detectors.
   h. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
   i. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
   j. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status, **as directed**.
2. Single-Station Duct Smoke Detectors:
   a. Comply with UL 268A; operating at 120-V ac.
   b. Sensor: LED or infrared light source with matching silicon-cell receiver.
      1) Detector Sensitivity: Smoke obscuration between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) when tested according to UL 268A.
   c. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. The fixed base shall be designed for mounting directly to air duct. Provide terminals in the fixed base for connection to building wiring.
      1) Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
   d. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
   e. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

F. Heat Detectors

1. General Requirements for Heat Detectors: Comply with UL 521.
2. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.
   a. Mounting: Adapter plate for outlet box mounting **OR** Twist-lock base interchangeable with smoke-detector bases, **as directed**.
   b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

3. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F (88 deg C).
   a. Mounting: Adapter plate for outlet box mounting **OR** Twist-lock base interchangeable with smoke-detector bases, **as directed**.
   b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Continuous Linear Heat-Detector System:
   a. Detector Cable: Rated detection temperature 155 deg F (68 deg C). NRTL listed for "regular" service and a standard environment. Cable includes two steel actuator wires twisted together with spring pressure, wrapped with protective tape, and finished with PVC outer sheath. Each actuator wire is insulated with heat-sensitive material that reacts with heat to allow the cable twist pressure to short- circuit wires at the location of elevated temperature.
   b. Control Unit: Two-zone or multizone unit as indicated. Provide same system power supply, supervision, and alarm features as specified for fire-alarm control unit.
   c. Signals to Fire-Alarm Control Unit: Any type of local system trouble shall be reported to fire-alarm control unit as a composite "trouble" signal. Alarms on each detection zone shall be individually reported to central fire-alarm control unit as separately identified zones.
   d. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

G. Notification Appliances
1. General Requirements for Notification Appliances: Individually addressed, connected to a signaling line circuit, equipped for mounting as indicated and with screw terminals for system connections.
2. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.
   a. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.
3. Chimes, Low-Level Output: Vibrating type, 75-dBA minimum rated output.
4. Chimes, High-Level Output: Vibrating type, 81-dBA minimum rated output.
5. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464 test protocol.
6. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
   a. Rated Light Output:
      1) 15 **OR** 30 **OR** 75 **OR** 110 **OR** 177, **as directed**, cd.
         OR
         15/30/75/110 cd, selectable in the field.
   b. Mounting: Wall mounted unless otherwise indicated.
   c. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
   d. Flashing shall be in a temporal pattern, synchronized with other units.
   e. Strobe Leads: Factory connected to screw terminals.
   f. Mounting Faceplate: Factory finished, red **OR** white, **as directed**.
7. Voice/Tone Notification Appliances:
   a. Appliances shall comply with UL 1480 and shall be listed and labeled by an NRTL.
   b. High-Range Units: Rated 2 to 15 W.
   c. Low-Range Units: Rated 1 to 2 W.
   d. Mounting: Flush **OR** Semirecessed **OR** Surface mounted and bidirectional, **as directed**.

e. Matching Transformers: Tap range matched to acoustical environment of speaker location.

H. Firefighters' Two-Way Telephone Communication Service
1. Dedicated, two-way, supervised, telephone voice communication links between fire-alarm control unit, the fire command center, **as directed**, and remote firefighters' telephone stations. Supervised telephone lines shall be connected to talk circuits by controls in a control module. Provide the following:
a. Common-talk type for firefighter use only.
b. Selective-talk type for use by firefighters and fire wardens.
c. Controls to disconnect phones from talk circuits if too many phones are in use simultaneously.
d. Audible Pulse and Tone Generator, and High-Intensity Lamp: When a remote telephone is activated, it causes audible signal to sound and high-intensity lamp to flash.
e. Selector panel controls shall provide for simultaneous operation of up to six telephones in selected zones. Indicate ground faults and open or shorted telephone lines on the panel front by individual LEDs.
f. Display: Graphic **OR** Liquid-crystal digital, **as directed**, to indicate location of caller.
g. Remote Telephone Cabinet: Flush- or surface-mounted cabinet as indicated, factory-standard red finish, with handset.
1) Install one-piece handset to cabinet with vandal-resistant armored cord. Silk-screened or engraved label on cabinet door, designating "Fire Warden Phone" **OR** "Fire Emergency Phone", **as directed.**
2) With "break-glass" type door access lock.
h. Remote Telephone Jack Stations: Single-gang, stainless-steel-plate mounted plug, engraved "Fire Warden Phone" **OR** "Fire Emergency Phone", **as directed.**
i. Handsets: <**Insert number**> push-to-talk-type sets with noise-canceling microphone, **as directed**, stored in a cabinet adjacent to fire-alarm control unit **OR** in the fire command center, **as directed**.

I. Magnetic Door Holders
1. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
a. Electromagnet: Requires no more than 3 W to develop 25-lbf (111-N) holding force.
b. Wall-Mounted Units: Flush mounted unless otherwise indicated.
c. Rating: 24-V ac or dc.
d. Rating: 120-V ac.
2. Material and Finish: Match door hardware.

J. Remote Annunciator
1. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
a. Mounting: Flush **OR** Surface, **as directed**, cabinet, NEMA 250, Type 1.
2. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

K. Addressable Interface Device
1. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.
2. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall **OR** to circuit-breaker shunt trip for power shutdown, **as directed**.

L. Digital Alarm Communicator Transmitter

1. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.
2. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture one **OR** two, **as directed**, telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either, **as directed**, line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
3. Local functions and display at the digital alarm communicator transmitter shall include the following:
    a. Verification that both telephone lines are available.
    b. Programming device.
    c. LED display.
    d. Manual test report function and manual transmission clear indication.
    e. Communications failure with the central station or fire-alarm control unit.
4. Digital data transmission shall include the following:
    a. Address of the alarm-initiating device.
    b. Address **OR** Zone, **as directed**, of the supervisory signal.
    c. Address **OR** Zone, **as directed**, of the trouble-initiating device.
    d. Loss of ac supply or loss of power.
    e. Low battery.
    f. Abnormal test signal.
    g. Communication bus failure.
5. Secondary Power: Integral rechargeable battery and automatic charger.
6. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

M. Radio Alarm Transmitter
1. Transmitter shall comply with NFPA 1221 and shall be listed and labeled by an NRTL.
2. Comply with 47 CFR 90.
3. Description: Manufacturer's standard commercial product; factory assembled, wired, tested, and ready for installation and operation.
    a. Packaging: A single, modular, NEMA 250, Type 1 metal enclosure with a tamper-resistant flush tumbler lock.
    b. Signal Transmission Mode and Frequency: VHF or UHF 2-W power output, coordinated with operating characteristics of the established remote alarm receiving station designated by the Owner.
    c. Normal Power Input: 120-V ac.
    d. Secondary Power: Integral-sealed, rechargeable, 12-V battery and charger. Comply with NFPA 72 requirements for battery capacity; submit calculations.
    e. Antenna: Omnidirectional, coaxial half-wave, dipole type with driving point impedance matched to transmitter and antenna cable output impedance. Wind-load strength of antenna and mounting hardware and supports shall withstand 100 mph (160 km/h), **as directed**, with a gust factor of 1.3 without failure.
    f. Antenna Cable: Coaxial cable with impedance matched to the transmitter output impedance.
    g. Antenna-Cable Connectors: Weatherproof.
    h. Alarm Interface Devices: Circuit boards, modules, and other auxiliary devices, integral to the transmitter, matching fire-alarm and other system outputs to message-generating inputs of the transmitter that produce required message transmissions.
4. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit or from its own internal sensors or controls and shall automatically transmit signal along with a unique code that identifies the transmitting station to the remote alarm receiving station. Transmitted messages shall correspond to standard designations for fire-

reporting system to which the signal is being transmitted and shall include separately designated messages in response to the following events or conditions:

a. Transmitter Low-Battery Condition: Sent when battery voltage is below 85 percent of rated value.
b. System Test Message: Initiated manually by a test switch within the transmitter cabinet, or automatically at an optionally preselected time, once every 24 hours, with transmission time controlled by a programmed timing device integral to transmitter controls.
c. Transmitter Trouble Message: Actuated by failure, in excess of one-minute duration, of the transmitter normal power source, derangement of the wiring of the transmitter, or any alarm input interface circuit or device connected to it.
d. Local Fire-Alarm-System Trouble Message: Initiated by events or conditions that cause a trouble signal to be indicated on the building system.
e. Local Fire-Alarm-System Alarm Message: Actuated when the building system goes into an alarm state. Identifies device that initiated the alarm.
f. Local Fire-Alarm-System Supervisory-Alarm Message: Actuated when the building alarm system indicates a supervisory alarm, **as directed**.

N. System Printer

1. Printer shall be listed and labeled by an NRTL as an integral part of fire-alarm system.

O. Device Guards

1. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
   a. Factory fabricated and furnished by manufacturer of device.
   b. Finish: Paint of color to match the protected device.

1.3 EXECUTION

A. Equipment Installation

1. Comply with NFPA 72 for installation of fire-alarm equipment.
2. Equipment Mounting: Install fire-alarm control unit on concrete base with tops of cabinets not more than 72 inches (1830 mm) above the finished floor. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-place Concrete".
   a. Install seismic bracing. Comply with requirements in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
   b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   e. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Equipment Mounting: Install fire-alarm control unit on finished floor with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.
   a. Comply with requirements for seismic-restraint devices specified in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
4. Install wall-mounted equipment, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.
   a. Comply with requirements for seismic-restraint devices specified in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
5. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.
   a. Connect new equipment to existing control panel in existing part of the building.
   b. Connect new equipment to existing monitoring equipment at the supervising station.

c. Expand, modify, and supplement existing control **OR** monitoring, **as directed**, equipment as necessary to extend existing control **OR** monitoring, **as directed**, functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

6. Smoke- or Heat-Detector Spacing:
   a. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
   b. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
   c. Smooth ceiling spacing shall not exceed 30 feet (9 m)
   d. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A or Appendix B in NFPA 72.
   e. HVAC: Locate detectors not closer than 3 feet (1 m) **OR** 5 feet (1.5 m), **as directed**, from air-supply diffuser or return-air opening.
   f. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture.
7. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.
8. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.
9. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.
10. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.
11. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
12. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling.
13. Device Location-Indicating Lights: Locate in public space near the device they monitor.
14. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.
15. Annunciator: Install with top of panel not more than 72 inches (1830 mm) above the finished floor.
16. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that will resist 100-mph (160-km/h), **as directed**, wind load with a gust factor of 1.3 without damage.

B. Connections
1. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware". Connect hardware and devices to fire-alarm system.
   a. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.
2. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet (1 m) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
   a. Alarm-initiating connection to smoke-control system (smoke management) at firefighter smoke-control system panel.
   b. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
   c. Smoke dampers in air ducts of designated air-conditioning duct systems.
   d. Alarm-initiating connection to elevator recall system and components.
   e. Alarm-initiating connection to activate emergency lighting control.
   f. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.

g. Supervisory connections at valve supervisory switches.
h. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
i. Supervisory connections at elevator shunt trip breaker.
j. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
k. Supervisory connections at fire-pump engine control panel.

C. Identification
1. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".
2. Install framed instructions in a location visible from fire-alarm control unit.

D. Grounding
1. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

E. Field Quality Control
1. Field tests shall be witnessed by authorities having jurisdiction.
2. Tests and Inspections:
a. Visual Inspection: Conduct visual inspection prior to testing.
1) Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
2) Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
b. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
c. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
d. Test audible appliances for the private operating mode according to manufacturer's written instructions.
e. Test visible appliances for the public operating mode according to manufacturer's written instructions.
f. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
3. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
4. Fire-alarm system will be considered defective if it does not pass tests and inspections.
5. Prepare test and inspection reports.
6. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
7. Annual Test and Inspection: One year after date of Final Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

END OF SECTION 28 46 13 31

SECTION 28 46 13 31a - ZONED (DC LOOP) FIRE-ALARM SYSTEM

1.1 GENERAL

A. Description Of Work
  1. This specification covers the furnishing and installation of materials for zoned (DC loop) fire alarm system. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
  1. Section Includes:
    a. Fire-alarm control unit.
    b. Manual fire-alarm boxes.
    c. System smoke detectors.
    d. Nonsystem smoke detectors.
    e. Heat detectors.
    f. Notification appliances.
    g. Magnetic door holders.
    h. Remote annunciator.
    i. Digital alarm communicator transmitter.
    j. Radio alarm transmitter.

C. Definitions
  1. LED: Light-emitting diode.
  2. NICET: National Institute for Certification in Engineering Technologies.

D. System Description
  1. Noncoded system, dedicated to fire-alarm service only.

E. Submittals
  1. General Submittal Requirements:
    a. Submittals shall be approved by authorities having jurisdiction prior to submitting them to the Owner.
    b. Shop Drawings shall be prepared by persons with the following qualifications:
      1) Trained and certified by manufacturer in fire-alarm system design.
      2) NICET-certified fire-alarm technician, Level III **OR** Level IV**OR** one who meets the requirements necessary for certification, **as directed**, minimum.
      3) Licensed or certified by authorities having jurisdiction.
  2. Product Data: For each type of product indicated.
  3. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.
    a. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
    b. Include voltage drop calculations for notification appliance circuits.
    c. Include battery size calculations.
    d. Include performance parameters and installation details for each detector, verifying that each detector is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
    e. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.

f. Include floor plans to indicate final outlet locations showing zone designation of each device. Show size and route of cable and conduits.

4. Delegated-Design Submittal: For smoke and heat detectors indicated to comply with performance requirements and design criteria, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.
   a. Drawings showing the location of each smoke and heat detector, the ratings of each, and installation details as needed to comply with the listing conditions of the detector.
   b. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72.
5. Qualification Data: For qualified Installer.
6. Field quality-control reports.
7. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. Deliver copies to authorities having jurisdiction, **as directed**, and include the following:
   a. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
   b. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
   c. Record copy of site-specific software.
   d. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
      1) Frequency of testing of installed components.
      2) Frequency of inspection of installed components.
      3) Requirements and recommendations related to results of maintenance.
      4) Manufacturer's user training manuals.
   e. Manufacturer's required maintenance related to system warranty requirements.
   f. Abbreviated operating instructions for mounting at fire-alarm control unit.
   g. Copy of NFPA 25.

F. Quality Assurance
1. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
2. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II **OR** Level III **OR** Level IV **OR** one who meets the requirements necessary for certification, **as directed**, technician.
3. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.
4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Project Conditions
1. Interruption of Existing Fire-alarm Service: Do not interrupt fire-alarm service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
   a. Notify the Owner no fewer than two days in advance of proposed interruption of fire-alarm service.
   b. Do not proceed with interruption of fire-alarm service without the Owner 's written permission.

H. Sequencing And Scheduling
1. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.

2. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.2 PRODUCTS

A. Systems Operational Description
1. Fire-alarm signal initiation shall be by one or more of the following devices and systems, **as directed**:
   a. Manual stations.
   b. Heat detectors.
   c. Smoke detectors.
   d. Duct smoke detectors.
   e. Automatic sprinkler system water flow.
   f. Fire-extinguishing system operation.
   g. Fire standpipe system.
2. Fire-alarm signal shall initiate the following actions:
   a. Continuously operate alarm notification appliances.
   b. Identify alarm zone at fire-alarm control unit and remote annunciators, **as directed**.
   c. Transmit an alarm signal to the remote alarm receiving station.
3. Supervisory signal initiation shall be by one or more of the following devices and systems:
   a. Valve supervisory switch.
4. System trouble signal initiation shall be by one or more of the following devices and actions:
   a. Open circuits, shorts, and grounds in designated circuits.
   b. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
   c. Loss of primary power at fire-alarm control unit.
   d. Ground or a single break in fire-alarm control unit internal circuits.
   e. Abnormal ac voltage at fire-alarm control unit.
   f. Break in standby battery circuitry.
   g. Failure of battery charging.
   h. Abnormal position of any switch at fire-alarm control unit or annunciator, **as directed**.
5. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators, **as directed**.

B. Fire-Alarm Control Unit
1. General Requirements for Fire-Alarm Control Unit:
   a. Modular, power-limited design with electronic modules, UL 864 listed.
      1) Include a real-time clock for time annotation of events.
2. Alphanumeric Display and System Controls: Display alarm, supervisory, and component status messages and the programming and control menu.
   a. Annunciator and Display: Liquid-crystal type, one line of 40 **OR** 80, **as directed**, characters, minimum.
3. Circuits:
   a. No Fewer Than Five Initiating Device Circuits:
      1) Four circuits, NFPA 72, Class B.
      2) One circuit(s), NFPA 72, Class A, Style 6
   b. No Fewer Than Two Notification Appliance Circuits: NFPA 72, Class B, Style Y.
4. Notification Appliance Circuit: Operation shall sound in a <**Insert pattern**>.
5. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be **OR** not be, **as directed**, connected to fire-alarm system.
6. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
7. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals **OR**

supervisory and digital alarm communicator transmitters **OR** digital alarm radio transmitters, **as directed**, shall be powered by the 24-V dc source.

a. Alarm current draw of the entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

8. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
   a. Batteries: Sealed lead calcium **OR** Sealed, valve-regulated, recombinant lead acid **OR** Vented, wet-cell pocket, plate nickel cadmium, **as directed**.
9. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

C. Manual Fire-Alarm Boxes
1. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
   a. Single-action mechanism, breaking-glass or plastic-rod **OR** pull-lever, **as directed**, type.
   b. Double-action mechanism requiring two actions to initiate an alarm, breaking-glass or plastic-rod **OR** pull-lever, **as directed**, type.
   c. Station Reset: Key- or wrench-operated switch.
   d. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
   e. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

D. System Smoke Detectors
1. General Requirements for System Smoke Detectors:
   a. Operating at 24-V dc, nominal.
   b. Detectors shall be four **OR** two, **as directed**,-wire type.
   c. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
   d. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
   e. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status, **as directed**.
   f. Provide multiple levels of detection sensitivity for each sensor, with alarm-verification feature, **as directed**.
2. Photoelectric Smoke Detectors: Comply with UL 268.
3. Ionization Smoke Detector: Comply with UL 268.
4. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
   a. Remote indication and test, **as directed**, station. Operating key switch initiates an alarm test, **as directed**.
   b. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
   c. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
   d. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

E. Nonsystem Smoke Detectors
1. Single-Station Smoke Detectors:

a. Comply with UL 217; suitable for NFPA 101, residential occupancies; operating at 120-V ac with 9-V dc battery as the secondary power source. Provide with "low" or "missing" battery chirping-sound device, **as directed**.
b. Auxiliary Relays: One Form C rated at 0.5 A **OR** Form A and one Form C, both rated at 0.5 A, **as directed**.
c. Audible Notification Appliance: Piezoelectric sounder rated at 90 dBA at 10 feet (3 m) according to UL 464.
d. Visible Notification Appliance: 177-cd strobe.
e. Heat sensor, 135 deg F (57 deg C) combination rate-of-rise and fixed temperature, **as directed**.
f. Test Switch: Push-to-test; simulates smoke at rated obscuration.
g. Tandem Connection: Allow tandem connection of number of indicated detectors; alarm on one detector shall actuate notification on all connected detectors.
h. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
i. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
j. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status, **as directed**.

2. Single-Station Duct Smoke Detectors:
   a. Comply with UL 268A; operating at 120-V ac.
   b. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. The fixed base shall be designed for mounting directly to air duct. Provide terminals in the fixed base for connection to building wiring.
      1) Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
   c. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
   d. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

F. Heat Detectors
1. General Requirements for Heat Detectors: Comply with UL 521.
2. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.
   a. Mounting: Adapter plate for outlet box mounting **OR** Twist-lock base interchangeable with smoke-detector bases, **as directed**.
3. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F (88 deg C).
   a. Mounting: Adapter plate for outlet box mounting **OR** Twist-lock base interchangeable with smoke-detector bases, **as directed**.

G. Notification Appliances
1. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.
   a. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.
2. Chimes, High-Level Output: Vibrating type, 81-dBA minimum rated output.
3. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464 test protocol.

4. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
    a. Rated Light Output:
        1) Indicated on Drawings.
        2) 15 **OR** 30 **OR** 75 **OR** 110 **OR** 177, **as directed**, cd.
           OR
           15/30/75/110 cd, selectable in the field.
    b. Mounting: Indicated on Drawings **OR** Wall mounted, **as directed**.
    c. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
    d. Flashing shall be in a temporal pattern, synchronized with other units.
    e. Strobe Leads: Factory connected to screw terminals.
    f. Mounting Faceplate: Factory finished, red **OR** white, **as directed**.

H. Magnetic Door Holders
1. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
    a. Electromagnet: Requires no more than 3 W to develop 25-lbf (111-N) holding force.
    b. Wall-Mounted Units: Flush mounted unless otherwise indicated.
    c. Rating: 24-V ac or dc.
    d. Rating: 120-V ac.
2. Material and Finish: Match door hardware.

I. Remote Annunciator
1. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
    a. Mounting: Flush **OR** Surface, **as directed**, cabinet, NEMA 250, Type 1.
2. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

J. Digital Alarm Communicator Transmitter
1. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.
2. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture one **OR** two, **as directed**, telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either, **as directed**, line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
3. Local functions and display at the digital alarm communicator transmitter shall include the following:
    a. Verification that both telephone lines are available.
    b. Programming device.
    c. LED display.
    d. Manual test report function and manual transmission clear indication.
    e. Communications failure with the central station or fire-alarm control unit.
4. Digital data transmission shall include the following:
    a. Zone of the alarm initiating device.
    b. Zone of the supervisory signal.
    c. Zone of the trouble initiating device.

d. Loss of ac supply or loss of power.
e. Low battery.
f. Abnormal test signal.
g. Communication bus failure.
5. Secondary Power: Integral rechargeable battery and automatic charger.
6. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

K. Radio Alarm Transmitter
1. Transmitter shall comply with NFPA 1221 and shall be listed and labeled by an NRTL.
2. Comply with 47 CFR 90.
3. Description: Manufacturer's standard commercial product; factory assembled, wired, tested, and ready for installation and operation.
a. Packaging: A single, modular, NEMA 250, Type 1 metal enclosure with a tamper-resistant flush tumbler lock.
b. Signal Transmission Mode and Frequency: VHF or UHF 2-W power output, coordinated with operating characteristics of the established remote alarm receiving station designated by the Owner.
c. Normal Power Input: 120-V ac.
d. Secondary Power: Integral-sealed, rechargeable, 12-V battery and charger. Comply with NFPA 72 requirements for battery capacity; submit calculations.
e. Antenna: Omnidirectional, coaxial half-wave, dipole type with driving point impedance matched to transmitter and antenna cable output impedance. Wind-load strength of antenna and mounting hardware and supports shall withstand 100 mph (160 km/h) with a gust factor of 1.3 without failure.
f. Antenna Cable: Coaxial cable with impedance matched to the transmitter output impedance.
g. Antenna-Cable Connectors: Weatherproof.
h. Alarm Interface Devices: Circuit boards, modules, and other auxiliary devices, integral to the transmitter, matching fire-alarm and other system outputs to message-generating inputs of the transmitter that produce required message transmissions.
4. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit or from its own internal sensors or controls and shall automatically transmit signal along with a unique code that identifies the transmitting station to the remote alarm receiving station. Transmitted messages shall correspond to standard designations for fire-reporting system to which the signal is being transmitted and shall include separately designated messages in response to the following events or conditions:
a. Transmitter Low-Battery Condition: Sent when battery voltage is below 85 percent of rated value.
b. System Test Message: Initiated manually by a test switch within the transmitter cabinet, or automatically at an optionally preselected time, once every 24 hours, with transmission time controlled by a programmed timing device integral to transmitter controls.
c. Transmitter Trouble Message: Actuated by failure, in excess of one-minute duration, of the transmitter normal power source, derangement of the wiring of the transmitter, or any alarm input interface circuit or device connected to it.
d. Local Fire-Alarm-System Trouble Message: Initiated by events or conditions that cause a trouble signal to be indicated on the building system.
e. Local Fire-Alarm-System Alarm Message: Actuated when the building system goes into an alarm state. Identifies device that initiated the alarm.
f. Local Fire-Alarm-System Supervisory-Alarm Message: Actuated when the building alarm system indicates a supervisory alarm, **as directed**.

L. Device Guards
1. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
a. Factory fabricated and furnished by manufacturer of the device.
b. Finish: Paint of color to match the protected device.

1.3 EXECUTION

A. Equipment Installation
1. Comply with NFPA 72 for installation of fire-alarm equipment.
2. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.
   a. Connect new equipment to the existing control panel in the existing part of the building.
   b. Connect new equipment to the existing monitoring equipment at the supervising station.
   c. Expand, modify, and supplement the existing control **OR** monitoring, **as directed**, equipment as necessary to extend the existing control **OR** monitoring, **as directed**, functions to the new points. New components shall be capable of merging with the existing configuration without degrading the performance of either system.
3. Smoke- or Heat-Detector Spacing:
   a. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
   b. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
   c. Smooth ceiling spacing shall not exceed 30 feet (9 m), **as directed**.
   d. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A or Appendix B, **as directed**, in NFPA 72.
   e. HVAC: Locate detectors not closer than 3 feet (1 m) **OR** 5 feet (1.5 m), **as directed**, from air-supply diffuser or return-air opening.
   f. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture.
4. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.
5. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.
6. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.
7. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.
8. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
9. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling.
10. Device Location-Indicating Lights: Locate in public space near the device they monitor.
11. Fire-Alarm Control Unit: Surface mounting, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.
12. Annunciator: Install with top of panel not more than 72 inches (1830 mm) above the finished floor.
13. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that will resist 100-mph (160-km/h), **as directed**, wind load with a gust factor of 1.3 without damage.

B. Connections
1. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware". Connect hardware and devices to fire-alarm system.
   a. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.

2. Connect supervised interface devices to the following devices and systems. Install the interface device less than 3 feet (1 m) from the device controlled.
   a. Smoke dampers in air ducts of designated air-conditioning duct systems.
   b. Supervisory connections at valve supervisory switches.
   c. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
   d. Supervisory connections at fire-pump engine control panel.

C. Identification
1. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".
2. Install framed instructions in a location visible from fire-alarm control unit.

D. Grounding
1. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

E. Field Quality Control
1. Field tests shall be witnessed by authorities having jurisdiction.
2. Tests and Inspections:
   a. Visual Inspection: Conduct the visual inspection prior to testing.
      1) Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
      2) Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
   b. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing, and Maintenance" Chapter in NFPA 72.
   c. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
   d. Test visible appliances for the public operating mode according to manufacturer's written instructions.
   e. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
3. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
4. Fire-alarm system will be considered defective if it does not pass tests and inspections.
5. Prepare test and inspection reports.
6. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
7. Annual Test and Inspection: One year after date of Final Completion, test fire-alarm system complying with the visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

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Task	Specification	Specification Description
28 49 11 00	28 16 11 00	Perimeter Security
28 49 11 00	28 16 11 00a	Intrusion Detection
28 49 11 00	28 16 11 00b	Security Access

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SECTION 31 01 20 00 - EARTHWORK

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for earthwork. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses, and plants.
   b. Excavating and backfilling for buildings and structures.
   c. Drainage course for concrete slabs-on-grade.
   d. Subbase course for concrete walks and pavements.
   e. Subbase course and base course for asphalt paving.
   f. Subsurface drainage backfill for walls and trenches.
   g. Excavating and backfilling trenches for utilities and pits for buried utility structures.
   h. Excavating well hole to accommodate elevator-cylinder assembly.

C. Definitions

1. Backfill: Soil material or controlled low-strength material used to fill an excavation.
   a. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
   b. Final Backfill: Backfill placed over initial backfill to fill a trench.
2. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.
3. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.
4. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
5. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
6. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
   a. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by the Owner. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
   b. Bulk Excavation: Excavation more than 10 feet (3 m) in width and more than 30 feet (9 m) in length.
   c. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by the Owner. Unauthorized excavation, as well as remedial work directed by the Owner, shall be without additional compensation.
7. Fill: Soil materials used to raise existing grades.
8. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. (0.76 cu. m) for bulk excavation or 3/4 cu. yd. (0.57 cu. m) for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:
   a. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch- (1065-mm-) wide, maximum, short-tip-radius rock bucket; rated at not less than 138-hp (103-kW) flywheel power with bucket-curling force of not less than 28,700 lbf (128 kN) and stick-crowd force of not less than 18,400 lbf (82 kN) with extra-long reach boom; measured according to SAE J-1179.

b. Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp (172-kW) flywheel power and developing a minimum of 47,992-lbf (213.3-kN) breakout force with a general-purpose bare bucket; measured according to SAE J-732.

9. If Standard Penetration Values are used to Define Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. (0.57 cu. m) or more in volume that exceed a standard penetration resistance of 100 blows/2 inches (97 blows/50 mm) when tested by a geotechnical testing agency, according to ASTM D 1586.
10. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
11. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
12. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.
13. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

D. Submittals

1. Product Data: For each type of the following manufactured products required:
   a. Geotextiles.
   b. Controlled low-strength material, including design mixture.
   c. Geofoam.
   d. Warning tapes.
2. Samples: For the following products, in sizes indicated below:
   a. Geotextile: 12 by 12 inches (300 by 300 mm).
   b. Warning Tape: 12 inches (300 mm) long; of each color.
3. Qualification Data: For qualified testing agency.
4. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:
   a. Classification according to ASTM D 2487.
   b. Laboratory compaction curve according to ASTM D 698 **OR** ASTM D 1557, **as directed**.
5. Blasting plan approved by authorities having jurisdiction.
6. Seismic survey report from seismic survey agency.
7. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

E. Quality Assurance

1. Blasting:
   a. Blasting will not be allowed.
      OR
      Comply with applicable requirements in NFPA 495, "Explosive Materials Code," and prepare a blasting plan reporting the following:
      1) Types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
      2) Seismographic monitoring during blasting operations.
2. Seismic Survey Agency: An independent testing agency, acceptable to authorities having jurisdiction, experienced in seismic surveys and blasting procedures to perform the following services:
   a. Report types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.

b. Seismographic monitoring during blasting operations.
3. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.
4. Pre-excavation Conference: Conduct conference at Project site.

F. Project Conditions
1. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.
   a. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the Owner and authorities having jurisdiction.
   b. Provide alternate routes around closed or obstructed traffic ways if required by the Owner or authorities having jurisdiction.
2. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining the Owner's property will be obtained by the Owner before award of Contract.
3. Do not proceed with work on adjoining property until directed by the Owner.
4. Utility Locator Service: Notify utility locator service **OR** Miss Utility" **OR** "Call Before You Dig" **OR** "Dig Safe System" **OR** "One Call", **as directed**, for area where Project is located before beginning earth moving operations.
5. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, specified in Division 01 Section(s) "Temporary Facilities And Controls" OR Division 31 Section(s) "Site Clearing", **as directed**, are in place.
6. Do not commence earth moving operations until plant-protection measures specified in Division 01 Section "Temporary Tree And Plant Protection" are in place.
7. The following practices are prohibited within protection zones:
   a. Storage of construction materials, debris, or excavated material.
   b. Parking vehicles or equipment.
   c. Foot traffic.
   d. Erection of sheds or structures.
   e. Impoundment of water.
   f. Excavation or other digging unless otherwise indicated.
   g. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
8. Do not direct vehicle or equipment exhaust towards protection zones.
9. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

1.2 PRODUCTS

A. Soil Materials
1. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
2. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487 **OR** Groups A-1, A-2-4, A-2-5, and A-3 according to AASHTO M 145, **as directed**, or a combination of these groups; free of rock or gravel larger than 3 inches (75 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
3. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487 **OR** Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 according to AASHTO M 145, **as directed**, or a combination of these groups.
   a. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
4. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.
5. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

6. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.
7. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.
8. Drainage Course: Narrowly graded mixture of washed, **as directed**, crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.
9. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch (25-mm) sieve and 0 to 5 percent passing a No. 4 (4.75-mm) sieve.
10. Sand: ASTM C 33; fine aggregate.
11. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

B. Geotextiles
1. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
    a. Survivability: Class 2; AASHTO M 288.
    b. Apparent Opening Size: No. 40 (0.425-mm) **OR** No. 60 (0.250-mm) **OR** No. 70 (0.212-mm), **as directed**, sieve, maximum; ASTM D 4751.
    c. Permittivity: 0.5 **OR** 0.2 **OR** 0.1, **as directed**, per second, minimum; ASTM D 4491.
    d. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.
2. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
    a. Survivability: Class 2; AASHTO M 288.
    b. Apparent Opening Size: No. 60 (0.250-mm) sieve, maximum; ASTM D 4751.
    c. Permittivity: 0.02 per second, minimum; ASTM D 4491.
    d. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

C. Controlled Low-Strength Material
1. Controlled Low-Strength Material: Self-compacting, low-density, **as directed**, flowable concrete material produced from the following:
    a. Portland Cement: ASTM C 150, Type **I OR** Type **II OR** Type III, **as directed**.
    b. Fly Ash: ASTM C 618, Class C or F.
    c. Normal-Weight Aggregate: ASTM C 33, 3/4-inch (19-mm) **OR** 3/8-inch (10-mm), **as directed**, nominal maximum aggregate size.
    d. Foaming Agent (if low-density, controlled low-strength material is required): ASTM C 869.
    e. Water: ASTM C 94/C 94M.
    f. Air-Entraining Admixture (not required for low-density, controlled low-strength material using foaming agent): ASTM C 260.
2. Produce low-density, controlled low-strength material with the following physical properties:
    a. As-Cast Unit Weight: 30 to 36 lb/cu. ft. (480 to 576 kg/cu. m) **OR** 36 to 42 lb/cu. ft. (576 to 675 kg/cu. m), **as directed**, at point of placement, when tested according to ASTM C 138/C 138M.
    b. Compressive Strength: 80 psi (550 kPa) **OR** 140 psi (965 kPa), **as directed**, when tested according to ASTM C 495.

    OR

    Produce conventional-weight, controlled low-strength material with 80-psi (550-kPa) **OR** 140-psi (965-kPa), **as directed**, compressive strength when tested according to ASTM C 495.

D. Geofoam

1. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.55-lb/cu. ft. (25-kg/cu. m) density, 25-psi (173-kPa) compressive strength **OR** Type X, 1.30-lb/cu. ft. (21-kg/cu. m) density, 15-psi (104-kPa) compressive strength **OR** Type VI, 1.80-lb/cu. ft. (29-kg/cu. m) density, 40-psi (276-kPa) compressive strength **OR** Type VII, 2.20-lb/cu. ft. (35-kg/cu. m) density, 60-psi (414-kPa) compressive strength **OR** Type V, 3.00-lb/cu. ft. (48-kg/cu. m) density, 100-psi (690-kPa) compressive strength, **as directed**.
2. Molded-Polystyrene Board Insulation: ASTM C 578, Type I, 0.90-lb/cu. ft. (15-kg/cu. m) density, 10-psi (69-kPa) compressive strength **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) density, 13-psi (90-kPa) compressive strength **OR** Type II, 1.35-lb/cu. ft. (22-kg/cu. m) density, 15-psi (104-kPa) compressive strength, **as directed**.
   a. Manufacture molded polystyrene with an inorganic mineral registered with the EPA and suitable for application as a termite deterrent.
3. Rigid Cellular Polystyrene Geofoam: ASTM D 6817, Type EPS 19, 1.15-lb/cu. ft. (18.4-kg/cu. m) density, 5.8-psi (40-kPa) compressive strength at 1 percent deformation; 16-psi (110-kPa) compressive strength at 10 percent deformation **OR** Type EPS 39, 2.40-lb/cu. ft. (38.4-kg/cu. m) density, 15-psi (103-kPa) compressive strength at 1 percent deformation; 40-psi (276-kPa) compressive strength at 10 percent deformation, **as directed**.
4. Connectors: Geofoam manufacturer's multibarbed, galvanized-steel sheet connectors **OR** Deformed steel reinforcing bars, 3/4 inch (19 mm) in diameter, **as directed**.

E. Accessories
1. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility; colored as follows:
   a. Red: Electric.
   b. Yellow: Gas, oil, steam, and dangerous materials.
   c. Orange: Telephone and other communications.
   d. Blue: Water systems.
   e. Green: Sewer systems.

   OR

   Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored as follows:
   f. Red: Electric.
   g. Yellow: Gas, oil, steam, and dangerous materials.
   h. Orange: Telephone and other communications.
   i. Blue: Water systems.
   j. Green: Sewer systems.

1.3 EXECUTION

A. Preparation
1. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.
2. Protect and maintain erosion and sedimentation controls during earth moving operations.
3. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

B. Dewatering
1. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

2. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
   a. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

C. Explosives
1. Explosives: Do not use explosives.
   OR
   Explosives: Obtain written permission from authorities having jurisdiction before bringing explosives to Project site or using explosives on Project site.
   a. Perform blasting without damaging adjacent structures, property, or site improvements.
   b. Perform blasting without weakening the bearing capacity of rock subgrade and with the least-practicable disturbance to rock to remain.

D. Excavation, General
1. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
   a. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
   b. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
      1) 24 inches (600 mm) outside of concrete forms other than at footings.
      2) 12 inches (300 mm) outside of concrete forms at footings.
      3) 6 inches (150 mm) outside of minimum required dimensions of concrete cast against grade.
      4) Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
      5) 6 inches (150 mm) beneath bottom of concrete slabs-on-grade.
      6) 6 inches (150 mm) beneath pipe in trenches, and the greater of 24 inches (600 mm) wider than pipe or 42 inches (1065 mm) wide.
2. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by the Owner. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.
   a. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.
      1) Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.
   b. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:
      1) 24 inches (600 mm) outside of concrete forms other than at footings.
      2) 12 inches (300 mm) outside of concrete forms at footings.
      3) 6 inches (150 mm) outside of minimum required dimensions of concrete cast against grade.
      4) Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
      5) 6 inches (150 mm) beneath bottom of concrete slabs-on-grade.
      6) 6 inches (150 mm) beneath pipe in trenches, and the greater of 24 inches (600 mm) wider than pipe or 42 inches (1065 mm) wide.

E. Excavation For Structures
1. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
a. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
b. Pile Foundations: Stop excavations 6 to 12 inches (150 to 300 mm) above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
c. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch (25 mm). Do not disturb bottom of excavations intended as bearing surfaces.
2. Excavations at Edges of Tree- and Plant-Protection Zones:
a. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
b. Cut and protect roots according to requirements in Division 01 Section "Temporary Tree And Plant Protection".

F. Excavation For Walks And Pavements
1. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

G. Excavation For Utility Trenches
1. Excavate trenches to indicated gradients, lines, depths, and elevations.
a. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
2. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit unless otherwise indicated.
a. Clearance: 12 inches (300 mm) each side of pipe or conduit **OR** As indicated, **as directed**.
3. Trench Bottoms (if a bedding course is not required under pipe and conduit): Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
a. For pipes and conduit less than 6 inches (150 mm) in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
b. For pipes and conduit 6 inches (150 mm) or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
c. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
d. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
4. Trench Bottoms (if a bedding course is required under pipe and conduit): Excavate trenches 4 inches (100 mm) deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.
a. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
5. Trenches in Tree- and Plant-Protection Zones:
a. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

b. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
c. Cut and protect roots according to requirements in Division 01 Section "Temporary Tree And Plant Protection".

H. Excavation For Elevator Cylinder
1. Drill well hole plumb in elevator pit to accommodate installation of elevator-cylinder assembly. Coordinate with applicable requirements for diameter and tolerances in Division 14 Section(s) "Hydraulic Elevators" OR "Hydraulic Freight Elevators", **as directed**.
2. Provide well casing as necessary to retain walls of well hole.

I. Subgrade Inspection
1. Notify the Owner when excavations have reached required subgrade.
2. If the Owner determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
3. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes) to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
a. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).
b. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by the Owner, and replace with compacted backfill or fill as directed.
4. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
5. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the Owner, without additional compensation.

J. Unauthorized Excavation
1. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi (17.2 MPa), may be used when approved by the Owner.
a. Fill unauthorized excavations under other construction, pipe, or conduit as directed by the Owner.

K. Storage Of Soil Materials
1. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
a. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

L. Backfill
1. Place and compact backfill in excavations promptly, but not before completing the following:
a. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
b. Surveying locations of underground utilities for Record Documents.
c. Testing and inspecting underground utilities.
d. Removing concrete formwork.
e. Removing trash and debris.
f. Removing temporary shoring and bracing, and sheeting.
g. Installing permanent or temporary horizontal bracing on horizontally supported walls.
2. Place backfill on subgrades free of mud, frost, snow, or ice.

M. Utility Trench Backfill
1. Place backfill on subgrades free of mud, frost, snow, or ice.

2. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
3. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches (450 mm) of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 03 Section "Cast-in-place Concrete".
4. Trenches under Roadways: Provide 4-inch- (100-mm-) thick, concrete-base slab support for piping or conduit less than 30 inches (750 mm) below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches (100 mm) of concrete before backfilling or placing roadway subbase course. Concrete is specified in Division 03 Section "Cast-in-place Concrete".
5. Backfill voids with satisfactory soil while removing shoring and bracing.
6. If soil material is required as initial backfill, place and compact initial backfill of subbase material **OR** satisfactory soil, **as directed**, free of particles larger than 1 inch (25 mm) in any dimension, to a height of 12 inches (300 mm) over the pipe or conduit.
   a. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
7. Controlled Low-Strength Material: If controlled low-strength material is permitted or required as initial backfill, place initial backfill of controlled low-strength material to a height of 12 inches (300 mm) over the pipe or conduit. Coordinate backfilling with utilities testing.
8. If satisfactory soil material is required as final backfill, place and compact final backfill of satisfactory soil to final subgrade elevation.
9. Controlled Low-Strength Material: If controlled low-strength material is permitted or required as final backfill, place final backfill of controlled low-strength material to final subgrade elevation.
10. Install warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

N. Soil Fill
1. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
2. Place and compact fill material in layers to required elevations as follows:
   a. Under grass and planted areas, use satisfactory soil material.
   b. Under walks and pavements, use satisfactory soil material.
   c. Under steps and ramps, use engineered fill.
   d. Under building slabs, use engineered fill.
   e. Under footings and foundations, use engineered fill.
3. Place soil fill on subgrades free of mud, frost, snow, or ice.

O. Geofoam Fill
1. Place a leveling course of sand, 2 inches (50 mm) thick, over subgrade. Finish leveling course to a tolerance of 1/2 inch (13 mm) when tested with a 10-foot (3-m) straightedge.
   a. Place leveling course on subgrades free of mud, frost, snow, or ice.
   b. Install geofoam blocks in layers with abutting edges and ends and with the long dimension of each block at right angles to blocks in each subsequent layer. Offset joints of blocks in successive layers.
   c. Install geofoam connectors at each layer of geofoam to resist horizontal displacement according to geofoam manufacturer's written instructions.
2. Cover geofoam with subdrainage **OR** separation, **as directed**, geotextile before placing overlying soil materials.

P. Soil Moisture Control
1. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
   a. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

b. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

Q. Compaction Of Soil Backfills And Fills
1. Place backfill and fill soil materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.
2. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
3. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698 **OR** ASTM D 1557, **as directed**:
   a. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches (300 mm) of existing subgrade and each layer of backfill or fill soil material at 95 percent.
   b. Under walkways, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 92 percent.
   c. Under turf or unpaved areas, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 85 percent.
   d. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

R. Grading
1. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
   a. Provide a smooth transition between adjacent existing grades and new grades.
   b. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
2. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
   a. Turf or Unpaved Areas: Plus or minus 1 inch (25 mm).
   b. Walks: Plus or minus 1 inch (25 mm).
   c. Pavements: Plus or minus 1/2 inch (13 mm).
3. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch (13 mm) when tested with a 10-foot (3-m) straightedge.

S. Subsurface Drainage
1. Subdrainage Pipe: Specified in Division 33 Section "Storm Utility Drainage Piping".
2. Subsurface Drain: If nonwoven geotextile is used in subsurface drainage applications, place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch (150-mm) course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches (300 mm) of filter material, placed in compacted layers 6 inches (150 mm) thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches (150 mm).
   a. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698 **OR** with a minimum of two passes of a plate-type vibratory compactor, **as directed**.
3. Drainage Backfill: If using free-draining granular backfill against walls, place and compact filter material over subsurface drain, in width indicated, to within 12 inches (300 mm) of final subgrade, in compacted layers 6 inches (150 mm) thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches (150 mm).
   a. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698 **OR** with a minimum of two passes of a plate-type vibratory compactor, **as directed**.

b. Place and compact impervious fill over drainage backfill in 6-inch- (150-mm-) thick compacted layers to final subgrade.

T. Subbase And Base Courses Under Pavements And Walks
1. Place subbase course and base course, **as directed**, on subgrades free of mud, frost, snow, or ice.
2. On prepared subgrade, place subbase course and base course, **as directed**, under pavements and walks as follows:
   a. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
   b. Place base course material over subbase course under hot-mix asphalt pavement.
   c. Shape subbase course and base course, **as directed**, to required crown elevations and cross-slope grades.
   d. Place subbase course and base course, **as directed**, 6 inches (150 mm) or less in compacted thickness in a single layer.
   e. Place subbase course and base course, **as directed**, that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
   f. Compact subbase course and base course, **as directed**, at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698 **OR** ASTM D 1557, **as directed**.
3. Pavement Shoulders: Place shoulders along edges of subbase course and base course, **as directed**, to prevent lateral movement. Construct shoulders, at least 12 inches (300 mm) wide, of satisfactory soil materials and compact simultaneously with each subbase and base, **as directed**, layer to not less than 95 percent of maximum dry unit weight according to ASTM D 698 **OR** ASTM D 1557, **as directed**.

U. Drainage Course Under Concrete Slabs-On-Grade
1. Place drainage course on subgrades free of mud, frost, snow, or ice.
2. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
   a. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
   b. Place drainage course 6 inches (150 mm) or less in compacted thickness in a single layer.
   c. Place drainage course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
   d. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

V. Field Quality Control
1. Special Inspections: If special inspections are required by code, engage a qualified special inspector to perform the following special inspections:
   a. Determine prior to placement of fill that site has been prepared in compliance with requirements.
   b. Determine that fill material and maximum lift thickness comply with requirements.
   c. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.
2. Testing Agency: Engage a qualified geotechnical engineering testing agency to perform tests and inspections.
3. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
4. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing

subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by the Owner.

5. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
   a. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. (186 sq. m) or less of paved area or building slab, but in no case fewer than three tests.
   b. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet (30 m) or less of wall length, but no fewer than two tests.
   c. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet (46 m) or less of trench length, but no fewer than two tests.
6. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

W. Protection
1. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
2. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
   a. Scarify or remove and replace soil material to depth as directed by the Owner; reshape and recompact.
3. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
   a. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

X. Disposal Of Surplus And Waste Materials
1. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off the Owner's property.
   OR
   Transport surplus satisfactory soil to designated storage areas on the Owner's property. Stockpile or spread soil as directed by the Owner.
   a. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off the Owner's property.

END OF SECTION 31 01 20 00

SECTION 31 05 13 00 - SUBDRAINAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Perforated-wall pipe and fittings.
2. Drainage conduits.
3. Drainage panels.
4. Geotextile filter fabrics.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Drainage conduits, including rated capacities.
2. Drainage panels, including rated capacities.
3. Geotextile filter fabrics.

PART 2 - PRODUCTS

2.1 PERFORATED-WALL PIPES AND FITTINGS

A. Perforated PE Pipe and Fittings:

1. NPS 6 (DN 150) and Smaller: ASTM F405 or AASHTO M 252, Type CP; corrugated, for coupled joints.
2. NPS 8 (DN 200) and Larger: ASTM F667; AASHTO M 252, Type CP; or AASHTO M 294, Type CP; corrugated; for coupled joints.
3. Couplings: Manufacturer's standard, band type.

B. Perforated PVC Sewer Pipe and Fittings: ASTM D2729, bell-and-spigot ends, for loose joints.

2.2 DRAINAGE CONDUITS

A. Molded-Sheet Drainage Conduits: Prefabricated geocomposite with cuspated, molded-plastic drainage core wrapped in geotextile filter fabric.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Nominal Size:

a. 12 Inches (305 mm) High by Approximately 1 Inch (25 mm) Thick: With minimum in-plane flow of [**30 gpm (114 L/min.)**] <**Insert value**> at hydraulic gradient of [**1.0**] <**Insert value**> when tested in accordance with ASTM D4716.

b. 18 Inches (457 mm) High by Approximately 1 Inch (25 mm) Thick: With minimum in-plane flow of [**45 gpm (170 L/min.)**] <**Insert value**> at hydraulic gradient of [**1.0**] <**Insert value**> when tested in accordance with ASTM D4716.

3. Filter Fabric: PP geotextile.
4. Fittings: HDPE with combination NPS 4 and NPS 6 (DN 100 and DN 150) outlet connection.

B. Multipipe Drainage Conduits: Prefabricated geocomposite with interconnected, corrugated, perforated-pipe core molded from HDPE complying with ASTM D1248 and wrapped in geotextile filter fabric.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Nominal Size:

a. 6 Inches (152 mm) High by Approximately 1-1/4 Inches (31 mm) Thick: With minimum in-plane flow of [**15 gpm (57 L/min.)**] <**Insert value**> at hydraulic gradient of [**1.0**] <**Insert value**> when tested in accordance with ASTM D4716.
b. 12 Inches (305 mm) High by Approximately 1-1/4 Inches (31 mm) Thick: With minimum in-plane flow of [**30 gpm (114 L/min.)**] <**Insert value**> at hydraulic gradient of [**1.0**] <**Insert value**> when tested in accordance with ASTM D4716.
c. 18 Inches (457 mm) High by Approximately 1-1/4 Inches (31 mm) Thick: With minimum in-plane flow of [**45 gpm (170 L/min.)**] <**Insert value**> at hydraulic gradient of [**1.0**] <**Insert value**> when tested in accordance with ASTM D4716.

3. Filter Fabric: Nonwoven, needle-punched geotextile.
4. Fittings: HDPE with combination NPS 4 and NPS 6 (DN 100 and DN 150) outlet connection.
5. Couplings: HDPE.

C. Single-Pipe Drainage Conduits: Prefabricated geocomposite with perforated corrugated core molded from HDPE complying with ASTM D3350 and wrapped in geotextile filter fabric.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Nominal Size:

a. 12 Inches (305 mm) High by Approximately 1 Inch (25 mm) Thick: With minimum in-plane flow of [**30 gpm (114 L/min.)**] <**Insert value**> at hydraulic gradient of [**1.0**] <**Insert value**> when tested in accordance with ASTM D4716.
b. 18 Inches (457 mm) High by Approximately 1 Inch (25 mm) Thick: With minimum in-plane flow of [**45 gpm (170 L/min.)**] <**Insert value**> at hydraulic gradient of [**1.0**] <**Insert value**> when tested in accordance with ASTM D4716.

3. Filter Fabric: PP geotextile.
4. Fittings: HDPE with combination NPS 4 and NPS 6 (DN 100 and DN 150) outlet connection.
5. Couplings: Corrugated HDPE band.

D. Mesh Fabric Drainage Conduits: Prefabricated geocomposite with plastic-filament drainage core wrapped in geotextile filter fabric. Include fittings for bends and connection to drainage piping.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Nominal Size: 6 inches (150 mm) high by approximately 0.9 inch (23 mm) thick.

a. Minimum In-Plane Flow: [**2.4 gpm (9.1 L/min.)**] <**Insert value**> at hydraulic gradient of [**1.0**] <**Insert value**> when tested in accordance with ASTM D4716.

3. Filter Fabric: Nonwoven geotextile made of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested in accordance with ASTM D4491.

E. Ring Fabric Drainage Conduits: Drainage conduit with HDPE rings-in-grid pattern drainage core, for field-applied geotextile filter fabric. Include fittings for bends and connection to drainage piping.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Nominal Size:

    a. 18 Inches (0.5 m) High by 1 Inch (25 mm) Thick: With minimum in-plane flow of [**82 gpm (310 L/min.)**] <**Insert value**> at hydraulic gradient of [**1.0**] <**Insert value**> when tested in accordance with ASTM D4716.
    b. 36 Inches (1 m) High by 1 Inch (25 mm) Thick: With minimum in-plane flow of [**164 gpm (621 L/min.)**] <**Insert value**> at hydraulic gradient of [**1.0**] <**Insert value**> when tested in accordance with ASTM D4716.

3. Filter Fabric: Comply with requirements for flat geotextile filter fabric specified in Part 2 "Geotextile Filter Fabrics" Article.

2.3 DRAINAGE PANELS

A. Molded-Sheet Drainage Panels: Prefabricated geocomposite, [**36 to 60 inches (915 to 1525 mm)**] <**Insert dimensions**> wide with drainage core faced with geotextile filter fabric.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Drainage Core: Three-dimensional, nonbiodegradable, molded PP.

    a. Minimum Compressive Strength: [**10,000 lbf/sq. ft. (479 kPa)**] [**15,000 lbf/sq. ft. (718 kPa)**] [**18,000 lbf/sq. ft. (862 kPa)**] [**21,000 lbf/sq. ft. (1005 kPa)**] <**Insert value**> when tested in accordance with ASTM D1621.
    b. Minimum In-Plane Flow Rate: [**2.8 gpm/ft. (35 L/min. per m)**] [**7 gpm/ft. (87 L/min. per m)**] [**15 gpm/ft. (186 L/min. per m)**] <**Insert value**> of unit width at hydraulic gradient of [**1.0**] <**Insert value**> and compressive stress of [**25 psig (172 kPa)**] <**Insert value**> when tested in accordance with ASTM D4716.

3. Filter Fabric, Nonwoven: Needle-punched geotextile, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with the following properties determined in accordance with AASHTO M 288:

    a. Survivability: [**Class 1**] [**Class 2**] [**Class 3**].
    b. Apparent Opening Size: [**No. 40 (0.425-mm)**] [**No. 60 (0.25-mm)**] [**No. 70 (0.212-mm)**] sieve, maximum.
    c. Permittivity: [**0.5**] [**0.2**] [**0.1**] per second, minimum.

4. Filter Fabric, Woven: Geotextile fabric, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation less than 50 percent; complying with the following properties determined in accordance with AASHTO M 288:

    a. Survivability: [**Class 1**] [**Class 2**] [**Class 3**].
    b. Apparent Opening Size: [**No. 40 (0.425-mm)**] [**No. 60 (0.25-mm)**] [**No. 70 (0.212-mm)**] [**No. 30 (0.6-mm)**] sieve, maximum.
    c. Permittivity: [**0.5**] [**0.2**] [**0.1**] [**0.02**] per second, minimum.

5. Film Backing: Polymeric film bonded to drainage core surface.

B. Mesh Fabric Drainage Panels: Prefabricated geocomposite with drainage core faced with geotextile filter fabric.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Drainage Core: Open-construction, resilient, plastic-filament mesh, approximately 0.4 inches (10.2 mm) thick.

    a. Minimum In-Plane Flow Rate: [**2.4 gpm/ft. (30 L/min. per m)**] <**Insert value**> of unit width at hydraulic gradient of [**1.0**] <**Insert value**> and normal pressure of 25 psig (172 kPa) when tested in accordance with ASTM D4716.

3. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested in accordance with ASTM D4491.

C. Net Fabric Drainage Panels: Prefabricated geocomposite with drainage core faced with geotextile filter fabric.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Drainage Core: Three-dimensional, PE nonwoven-strand geonet, approximately 0.25 inches (6 mm) thick.

    a. Minimum In-Plane Flow Rate: [**2.4 gpm/ft. (30 L/min. per m)**] [**5 gpm/ft. (62 L/min. per m)**] <**Insert value**> of unit width at hydraulic gradient of [**1.0**] <**Insert value**> and normal pressure of 25 psig (172 kPa) when tested in accordance with ASTM D4716.

3. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested in accordance with ASTM D4491.

D. Ring Fabric Drainage Panels: Drainage-core panel for field application of geotextile filter fabric.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Drainage Core: Three-dimensional, HDPE rings-in-grid pattern, approximately 1 inch (25 mm) thick.

    a. Minimum In-Plane Flow Rate: [**40 gpm/ft. (500 L/min. per m)**] <**Insert value**> of unit width at hydraulic gradient of [**1.0**] <**Insert value**> and normal pressure of 25 psig (172 kPa) when tested in accordance with ASTM D4716.

2.4 SOIL MATERIALS

A. Soil materials are specified in Section 312000 "Earth Moving."

2.5 WATERPROOFING FELTS

A. Material: Comply with [**ASTM D226, Type I, asphalt**] [**or**] [**ASTM D227, coal-tar**]-saturated organic felt.

2.6 GEOTEXTILE FILTER FABRICS

A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. (4480 to 13 440 L/min. per sq. m) when tested in accordance with ASTM D4491.

B. Structure Type: Nonwoven, needle-punched continuous filament.

1. Survivability: AASHTO [**M 288 Class 2**] <**Insert class**>.
2. Styles: Flat and sock.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.

B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.

C. Verify that drainage panels installed as part of foundation wall waterproofing is properly positioned to drain into subdrainage system.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.3 FOUNDATION DRAINAGE INSTALLATION

A. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than 6 inches (150 mm) deep and 12 inches (300 mm) wide.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).

D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with [**adhesive**] [**or**] [**tape**].

E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for foundation subdrainage.

F. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.

G. After satisfactory testing, cover drainage piping to width of at least 6 inches (150 mm) on side away from footing and above top of pipe to within 12 inches (300 mm) of finish grade.

H. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.

I. Place layer of [**flat-style geotextile filter fabric**] [**waterproofing felt**] over top of drainage course, overlapping edges at least 4 inches (100 mm).

J. Install drainage panels on foundation walls as follows:

1. Coordinate placement with other drainage materials.
2. Lay perforated drainage pipe at base of footing. Install as indicated in Part 3 "Piping Installation" Article.
3. Separate 4 inches (100 mm) of fabric at beginning of roll and cut away 4 inches (100 mm) of core. Wrap fabric around end of remaining core.
4. Attach panels to wall beginning at subdrainage pipe. Place and secure molded-sheet drainage panels, with geotextile facing away from wall.

K. Place backfill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Final backfill to finish elevations and slope away from building.

3.4 UNDERSLAB DRAINAGE INSTALLATION

A. Excavate for underslab drainage system after subgrade material has been compacted but before drainage course has been placed. Include horizontal distance of at least 6 inches (150 mm) between drainage pipe and trench walls. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).

D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with [**adhesive**] [**or**] [**tape**].

E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for underslab subdrainage.

F. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.

G. After satisfactory testing, cover drainage piping with drainage course to elevation of bottom of slab, and compact and wrap top of drainage course with flat-style geotextile filter fabric.

H. Install horizontal drainage panels as follows:

1. Coordinate placement with other drainage materials.
2. Lay perforated drainage pipe at inside edge of footing.
3. Place drainage panel over drainage pipe with core side up. Peel back fabric and wrap fabric around pipe. Locate top of core at bottom elevation of floor slab.
4. Butt additional panels against other installed panels. If panels have plastic flanges, overlap installed panel with flange.

3.5 RETAINING-WALL DRAINAGE INSTALLATION

A. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

B. Place supporting layer of drainage course over compacted subgrade to compacted depth of not less than 4 inches (100 mm).

C. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with [**adhesive**] [**or**] [**tape**].

D. Install drainage piping as indicated in Part 3 "Piping Installation" Article for retaining-wall subdrainage.

E. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.

F. After satisfactory testing, cover drainage piping to width of at least 6 inches (150 mm) on side away from footing and above top of pipe to within 12 inches (300 mm) of finish grade.

G. Place drainage course in layers not exceeding 3 inches (75 mm) in loose depth; compact each layer placed and wrap top of drainage course with flat-style geotextile filter fabric.

H. Place layer of [**flat-style geotextile filter fabric**] [**waterproofing felt**] over top of drainage course, overlapping edges at least 4 inches (100 mm).

I. Install drainage panels on wall as follows:

1. Coordinate placement with other drainage materials.
2. Lay perforated drainage pipe at base of footing as described elsewhere in this Specification. Do not install aggregate.
3. If weep holes are used instead of drainage pipe, cut 1/2-inch- (13-mm-) diameter holes on core side at weep-hole locations. Do not cut fabric.
4. Mark horizontal calk line on wall at a point 6 inches (150 mm) less than panel width above footing bottom. Before marking wall, subtract footing width.
5. Separate 4 inches (100 mm) of fabric at beginning of roll and cut away 4 inches (100 mm) of core. Wrap fabric around end of remaining core.
6. Attach panel to wall at horizontal mark and at beginning of wall corner. Place core side of panel against wall. Use concrete nails with washers through product. Place nails from 2 to 6 inches (50 to 150 mm) below top of panel, approximately 48 inches (1200 mm) apart.[**Construction adhesives, metal stick pins, or double-sided tape may be used instead of nails.**] Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.
7. If another panel is required on same row, cut away 4 inches (100 mm) of installed panel core and wrap fabric over new panel.
8. If additional rows of panel are required, overlap lower panel with 4 inches (100 mm) of fabric.
9. Cut panel as necessary to keep top 12 inches (300 mm) below finish grade.
10. For inside corners, bend panel. For outside corners, cut core to provide 3 inches (75 mm) for overlap.

J. Fill to Grade: Place satisfactory soil fill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Fill to finish grade.

3.6 LANDSCAPING DRAINAGE INSTALLATION

A. Provide trench width to allow installation of drainage conduit. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).

D. Install drainage conduits as indicated in Part 3 "Piping Installation" Article for landscaping subdrainage with horizontal distance of at least 6 inches (150 mm) between conduit and trench walls. Wrap drainage conduits without integral geotextile filter fabric with flat-style geotextile filter fabric before installation. Connect fabric sections with [**adhesive**] [**or**] [**tape**].

E. Add drainage course to top of drainage conduits.

F. After satisfactory testing, cover drainage conduit to within 12 inches (300 mm) of finish grade.

G. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.

H. Place layer of [**flat-style geotextile filter fabric**] [**waterproofing felt**] over top of drainage course, overlapping edges at least 4 inches (100 mm).

I. Fill to Grade: Place satisfactory soil fill material over drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Fill to finish grade.

3.7 PIPING INSTALLATION

A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's written instructions and other requirements indicated.

1. Foundation Subdrainage: Install piping level and with a minimum cover of [**36 inches (915 mm)**] <**Insert dimension**> unless otherwise indicated.
2. Underslab Subdrainage: Install piping level.
3. Plaza Deck Subdrainage: Install piping level.
4. Retaining-Wall Subdrainage: When water discharges at end of wall into stormwater piping system, install piping level and with a minimum cover of [**36 inches (915 mm)**] <**Insert dimension**> unless otherwise indicated.
5. Landscaping Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of [**0.5**] <**Insert value**> percent and with a minimum cover of [**36 inches (915 mm)**] <**Insert dimension**> unless otherwise indicated.
6. Lay perforated pipe with perforations down.
7. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.

B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.

C. Install thermoplastic piping in accordance with ASTM D2321.

3.8 PIPE JOINT CONSTRUCTION

A. Join perforated PE pipe and fittings with couplings in accordance with ASTM D3212 with loose banded, coupled, or push-on joints.

B. Join perforated PVC sewer pipe and fittings in accordance with ASTM D3212 with loose bell-and-spigot, push-on joints.

C. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.9 BACKWATER VALVE INSTALLATION

A. Comply with requirements for backwater valves specified in Section 334100 "Storm Utility Drainage Piping."

B. Install horizontal backwater valves in header piping downstream from perforated subdrainage piping.

C. Install horizontal backwater valves in piping[**in manholes or pits**] where indicated.

3.10 CLEANOUT INSTALLATION

A. Comply with requirements for cleanouts specified in Section 334100 "Storm Utility Drainage Piping."

B. Cleanouts for [**Foundation**] [**Retaining-Wall**] [**and**] [**Landscaping**] Subdrainage:

1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
2. In vehicular-traffic areas, use NPS 4 (DN 100) cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, [**18 by 18 by 12 inches (450 by 450 by 300 mm)**] <**Insert dimensions**> deep. Set top of cleanout flush with grade.
3. In nonvehicular-traffic areas, use NPS 4 (DN 100) [**cast-iron**] [**PVC**] pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, [**12 by 12 by 4 inches (300 by 300 by 100 mm)**] <**Insert dimensions**> deep. Set top of cleanout [**1 inch (25 mm)**] [**2 inches (50 mm)**] <**Insert dimension**> above grade.
4. Comply with requirements for concrete specified in Section 033000 "Cast-in-Place Concrete."

C. Cleanouts for Underslab Subdrainage:

1. Install cleanouts and riser extensions from piping to top of slab. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
2. Use NPS 4 (DN 100) cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout flush with top of slab.

3.11 CONNECTIONS

A. Comply with requirements for piping specified in Section 334100 "Storm Utility Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect low elevations of subdrainage system to[**building's**] solid-wall-piping storm drainage system.

C. Where required, connect low elevations of [**foundation**] [**underslab**] subdrainage to stormwater sump pumps. Comply with requirements for sump pumps specified in Section 221429 "Sump Pumps."

3.12 IDENTIFICATION

A. Arrange for installation of green warning tapes directly over piping. Comply with requirements for underground warning tapes specified in specified in Section 312000 "Earth Moving."

1. Install PE warning tape or detectable warning tape over ferrous piping.
2. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.13 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling.
2. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

B. Drain piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.14 CLEANING

A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION 31 05 13 00

Task	Specification	Specification Description
31 05 13 00	31 01 20 00	Earthwork
31 05 16 00	31 01 20 00	Earthwork
31 05 16 00	31 05 13 00	Subdrainage

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SECTION 31 11 00 00 - SITE CLEARING

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for site clearing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Protecting existing vegetation to remain.
   b. Removing existing vegetation.
   c. Clearing and grubbing.
   d. Stripping and stockpiling topsoil.
   e. Removing above- and below-grade site improvements.
   f. Disconnecting, capping or sealing, and removing site utilities **OR** abandoning site utilities in place, **as directed**.
   g. Temporary erosion- and sedimentation-control measures.

C. Definitions

1. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
   OR
   Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.
2. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow.
   OR
   Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches (50 mm) in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.
3. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.
   OR
   Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and indicated on Drawings **OR** defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated, **as directed**.
4. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

D. Material Ownership

1. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain the Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

E. Submittals

1. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
   a. Use sufficiently detailed photographs or videotape.

b. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

2. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

F. Quality Assurance

1. Preinstallation Conference: Conduct conference at Project site.

G. Project Conditions

1. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
   a. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the Owner and authorities having jurisdiction.
   b. Provide alternate routes around closed or obstructed traffic ways if required by the Owner or authorities having jurisdiction.
2. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining the Owner's property will be obtained by the Owner before award of Contract.
   a. Do not proceed with work on adjoining property until directed by the Owner.
3. Salvable Improvements: Carefully remove items indicated to be salvaged and store on the Owner's premises where indicated.
4. Utility Locator Service: Notify utility locator service **OR** Miss Utility **OR** Call Before You Dig **OR** Dig Safe System **OR** One Call, **as directed**, for area where Project is located before site clearing.
5. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.
6. The following practices are prohibited within protection zones:
   a. Storage of construction materials, debris, or excavated material.
   b. Parking vehicles or equipment.
   c. Foot traffic.
   d. Erection of sheds or structures.
   e. Impoundment of water.
   f. Excavation or other digging unless otherwise indicated.
   g. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
7. Do not direct vehicle or equipment exhaust towards protection zones.
8. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.
9. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

1.2 PRODUCTS

A. Materials

1. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 31 Section "Earth Moving".
   a. If soil backfill is required in below-grade areas after site clearing, obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.
2. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with MPI #79, Alkyd Anticorrosive Metal Primer **OR** SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating, **as directed**.
   a. Use coating with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1.3 EXECUTION

A. Preparation

1. Protect and maintain benchmarks and survey control points from disturbance during construction.
2. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated. Flag **OR** Wrap a 1-inch (25-mm) blue vinyl tie tape flag around, **as directed**, each tree trunk at 54 inches (1372 mm) above the ground.
3. Protect existing site improvements to remain from damage during construction.
   a. Restore damaged improvements to their original condition, as acceptable to the Owner.

B. Temporary Erosion And Sedimentation Control
1. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.
2. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
3. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
4. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

C. Tree And Plant Protection
1. General: Protect trees and plants remaining on-site according to requirements in Division 01 Section "Temporary Tree And Plant Protection".
2. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by the Owner.

D. Existing Utilities
1. the Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.
   OR
   Verify that utilities have been disconnected and capped before proceeding with site clearing.
2. Locate, identify, disconnect, and seal or cap utilities indicated to be removed.
   a. Arrange with utility companies to shut off indicated utilities.
      OR
      the Owner will arrange to shut off indicated utilities when requested by Contractor.
3. Locate, identify, and disconnect utilities indicated to be abandoned in place.
4. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   a. Notify the Owner not less than two days in advance of proposed utility interruptions.
   b. Do not proceed with utility interruptions without the Owner 's written permission.
5. Excavate for and remove underground utilities indicated to be removed.
   OR
   Removal of underground utilities is included in Division 21 OR Division 22 OR Division 23 OR Division 26 OR Division 28.

E. Clearing And Grubbing
1. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
   a. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
   b. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches (450 mm) below exposed subgrade.
   c. Use only hand methods for grubbing within protection zones.
   d. Chip removed tree branches and stockpile in areas approved by the Owner **OR** dispose of off-site, **as directed**.
2. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

a. Place fill material in horizontal layers not exceeding a loose depth of 8 inches (200 mm), and compact each layer to a density equal to adjacent original ground.

F. Topsoil Stripping
1. Remove sod and grass before stripping topsoil.
2. Strip topsoil to depth indicated on Drawings **OR** to depth of 6 inches (150 mm), **as directed**, in a manner to prevent intermingling with underlying subsoil or other waste materials.
   a. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches (50 mm) in diameter; trash, debris, weeds, roots, and other waste materials.
3. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
   a. Limit height of topsoil stockpiles to 72 inches (1800 mm).
   b. Do not stockpile topsoil within protection zones.
   c. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
   d. Stockpile surplus topsoil to allow for respreading deeper topsoil.

G. Site Improvements
1. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.
2. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
   a. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
   b. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

H. Disposal Of Surplus And Waste Materials
1. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off the Owner's property.
2. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 31 11 00 00

SECTION 31 13 13 00 - TREE PROTECTION AND TRIMMING

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for tree protection and trimming. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section includes general protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction.

C. Definitions

1. Caliper: Diameter of a trunk measured by a diameter tape or the average of the smallest and largest diameters at 6 inches (150 mm) above the ground for trees up to, and including, 4-inch (100-mm) size; and 12 inches (300 mm) above the ground for trees larger than 4-inch (100-mm) size.
2. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.
3. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and indicated on Drawings **OR** defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated, **as directed**.
4. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

D. Submittals

1. Product Data: For each type of product indicated.
2. Tree Pruning Schedule: Written schedule detailing scope and extent of pruning of trees to remain that interfere with or are affected by construction.
3. Qualification Data: For qualified arborist and tree service firm.
4. Certification: From arborist, certifying that trees indicated to remain have been protected during construction according to recognized standards and that trees were promptly and properly treated and repaired when damaged.
5. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.
6. Existing Conditions: Documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.
   a. Use sufficiently detailed photographs or videotape.
   b. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

E. Quality Assurance

1. Arborist Qualifications: Certified Arborist as certified by ISA **OR** Certified Arborist-Municipal Specialist as certified by ISA **OR** Licensed arborist in jurisdiction where Project is located **OR** Current member of ASCA **OR** Registered Consulting Arborist as designated by ASCA, **as directed**.
2. Tree Service Firm Qualifications: An experienced tree service firm that has successfully completed temporary tree and plant protection work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.
3. Preinstallation Conference: Conduct conference at Project site.

F. Project Conditions

1. The following practices are prohibited within protection zones:
   a. Storage of construction materials, debris, or excavated material.
   b. Parking vehicles or equipment.
   c. Foot traffic.
   d. Erection of sheds or structures.
   e. Impoundment of water.
   f. Excavation or other digging unless otherwise indicated.
   g. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
2. Do not direct vehicle or equipment exhaust toward protection zones.
3. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.

1.2 PRODUCTS

A. Materials
1. Topsoil: Natural or cultivated top layer of the soil profile or manufactured topsoil; containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 1 inch (25 mm) in diameter; and free of weeds, roots, and toxic and other nonsoil materials.
   a. Obtain topsoil only from well-drained sites where topsoil is 4 inches (100 mm) deep or more; do not obtain from bogs or marshes.

   OR

   Topsoil: Stockpiled topsoil from location shown on Drawings **OR** Imported or manufactured topsoil complying with ASTM D 5268, **as directed**.
2. Organic Mulch: Free from deleterious materials and suitable as a top dressing for trees and shrubs, consisting of one of the following:
   a. Type: Shredded hardwood **OR** Ground or shredded bark **OR** Wood and bark chips, **as directed**.
   b. Size Range: 3 inches (76 mm) maximum, 1/2 inch (13 mm) minimum.
3. Protection-Zone Fencing: Fencing fixed in position and meeting one of the following requirements, **as directed**. Previously used materials may be used when approved by the Owner.
   a. Chain-Link Protection-Zone Fencing: Galvanized-steel **OR** Polymer-coated steel **OR** Polymer-coated galvanized-steel, **as directed**, fencing fabricated from minimum 2-inch (50-mm) opening, 0.148-inch- (3.76-mm-) diameter wire chain-link fabric; with pipe posts, minimum 2-3/8-inch- (60-mm-) OD line posts, and 2-7/8-inch- (73-mm-) OD corner and pull posts; with 1-5/8-inch- (42-mm-) OD top rails **OR** with 0.177-inch- (4.5-mm-) diameter top tension wire, **as directed**, and 0.177-inch- (4.5-mm-) diameter bottom tension wire; with tie wires, hog ring ties, and other accessories for a complete fence system.
      1) Height: 4 feet (1.2 m) **OR** 6 feet (1.8 m) **OR** 8 feet (2.4 m), **as directed**.
      2) Polymer-Coating Color (if polymer coating is required): Dark green **OR** Olive green **OR** Brown **OR** Black, **as directed**.
   b. Plywood Protection-Zone Fencing: Plywood framed with four 2-by-4-inch (50-by-100-mm) rails, with 4-by-4-inch (100-by-100-mm) preservative-treated wood posts spaced not more than 8 feet (2.4 m) apart.
      1) Height: 4 feet (1.2 m) **OR** 6 feet (1.8 m), **as directed**.
      2) Plywood and Lumber: Comply with requirements in Division 06 Section "Rough Carpentry" **OR** Division 06 Section "Miscellaneous Rough Carpentry", **as directed**.
   c. Wood Protection-Zone Fencing: Constructed of two 2-by-4-inch (50-by-100-mm) horizontal rails, with 4-by-4-inch (100-by-100-mm) preservative-treated wood posts spaced not more than 8 feet (2.4 m) apart, and lower rail set halfway between top rail and ground.
      1) Height: 4 feet (1.2 m).

2) Lumber: Comply with requirements in Division 06 Section "Rough Carpentry" **OR** Division 06 Section "Miscellaneous Rough Carpentry", **as directed**.

d. Plastic Protection-Zone Fencing: Plastic construction fencing constructed of high-density extruded and stretched polyethylene fabric with 2-inch (50-mm) maximum opening in pattern and weighing a minimum of 0.4 lb/ft. (0.6 kg/m); remaining flexible from minus 60 to plus 200 deg F (minus 16 to plus 93 deg C); inert to most chemicals and acids; minimum tensile yield strength of 2000 psi (13.8 MPa) and ultimate tensile strength of 2680 psi (18.5 MPa); secured with plastic bands or galvanized-steel or stainless-steel wire ties; and supported by tubular or T-shape galvanized-steel posts spaced not more than 8 feet (2.4 m) apart.

1) Height: 4 feet (1.2 m).

2) Color: High-visibility orange, nonfading.

e. Gates: Single **OR** Double, **as directed**, swing access gates matching material and appearance of fencing, to allow for maintenance activities within protection zones; leaf width 24 inches (610 mm) **OR** 36 inches (914 mm) **OR** As indicated, **as directed**.

4. Protection-Zone Signage: Shop-fabricated, rigid plastic or metal sheet with attachment holes prepunched and reinforced; legibly printed with nonfading lettering and as follows:

a. Size and Text: As shown on Drawings.

b. Lettering: 3-inch- (75-mm-) high minimum, white **OR** black, **as directed**, characters on white **OR** red, **as directed**, background.

1.3 EXECUTION

A. Examination

1. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

2. For the record, prepare written report, endorsed by arborist, listing conditions detrimental to tree and plant protection.

B. Preparation

1. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated. Flag **OR** Tie a 1-inch (25-mm) blue-vinyl tape around, **as directed**, each tree trunk at 54 inches (1372 mm) above the ground.

2. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.

3. Tree-Protection Zones: Mulch areas inside tree-protection zones and other areas indicated.

a. Apply 4-inch (100-mm) **OR** 6-inch (150-mm), **as directed**, average thickness of organic mulch. Do not place mulch within 6 inches (150 mm) of tree trunks.

C. Tree- And Plant-Protection Zones

1. Protection-Zone Fencing: Install protection-zone fencing along edges of protection zones before materials or equipment are brought on the site and construction operations begin in a manner that will prevent people and animals from easily entering protected area except by entrance gates. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation.

a. Chain-Link Fencing: Install to comply with ASTM F 567 and with manufacturer's written instructions.

b. Posts: Set or drive posts into ground one-third the total height of the fence without concrete footings. Where a post is located on existing paving or concrete to remain, provide appropriate means of post support acceptable to the Owner.

c. Access Gates: Install where indicated; adjust to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

2. Protection-Zone Signage: Install protection-zone signage in visibly prominent locations in a manner approved by the Owner. Install one sign spaced approximately every 20 feet (6 m) **OR** 35 feet (10.5 m) **OR** 50 feet (15 m), **as directed**, on protection-zone fencing, but no fewer than four signs with each facing a different direction.
3. Maintain protection zones free of weeds and trash.
4. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by the Owner.
5. Maintain protection-zone fencing and signage in good condition as acceptable to the Owner and remove when construction operations are complete and equipment has been removed from the site.
   a. Do not remove protection-zone fencing, even temporarily, to allow deliveries or equipment access through the protection zone.
   b. Temporary access is permitted subject to preapproval in writing by arborist if a root buffer effective against soil compaction is constructed as directed by arborist. Maintain root buffer so long as access is permitted.

D. Excavation
1. General: Excavate at edge of protection zones and for trenches indicated within protection zones according to requirements in Division 31 Section "Earth Moving".
2. Trenching near Trees: Where utility trenches are required within protection zones, hand excavate under or around tree roots or tunnel under the roots by drilling, auger boring, or pipe jacking. Do not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots as required for root pruning.
3. Redirect roots in backfill areas where possible. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking. If encountered immediately adjacent to location of new construction and redirection is not practical, cut roots approximately 3 inches (75 mm) back from new construction and as required for root pruning.
4. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

E. Root Pruning
1. Prune roots that are affected by temporary and permanent construction. Prune roots as follows:
   a. Cut roots manually by digging a trench and cutting exposed roots with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
   b. Cut Ends: Do not paint cut root ends **OR** Coat cut ends of roots more than 1-1/2 inches (38 mm) in diameter with an emulsified asphalt or other coating formulated for use on damaged plant tissues and that is acceptable to arborist, **as directed**.
   c. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
   d. Cover exposed roots with burlap and water regularly.
   e. Backfill as soon as possible according to requirements in Division 31 Section "Earth Moving".
2. Root Pruning at Edge of Protection Zone: Prune roots 12 inches (300 mm) outside **OR** 12 inches (300 mm) inside **OR** 6 inches (150 mm) outside **OR** 6 inches (150 mm) inside **OR** flush with the edge, **as directed**, of the protection zone, by cleanly cutting all roots to the depth of the required excavation.
3. Root Pruning within Protection Zone: Clear and excavate by hand to the depth of the required excavation to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

F. Crown Pruning
1. Prune branches that are affected by temporary and permanent construction. Prune branches as follows:
   a. Prune trees to remain to compensate for root loss caused by damaging or cutting root system. Provide subsequent maintenance during Contract period as recommended by arborist.
   b. Pruning Standards: Prune trees according to ANSI A300 (Part 1) and the following:
      1) Type of Pruning: Cleaning **OR** Thinning **OR** Raising **OR** Reduction, **as directed**.
      2) Specialty Pruning: Restoration **OR** Vista **OR** Palm **OR** Utility, **as directed**.
   c. Cut branches with sharp pruning instruments; do not break or chop.
   d. Do not apply pruning paint to wounds.
2. Chip removed branches and spread over areas identified by the Owner **OR** stockpile in areas approved by the Owner **OR** dispose of off-site, **as directed**.

G. Regrading
1. Lowering Grade: Where new finish grade is indicated below existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.
   OR
   Lowering Grade within Protection Zone: Where new finish grade is indicated below existing grade around trees, slope grade away from trees as recommended by arborist unless otherwise indicated.
   a. Root Pruning: Prune tree roots exposed by lowering the grade. Do not cut main lateral roots or taproots; cut only smaller roots. Cut roots as required for root pruning.
2. Raising Grade: Where new finish grade is indicated above existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.
   OR
   Minor Fill within Protection Zone: Where existing grade is 2 inches (50 mm) or less below elevation of finish grade, fill with topsoil. Place topsoil in a single uncompacted layer and hand grade to required finish elevations.

H. Field Quality Control
1. Inspections: Engage a qualified arborist to direct plant-protection measures in the vicinity of trees, shrubs, and other vegetation indicated to remain and to prepare inspection reports.

I. Repair And Replacement
1. General: Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by the Owner.
   a. Submit details of proposed root cutting and tree and shrub repairs.
   b. Have arborist perform the root cutting, branch pruning, and damage repair of trees and shrubs.
   c. Treat damaged trunks, limbs, and roots according to arborist's written instructions.
   d. Perform repairs within 24 hours.
   e. Replace vegetation that cannot be repaired and restored to full-growth status, as determined by the Owner.
2. Trees: Remove and replace trees indicated to remain that are more than 25 **OR** 66, **as directed**, percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that the Owner determines are incapable of restoring to normal growth pattern.
   a. Provide new trees of same size and species as those being replaced for each tree that measures 6 inches (150 mm) **OR** 4 inches (100 mm), **as directed**, or smaller in caliper size.
      OR
      Provide one **OR** two, **as directed**, new tree(s) of 6-inch (150-mm) **OR** 4-inch (100-mm), **as directed**, caliper size for each tree being replaced that measures more than 6 inches (150 mm) **OR** 4 inches (100 mm), **as directed**, in caliper size.
      1) Species: Species selected by the Owner.

b. Plant and maintain new trees as specified in Division 32 Section "Plants".

3. Soil Aeration: Where directed by the Owner, aerate surface soil compacted during construction. Aerate 10 feet (3 m) beyond drip line and no closer than 36 inches (900 mm) to tree trunk. Drill 2-inch- (50-mm-) diameter holes a minimum of 12 inches (300 mm) deep at 24 inches (600 mm) o.c. Backfill holes with an equal mix of augered soil and sand.

J. Disposal Of Surplus And Waste Materials

1. Disposal: Remove excess excavated material, displaced trees, trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 13 13 00

Task	Specification	Specification Description
31 13 13 00	31 11 00 00	Site Clearing
31 13 16 00	31 11 00 00	Site Clearing
31 13 16 00	31 13 13 00	Tree Protection And Trimming

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SECTION 31 23 16 13 - EXCAVATION SUPPORT AND PROTECTION

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for excavation support and protection. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Performance Requirements
   1. Design, **as directed**, furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.
      a. Delegated Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
      b. Prevent surface water from entering excavations by grading, dikes, or other means.
      c. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
      d. Monitor vibrations, settlements, and movements.

C. Submittals
   1. Shop Drawings: For excavation support and protection system.
   2. Delegated-Design Submittal: For excavation support and protection system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Quality Assurance
   1. Preinstallation Conference: Conduct conference at Project site.

E. Project Conditions
   1. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
      a. Notify the Owner no fewer than two days in advance of proposed interruption of utility.
      b. Do not proceed with interruption of utility without the Owner's written permission.
   2. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
      a. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify the Owner if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

1.2 PRODUCTS

A. Materials
   1. General: Provide materials that are either new or in serviceable condition.
   2. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.
   3. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.

a. Corners: Site-fabricated mechanical interlock **OR** Roll-formed corner shape with continuous interlock, **as directed**.

4. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of size and strength required for application, **OR** 3 inches (75 mm) **OR** 4 inches (100 mm), **as directed**.
5. Shotcrete: Comply with Division 03 Section "Shotcrete" for shotcrete materials and mixes, reinforcement, and shotcrete application.
6. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.
7. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
8. Tiebacks: Steel bars, ASTM A 722/A 722M.
9. Tiebacks: Steel strand, ASTM A 416/A 416M.

1.3 EXECUTION

A. Preparation

1. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.
   a. Shore, support, and protect utilities encountered.
2. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
   a. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
3. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces are not impeded.
4. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.
5. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

B. Soldier Piles And Lagging

1. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment.
2. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.
3. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

C. Sheet Piling

1. Before starting excavation, install one-piece sheet piling lengths and tightly interlock to form a continuous barrier. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches (1500 mm). Accurately align exposed faces of sheet piling to vary not more than 2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment. Cut tops of sheet piling to uniform elevation at top of excavation.

D. Tiebacks

1. Tiebacks: Drill, install, grout, and tension tiebacks. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.
   a. Test loading shall be observed by a qualified professional engineer responsible for design of excavation support and protection system.

b. Maintain tiebacks in place until permanent construction is able to withstand lateral soil and hydrostatic pressures.

E. Bracing
1. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.
a. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by the Owner.
b. Install internal bracing, if required, to prevent spreading or distortion of braced frames.
c. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

F. Removal And Repairs
1. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.
a. Remove excavation support and protection systems to a minimum depth of 48 inches (1200 mm) below overlaying construction and abandon remainder.
b. Fill voids immediately with approved backfill compacted to density specified in Division 31 Section "Earth Moving".
c. Repair or replace, as approved by the Owner, adjacent work damaged or displaced by removing excavation support and protection systems.
2. Leave excavation support and protection systems permanently in place.

END OF SECTION 31 23 16 13

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Task	Specification	Specification Description
31 23 16 13	31 01 20 00	Earthwork

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SECTION 31 23 16 16 - CHAIN-LINK FENCES AND GATES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for chain-link fences and gates. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Chain-link fences.
   b. Gates: Manually and Motor operated, horizontal slide and swing.

C. Performance Requirements
1. Delegated Design: Design chain-link fences and gates, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Structural Performance: Chain-link fence and gate framework shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to ASCE/SEI 7:
   a. Minimum Post Size and Maximum Spacing: Determine according to CLFMI WLG 2445, based on mesh size and pattern specified and on the following:
      1) Wind Loads: <**Insert loads required for Project location**>.
      2) Exposure Category: B **OR** C **OR** D, **as directed**.
      3) Fence Height: 10 feet (3 m).
      4) Material Group: IA, ASTM F 1043, Schedule 40 steel pipe **OR** IC, electric-resistance-welded round steel pipe, **as directed**.
3. Lightning Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

D. Submittals
1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chain-link fences and gates.
   a. Fence and gate posts, rails, and fittings.
   b. Chain-link fabric, reinforcements, and attachments.
   c. Accessories: Privacy slats **OR** Barbed wire **OR** Barbed tape, **as directed**.
   d. Gates and hardware.
   e. Gate operators, including operating instructions.
   f. Motors: Show nameplate data, ratings, characteristics, and mounting arrangements.
2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show accessories, hardware, gate operation, and operational clearances.
   a. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
   b. Wiring Diagrams: For power, signal, and control wiring.
3. Samples: Prepared on Samples of size indicated below:
   a. Polymer-Coated Components: In 6-inch (150-mm) lengths for components and on full-sized units for accessories.
4. Delegated-Design Submittal: For chain-link fences and gate framework indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

5. Qualification Data: For qualified professional engineer **OR** testing agency **OR** factory-authorized service representative, **as directed**.
6. Product Certificates: For each type of chain-link fence, operator, and gate, from manufacturer.
7. Product Test Reports: For framing strength according to ASTM F 1043.
8. Field quality-control reports.
9. Operation and Maintenance Data: For the following to include in emergency, operation, and maintenance manuals:
   a. Polymer finishes.
   b. Gate hardware.
   c. Gate operator.
10. Warranty: Sample of special warranty.

E. Quality Assurance
1. Testing Agency Qualifications: For testing fence grounding. Member company of NETA or an NRTL.
   a. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for gates with automatic gate operators serving as a required means of access.
4. Preinstallation Conference: Conduct conference at Project site.

F. Project Conditions
1. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer **OR** Installer, **as directed**, agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Faulty operation of gate operators and controls.
      2) Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   b. Warranty Period: Five **OR** 15, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Chain-Link Fence Fabric
1. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist. Comply with CLFMI Product Manual and with requirements indicated below:
   a. Fabric Height: As indicated on Drawings **OR** As directed.
   b. Steel Wire Fabric: Wire with a diameter of 0.192 inch (4.88 mm) **OR** 0.148 inch (3.76 mm) **OR** 0.120 inch (3.05 mm) **OR** 0.113 inch (2.87 mm), **as directed**.
      1) Mesh Size: 2-1/8 inches (54 mm) **OR** 2 inches (50 mm) **OR** 1-3/4 inches (44 mm) **OR** 1 inch (25 mm), **as directed**.
      2) Aluminum-Coated Fabric: ASTM A 491, Type **I**, 0.40 oz./sq. ft. (122 g/sq. m) **OR** 0.35 oz./sq. ft. (107 g/sq. m) **OR** 0.30 oz./sq. ft. (92 g/sq. m), **as directed**.
      3) Zinc-Coated Fabric: ASTM A 392, Type **II**, Class 1, 1.2 oz./sq. ft. (366 g/sq. m) **OR** Class 2, 2.0 oz./sq. ft. (610 g/sq. m), **as directed**, with zinc coating applied before **OR** after, **as directed**, weaving.

4) Zn-5-Al-MM Aluminum-Mischmetal-Coated Fabric: ASTM F 1345, Type III, Class 1, 0.60 oz./sq. ft. (183 g/sq. m) **OR** Class 2, 1.0 oz./sq. ft. (305 g/sq. m), **as directed**.
5) Polymer-Coated Fabric: ASTM F 668, Class 1 **OR** Class 2a **OR** Class 2b, **as directed**, over aluminum **OR** zinc **OR** Zn-5-Al-MM-alloy, **as directed**,-coated steel wire.
   a) Color: Dark green **OR** Olive green **OR** Brown **OR** Black **OR** As selected from manufacturer's full range, **as directed**, complying with ASTM F 934.
6) Coat selvage ends of fabric that is metallic coated before the weaving process with manufacturer's standard clear protective coating.

c. Aluminum Wire Fabric: ASTM F 1183, with mill **OR** caustic-cleaned or etched, **as directed**, finish, and wire diameter of 0.148 inch (3.76 mm) **OR** 0.192 inch (4.88 mm), **as directed**.
   1) Mesh Size: 2 inches (50 mm) **OR** 1 inch (25 mm), **as directed**.

d. Selvage: Knuckled at both selvages **OR** Twisted top and knuckled bottom, **as directed**.

B. Fence Framing

1. Posts and Rails: Comply with ASTM F 1043 for framing, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 or ASTM F 1083, **as directed**, based on the following:
   a. Fence Height: 72 inches (1830 mm) **OR** 96 inches (2440 mm) **OR** As indicated on Drawings, **as directed**.
   b. Light Industrial Strength: Material Group IC-L, round steel pipe, electric-resistance-welded pipe **OR** Group II-L, roll-formed steel C-section shapes **OR** Group III-L, hot-rolled H-beam shapes **OR** Group IV, Alternative Design, **as directed**.
      1) Line Post: 1.9 inches (48 mm) in diameter **OR** 2.375 inches (60 mm) in diameter **OR** 2.875 inches (73 mm) in diameter **OR** 2.25 by 1.7 inches (57 by 43 mm), **as directed**.
      2) End, Corner and Pull Post: 2.375 inches (60 mm) **OR** 2.875 inches (73 mm) **OR** 4.0 inches (102 mm) **OR** 2.25 by 1.7 inches (57 by 43 mm), **as directed**.
   c. Heavy Industrial Strength: Material Group IA, round steel pipe, Schedule 40 **OR** Group IC, round steel pipe, electric-resistance-welded pipe **OR** Group II, roll-formed steel C-section shapes **OR** Group III, hot-rolled H-beam shapes **OR** Group IV, Alternative Design, **as directed**.
      1) Line Post: 1.9 inches (48 mm) in diameter **OR** 2.375 inches (60 mm) in diameter **OR** 2.875 inches (73 mm) in diameter **OR** 4.0 inches (102 mm) in diameter **OR** 6.625 inches (168 mm) in diameter **OR** 1.875 by 1.63 inches (48 by 41 mm) **OR** 2.25 by 1.70 inches (67 by 43 mm) **OR** 3.25 by 2.50 inches (83 by 64 mm), **as directed**.
      2) End, Corner and Pull Post: 2.375 inches (60 mm) in diameter **OR** 2.875 inches (73 mm) in diameter **OR** 4.0 inches (102 mm) in diameter **OR** 6.625 inches (168 mm) in diameter **OR** 2.25 by 1.70 inches (67 by 43 mm) **OR** 3.25 by 2.50 inches (83 by 64 mm) **OR** 3.5 by 1.5 inches (89 by 38 mm), **as directed**.
   d. Horizontal Framework Members: Intermediate, top and bottom rails, **as directed**, complying with ASTM F 1043.
      1) Top Rail: 1.66 inches (42 mm) in diameter **OR** 1.25 by 1.63 inches (32 by 41 mm), **as directed**.
   e. Brace Rails: Comply with ASTM F 1043.
   f. Metallic Coating for Steel Framing:
      1) Type A, consisting of not less than minimum 2.0-oz./sq. ft. (0.61-kg/sq. m) average zinc coating per ASTM A 123/A 123M or 4.0-oz./sq. ft. (1.22-kg/sq. m) zinc coating per ASTM A 653/A 653M.
      2) Type B, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film.
      3) External, Type B, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear,

verifiable polymer film. Internal, Type D, consisting of 81 percent, not less than 0.3-mil- (0.0076-mm-) thick, zinc-pigmented coating.

4) Type C, Zn-5-Al-MM alloy, consisting of not less than 1.8-oz./sq. ft. (0.55-kg/sq. m) coating.

5) Coatings: Any coating above.

g. Polymer coating over metallic coating.

1) Color: Match chain-link fabric **OR** Dark green **OR** Olive green **OR** Brown **OR** Black **OR** As selected from manufacturer's full range, **as directed**, complying with ASTM F 934.

C. Tension Wire

1. Metallic-Coated Steel Wire: 0.177-inch- (4.5-mm-) diameter, marcelled tension wire complying with ASTM A 817 and ASTM A 824, with the following metallic coating:

a. Type I, aluminum coated (aluminized).

b. Type II, zinc coated (galvanized) by hot-dip **OR** electrolytic, **as directed**, process, with the following minimum coating weight:

1) Class 3: Not less than 0.8 oz./sq. ft. (244 g/sq. m) of uncoated wire surface.

2) Class 4: Not less than 1.2 oz./sq. ft. (366 g/sq. m) of uncoated wire surface.

3) Class 5: Not less than 2 oz./sq. ft. (610 g/sq. m) of uncoated wire surface.

4) Matching chain-link fabric coating weight.

c. Type III, Zn-5-Al-MM alloy with the following minimum coating weight:

1) Class 60: Not less than 0.6 oz./sq. ft. (183 g/sq. m) of uncoated wire surface.

2) Class 100: Not less than 1 oz./sq. ft. (305 g/sq. m) of uncoated wire surface.

3) Matching chain-link fabric coating weight.

2. Polymer-Coated Steel Wire: 0.177-inch- (4.5-mm-) **OR** 0.148-inch- (3.8-mm-), **as directed**, diameter, tension wire complying with ASTM F 1664, Class 1 **OR** Class 2a **OR** Class 2b, **as directed**, over aluminum **OR** zinc **OR** Zn-5-Al-MM-alloy, **as directed**,-coated steel wire.

a. Color: Match chain-link fabric **OR** Dark green **OR** Olive green **OR** Brown **OR** Black **OR** As selected from manufacturer's full range, **as directed**, complying with ASTM F 934.

3. Aluminum Wire: 0.192-inch- (4.88-mm-) diameter tension wire, mill finished, complying with ASTM B 211 (ASTM B211M), Alloy 6061-T94 with 50,000-psi (344-MPa) minimum tensile strength.

D. Swing Gates

1. General: Comply with ASTM F 900 for gate posts and single **OR** double, **as directed**, swing gate types. Provide automated vehicular gates that comply with ASTM F 2200, **as directed**.

a. Gate Leaf Width: 36 inches (914 mm) **OR** As indicated, **as directed**.

b. Gate Fabric Height: 72 inches (1830 mm) or less **OR** More than 72 inches (1830 mm) **OR** As indicated, **as directed**.

2. Pipe and Tubing:

a. Zinc-Coated Steel: Comply with ASTM F 1043 and ASTM F 1083; protective coating and finish to match fence framing **OR** manufacturer's standard protective coating and finish, **as directed**.

b. Aluminum: Comply with ASTM B 429/B 429M; mill **OR** manufacturer's standard, **as directed**, finish.

c. Gate Posts: Round tubular steel **OR** Rectangular tubular steel **OR** Round tubular aluminum **OR** Rectangular tubular aluminum, **as directed**.

d. Gate Frames and Bracing: Round tubular steel **OR** Rectangular tubular steel **OR** Round tubular aluminum **OR** Rectangular tubular aluminum, **as directed**.

3. Frame Corner Construction: Welded **OR** Assembled with corner fittings, **as directed**.

4. Extended Gate Posts and Frame Members: Extend gate posts and frame end members above top of chain-link fabric at both ends of gate frame 12 inches (300 mm) **OR** as indicated, **as directed**, to attach barbed wire **OR** tape, **as directed**, assemblies.

5. Hardware:

a. Hinges: 180-degree inward **OR** 180-degree outward **OR** 360-degree inward and outward, **as directed**, swing.
b. Latches permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate, **as directed**.
c. Padlock and Chain: Owner furnished.
d. Lock: Manufacturer's standard internal device furnished in lieu of gate latch, **as directed**.
e. Closer: Manufacturer's standard, **as directed**.

E. Horizontal-Slide Gates
1. General: Comply with ASTM F 1184 for gate posts and single **OR** double, **as directed**, sliding gate types. Provide automated vehicular gates that comply with ASTM F 2200, **as directed**.
   a. Classification: Type **I** Overhead Slide (opening widths to 40 feet (12.2 m) with an overhead clearance of up to 22 feet (6.7 m)).
      1) Gate Leaf Width: As indicated **OR** As directed.
      2) Gate Fabric Height: 72 inches (1830 mm) or less **OR** More than 72 inches (1830 mm) **OR** As indicated, **as directed**.
   b. Classification: Type **II** Cantilever Slide (opening widths to 30 feet (9.1 m) and heights to 8 feet (2.44 m))
      1) Class 1 with external **OR** Class 2 with internal, **as directed**, roller assemblies.
      2) Gate Frame Width and Height: 48 inches (1200 mm) wide or less by 72 inches (1830 mm) high or less **OR** More than 48 inches (1200 mm) wide by any height **OR** As indicated, **as directed**.
2. Pipe and Tubing:
   a. Zinc-Coated Steel: Protective coating and finish to match fence framing **OR** Manufacturer's standard protective coating and finish, **as directed**.
   b. Aluminum: Comply with ASTM B 429/B 429M; mill **OR** manufacturer's standard, **as directed**, finish.
   c. Gate Posts: Comply with ASTM F 1184. Provide round tubular steel **OR** rectangular tubular steel **OR** round tubular aluminum **OR** rectangular tubular aluminum, **as directed**, posts.
   d. Gate Frames and Bracing: Round tubular steel **OR** Rectangular tubular steel **OR** Round tubular aluminum **OR** Rectangular tubular aluminum, **a directed**.
3. Frame Corner Construction: Welded **OR** Assembled with corner fittings, **as directed**.
4. Extended Gate Posts and Frame Members: Extend gate posts and frame end members above top of chain-link fabric at both ends of gate frame 12 inches (300 mm) **OR** as indicated, **as directed,** as required to attach barbed wire **OR** tape, **as directed**, assemblies.
5. Overhead Track Assembly: Manufacturer's standard track, with overhead framing supports, bracing, and accessories, engineered to support size, weight, width, operation, and design of gate and roller assemblies.
6. Hardware:
   a. Latches permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate, **as directed**.
   b. Padlock and Chain: Owner furnished.
   c. Lock: Manufacturer's standard internal device furnished in lieu of gate latch, **as directed**.
   d. Hangers, roller assemblies, and stops fabricated from galvanized steel **OR** galvanized malleable iron **OR** mill-finished Grade 319 aluminum-alloy casting with stainless-steel fasteners, **as directed**.

F. Fittings
1. General: Comply with ASTM F 626.
2. Post Caps: Provide for each post.
   a. Provide line post caps with loop to receive tension wire or top rail.
3. Rail and Brace Ends: For each gate, corner, pull, and end post.
4. Rail Fittings: Provide the following:
   a. Top Rail Sleeves: Pressed-steel or round-steel tubing **OR** Aluminum Alloy 6063, **as directed**, not less than 6 inches (152 mm) long.

b. Rail Clamps: Line and corner boulevard clamps for connecting intermediate, and bottom, **as directed**, rails in the fence line-to-line posts.

5. Tension and Brace Bands: Pressed steel **OR** Aluminum Alloy 6063, **as directed**.
6. Tension Bars: Steel **OR** Aluminum **OR** Fiberglass, **as directed**, length not less than 2 inches (50 mm) shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.
7. Truss Rod Assemblies: Steel, hot-dip galvanized after threading **OR** Mill-finished aluminum, **as directed**, rod and turnbuckle or other means of adjustment.
8. Barbed Wire Arms: Pressed steel or cast iron **OR** Aluminum, **as directed**, with clips, slots, or other means for attaching strands of barbed wire, and means for attaching to posts **OR** integral with post cap, **as directed**; for each post unless otherwise indicated, and as follows:
   a. Provide line posts with arms that accommodate top rail or tension wire.
   b. Provide corner arms at fence corner posts, unless extended posts are indicated.
   c. Type I, single slanted arm.
   d. Type II, single vertical arm.
   e. Type III, V-shaped arm.
   f. Type IV, A-shaped arm.
9. Tie Wires, Clips, and Fasteners: According to ASTM F 626.
   a. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:
      1) Hot-Dip Galvanized Steel: 0.106-inch- (2.69-mm-) **OR** 0.148-inch- (3.76-mm-), **as directed**, diameter wire; galvanized coating thickness matching coating thickness of chain-link fence fabric, **as directed**.
      2) Aluminum: ASTM B 211 (ASTM B 211M); Alloy 1350-H19; 0.148-inch- (3.76-mm-) **OR** 0.192-inch- (4.88-mm-), **as directed**, diameter, mill-finished wire.
10. Finish:
    a. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz. /sq. ft. (366 g /sq. m) zinc.
       1) Polymer coating over metallic coating.
    b. Aluminum: Mill finish.

G. Privacy Slats

1. Material: PVC, UV-light stabilized, flame resistant, four ply, **as directed**, not less than 0.006 inch (0.15 mm) **OR** 0.023 inch (0.58 mm), **as directed**, thick; attached to not less than 0.0475-inch- (1.21-mm-) diameter, twisted galvanized wire; hedge-type lattice, **as directed**; sized to fit mesh specified for direction indicated.

   OR

   Material: Polyethylene tubular slats, not less than 0.023 inch (0.58 mm) thick, manufactured for chain-link fences from virgin polyethylene containing UV inhibitor, sized to fit mesh specified for direction indicated; with vandal-resistant fasteners and lock strips **OR** fins for increased privacy factor, **as directed**.

   OR

   Material: Fiber-glass-reinforced plastic, UV-light stabilized, not less than 0.06 inch (1.5 mm) thick, sized to fit mesh specified for direction indicated; with vandal-resistant fasteners and lock strips, **as directed**.

   OR

   Material: Aluminum, not less than 0.01 inch (0.25 mm) thick, sized to fit mesh specified for direction indicated.

   OR

   Material: Redwood, 5/16 inch (7.9 mm) thick, sized to fit mesh specified for direction indicated.
2. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range **OR** As indicated on Drawings, **as directed**.

H. Barbed Wire

1. Steel Barbed Wire: Comply with ASTM A 121, for two-strand barbed wire, 0.099-inch- (2.51-mm-) diameter line wire with 0.080-inch- (2.03-mm-) diameter, four-point round barbs spaced not more than 5 inches (127 mm) o.c.
   a. Aluminum Coating: Type A.
   b. Zinc Coating: Type Z, Class 3.
2. Polymer-Coated, Galvanized-Steel Barbed Wire: Comply with ASTM F 1665 two-strand barbed wire, 0.080-inch- (2.03-mm-) diameter line wire with 0.080-inch- (2.03-mm-) diameter, four-point round aluminum alloy **OR** galvanized-steel, **as directed**, barbs spaced not more than 5 inches (127 mm) o.c.:
   a. Polymer Coating: Class 1 **OR** Class 2a **OR** Class 2b, **as directed**, over aluminum **OR** zinc **OR** Zn-5-Al-MM-alloy, **as directed**,-coated steel wire.
      1) Color: Match chain-link fabric **OR** Dark green **OR** Olive green **OR** Brown **OR** Black **OR** As selected from manufacturer's full range, **as directed**, complying with ASTM F 934.

I. Barbed Tape
1. Wire-Reinforced Tape: ASTM F 1910; with four-point, needle-sharp barbs permanently cold clenched around a core wire.
   a. Core Wire: High-tensile-strength, zinc-coated steel **OR** stainless steel, **as directed**.
2. Clips: Stainless steel, 0.065 inch (1.7 mm) thick by 0.375 inch (9.5 mm) wide, capable of withstanding a minimum 150-lbf (667-N) pull load to limit extension of coil, resulting in a concertina pattern when deployed.
3. Tie Wires: Stainless steel, 0.065 inch (1.7 mm) in diameter.
4. Fabrication: Continuous coils of barbed tape as defined in ASTM F 1379 for the following characteristics:
   a. Configuration: Single **OR** Double, **as directed**, coil.
   b. Style: Helical **OR** Concertina, **as directed**, pattern.
   c. Coil Diameter(s): 18 inches (457 mm) **OR** 24 inches (610 mm) **OR** 24-inch (610-mm) inner coil and 30-inch (762-mm) outer coil **OR** As indicated on Drawings, **as directed**.
   d. Coil Loop Spacing(s): 12 inches (300 mm) **OR** Manufacturer's standard **OR** As indicated on Drawings, **as directed**.
   e. Barb Length Classification: Long, 1.2-inch (30.5-mm) **OR** Medium, 0.4-inch (10.2-mm) **OR** Short, 0.1875-inch (4.76-mm), **as directed**, barb.
   f. Barb Spacing: 4 inches (102 mm) o.c.
   g. Barb Set: Straight **OR** Offset **OR** Manufacturer's standard, **as directed**.

J. Gate Operators
1. General: Provide factory-assembled automatic operating system designed for gate size, type, weight, and operation frequency. Provide operation control system with characteristics suitable for Project conditions, with remote-control stations, safety devices, and weatherproof enclosures; coordinate electrical requirements with building electrical system.
   a. Provide operator designed so motor may be removed without disturbing limit-switch adjustment and without affecting auxiliary emergency operator.
   b. Provide operator with UL approval **OR** -approved components, **as directed**.
   c. Provide electronic components with built-in troubleshooting diagnostic feature.
   d. Provide unit designed and wired for both right-hand/left-hand opening, permitting universal installation.
2. Comply with NFPA 70.
3. UL Standard: Fabricate and label gate operators to comply with UL 325.
4. Motor Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, within installed environment, with indicated operating sequence, and without exceeding nameplate rating or considering service factor. Comply with NEMA MG 1 and the following:
   a. Voltage: 12-V dc **OR** 120 V **OR** 208-220 V **OR** NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected, **as directed**.
   b. Horsepower: 1/4 **OR** 1/3 **OR** 3/4, **as directed**.
   c. Enclosure: Open dripproof **OR** Totally enclosed **OR** Manufacturer's standard, **as directed**.

d. Duty: Continuous duty at ambient temperature of 105 deg F (40 deg C) and at altitude of 3300 feet (1005 m) above sea level.
e. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.
f. Phase: One **OR** Polyphase, **as directed**.

5. Gate Operators: Gate **OR** Equipment base/pad **OR** Pedestal post **OR** In ground, **as directed**, mounted and as follows:
   a. Hydraulic Swing **OR** Slide, **as directed**, Gate Operators:
      1) Duty: Light **OR** Medium **OR** Heavy, **as directed**, duty, residential **OR** commercial/industrial, **as directed**.
      2) Gate Speed: Minimum 45 feet (13.7 m) **OR** 60 feet (18.2 m), **as directed**, per minute.
      3) Maximum Gate Weight: 300 lb (137 kg).
      4) Frequency of Use: 10 cycles per hour **OR** 25 cycles per hour **OR** Continuous duty, **as directed**.
      5) Locking: Hydraulic in both directions.
      6) Heater: Manufacturer's standard track and roller heater with thermostatic control.
      7) Operating Type: Crank arm **OR** Wheel and rail drive **OR** Roller chain, **as directed**, with manual release, **as directed**.
   b. Mechanical Swing **OR** Slide, **as directed**, Gate Operators:
      1) Duty: Light **OR** Medium **OR** Heavy, **as directed**, duty, residential **OR** commercial/industrial, **as directed**.
      2) Gate Speed: Minimum 45 feet (13.7 m) per minute **OR** 60 feet (18.2 m) per minute **OR** variable speed, **as directed**.
      3) Maximum Gate Weight: 600 lb (272 kg) **OR** 800 lb (363 kg), **as directed**.
      4) Frequency of Use: 10 cycles per hour **OR** 25 cycles per hour **OR** 60 cycles per hour **OR** Continuous duty, **as directed**.
      5) Operating Type: Crank arm **OR** Wheel and rail drive **OR** Roller chain, **as directed**, with manual release, **as directed**.
      6) Drive Type: Enclosed worm gear **OR** worm gear and chain-and-sprocket, **as directed**, reducers, roller-chain drive.

         OR

         Drive Type: V-belt and worm gear **OR** chain-and-sprocket, **as directed**, reducers, roller-chain drive.

6. Remote Controls: Electric controls separated from gate and motor and drive mechanism, with NEMA ICS 6, Type 1 **OR** NEMA ICS 6, Type 4, **as directed**, enclosure for surface **OR** recessed or flush **OR** equipment base/pad **OR** pedestal, **as directed**, mounting and with space for additional optional equipment. Provide the following remote-control device(s):
   a. Control Station: Keyed, two **OR** three, **as directed**,-position switch, located remotely from gate. Provide two keys per station.

      OR

      Control Station: Momentary-contact, single **OR** three, **as directed**,-button-operated; located remotely from gate. Key switch to lock out open and close buttons, **as directed**.
      1) Function: Open, stop, **as directed**, and close.
   b. Card Reader: Functions only when authorized card is presented. Programmable, magnetic multiple **OR** single, **as directed**,-code system, permitting four different access time periods, **as directed**; face-lighted unit fully visible at night, **as directed**.
      1) Reader Type: Touch plate **OR** Swipe **OR** Insertion **OR** Proximity, **as directed**.
      2) Features: Timed anti-passback **OR** Limited-time usage **OR** Capable of monitoring and auditing gate activity, **as directed**.
   c. Digital Keypad Entry Unit: Multiple-code capability **OR** Multiple-programmable, code capability, **as directed**, of not less than five **OR** 500 **OR** 2500, **as directed**, possible individual codes, consisting of one- to seven **OR** four **OR** five, **as directed**,-digit codes, and permitting four different access time periods, **as directed**.
      1) Features: Timed anti-passback **OR** Limited-time usage **OR** Capable of monitoring and auditing gate activity, **as directed**.

2) Face-lighted unit with metal-keyed **OR** keyless-membrane, **as directed**, keypad fully visible at night.

d. Radio Control: Digital system consisting of code-compatible universal receiver for each gate, located where indicated, with remote antenna with coaxial cable and mounting brackets designed to operate gates. Provide one **OR** two, **as directed**, programmable transmitter(s) with multiple-code capability permitting validating or voiding of not less than 1000 **OR** 10,000, **as directed**, codes per channel configured for the following functions:

1) Transmitters: Single **OR** Three, **as directed**,-button operated, with open **OR** open and close, **as directed**, function.

2) Channel Settings: Two **OR** Three **OR** Four, **as directed**, independent channel settings controlling separate receivers for operating more than one gate from each transmitter.

e. Telephone Entry System: Hands-free voice-communication system for connection to building telephone system with digital-entry code activation of gate operator and auxiliary keypad entry, **as directed**.

1) Residential System: Designed to be wired to same line with telephone.

OR

Multiunit System: Designed to be wired to a dedicated telephone line, with capacity to access 20 **OR** 100, **as directed**, telephones and with electronic directory, **as directed**.

f. Vehicle Loop Detector: System including automatic closing timer with adjustable time delay before closing, timer cut-off switch, **as directed**, and loop detector designed to open and close gate **OR** hold gate open until traffic clears **OR** reverse gate, **as directed**. Provide electronic detector with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light designed to detect presence or transit of a vehicle over an embedded loop of wire and to emit a signal activating the gate operator. Provide number of loops consisting of multiple strands of wire, number of turns, loop size, and method of placement at location shown on Drawings, as recommended in writing by detection system manufacturer for function indicated.

1) Loop: Wire, in size indicated for field assembly, for pave-over **OR** saw-cut with epoxy-grouted, **as directed**, installation.

OR

Loop: Factory preformed in size indicated; style for pave-over **OR** saw-cut with epoxy-grouted, **as directed**, installation.

g. Vehicle Presence Detector: System including automatic closing timer with adjustable time delay before closing, timer cut-off switch, **as directed**, and presence detector designed to open and close gate **OR** hold gate open until traffic clears **OR** reverse gate, **as directed**. Provide retroreflective **OR** emitter/receiver, **as directed**, detector with adjustable detection zone pattern and sensitivity, designed to detect the presence or transit of a vehicle in gate pathway when infrared beam in zone pattern is interrupted, and to emit a signal activating the gate operator.

7. Obstruction Detection Devices: Provide each motorized gate with automatic safety sensor(s). Activation of sensor(s) causes operator to immediately function as follows:

a. Action: Reverse gate in both opening and closing cycles and hold until clear of obstruction **OR** Stop gate in opening cycle and reverse gate in closing cycle and hold until clear of obstruction, **as directed**.

b. Internal Sensor: Built-in torque or current monitor senses gate is obstructed.

c. Sensor Edge: Contact-pressure-sensitive safety edge, profile, and sensitivity designed for type of gate and component indicated, in locations as follows. Connect to control circuit using take-up cable reel **OR** self-coiling cable **OR** gate edge transmitter and operator receiver system, **as directed**.

1) Along entire gate leaf leading edge (for swing gates and slide gates).

2) Along entire gate leaf trailing edge (for slide gates).

3) Across entire gate leaf bottom edge (for vehicular swing and slide gates complying with UL 325 or to suit Project; consider retaining for pedestrian gates).

4) Along entire length of gate posts (for slide gates; revise for sensor edge at pinch point post of swing gates).
5) Along entire length of gate guide posts (for Type II Cantilever Slide, Class 1 gates).
6) Where indicated on Drawings.

d. Photoelectric/Infrared Sensor System: Designed to detect an obstruction in gate's path when infrared beam in the zone pattern is interrupted.

8. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop gate at fully retracted and fully extended positions.
   a. Type: Integral fail-safe release, allowing gate to be pushed open without mechanical devices, keys, cranks, or special knowledge **OR** Mechanical device, key, or crank-activated release, **as directed**.
9. Operating Features:
   a. Digital Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features with capability for monitoring and auditing gate activity, **as directed**. Provide unit that is isolated from voltage spikes and surges.
   b. System Integration: With controlling circuit board capable of accepting any type of input from external devices.
   c. Master/Slave Capability: Control stations designed and wired for gate pair operation.
   d. Automatic Closing Timer: With adjustable time delay before closing and timer cut-off switch, **as directed**.
   e. Open Override Circuit: Designed to override closing commands.
   f. Reversal Time Delay: Designed to protect gate system from shock load on reversal in both directions.
   g. Maximum Run Timer: Designed to prevent damage to gate system by shutting down system if normal time to open gate is exceeded.
   h. Clock Timer: 24-hour **OR** Seven-day, **as directed**, programmable for regular events.
10. Accessories:
   a. Warning Module: Audio **OR** Visual, **as directed**, constant **OR** strobe, **as directed**,-light alarm sounding three to five seconds in advance of gate operation and continuing until gate stops moving; compliant with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.
   b. Battery Backup System: Battery-powered drive and access-control system, independent of primary drive system.
      1) Fail Safe: Gate opens and remains open until power is restored.
      2) Fail Secure: Gate cycles on battery power, then fail safe when battery is discharged.
   c. External electric-powered solenoid **OR** magnetic, **as directed**, lock with delay timer allowing time for lock to release before gate operates.
   d. Fire **OR** Postal, **as directed**, box.
   e. Fire strobe **OR** siren, **as directed**, alarm.
   f. Intercom System: <**Insert requirements**>.
   g. Instructional, Safety, and Warning Labels and Signs: According to UL 325 **OR** Manufacturer's standard for components and features specified **OR** As indicated on Drawings, **as directed**.
   h. Equipment Bases/Pads: Cast-in-place or precast concrete, depth not less than 12 inches (300 mm), dimensioned and reinforced according to gate-operator component manufacturer's written instructions and as indicated on Drawings.

K. Grout And Anchoring Cement
1. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.
2. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to

erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer, for exterior applications.

L. Fence Grounding
1. Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.
   a. Material above Finished Grade: Copper **OR** Aluminum, **as directed**.
   b. Material on or below Finished Grade: Copper.
   c. Bonding Jumpers: Braided copper tape, 1 inch (25 mm) wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.
2. Connectors and Grounding Rods: Comply with UL 467.
   a. Connectors for Below-Grade Use: Exothermic welded type.
   b. Grounding Rods: Copper-clad steel, 5/8 by 96 inches (16 by 2440 mm).

1.3 EXECUTION

A. Examination
1. Examine areas and conditions, with Installer present, for compliance with requirements for a verified survey of property lines and legal boundaries, **as directed**, site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
   a. Do not begin installation before final grading is completed unless otherwise permitted by the Owner.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (152.5 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

C. Installation, General
1. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements indicated.
   a. Install fencing on established boundary lines inside property line.

D. Chain-Link Fence Installation
1. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.
2. Post Setting: Set posts in concrete **OR** with mechanical anchors **OR** by mechanically driving into soil, **as directed**, at indicated spacing into firm, undisturbed soil.
   a. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
   b. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
      1) Exposed Concrete: Extend 2 inches (50 mm) above grade; shape and smooth to shed water.
      2) Concealed Concrete: Top 2 inches (50 mm) below grade as indicated on Drawings to allow covering with surface material.
      3) Posts Set into Concrete in Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout **OR** anchoring cement, **as directed**, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.
      4) Posts Set into Voids in Concrete: Form or core drill holes not less than 5 inches (125 mm) deep and 3/4 inch (20 mm) larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with

nonshrink, nonmetallic grout **OR** anchoring cement, **as directed**, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.

c. Mechanically Driven Posts: Drive into soil to depth of 30 inches (762 mm) **OR** 36 inches (914 mm), **as directed**. Protect post top to prevent distortion.

3. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more **OR** 30 degrees or more **OR** as indicated on Drawings, **as directed**.
4. Line Posts: Space line posts uniformly at 96 inches (2440 mm) **OR** 10 feet (3 m), **as directed**, o.c.
5. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.
   a. Locate horizontal braces at midheight of fabric 72 inches (1830 mm) or higher, on fences with top rail and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.
6. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch- (3.05-mm-) diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches (610 mm) o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:
   a. Extended along top **OR** bottom **OR** top and bottom, **as directed**, of fence fabric. Install top tension wire through post cap loops. Install bottom tension wire within 6 inches (152 mm) of bottom of fabric and tie to each post with not less than same diameter and type of wire.
   b. Extended along top of barbed wire arms **OR** extended posts, **as directed**, and top of fence fabric for supporting barbed tape.
   c. As indicated.
7. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.
8. Intermediate and Bottom Rails: Install and secure to posts with fittings.
9. Chain-Link Fabric: Apply fabric to outside **OR** inside, **as directed**, of enclosing framework. Leave 1 inch (25.4 mm) **OR** 2 inches (50 mm), **as directed**, between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
10. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches (380 mm) o.c.
11. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.
    a. Maximum Spacing: Tie fabric to line posts at 12 inches (300 mm) o.c. and to braces at 24 inches (610 mm) o.c.
12. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts, **as directed**.
13. Privacy Slats: Install slats in direction indicated, securely locked in place.
    a. Vertically **OR** Horizontally, **as directed**, for privacy factor of 70 to 75.

       OR

       Diagonally, for privacy factor of 80 to 85.

       OR

       Direction and privacy factor, **as directed**, as indicated.

14. Barbed Wire: Install barbed wire uniformly spaced, angled toward security side of fence **OR** as indicated on Drawings, **as directed**. Pull wire taut, install securely to extension arms, and secure to end post or terminal arms.
15. Barbed Tape: Comply with ASTM F 1911. Install barbed tape uniformly in configurations indicated and fasten securely to prevent movement or displacement.

E. Gate Installation

1. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

F. Gate Operator Installation

1. General: Install gate operators according to manufacturer's written instructions, aligned and true to fence line and grade.
2. Excavation for Support Posts **OR** Pedestals **OR** Equipment Bases/Pads, **as directed**: Hand-excavate holes for bases/pads, in firm, undisturbed soil to dimensions and depths and at locations as required by gate-operator component manufacturer's written instructions and as indicated.
3. Vehicle Loop Detector System: Cut grooves in pavement and bury **OR** Bury, **as directed**, and seal wire loop according to manufacturer's written instructions. Connect to equipment operated by detector.
4. Comply with NFPA 70 and manufacturer's written instructions for grounding of electric-powered motors, controls, and other devices.

G. Grounding And Bonding

1. Fence Grounding: Install at maximum intervals of 1500 feet (450 m), **as directed**, except as follows:
   a. Fences within 100 Feet (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet (225 m), **as directed**.
      1) Gates and Other Fence Openings: Ground fence on each side of opening.
         a) Bond metal gates to gate posts.
         b) Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches (460 mm) below finished grade.
2. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet (45 m) on each side of crossing.
3. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.
4. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches (150 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at the grounding location, including the following:
   a. Make grounding connections to each barbed wire strand with wire-to-wire connectors designed for this purpose.
   b. Make grounding connections to each barbed tape coil with connectors designed for this purpose.
5. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.
6. Connections: Make connections to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
   a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
   b. Make connections with clean, bare metal at points of contact.
   c. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.

d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

7. Bonding to Lightning Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor complying with NFPA 780.

H. Field Quality Control

1. Grounding-Resistance Testing: Engage a qualified testing agency to perform tests and inspections.
   a. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance no fewer than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method according to IEEE 81.
   b. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify the Owner promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.
   c. Report: Prepare test reports certified by a testing agency of grounding resistance at each test location. Include observations of weather and other phenomena that may affect test results.

I. Adjusting

1. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
2. Automatic Gate Operator: Energize circuits to electrical equipment and devices. Adjust operators, controls, safety devices, alarms, **as directed**, and limit switches.
   a. Hydraulic Operator: Purge operating system, adjust pressure and fluid levels, and check for leaks.
   b. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   c. Test and adjust controls, alarms, **as directed**, and safeties. Replace damaged and malfunctioning controls and equipment.
3. Lubricate hardware, gate operator, **as directed**, and other moving parts.

J. Demonstration

1. Train the Owner's personnel to adjust, operate, and maintain chain-link fences and gates.

END OF SECTION 31 23 16 16

Task	Specification	Specification Description
31 23 16 16	31 13 13 00	Tree Protection And Trimming

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SECTION 31 23 16 26 - EMBANKMENT

1.1 GENERAL

A. Description Of Work
1. This specification covers the reuse of suitable excavated material or furnishing material at the Contractor's expense to construct embankments where and as required by the Owner.

B. Submittals
1. Preconstruction Submittals
a. Construction equipment list.
b. Contractor shall record Existing Conditions prior to starting work in accordance with the paragraph entitled, "Existing Conditions," of this section.
c. Location of Utilities
d. Location of Tests
e. Location of Inspection
f. Location of Approved Utilities
g. A protection plan verifying the Existing Utilities left in place.
2. Test Reports for Soil Test within three working days of test date. Soil test shall comply with paragraph entitled, "Quality Control Testing During Construction."
3. Certificates of compliance for Proposed Soil Materials shall be submitted in accordance with paragraph entitled, "Tests for Proposed Soil Materials."

C. Definitions
1. Soil Materials
a. Cohesionless soil materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Moisture-density relations of compacted cohesionless soils when plotted on graphs will show straight lines or reverse-shaped moisture-density curves.
b. Cohesive soil materials include clayey and silty gravels, sand-clay mixtures, gravel-silt mixtures, clayey and silty sands, sand-silt mixtures, clays, silts, and very fine sands. Moisture density relations of compacted cohesive soils when plotted on graphs will show normal moisture-density curves.
2. Subgrade shall mean the top surface of a backfill or fill or the uppermost surface of an excavation, graded to conform to the required subgrade elevation and compacted to densities indicated.
3. Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure in AASHTO T 180, Method B or D.
4. Classified Excavation: Separate consideration will be given to the nature of the materials excavated, in accordance with the following designations and classifications.
a. Rock excavation shall include blasting, excavating, grading, and disposing of material classified as rock and shall include the satisfactory removal and disposition of boulders 1/2-cu yd (0.4 cu m) or more in volume; solid rock; rock material in ledges, bedded deposits, and unstratified masses which cannot be removed without systematic drilling and blasting; and conglomerate deposits that are so firmly cemented as to possess the characteristics of solid rock that is impossible to remove without systematic drilling and blasting. The removal of any concrete or masonry structures, except pavements, exceeding 1/2-cu yd (0.4 cu m) in volume that may be encountered in the work shall be included in this classification.
b. Common excavation shall include the satisfactory removal and disposition of materials not classified as rock excavation.
5. Unclassified Excavation: No consideration will be given to the nature of the materials, and all excavation will be designated as unclassified excavation.

D. Sampling And Testing

1. Soil Test and Inspection Service: Soil survey for satisfactory soil materials and samples of soil materials shall be furnished by the Contractor. A certified soil testing service approved by the Owner shall be provided by the Contractor. Testing shall include soil survey for satisfactory soil materials, sampling and testing soil materials proposed for use in the work, and field-testing facilities for quality control during construction period.
2. Tests for Proposed Soil Materials: Soil materials proposed for use in the work shall be tested. The materials shall be approved by the Owner prior to start of work as follows:

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Satisfactory soil materials	Sampling	AASHTO T 2	One for each source of materials to determine conformance to definition of satisfactory soil materials; additional tests whenever there is any apparent change
	Preparation of samples	AASHTO T 87	
	Sieve analysis of fine and coarse aggregate	ASTM C 136	
	Mechanical analysis of soils	ASTM D 422	
	Liquid limit of Soils	ASTM D 4318	
	Plastic limit and plasticity index of soils	ASTM D 4318	
	Moisture-density relations of soil	AASHTO T 180, Method B or D	

3. Quality Control Testing During Construction: Soil Test on materials shall be performed during construction as follows:

MATERIAL	REQUIREMENT	TEST METHOD	MATERIAL TESTED AND NUMBER OF TESTS
Soil material-in-place after compaction	Density of soil-in-place	ASTM D 1556 Sand Cone Method or ASTM D 2922 Nuclear Method	At least three daily for each subgrade soil material, and for each layer of soil material; additional tests whenever there is any change in moisture

4. Field Testing Facilities at Subbase Mixing Plant: Field-testing facilities for the purpose of testing subbase course material at the mixing plant shall be provided by the Contractor's soil-testing service.
5. Reports: No soil material shall be used until soil test reports have been reviewed and approved.
6. Evaluation of Test Results
   a. Soil materials of any classification shall not have a moisture content at the time of compaction that would be classified as unsatisfactory soil materials in the paragraph entitled, "Definitions."
   b. Results of density of soil-in-place tests shall be considered satisfactory if the average of any group of four consecutive density tests which may be selected is in each instance equal to or greater than the specified density, and if no density test has a value more than 2 percentage points below the specified density.

E. Use Of Explosives:
1. Explosives shall not be used or brought to the project site without prior written approval. Such approval shall not be construed as relieving the Contractor of responsibility for injury to persons or for damage to property due to blasting operations. Blasting shall be performed by skilled personnel in accordance with governing authorities and as approved. Minimum safety requirements for blasting shall be in accordance with OSHA Regulations 29 CFR 1926, Subpart U.
OR
The use of explosives will not be permitted.

F. Protection Of Persons And Property
1. Excavations shall be barricaded and posted with warning signs for the safety of persons. Warning lights shall be provided during hours of darkness.
2. Structures, utilities, sidewalks, pavements, and other facilities immediately adjacent to excavations shall be protected against damage including settlement, lateral movement, undermining, and washout.
3. Topsoil removal operations shall be conducted to ensure safety of persons and to prevent damage to existing structures and utilities, construction in progress, trees and vegetation to remain standing, and other property.

G. Construction Equipment List: Construction Equipment List for all major equipment to be used in this section shall be submitted to the Owner prior to start of work.

H. Existing Conditions
1. Records of Existing Conditions shall be submitted by the Contractor prior to the start of work. The Contractor shall verify the existing conditions are correct as shown on the plans and described in the specifications. the Owner shall be notified immediately if any discrepancies are found.

2. Records of underground utilities, Location of Utilities, Location of Inspection, Location of Tests, and Location of Approved Utilities shall be submitted to the Owner prior to start of work.

1.2 PRODUCTS

A. Materials
1. Satisfactory Materials shall mean AASHTO M 145 (ASTM D 3282), Soil Classification Groups A-1, A-2-4, A-2-5, and A-3.
2. Unsatisfactory Materials shall mean AASHTO M 145, Soil Classification Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7, peat and other highly organic soils, and soil materials of any classification that have a moisture content, at the time of compaction, beyond the range of 1 percentage point below and 3 percentage points above the optimum moisture content of the soil material as determined by moisture-density relations test.
3. Topsoil shall be any soil removed from the project site which consists of clay or sandy loam. The topsoil shall be reasonably free from subsoil, clay lumps, brush, objectionable weeds, and other litter, and shall be free from stones, stumps, roots, and other objectionable material larger than 2 in. (50 mm) in any dimension.
4. Compost shall be yard trimmings or yard waste compost processed and graded according to state and local regulations.
5. Topsoil Blend: Where insufficient topsoil is removed from the project site for later reuse, the topsoil removed shall be stockpiled and blended with compost at the site to achieve the required volume.

1.3 EXECUTION

A. Blasting:
1. Where explosives are used in rock excavation, the charges shall be so proportioned and placed that they will not loosen the rock outside the excavation lines indicated, or as specified. Contractor shall remove, at no additional cost, any material outside the authorized cross section that may be shattered or loosened by blasting.
OR
Blasting is not required or permitted.

B. Conservation Of Topsoil: Topsoil shall be stripped to a depth of not less than 4 in. (100 mm); when stored it shall be kept separate from other excavated materials, free of roots, stones, and other undesirable materials. Where indicated, topsoil shall be removed without contamination with subsoil and spread on areas already graded and prepared for topsoil, or when so specified, topsoil shall be transported and deposited in stockpiles convenient to areas that are to receive application of the topsoil later or at locations indicated or specified by the Owner. Topsoil blend shall be used on all embankments when there is not enough topsoil available.

C. Excavation
1. Excavations specified shall be done on either a classified or unclassified basis as directed by the Owner.
2. Contractor shall perform excavation of every type of material encountered by cutting accurately to the cross sections to the lines, grades, and elevations indicated. Grading shall be in conformity with the typical sections indicated and the tolerances specified in paragraph entitled, "Finishing."
3. Satisfactory excavated materials shall be transported to and placed in fill or embankment areas within the limits of the work. Unsatisfactory materials encountered within the limits of the work shall be excavated below grade and replaced with satisfactory materials as directed. Surplus satisfactory excavated material not required for fill or embankment shall be disposed in areas approved for surplus materials storage or designated waste areas. Unsatisfactory excavated material shall be disposed in designated waste or spoil areas. During construction, excavation

and filling shall be performed in a manner and sequence that will provide proper drainage at all times. Material required for fill or embankment in excess of that produced by excavation within the grading limits shall be excavated from the borrow areas indicated or from other approved areas selected by the Owner.

4. Excavation of Ditches, Gutters, and Channels: Care shall be taken not to excavate ditches and gutters below grades shown. Excessive open-ditch or gutter excavation shall be backfilled with suitable materials to grades indicated at no additional cost. Materials excavated shall be disposed as indicated, except that in no case shall material be deposited less than 3 ft. (1 m) from the edge of a ditch. Contractor shall maintain excavations free from debris until final acceptance of the work.
5. Excavation for Drainage Structures
   a. Dimensions and elevations of footings and foundation excavations indicated are only approximate and may be changed if necessary to ensure adequate foundation support. Trenches and foundation pits shall be of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations. Rock or other hard foundation material shall be cleaned of loose debris and cut to a firm surface, either level, stepped, or serrated. Loose disintegrated rock and thin strata shall be removed. When concrete or masonry is to be placed in an excavated area, special care shall be taken not to disturb the bottom of the excavation. Excavation to the final grade level shall not be made until just before concrete or masonry is to be placed.
   b. Where pile foundations are to be used, the excavation of each pit shall be stopped at an elevation 1 ft. (300 mm) above the base of the footing, as specified, before piles are driven. After pile driving has been completed, loose and displaced material shall be removed and excavation completed, leaving a smooth, solid, undisturbed surface to receive concrete or masonry.
6. Protection or Removal of Utility Lines: Existing Utilities that are indicated to be retained, or the locations of which have been ascertained from the Owner utility drawings, as well as utility lines encountered during excavation, shall be protected from damage during excavation and backfilling. However, reliance on the information obtained from the Owner drawings does not absolve the Contractor of responsibility for damages, so careful hand methods shall be used to verify the location of underground utilities. Damage shall be reported immediately and satisfactorily repaired by the Contractor at no additional cost. The Contractor shall provide sketches of existing conditions if there are variances, as well as any modifications, on "as-built" drawings. When utility lines that are to be removed are encountered within the area of operations, the Contractor shall give notice in ample time for the necessary measures to be taken to prevent interruption of service.

D. Classification Of Excavation: Excavations specified shall be done on either a classified or unclassified basis as provided for under the item designations of the Contract.

E. Utilization Of Excavation Materials: Unsatisfactory materials removed from excavations shall be disposed in designated areas. Satisfactory material removed from excavations shall be used, insofar as practicable, in the construction of fills, embankments, subgrades, shoulders, bedding; as backfill; and for similar purposes. No satisfactory excavated material shall be wasted without specific written authorization. Satisfactory material authorized to be wasted shall be disposed in designated areas approved for surplus material storage or designated waste areas as directed. Coarse rock from excavations shall be stockpiled and used for constructing slopes of embankments adjacent to streams, for constructing slopes or sides and bottoms of channels, and for protecting against erosion. Hand placing of coarse rock from excavations will not be required. Excavated material shall not be disposed in a manner as to obstruct the flow of any stream, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way.

F. Selection Of Borrow Material: Borrow material shall be selected to meet the requirements and conditions of the particular fill or embankment for which it is to be used. Borrow material shall be obtained from the borrow areas indicated on the plans or from other approved sources, either private or within the limits of the project site, selected by the Contractor. Unless otherwise provided in the contract, the Contractor shall obtain from the Owner the right to procure material, pay all royalties and other charges involved, and bear all expense of developing the sources, including rights-of-way for hauling. Borrow material from approved sources on the Owner-controlled land may be obtained without payment of royalties. Unless specifically provided, no borrow shall be obtained within the limits of the project site without prior written approval. Necessary clearing, grubbing, and satisfactory drainage of borrow pits and the disposal of debris shall be considered related operations to the borrow excavation and shall be performed by the Contractor at no additional cost to the Owner.

G. Opening And Drainage Of Excavation And Borrow Pits: The Contractor shall give notice sufficiently in advance of the opening of any excavation or borrow pit to permit elevations and measurements of the undisturbed ground surface to be taken. Unless otherwise permitted, borrow pits and other excavation areas shall be excavated in such manner as will afford adequate drainage. Overburden and other spoil material shall be transported to designated spoil areas or otherwise disposed as directed. Borrow pits shall be neatly trimmed and left in such shape as will facilitate accurate measurements after the excavation is completed.

H. Grading Areas: When so provided and indicated, work under contract will be divided into grading areas, within which satisfactory excavated material shall be placed in embankments, fills, and required backfills. Contractor shall not haul satisfactory material excavated in one grading area to another grading area, except when so directed in writing.

I. Preparation Of Ground Surface For Embankments
1. Ground surface on which fill is to be placed shall be stripped of live, dead, or decayed vegetation, rubbish, debris, and other unsatisfactory material; shall be plowed, disked, or otherwise broken up; pulverized; moistened or aerated as necessary; mixed; and compacted to at least 90 percent maximum density for cohesive materials or 100 percent maximum density for cohesionless materials.
2. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment. The prepared ground surface shall be scarified and moistened or aerated just prior to placement of embankment materials to ensure adequate bond between embankment material and the prepared ground surface.

J. Embankments
1. Earth Embankments
    a. Earth embankments shall be constructed from satisfactory materials free of organic or frozen material and rocks with maximum dimensions not greater than 3 in. (75 mm). The material shall be placed in successive horizontal layers of loose material not more than 6 in. (150 mm) in depth. Each layer shall be spread uniformly on a prepared surface, i.e., a soil surface that has been moistened or aerated and scarified plowed, disked, or otherwise broken up in such a manner that the fill will bond with the surface on which it is placed, mixed, and compacted to at least 90 percent maximum density for borrow materials or 100 percent maximum density for excavated materials. Compaction requirements for the upper portion of earth embankments forming subgrade for pavements shall be identical to those requirements specified in paragraph entitled, "Subgrade Preparation."
    b. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment.
2. Rock Embankments
    a. Rock embankments shall be constructed from material essentially classified as rock excavation, placed in successive horizontal layers of loose material not more than 8 to 10 in. (200 to 250 mm) in depth. Pieces of rock larger than 8 to 10 in. (200 to 250 mm) in greatest dimension shall not be used.
    b. Each layer of material shall be spread uniformly and shall be completely saturated and compacted to density as directed by the Owner.

c. Each layer of material shall be spread uniformly and shall be completely saturated and compacted until the interstices are filled with well-compacted materials and the entire layer is a dense, compacted mass.

d. Each successive layer of material shall adequately bond to the material on which it is placed.

e. Compaction shall be accomplished with vibratory compactors with a minimum static weight of 20,000 lbs. (90 kN), heavy rubber-tired rollers weighing not less than 25,000 lbs. (110 kN) or steel-wheeled rollers with a loaded weight of not less than 4,000 lb/ft (58,400 N/m) of drum length.

f. Rock shall not be used above a point 6 in. (150 mm) below the surface of an embankment that is to be paved.

K. Subgrade Preparation

1. Construction

a. Subgrade shall be shaped to line, grade, and cross section and compacted as specified. This operation shall include plowing, disking, and any moistening or aerating required to obtain proper compaction. Soft or otherwise unsatisfactory material shall be removed and replaced with satisfactory excavated material or other approved material as directed. Rock encountered in the cut sections shall be excavated to a depth of 6 in. (150 mm) below finished grade for the subgrade. Low areas resulting from removal of unsatisfactory material or excavation of rock shall be brought up to required grade with satisfactory materials, and the entire subgrade shall be shaped to line, grade, and cross section and compacted as specified.

b. After rolling, the surface of the subgrade for roadways and/or airfields shall indicate a deviation not greater than 3/8 in. (10 mm) when tested with a 10-ft (3.0 m) straightedge applied both parallel with, and at right angles to, the centerline of the area.

c. Elevation of the finished subgrade shall vary not more than 1/4-in. (6 mm) from the established grade and approved cross section.

2. Compaction: Compaction for pavements and shoulders shall be accomplished with approved equipment until the layer is compacted to the full depth to at least 95 percent maximum density.

L. Shoulder Construction: Shoulders shall be constructed of satisfactory excavated or borrow materials or as otherwise indicated on the plans. Shoulders shall be constructed as soon as possible after adjacent paving is complete, but in the case of rigid pavements, shoulders shall not be constructed until permission has been obtained. The entire shoulder area shall be compacted to at least the percentage of maximum density as specified for specific ranges of depth below the surface of the shoulder. Compaction shall be accomplished with approved equipment. Shoulder construction shall be done in proper sequence in such a manner that adjacent ditches will be drained effectively and no damage of any kind is done to the adjacent, completed pavement. The completed shoulders shall be true to alignment and grade and shaped to drain in conformity with the cross section indicated.

M. Finishing: Surface of excavations, embankments, and subgrades shall be finished to a reasonably smooth and compact surface substantially in accordance with the lines, grades, and cross sections or elevations indicated. Degree of finish for graded areas shall be within 1/10 ft (30 mm) of the grades and elevations indicated, except that the degree of finish for subgrades shall be as specified. Gutters and ditches shall be finished as indicated. Surface of areas to be turfed shall be finished to a smoothness suitable for the application of turfing materials.

N. Subgrade And Embankment Protection: During construction, embankments and excavations shall be kept shaped and drained. Ditches and drains along subgrade shall be maintained in such a manner as to drain effectively at all times. Finished subgrade shall not be disturbed by traffic or other operations and shall be protected and maintained by the Contractor in a satisfactory condition until ballast, subbase, base, or pavement is placed. Storage or stockpiling materials on finished subgrade will not be permitted. Subbase, base course, ballast, or pavement shall not be laid until the subgrade has been checked and approved, and in no case shall subbase, base, surfacing, pavement, or ballast be placed on a muddy, spongy, or frozen subgrade.

END OF SECTION 31 23 16 26

Task	Specification	Specification Description
31 23 16 26	31 01 20 00	Earthwork
31 23 16 33	31 01 20 00	Earthwork
31 23 16 36	31 23 16 13	Excavation Support And Protection
31 23 16 36	31 01 20 00	Earthwork
31 23 16 46	31 23 16 13	Excavation Support And Protection
31 23 16 46	31 01 20 00	Earthwork

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SECTION 31 23 19 00 - DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Construction dewatering.

B. Related Requirements:

1. Section 013233 "Photographic Documentation" for recording preexisting conditions and dewatering system progress.
2. Section 015723 "Temporary Storm Water Pollution Control" for temporary storm water pollution controls mandated under the EPA's National Pollutant Discharge Elimination System.
3. Section 312000 "Earth Moving" for excavating, backfilling, site grading, and controlling surface-water runoff and ponding.

1.2 ALLOWANCES

A. See Section 012100 "Allowances" for description of allowances affecting items specified in this Section.

1. Dewatering observation wells are part of [**dewatering**] <**Insert description**> allowance.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**>.

1. Verify availability of Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review condition of site to be dewatered, including coordination with temporary erosion-control measures and temporary controls and protections.
3. Review geotechnical report.
4. Review proposed site clearing and excavations.
5. Review existing utilities and subsurface conditions.
6. Review observation and monitoring of dewatering system.

1.4 ACTION SUBMITTALS

A. Shop Drawings: For dewatering system, prepared by or under the supervision of a qualified professional engineer.

1. Include plans, elevations, sections, and details.
2. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.
3. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.

4. Include written plan for dewatering operations, including sequence of well and well-point placement coordinated with excavation shoring and bracings and control procedures to be adopted if dewatering problems arise.

B. Delegated Design Submittals: For dewatering system, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Submittals:

1. Field quality-control reports.

B. Qualification Statements: For [**Installer**] [**and**] [**land surveyor**] <**Insert entity or specialist**>.

C. Delegated design engineer qualifications.

D. Existing Conditions: Using [**photographs**] [**or**] [**video recordings**], show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by dewatering operations. Submit before Work begins.

E. Record Drawings: Identify locations and depths of capped wells and well points and other abandoned-in-place dewatering equipment.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Installer: An experienced installer that has specialized in [**design of dewatering systems and**]dewatering work.
2. Delegated Design Engineer: A professional engineer who is legally qualified to practice in [**state**] <**Insert jurisdiction**> where Project is located and who is experienced in providing engineering services of the type indicated.
3. Land Surveyor: A professional land surveyor who is legally qualified to practice in [**state**] <**Insert jurisdiction**> where Project is located.

1.7 FIELD CONDITIONS

A. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for dewatering in accordance with the performance requirements.
2. The geotechnical report is [**included**] [**referenced**] elsewhere in Project Manual.

B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design dewatering system.

B. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of groundwater and permit excavation and construction to proceed on dry, stable subgrades.

1. Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer.
2. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, prevention of flooding in excavation, and prevention of damage to subgrades and permanent structures.
3. Prevent surface water from entering excavations by grading, dikes, or other means.
4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
5. Remove dewatering system when no longer required for construction.

C. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with water- and debris-disposal regulations of authorities having jurisdiction.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.

1. Prevent surface water and subsurface or groundwater from entering excavations, from ponding on prepared subgrades, and from flooding site or surrounding area.
2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Provide temporary grading to facilitate dewatering and control of surface water.

D. Protect and maintain temporary erosion and sedimentation controls, which are specified in [**Section 015000 "Temporary Facilities and Controls,"**] [**Section 015723 "Temporary Storm Water Pollution Control"**] [**Section 311000 "Site Clearing,"**] during dewatering operations.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

1. Space well points or wells at intervals required to provide sufficient dewatering.
2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

B. Place dewatering system into operation to lower water to specified levels before excavating below groundwater level.

C. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

D. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

3.3 OPERATION

A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.

B. Operate system to lower and control groundwater to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
2. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
3. Maintain piezometric water level a minimum of [**24 inches (600 mm)**] [**60 inches (1500 mm)**] <**Insert dimension**> below bottom of excavation.

C. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.

D. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches (900 mm) below overlying construction.

3.4 FIELD QUALITY CONTROL

A. Observation Wells: Provide observation wells or piezometers, take measurements, and maintain at least the minimum number indicated; additional observation wells may be required by authorities having jurisdiction.

1. Observe and record daily elevation of groundwater and piezometric water levels in observation wells.
2. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. In areas where observation wells are not functioning properly, suspend construction

activities until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.

3. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.

B. Survey-Work Benchmarks: Resurvey benchmarks [**regularly**] [**monthly**] <**Insert time period**> during dewatering and maintain an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

C. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.

D. Prepare reports of observations.

3.5 PROTECTION

A. Protect and maintain dewatering system during dewatering operations.

B. Promptly repair damages to adjacent facilities caused by dewatering.

END OF SECTION 31 23 19 00

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Task	Specification	Specification Description
31 23 19 00	21 05 23 00	Piped Utilities Basic Materials And Methods
31 23 23 23	31 01 20 00	Earthwork
31 23 23 33	31 23 16 13	Excavation Support And Protection
31 23 23 33	31 01 20 00	Earthwork

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SECTION 31 24 13 00 - LEVEE CLOSURE

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing of labor and materials for providing levee closures.

1.2 PRODUCTS - (Not Used)

1.3 EXECUTION

A. If there is deemed, by the Owner, to be considerable risk of flooding involved with removing drainage structures and gates in the existing Levee System, the Contractor shall perform the work of this contract as follows:

1. Only one drainage structure/flap gate will be allowed to be disrupted at one time. All proposed work at each drainage structure shall be completed before proceeding to the next structure.
2. The Contractor shall have all materials required for each structure installation secured on site, before beginning construction on that structure.
3. The Contractor shall have all necessary materials on site to temporarily plug existing and/or proposed piping through the levee.
4. Weather and river flow conditions shall be monitored at all times by the Contractor while each drainage structure is open to flow. The Contractor shall construct an adequate closure in a timely fashion to plug the drainage structure preventing flow through the levee.

END OF SECTION 31 24 13 00

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Task	Specification	Specification Description
31 24 13 00	31 01 20 00	Earthwork
31 24 13 00	31 23 16 26	Embankment

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SECTION 31 25 14 13 - GEOSYNTHETIC FABRIC

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing of labor, material and equipment for the installation of geosynthetic fabric.

1.2 PRODUCTS

A. Materials
   1. Erosion Control Fabric - Photo and biodegradable plastic Curlex Blanket as manufactured by American Excelsior Co. or approved equal.
   2. Drainage/Leach Bed - Non-woven polypropylene/polyethylene fabric, Mirafi 140N or approved equal.
   3. Road Base and Structure Reinforcement - Woven polypropylene fabric, Mirafi 600X or approved equal.
   4. Sediment and Job Site erosion control - woven polypropylene fabric - Envirofence by Mirafi or approved equal.

1.3 EXECUTION

A. For sediment and job site erosion control fabric, the Contractor shall provide and install silt fence as detailed on the Storm Water Management and Erosion Control Plan. It shall be the Contractor's option to provide fabricated reinforced silt fence or prefabricated units, unless otherwise noted. In all installations, the bottom flap of filter cloth shall be firmly embedded into undisturbed or stabilized grade. Embedment shall resist pullout and prevent flow under the installation.

END OF SECTION 31 25 14 13

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Task	Specification	Specification Description
31 25 14 13	01 56 26 00	Sediment Removal
31 25 14 13	01 56 26 00a	Erosion Control
31 25 14 16	01 56 26 00	Sediment Removal
31 25 14 16	31 25 14 13	Geosynthetic Fabric
31 25 14 16	01 56 26 00a	Erosion Control

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SECTION 31 25 14 23 - UNIT PAVERS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for unit pavers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Brick pavers set in aggregate, bituminous or mortar setting beds.
      b. Concrete pavers set in aggregate, bituminous or mortar setting beds.
      c. Asphalt-block pavers set in bituminous setting beds.
      d. Stone pavers set in aggregate or mortar setting beds.
      e. Plastic or Steel or Aluminum edge restraints.
      f. Cast-in-place concrete edge restraints.
      g. Precast concrete curbs.
      h. Stone curbs.

C. Preconstruction Testing
   1. Preconstruction Adhesion and Compatibility Testing: Submit to latex-additive manufacturer, for testing as indicated below, samples of paving materials that will contact or affect mortar and grout that contain latex additives.
      a. Use manufacturer's standard test methods to determine whether mortar and grout materials will obtain optimum adhesion with, and will be nonstaining to, installed pavers and other materials constituting paver installation.

D. Action Submittals
   1. Product Data: For materials other than water and aggregates.
   2. Product Data: For the following:
      a. Pavers.
      b. Bituminous setting materials.
      c. Mortar and grout materials.
      d. Edge restraints.
      e. Precast concrete curbs.
      f. Stone curbs.
   3. LEED Submittals:
      a. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.
   4. Adhesion and Compatibility Test Reports: From latex-additive manufacturer for mortar and grout containing latex additives.
   5. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C 136.
   6. Samples for Initial Selection: For the following:
      a. Each type of unit paver indicated.
      b. Joint materials involving color selection.
      c. Exposed edge restraints involving color selection.
      d. Precast concrete curbs.
      e. Granite for stone curbs.
   7. Samples for Verification:

a. Full-size units of each type of unit paver indicated. Assemble no fewer than five Samples of each type of unit on suitable backing and grout joints.]
b. Joint materials.
c. Exposed edge restraints.
d. Precast concrete curbs.
e. Stone curbs.

E. Quality Assurance
1. Source Limitations: Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.
2. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
a. Approved mockups may become part of the completed Work if undisturbed at time of Final Completion.
3. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
2. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
3. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
4. Store liquids in tightly closed containers protected from freezing.
5. Store asphalt cement and other bituminous materials in tightly closed containers.

G. Project Conditions
1. Cold-Weather Protection: Do not use frozen materials or build on frozen subgrade or setting beds.
2. Weather Limitations for Bituminous Setting Bed:
a. Install bituminous setting bed only when ambient temperature is above 40 deg F (4 deg C) and when base is dry.
b. Apply asphalt adhesive only when ambient temperature is above 50 deg F (10 deg C) and when temperature has not been below 35 deg F (2 deg C) for 12 hours immediately before application. Do not apply when setting bed is wet or contains excess moisture.
3. Weather Limitations for Mortar and rout:
a. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
b. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F (38 deg C) and higher.
1) When ambient temperature exceeds 100 deg F (38 deg C), or when wind velocity exceeds 8 mph (13 km/h) and ambient temperature exceeds 90 deg F (32 deg C), set pavers within 1 minute of spreading setting-bed mortar.

1.2 PRODUCTS

A. Brick Pavers
1. Regional Materials: Provide brick pavers that have been manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.

2. Brick Pavers: Light-traffic paving brick; ASTM C 902; Class SX for exposure to freezing weather **OR** Class MX for exterior uses that do not expose brick to freezing, **as directed**, Type I for locations exposed to extensive abrasion, such as sidewalks and driveways in public spaces **OR** Type II for locations exposed to intermediate abrasion, such as heavily traveled residential walkways and driveways **OR** Type III for locations exposed to low abrasion, such as floors and patios exposed in single-family homes, **as directed**. Application PS normal tolerance for installation with grouted joints **OR** Application PX close tolerance for ungrouted joints **OR** Application PA non-uniform sized for decorative effect, **as directed**. Provide brick without frogs or cores in surfaces exposed to view in the completed Work.
   a. Thickness: 1-1/4 inches (32 mm) **OR** 1-1/2 inches (38 mm) **OR** 1-5/8 inches (41 mm) **OR** 2-1/4 inches (57 mm) **OR** 2-5/8 inches (67 mm), **as directed**.
   b. Face Size: 3-3/4 by 7-1/2 inches (95 by 190 mm) **OR** 3-5/8 by 7-5/8 inches (92 by 194 mm) **OR** 3-5/8 by 11-5/8 inches (92 by 295 mm) **OR** 7-5/8 by 7-5/8 inches (194 by 194 mm) **OR** 4 by 8 inches (102 by 203 mm) **OR** 4 by 12 inches (102 by 305 mm) **OR** 8 by 8 inches (203 by 203 mm), **as directed**.
   c. Color: As selected from manufacturer's full range.
3. Brick Pavers: Heavy vehicular paving brick; ASTM C 1272, Type F, Application PX **OR** Type R, Application PS **OR** Type R, Application PX **OR** Type R, Application PA, **as directed**. Provide brick without frogs or cores in surfaces exposed to view in the completed Work.
   a. Type R is for units set in a mortar setting bed or a bituminous setting bed supported by an adequate base. Type F is for units set in a sand setting bed with sand between the pavers. Application PS is for general use; Application PX is for pavers with close dimensional tolerances. Application PX must be selected if specifying Type F
   b. Thickness: 2-1/4 inches (57 mm) **OR** 2-5/8 inches (67 mm), **as directed**.
   c. Face Size: 3-3/4 by 7-1/2 inches (95 by 190 mm) **OR** 3-5/8 by 7-5/8 inches (92 by 194 mm) **OR** 3-5/8 by 11-5/8 inches (92 by 295 mm) **OR** 7-5/8 by 7-5/8 inches (194 by 194 mm) **OR** 4 by 8 inches (102 by 203 mm) **OR** 4 by 12 inches (102 by 305 mm) **OR** 8 by 8 inches (203 by 203 mm), **as directed**.
   d. Color: As selected from manufacturer's full range.
4. Efflorescence: Brick shall be rated "not effloresced" when tested according to ASTM C 67.
5. Temporary Protective Coating: Precoat exposed surfaces of brick pavers with a continuous film of a temporary protective coating that is compatible with brick, mortar, and grout products and can be removed without damaging grout or brick. Do not coat unexposed brick surfaces; handle brick to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.

B. Concrete Pavers
1. Concrete Pavers: Solid interlocking paving units complying with ASTM C 936 and resistant to freezing and thawing when tested according to ASTM C 67, made from normal-weight aggregates.
   a. Thickness: 2-3/8 inches (60 mm) **OR** 3-1/8 inches (80 mm), **as directed**.
   b. Face Size and Shape: 3-7/8 inches (98 mm) square **OR** 4-7/16 inches (113 mm) **OR** 8-7/8 inches (225 mm) **OR** 9 inches (229 mm)square, **as directed**.
   c. Face Size and Shape: 3-7/8-by-7-7/8 inch (98-by-200 mm) **OR 4-by-8-inch (102-by-203-mm) OR** 4-7/16-by-8-7/8 inch (113-by 225-mm), **as directed,** rectangle.
   d. Face Size and Shape: 5-1/2-inch (140-mm) octagon with attached 3-1/2-inch (89-mm) square **OR** 4-1/2-by-9 inch (114-by-229 mm) rectangle with saw-tooth edges **OR** 4-3/4-inch (121-mm) rectangular and trapezoidal units arranged in semicircular courses to produce fan-shaped pattern, **as directed.**
   e. Color: As selected from manufacturer's full range.
2. Concrete Pavers: Solid paving units, made from normal-weight concrete with a compressive strength not less than 5000 psi (34 MPa) **OR** 6000 psi (41 MPa), **as directed**, water absorption not more than 5 percent according to ASTM C 140, and no breakage and not more than 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C 67.

a. Thickness: 1-5/8 inches (41 mm) **OR** 1-3/4 inches (45 mm) **OR** 2 inches (51 mm) **OR** 2-3/8 inches (60 mm), **as directed**.
b. Face Size and Shape: 8-7/8 inches (225 mm) square **OR** 9 inches (229 mm) square **OR** 12 inches (305 mm) square **OR** 18 inches (457 mm) square **OR** 24 inches (610 mm) square, **as directed**.
c. Face Size and Shape: 9-by-18 inch (229-by-457 mm) **OR** 12-by-24 inch (305-by-610 mm), **as directed,** rectangle.
d. Face Size and Shape: As indicated.
e. Color: As selected from manufacturer's full range.

3. Concrete Pavers: Solid paving units complying with ASTM C 1491, made from lightweight concrete.
   a. Thickness: 1-5/8 inches (41 mm) **OR** 1-3/4 inches (45 mm) **OR** 2 inches (51 mm), **as directed**.
   b. Face Size and Shape: 9 inches (229 mm) square **OR** 12 inches (305 mm) square **OR** 18 inches (457 mm) square, **as directed.**
   c. Color: As selected from manufacturer's full range.

C. Asphalt-Block Pavers

1. Asphalt-Block Pavers: Solid units made from asphalt cement complying with ASTM D 312, Type **III**; inorganic stone dust or cement filler; and coarse aggregate, consisting of clean, hard, unweathered stone crushed into angular particles varying in size up to 3/8 inch (9.5 mm).
   a. Thickness: 1-1/4 inches (32 mm) **OR** 2 inches (51 mm) **OR** 3 inches (76 mm), **as directed**.
   b. Face Size: 4 by 6 inches (102 by 152 mm) **OR** 6 by 6 inches (152 by 152 mm) **OR** 8 by 8 inches (203 by 203 mm) **OR** 5 by 12 inches (127 by 305 mm) **OR** 6 by 12 inches (152 by 305 mm) **OR** 8-inch- (203-mm-) wide hexagon, **as directed**.
   c. Finish: Natural, smooth **OR** Ground **OR** Ground and sandblasted, **as directed**.
   d. Color: As selected from manufacturer's full range.

D. Stone Pavers

1. Granite Pavers: Rectangular paving slabs made from granite complying with ASTM C 615
   a. Color and Grain: Light gray **OR** Dark gray **OR** Buff **OR** White **OR** Black **OR** Pink, **as directed,** with medium **OR** fine, **as directed,** grain.
   b. Finish: Honed **OR** Thermal, **as directed.**
   c. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.
   d. Thickness: Not less than 3/4 inch (20 mm) **OR** 30 mm **OR** 1-1/4 inches (32 mm) **OR** 1-5/8 inches (40 mm), **as directed**, unless otherwise indicated.
   e. Face Size: 9 inches (229 mm) square **OR** 12 inches (305 mm) square **OR** 18 inches (457 mm) square **OR** 9 by 18 inches (229 by 457 mm)**, as directed.**
2. Limestone Pavers: Rectangular paving slabs made from limestone complying with ASTM C 568.
   a. Classification: **II** Medium-Density **OR III** High-Density**, as directed**.
   b. Stone Abrasion Resistance: Minimum value of 10, based on testing according to ASTM C 241 or ASTM C 1353.
   c. Finish: Smooth **OR** Chat sawed **OR** Shot sawed**, as directed.**
   d. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.
   e. Thickness: Not less than 1 inch (25 mm) **OR** 1-1/4 inches (32 mm) **OR** 1-5/8 inches (40 mm) **OR** 2 inches (50 mm)**, as directed,** unless otherwise indicated.
   f. Face Size: 9 inches (229 mm) square **OR** 12 inches (305 mm) square **OR** 18 inches (457 mm) square **OR** 9 by 18 inches (229 by 457 mm), **as directed.**
3. Marble Pavers: Rectangular paving slabs made from marble complying with ASTM C 503.
   a. Stone Abrasion Resistance: Minimum value of 10, based on testing according to ASTM C 241 or ASTM C 1353.
   b. Description: Uniform, fine- to medium-grained, white stone with only slight veining.

c. Finish: Honed **OR as directed.**
d. Match samples for color, finish, and other stone characteristics relating to aesthetic effects.
e. Thickness: Not less than 3/4 inch (20 mm) **OR** 30 mm **OR** 1-1/4 inches (32 mm), **as directed**.
f. Face Size: 9 inches (229 mm) square**OR**12 inches (305 mm) square **OR** 18 inches (457 mm) square **OR** 9 by 18 inches (229 by 457 mm) **as directed**.

4. Quartz-Based Stone Pavers: Rectangular paving slabs **OR** Random polygonal flagstones made from quartz-based stone complying with ASTM C 616, Classification I Sandstone **OR** II Quartzitic Sandstone **OR** III Quartzite, **as directed**.
a. Stone Abrasion Resistance: Minimum value of 10, based on testing according to ASTM C 241 or ASTM C 1353.
b. Finish: Sand rubbed **OR** Natural cleft **OR** Thermal, **as directed**.
c. Match samples for color, finish, and other stone characteristics relating to aesthetic effects.
d. Thickness: Not less than 1 inch (25 mm) **OR** 1-1/4 inches (32 mm) **OR** 1-1/2 inches (38 mm) **OR** 1-5/8 inches (40 mm) **OR** 2 inches (50 mm), **as directed**.
e. Face Size: 9 inches (229 mm) square **OR** 12 inches (305 mm) square **OR** 18 inches (457 mm) square **OR** 9 by 18 inches (229 by 457 mm), **as directed**.

5. Slate Pavers: Rectangular paving slabs **OR** Random polygonal flagstones made from slate complying with ASTM C 629, Classification I Exterior, with a fine, even grain and unfading color, from clear, sound stock.
a. Color: Black **OR** Blue-black **OR** Gray **OR** Blue-gray **OR** Green **OR** Purple **OR** Mottled purple and green **OR** Red, **as directed**.
b. Stone Abrasion Resistance: Minimum value of 8, based on testing according to ASTM C 241 or ASTM C 1353.
c. Finish: Honed **OR** Sand rubbed **OR** Natural cleft, **as directed**.
d. Match samples for color, finish, and other stone characteristics relating to aesthetic effects.
e. Thickness: Not less than 1/2 inch (13 mm) **OR** 3/4 inch (20 mm) **OR** 1 inch (25 mm), **as directed**.
f. Face Size: 9 inches (229 mm) square **OR** 12 inches (305 mm) square **OR** 18 inches (457 mm) square **OR** 9 by 18 inches (229 by 457 mm), **as directed**.

6. Travertine Pavers: Rectangular paving slabs made from travertine complying with ASTM C 1527, Classification I Exterior.
a. Stone Abrasion Resistance: Minimum value of 10, based on testing according to ASTM C 241 or ASTM C 1353.
b. Cut: Vein cut.
c. Filling: Fill pores on faces of stone with cementitious filler of color as selected by the Owner.
d. Finish: Honed **OR as directed**.
e. Match samples for color, finish, and other stone characteristics relating to aesthetic effects.
f. Thickness: Not less than 3/4 inch (20 mm) **OR** 30 mm **OR** 1-1/4 inches (32 mm), **as directed**.
g. Face Size: 9 inches (229 mm) square **OR** 12 inches (305 mm) square **OR** 18 inches (457 mm) square **OR** 9 by 18 inches (229 by 457 mm), **as directed.**

7. Rough-Stone Pavers: Rectangular tumbled paving stones, with split or thermal-finished faces and edges, made from granite complying with ASTM C 615.
a. Granite Color and Grain: Light gray **OR** Dark gray **OR** Buff **OR** White **OR** Black **OR** Pink, **as directed,** with medium **OR** fine, **as directed,** grain.
b. Thickness: 1-1/4 inches (32 mm) **OR** 2 inches (51 mm) **OR** 3 inches (76 mm) **OR** 4 inches (102 mm) **OR** 4 inches (102 mm), plus or minus 1/2 inch (13 mm), **as directed**.
c. Face Size: 4 by 4 inches (100 by 100 mm), plus or minus 1/2 inch (13 mm) **OR** 3 to 5 inches (75 to 125 mm) by 8 to 12 inches (200 to 300 mm), **as directed**.

E. Curbs And Edge Restraints

1. Plastic Edge Restraints: Manufacturer's standard triangular PVC extrusions 1-3/4 inches (45 mm) high by 3-1/2 inches (89 mm) wide **OR** 3-1/8 inches (79 mm) high by 9-1/2 inches (241 mm) wide, **as directed,** designed to serve as edge restraints for unit pavers; rigid type for straight

edges and flexible type for curved edges, with pipe connectors and 3/8-inch (9.5-mm) diameter by 12-inch- (300-mm-) long steel spikes.

2. Steel Edge Restraints: Manufacturer's standard painted steel edging 3/16 inch (4.8 mm) thick by 4 inches (100 mm) high **OR** 1/4 inch (6.4 mm) thick by 5 inches (125 mm) high, **as directed** with loops pressed from or welded to face to receive stakes at 36 inches (900 mm) o.c., and steel stakes 15 inches (380 mm) long for each loop.
   a. Color: As selected from manufacturer's full range.
3. Aluminum Edge Restraints: Manufacturer's standard straight, 1/8-inch- (3.2-mm-) thick by 4-inch- (100-mm-) high **OR** straight, 3/16-inch- (4.8-mm-) thick by 4-inch- (100-mm-) high **OR** L-shaped, 1/8-inch- (3.2-mm-) thick by 1-3/8-inch- (35-mm-) high **OR** L-shaped, 3/16-inch- (4.8-mm-) thick by 2-1/4-inch- (57-mm-) high, **as directed** extruded-aluminum edging with loops pressed from face to receive stakes at 12 inches (300 mm) o.c., and aluminum stakes 12 inches (300 mm) long for each loop.
4. Job-Built Concrete Edge Restraints: Comply with requirements in Division 3 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of 3000 psi (20 MPa).
5. Precast Concrete Curbs: Made from normal-weight concrete with a compressive strength not less than 5000 psi (34 MPa) **OR** 6000 psi (41 MPa), **as directed** and water absorption not more than 5 percent, in shapes and sizes indicated.
6. Stone Curbs: Granite curbing, with face battered 1 inch per foot (1:12), produced in random lengths not less than 36 inches (900 mm) from granite complying with ASTM C 615.
   a. Granite Color and Grain: Light gray **OR** Dark gray **OR** Buff **OR** White **OR** Black **OR** Pink, **as directed** with fine **OR** medium **OR** coarse grain, **as directed**.
   b. Top Width: 4 inches (102 mm) **OR** 5 inches (127 mm) **OR** 6 inches (152 mm), **as directed**.
   c. Face Height: 4 inches (102 mm) **OR** 6 inches (152 mm) **OR** 8 inches (203 mm), **as directed**.
   d. Total Height: 12 inches (305 mm) **OR** 16 inches (406 mm) **OR** 18 inches (457 mm), **as directed**.
   e. Top Finish: Sawed **OR** Thermal **OR** Bush hammered, **as directed**.
   f. Face Finish: Split **OR** Sawed **OR** Thermal **OR** Bush hammered, **as directed.**

F. Accessories
1. Cork Joint Filler: Preformed strips complying with ASTM D 1752, Type II.
2. Compressible Foam Filler: Preformed strips complying with ASTM D 1056, Grade 2A1.

G. Aggregate Setting-Bed Materials
1. Graded Aggregate for Sub-base: Sound, crushed stone or gravel complying with ASTM D 448 for Size No. 57 **OR** ASTM D 2940, sub-base material **OR** requirements in Division 31 Section "Earth Moving" for sub-base material, **as directed**.
2. Graded Aggregate for Base: Sound, crushed stone or gravel complying with ASTM D 448 for Size No. 8 **OR** ASTM D 2940, base material **OR** requirements in Division 31 Section "Earth Moving" for base course, **as directed**.
3. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate.
4. Stone Screenings for Leveling Course: Sound stone screenings complying with ASTM D 448 for Size No. 10.
5. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 (1.18-mm) sieve and no more than 10 percent passing No. 200 (0.075-mm) sieve.
   a. Provide sand of color needed to produce required joint color.
6. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications; made from polyolefins or polyesters, with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
   a. Survivability: Class 2, AASHTO M 288.
   b. Apparent Opening Size: No. 60 (0.250-mm) sieve, maximum; ASTM D 4751.

c. Permittivity: 0.02 per second, minimum; ASTM D 4491.
d. UV Stability: 50 percent after 500 hours' exposure, ASTM D 4355.

7. Drainage Geotextile: Nonwoven needle-punched geotextile made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
   a. Survivability: Class 2, AASHTO M 288.
   b. Apparent Opening Size: No. 40 (0.425-mm) sieve, maximum; ASTM D 4751.
   c. Permittivity: 0.5 per second, minimum; ASTM D 4491.
   d. UV Stability: 50 percent after 500 hours' exposure, ASTM D 4355.
8. Herbicide: Commercial chemical for weed control, registered with the EPA. Provide in granular, liquid, or wettable powder form.

H. Bituminous Setting-Bed Materials
1. Primer for Base: ASTM D 2028, cutback asphalt, grade as recommended by unit paver manufacturer.
2. Fine Aggregate for Setting Bed: ASTM D 1073, No. 2 or No. 3.
3. Asphalt Cement: ASTM D 3381, Viscosity Grade AC-10 or Grade AC-20.
4. Neoprene-Modified Asphalt Adhesive: Paving manufacturer's standard adhesive consisting of oxidized asphalt combined with 2 percent neoprene and 10 percent long-fibered mineral fibers containing no asbestos.
5. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 (1.18-mm) sieve and no more than 10 percent passing No. 200 (0.075-mm) sieve.
   a. Provide sand of color needed to produce required joint color.

I. Mortar Setting-Bed Materials
1. Portland Cement: ASTM C 150, Type I or II.
2. Hydrated Lime: ASTM C 207, Type S.
3. Sand: ASTM C 144.
4. Latex Additive: Manufacturer's standard, acrylic resin or styrene-butadiene-rubber water emulsion, **as directed** serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed, and not containing a retarder.
5. Thinset Mortar: Latex-modified portland cement mortar complying with ANSI A118.4.
   a. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
   b. Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site, as directed.
6. Water: Potable.
7. Reinforcing Wire Fabric: Galvanized, welded wire fabric, 2-by-2-inch (51-by-51-mm) by 0.062-inch- (1.57-mm-) diameter wire; comply with ASTM A 1064/A 1064M and ASTM A 82/A 82M except for minimum wire size.

J. Grout Materials
1. Sand-Portland Cement Grout: ANSI A108.10, composed of white or gray cement, unfading mineral pigments and white or colored sand as required to produce required color.
   a. Colored Mortar Pigments for Grout: Natural and synthetic iron and chromium oxides, compounded for use in mortar and grout mixes. Use only pigments that have proved, through testing and experience, to be satisfactory for use in portland cement grout.
2. Standard Cement Grout: ANSI A118.6, sanded.
3. Polymer-Modified Grout: ANSI A118.7, sanded grout; in color indicated.
   a. Polymer Type: Ethylene-vinyl acetate or acrylic additive in dry, redispersible form; prepackaged with other dry ingredients.
   b. Polymer Type: Acrylic resin or styrene-butadiene rubber in liquid-latex form for addition to prepackaged dry-grout mix.
4. Grout Colors: As selected from manufacturer's full range.
5. Water: Potable.

K. Bituminous Setting-Bed Mix
1. Mix bituminous setting-bed materials at an asphalt plant in approximate proportion, by weight, of 7 percent asphalt cement to 93 percent fine aggregate, unless otherwise indicated. Heat mixture to 300 deg F (149 deg C).

L. Mortar And Grout Mixes
1. General: Comply with referenced standards and with manufacturers' written instructions. Discard mortars and grout if they have reached their initial set before being used.
2. Mortar-Bed Bond Coat: Mix neat cement or cement and sand with latex additive **OR** water, **as directed,** to a creamy consistency.
3. Portland Cement-Lime Setting-Bed Mortar: Type M complying with ASTM C 270, Proportion Specification.
4. Latex-Modified, Portland Cement Setting-Bed Mortar: Proportion and mix portland cement, sand, and latex additive for setting bed to comply with written instructions of latex-additive manufacturer and as necessary to produce stiff mixture with a moist surface when bed is ready to receive pavers.
5. Latex-Modified, Portland Cement Slurry Bond Coat: Proportion and mix portland cement, aggregate, and liquid latex for bond coat to comply with written instructions of liquid-latex manufacturer.
6. Thinset Mortar Bond Coat: Proportion and mix thinset mortar ingredients according to manufacturer's written instructions.
7. Job-Mixed Portland Cement Grout: Proportion and mix job-mixed portland cement and aggregate grout to match setting-bed mortar except omit hydrated lime and use enough water to produce a pourable mixture.
   a. Pigmented Grout: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1:10, by weight.
   b. Colored-Aggregate Grout: Produce color required by combining colored sand with portland cement of selected color.
8. Package Grout Mix: Proportion and mix grout ingredients according to grout manufacturer's written instructions.

1.3 EXECUTION

A. Examination
1. Examine areas indicated to receive paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
2. Where pavers are to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations, including areas where waterproofing system is turned up or flashed against vertical surfaces.
3. Proceed with installation only after unsatisfactory conditions have been corrected and waterproofing protection is in place.

B. Preparation
1. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.
2. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.
3. Proof-roll prepared subgrade according to requirements in Division 31 Section "Earth Moving" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive subbase and base course for unit pavers.

C. Installation, General
1. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.

2. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
3. Cut unit pavers with motor-driven masonry saw equipment to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible.
   a. For concrete pavers, a block splitter may be used.
4. Handle protective-coated brick pavers to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.
5. Joint Pattern: Running bond **OR** Herringbone **OR** Basket weave **OR** Match and continue existing unit paver joint pattern, **as directed**.
6. Pavers over Waterproofing: Exercise care in placing pavers and setting materials over waterproofing so protection materials are not displaced and waterproofing is not punctured or otherwise damaged. Carefully replace protection materials that become displaced and arrange for repair of damaged waterproofing before covering with paving.
   a. Provide joint filler at waterproofing that is turned up on vertical surfaces, unless otherwise indicated; where unfilled joints are indicated, provide temporary filler or protection until paver installation is complete.
7. Tolerances: For smooth pavers where slopes to drains are critical. Do not exceed 1/32-inch (0.8-mm) unit-to-unit offset from flush (lippage) nor 1/8 inch in 10 feet (3 mm in 3 m) from level, or indicated slope, for finished surface of paving.
   OR
   Tolerances: For smooth, flat pavers. Do not exceed 1/16-inch (1.6-mm) unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches (3 mm in 600 mm) and 1/4 inch in 10 feet (6 mm in 3 m) from level, or indicated slope, for finished surface of paving.
8. Expansion and Control Joints: Provide for sealant-filled joints at locations and of widths indicated. Provide compressible foam filler as backing for sealant-filled joints unless otherwise indicated; where unfilled joints are indicated, provide temporary filler until paver installation is complete. Install joint filler before setting pavers. Sealant materials and installation are specified in Division 07 Section "Joint Sealants".
   OR
   Expansion and Control Joints: Provide cork joint filler at locations and of widths indicated. Install joint filler before setting pavers. Make top of joint filler flush with top of pavers.
9. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.
   a. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after unit paver installation.
   b. For metal edge restraints with top edge exposed, drive stakes at least 1 inch (25 mm) below top edge.
   c. Install job-built concrete edge restraints to comply with requirements in Division 03 Section "Cast-in-place Concrete".
   d. Where pavers set in mortar bed are indicated as edge restraints for pavers set in aggregate setting bed, install pavers set in mortar and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.
   e. Where pavers embedded in concrete are indicated as edge restraints for pavers set in aggregate setting bed, install pavers embedded in concrete and allow concrete to cure before placing aggregate setting bed and remainder of pavers. Hold top of concrete below aggregate setting bed.
10. Provide steps made of pavers as indicated. Install paver steps before installing adjacent pavers.
   a. Where pavers set in mortar bed are indicated for steps constructed adjacent to pavers set in aggregate setting bed, install steps and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.

D. Aggregate Setting-Bed Applications
1. Compact soil subgrade uniformly to at least 95 percent of ASTM D 698 **OR** ASTM D 1557, **as directed,** laboratory density.

2. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined, and replace with compacted backfill or fill as directed.
3. Place separation geotextile over prepared subgrade, overlapping ends and edges at least 12 inches (300 mm).
4. Place aggregate subbase and base **OR** base, **as directed.**
   a. For light-traffic compact by tamping with plate vibrator, and screed to depth indicated.
   b. For heavy duty compact to 100 percent of ASTM D 1557 maximum laboratory density, and screed to depth indicated.
5. Place drainage geotextile over compacted base course, overlapping ends and edges at least 12 inches (300 mm).
6. Place leveling course and screed to a thickness of 1 to 1-1/2 inches (25 to 38 mm), taking care that moisture content remains constant and density is loose and constant until pavers are set and compacted.
7. Treat leveling course with herbicide to inhibit growth of grass and weeds.
8. Set pavers with a minimum joint width of 1/16 inch (1.5 mm) and a maximum of 1/8 inch (3 mm), being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8 inch (10 mm) with pieces cut to fit from full-size unit pavers.
   a. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.
9. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf (16- to 22-kN) compaction force at 80 to 90 Hz. Use vibrator with neoprene mat on face of plate or other means as needed to prevent cracking and chipping of pavers. Perform at least three passes across paving with vibrator.
   a. Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least 36 inches (900 mm) of uncompacted pavers adjacent to temporary edges.
   b. Before ending each day's work, compact installed concrete pavers except for 36-inch (900 mm) width of uncompacted pavers adjacent to temporary edges (laying faces).
   c. As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within 36 inches (90 mm) of laying face.
   d. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and cover leveling course on which pavers have not been placed with nonstaining plastic sheets to protect them from rain.
10. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.
11. Do not allow traffic on installed pavers until sand has been vibrated into joints.
12. Repeat joint-filling process 30 days later.

E. Bituminous Setting-Bed Applications
1. Apply primer to concrete slab or binder course immediately before placing setting bed.
2. Prepare for setting-bed placement by locating 3/4-inch- (19-mm-) deep control bars approximately 11 feet (3.3 m) apart, to serve as guides for striking board. Adjust bars for accurate setting of paving units to finished grades indicated.
3. Place bituminous setting bed between control bars. Spread mix at a minimum temperature of 250 deg F (121 deg C). Strike setting bed smooth, firm, even, and not less than 3/4 inch (19 mm) thick. Add fresh bituminous material to low, porous spots after each pass of striking board. Carefully fill depressions that remain after removing depth-control bars.
   a. Roll setting bed with power roller to a nominal depth of 3/4 inch (19 mm). Adjust thickness as necessary to allow accurate setting of unit pavers to finished grades indicated. Complete rolling before mix temperature cools to 185 deg F (85 deg C).
4. Apply neoprene-modified asphalt adhesive to cold setting bed by squeegeeing or troweling to a uniform thickness of 1/16 inch (1.6 mm). Proceed with setting of paving units only after adhesive is tacky and surface is dry to touch.

5. Place pavers carefully by hand in straight courses, maintaining accurate alignment and uniform top surface. Protect newly laid pavers with plywood panels on which workers can stand. Advance protective panels as work progresses, but maintain protection in areas subject to continued movement of materials and equipment to avoid creating depressions or disrupting alignment of pavers. If additional leveling of paving is required, and before treating joints, roll paving with power roller after sufficient heat has built up in the surface from several days of hot weather.
6. Joint Treatment: Place unit pavers with hand-tight joints. Fill joints by sweeping sand over paved surface until joints are filled. Remove excess sand after joints are filled.

F. Mortar Setting-Bed Applications
1. Saturate concrete sub-base with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.
2. Apply mortar-bed bond coat over surface of concrete sub-base about 15 minutes before placing setting bed. Limit area of bond coat to avoid its drying out before placing setting bed. Do not exceed 1/16-inch (1.6-mm) thickness for bond coat.
3. Apply mortar bed over bond coat immediately after applying bond coat. Spread and screed to subgrade elevations required for accurate setting of pavers to finished grades indicated.
4. Place reinforcing wire over concrete sub-base, lapped at joints by at least one full mesh and supported so mesh becomes embedded in the middle of setting bed. Hold edges back from vertical surfaces approximately 1/2 inch (13 mm).
5. Place mortar bed with reinforcing wire fully embedded in middle of setting bed. Spread and screed setting bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.
6. Mix and place only that amount of mortar that can be covered with pavers before initial set. Cut back and discard setting-bed material that has reached initial set before placing pavers.
7. Wet brick pavers before laying if the initial rate of absorption exceeds 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.
8. Place pavers before initial set of cement occurs. Immediately before placing pavers, apply uniform 1/16-inch- (1.5-mm-) thick, slurry bond coat to bed or to back of each paver.
9. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.
10. Spaced Joint Widths: Provide 3/8-inch (10-mm) **OR** 1/2-inch (13-mm) **OR** 3/4-inch (19-mm), **as directed,** nominal joint width with variations not exceeding plus or minus 1/16 inch (1.5 mm) **OR** 1/8 inch (3 mm) **OR** 3/16 inch (4.5 mm), **as directed**.
11. Grouted Joints: Grout paver joints complying with ANSI A108.10.
12. Grout joints as soon as possible after initial set of setting bed.
    a. Force grout into joints, taking care not to smear grout on adjoining surfaces.
    b. Clean pavers as grouting progresses by dry brushing or rubbing with dry burlap to remove smears before tooling joints.
    c. Tool exposed joints slightly concave when thumbprint hard.
    d. If tooling squeezes grout from joints, remove excess grout and smears by dry brushing or rubbing with dry burlap and tool joints again to produce a uniform appearance.
13. Cure grout by maintaining in a damp condition for seven days, unless otherwise recommended by grout or liquid-latex manufacturer.

G. Repairing, Pointing, And Cleaning
1. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.
2. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.

3. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.
   a. Remove temporary protective coating as recommended by coating manufacturer and as acceptable to paver and grout manufacturers.
   b. Do not allow protective coating to enter floor drains. Trap, collect, and remove coating material.

END OF SECTION 31 25 14 23

Task	Specification	Specification Description
31 25 14 23	01 56 26 00	Sediment Removal
31 25 14 23	31 25 14 13	Geosynthetic Fabric
31 25 14 23	01 56 26 00a	Erosion Control

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SECTION 31 25 14 26 - SILT FENCES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing of labor, material and equipment for the installation of silt fencing.

1.2 PRODUCTS

A. Materials
   1. Fabricated Units
      a. Posts: 36" long, 2" hardwood or "T" or "U" type steel.
      b. Fence: Woven wire, 14-1/2 ga. 6-inch max. mesh opening.
      c. Filter Cloth: MIRAFI 100X or approved equal.
   2. Prefabricated Units
      a. Envirofence by MIRAFI or approved equal.

1.3 EXECUTION

A. The Contractor shall provide and install silt fences as directed by the Owner. It shall be the Contractor's option to provide fabricated reinforced silt fence or prefabricated units, unless otherwise directed. In all installations, the bottom flap of filter cloth shall be firmly embedded into undisturbed or stabilized grade. Embedment shall resist pullout and prevent flow under the installation.

END OF SECTION 31 25 14 26

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Task	Specification	Specification Description
31 25 14 26	01 56 26 00	Sediment Removal
31 25 14 26	01 56 26 00a	Erosion Control

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SECTION 31 31 16 13 - TERMITE CONTROL

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for termite control. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Soil and wood treatment with termiticide.
b. Bait-station system.
c. Metal mesh barrier system.
d. Polymer sheet barrier system with termiticide.
e. Polymer barrier fittings with termiticide for installation around utility penetrations.

C. Submittals
1. Product Data: For each type of termite control product.
a. Include the EPA-Registered Label for termiticide products.
2. Qualification Data: For qualified Installer.
3. Product Certificates: For termite control products, from manufacturer.
4. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:
a. Date and time of application.
b. Moisture content of soil before application.
c. Termiticide brand name and manufacturer.
d. Quantity of undiluted termiticide used.
e. Dilutions, methods, volumes used, and rates of application.
f. Areas of application.
g. Water source for application.
5. Wood Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:
a. Date and time of application.
b. Termiticide brand name and manufacturer.
c. Quantity of undiluted termiticide used.
d. Dilutions, methods, volumes used, and rates of application.
e. Areas of application.
6. Bait-Station System Application Report: After installation of bait-station system is completed, submit report for Owner's records and include the following:
a. Location of areas and sites conducive to termite feeding and activity.
b. Plan drawing showing number and locations of bait stations.
c. Dated report for each monitoring and inspection occurrence indicating level of termite activity, procedure, and treatment applied before time of Final Completion.
d. Termiticide brand name and manufacturer.
e. Quantities of termiticide and nontoxic termite bait used.
f. Schedule of inspections for one year from date of Final Completion.
7. Polymer Sheet Barrier System with Termiticide Application Report: After installation of polymer sheet barrier system with termiticide is completed, submit report for Owner's records and include the following:
a. Plan drawing showing extent of sheet barrier and number and locations of each type of polymer barrier fitting.
b. Termiticide brand name and manufacturer.

c. Schedule of inspections for one year from date of Final Completion.

8. Polymer Barrier Fittings with Termiticide Application Report: After installation of polymer barrier fittings with termiticide is completed, submit report for Owner's records and include the following:
    a. Plan drawing showing number and locations of each type of polymer barrier fitting with termiticide.
    b. Termiticide brand name and manufacturer.
    c. Schedule of inspections for one year from date of Final Completion.
9. Warranties: Sample of special warranties.

D. Quality Assurance
1. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located, and who employs workers trained and approved by manufacturer to install manufacturer's products.
2. Regulatory Requirements: Formulate and apply termiticides and termiticide devices according to the EPA-Registered Label.
3. Source Limitations: Obtain termite control products from single source.
4. Preinstallation Conference: Conduct conference at Project site.

E. Project Conditions
1. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.
2. Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.
3. Apply wood treatment after framing, sheathing, and exterior weather protection is completed but before electrical and mechanical systems are installed.
4. Install bait-station system during construction to determine areas of termite activity and after construction, including landscaping, is completed.
5. Install polymer sheet barrier system with termiticide prior to placing concrete slab reinforcement and pouring concrete and after installation and inspection of footings, foundations, and plumbing and electrical pipes and conduits.
6. Install polymer barrier fittings with termiticide around utility penetrations prior to pouring concrete and after installation and inspection of plumbing and electrical pipes and conduits, slab vapor barrier, and concrete slab reinforcement.

F. Warranty
1. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.
    a. Warranty Period: Three **OR** Five, **as directed**, years from date of Final Completion.
2. Wood Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of applied wood termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite damage is discovered during warranty period, repair or replace damage caused by termite infestation and treat replacement wood.
    a. Warranty Period: 12 years from date of Final Completion.
3. Polymer Sheet Barrier System with Termiticide Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of installation of polymer sheet barrier system with termiticide, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat and repair or replace damage caused by termite infestation.
    a. Warranty Period: 10 years from date of Final Completion.

4. Polymer Barrier Fittings with Termiticide Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of installation of polymer barrier fittings with termiticide, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat and repair or replace damage caused by termite infestation.
   a. Warranty Period: Five years from date of Final Completion.

G. Maintenance Service
1. Continuing Service (as directed): Beginning at Final Completion, provide 12 months' continuing service including monitoring, inspection, and re-treatment for occurrences of termite activity. Provide a standard continuing service agreement. State services, obligations, conditions, terms for agreement period, and terms for future renewal options.

1.2 PRODUCTS

A. Soil Treatment
1. Termiticide: Provide an EPA-Registered termiticide, complying with requirements of authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to product's EPA-Registered Label.
   a. Service Life of Treatment: Soil treatment termiticide that is effective for not less than three **OR** five, **as directed**, years against infestation of subterranean termites.

B. Wood Treatment
1. Borate: Provide an EPA-Registered borate temiticide, complying with requirements of authorities having jurisdiction, in an aqueous solution for spray application and a gel solution for pressure injection, formulated to prevent termite infestation in wood. Provide quantity required for application at the label volume and rate for the maximum diffusible borate concentration allowed for each specific use, according to product's EPA-Registered Label.

C. Bait-Station System
1. Provide bait stations based on the dimensions of building perimeter indicated on Drawings, according to manufacturer's EPA-Registered Label for product, manufacturer's written instructions, and the following:
   a. No fewer than one bait station per 8 linear feet (2.4 linear meters) **OR** 20 linear feet (6.1 linear meters), **as directed**.
   b. No fewer than one cluster of bait stations per 20 linear feet (6.1 linear meters), consisting of no fewer than three bait stations per cluster.

D. Metal Mesh Barrier System
1. Stainless-Steel Mesh: 0.025-by-0.018-inch (0.64-by-0.45-mm) mesh of 0.08-inch- (2.0-mm-) diameter, stainless-steel wire, Type 316.

E. Polymer Sheet Barrier System
1. Polymer Sheet: 16-mil- (0.40-mm-) thick, multilayered, laminated, polymer sheet with lambda-cyhalothrin termiticide sealed between two outer polymer layers.

F. Polymer Barrier Fittings
1. Pipe/Conduit Fitting: Integral 2-1/2-inch- (65-mm-) long polymer sleeve and 1-inch- (25-mm-) wide circular flange with lambda-cyhalothrin termiticide sealed between two outer polymer layers; with fasteners.
2. Tub Trap Fitting: Integral polymer boot and 23-by-23-inch (585-by-585-mm) flange with lambda-cyhalothrin termiticide sealed between two outer polymer layers; with fasteners.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termiticide label requirements, interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.
2. Proceed with application only after unsatisfactory conditions have been corrected.

B. Preparation
1. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's written instructions for preparation before beginning application of termite control treatment. Remove all extraneous sources of wood cellulose and other edible materials such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.
2. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.
   a. Fit filling hose connected to water source at the site with a backflow preventer, complying with requirements of authorities having jurisdiction.

C. Application, General
1. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's EPA-Registered Label for products.

D. Applying Soil Treatment
1. Application: Mix soil treatment termiticide solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of termiticide, according to manufacturer's EPA-Registered Label, to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction. Distribute treatment evenly.
   a. Slabs-on-Grade and Basement Slabs: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
   b. Foundations: Adjacent soil, including soil along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing. Avoid soil washout around footings.
   c. Crawlspaces: Soil under and adjacent to foundations as previously indicated. Treat adjacent areas including around entrance platform, porches, and equipment bases. Apply overall treatment only where attached concrete platform and porches are on fill or ground.
   d. Masonry: Treat voids.
   e. Penetrations: At expansion joints, control joints, and areas where slabs will be penetrated.
2. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.
3. Protect termiticide solution, dispersed in treated soils and fills, from being diluted until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.
4. Post warning signs in areas of application.
5. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

E. Applying Wood Treatment

1. Application: Mix wood treatment solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of borate, according to manufacturer's EPA-Registered Label, so that wood framing, sheathing, siding, and structural members subject to infestation receive treatment.
    a. Framing and Sheathing: Apply termiticide solution by spray to bare wood for complete coverage.
    b. Wood Members More Than 4 Inches (100 mm) Thick: Inject termiticide gel solution under pressure into holes of size and spacing required by manufacturer for treatment.
    c. Exterior Uncoated Wood Trim and Siding: Apply termiticide solution to bare wood siding. After 48 hours, apply a seal coat of paint as specified in Division 07.

F. Installing Bait-Station System
1. Place bait stations according to the EPA-Registered Label for the product and manufacturer's written instructions, in the following areas that are conducive to termite feeding and activity:
    a. Conducive sites and locations indicated on Drawings.
    b. In and around infested trees and stumps.
    c. In mulch beds.
    d. Where wood directly contacts soil.
    e. Areas of high soil moisture.
    f. Near irrigation sprinkler heads.
    g. Each area where roof drainage system, including downspouts and scuppers, drains to soil.
    h. Along driplines of roof overhangs without gutters.
    i. Where condensate lines from mechanical equipment drip or drain to soil.
    j. At plumbing penetrations through ground-supported slabs.
    k. Other sites and locations as determined by licensed Installer.
2. Inspect and service bait stations from time of their application until Final Completion unless extended by continuing service agreement, according to the EPA-Registered Label for product and manufacturer's written instructions for termite management system and bait products.
    a. Service Frequency: Inspect bait stations not less than once every **OR** every three, **as directed**, month(s).

G. Installing Metal Mesh Barrier System
1. Install metal mesh barrier system where indicated to provide a continuous barrier to entry of subterranean termites according to manufacturer's written instructions.
    a. Fit mesh tightly around pipe or other penetrations, and terminate at slab and foundation perimeters.
    b. Install mesh under the perimeter of concrete slab edges and joints after vapor barrier and reinforcing steel are in place, and comply with manufacturer's written installation methods.
2. Inspect annually for termite activity and effectiveness of metal mesh barrier system according to manufacturer's written instructions.

H. Installing Polymer Sheet Barrier System
1. Install polymer sheet barrier system according to manufacturer's EPA-Registered Label to provide a complete and continuous barrier to entry of subterranean termites.
2. Remove any pipe wrap material so that the polymer sheet barrier system and fittings can be applied directly to the pipe or conduit. After installing the barrier, reapply pipe wrap material both below and above the blocker to protect the pipe from contact with concrete.
3. Install polymer barrier fittings around each utility pipe and conduit penetrating concrete slab and/or foundation walls according to the EPA-Registered Label for the product and manufacturer's written instructions.

I. Installing Polymer Barrier Fittings
1. Remove any pipe wrap material so that the polymer barrier fittings can be applied directly to the pipe or conduit. After installing the barrier, reapply pipe wrap material both below and above the blocker to protect the pipe from contact with concrete.

2. Install polymer barrier fittings around each utility pipe and conduit penetrating concrete slab and/or foundation walls according to the EPA-Registered Label for the product and manufacturer's written instructions.

END OF SECTION 31 31 16 13

SECTION 31 31 19 13 - SOIL STERILIZATION

1.1 GENERAL

A. Description Of Work
   1. This specification covers soil sterilization. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations.

1.2 PRODUCTS

A. Weed Eradication and Soil Fumigation: Products approved by the Environmental Protection Agency.

B. Liquid and Dry Herbicides:
   1. Bare Ground Herbicides: Bromacil powder mixture or an ammonium sulfamate spray.
   2. Wetting Agents: As required.

C. Equipment: Equipment shall be appropriate to the application and approved before use by the Owner.

1.3 EXECUTION

A. Soil: After the subgrade has been prepared, all areas to be surfaced shall be treated with a weed eradicator and soil fumigant only in the designated areas.

B. Wetting Agents may be used as an additive to improve the performance of weed and brush herbicides.

END OF SECTION 31 31 19 13

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SECTION 31 32 13 16 - SOIL STABILIZATION-LIME

1.1 GENERAL

A. Description Of Work

1. This specification covers furnishing of materials and the preparation and production of a stabilized subgrade by the addition of hydrated lime to the native material.

1.2 PRODUCTS

A. Hydrated lime material requirements shall be as follows:

1. Available Lime Index as Calcium Hydroxide: 90 percent minimum.
2. Residue retained on No. 30 Sieve: 1 percent maximum.
3. Residue retained on No. 200 Sieve: 20 percent maximum.

1.3 EXECUTION:

A. Preparation: Scarify the subgrade to the depth required and pulverize the material until it is substantially free of lumps greater than three inches in diameter.

B. Installation: Lime shall be applied to the pulverized material as a slurry, unless otherwise directed. Water shall be added as needed to provide a moisture content of not less than 20 percent. Surface-applied lime slurry shall be plowed and/or disked into the soil as necessary. The resulting mixture shall be aged for not less than 48 hours before compaction.

END OF SECTION 31 32 13 16

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SECTION 31 32 13 19 - SOIL STABILIZATION-VIBROFLOTATION

1.1 GENERAL

A. This specification covers soil stabilization of sandy subsurfaces by the method of vibroflotation.

1.2 PRODUCTS - (Not Used)

1.3 EXECUTION

A. The vibroflotation process shall be applied only to areas of clean, granular soils, with not over 20 percent silt or 10 percent clay. Vibrators shall be water-jetted into the soil mass to the depth required. The vibrator shall be withdrawn in 1 foot increments as the saturated soil compacts laterally and at a rate of approximately 1 ft/min to a minimum relative density of 70 percent. As the surface crater forms, sand or crushed rock shall be added and compacted to the appropriate line and grade. The horizontal distance between successive treatments shall not exceed 5 feet, or as directed.

END OF SECTION 31 32 13 19

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Task	Specification	Specification Description
31 32 13 19	31 32 13 16	Soil Stabilization-Lime
31 32 13 29	31 32 13 16	Soil Stabilization-Lime
31 32 19 13	31 32 13 16	Soil Stabilization-Lime
31 32 19 13	31 25 14 13	Geosynthetic Fabric

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SECTION 31 32 19 16 - SEWAGE TREATMENT LAGOONS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for the repair and maintenance of sewage treatment lagoons. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Materials
1. Concrete Block shall comply with ASTM C 129.
2. Concrete Grout shall comply with Fed. Spec. MMM-A-001993.
3. Riprap Stone shall comply with AREA-01.
4. Concrete Repair Material shall comply with Fed. Spec. MMM-A-001993.
5. Sand shall comply with ASTM C 33.
6. Portland Cement shall comply with ASTM C 150, Type V.
7. Rubble shall consist of broken concrete or broken stone.

1.3 EXECUTION

A. Algae Removal shall be by mechanical or manual methods and shall include, but not be limited to, skimming, pumping through a screen, raking, or draining and cleaning the lagoon.

B. Slope and Dike Reconstruction shall be made to re-establish the original design configuration and grades. Place riprap, where required, so that its angle of repose is not exceeded.

C. Liner Reconstruction and Repair shall be made with materials compatible with the existing liner and compatible with the wastewater and sludge to be contained therein.

D. Repairs to Elastomeric Membrane Liners shall be made with like material and shall overlap all cuts, tears, fractures or other defects a minimum of 4 inches. Cut repair pieces square or rectangular. The method of bonding the new material to existing material shall be similar to the original joint banding method, except when the original joints have failed. In this case, the material supplier shall demonstrate that an alternate jointing system shall be satisfactory to the Owner. Replace earth or sand cover removed during repair or replacement of plastic liner to the same thickness as the original installation.

E. Repairs to Non-Elastomeric Membrane Liners shall be made by cutting out defective areas back to sound liner material and replacing with similar material. Joints shall be watertight.

END OF SECTION 31 32 19 16

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SECTION 31 32 19 16a - POND RESERVOIR LINERS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for pond and reservoir liners. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes geomembrane liners and floating covers for ponds and reservoirs.

C. Definitions
   1. Plastics Terminology: See ASTM D 1600 for definitions of abbreviated terms for plastics not otherwise defined in this Section.
   2. CSPE: Chlorosulfonated polyethylene.
   3. EIA: Ethylene interpolymer alloy.
   4. EPDM: Ethylene-propylene-diene terpolymer.
   5. PE: Polyethylene.
   6. PP: Polypropylene.

D. Performance Requirements
   1. Provide geomembrane liners and floating covers, **as directed**, that prevent the passage of water and gas, **as directed**.

E. Submittals
   1. Product Data: For each type of product indicated. Include the following:
      a. Sheets for geomembrane liners and floating covers.
      b. Seaming adhesives, solvents, and extrusions.
      c. Penetration assemblies.
      d. Accessories for floating covers.
   2. Shop Drawings: Show fabrication and installation details for geomembrane liners. Show panel layout, seams, penetrations, perimeter anchorage, floating cover, and methods of attachment and sealing to other construction. Differentiate between factory and field seams and joints.
   3. Samples: For the following products, in sizes indicated:
      a. Geomembrane Panels: For each type, not less than one 12-inch (300-mm) seam length for factory-bonded sheets and one 12-inch (300-mm) seam length for field-bonded sheets.
   4. Qualification Data: For qualified Installer **OR** testing agency, **as directed**.
   5. Product Certificates: For each type of geomembrane liner and floating cover, from manufacturer.
   6. Product Test Reports: For each geomembrane sheet, based on evaluation of comprehensive tests performed by a qualified testing agency.
   7. Source quality-control reports.
   8. Field quality-control reports.
   9. Maintenance Data: For geomembrane liner and floating cover to include in maintenance manuals.
   10. Warranty: Special warranty specified in this Section.

F. Quality Assurance
   1. Installer Qualifications: Fabricator of products **OR** An employer of workers trained and approved by manufacturer, **as directed**.
   2. Source Limitations: Obtain geomembrane liner and floating cover, accessories, and required seaming materials, solvents, and adhesives from single source.
   3. Preinstallation Conference: Conduct conference at Project site.

a. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
b. Review structural load limitations.
c. Review limitations on equipment and Installer's personnel.
d. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
e. Review required testing, inspecting, and certifying procedures.
f. Review existing and forecasted weather conditions and procedures for unfavorable conditions.

G. Project Conditions
1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit placement and seaming of geomembrane liners and floating covers to be performed according to manufacturers' written instructions and warranty requirements.

H. Warranty
1. Special Warranty: Specified form in which geomembrane manufacturer, geomembrane liner and floating cover fabricator, and geomembrane liner and floating cover Installer agree to repair or replace geomembrane liner and floating cover that fail(s) in materials or workmanship or that deteriorate(s) under conditions of normal weather within specified warranty period. Warranty does not include deterioration or failure of geomembrane liner and floating cover due to exposure to harmful chemicals, gases or vapors, abnormal and severe weather phenomena, fire, earthquakes, floods, vandalism, or abuse by persons, animals, or equipment.
a. Failures include, but are not limited to, the following:
1) Leaks in geomembrane liner and floating cover.
2) Defects in seams.
3) Cracks and holes in floating cover.
b. Warranty Period: One **OR** Five **OR** 10, **as directed**, year(s) from date of Final Completion.

1.2 PRODUCTS

A. CSPE Sheet Materials
1. CSPE Sheet: Formulated from CSPE for use in hydraulic structures and formed into uniform, flexible sheets.
a. Reinforcing Scrim: One-ply polyester fabric totally encapsulated between two sheets.
1) Construction: 6 x 6 - 1000 d **OR** 8 x 8 - 250 d **OR** 10 x 10 - 1000 d, **as directed.**
b. Nominal Thickness: 45-mil- (1.14-mm-) thick sheet per ASTM D 5199 or ASTM D 751, Optical Method.
c. Nominal Thickness over Scrim: 11-mil- (0.28-mm-) thick sheet per ASTM D 5199 or ASTM D 751, Optical Method.
d. Breaking Strength: Not less than 200 lbf (0.89 kN) minimum average per ASTM D 751, Procedure A.
e. Tear Strength, Initial: Not less than 70 lbf (0.31 kN) minimum average per ASTM D 5884 or ASTM D 751, Procedure B.
f. Tear Strength, after Aging: Not less than 35 lbf (0.16 kN) minimum average per ASTM D 5884 or ASTM D 751, Procedure B.
g. Puncture Resistance: Not less than 200 lbf (0.89 kN) minimum average per ASTM D 4833.
h. Hydrostatic Resistance: Not less than 250-psi (1725-kPa) minimum average resistance per ASTM D 5514, Procedure A or ASTM D 751, Method A, Procedure 1.
i. Dimensional Stability, Reinforced Sheet: Not more than plus or minus 2 percent per ASTM D 1204.
j. Low-Temperature Flexibility: Pass, 1/8-inch (3-mm) mandrel, four hours at minus 40 deg F (minus 40 deg C), and per ASTM D 2136.

k. UV-Light Resistance: Pass, 4000 hours at 176 deg F (80 deg C), per ASTM G 155.
l. Ply Adhesion: Not less than 7 lbf/in. (1.2 kN/m) **OR** 10 lbf/in. (1.75 kN/m), **as directed**, of seam width, or film tearing bond, according to ASTM D 413, Machine Method.
m. Water Absorption (for low-water-absorption CSPE): Not more than 2 percent at 70 deg F (21 deg C) and not more than 30 percent at 158 deg F (70 deg C) for 30 days each per ASTM D 471, 30-mil- (0.76-mm-) thick sheet.

B. EIA Sheet Materials
1. EIA Sheet: Formulated from EIA for use in hydraulic structures and formed into uniform, flexible sheets.
a. Reinforcing Scrim: One-ply polyester fabric totally encapsulated between two sheets.
1) Construction: 6 x 6 - 1000 d **OR** 8 x 8 - 500 d **OR** 10 x 10 - 1000 d **OR** 10 x 11 - 2520 d x 2000 d, **as directed**.
b. Nominal Thickness: 36-mil- (0.91-mm-) thick sheet per ASTM D 1593 or ASTM D 751, Optical Method.
c. Tensile Strength: Not less than 400 lbf (1.8 kN) minimum average per ASTM D 751, Procedure A.
d. Tear Strength: Not less than 35 lbf (0.16 kN) minimum average per ASTM D 5884 or ASTM D 751, Procedure B.
e. Puncture Resistance: Not less than 150 lbf (0.67 kN) minimum average per ASTM D 4833.
f. Hydrostatic Resistance: Not less than 100-psi (690-kPa) minimum average resistance per ASTM D 751, Procedure A.
g. Dimensional Stability, Reinforced Sheet: Not more than plus or minus 2 percent per ASTM D 1204.
h. Low-Temperature Flexibility: Pass, 1/8-inch (3-mm) mandrel, four hours at minus 30 deg F (minus 34 deg C), and per ASTM D 2136.
i. UV-Light Resistance: Pass, 4000 hours at 176 deg F (80 deg C), per ASTM G 155.
j. Ply Adhesion: Not less than 7 lbf/in. (1.2 kN/m) **OR** 10 lbf/in. (1.75 kN/m), **as directed**, of seam width, or film tearing bond, according to ASTM D 413, Machine Method.

C. EPDM Sheet Materials
1. EPDM Sheet: Formulated from EPDM, compounded for use in hydraulic structures and formed into uniform, flexible sheets.
a. Reinforcing Scrim: One-ply polyester fabric totally encapsulated between two sheets.
1) Construction: 9 x 9 - 1000 d **OR** 10 x 10 - 1000 d, **as directed**.
b. Nominal Thickness: 45-mil- (1.14-mm-) thick sheet per ASTM D 5199 or ASTM D 751, Optical Method.
c. Breaking Strength: Not less than 190 lbf (0.85 kN) minimum average per ASTM D 882, ASTM D 7004, or ASTM D 751, Procedure A.
d. Tear Resistance: Not less than 130 lb (0.58 kN) minimum average per ASTM D 1004.
e. Puncture Strength: Not less than 60 lbf (0.27 kN) minimum average per ASTM D 4833.

D. PE Sheet Materials
1. PE Sheet: Formulated from virgin PE, compounded for use in hydraulic structures, and formed into uniform sheets.
a. Sheet Texture: One side smooth; other side smooth **OR** textured, **as directed**.
b. Nominal Density: Low density, 0.910 to 0.925 g/cu. cm **OR** Linear low density, 0.919 to 0.925 g/cu. cm **OR** Medium density, 0.926 to 0.939 g/cu. cm **OR** High density, 0.940 to 0.959 g/cu. Cm, **as directed**, per ASTM D 1505.
c. Nominal Thickness: 60-mil- (1.5-mm-) thick sheet per ASTM D 5199 **OR** ASTM D 5994, **as directed**.
d. Melt Flow Index: Not more than 0.035 oz./10 minutes (1.0 g/10 minutes) per ASTM D 1238, Condition 190/2.16.
e. Carbon Black Content: 2 to 3 percent per ASTM D 1603 or ASTM D 4218.
f. Carbon Black Dispersion: Per ASTM D 5596, Category 1 and 2.

g. Oxidation Induction Time: Not less than 100 minutes per ASTM D 3895.
h. Tensile Properties: Not less than indicated for each direction, per ASTM D 638, Type IV or ASTM D 6693, Type IV.
  1) Strength at Yield: Not less than 126 lbf/in. (22 kN/m) and 2100 psi (14.5 MPa) minimum average.
  2) Strength at Break: Not less than 228 lbf/in. (40 kN/m) and 3800 psi (26.2 MPa) minimum average.
  3) Elongation at Yield: Not less than 12 percent minimum average.
  4) Elongation at Break: Not less than 700 percent minimum average.
i. Tear Resistance: Not less than 39 lbf (0.18 kN) minimum average per ASTM D 1004.
j. Puncture Resistance: Not less than 108 lbf (0.48 kN) minimum average per ASTM D 4833.
k. Dimensional Stability, Reinforced Sheet: Not more than plus or minus 2 percent per ASTM D 1204.
l. Low-Temperature Brittleness: Four hours at minus 76 deg F (minus 60 deg C) per ASTM D 746.
m. Environmental Stress Cracking Resistance: Not less than 1500 hours per ASTM D 1693, Condition B.

E. PP Sheet Materials
1. PP Sheet: Formulated from virgin PP, compounded for use in hydraulic structures, and formed into uniform, flexible sheets.
  a. Reinforcing Scrim: One-ply polyester fabric totally encapsulated between two sheets.
    1) Construction: 9 x 9 - 1000 d **OR** 10 x 10 - 1000 d, **as directed**.
  b. Sheet Texture: One side smooth; other side smooth **OR** textured, **as directed**.
  c. Nominal Thickness: 45-mil- (1.14-mm-) thick sheet per ASTM D 5199 or ASTM D 751, Optical Method **OR** ASTM D 5994, **as directed**.
  d. Tensile Strength: Not less than 250 lbf (1.1 kN) minimum average per ASTM D 412, ASTM D 7003, ASTM D 6693, or ASTM D 751, Procedure A.
  e. Tear Resistance: Not less than 55 lbf (0.24 kN) minimum average per ASTM D 1004, ASTM D 5884, ASTM D 7003, or ASTM D 751, Procedure B.
  f. Puncture Resistance: Not less than 200 lbf (0.88 kN) minimum average per ASTM D 4833 or ASTM D 7003.
  g. Low-Temperature Flexibility: Pass, 1/8-inch (3-mm) mandrel, four hours at minus 40 deg F (minus 40 deg C), and per ASTM D 2136.
  h. Hydrostatic Resistance: Not less than 250-psi (1725-kPa) minimum average resistance per ASTM D 5514, Procedure A or ASTM D 751, Method A, Procedure 1.
  i. Dimensional Stability, Reinforced Sheet: Not more than plus or minus 1 percent per ASTM D 1204.
  j. Ply Adhesion: Not less than 20 lbf/in. (3.5 kN/m) of seam width, or film tearing bond, according to ASTM D 413, Machine Method.

F. PVC Sheet Materials
1. PVC Sheet: Formulated from virgin PVC with plasticizers and other modifiers, compounded for use in hydraulic structures, and formed into uniform, flexible sheets with material properties complying with ASTM D 7176 **OR** PGI 1104, "Specification for PVC Geomembranes", **as directed**, for nominal thickness indicated.
  a. Nominal Thickness: 10 mils (0.25 mm) **OR** 20 mils (0.51 mm) **OR** 30 mils (0.76 mm) **OR** 40 mils (1.02 mm) **OR** 50 mils (1.3 mm) **OR** 60 mils (1.5 mm), **as directed**.
  b. Sheet Texture: One side smooth; other side smooth **OR** matte **OR** faille textured, **as directed**.

G. Floating Cover Accessories
1. Screened Scupper Hoses: Manufacturer's standard.

2. Flotation Blocks: Closed-cell polyethylene foam blocks approximately 4 by 12 inches (102 by 300 mm), 2.2 lb/cu. ft. (35.2 kg/cu. m).
3. Access Hatch: Manufacturer's standard, in size indicated.

H. Miscellaneous Materials
1. Adhesives: Provide types of adhesive primers, compounds, solvents, and tapes recommended in writing by geomembrane liner manufacturer for bonding to structures (if required), for sealing of seams in geomembrane liner, and for sealing penetrations through geomembrane liner.
2. Penetration Assemblies: Provide manufacturer's standard factory-fabricated assemblies for sealing penetrations. Include joint sealant recommended in writing by geomembrane liner manufacturer and compatible with geomembrane liner, containment conditions, and materials.
3. Battens: Long-length strips of material indicated, size as shown on Drawings. Fabricate battens with sharp projections removed and edges eased and then predrilled or punched for anchors. Provide anchors, or other type of attachment, of type and spacing recommended in writing by geomembrane liner manufacturer for attaching geomembrane liner system to substrate and as indicated.
   a. Batten Material: Liner manufacturer's standard system.
      OR
      Batten Material: Aluminum; with stainless-steel anchors, complete with gasket and sealant compatible with geomembrane liner, containment conditions, and materials.
      OR
      Batten Material: Stainless steel; with stainless-steel anchors, complete with gasket and sealant compatible with geomembrane liner, containment conditions, and materials.
      OR
      Batten Material: Plastic compatible with geomembrane liner, cast in place or fastened with stainless-steel anchors, designed to continuously seal geomembrane liner to batten.
4. Sand: ASTM C 33; fine aggregate, natural or manufactured sand.

I. Fabrication
1. Fabricate geomembrane liner and floating cover, **as directed**, panels from sheets in sizes as large as possible with factory-sealed seams, consistent with limitations of weight and installation procedures. Minimize field seaming.
2. Fabricate flotation blocks, wrap in geomembrane, and attach to underside of floating cover according to manufacturer's written instructions.
3. Fabricate ballast tubes of sand-filled geomembrane and attach to top surface of floating cover according to manufacturer's written instructions.
4. Install built-in accessories, hatches, access panels, vents, and walkways on geomembrane floating cover.

J. Source Quality Control
1. Testing Agency: Engage a qualified testing agency to evaluate geomembrane seams.
2. Destructive Testing: Test for bonded seam strength and peel adhesion every 3000 feet (915 m) or once per panel, whichever is more frequent.
3. CSPE Liner and Floating Cover: Test and inspect factory seams, according to ASTM D 4545, for peel adhesion not less than 10 lbf/in. (1.75 kN/m) of seam width and for bonded seam strength not less than 180 lbf/in. (32 kN/m) of seam width for seams constructed from two scrim-reinforced sheets, each with nominal sheet thickness of not less than 45 mils (1.14 mm).
4. EIA Liner and Floating Cover: Test and inspect factory seams, according to ASTM D 4545, for peel adhesion not less than 10 lbf/in. (1.75 kN/m) of seam width and for bonded seam strength not less than 270 lbf/in. (48 kN/m) of seam width for seams constructed from two scrim-reinforced sheets, each with nominal sheet thickness of not less than 36 mils (0.91 mm).
5. EPDM Liner: Test and inspect factory seams, according to ASTM D 4545, for peel adhesion not less than 10 lbf/in. (1.75 kN/m) of seam width and for bonded seam strength not less than 160 lbf/in. (28 kN/m) of seam width for seams constructed from two scrim-reinforced sheets, each with nominal sheet thickness of not less than 45 mils (1.14 mm).

6. PE Liner: Test and inspect factory seams, according to ASTM D 4545, for peel adhesion and for bonded seam strength indicated.
   a. Peel Adhesion/Extrusion: Film tear bond and not less than 78 lbf/in. (13.7 kN/m) of extrusion-bonded seam width.
      OR
      Peel Adhesion/Fusion: Film tear bond and not less than 90 lbf/in. (15.8 kN/m) of fused seam width.
   b. Bonded Seam Strength: Not less than 120 lbf/in. (21 kN/m) of seam width for seams constructed from two scrim-reinforced sheets, each with nominal sheet thickness of not less than 45 mils (1.14 mm).
7. PP Liner and Floating Cover: Test and inspect factory seams, according to ASTM D 4545, for peel adhesion not less than 20 lbf/in. (3.5 kN/m) of seam width and for bonded seam strength not less than 200 lbf/in. (35 kN/m) of seam width for seams constructed from two scrim-reinforced sheets, each with nominal sheet thickness of not less than 45 mils (1.14 mm).
8. PVC Liner and Floating Cover: Test and inspect factory seams, according to ASTM D 4545, for peel adhesion not less than 10 lbf/in. (1.75 kN/m) of seam width and for bonded seam strength not less than that indicated below for seams constructed from two sheets of minimum nominal thickness indicated for each:
   a. Bonded Seam Strength for 10-mil- (0.25-mm-) Thick Sheets: 20 lbf/in. (3.5 kN/m) of seam width.
   b. Bonded Seam Strength for 20-mil- (0.51-mm-) Thick Sheets: 38.5 lbf/in. (6.7 kN/m) of seam width.
   c. Bonded Seam Strength for 30-mil- (0.76-mm-) Thick Sheets: 58.4 lbf/in. (10.2 kN/m) of seam width.
   d. Bonded Seam Strength for 40-mil- (1.02-mm-) Thick Sheets: 77.6 lbf/in. (13.6 kN/m) of seam width.
   e. Bonded Seam Strength for 50-mil- (1.3-mm-) Thick Sheets: 96 lbf/in. (16.8 kN/m) of seam width.
   f. Bonded Seam Strength for 60-mil- (1.5-mm-) Thick Sheets: 116 lbf/in. (20.3 kN/m) of seam width.

1.3 EXECUTION

A. Examination
   1. Examine substrates, with Installer present, for compliance with requirements for soil compaction and grading; for subgrade free from angular rocks, rubble, roots, vegetation, debris, voids, protrusions, and ground water; and for other conditions affecting performance of geomembrane liner.
   2. Examine anchor trench excavation **OR** concrete perimeter, **as directed,** where geomembrane liner and floating cover, **as directed**, will be secured, for substrate conditions indicated above and for correct location and configuration.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
   1. Provide temporary ballast, until edges are permanently secured, that does not damage geomembrane liner or substrate, to prevent uplift of geomembrane liner in areas with prevailing winds.
   2. Prepare surfaces of construction penetrating through geomembrane liner according to geomembrane liner manufacturer's written instructions.
   3. Remove curing compounds and coatings from concrete surfaces to be sealed to geomembrane liner.

C. Installation

1. General: Place geomembrane liner over prepared surfaces to ensure minimum handling. Install according to Shop Drawings and in compliance with geomembrane liner manufacturer's written instructions. Begin placing geomembrane liner at Project's upwind direction and proceed downwind. Install geomembrane liner in a relaxed condition, free from stress and with minimum wrinkles, and in full contact with subgrade. Do not bridge over voids or low areas in the subgrade. Fit closely and seal around inlets, outlets, and other projections through geomembrane liner. Permanently secure edges.
2. Field Seams: Comply with geomembrane liner and floating cover manufacturer's written instructions. Form seams by lapping edges of panels 2 to 4 inches (50 to 102 mm) unless instructions require a larger overlap. Wipe contact surfaces clean and free of dirt, dust, moisture, and other foreign materials. Use solvent-cleaning methods and grind geomembrane seam surfaces if recommended by geomembrane liner manufacturer. Proceed with seaming at required temperatures for materials and ambient conditions. Continuously bond sheet to sheet to construct single or double seams of width recommended for method of seaming used. Seal or fuse free seam edges. Inspect seams and reseal voids.
   a. Adhesive Bonding: Apply bonding cement to both contact surfaces in seam area and press together immediately, or use other seaming methods as instructed by geomembrane liner manufacturer. Roll to press surfaces together, to distribute adhesive to leading edges of panels, and to remove wrinkles and fishmouths. Remove excess adhesive.
      OR
      Thermal Bonding: Use thermal-welding technique recommended by geomembrane liner manufacturer. Apply pressure to smoothly bond surfaces together. Examine for and patch wrinkles and fishmouths.
3. Installation in Anchor Trench: Install geomembrane liner and floating cover in trench according to manufacturer's written instructions. Backfill and compact to lock liner into trench.
4. Attachment to Concrete: Use manufacturer's standard system to suit Project conditions. Support adhesive and geomembrane on minimum 8-inch- (200-mm-) wide concrete substrate unless otherwise indicated.
   a. Install batten strips over geomembrane liner and floating cover as shown on Drawings.
   b. Install antichafing strips of geomembrane sheet between geomembrane liner and floating cover according to manufacturer's written instructions.
   c. Install floating cover with perimeter fold.
5. Floating Cover Flotation Control: Connect drainage hoses in perimeter fold, sumps, or scuppers to pump or gravity drain system.
6. Liner Repairs: Repair tears, punctures, and other imperfections in geomembrane liner field and seams using patches of geomembrane liner material, liner-to-liner bonding materials, and bonding methods according to geomembrane liner manufacturer's written instructions. Apply bonding solvent or weld to contact surfaces of both patch and geomembrane liner, and press together immediately. Roll to remove wrinkles.

D. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Nondestructive Testing: Visually inspect seams and patches. Comply with ASTM D 4437 for Air Lance Test, Vacuum Box Testing, or Ultrasonic (High Frequency) Pulse Echo Testing or with GRI Test Method GM6, as applicable to geomembrane liner and floating cover and seam construction. Record locations of failed seams and patches. Individually number and date occurrences and details of leak and remedial action. Repair leaking seams and patches.
3. Prepare test and inspection reports.

E. Disinfection
1. Disinfect the complete installation according to procedures in AWWA C652.

F. Protection
1. Protect installed geomembrane liner and floating cover according to manufacturer's written instructions. Repair or replace areas of geomembrane liner damaged by scuffing, punctures, traffic, rough subgrade, or other unacceptable conditions.

2. Before initial filling of pond or placement of earth cover, inspect seams and patched areas to ensure tight, continuously bonded installation. Repair damaged geomembrane and seams and reinspect repaired work.

END OF SECTION 31 32 19 16a

Task	Specification	Specification Description
31 32 19 16	21 05 23 00	Piped Utilities Basic Materials And Methods
31 32 19 16	31 32 13 16	Soil Stabilization-Lime
31 32 19 16	31 25 14 13	Geosynthetic Fabric

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SECTION 31 36 13 00 - WIRE MESH GABIONS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of wire mesh gabions. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Description: Gabion units shall consist of compartmented rectangular basket containers filled with stone. The required sizes of the gabion units are Length times Width times Depth. Twisted or welded wire mesh shall be used. Baskets shall be fabricated from galvanized steel wire formed into a nonraveling mesh.

C. Submittals
   1. Samples: Stone fill material submitted for approval prior to delivery.

1.2 PRODUCTS

A. Steel Twisted Wire Mesh Gabions: Gabion basket units shall be of nonraveling construction and fabricated from a double twisted hexagonal wire mesh. The size of mesh openings shall be approximately 3-1/4 in. by 4-1/2 in. (80 by 115 mm). The gabion mesh wires shall be wrapped around the selvage wire no less than 1 1/2 times and shall interconnect with adjacent mesh wires. All steel wire used shall be galvanized prior to fabrication into mesh. All gabion diaphragm and frame wire shall equal or exceed ASTM A 641, and possess soft tensile strength of 60,000 psi (415 Mpa) with a tolerance of minus 2,000 psi (14 Mpa). The galvanized wire shall have a Finish 5, Class 3, zinc coating, as indicated in ASTM A 641. The weight of coating shall be determined by ASTM A 90. The grade of zinc used for coating shall be High Grade or Special High Grade as prescribed in ASTM B 6, Table 1. The uniformity of coating shall equal or exceed four 1-minute dips by the Preece Test, as determined by ASTM A 239.

B. Steel Welded Wire Mesh Gabions: Gabion basket units shall be of nonraveling construction and fabricated from a welded square wire mesh. The size of mesh openings shall be approximately 3 in. by 3 in. (75 by 75 mm). The welded joints of the wire mesh shall conform to ASTM A 1064 except that the weld shears shall be at least 600 lbs (2700 N). All gabion diaphragm and frame wire shall equal or exceed ASTM A 641, and possess soft tensile strength of 60,000 psi (415 Mpa) with a tolerance of minus 2,000 psi (14 Mpa). The galvanized wire shall have a Finish 5 Class 3 zinc coating, indicated in ASTM A 641. The weight of coating shall be determined by ASTM A 90. The grade of zinc used for coating shall be High Grade or Special High Grade as prescribed in ASTM B 6, Table 1. The uniformity of coating shall equal or exceed four 1-minute dips by the Preece Test, as determined by ASTM A 239.

C. Mesh wire shall be minimum 0.120-in. (3.05 mm) diameter after coating with 0.85 oz/sq ft (240 g/sq m) zinc coating.

D. Selvage wire shall be minimum 0.150-in. (3.80 mm) diameter after coating with 0.85 oz/sq ft (240 g/sq m) zinc coating.

E. Wire used for lacing or as internal connecting wire within basket cells shall be minimum 0.087-in. (2.21 mm) diameter after coating with 0.70 oz/sq ft (220 g/sq m) zinc coating and may have soft tensile strength designation.

F. Stone Fill

1. Quality: Stone shall be durable and of suitable quality to ensure permanence in the structure and climate in which it is to be used. It shall be free of cracks, seams, and other defects that would tend to increase unduly its deterioration from natural causes or reduce its size to that which could not be retained in the gabion baskets. The inclusion of more than 5% by weight of dirt, sand, clay, and rock fines will not be permitted. The sources from which the Contractor proposes to obtain the material shall be selected well in advance of the time when the material will be required in the work. Suitable samples of stone fill material shall be collected in the presence of the Owner's representative and submitted to the Owner for approval prior to delivery of any such material to the site of the work. Unless otherwise specified, all test samples shall be obtained by the Contractor and delivered at its expense to the Owner. Suitable tests and/or service records will be used to determine the acceptability of the stone. In the event suitable test reports and service records are not available, the material shall be subjected to such tests as are necessary to determine its acceptability for use in the work. Tests to which the material may be subjected include petrographic analysis, specific gravity, absorption, wetting and drying, freezing and thawing, and such other tests as may be considered necessary to demonstrate to the satisfaction of the Owner that the materials are acceptable for use in the work.
2. Gradation: Stone fill used in the gabions shall be a well-graded mixture with sizes ranging between 4 in. and 8 in. (100 and 200 mm), based on US Standard square mesh sieves. No stone shall have a minimum dimension less than 4 in. (100 mm) and a maximum dimension greater than 12 in. (300 mm) in any direction. The ratio of the maximum dimension to the minimum dimension shall not be greater than two. If the height of the gabion basket is 12 in. (300 mm) or less, stone shall have no dimensions greater than 8 in. (200 mm) in any direction.
3. Filter Material: The material shall be composed of tough durable particles, reasonably free from thin, flat, and elongated pieces, and contain no organic matter or soft friable particles in quantities considered objectionable by the Owner. Filter material shall consist of sand and gravel or crushed stone, well graded between the prescribed limits listed below, and conform to the requirements of paragraph STONE FILL, subparagraph QUALITY as to quality.

1.3 EXECUTION:

A. Foundation Preparation: No foundation preparation work shall take place on frozen or snow-covered ground. After excavation or stripping to the extent indicated on the drawings or as directed by the Owner, all remaining loose or otherwise unsuitable materials shall be removed. All depressions shall be carefully backfilled to grade. If pervious materials are encountered in the foundation depressions, the areas shall be backfilled with free-draining materials. Otherwise, the depressions shall be backfilled with suitable materials from adjacent required excavation, or other approved source, and compacted to a density at least equal to that of the adjacent foundation. Any buried debris protruding from the foundation that will impede the proper installation and final appearance of the gabion layer shall also be removed, and the voids carefully backfilled and compacted as specified above. Immediately prior to placing the material, the prepared foundation surface shall be inspected by the Owner, and no material shall be placed thereon until that area has been approved.

B. Filter Placement: Filter material shall be spread uniformly on the prepared foundation surface in a manner satisfactory to the Owner, and to the slopes, lines, and grades as indicated on the drawings or as directed. Placing of filter material by methods which will tend to segregate particle sizes will not be permitted. Any damage to the foundation surface during filter placement shall be repaired before proceeding with the work. Compaction of the filter materials will not be required, but it shall be finished to present a reasonably even surface free from mounds or windrows.

C. Fabrication: Gabions shall be fabricated in such a manner that the sides, ends, lid, and diaphragms can be assembled at the construction site into rectangular baskets of the sizes specified and shown on the drawings. Gabions shall be of single unit construction, i.e., the base, lid, ends, and sides shall be either woven into a single unit, or one edge of these members connected to the base section of the gabion in such a manner that the minimum strengths of the wire mesh and connections as stated in paragraph

MATERIALS are met. Where the length of the gabion exceeds one and one-half its horizontal width, the gabion shall be equally divided by diaphragms of the same mesh and gage as the body of the gabions, into cells whose length does not exceed the horizontal width. The gabion shall be furnished with the necessary diaphragms secured in proper position on the base in such a manner that no additional tying at this juncture will be necessary. For twisted wire gabions, all perimeter edges of the mesh forming the gabion shall be securely selvaged. In addition, the selvaged edges shall be so wrapped and reinforced with the mesh ends that the selvage wire will not be deformed locally about the lacing wire or wire fasteners when baskets are filled or during lid closing. Lacing wire, connecting wire, and/or wire fasteners shall be supplied in sufficient quantity for securely fastening all diaphragms and edges of the gabion.

D. Assembly And Installation: For gabion units in excess of 4 ft. (1.3 m) in thickness, and placed in horizontal or near horizontal position to resist high velocity flow, or as part of a stilling basin feature, a minimum of two uniformly spaced vertical connecting wires per cell linking the foundation mesh to basket lid mesh should be specified. Empty gabion units shall be assembled individually and placed on the approved surface with the sides, ends, and diaphragms erected in such a manner to ensure the correct position of all creases and that the tops of all sides are level. Filling of gabion units in one place and then transporting them to their final position in the work will not be permitted. The front row of gabion units shall be placed first and successively constructed toward the top of the slope or the back of the structure. All gabion units shall be properly staggered horizontally and vertically. Finished gabion structure shall have no gaps along the perimeter of the contact surfaces between adjoining gabion basket units. All adjoining empty gabion units shall be connected by lacing wire/or wire fasteners along the perimeter of their contact surfaces in order to obtain a monolithic structure. Lacing of adjoining basket units shall be accomplished by continuous stitching with alternating single and double loops at intervals of not more than 5 in. (125 mm), and a half hitch shall be included at every double loop. All lacing wire terminals shall be securely fastened. Wire fasteners may be used in lieu of lacing wire for forming individual baskets and joining empty baskets together prior to stone filling. All joining shall be made through selvage-to-selvage or selvage-to-edge wire connection; mesh-to-mesh or selvage-to-mesh wire connection is prohibited except in the case where baskets are offset or stacked and selvage-to-mesh or mesh-to-mesh wire connection would be necessary. Wire fasteners shall not be used to tie or join stone-filled baskets, unless approved by the Owner. As a minimum, a fastener shall be installed at each mesh opening at the location where mesh wire meets selvage or edge wire. The initial line of basket units shall be placed on the prepared filter layer surface and partially filled to provide anchorage against deformation and displacement during filling operations. After adjoining empty basket units are set to line and grade and common sides with adjacent units thoroughly laced or fastened, they shall be placed in tension and stretched to remove any kinks from the mesh and to a uniform alignment. The stretching of empty basket units shall be accomplished in such a manner as to prevent any possible unraveling. Stone filling operations shall carefully proceed with placement by hand or machine so as not to damage galvanized wire coating, to assure a minimum of voids between the stones, and the maintenance of alignment throughout the filling process. Undue deformation and bulging of the mesh shall be corrected prior to further stone filling. To avoid localized deformation, the basket units in any row are to be filled in stages consisting of maximum 12-in. (300 mm) courses, and at no time shall any cell be filled to a depth exceeding 1 ft. (300 mm) more than the adjoining cell. The maximum height from which the stone may be dropped into the basket units shall be 36 in. (1 m). For gabion units in excess of 2 ft. (0.67 m) in height, two uniformly spaced internal connecting wires shall be placed between each stone layer in all front and side gabion units, connecting the back and the front faces of the compartments. Connecting wires or alternatively the preformed stiffeners shall be looped around two twisted wire mesh openings or a welded wire joint at each basket face and the wire terminals shall be securely twisted to prevent their loosening. For twisted wire gabions, the internal connecting wires or preformed stiffeners are installed. For welded wire gabion units, preformed stiffeners are installed across the corners of gabion panels. Along all exposed faces, the outer layer of stone shall be carefully placed and arranged by hand to ensure a neat and compact appearance. The last layer of stone shall be uniformly overfilled 1 to 2 in. (25 to 50 mm) to compensate for the future settlement in rock but still allow for the proper closing of the lid and to provide an even surface that is uniform in appearance. Final adjustments for compaction and surface tolerance shall be done by hand. Lids shall be stretched tight over the stone fill using only an approved lid closing tool, until the lid meets the perimeter edges of the front and end panels. Using crowbars or other single point leverage bars for lid closing shall be prohibited. The lid shall then be tightly tied with lacing wire, or with wire fasteners if approved by the Owner, along all edges, ends, and internal cell diaphragms by continuous stitching with alternating single and double loops at intervals of not more than 5 in. (125 mm), and a half hitch shall be included at every double loop. Special attention shall be given to see that all projections or wire ends are turned into the baskets. The Contractor shall have the option of providing gabion baskets with separate roll-out lids for the slope baskets. Roll-out lids shall be fabricated of the same material as the basket units and shall be furnished in widths as required for the contract work. as directed by the Owner, or where a complete gabion unit cannot be installed because of space limitations, the basket unit shall be cut, folded, and wired together to suit existing site conditions. The mesh must be cleanly cut and the surplus mesh cut out completely, or folded back and neatly wired to an adjacent gabion face. The assembling, installation, filling, lid closing, and lacing of the reshaped gabion units shall be carried out as specified above.

END OF SECTION 31 36 13 00

SECTION 31 37 13 00 - RIPRAP

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of riprap. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCTS

A. Riprap: Stone used for dumped riprap shall be hard, durable, angular in shape, resistant to weathering and to water action, and free from overburden, spoil, shale, and organic material. Neither width nor thickness of a single stone should be less than one third its length. Rounded stone, boulders, shale, and stone with shale seams will not be acceptable. The minimum density of the riprap material shall be 162 pounds per cubic foot. Each load of riprap shall be reasonably well graded. Sand and rock dust exceeding 5 percent by weight of each load shall not be permitted.

B. Riprap Bedding: The riprap bedding blanket shall consist of well graded gravel, crushed rock, sand, or a combination thereof with a maximum size of 6 inches. All material comprising the riprap bedding blanket shall be composed of tough, durable particles, reasonably free from thin, flat, and elongated pieces, and shall contain no organic matter nor soft, friable particles in excess quantities.

1.3 EXECUTION

A. Preparation: Prepare earth slopes by grading and compacting.

B. Installation:
   1. Riprap Bedding Blanket Layers shall be placed on the prepared slope or area to develop the full thickness. Each layer shall be placed in one operation, using methods that will not cause segregation of particle sizes within the bedding. The surface of the finished layer should be reasonably even and free from mounds or windows.
   2. Stone for Riprap shall be placed on the prepared slope or area in a manner that will product a reasonably well-graded mass of stone with the minimum practicable percentage of voids. Riprap shall be placed to its full course in one operation and in such a manner as to avoid displacing the underlying material. The larger stones shall be well distributed and the entire mass of stone shall be well-graded. The result shall be a compact, uniform riprap layer.

END OF SECTION 31 37 13 00

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Task	Specification	Specification Description
31 37 13 00	01 22 16 00	No Specification Required
31 37 13 00	31 32 19 16	Sewage Treatment Lagoons
31 37 16 13	31 37 13 00	Riprap
31 37 16 13	31 32 19 16	Sewage Treatment Lagoons
31 41 16 13	31 23 16 13	Excavation Support And Protection
31 45 13 00	31 32 13 19	Soil Stabilization-Vibroflotation

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SECTION 31 62 13 23 - PRESTRESSED CONCRETE PILES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for relief wells. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. Shop Drawings: Submit shop drawings.
   2. Statements
      a. Before installation, all well screen shall be approved.
      b. The filter pack material and its gradation shall be approved before it is placed.
      c. Submit the cement grout mixture proportion to be used in plugging abandoned wells.
   3. Reports: Submit sampling and testing reports for each relief well, logs of the borings, well screen and riser pipe, backfill material, and pump tests. Register each well with the state as required by the state in which the well is installed.

C. Regulatory Requirements: The state statutory and regulatory requirements form a part of this specification.

1.2 PRODUCTS

A. Well Screen: The Contractor may, at its option, furnish and install well screen of any of the alternate types specified. The clear inside diameter of the screen shall be as directed by the Owner. Screen openings shall be uniform in size and pattern, and shall be spaced approximately equally around the circumference of the pipe.
   1. PVC Pipe Screen: Pipe, fittings, and screen shall be of the size and types specified. Pipe, fittings, and screen shall conform to ASTM D 1784, ASTM D 1785, ASTM D 2466, or ASTM D 2467. All joints in the PVC pipe shall include couplings and shall be glued with a solvent cement conforming to ASTM D 2564. The PVC pipe strength properties shall be equivalent to PVC 1120 Schedule 40 **OR** 80, **as directed**, unthreaded plastic pipe.
      a. Couplings: Couplings shall be bonded socket **OR** threaded, **OR** certilock, **as directed**, type. Fittings shall be produced of the same material and equal quality as specified for plastic pipe screen. Socket type fitting connections of pipe sections shall be bonded with solvent cement. The determination of the proportions and preparation of adhesives, the method of application, and the procedure used for making and curing the connections shall be the responsibility of the Contractor. The system for making joints at the relief well site shall provide a curing period adequate to develop the ultimate strength of the solvent cement. Self-tapping screws or other devices for holding pipe in the couplings during the setting period may be utilized as long as the screws do not penetrate the inside of the pipe. In no case shall a newly-made joint in the casing be stressed, lowered into the relief well, or be submerged in water prior to complete curing of the solvent cement adhesive.
      b. Perforations: The PVC well screen shall be mill slot **OR** continuous wire wrapped rod base **OR** continuous wire wrapped rod base on perforated pipe **OR** continuous wire wrapped on perforated pipe screen **OR** similar to that manufactured by Johnson Well Equipment, Inc., Pensacola, FL, telephone (904) 453-3131, **as directed**. All well screen shall have smooth, sharp-edged openings free of burns, chipped edges, or broken areas on the interior and exterior surfaces of the pipe. The slots or groups of slots shall be distributed in a uniform pattern around the periphery of the pipe and shall be oriented with the length of the slot parallel to, normal to, or diagonal with the axis of the pipe.

2. Fiberglass Pipe Screen: Fiberglass pipe screen and fittings shall be manufactured from thermosetting epoxy resins and glass fiber by either a centrifugal casting process or by a filament winding process. Glass fiber used shall be continuous filament, electrical glass with a finish compatible with epoxy resins. Each glass fiber or filament shall be thoroughly impregnated with epoxy resin. Fiberglass pipe wall thickness, strength and durability requirements shall be equivalent to the Fiberglass/Epoxy pipe produced by Fiberglass Resources Corporation of Farmingdale, New York or Burgess Well Company, Inc., Minden, Nebraska, telephone (308) 832-1642. All fiberglass pipe and fittings shall be round and straight, of uniform quality and workmanship, and free from all defects including indentation, delamination, bends, cracks, blisters, porosity, dry spots, resin segregation and resin-starved areas. The inside of the pipe and fittings shall be smooth and uniform. The impregnation of the glass fiber with resin shall be such that when the pipe is cut or slotted, no fraying or looseness of glass fiber occurs.
   a. Couplings: Couplings for fiberglass pipe sections shall be socket threaded or mechanical key-type couplings. The couplings shall be manufactured of the same materials used for the fiberglass pipe specified herein and may be either cast integrally with the pipe sections or as separate components for attachment to the pipe in the manufacturers plant. Key-type couplings shall consist of male and female halves designed for joining and locking together by means of a key strip inserted in grooves in the coupling halves. The minimum wall thickness remaining at any grooved section shall not be less than the minimum thickness specified for pipe. Key strips and locking strips shall be of fiberglass, plastic or other non-corrosive material capable of withstanding shearing and bearing stresses equivalent to the design load for the coupling. Socket type fitting connections of the pipe sections shall be bonded with epoxy adhesive. The epoxy materials and bonding agents shall be as recommended by the pipe manufacturer. Self-tapping screws or other devices for holding adhesive-joined pipe in the couplings during the curing period may be utilized. In no case shall a newly-made joint in the casing pipe be lowered into the relief well, or be submerged in water prior to complete curing of the adhesive.
   b. Perforations: All fiberglass well screen shall be mill slot **OR** continuous wire wrapped rod base, **as directed**. All relief well screen shall have smooth, sharp-edged openings free of burrs, chipped edges, or broken areas on the interior and exterior surfaces of the pipe. The slots or groups of slots shall be distributed in a uniform pattern around the periphery of the pipe and shall be oriented with the length of the slot parallel to, normal to, or diagonal with the axis of the pipe.
3. Steel Pipe Screen: Steel well screen shall consist of perforated or slotted sections of steel pipe conforming to the requirements of ASTM A 53.
   a. Couplings: Couplings for steel pipe screen shall be welded joints or threaded couplings. Welding shall be performed in accordance with requirements in ASME B31.9. Couplings shall meet the material requirements specified for steel pipe screen, except perforations shall be omitted. All threaded pipe and fittings shall be threaded in accordance with ASME B1.20.1. All threaded pipe sections may be field connected. Couplings shall be given the same protection against corrosion as specified for the well screen pipe. Protective coatings damaged while making couplings shall have the areas recoated.
   b. Perforations: All steel pipe to be used as relief well screen shall be provided with perforations which shall consist of either machine-cut slots; drilled or punched openings. The slots or groups of slots shall be distributed in a uniform pattern around the periphery of the pipe and shall be oriented with the length of the slot parallel to, normal to, or diagonal with the axis of the pipe. The pattern of the openings shall be uniformly spaced around the periphery of the pipe.
4. Stainless Steel Well Screen: The perforated well screen and fittings shall be fabricated entirely from stainless steel conforming to ASTM A 312/A 312M, Type 304, 304-L, 316 or 316-L. The well screen shall be of stainless steel with a keystone wire-wrapped continuous slot strainer equivalent to that manufactured by Howard Smith Screen Company, Houston, TX, telephone (713) 869-5771 or Johnson Screens, St. Paul, MN 55164, telephone (612) 636-3900.
   a. Couplings: Couplings for the stainless steel well screen shall consist of the same material as the well screen and shall be threaded, flanged, and/or fitted with a welding ring. The

couplings shall conform in design to the couplings recommended by the manufacturer of the well screen.

b. Tailpipe for Well Screen: The tailpipe for each well screen shall be made of the same material and at least the same minimum thickness as the riser pipe and shall include a bottom plug.

B. Riser Pipe: The relief well riser pipe material and method of manufacture shall conform to the requirements specified in paragraph WELL SCREEN, except that the screen perforations or opening shall be omitted. The relief well riser pipe diameter and discharge details shall be as directed. Couplings to the well screen and between riser pipe sections shall be as specified in paragraph COUPLING.

C. Filter Pack: Material for the filter pack around the riser pipes and screens shall be a washed grave, **OR** washed sand **OR** dry processed sand, **as directed**, composed of hard, tough, and durable particles free from adherent coating. The filter pack shall not be crushed stone. The filter pack material shall contain no detrimental quantities of organic matter nor soft, friable, thin, or elongated particles in accordance with the quality requirements in ASTM C 33, Table 1 and Table 3, Class 5S, and in ASTM E 11, Table 1.

D. Outlet For Relief Well: Check Valve.

1. The check valve shall be a one piece reinforced all rubber (neoprene) check valve with an integral elastomer flange similar and equal to the Red Valve Series 35, manufactured by Red Valve Company, Inc., 700 North Bell Ave., Pittsburgh, PA 15106, telephone (412) 279-0044. The backup ring for the check valve shall be stainless steel. Stainless steel bolts, washers, and nuts shall be used to fasten the valves onto the flanged end of the pipes. The check valve shall be installed with the flared end duck bill in a vertical position.
   OR
   Fabricate check valves of brass **OR** stainless steel **OR** aluminum, **as directed**, plate, threaded fasteners and rods. Fabricate sealing disc of silicone sponge rubber free of porous areas, foreign materials, and visible defects.
2. Workmanship and metalwork fabrication of check valves shall be as directed. Install check valves accurately vertically and adjust to the required elevation.

E. Concrete: Concrete shall conform to the requirements specified in Division 03 Section "Cast-in-place Concrete".

1.3 EXECUTION

A. Drilling: Wells may be drilled by the reverse rotary circulation method or other method approved, which will ensure proper placement of the well screen, riser pipe, and filter pack. Methods which involve radical displacement of the formation, or which may reduce the yield of the well, will not be permitted. Excavated material shall be disposed of as directed.

1. Reverse Circulation Method: If the reverse circulation method is used for drilling wells, all of the drilling fluid shall be removed from the filter pack and the natural pervious formation. If in the opinion of the Owner the walls of the hole above the top of the filter pack require support during development operations, a temporary casing similar to that specified in paragraph TEMPORARY CASING shall be placed so as to extend from the ground surface to at least 3 ft (1 m) below the top of the filter pack. The diameter of the hole shall be such as will permit the placement of the minimum thickness of filter pack as specified in paragraph FILTER PACK PLACEMENT. The drilling fluid shall be a suspension of fine grained soil or shall be a commercial product of a recognized manufacturer, shall be approved by the Owner, and shall have the characteristic of being readily removable from the filter pack and the walls of the formation by development as specified in paragraph DEVELOPMENT. The use of bentonite will not be permitted.
2. Temporary Casing: Temporary well casing of either iron or steel of sufficient length to case to the bottom of all borings shall be available at the construction site. the Owner will direct the use of a temporary casing to the bottom of the boring during drilling and placement of screen, riser, and

filter pack when it believes it is necessary to provide adequate support to the sides of the hole. When the walls of the boring will require support only during development operations a temporary casing will be required to extend only to a depth 3 ft (3 m) below the top of the filter pack. The temporary casing, shall have sufficient thickness to retain its shape and maintain a true section throughout its depth, and may be in sections of any convenient length. The temporary casing shall be such as to permit its removal without disturbing the filter pack, riser, or well screen. The setting of temporary casing shall be such that no cavity will be created outside of it at any point along its length. In the event the temporary casing should become unduly distorted or bent it shall be discarded and a new casing shall be used during installation of any additional relief wells.

B. Installation Of Riser Pipe And Screen

1. Assembly: All riser pipe and screen shall be in good condition before installation and all couplings and other accessory parts shall be securely fastened in place. The successive lengths of pipe shall be arranged to provide accurate placement of the screen sections in the bore hole. The riser-pipe shall be provided with an approved cap and a flanged top section, the top of which shall be set at the elevation directed. Centralizers shall be attached to the assembled riser pipe and screen in such numbers and of a type that they will satisfactorily center the riser pipe and screen in the well and will hold it securely in position while the filter pack material is being placed.
2. Joints: Sections of relief well pipe shall be joined together as specified in paragraph COUPLINGS. Joints shall be designed and constructed to have the strength of the pipe and where possible a strength capable to support the weight of the relief well stem as it is lowered into the hole. When not practicable to construct joints that will support the weight of the relief well stem, the stem shall be supported at the lower end by any approved means that will assure that the joints do not open while being lowered into place in the well.
3. Installation: The assembled riser pipe and screen shall be placed in the bore hole in such manner as to avoid jarring impacts and to ensure that the assembly is centered and not damaged or disconnected. The screen shall be suspended in the hole and not resting on the bottom of the hole. After the screen and riser pipe have been placed, a filter pack shall be constructed around the screen section as specified in paragraph FILTER PACK PLACEMENT and the well developed as specified in paragraph DEVELOPMENT. The top of the riser pipe shall be held at the designated elevation during placement of the filter pack.
4. Check for Plumbness and Alignment: The well shall be constructed and all casing set round, plumb, and true. The Contractor shall perform the following tests after the installation of the well but prior to backfilling, and before its acceptance. Additional tests may be made during the performance of the work at the option of the Contractor. Should the Contractor fail to correct, at no additional cost to the Owner, any faulty alignment or plumbness disclosed as a result of these tests, the Owner may refuse to accept the well. the Owner may waive the requirements for plumbness if in its judgement the Contractor has exercised all possible care in constructing the well and the defect is due to circumstances beyond its control or if the utility of the completed well is not materially affected or if the cost of necessary remedial measures will be excessive. In no event will the provisions with respect to alignment be waived.
   a. Plumbness: Plumbness shall be tested by use of a plumb line. The plummet shall be suspended from a small diameter wire rope and its point of suspension shall be in the exact center of the plummet. The plummet shall be sufficiently heavy to stretch the wire rope taut. The wire rope shall pass over a guide sheave which shall be positioned above the top of the well and adjusted horizontally so that the plummet hangs in the center of the well. Displacement of the wire rope during the plumbness check shall be measured by means of a transparent plastic sheet on which a number of concentric circles shall be scribed or drawn, and which is centered on the top of the well. The exact center of these circles shall be marked, and then a slot, slightly larger than the plumb line and extending from this center to the edge, shall be cut in the plastic sheet. As the plummet is lowered, any out-of-plumb condition of the well will be indicated by the wire rope tending to drift away from the center, and the plastic sheet shall be rotated until the slot is oriented in the direction of this drift, while at all times maintaining the center of the concentric circles coincident with the center of the well. Measurement of the amount of drift shall be made

along the edge of the slot for each increment by which the plummet is lowered into the well. Drift at any depth shall be determined by multiplying the measured plumb line displacement by the total length of the plumb line and dividing the result by the fixed distance between the guide sheave and the top of the well. If desired, alignment may be calculated from the plumbness data in lieu of the alignment check described in paragraph ALIGNMENT. Should the well vary from the vertical in excess of allowable, the plumbness of the well shall be corrected by the Contractor at no additional cost to the Owner.

b. Alignment: Alignment shall be tested by lowering into the well a section of cylinder or a dummy of the same length. The outside diameter of cylinder shall be smaller than the inside diameter of the well. Should the cylinder fail to move freely throughout the length of the well, the alignment of the well shall be corrected by the Contractor at no additional expense to the Owner.

C. Filter Pack Placement: After the well screen and riser pipe have been installed, the filter pack material shall be placed by tremie, when using a well graded material, in an approved manner such that segregation will not occur. When using a uniform graded filter material, the material may be poured around the well screen at a rate that will prevent bridging of the material. The material shall be placed around all sides of the screen to assure that the screen is not pushed against the side of the bore hole causing the screen to come in contact with foundation material or prevent the proper thickness of filter from being placed uniformly around the screen. The filter pack shall be placed at a constant rate from the start of placement until it has reached the elevation directed. If a tremie is required, a double string of tremie pipe shall be used. The pipes shall be placed on opposite sides of the screen and/or casing, that is, 180 degrees apart, and shall be guided in such a manner that they will remain in this position throughout the placing process. The tremie pipes shall be set in place, filled completely with filter pack prior to being lifted off the bottom of the hole. The filter pack in the tremie pipe shall be kept above the water surface in the well throughout the placing process. In no case shall the gradation of the filter pack fall outside of the range specified in paragraph FILTER PACK.

D. Development

1. General: Following placement of filter pack materials, the Contractor shall develop the relief well by jetting, surging, intermittent pumping, or other approved methods as may be necessary to give the maximum yield of water. At the time of development of any relief well, the well shall be free of drawdown or surcharge effects due to pump testing, developing or drilling at another location. The Contractor shall be responsible for maintaining at the relief well the needed access and work area and clearance in the relief well necessary to accomplish development. The Contractor shall furnish, install, or construct the necessary discharge line and troughs to conduct and dispose of the discharge a sufficient distance from the work areas to prevent damage. Development shall be conducted to achieve a stable well of maximum efficiency and shall be continued until a satisfactory sand test, as specified in paragraph SAND TEST, is obtained. As development proceeds, filter pack material shall be added to the annular space around the screen to maintain the top elevation of the filter pack to the specified elevation. The Contractor shall provide an open tube or other approved means for accurately determining the water level in the well under all conditions. If at any time during the development process it becomes apparent in the opinion of the Owner that the well may be damaged, development operations shall be immediately terminated. the Owner may require a change in method if the method selected does not accomplish the desired results. the Owner may order that wells which continue to produce excessive amounts of fines after development for 6 hours be abandoned, plugged, and backfilled, and may require the Contractor to construct new wells nearby. All materials pulled into the well by the development process shall be removed prior to performing the pumping test.

a. Jetting: Jetting should be performed using either a single or double ring jet. The jetting tool shall be constructed of high-strength material and conservatively designed and proportioned so that it will withstand high pressures. The jetting tool shall have two hydraulically balanced nozzles spaced 180 degrees **OR** four diameter holes spaced 90 degrees, **as directed**, apart and which shall exert the jetting force horizontally through the screen slots. The rings shall be constructed such that the tips of the jets shall be within 1/2 in. (13 mm) from the inner surface of the well screen. The pump used in conjunction with the jetting tool shall be capable of providing a minimum jetting fluid exit velocity of 150 feet per second (45 meters per second). Prior to commencing jetting, and following each jetting cycle, all sand and/or other materials shall be removed from inside the screen. All wells shall be pumped during the jetting cycle to remove incoming sand and other material. Such pumping shall be at a rate not less than 115 percent of the rate at which fluid is introduced through the jetting tool. This will allow a flow of material into the well as it is being developed. Water used for development shall be free of sand. the Owner may require other means of developing the well such as intermittent pumping method, variation of the intermittent pumping method, or surge block if it appears that the development of the well is not producing the desired results.

b. Intermittent Pumping: Intermittent pumping shall be performed by pumping the well at a capacity sufficient to produce a rapid drawdown, stopping the pump (backflow through pump will not be permitted) to permit the water surface to rise to its former elevation, and repeating this procedure. Cycle time for this procedure will vary as directed but will not be more than 3 cycles per minute. A deep well turbine pump, or electric submersible pump with check valve, shall be used with any attachment necessary to accomplish rapid starting and stopping for intermittent pumping. The intake shall be set below the maximum expected drawdown in the well. Prior to commencing intermittent pumping, and periodically during development by this method, all sand and/or other materials shall be removed from inside the screen. The amount of drawdown may be decreased if, in the opinion of the Owner, the efficiency of the well might otherwise be impaired.

c. Surging: Surging of the well shall require use of a circular block which is smaller in diameter than the inside diameter of the relief well and is constructed of a material which will not damage the screen if the block comes in contact with the screen, and a bailer or pump to remove materials drawn into the well. The surging shall be continued for a period of approximately one hour or until little or no additional material from the foundation or filter pack can be pulled through the screen. The surge block shall be moved by a steady motion up and down the full length of the well screen. Prior to commencing surging, and periodically during development by this method, all sand and/or other materials shall be removed from inside the screen. All materials pulled into the well by the surging process shall be removed by the Contractor.

E. Backfilling: After the well has been developed, additional filter pack shall be added if necessary to meet the requirements of paragraph FILTER PACK PLACEMENT. Then the annular space above the filter pack, shall be backfilled by first placing a layer of concrete sand on the filter pack and then filling the remainder of the space up to the finished ground surface **OR** well pit, **as directed**, with grout or concrete. The concrete backfill shall be placed to a depth at least equal to the existing impervious blanket. For PVC riser pipe, after the well has been developed, additional filter pack shall be added if necessary for it to meet the requirements of paragraph FILTER PACK PLACEMENT. Then the remaining annular space above the filter pack shall be backfilled by first placing a layer of concrete sand on the filter pack and then filling the remainder of the space up to the finished ground surface **OR** well pit, **as directed**, with bentonite. The temporary casing, if used, shall be withdrawn in increments as the backfill is placed. The Contractor shall fill with impervious material to original grade all pits such as those incidental to the reverse rotary circulation method of drilling.

F. Plugging Of Abandoned Wells: The Contractor has the option of attempting to remove the well screen. If the well screen can be removed, the Contractor will grout the bore hole starting from the bottom of the hole. The grouting shall start at the elevation of the bottom of the tailpipe of the well. If the well screen can not be removed or breaks off during the removal attempt, the Contractor shall still be responsible for grouting the well from the bottom of the tailpipe to within 3 ft (1 m) of ground surface. Either of the above abandonment procedures may require the Contractor to redrill the hole so that the bore hole can be grouted. The well shall be grouted from the bottom of the tailpipe. After the grout has setup the riser pipe shall be cutoff. Then the hole shall be backfilled. The cement grout mixture proportion to be used shall be submitted for approval.

G. Tests

1. Pump Test: Upon completion but before acceptance, each well shall be subjected to a pump test of which a sand test will form a part. The Contractor shall provide a deep well turbine pump, capable of producing the specified drawdowns over periods of time sufficient to satisfactorily perform the pump test specified herein. The intake shall be set below the maximum expected drawdown in the well. The amount of sand shall be measured after each test. The pump shall be complete with either gasoline, diesel, or electric motor of adequate size. In case an electric motor is used, the Contractor shall provide, without additional cost to the Owner, the electric power and the necessary wiring. The Contractor shall provide an open tube or other approved means for accurately determining the water level in the well. The Contractor shall furnish and install an orifice meter of approved design or other approved equipment for the purpose of measuring the discharge from the well during the pumping test. The Contractor shall furnish, install, or construct the necessary pipe discharge line, troughs, or ditches necessary to dispose of the pumping test discharge a sufficient distance from the work area to prevent damage. The tests will be conducted under the direction of the Owner and may be made as soon as each well is completed. Test data will be recorded by the Owner. The Contractor shall test each well by pumping continuously for a minimum of 6 hours. Prior to starting the pump test all material shall be removed from the bottom of the well. If the test is interrupted, other than by order of the Owner, prior to the completion of the specified period of continuous operation, the test shall be re-run. In addition to the required pumping test, the Owner may direct the Contractor to perform additional pump tests. Such additional testing shall conform in general to the requirements specified herein except that the duration of the tests and the approximate draw-down will be determined by the Owner. In the event that sand or other material collects in the well as a result of the pump test, accurate measurements shall be taken as to the quantity of material in the well and all such material shall be removed by the Contractor. Upon completion of the pump test, the Contractor shall remove all equipment, discharge lines, electrical lines, lumber, and debris, and shall backfill any excavated areas with impervious material.
2. Sand Test: As part of each Pump Test or at the end of each intermittent pumping a determination of the amount of sand (filter pack and/or foundation material) a well is producing shall be performed. Prior to starting the sand test all material shall be removed from the bottom of the tailpipe. After the pump is at the desired pumping rate the flow from the discharge shall be diverted into a container that will collect all the sand being carried by the water **OR** through a Rossum Sand Tester, **as directed**. Upon completion of the test the amount of sand in the tailpipe shall be determined to verify that no material is being deposited in the bottom of the well.
3. Filter Pack Sampling and Testing: The Contractor shall verify that all materials conform to the specifications before delivery to the project. The particle size distribution of the filter pack shall be sampled and tested by the Contractor in accordance with ASTM C 136 and ASTM D 75. Within 48 hours before being placed in the relief well to be back-filled, the filter pack shall be sampled from the material stockpiled at the project site. There shall be at least one particle size distribution test on the filter pack for each well. A pump test shall be performed in accordance with technical provisions herein specified.
4. Reports: Reports shall include, for each relief well, logs of the boring, elevations of the well screen, top of riser pipe, bottom of the tailpipe, filter pack gradation, quantity of filter pack added during development, pump test, sand test, and report of backfilling. The log of backfill material shall include the filter pack particle size distribution test data, and notes concerning installation and development of the relief well. The pump test log shall include the duration of the test and the draw-down response data with time in the pumped well, in adjacent wells, and in nearby piezometers. The relief well log and the pump test log shall be submitted to the Owner. The Contractor shall also submit a report of the well installation to the appropriate public agency and in the form required by state statutory and/or regulatory requirements specified in paragraph REGULATORY REQUIREMENTS.

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SECTION 31 62 16 16 - STEEL H PILES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for steel H piles. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes steel H piles.

C. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: For steel piles. Show fabrication and installation details for piles, including details of driving points, splices, and pile caps.
   a. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
   b. Include arrangement of static pile reaction frame, test and anchor piles, equipment, and instrumentation. Submit structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
3. Welding certificates.
4. Mill Test Reports: For steel H piles, steel castings, and steel plate, signed by manufacturer.
5. Pile-Driving Equipment Data: Include type, make, and rated energy range; weight of striking part of hammer; weight of drive cap; and, type, size, and properties of hammer cushion.
6. Static Pile Test Reports: Submit within three days of completing each test.
7. Pile-Driving Records: Submit within three days of driving each pile.
8. Field quality-control reports.
9. Preconstruction Photographs: Photographs or video of existing conditions of adjacent construction. Submit before the Work begins.

D. Quality Assurance
1. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
2. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
3. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
1. Deliver piles to Project site in such quantities and at such times to ensure continuity of installation. Handle and store piles at Project site to prevent buckling or physical damage.
   a. Painted Piles: Protect finish and touch up paint damage before driving piles.

F. Project Conditions
1. Protect structures, underground utilities, and other construction from damage caused by pile driving.
2. Preconstruction Photographs: Inventory and record the condition of adjacent structures, underground utilities, and other construction. Provide photographs **OR** video, **as directed**, of conditions that might be misconstrued as damage caused by pile driving.

1.2 PRODUCTS

A. Steel H Piles

1. High-Strength, Low-Alloy, Columbium-Vanadium Structural Steel: ASTM A 572/A 572M, Grade 50 (Grade 345) **OR** Grade 60 (Grade 415), **as directed**.
2. High-Strength, Low-Alloy, Nickel, Copper, Phosphorous Steel H Piles: ASTM A 690/A 690M.
3. High-Strength, Low-Alloy, Structural Steel: ASTM A 588/A 588M.

B. Pile Accessories
1. Driving Points: Manufacturer's standard one-piece driving point, fabricated from steel castings as follows to provide full bearing of web and flange of pile tip:
    a. Carbon-Steel Castings: ASTM A 27/A 27M, Grade 65-35 (Grade 450-240), heat treated **OR** Grade N1, **as directed**.
    b. High-Strength Steel Castings: ASTM A 148/A 148M, Grade 80-40 (Grade 550-275) **OR** Grade 90-60 (Grade 620-415), **as directed**.
2. Splice Unit: Manufacturer's standard splice unit, fabricated from two connected steel plates, of same material as H pile or material of equal strength, shaped to encase web and part of each flange.

C. Paint
1. Paint, **as directed**: SSPC-Paint 16; self-priming, two-component, coal-tar epoxy polyamide, black **OR** red **OR** manufacturer's standard color, **as directed**.

D. Fabrication
1. Fabricate and assemble piles in shop to greatest extent possible.
2. Pile-Length Markings: Mark each pile with horizontal lines at 12-inch (305-mm) intervals; label the distance from pile tip at 60-inch (1.52-m) intervals. Maintain markings on piles until driven.
3. Fabricate full-length piles to eliminate splicing during driving, with ends square.
   OR
   Fabricate full-length piles by splicing lengths of H pile together. Accurately mill meeting ends of piles and bevel for welding. Maintain axial alignment of pile lengths. Maintain structural properties of pile across splice.
4. Splice Units: Notch web of pile, fit splice unit into position, and weld according to manufacturer's written instructions and AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.
   OR
   Continuously Welded Splices: Splice piles by continuously welding according to AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.
    a. Splice piles during fabrication or field installation, **as directed**.
5. Fit and weld driving points to tip of pile according to manufacturer's written instructions and AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.

E. Shop Painting, **as directed**
1. General: Shop paint steel pile surfaces, except for surfaces to be encased in concrete, as follows:
    a. Extend painting to a depth of 60 inches (1.52 m) below finished grade **OR** low-tide level, **as directed**, to top of exposed pile.
2. Surface Preparation: Clean surfaces to be painted. Remove loose rust and loose mill scale, spatter, slag, and flux deposits. Prepare surfaces according to SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning."
3. Painting: Immediately after surface preparation, apply coat of paint according to manufacturer's written instructions to provide a dry film thickness of not less than 8 mils (0.2 mm).
    a. Apply second coat to provide a dry film thickness of not less than 8 mils (0.2 mm), resulting in a two-coat paint system thickness of not less than 16 mils (0.4 mm).

b. Apply second and third coats with each coat having a dry film thickness of not less than 8 mils (0.2 mm), resulting in a three-coat paint system thickness of not less than 24 mils (0.6 mm).
c. Mark pile lengths after shop painting.

1.3 EXECUTION

A. Examination
1. Site Conditions: Do not start pile-driving operations until earthwork fills have been completed or excavations have reached an elevation of 6 to 12 inches (152 to 305 mm) above bottom of footing or pile cap.

B. Driving Equipment
1. Pile Hammer: Air-, steam-, hydraulic-, or diesel-powered type capable of consistently delivering adequate peak-force duration and magnitude to develop the ultimate capacity required for type and size of pile driven and character of subsurface material anticipated.
2. Hammer Cushions and Driving Caps: Between hammer and top of pile, provide hammer cushion and steel driving cap as recommended by hammer manufacturer and as required to drive pile without damage.
3. Leads: Use fixed, semifixed, or hanging-type pile-driver leads that will hold full length of pile firmly in position and in axial alignment with hammer.

C. Static Pile Tests, **as directed**
1. General: Static pile tests will be used to verify driving criteria and pile lengths and to confirm allowable load of piles.
   a. Furnish test piles 60 inches (1.52 m) longer than production piles.
   b. Determination of actual length of piles will be based on results of static pile tests.
2. Pile Tests: Arrange and perform the following pile tests:
   a. Axial Compressive Static Load Test: ASTM D 1143.
   b. Axial Tension Static Load Test: ASTM D 3689.
   c. Lateral Load Test: ASTM D 3966.
3. Equip each test pile with two telltale rods, according to ASTM D 1143, for measuring deformation during load test.
4. Provide pile reaction frame, anchor piles, equipment, and instrumentation with sufficient reaction capacity to perform tests. Notify the Owner at least 48 hours in advance of performing tests. On completion of testing, remove testing structure, anchor piles, equipment, and instrumentation.
   a. Allow a minimum of seven days to elapse after driving test piles before starting pile testing.
   b. Number of Test Piles: One pile **OR** As indicated, **as directed**.
5. Driving Test Piles: Drive test piles at locations indicated to the minimum penetration or driving resistance indicated. Use test piles identical to those required for Project and drive with appropriate pile-driving equipment operating at rated driving energy to be used in driving permanent piles.
6. Approval Criteria: Allowable load shall be the load acting on the test pile when the lesser of, **as directed**, the following criteria are met, divided by a factor of safety of 2:
   a. Net settlement, after deducting rebound, of not more than 0.01 inch/ton (0.25 mm/907 kg) of test load.
   b. Total settlement exceeds the pile elastic compression by 0.15 inch (4 mm), plus 1.0 percent of the tip diagonal dimension.
   c. A plunging failure or sharp break in the load settlement curve.
7. Test Pile-Driving Records: Prepare driving records for each test pile, compiled and attested to by a qualified professional engineer, **as directed**. Include same data as required for driving records of permanent piles.
8. Test piles that comply with requirements, including location tolerances, may be used on Project.

D. Driving Piles

1. General: Continuously drive piles to elevations or penetration resistance indicated or established by static load testing of piles, **as directed**. Establish and maintain axial alignment of leads and piles before and during driving.
2. Predrilling, **as directed**: Provide pre-excavated holes where indicated, to depths indicated. Drill holes with a diameter less than the largest cross-section dimension of pile.
   a. Firmly seat pile in predrilled hole by driving with reduced energy before starting final driving.
3. Heaved Piles: Redrive heaved piles to tip elevation at least as deep as original tip elevation with a driving resistance at least as great as original driving resistance.
4. Driving Tolerances: Drive piles without exceeding the following tolerances, measured at pile heads:
   a. Location: 4 inches (102 mm) from location indicated after initial driving, and 6 inches (152 mm) after pile driving is completed.
   b. Plumb: Maintain 1 inch (25 mm) in 4 feet (1.2 m) from vertical, or a maximum of 4 inches (102 mm), measured when pile is aboveground in leads.
   c. Batter Angle: Maximum 1 inch (25 mm) in 4 feet (1.2 m) from required angle, measured when pile is aboveground in leads.
5. Withdraw damaged or defective piles and piles that exceed driving tolerances and install new piles within driving tolerances.
   a. Fill holes left by withdrawn piles using cohesionless soil material such as gravel, broken stone, and gravel-sand mixtures. Place and compact in lifts not exceeding 72 inches (1.83 m).
      OR
      Fill holes left by withdrawn piles as directed by the Owner.

   OR

   Abandon and cut off rejected piles as directed by the Owner. Leave rejected piles in place and install new piles in locations as directed by the Owner.
6. Cutting Off: Cut off tops of driven piles square with pile axis and at elevations indicated.
7. Pile-Driving Records: Maintain accurate driving records for each pile, compiled and attested to by a qualified professional engineer, **as directed**. Include the following data:
   a. Project name and number.
   b. Name of Contractor.
   c. Pile location in pile group and designation of pile group.
   d. Sequence of driving in pile group.
   e. Pile dimensions.
   f. Ground elevation.
   g. Elevation of tips after driving.
   h. Final tip and cutoff elevations of piles after driving pile group.
   i. Records of redriving.
   j. Elevation of splices.
   k. Type, make, model, and rated energy of hammer.
   l. Weight and stroke of hammer.
   m. Type of pile-driving cap used.
   n. Cushion material and thickness.
   o. Actual stroke and blow rate of hammer.
   p. Pile-driving start and finish times, and total driving time.
   q. Time, pile-tip elevation, and reason for interruptions.
   r. Number of blows for every 12 inches (305 mm) of penetration, and number of blows per 1 inch (25 mm) for the last 6 inches (152 mm) of driving.
   s. Pile deviations from location and plumb.
   t. Preboring, jetting, or special procedures used.
   u. Unusual occurrences during pile driving.

E. Field Quality Control

1. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
   a. Pile foundations.
2. Testing Agency: Engage a qualified independent testing agency to perform tests and inspections.
3. Tests and Inspections:
   a. Dynamic Pile Testing: High-strain dynamic monitoring shall be performed and reported according to ASTM D 4945 during initial driving and during restriking on five single piles **OR** 3 percent of piles, **as directed**.
   b. Weld Testing: In addition to visual inspection, welds shall be tested and inspected according to AWS D1.1/D1.1M and inspection procedures listed below, at testing agency's option. Correct deficiencies in Work that test reports and inspections indicate do not comply with the Contract Documents.
      1) Liquid Penetrant Inspection: ASTM E 165.
      2) Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
      3) Radiographic Inspection: ASTM E 94, minimum quality level "2-2T."
      4) Ultrasonic Inspection: ASTM E 164.

F. Touchup Painting, **as directed**
1. Clean field welds, splices, and abraded painted areas and field-apply paint according to SSPC-PA 1. Use same paint and apply same number of coats as specified for shop painting.
   a. Apply touchup paint before driving piles to surfaces that will be immersed or inaccessible after driving.

G. Disposal
1. Remove withdrawn piles and cutoff sections of piles from site and legally dispose of them off Owner's property.

END OF SECTION 31 62 16 16

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SECTION 31 62 16 19 - CONCRETE-FILLED STEEL PILES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for concrete-filled steel piles. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section includes concrete-filled steel shell and pipe piles.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. Shop Drawings: For composite piles. Show fabrication and installation details for piles, including splices and tip details.
      a. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
      b. Indicate locations, sizes, type, and arrangement of reinforcement.
      c. Include arrangement of static pile reaction frame, test and anchor piles, equipment, and instrumentation. Submit structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   3. Welding certificates.
   4. Design Mixes: For each concrete mix. Include revised mix proportions when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
   5. Material Certificates: For steel shell piles and accessories, steel pipe piles and accessories, steel reinforcement and concrete admixtures, from manufacturer.
   6. Material Test Reports: For concrete materials.
   7. Pile-Driving Equipment Data: Include type, make, and rated energy range; weight of striking part of hammer; weight of drive cap; and, type, size, and properties of hammer cushion.
      a. Include mandrel type and details.
   8. Static Pile Test Reports: Submit within three days of completing each test.
   9. Pile-Driving Records: Submit within three days of driving each pile.
   10. Field quality-control reports.
   11. Preconstruction Photographs: Photographs or video of existing conditions of adjacent construction. Submit before the Work begins.

D. Quality Assurance
   1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
   2. Comply with requirements in ACI 301, "Specifications for Structural Concrete."
   3. Welding Qualifications: Qualify procedures and personnel according to the following:
      a. AWS D1.1/D1.1M, "Structural Welding Code - Steel"
      b. AWS D1.3, "Structural Welding Code - Sheet Steel."
   4. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
   1. Deliver piles to Project site in such quantities and at such times to ensure continuity of installation. Handle and store piles at Project site to prevent physical damage.
      a. Painted Piles: Protect finish and touch up damage before driving piles.

F. Project Conditions

1. Protect structures, underground utilities, and other construction from damage caused by pile driving.
2. Preconstruction Photographs: Inventory and record the condition of adjacent structures, underground utilities, and other construction. Provide photographs **OR** video, **as directed**, of conditions that might be misconstrued as damage caused by pile driving.

1.2 PRODUCTS

A. Steel Shell Piles
1. Fluted Pile Shells: Manufacturer's standard, vertically fluted pile shells; cold formed from steel sheet; 50,000-psi (345-MPa) minimum yield strength after forming. Fabricate watertight, uniformly tapered sections with forged-steel conical nose welded to tip.
    a. Constant Diameter Extensions: Fabricate with splice overlap capable of telescoping into tapered section.
    b. Taper: 0.14 inch in 12 inches (1:86) **OR** 0.25 inch in 12 inches (1:48) **OR** 0.40 inch in 12 inches (1:30), **as directed**.
    c. Thickness: 0.150 inch (3.80 mm) **OR** 0.179 inch (4.55 mm) **OR** 0.209 inch (5.31 mm) **OR** 0.239 inch (6.07 mm), **as directed**.
2. Helically Corrugated Pile Shells: Manufacturer's standard, helically corrugated, uniform-diameter, steel sheet shell piles; of sufficient strength and thickness to remain watertight and resist distortion and buckling due to soil pressure, internal mandrel operation, or redriving. Fabricate in one-piece lengths with 3/16-inch- (4.76-mm-) thick, minimum steel-plate boot continuously welded to tip and as follows:
    a. Nominal Diameter: 8-5/8 inches (219 mm) **OR** 10-5/8 inches (270 mm) **OR** 11-1/8 inches (283 mm) **OR** 12-1/4 inches (311 mm) **OR** 14 inches (350 mm) **OR** 16-1/8 inches (410 mm), **as directed**.
    b. Thickness: 0.048 inch (1.21 mm), minimum **OR** 0.060 inch (1.52 mm), minimum **OR** 0.075 inch (1.90 mm), minimum **OR** 0.105 inch (2.66 mm), **as directed**.

B. Steel Pipe Piles
1. Steel Pipe: ASTM A 252, Grade 2 **OR** Grade 3, **as directed**; seamless or welded.

C. Steel Reinforcement
1. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420); deformed.
2. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M.
3. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending, as follows:
    a. Steel Reinforcement: ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**; deformed.
4. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M, as follows:
    a. Steel Reinforcement: ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**; deformed.
5. Plain Steel Wire: ASTM A 82/A 82M, as drawn **OR** galvanized, **as directed**.
6. Deformed-Steel Wire: ASTM A 496/A 496M.
7. Epoxy-Coated-Steel Wire: ASTM A 884/A 884M, Class A coated, plain **OR** deformed, **as directed**.

D. Concrete Materials
1. Portland Cement: ASTM C 150, Type I or II.
    a. Fly Ash: ASTM C 618, Class C or F.
    b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
2. Blended Hydraulic Cement: ASTM C 595, Type IS, portland blast-furnace slag **OR** Type IP, portland-pozzolan **OR** Type I (PM), pozzolan-modified portland **OR** Type I (SM), slag-modified Portland, **as directed**, cement.

3. Normal-Weight Aggregates: ASTM C 33, Class 4S **OR** Class 4M **OR** Class 1N, **as directed**, uniformly graded, 3/4-inch (19-mm) maximum aggregate size. Provide aggregates from a single source.
4. Water: Potable, complying with ASTM C 94/C 94M requirements.
5. Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent chloride ions by mass of cementitious material.
   a. Air-Entraining Admixture: ASTM C 260.
   b. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
   c. Retarding Admixture: ASTM C 494/C 494M, Type B.
   d. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
   e. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
   f. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
   g. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

E. Pile Accessories
1. Driving Points: Manufacturer's standard 60-degree conical driving point, with integral reinforcing ribs, to provide full bearing of pipe pile tip. Fabricate from steel castings as follows:
2. Inside Cutting Shoes: Manufacturer's standard, inside-flanged, open-ended cutting shoe, to provide full bearing of pipe pile tip. Fabricate from steel castings as follows:
3. Outside Cutting Shoes: Manufacturer's standard, outside-flanged, open-ended cutting shoe, to provide full bearing of pipe pile tip. Fabricate from steel castings as follows:
   a. Carbon-Steel Castings: ASTM A 27/A 27M, Grade 65-35 (Grade 450-240), heat treated **OR** Grade N1, **as directed**.
   b. High-Strength Steel Castings: ASTM A 148/A 148M, Grade 80-40 (Grade 550-275) **OR** Grade 90-60 (Grade 620-415), **as directed**.
4. Splice Coupling: Manufacturer's standard splice coupling, rolled from ASTM A 36/A 36M, carbon-steel bar or cast from heat-treated carbon steel, ASTM A 27/A 27M, Grade 65-35 (Grade 450-240), with interior stop and internally tapered for friction fit driving.

F. Paint
1. Paint: SSPC-Paint 16; self-priming, two-component, coal-tar epoxy polyamide, black **OR** red **OR** manufacturer's standard color, **as directed**.

G. Concrete Mixes
1. Prepare concrete design mixes according to ACI 301, determined by either laboratory trial batch or field test data basis.
   a. Use a qualified testing agency for preparing and reporting proposed mix designs determined by laboratory trial batch.
2. Proportion mixes according to ACI 301 to provide normal-weight concrete suitable for piles with the following properties:
   a. Compressive Strength (28 Days): 5000 psi (34.5 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3000 psi (20.7 MPa), **as directed**.
   b. Maximum Water-Cementitious Material Ratio at Point of Placement: 0.45 **OR** 0.50, **as directed**.
   c. Slump Limit: 5 inches (127 mm) **OR** 8 inches (203 mm), **as directed**, plus or minus 1 inch (25 mm).
3. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content of 6.0 percent, plus or minus 1.5 **OR** 2.5 to 4.5, **as directed**, percent.
4. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 limits as if concrete were exposed to deicing chemicals.
5. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 **OR** 0.30, **as directed**, percent by weight of cement.
6. Concrete-mix design adjustments may be considered if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant. Resubmit and obtain approval from the Owner of proposed changes to concrete-mix proportions.

H. Fabrication
1. Fabricate and assemble piles in shop to greatest extent possible.
2. Fabricate full-length piles to eliminate splicing during driving.
OR
Fabricate full-length piles by splicing pile lengths together. Maintain axial alignment of pile lengths. Maintain structural properties of pile across splice.
a. Splice Coupling: Fit splice coupling into position and weld to adjoining steel pipe pile sections according to manufacturer's written instructions and AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.
b. Welded Splices: Accurately mill meeting ends of steel pipe piles and bevel for welding. Continuously weld pile according to AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.
c. Welded Splices: Continuously weld steel shell pile according to manufacturer's written instructions and AWS D1.1/D1.1M and AWS D1.3, **as directed**, for procedures, appearance and quality of welds, and methods used in correcting welding work.
d. Splice piles during fabrication or field installation.
3. Fit and weld driving points to tip of pile according to manufacturer's written instructions and AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.
OR
Fit and weld cutting shoes to tip of pile according to manufacturer's written instructions and AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.
4. Pile-Length Markings: Mark each pile with horizontal lines at 12-inch (305-mm) intervals; label the distance from pile tip at 60-inch (1.52-m) intervals. Maintain markings on piles until driven.

I. Shop Painting, **as directed**
1. General: Shop paint steel pile surfaces, except for surfaces to be encased in concrete, as follows:
a. Extend painting to a depth of 60 inches (1.52 m) below finished grade **OR** low-tide level, **as directed**, to top of exposed pile.
2. Surface Preparation: Clean surfaces to be painted. Remove loose rust and loose mill scale, and remove spatter, slag, or flux deposits. Prepare surfaces according to SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning."
3. Painting: Immediately after surface preparation, apply coat of paint according to manufacturer's written instructions to provide a dry film thickness of not less than 8 mils (0.2 mm).
a. Apply second coat to provide a dry film thickness of not less than 8 mils (0.2 mm), resulting in a two-coat paint system thickness of not less than 16 mils (0.4 mm).
b. Apply second and third coats with each coat having a dry film thickness of not less than 8 mils (0.2 mm), resulting in a three-coat paint system thickness of not less than 24 mils (0.6 mm).
c. Mark pile lengths after shop painting.

J. Concrete Mixing
1. Ready-Mixed Concrete: Comply with ASTM C 94/C 94M.
a. Do not add water to concrete mix after mixing.
b. Maintain concrete temperature to not exceed 90 deg F (32 deg C).

1.3 EXECUTION

A. Examination

1. Site Conditions: Do not start pile-driving operations until earthwork fills have been completed or excavations have reached an elevation of 6 to 12 inches (152 to 305 mm) above bottom of footing or pile cap.

B. Driving Equipment
   1. Pile Hammer: Air-, steam-, hydraulic-, or diesel-powered type capable of consistently delivering adequate peak-force duration and magnitude to develop the ultimate capacity required for type and size of pile driven and character of subsurface material anticipated.
   2. Hammer Cushions and Driving Caps: Between hammer and top of pile, provide hammer cushion and steel driving cap as recommended by hammer manufacturer and as required to drive pile without damage.
   3. Leads: Use fixed, semifixed, or hanging-type pile-driver leads that will hold full length of pile firmly in position and in axial alignment with hammer.
   4. Mandrel: Expandable mandrel, capable of distributing driving energy throughout length of steel shell pile.

C. Static Pile Tests, **as directed**
   1. General: Static pile tests will be used to verify driving criteria and pile lengths and to confirm allowable load of piles.
      a. Furnish test piles 60 inches (1.52 m) longer than production piles.
      b. Determination of actual length of piles will be based on results of static pile tests.
   2. Pile Tests: Arrange and perform the following pile tests:
      a. Axial Compressive Static Load Test: ASTM D 1143.
      b. Axial Tension Static Load Test: ASTM D 3689.
      c. Lateral Load Test: ASTM D 3966.
   3. Equip each test pile with two telltale rods, according to ASTM D 1143, for measuring deformation during load test.
   4. Provide pile reaction frame, anchor piles, equipment, and instrumentation with sufficient reaction capacity to perform tests. Notify the Owner at least 48 hours in advance of performing tests. On completion of testing, remove testing structure, anchor piles, equipment, and instrumentation.
      a. Allow a minimum of seven days to elapse after driving test piles before starting pile testing.
      b. Number of Test Piles: One pile **OR** As indicated, **as directed**.
   5. Driving Test Piles: Drive test piles at locations indicated to the minimum penetration or driving resistance indicated. Use test piles identical to those required for Project and drive with appropriate pile-driving equipment operating at rated driving energy to be used in driving permanent piles.
      a. Pile Design Load: As indicated **OR as directed**.
   6. Approval Criteria: Allowable load shall be the load acting on the test pile when the lesser of, **as directed**, the following criteria are met, divided by a factor of safety of 2:
      a. Net settlement, after deducting rebound, of not more than 0.01 inch/ton (0.25 mm/907 kg) of test load.
      b. Total settlement exceeds the pile elastic compression by 0.15 inch (4 mm), plus 1.0 percent of the tip diagonal dimension.
      c. A plunging failure or sharp break in the load settlement curve.
   7. Test Pile-Driving Records: Prepare driving records for each test pile, compiled and attested to by a qualified professional engineer, **as directed**. Include same data as required for driving records of permanent piles.
   8. Test piles that comply with requirements, including location tolerances, may be used on Project.

D. Steel Reinforcement
   1. Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
   2. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with concrete.
   3. Fabricate and install reinforcement cages symmetrically about axis of pile shell **OR** pipe, **as directed**, in a single unit.

4. Accurately position, support, and secure reinforcement against displacement during concreting. Maintain minimum cover on reinforcement.
5. Protect exposed ends of extended reinforcement, dowels, or anchor bolts from mechanical damage and exposure to weather.

E. Concrete Placement
1. Do not place concrete until other piles within a radius of 20 feet (6 m) have been driven and approved.
2. Inspection: Before placing concrete, allow testing and inspecting agency to visually inspect and verify that each pile shell **OR** pipe, **as directed**, is clean, watertight, plumb, and free of distortion or other defects.
3. Place concrete in a continuous operation and without segregation immediately after cleaning out pile shell **OR** pipe, **as directed**.
4. Place concrete by means of bottom discharge bucket, flexible drop chute, steep-sided funnel hopper, or tremie or pump concrete into place.
5. Place concrete in a dry pile shell **OR** pipe, **as directed**, unless placement underwater is approved by the Owner.
    a. Place concrete underwater by tremie method or pumping. Control placement operations to ensure tremie is embedded no less than 60 inches (1.52 m) into concrete, and flow of tremied concrete is continuous from bottom to top of pile shell **OR** pipe, **as directed**.
    b. Other methods of depositing concrete may be used if approved by the Owner.
6. Consolidate final 10 feet (3 m) of concrete during placement to ensure that concrete is thoroughly worked around steel reinforcement and into corners.
7. Screed concrete level at cutoff elevation and apply a scoured, rough finish.

F. Driving Piles
1. General: Continuously drive piles to elevations or penetration resistance indicated or established by static load testing of piles, **as directed**. Establish and maintain axial alignment of leads and piles before and during driving.
2. Predrilling, **as directed**: Provide pre-excavated holes where indicated, to depths indicated. Drill holes with a diameter less than the largest cross-section dimension of pile.
    a. Firmly seat pile in predrilled hole by driving with reduced energy before starting final driving.
3. Heaved Piles: Redrive heaved piles to tip elevation at least as deep as original tip elevation with a driving resistance at least as great as original driving resistance.
4. Pile Splices: Splice piles during installation and align pile segments concentrically.
5. Driving Tolerances: Drive piles without exceeding the following tolerances, measured at pile heads:
    a. Location: 4 inches (102 mm) from location indicated after initial driving, and 6 inches (152 mm) after pile driving is completed.
    b. Plumb: Maintain 1 inch (25 mm) in 4 feet (1.2 m) from vertical, or a maximum of 4 inches (102 mm), measured when pile is aboveground in leads.
    c. Batter Angle: Maximum 1 inch (25 mm) in 4 feet (1.2 m) from required angle, measured when pile is aboveground in leads.
6. Excavation: Clean out steel pipe pile by removing soil and debris from inside pile before placing steel reinforcement or concrete.
7. Withdraw damaged or defective piles and piles that exceed driving tolerances and install new piles within driving tolerances.
    a. Fill holes left by withdrawn piles using cohesionless soil material such as gravel, broken stone, and gravel-sand mixtures. Place and compact in lifts not exceeding 72 inches (1.83 m).
    OR
    Fill holes left by withdrawn piles as directed by the Owner.

OR

Abandon and cut off rejected piles as directed by the Owner. Leave rejected piles in place and install new piles in locations as directed by the Owner.

8. Cutting Off: Cut off tops of driven piles square with pile axis and at elevations indicated.
9. Pile-Driving Records: Maintain accurate driving records for each pile, compiled and attested to by a qualified professional engineer, **as directed**. Include the following data:
   a. Project name and number.
   b. Name of Contractor.
   c. Pile location in pile group and designation of pile group.
   d. Sequence of driving in pile group.
   e. Pile dimensions.
   f. Ground elevation.
   g. Elevation of tips after driving.
   h. Final tip and cutoff elevations of piles after driving pile group.
   i. Records of redriving.
   j. Elevation of splices.
   k. Type, make, model, and rated energy of hammer.
   l. Weight and stroke of hammer.
   m. Type of pile-driving cap used.
   n. Cushion material and thickness.
   o. Actual stroke and blow rate of hammer.
   p. Pile-driving start and finish times, and total driving time.
   q. Time, pile-tip elevation, and reason for interruptions.
   r. Number of blows for every 12 inches (305 mm) of penetration, and number of blows per 1 inch (25 mm) for the last 6 inches (152 mm) of driving.
   s. Pile deviations from location and plumb.
   t. Preboring, jetting, or special procedures used.
   u. Unusual occurrences during pile driving.

G. Field Quality Control

1. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
   a. Pile foundations.
2. Testing Agency: Engage a qualified independent testing agency to perform tests and inspections.
3. Tests and Inspections:
   a. Dynamic Pile Testing: High-strain dynamic monitoring shall be performed and reported according to ASTM D 4945 during initial driving and during restriking on 5 single piles **OR** 3 percent of piles, **as directed**.
   b. Low-strain integrity measurement shall be performed and reported for each pile.
   c. Weld Testing: In addition to visual inspection, welds shall be tested and inspected according to AWS D1.1/D1.1M and the inspection procedures listed in subparagraphs below, at testing agency's option. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.
      1) Liquid Penetrant Inspection: ASTM E 165.
      2) Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
      3) Radiographic Inspection: ASTM E 94; minimum quality level "2-2T."
      4) Ultrasonic Inspection: ASTM E 164.
   d. Concrete: Sampling and testing of concrete for quality control shall include the following:
      1) Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94/C 94M.
         a) Slump: ASTM C 143/C 143M; one test at point of placement for each compressive-strength test, but no fewer than one test for each concrete load.
         b) Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (5 deg C) and below or when 80 deg F (27 deg C) and above, and one test for each set of compressive-strength specimens.

c) Compression Test Specimens: ASTM C 31/C 31M; one set of four standard cylinders for each compressive-strength test unless otherwise indicated. Mold and store cylinders for laboratory-cured test specimens unless field-cured test specimens are required.

d) Compressive-Strength Tests: ASTM C 39/C 39M; one set for each truck load. One specimen shall be tested at seven days, two specimens shall be tested at 28 days, and one specimen shall be retained in reserve for later testing if required.

2) When frequency of testing will provide fewer than five strength tests for a given class of concrete, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

3) When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing in-place concrete.

4) Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi (3.45 MPa).

5) Test results shall be reported in writing to the Owner, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, concrete type and class, location of concrete batch in piles, design compressive strength at 28 days, concrete-mix proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

6) Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as sole basis for acceptance or rejection.

7) Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate concrete strengths or other requirements have not been met.

H. Touchup Painting, a**s directed**

1. Clean field welds, splices, and abraded painted areas and field-apply paint according to SSPC-PA 1. Use same paint and apply same number of coats as specified for shop painting.
   a. Apply touchup paint before driving piles to surfaces that will be immersed or inaccessible after driving.

I. Disposal

1. Remove withdrawn piles and cutoff sections of piles from site and legally dispose of them off Owner's property.

END OF SECTION 31 62 16 19

SECTION 31 62 19 00 - TIMBER PILES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for timber piles. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes round timber piles.

C. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: For timber piles. Show fabrication and installation details for piles, including details of driving shoes, tips or boots, and pile butt protection.
   a. Include arrangement of static pile reaction frame, test and anchor piles, equipment, and instrumentation. Submit structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
3. Round timber pile treatment data as follows, including chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material:
   a. For each type of preservative-treated timber product include certification by treating plant stating type of preservative solution and pressure process used, net amount of preservative retained, and compliance with applicable standards.
   b. For waterborne-treated products include statement that moisture content of treated materials was reduced to levels indicated before shipment to Project site.
4. Pile-Driving Equipment Data: Include type, make, and rated energy range; weight of striking part of hammer; weight of drive cap; and, type, size, and properties of hammer cushion.
5. Static Pile Test Reports: Submit within three days of completing each test.
6. Pile-Driving Records: Submit within three days of driving each pile.
7. Field quality-control reports.
8. Warranty of chemical treatment manufacturer for each type of treatment.
9. Preconstruction Photographs: Photographs or video of existing conditions of adjacent construction. Submit before the Work begins.

D. Quality Assurance
1. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
2. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
1. Deliver piles to Project site in such quantities and at such times to ensure continuity of installation. Handle and store piles at Project site to prevent breaks, cuts, abrasions, or other physical damage and as required by AWPA M4.
   a. Do not drill holes or drive spikes or nails into pile below cutoff elevation.

F. Project Conditions
1. Protect structures, underground utilities, and other construction from damage caused by pile driving.
2. Preconstruction Photographs: Inventory and record the condition of adjacent structures, underground utilities, and other construction. Provide photographs **OR** video, **as directed**, of conditions that might be misconstrued as damage caused by pile driving.

1.2 PRODUCTS

A. Timber Piles
1. Round Timber Piles: ASTM D 25, unused, clean peeled, one piece from butt to tip; of the following species and size basis:
a. Species: Coastal Douglas fir **OR** Southern yellow pine, **as directed**.
b. Size Basis: Butt circumference **OR** Class A **OR** Class B **OR** Tip circumference **OR** 8-inch (203-mm) tip and natural taper, **as directed**.
2. Pressure-treat round timber piles according to AWPA C3 and, **as directed**, AWPA C18 **OR** AWPA C14, **as directed**, as follows:
a. Service Condition: Land and freshwater **OR** Foundation **OR** Saltwater **OR** Marine piles - dual treatment, **as directed**.
b. Treatment: Waterborne preservative **OR** Creosote or creosote solution **OR** Oil-borne preservative **OR** Waterborne preservative, severe marine borer hazard **OR** Dual treatment consisting of waterborne preservative, followed by creosote or creosote solution, **as directed**.

B. Pile Accessories
1. Driving Shoes: Fabricate from ASTM A 1011/A 1011M, hot-rolled carbon-steel strip to suit pile-tip diameter, of the following type and thickness, and secure to pile tip so as to not affect pile alignment during driving:
a. Type: Flat boot **OR** Arrow point, **as directed**.
b. Thickness: 3/16 inch (4.8 mm) **OR** 1/4 inch (6 mm), **as directed**.

C. Fabrication
1. Pile Tips: Cut and shape pile tips to accept driving shoes. Fit and fasten driving shoes to pile tips according to manufacturer's written instructions.
2. Pile Butt: Trim pile butt and cut perpendicular to longitudinal axis of pile. Chamfer and shape butt to fit tightly to driving cap of hammer.
3. Field-Applied Wood Preservative: Treat field cuts, holes, and other penetrations according to AWPA M4.
a. Coal-tar roofing cement for treating drilled holes or sealing cutoffs shall be free of asbestos.
4. Pile Splices: Splices will not be permitted.
5. Pile-Length Markings: Mark each pile with horizontal lines at 12-inch (305-mm) intervals; label the distance from pile tip at 60-inch (1.52-m) intervals. Maintain markings on piles until driven.

1.3 EXECUTION

A. Examination
1. Site Conditions: Do not start pile-driving operations until earthwork fills have been completed or excavations have reached an elevation of 6 to 12 inches (152 to 305 mm) above bottom of footing or pile cap.

B. Driving Equipment
1. Pile Hammer: Air-, steam-, hydraulic-, or diesel-powered type capable of consistently delivering adequate peak-force duration and magnitude to develop the ultimate capacity required for type and size of pile driven and character of subsurface material anticipated.
2. Hammer Cushions and Driving Caps: Between hammer and top of pile, provide hammer cushion and steel driving cap as recommended by hammer manufacturer and as required to drive pile without damage.
3. Leads: Use fixed, semifixed, or hanging-type pile-driver leads that will hold full length of pile firmly in position and in axial alignment with hammer.

C. Static Pile Tests, **as directed**

1. General: Static pile tests will be used to verify driving criteria and pile lengths and to confirm allowable load of piles.
   a. Furnish test piles 60 inches (1.52 m) longer than production piles.
   b. Determination of actual length of piles will be based on results of static pile tests.
2. Pile Tests: Arrange and perform the following pile tests:
   a. Axial Compressive Static Load Test: ASTM D 1143.
   b. Axial Tension Static Load Test: ASTM D 3689.
   c. Lateral Load Test: ASTM D 3966.
3. Equip each test pile with two telltale rods, according to ASTM D 1143, for measuring deformation during load test.
4. Provide pile reaction frame, anchor piles, equipment, and instrumentation with sufficient reaction capacity to perform tests. Notify the Owner at least 48 hours in advance of performing tests. On completion of testing, remove testing structure, anchor piles, equipment, and instrumentation.
   a. Allow a minimum of seven days to elapse after driving test piles before starting pile testing.
   b. Number of Test Piles: One pile **OR** As indicated, **as directed**.
5. Driving Test Piles: Drive test piles at locations indicated to the minimum penetration or driving resistance indicated. Use test piles identical to those required for Project and drive with appropriate pile-driving equipment operating at rated driving energy to be used in driving permanent piles.
6. Approval Criteria: Allowable load shall be the load acting on the test pile when the lesser of, **as directed**, the following criteria are met, divided by a factor of safety of 2:
   a. Net settlement, after deducting rebound, of not more than 0.01 inch/ton (0.25 mm/907 kg) of test load.
   b. Total settlement exceeds the pile elastic compression by 0.15 inch (4 mm), plus 1.0 percent of the tip diagonal dimension.
   c. A plunging failure or sharp break in the load settlement curve.
7. Test Pile-Driving Records: Prepare driving records for each test pile, compiled and attested to by a qualified professional engineer, **as directed**. Include same data as required for driving records of permanent piles.
8. Test piles that comply with requirements, including location tolerances, may be used on Project.

D. Driving Piles

1. General: Continuously drive piles to elevations or penetration resistance indicated or established by static load testing of piles, **as directed**. Establish and maintain axial alignment of leads and piles before and during driving.
2. Spudding: Drive spud piles through overlying highly resistant strata or obstructions and withdraw for reuse.
3. Predrilling, **as directed**: Provide pre-excavated holes where indicated, to depths indicated. Drill holes with a diameter less than the largest cross-section dimension of pile.
   a. Firmly seat pile in predrilled hole by driving with reduced energy before starting final driving.
4. Heaved Piles: Redrive heaved piles to tip elevation at least as deep as original tip elevation with a driving resistance at least as great as original driving resistance.
5. Driving Tolerances: Drive piles without exceeding the following tolerances, measured at pile heads:
   a. Location: 4 inches (102 mm) from location indicated after initial driving, and 6 inches (152 mm) after pile driving is completed.
   b. Plumb: Maintain 1 inch (25 mm) in 4 feet (1.2 m) from vertical, or a maximum of 4 inches (102 mm), measured when pile is aboveground in leads.
   c. Batter Angle: Maximum 1 inch (25 mm) in 4 feet (1.2 m) from required angle, measured when pile is aboveground in leads.
6. Withdraw damaged or defective piles and piles that exceed driving tolerances and install new piles within driving tolerances.

a. Fill holes left by withdrawn piles using cohesionless soil material such as gravel, broken stone, and gravel-sand mixtures. Place and compact in lifts not exceeding 72 inches (1.83 m).
OR
Fill holes left by withdrawn piles as directed by the Owner.

OR
Abandon and cut off rejected piles as directed by the Owner. Leave rejected piles in place and install new piles in locations as directed by the Owner.

7. Cutting Off: Cut off butts of driven piles square with pile axis and at elevations indicated.
   a. Cover cut-off piling surfaces with caps overlapping pile end by minimum 2 inches (51 mm) **OR** minimum three coats of preservative treatment, **as directed**, according to AWPA M4.
8. Pile-Driving Records: Maintain accurate driving records for each pile, compiled and attested to by a qualified professional engineer, **as directed**. Include the following data:
   a. Project name and number.
   b. Name of Contractor.
   c. Pile species.
   d. Pile location in pile group and designation of pile group.
   e. Sequence of driving in pile group.
   f. Pile dimensions.
   g. Ground elevation.
   h. Elevation of tips after driving.
   i. Final tip and cutoff elevations of piles after driving pile group.
   j. Records of redriving.
   k. Elevation of splices.
   l. Type, make, model, and rated energy of hammer.
   m. Weight and stroke of hammer.
   n. Type of pile-driving cap used.
   o. Cushion material and thickness.
   p. Actual stroke and blow rate of hammer.
   q. Pile-driving start and finish times, and total driving time.
   r. Time, pile-tip elevation, and reason for interruptions.
   s. Number of blows for every 12 inches (305 mm) of penetration, and number of blows per 1 inch (25 mm) for the last 6 inches (152 mm) of driving.
   t. Pile deviations from location and plumb.
   u. Preboring, jetting, or special procedures used.
   v. Unusual occurrences during pile driving.

E. Field Quality Control
1. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
   a. Pile foundations.
2. Testing Agency: Engage a qualified independent testing agency to perform tests and inspections.
3. Tests and Inspections:
   a. Dynamic Pile Testing: High-strain dynamic monitoring shall be performed and reported according to ASTM D 4945 during initial driving and during restriking on five single piles **OR** 3 percent of piles, **as directed**.

F. Disposal
1. Remove withdrawn piles and cutoff sections of piles from site and legally dispose of them off Owner's property.

END OF SECTION 31 62 19 00

Task	Specification	Specification Description
31 62 23 13	31 62 16 19	Concrete-Filled Steel Piles

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SECTION 31 64 13 00 - DRILLED PIERS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for drilled piers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Dry-installed drilled piers.
      b. Slurry displacement-installed drilled piers.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. Design Mixtures: For each concrete mixture.
   3. Shop Drawings: For concrete reinforcement.
   4. Welding certificates.
   5. Material certificates **OR** test reports, **as directed**.

D. Quality Assurance
   1. Welding Qualifications: Qualify procedures and personnel according to the following:
      a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
      b. AWS D1.4, "Structural Welding Code - Reinforcing Steel."
   2. Drilled-Pier Standard: Comply with ACI 336.1 unless modified in this Section.
   3. Preinstallation Conference: Conduct conference at Project site.

E. Project Conditions
   1. Existing Utilities: Locate existing underground utilities before excavating drilled piers. If utilities are to remain in place, provide protection from damage during drilled-pier operations.
      a. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, adapt drilling procedure if necessary to prevent damage to utilities. Cooperate with the Owner and utility companies in keeping services and facilities in operation without interruption. Repair damaged utilities to satisfaction of utility the Owner.
   2. Interruption of Existing Utilities: Do not interrupt any utility to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
      a. Notify the Owner no fewer than two days in advance of proposed interruption of utility.
      b. Do not proceed with interruption of utility without the Owner’s written permission.
   3. Survey Work: Engage a qualified land surveyor or professional engineer to perform surveys, layouts, and measurements for drilled piers. Before excavating, lay out each drilled pier to lines and levels required. Record actual measurements of each drilled pier's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.
      a. Record and maintain information pertinent to each drilled pier and cooperate with the Owner's testing and inspecting agency to provide data for required reports.

1.2 PRODUCTS

A. Steel Reinforcement
   1. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
   2. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

3. Galvanized Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, ASTM A 767/A 767M, Class I **OR** Class II, **as directed**, zinc coated after fabrication and bending.
4. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, ASTM A 775/A 775M or ASTM A 934/A 934M, epoxy coated, with less than 2 percent damaged coating in each 12-inch (300-mm) bar length.
5. Plain-Steel Wire: ASTM A 82, as drawn **OR** galvanized, **as directed**.
6. Deformed-Steel Wire: ASTM A 496.
7. Epoxy-Coated Wire: ASTM A 884/A 884M, Class A, Type 1 coated, as-drawn, plain **OR** deformed, **as directed**,-steel wire, with less than 2 percent damaged coating in each 12-inch (300-mm) wire length.
8. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), plain. Cut bars true to length with ends square and free of burrs.

B. Concrete Materials
1. Cementitious Material: Use the following cementitious materials, of same type, brand, and source, throughout Project:
   a. Portland Cement: ASTM C 150, Type I **OR** Type II **OR** Type I/II **OR** Type III **OR** Type V, **as directed**. Supplement with the following, **as directed**:
      1) Fly Ash: ASTM C 618, Class C **OR** Class F, **as directed**.
      2) Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
   b. Blended Hydraulic Cement: ASTM C 595, Type IS, portland blast-furnace slag **OR** Type IP, portland-pozzolan **OR** Type I (PM), pozzolan-modified portland **OR** Type I (SM), slag-modified Portland, **as directed**, cement.
2. Normal-Weight Aggregate: ASTM C 33, graded, 3/4-inch- (19-mm-) nominal maximum coarse-aggregate size.
   a. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
3. Water: ASTM C 94/C 94M and potable.
4. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
   a. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
   b. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
   c. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
   d. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
5. Sand-Cement Grout: Portland cement, ASTM C 150, Type II; clean natural sand, ASTM C 404; and water to result in grout with a minimum 28-day compressive strength of 1000 psi (6.9 MPa), of consistency required for application.

C. Steel Casings
1. Steel Pipe Casings: ASTM A 283/A 283M, Grade C, or ASTM A 36/A 36M, carbon-steel plate, with joints full-penetration welded according to AWS D1.1/D1.1M.
2. Corrugated-Steel Pipe Casings: ASTM A 929/A 929M, steel sheet, zinc coated.
3. Liners: Comply with ACI 336.1.

D. Slurry
1. Slurry: Pulverized bentonite, pulverized attapulgite, or polymers mixed with water to form stable colloidal suspension; complying with ACI 336.1 for density, viscosity, sand content, and pH.

E. Concrete Mixtures
1. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
2. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 limits as if concrete were exposed to deicing chemicals.

3. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 **OR** 0.30, **as directed**, percent by weight of cement.
4. Proportion normal-weight concrete mixture as follows:
    a. Compressive Strength (28 Days): 6000 psi (41.4 MPa) **OR** 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**.
    b. Maximum Water-Cementitious Materials Ratio: 0.50 **OR** 0.45 **OR** 0.40, **as directed**.
    c. Minimum Slump: Capable of maintaining the following slump until completion of placement:
        1) 4 inches (100 mm) for dry, uncased, or permanent-cased drilling method.
        2) 6 inches (150 mm) for temporary-casing drilling method.
        3) 7 inches (175 mm) for slurry displacement method.
    d. Air Content: Do not air entrain concrete.

F. Fabricating Reinforcement
1. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

G. Concrete Mixing
1. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
    a. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

1.3 EXECUTION

A. Preparation
1. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, vibration, and other hazards created by drilled-pier operations.

B. Excavation
1. Unclassified Excavation: Excavate to bearing elevations regardless of character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions.
    a. Obstructions: Unclassified excavation may include removal of unanticipated boulders, concrete, masonry, or other subsurface obstructions. No changes in the Contract Sum or the Contract Time will be authorized for removal of obstructions.
2. Classified Excavation: Excavation is classified as standard excavation, special excavation, and obstruction removal and includes excavation to bearing elevations as follows:
    a. Standard excavation includes excavation accomplished with conventional augers fitted with soil or rock teeth, drilling buckets, or underreaming tools attached to drilling equipment of size, power, torque, and downthrust necessary for the Work.
    b. Special excavation includes excavation that requires special equipment or procedures above or below indicated depth of drilled piers where drilled-pier excavation equipment used in standard excavation, operating at maximum power, torque, and downthrust, cannot advance the shaft.
        1) Special excavation requires use of special rock augers, core barrels, air tools, blasting, or other methods of hand excavation.
        2) Earth seams, rock fragments, and voids included in rock excavation area will be considered rock for full volume of shaft from initial contact with rock.
    c. Obstructions: Payment for removing unanticipated boulders, concrete, masonry, or other subsurface obstructions that cannot be removed by conventional augers fitted with soil or rock teeth, drilling buckets, or underreaming tools attached to drilling equipment of size, power, torque, and downthrust necessary for the Work will be according to Contract provisions for changes in the Work.

3. Prevent surface water from entering excavated shafts. Conduct water to site drainage facilities.
4. Excavate shafts for drilled piers to indicated elevations. Remove loose material from bottom of excavation.
   a. Excavate bottom of drilled piers to level plane within 1:12 tolerance.
   b. Remove water from excavated shafts before concreting.
   c. Excavate rock sockets of dimensions indicated.
   d. Cut series of grooves about perimeter of shaft to height from bottom of shaft, vertical spacing, and dimensions indicated.
5. Notify and allow testing and inspecting agency to test and inspect bottom of excavation. If unsuitable bearing stratum is encountered, make adjustments to drilled piers as determined by the Owner.
   a. Do not excavate shafts deeper than elevations indicated unless approved by the Owner.
   b. Payment for additional authorized excavation will be according to Contract provisions for changes in the Work.
6. End-Bearing Drilled Piers: If further exploration below bearing elevation is required for end-bearing piers or if soft soils are suspected, probe with auger to a depth below bearing elevation, equal to diameter of the bearing area of drilled pier. Determine whether voids, clay seams, or solution channels exist.
   a. Fill augur-probe holes with grout.
7. End-Bearing Drilled Piers: If drilled piers bear on clay or hardpan, probe with auger to a depth of 96 inches (2450 mm) below bottom elevation of shaft, and visually inspect and classify soil. Verify continuity and thickness of stratum.
8. Excavate shafts for closely spaced drilled piers and for drilled piers occurring in fragile or sand strata only after adjacent drilled piers are filled with concrete and allowed to set.
9. Slurry Displacement Method: Stabilize excavation with slurry maintained a minimum of 60 inches (1500 mm) above ground-water level and above unstable soil strata to prevent caving or sloughing of shaft. Maintain slurry properties before concreting.
   a. Excavate and complete concreting of drilled pier on same day if possible, or redrill, clean, and test slurry in excavation before concreting.
   b. Clean bottom of each shaft before concreting.
10. Temporary Casings: Install watertight steel casings of sufficient length and thickness to prevent water seepage into shaft; to withstand compressive, displacement, and withdrawal stresses; and to maintain stability of shaft walls.
   a. Remove temporary casings, maintained in plumb position, during concrete placement and before initial set of concrete, or leave temporary casings in place, **as directed**.
11. Bells: Excavate bells for drilled piers to shape, base thickness, and slope angle indicated. Excavate bottom of bells to level plane and remove loose material before placing concrete.
   a. Shore bells in unstable soil conditions to prevent cave-in during excavation, inspection, and concreting.
12. Tolerances: Construct drilled piers to remain within ACI 336.1 tolerances.
   a. If location or out-of-plumb tolerances are exceeded, provide corrective construction. Submit design and construction proposals to the Owner for review before proceeding.

C. Permanent Steel Casings
1. Install steel casings of minimum wall thickness indicated and of diameter not less than diameter of drilled pier.
   a. Install casings as excavation proceeds, to maintain sidewall stability.
   b. Fabricate bottom edge of lowest casing section with cutting shoe capable of penetrating rock and achieving water seal.
   c. Connect casing sections by continuous penetration welds to form watertight, continuous casing.
   d. Remove and replace or repair casings that have been damaged during installation and that could impair strength or efficiency of drilled pier.
   e. Fill annular void between casing and shaft wall with grout.

2. Corrugated-Steel Casings: Provide corrugated-steel casings formed from zinc-coated steel sheet.
   a. Corrugated casings may be delivered in sections or panels of convenient length and field connected according to manufacturer's written instructions.

D. Steel Reinforcement
1. Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
2. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with concrete.
3. Fabricate and install reinforcing cages symmetrically about axis of shafts in a single unit.
4. Accurately position, support, and secure reinforcement against displacement during concreting. Maintain minimum cover over reinforcement.
5. Use templates to set anchor bolts, leveling plates, and other accessories furnished in work of other Sections. Provide blocking and holding devices to maintain required position during final concrete placement.
6. Protect exposed ends of extended reinforcement, dowels, or anchor bolts from mechanical damage and exposure to weather.

E. Concrete Placement
1. Place concrete in continuous operation and without segregation immediately after inspection and approval of shaft by the Owner's independent testing and inspecting agency.
   a. Construct a construction joint if concrete placement is delayed more than one hour. Level top surface of concrete and insert joint dowel bars, **as directed**. Before placing remainder of concrete, clean surface laitance, roughen, and slush concrete with commercial bonding agent or with sand-cement grout mixed at ratio of 1:1.
2. Dry Method: Place concrete to fall vertically down the center of drilled pier without striking sides of shaft or steel reinforcement.
   a. Where concrete cannot be directed down shaft without striking reinforcement, place concrete with chutes, tremies, or pumps.
   b. Vibrate top 60 inches (1500 mm) of concrete.
3. Slurry Displacement Method: Place concrete in slurry-filled shafts by tremie methods or pumping. Control placement operations to ensure that tremie or pump pipe is embedded no fewer than 60 inches (1500 mm) into concrete and that flow of concrete is continuous from bottom to top of drilled pier.
4. Coordinate withdrawal of temporary casings with concrete placement to maintain at least a 60-inch (1500-mm) head of concrete above bottom of casing.
   a. Vibrate top 60 inches (1500 mm) of concrete after withdrawal of temporary casing.
5. Screed concrete at cutoff elevation level and apply scoured, rough finish. Where cutoff elevation is above the ground elevation, form top section above grade and extend shaft to required elevation.
6. Protect concrete work, according to ACI 301, from frost, freezing, or low temperatures that could cause physical damage or reduced strength.
   a. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
   b. Do not use calcium chloride, salt, or other mineral-containing antifreeze agents or chemical accelerators.
7. If hot-weather conditions exist that would seriously impair quality and strength of concrete, place concrete according to ACI 301 to maintain delivered temperature of concrete at no more than 90 deg F (32 deg C).
   a. Place concrete immediately on delivery. Keep exposed concrete surfaces and formed shaft extensions moist by fog sprays, wet burlap, or other effective means for a minimum of seven days.

F. Field Quality Control

1. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
   a. Drilled piers.
   b. Excavation.
   c. Concrete.
   d. Steel reinforcement welding.
2. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
3. Drilled-Pier Tests and Inspections: For each drilled pier, before concrete placement.
   a. Soil Testing: Bottom elevations, bearing capacities, and lengths of drilled piers indicated have been estimated from available soil data. Actual elevations and drilled-pier lengths and bearing capacities will be determined by testing and inspecting agency. Final evaluations and approval of data will be determined by the Owner.
      1) Bearing Stratum Tests: Testing agency will take undisturbed hardpan **OR** rock, **as directed**, core samples from drilled-pier bottoms and test each sample for compression, moisture content, and density, and will report results and evaluations.
4. Concrete Tests and Inspections: ASTM C 172 except modified for slump to comply with ASTM C 94/C 94M.
   a. Slump: ASTM C 143/C 143M; one test at point of placement for each compressive-strength test but no fewer than one test for each concrete load.
   b. Concrete Temperature: ASTM C 1064/C 1064M; 1 test hourly when air temperature is 40 deg F (4.4 deg C) and below and 80 deg F (27 deg C) and above, and 1 test for each set of compressive-strength specimens.
   c. Compression Test Specimens: ASTM C 31/C 31M; one set of four standard cylinders for each compressive-strength test unless otherwise indicated. Mold and store cylinders for laboratory-cured test specimens unless field-cured test specimens are required.
   d. Compressive-Strength Tests: ASTM C 39; one set for each drilled pier but not more than one set for each truck load. One specimen will be tested at 7 days, 2 specimens will be tested at 28 days, and 1 specimen will be retained in reserve for later testing if required.
   e. If frequency of testing will provide fewer than five strength tests for a given class of concrete, testing will be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
   f. If strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
   g. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).
   h. Report test results in writing to the Owner, concrete manufacturer, and Contractor within 48 hours of testing. List Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests in reports of compressive-strength tests.
   i. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by the Owner but will not be used as sole basis for approval or rejection of concrete.
   j. Additional Tests: Testing and inspecting agency will make additional tests of concrete if test results indicate that slump, compressive strengths, or other requirements have not been met, as directed by the Owner.
      1) Continuous coring of drilled piers may be required, at Contractor's expense, if temporary casings have not been withdrawn within specified time limits or if observations of placement operations indicate deficient concrete quality, presence of voids, segregation, or other possible defects.

k. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.
l. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

5. An excavation, concrete, or a drilled pier will be considered defective if it does not pass tests and inspections.
6. Prepare test and inspection reports for each drilled pier as follows:
   a. Actual top and bottom elevations.
   b. Actual drilled-pier diameter at top, bottom, and bell.
   c. Top of rock elevation.
   d. Description of soil materials.
   e. Description, location, and dimensions of obstructions.
   f. Final top centerline location and deviations from requirements.
   g. Variation of shaft from plumb.
   h. Shaft excavating method.
   i. Design and tested bearing capacity of bottom.
   j. Depth of rock socket.
   k. Levelness of bottom and adequacy of cleanout.
   l. Properties of slurry and slurry test results at time of slurry placement and at time of concrete placement.
   m. Ground-water conditions and water-infiltration rate, depth, and pumping.
   n. Description, purpose, length, wall thickness, diameter, tip, and top and bottom elevations of temporary or permanent casings. Include anchorage and sealing methods used and condition and weather tightness of splices if any.
   o. Description of soil or water movement, sidewall stability, loss of ground, and means of control.
   p. Bell dimensions and variations from original design.
   q. Date and time of starting and completing excavation.
   r. Inspection report.
   s. Condition of reinforcing steel and splices.
   t. Position of reinforcing steel.
   u. Concrete placing method, including elevation of consolidation and delays.
   v. Elevation of concrete during removal of casings.
   w. Locations of construction joints.
   x. Concrete volume.
   y. Concrete testing results.
   z. Remarks, unusual conditions encountered, and deviations from requirements.

G. Disposal Of Surplus And Waste Materials
1. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off the Owner's property.

END OF SECTION 31 64 13 00

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SECTION 31 66 15 00 - RESISTANCE PIER SYSTEMS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of 2-Piece Resistance Piers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Scope of Work: The work includes, but is not limited, to the following:
1. All soil excavation;
2. Preparation of the footing and stem wall or foundation grade beam;
3. Installation of the Pier Bracket including concrete anchors;
4. Mounting of the Drive Stand Assembly and the installation of steel Pier Sections to designed specifications;
5. Installation of the Top Pier Platform and Two Piece Lift Head Assembly;
6. Lifting of the structure with hydraulic rams and the restoration of the structure to a permanent elevation;
7. Replacement of the soil and general site clean-up.

1.2 PRODUCTS

A. Pier Bracket
1. Standard 2-Piece Pier Bracket (2-7/8" Diameter Pier Pipe): The Pier Bracket shall be a welded assembly of 5/8 and 1/2 inch thick flame cut steel plates conforming to ASTM A36, A568 and A569. The Pier Bracket shall provide 69 square inches of bearing surface against the bottom of the footing and a minimum of 48 square inches against the vertical face of the foundation. The Pier Bracket shall have guides for the top pier platform, two 9/16 inch diameter bracket mounting holes, two 11/16 inch diameter pier pin holes and four 1-1/32 inch diameter alignment and equipment mounting holes.
2. Standard 2-Piece Pier Bracket (3-1/2" & 4" Diameter Pier Pipe): The Pier Bracket for the 3-1/2 inch or 4-inch diameter pier shall be a welded assembly of 5/8 and 1/2 inch thick flame cut steel plates conforming to ASTM A36, A568 and A569. The Pier Bracket shall provide 74 square inches of bearing surface against the bottom of the footing and a minimum of 59 square inches against the vertical face of the foundation. The Pier Bracket shall have guides for the Top Pier Platform, two 9/16 inch diameter bracket mounting holes, two 11/16 inch diameter pier pin holes and six 1-1/32 inch diameter alignment and equipment mounting holes.
3. Heavy Duty 2-Piece Pier Bracket (4-1/2" Diameter Pier Pipe): The Pier Bracket shall be a welded assembly of 5/8 and 1/2 inch thick flame cut steel plates conforming to ASTM A36, A568 and A569. The Pier Bracket shall provide 74 square inches of bearing surface against the bottom of the footing and a minimum of 128 square inches against the vertical face of the foundation. The Pier Bracket shall have guides for the Top Pier Platform, four 9/16 inch diameter bracket mounting holes, two 7/8 inch diameter pier pin holes and six 1-1/32 inch diameter alignment and equipment mounting holes.
4. Flat Plate 2-Piece Pier Bracket (2-7/8", 3-1/2" & 4" Diameter Pier Pipe): The Pier Bracket shall be a welded assembly of 5/8 and 1/2-inch thick flame cut steel plates conforming to ASTM A36, A568 and A569. The Pier Bracket shall provide 320 square inches of surface contact against a vertical face of the stem wall or column. The Pier Bracket shall have guides for the Top Pier Platform, four 1 inch and four 1-1/8 inch diameter bracket mounting holes, four 11/16 inch diameter pier pin holes and six 1-1/32 inch diameter alignment and equipment mounting holes.
5. Curved Plate 2-Piece Pier Bracket (2-7/8", 3-1/2 & 4" Diameter Pier Pipe): The Curved Plate series of Pier Brackets shall be constructed as specified in Paragraph A.1 above with the

exception that the plate that mounts against the circular column shall be rolled to conform to the diameter of the column.

B. Anchor Bolts
1. Standard Pier Anchor Bolts: Each Pier Bracket requires two 1/2 inch diameter by 5-1/2 inch long (minimum) steel concrete expansion bolts (Four required for the 4-1/2" Diameter Heavy Duty 2-Piece Pier), cadmium plated with an ultimate pull out capacity of 6,300 pounds, working load 2,400 pounds. Bolts are required for mounting only. The Anchor Bolts shall be supplied with a flat washer and nut.
2. Plate Pier Anchor Bolts: Each Pier Bracket requires two 1/2 inch diameter by 5-1/2 inch long (minimum), four 3/4 inch diameter by 7-1/2 inch long (minimum) and four 3/4 inch diameter (minimum) by 10 inch long (minimum) steel concrete expansion bolts, cadmium plated with an ultimate pull out capacity of 7,250 pounds (minimum) to achieve maximum capacity. (Lighter bolt design may be used with lighter load applications.) The Anchor Bolts shall be supplied with a flat washer and nut.

C. Grout (Optional)
1. Pressure Bearing Grout: Quick setting premixed mortar with a 4,500 psi (minimum), three day strength. Master Builder's 713 Non-Shrink Grout or equivalent.
2. Flowable Pipe Grout: Quick setting, neat cement flowable grout with a 4,000 psi (minimum), three day strength.
3. Flowable Grout Fill: The grout slurry shall consist of sand, soil or other suitable void fill material mixed with any recognized lubricant such as 12 per cent cement (2-1/2 sack mix), bentonite or other lubricant to promote proper flow characteristics.

D. Drive Stand Assembly: The Drive Stand Assembly shall be a welded steel frame with a double acting hydraulic actuator capable of pressing the 42 inch long steel Pier Sections through the soil to a load bearing strata. The Drive Stand Assembly shall be temporarily attached to the Pier Bracket by means of one inch diameter by 2-3/4 inch long high strength locking pins.

E. Pier Section
1. Pier Section (2-7/8" Diameter x 0.165" Wall Thickness): Each Pier Section shall be fabricated from a 2-7/8 inch outside diameter by 42-inch long mill rolled, induction heat treated steel section with a 0.165 inch wall thickness. Yield strength shall be 50,000 psi and tensile strength shall be 55,000 psi. The initial section shall have a 3-1/2 inch outside diameter collar welded to the lead end of the pipe to assist in reducing wall friction during driving of the pier to capacity. The Pier Sections that follow shall each have a Coupling welded to one end. Steel in this section shall conform to ASTM A513.
2. Standard Pier Section (3-1/2" Diameter x 0.160" Wall Thickness): Each Pier Section shall be fabricated from a 3-1/2 inch outside diameter by 42-inch long mill rolled galvanized steel section with a 0.160 inch wall thickness. Yield strength shall be 50,000 psi and tensile strength shall be 55,000 psi. A triple coat corrosion protection of zinc chromate and clear polymer coating shall be provided. The initial section shall have a 4 inch outside diameter collar welded to the lead end of the pipe to assist in reducing wall friction during driving of the pier to capacity. The Pier Sections that follow shall each have a Coupling welded to one end. Steel in this section shall conform to ASTM A53, A513, A588, and B6.
3. Pier Section (4" Diameter x 0.219" Wall Thickness): Each Pier Section shall be fabricated from a 4 inch outside diameter by 42-inch long mill rolled steel section with a 0.219 inch wall thickness. Yield strength shall be 50,000 psi and tensile strength shall be 55,000 psi. The initial section shall have a 4-1/2 inch outside diameter collar welded to the lead end of the pipe to assist in reducing wall friction during driving of the pier to capacity. The Pier Sections that follow shall each have a Coupling welded to one end. Steel in this section shall conform to ASTM A513.
4. Heavy Duty Pier Section (4-1/2" Diameter x 0.238" Wall Thickness): Each Pier Section shall be fabricated from a 4-1/2 inch diameter, 0.238 wall thick pipe. Yield strength shall be 50,000 psi and tensile strength shall be 55,000 psi. The initial section shall have a 5 inch outside diameter

collar welded to the lead end of the pipe to assist in reducing wall friction during driving of the pier to capacity. The Pier Sections that follow shall each have a Coupling welded to one end. Steel in this section shall conform to ASTM A513.

F. Coupling: The Pier Coupling shall be a 6-inch long tubular steel section of suitable diameter to fit inside the Pier Section. The Coupling shall be inserted and attached 3 inches inside one end of each Pier Section that follows the initial Pier Section. The remaining 3 inches of the Coupling shall extend beyond the Pier Section. All components shall conform to ASTM A513. On the 3-1/2" Pier Pipe, the Coupling shall be attached by an embossed mechanical connection. On all other Pier Pipe sizes, the Coupling shall be attached by plug welding the Coupling to the Pier Pipe.

G. Modified Sleeve Pier Section (Modified Pier Only): The Modified Sleeve Pier Section shall be fabricated from a 3-1/2 inch diameter, 0.216 inch thick wall or 4 inch diameter, 0.219 inch thick wall mill rolled steel pipe, by 42 inches long. The yield strength shall be 50,000 psi. The Pipe Sleeve shall be mounted over the last Pier Section and shall be used to increase the moment transfer capacity from the Top Pier Platform to the Pier Section. Steel in this section shall conform to ASTM A36.

H. Pier Sleeving (Optional): Pier Sleeving shall be used to stiffen the segmented joints through areas of weak soils. Depending upon the product, the sleeve sections shall be fabricated from 3 inch diameter, schedule 40 pipe, or 4 inch diameter, 0.219 inch thick wall mill rolled steel pipe, or 4-1/2 inch diameter, 0.238 thick wall mill rolled steel pipe by 42 inches long. The Sleeving shall be driven over the Pier Sections in the area of weak soils. The Sleeving shall be installed in a manner that staggers the joints in the Pier with the joints in the Sleeving. Steel in this section shall conform to one or more of ASTM A53, A513, A588, B6.

I. Top Pier Platform
1. Top Pier Platform For Standard, Modified And Plate Piers: The Standard Pier Platform shall be a welded assembly consisting of an 18 inch long steel tube of suitable size to fit over the Pier Section that shall form the cap cylinder. The cap cylinder shall have two 10 inch long by 5/8 inch thick steel plates welded as vertical stabilizers to the sides of the steel cap cylinder. The top of the Top Pier Platform shall be a 1 inch thick steel plate welded to the top of the cap cylinder. All steel elements shall conform to ASTM A36.
2. Top Pier Platform For 4-1/2" Diameter Piers: A 4 inch outside diameter by 20 inch long steel pipe shall be welded to the inside of a 4-1/2 outside diameter by 10 inch long steel pipe to form the cap cylinder. The cap cylinder shall have two 9-1/2 inch long by 5/8 inch thick steel plates welded as vertical stabilizers to the sides of the steel cap cylinder. At the top of the Top Pier Platform shall be a 1 inch thick steel plate welded to the top of the cap cylinder. All steel elements shall conform to ASTM A36.

J. High Strength Pier Pins
1. High Strength Pier Pins For Standard, Modified And Plate Piers: Two 5/8 inch diameter by three inch long high strength, heat treated cadmium plated Pier Pins are required per pier. The Pier Pins shall be capable of providing 55,000 pounds of ultimate shear resistance capacity in double shear configuration. Pier Pins shall be 10B21 Boron Steel and heat treated to RC36 +/-. Pins shall conform to ASTM A490.
2. High Strength Pier Pins For 4-1/2" Diameter Piers: Two 3/4 inch diameter by 3-1/4 inch long high strength cadmium plated Pier Pins are required per pier. The Pier Pins are capable of providing a minimum 30,000 pounds of shear capacity at each point of shear. Pier Pins shall be equivalent to Grade 8.

K. Lift Shims: The Lift Shims shall be 5/8 inch by 1-1/2 inch and either 7 gauge or 16 gauge cadmium plated hot rolled steel. Lift Shims shall be used as required. The steel shall conform to ASTM A36.

L. Two Piece Lift Head Assembly: The Two Piece Lift Head shall be a welded assembly that consists of 5/8 inch thick and 1 inch thick steel plates and is capable of providing a minimum of 45,000 pounds resistance capacity. The Two Piece Lift Head Assembly shall be temporarily attached to the Pier

Bracket by means of one inch diameter by 2-3/4 inch long high strength locking pins that are inserted through matching 1-1/32 inch diameter holes.

M. Lateral Support Device: The Lateral Support Device is a specialized tool used to provide a horizontal force to the bottom of the Pier Bracket during Pier Section installation. The Lateral Support Device shall help counteract the torque developed between the structure and the Pier Bracket during Pier Section installation. The Lateral Support Device is a welded assembly of steel plate and tubing that has an adjustable length by means of a hand actuated thread and by a steel pin inserted through adjustment holes in the Lateral Support Device.

N. Helical Outrigger Assembly (Optional): The Helical Outrigger Assembly shall provide supplemental drive resistance when installing the Pier Sections. This optional assembly is for use on light structures with low structural integrity. It is also used to push the Pier Section through weak or unsuitable strata and to develop a higher factor of safety. The Helical Outrigger Assembly shall consist of Helical Anchors, Helical Extension Sections, Connector Pins and Extension Rods.

O. Weldments: All welded connections shall conform to the requirements of the American Welding Society, “Structural Welding Code AWS D1.1”, and applicable revisions.

1.3 EXECUTION

A. Exposure Of Footing Or Grade Beam: An area shall be excavated immediately adjacent to the building foundation to expose the footing, bottom of the grade beam, stem wall or column to a width of at least 36 inches and at least 15 inches beneath the proposed elevation of the base of the Pier Bracket. A chipping hammer shall be used to smooth and prepare the foundation for mounting of the Pier Bracket. The vertical and bottom face of the footing, if applicable, shall, to the extent possible, be smooth and at right angles to each other. The spread footing, if present, shall be notched to allow the Pier Bracket to mount directly under the bearing load of the stem wall, or shall be core drilled to allow the Pier Pipe from the Plate Pier to be installed. DO NOT cut any reinforcing steel in the footing element without approval by the engineer. The surfaces shall be smooth, free of all dirt, debris, and loose concrete so as to provide firm bearing surfaces for the Pier Bracket.

B. Installation Of The Pier Bracket
   1. Installation Of The Standard & Heavy Duty Two Piece Pier Bracket
      a. The Pier Bracket shall be temporarily mounted to the Drive Stand Assembly using one inch diameter locking pins and retaining clips. This assembly shall be lowered into the excavation adjacent to the foundation. The Pier Bracket shall then be seated flush against the footing using a hydraulic actuator or ram. The Pier Bracket shall be then fastened to the footing with two expansion Anchor Bolts. If the Pier Bracket does not have continuous bearing support on either the vertical or horizontal face, then Pressure Bearing Grout shall be used to provide proper bearing prior to driving the pier. Care should be exercised to insure that the Drive Stand Assembly frame is aligned plumb prior to driving each Pier Section. A carpenter’s level may be used to verify the vertical alignment.
      b. Install a Lateral Support Device between the bottom front side of the Pier Bracket and the vertical wall of the excavation opposite the pier. During installation of the Pier Sections, maintain support against the Pier Bracket with the Lateral Support Device. If required, install the optional Helical Outrigger Assembly to provide Supplemental Drive Resistance at this time.
   2. Installation Of The Two-Piece Plate Pier Bracket: A bolt template shall be used to properly locate and align the Pier Bracket at the location directed by the designer or directly over the cored hole in the footing element, if present. Once the anchor bolt holes are located, the 8 bolts shall be installed to the vertical face. The Plate Pier Bracket shall be installed with the nuts and washers provided with the anchor bolts. The longer bolts mount to the lower holes. Follow manufacturer’s recommendations for bolt installation and maintain maximum embedment of the bolts. If the Pier

Bracket does not have continuous bearing support on the vertical face, then Pressure Bearing Grout shall be used to provide proper bearing prior to driving the pier. Care should be exercised to insure that the Pier Bracket is aligned plumb. A carpenter's level may be used to verify the vertical alignment.

C. Driving And Testing Pier Sections
1. Driving Of Pier Sections: All Pier Sections shall be continuously driven by use of the Drive Stand Assembly. The initial Pier Section shall have the friction reduction collar on the bottom end. Additional Pier Sections shall be added as the pier driving operation continues. Driving of the Pier Sections will continue until rock or an equal bearing strata is reached.
2. Load Testing Pier Section
a. Using The Double Acting Hydraulic Actuator: The pier shall be driven using the Drive Stand Assembly and the double acting hydraulic actuator until the maximum operating pressure of the hydraulic cylinder is reached or until lift of the structure is achieved, whichever occurs first. If the maximum hydraulic cylinder operating pressure is reached without lifting the structure, load test the Pier Section per Paragraph b following.
b. Using A Hydraulic Ram: Load testing the Pier to a force greater than the capacity of the hydraulic cylinder shall be achieved by removing the double acting hydraulic actuator from the Drive Stand Assembly and replacing it with the Supplemental Block. Install a 25 or 50 ton hydraulic ram, depending upon test force required, between the last Pier Section and the Supplemental Block. The hydraulic ram shall be actuated with a hand pump until bearing strata is verified as defined by a maximum installation force of:
45,000 lbs. for 2-7/8" Dia. x 0.165" 2-Piece Pier & Plate Pier,
52,500 lbs. for 2-7/8" Dia. x 0.165" 2-Piece Modified Pier & Modified Plate Pier,
65,000 lbs. for 3-1/2" Dia. x 0.160" 2-Piece Pier & Plate Pier,
67,500 lbs. for 3-1/2" Dia. x 0.160" 2-Piece Modified Pier & Modified Plate Pier,
71,250 lbs. for 4" Dia. x 0.219" 2-Piece Pier & Plate Pier
75,000 lbs. for 4" Dia. x 0.219" 2-Piece Modified Pier & Modified Plate Pier
82,500 lbs. for 4-1/2" Dia. Heavy Duty 2-Piece Pier;
or until lift of the structure is achieved, whichever is less.
3. Drive Equipment Removal: The Drive Stand Assembly shall be then removed from the Pier Bracket by removing the one inch diameter locking pins. The optional Helical Outrigger Assembly shall be removed at this time. (NOTE: If the 3-1/2" Diameter Modified Pier is being installed, or if the Pier is to be sleeved; perform the operations in Paragraph 4. following, before removing the Drive Stand Assembly.)
4. Cutting Final Pier Section: It is likely that the final installed Pier Section will have to be removed from the hole and cut to a length suitable to provide space for installing the Top Pier Platform. Mark and cut the Pier Section to the proper length using a metal cutting saw capable of a smooth cut at 90 degrees to the length of the Pier Section. After cutting to length, the final Pier Section is replaced.

D. Driving Of Pipe Sleeve (Optional): Once the capacity of the pier is achieved, the Drive Stand Assembly shall be used to push the Modified Sleeving Pier Section or plain Pier Sleeving over the last Pier Section or sections. **Do not exceed the manufacturer's rated operating capacity for the hydraulic cylinde**r. The joints between the Pier Sleeves shall be staggered with the Couplings on the Pier Sections. Once the Pipe Sleeve(s) are installed, the Drive Stand Assembly shall be removed from the Pier Bracket by removing the one inch diameter locking pins.

E. Installing Pipe Grout (Optional): Once the pier is installed to load bearing stratum and cut to the proper elevation, a neat cement flowable grout may be installed to the pier pipe. The grout will increase the moment of inertia (stiffness) and corrosion resistance of the pier. The grout shall be introduced to the bottom of the pier by means of a tube inserted into the pier pipe. As the grout is pumped into the pier pipe the tube shall be removed as the elevation of the grout increases. The process shall be executed carefully so that air is not entrained into the grout.

F. Installation Of The Top Pier Platform: The Top Pier Platform shall be installed over the last installed Pier Section. Align the vertical stabilizers within the channels on the legs of the Pier Bracket and tap the Top Pier Platform until it contacts the top of the final Pier Section. A small port shall be provided between the cap cylinder and the platform to verify contact.

G. Installation Of The Two Piece Lift Head Assembly: The Two Piece Lift Head Assembly shall be temporarily attached to the Pier Bracket by aligning the holes in each assembly. The one inch diameter locking pins and clips are used to align and hold the two pieces together.

H. Lifting And Holding: The lifting and holding operation is designed to raise the structure and to restore it to as close to the original elevation as the construction will allow. Normally this lift and hold operation is accomplished with several Pier placements simultaneously. Install one 25 or 30 ton hydraulic ram as required between the Two Piece Lift Head Assembly and the Top Pier Platform on each pier. Install 3-1/2 inch square pier shims or equal to reduce excess space between the ram and the Two Piece Lift Head Assembly. The rams shall be actuated simultaneously to raise the structure. Lifting shall continue until the structure is restored to its approximate original elevation or to design specifications. Once restored, install the cadmium plated Lift Shims above the vertical stabilizer plates of the Top Pier Platform. The 7 gauge shims shall always be used for this operation. The 16 gauge shims shall only be used for fine adjustments between the stack of shims and the bottom of the pier pin holes in the Pier Bracket. Install two High Strength Pier Pins into the holes in the Pier Bracket by tapping the High Strength Pier Pins into place. There must be a snug fit of the High Strength Pier Pins and the Lift Shims. The load is transferred to the Pier System by removing the pressure from the hydraulic rams. Remove the ram and then remove the one inch locking pins along with the Two Piece Lift Head Assembly from the Pier Bracket.

I. Documentation: The installer shall carefully monitor the driving force applied to the Pier Sections as the pier is installed. It is recommended that the driving force be recorded at 3-1/2 foot unless directed otherwise by the Engineer. The form of the data may be as directed by the customer or the Engineer. The Lifting Force, Lift, and Pier Depth shall also be recorded and presented in a tabular form. In addition, the installer shall know and have the desired terminal pressure that will create the desired driving force approved by the Engineer prior to beginning the pier installation.

J. Void Filling (Optional - Depends upon soil characteristics, structure, and amount of lift): After raising operations are complete, voids created between the foundation and underlying soil shall be filled using a low pressure injection of grout slurry. Injection shall be through holes through the foundation. The contractor shall inject the grout in such a manner as to completely fill the void without trapping pockets of air. When the operation is complete, the contractor shall repair the injection holes by filling the holes with high strength non-shrinking grout and finishing to reasonably match the existing surface textures and elevations.

K. Clean Up: Once all of the equipment has been removed, the area shall be backfilled using the previously excavated soil. The backfill shall be made by placing no more than 8 inches of loose material in a lift and compacting that soil prior to placement of the next 8-inch lift. Sufficient lifts shall be used to restore the ground to its original elevation and density. Slope the soil contour for drainage away from the foundation.

END OF SECTION 31 66 15 00

SECTION 32 01 11 53 - TRAFFIC COATINGS

1.1 GENERAL

A. Description Of Work:

1. This specification covers the furnishing and installation of materials for traffic coating. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes traffic coatings for the following applications:
   a. Interior and exterior pedestrian traffic.
   b. Vehicular traffic.
   c. Pavement markings.

C. Submittals

1. Product Data: For each product indicated.
2. Shop Drawings: Show extent of each traffic coating. Include details for treating substrate joints and cracks, flashings, deck penetrations, and other termination conditions.
3. Samples: For each type of finish indicated.
4. Material test reports.
5. Material certificates.
6. Qualification data.
7. Maintenance data.
8. Warranty.
9. LEED Submittal:
   a. Product Data for Credit EQ 4.2: For interior field-applied traffic coatings and pavement marking paints, including printed statement of VOC content.

D. Quality Assurance

1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of traffic coatings required for this Project.
2. Fire-Test-Response Characteristics: Provide traffic coating materials with the fire-test-response characteristics as determined by testing identical products per test method below for deck type and slopes indicated by an independent testing and inspecting agency that is acceptable to authorities having jurisdiction.
   a. Class A **OR** B **OR** C, **as directed**, roof covering per ASTM E 108 or UL 790.
3. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling

1. Deliver materials in original packages and containers with seals unbroken and bearing manufacturer's labels showing the following information:
   a. Manufacturer's brand name.
   b. Type of material.
   c. Directions for storage.
   d. Date of manufacture and shelf life.
   e. Lot or batch number.
   f. Mixing and application instructions.
   g. Color.
2. Store materials in a clean, dry location protected from exposure to direct sunlight. In storage areas, maintain environmental conditions within range recommended in writing by manufacturer.

F. Project Conditions

1. Environmental Limitations: Apply traffic coatings within the range of ambient and substrate temperatures recommended in writing by manufacturer. Do not apply traffic coatings to damp or wet substrates, when temperatures are below 40 deg F (5 deg C), when relative humidity exceeds 85 percent, or when temperatures are less than 5 deg F (3 deg C) above dew point.
   a. Do not apply traffic coatings in snow, rain, fog, or mist, or when such weather conditions are imminent during the application and curing period. Apply only when frost-free conditions occur throughout the depth of substrate.
2. Do not install traffic coating until items that will penetrate membrane have been installed.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which traffic coating manufacturer agrees to repair or replace traffic coatings that deteriorate during the specified warranty period. Warranty does not include deterioration or failure of traffic coating due to unusual weather phenomena, failure of prepared and treated substrate, formation of new substrate cracks exceeding 1/16 inch (1.6 mm) in width, fire, vandalism, or abuse by snowplow, maintenance equipment, and truck traffic.
   a. Deterioration of traffic coatings includes the following:
      1) Adhesive or cohesive failures.
      2) Abrasion or tearing failures.
      3) Surface crazing or spalling.
      4) Intrusion of water, oils, gasoline, grease, salt, deicer chemicals, or acids into deck substrate.
   b. Warranty Period: Five years from date of Final Completion.

1.2 PRODUCTS

A. Materials
1. Traffic Coatings: Complying with ASTM C 957.
2. Material Compatibility: Provide primers; base, intermediate, and topcoats; and miscellaneous materials that are compatible with one another and with substrate under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
3. VOC Content: Provide traffic coatings and pavement marking paints, for use inside the weatherproofing system, with VOC content of 150 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Traffic Coating
1. Primer: Manufacturer's standard factory-formulated primer recommended for substrate and conditions indicated.
   a. Material: Epoxy **OR** Urethane, **as directed**.
2. Preparatory and Base Coats: Single- or multicomponent, aromatic liquid urethane elastomer.
3. Intermediate Coat: Single- or multicomponent, aromatic liquid urethane elastomer **OR** Single- or multicomponent, aliphatic liquid urethane elastomer **OR** Liquid epoxy, **as directed**.
4. Topcoat: Single- or multicomponent, aromatic liquid urethane elastomer **OR** Single- or multicomponent, aliphatic liquid urethane elastomer **OR** Single- or multicomponent, aromatic liquid urethane elastomer with UV inhibitors **OR** Liquid epoxy, **as directed**.
   a. Color: As selected by the Owner from manufacturer's full range.
5. Aggregate: Uniformly graded, washed silicon carbide sand **OR** Uniformly graded, washed silica sand **OR** Uniformly graded, washed flint shot silica **OR** Walnut shell granules **OR** Aluminum-oxide grit, **as directed**, of particle sizes, shape, and minimum hardness recommended in writing by traffic coating manufacturer.
   a. Spreading Rate: As recommended by manufacturer for substrate and service conditions indicated, but not less than the following:
      1) Intermediate Coat: 8 to 10 lb/100 sq. ft. (3.6 to 4.5 kg/10 sq. m) **OR** To refusal, **as directed**.

2) Topcoat: 8 to 10 lb/100 sq. ft. (3.6 to 4.5 kg/10 sq. m) **OR** As required to achieve slip-resistant finish, **as directed**.

C. Miscellaneous Materials
1. Joint Sealants: As specified in Division 07 Section "Joint Sealants".
2. Sheet Flashing: Nonstaining.
   a. Minimum Thickness: 60 mils (1.5 mm) **OR** 50 mils (1.3 mm), **as directed**.
   b. Material: Sheet material recommended in writing by traffic coating manufacturer **OR** Uncured neoprene sheet **OR** Cured neoprene sheet, **as directed**.
3. Adhesive: Contact adhesive recommended in writing by traffic coating manufacturer.
4. Reinforcing Strip: Fiberglass mesh recommended in writing by traffic coating manufacturer.

D. Pavement Markings
1. Pavement-Marking Paint: Alkyd-resin ready mixed, complying with AASHTO M 248, Type S **OR** N **OR** F, **as directed**.
   a. Color: White **OR** Yellow **OR** As indicated, **as directed**.
      1) Use blue for spaces accessible to people with disabilities.
2. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, with drying time of less than three **OR** 45, **as directed**, minutes.
   a. Color: White **OR** Yellow **OR** As indicated, **as directed**.
      1) Use blue for spaces accessible to people with disabilities.
3. Glass Beads: AASHTO M 247, Type 1.

1.3 EXECUTION

A. Examination
1. Examine substrates, with Installer present, for compliance with requirements and for other conditions affecting performance of traffic coatings.
   a. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance.
   b. Verify compatibility with and suitability of substrates.
   c. Begin coating application only after minimum concrete curing and drying period recommended by traffic coating manufacturer has passed, after unsatisfactory conditions have been corrected, and after surfaces are dry.
   d. Verify that substrates are visibly dry and free of moisture.
      1) Test for moisture vapor transmission by plastic sheet method according to ASTM D 4263.
      2) Test for moisture content by measuring with an electronic moisture meter **OR** method recommended in writing by manufacturer, **as directed**.
   e. Application of coating indicates acceptance of surfaces and conditions.

B. Preparation
1. Clean and prepare substrates according to ASTM C 1127 and manufacturer's written recommendations to produce clean, dust-free, dry substrate for traffic coating application.
2. Mask adjoining surfaces not receiving traffic coatings, deck drains, and other deck substrate penetrations to prevent spillage, leaking, and migration of coatings.
3. Concrete Substrates: Mechanically abrade concrete surfaces to a uniform profile according to ASTM D 4259. Do not acid etch.
   a. Remove grease, oil, paints, and other penetrating contaminants from concrete.
   b. Remove concrete fins, ridges, and other projections.
   c. Remove laitance, glaze, efflorescence, curing compounds, concrete hardeners, form-release agents, and other incompatible materials that might affect coating adhesion.
   d. Remove remaining loose material to provide a sound surface, and clean surfaces according to ASTM D 4258.

C. Terminations And Penetrations
1. Prepare vertical and horizontal surfaces at terminations and penetrations through traffic coatings and at expansion joints, drains, and sleeves according to ASTM C 1127 and manufacturer's written recommendations.
2. Provide sealant cants at penetrations and at reinforced and nonreinforced, deck-to-wall butt joints.
3. Terminate edges of deck-to-deck expansion joints with preparatory base-coat strip.
4. Install sheet flashings at deck-to-wall expansion and dynamic joints, and bond to deck and wall substrates according to manufacturer's written recommendations.

D. Joint And Crack Treatment
1. Prepare, treat, rout, and fill joints and cracks in substrates according to ASTM C 1127 and manufacturer's written recommendations. Before coating surfaces, remove dust and dirt from joints and cracks according to ASTM D 4258.
   a. Comply with recommendations in ASTM C 1193 for joint-sealant installation.

E. Traffic Coating Application
1. Apply traffic coating material according to ASTM C 1127 and manufacturer's written recommendations.
   a. Start traffic coating application in presence of manufacturer's technical representative.
   b. Verify that wet film thickness of each component coat complies with requirements every 100 sq. ft. (9 sq. m).
2. Apply traffic coatings to prepared wall terminations and vertical surfaces to height indicated, and omit aggregate on vertical surfaces.
3. Cure traffic coatings according to manufacturer's written recommendations. Prevent contamination and damage during application and curing stages.

F. Pavement Markings
1. Do not apply traffic paint for striping and other markings until traffic coating has cured according to manufacturer's written recommendations.
2. Apply traffic paint for striping and other markings with mechanical equipment to produce uniform straight edges. Apply at manufacturer's recommended rates for a 15-mil- (0.38-mm-) minimum wet film thickness.
3. Spread glass beads uniformly into wet traffic paint at a rate of 6 lb/gal. (0.72 kg/L).

G. Field Quality Control
1. Testing: Engage a qualified testing agency to perform the following field tests and inspections and prepare test reports:
   a. Samples of material delivered to Project site shall be taken, identified, sealed, and certified in presence of the Owner and Contractor.
   b. Testing agency shall perform tests for characteristics specified, using applicable referenced testing procedures.
   c. Testing agency shall verify thickness of coatings during traffic coating application.
   d. If test results show traffic coating materials do not comply with requirements, remove noncomplying materials, prepare surfaces, and reapply traffic coatings.
2. Flood Testing: Flood test each deck area for leaks, according to recommendations in ASTM D 5957, after traffic coating has completely cured. Install temporary containment assemblies, plug or dam drains, and flood with potable water.
   a. Flood to an average depth of 2-1/2 inches (65 mm) with a minimum depth of 1 inch (25 mm) and not exceeding a depth of 4 inches (100 mm).
   b. Flood each area for 24 **OR** 48 **OR** 72, **as directed**, hours.
   c. After flood testing, repair leaks, repeat flood tests, and make further repairs until traffic coating installation is watertight.
   d. Engage an independent testing agency to observe flood testing and examine underside of decks and terminations for evidence of leaks during flood testing.

3. Final Traffic Coating Inspection: Arrange for traffic coating manufacturer's technical personnel to inspect membrane installation on completion.
    a. Notify the Owner 48 hours in advance of date and time of inspection.
4. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

H. Protecting And Cleaning
1. Protect traffic coatings from damage and wear during remainder of construction period.
2. Clean spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 32 01 11 53

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Task	Specification	Specification Description
32 01 11 53	03 31 13 00	Cement Concrete Pavement

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SECTION 32 01 13 61 - ASPHALT PAVING

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for asphalt paving. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Cold milling of existing hot-mix asphalt pavement.
      b. Hot-mix asphalt patching.
      c. Hot-mix asphalt paving.
      d. Hot-mix asphalt paving overlay.
      e. Asphalt surface treatments.
      f. Pavement-marking paint.
      g. Traffic-calming devices.
      h. Imprinted asphalt.

C. Definition
   1. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

D. Submittals
   1. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
      a. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
      b. Job-Mix Designs: For each job mix proposed for the Work.
   2. Material Certificates: For each paving material, from manufacturer.

E. Quality Assurance
   1. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of state in which Project is located.
   2. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of State or local DOT for asphalt paving work.
      a. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.
   3. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
   1. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.
   2. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

G. Project Conditions
   1. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
      a. Prime Coat: Minimum surface temperature of 60 deg F (15.6 deg C).
      b. Tack Coat: Minimum surface temperature of 60 deg F (15.6 deg C).

c. Slurry Coat: Comply with weather limitations in ASTM D 3910.
d. Asphalt Base Course: Minimum surface temperature of 40 deg F (4.4 deg C) and rising at time of placement.
e. Asphalt Surface Course: Minimum surface temperature of 60 deg F (15.6 deg C) at time of placement.

2. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F (4.4 deg C) for oil-based materials **OR** 55 deg F (12.8 deg C) for water-based materials, **as directed**, and not exceeding 95 deg F (35 deg C).
3. Imprinted Asphalt Paving: Proceed with coating imprinted pavement only when air temperature is at least 50 deg F (10 deg C) and rising and will not drop below 50 deg F (10 deg C) within 8 hours of coating application. Proceed only if no precipitation is expected within two hours after applying the final layer of coating.

1.2 PRODUCTS

A. Aggregates
1. General: Use materials and gradations that have performed satisfactorily in previous installations.
2. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.
3. Fine Aggregate: ASTM D 1073 or AASHTO M 29, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.
   a. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.
4. Mineral Filler: ASTM D 242 or AASHTO M 17, rock or slag dust, hydraulic cement, or other inert material.

B. Asphalt Materials
1. Asphalt Binder: AASHTO M 320 or AASHTO MP 1a, PG 64-22 **OR** PG 58-28 **OR** PG 70-22, **as directed**.
2. Asphalt Cement: ASTM D 3381 for viscosity-graded material **OR** ASTM D 946 for penetration-graded material, **as directed**.
3. Prime Coat:
   a. ASTM D 2027, medium-curing cutback asphalt, MC-30 or MC-70 **OR** MC-250, **as directed**.
   OR
   Asphalt emulsion prime coat complying with State or local DOT requirements.
4. Tack Coat: ASTM D 977 or AASHTO M 140 emulsified asphalt, or ASTM D 2397 or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.
5. Fog Seal: ASTM D 977 or AASHTO M 140 emulsified asphalt, or ASTM D 2397 or AASHTO M 208 cationic emulsified asphalt, slow setting, factory diluted in water, of suitable grade and consistency for application.
6. Slurry Seal: ASTM D 3910, Type 1 **OR** Type 2 **OR** Type 3, **as directed.**
7. Chip Seal: ASTM D 977 or AASHTO M 140 emulsified asphalt, or ASTM D 2397 or AASHTO M 208 cationic emulsified asphalt, slow setting, factory diluted in water, of suitable grade and consistency for application. RS-2 **OR** RS-2P **OR** CRS-2 **OR** CRS-2P **OR** HFRS-2 **OR** HFRS-**2P**, **as directed.**
8. Sand Seal: AASHTO M 140 emulsified asphalt or AASHTO M 208 cationic emulsified asphalt, slow setting, factory diluted in water, of suitable grade and consistency for application. Sand shall meet the following gradation as tested by AASHTO T27.
9. Water: Potable.
10. Undersealing Asphalt: ASTM D 3141, pumping consistency.

C. Auxiliary Materials
1. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.
2. Sand: ASTM D 1073 or AASHTO M 29, Grade Nos. 2 or 3.
3. Paving Geotextile: AASHTO M 288, nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications.
4. Joint Sealant: ASTM D 6690 or AASHTO M 324, Type I **OR** Type II or III **OR** Type IV, **as directed**, hot-applied, single-component, polymer-modified bituminous sealant.
5. Pavement-Marking Paint: Color shall be White **OR** Yellow **OR** Blue, **as directed**.
   a. Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, Type N **OR** Type F **OR** Type S, **as directed**; colors complying with FS TT-P-1952.
      OR
      MPI #32 Alkyd Traffic Marking Paint.
      OR
      Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than three **OR** 45, **as directed**, minutes.
      OR
      MPI #97 Latex Traffic Marking Paint.
6. Glass Beads: AASHTO M 247, Type 1.
7. Wheel Stops:
   a. Precast, air-entrained concrete, 2500-psi (17.2-MPa) minimum compressive strength, 4-1/2 inches (115 mm) high by 9 inches (225 mm) wide by 72 inches (1800 mm) long. Provide chamfered corners, drainage slots on underside, and holes for anchoring to substrate.
      OR
      Solid, integrally colored, 96 percent recycled HDPE or commingled postconsumer and postindustrial recycled plastic; UV stabilized; 4 inches (100 mm) high by 6 inches (150 mm) wide by 72 inches (1800 mm) long. Provide chamfered corners, drainage slots on underside, and holes for anchoring to substrate.
   b. Dowels: Galvanized steel, 3/4-inch (19-mm) diameter, 10-inch (254-mm) minimum length.
   c. Adhesive: As recommended by wheel-stop manufacturer for application to asphalt pavement.

D. Preformed Traffic-Calming Devices
1. Speed Bumps **OR** Humps **OR** Cushions, **as directed**: Solid, integrally colored, 100 percent postconsumer or commingled postconsumer and postindustrial recycled rubber **OR** plastic, **as directed**; UV stabilized. Provide holes for anchoring to substrate.
   a. Size: Modular bumps 2 inches (51 mm) high by 10 inches (254 mm) wide by 72 inches (1800 mm) long, with overall length as dimensioned on Drawings.
   b. Size: Modular assemblies 3 inches (76 mm) high by 12 feet (3.7 m) in overall width **OR** 4 inches (102 mm) high by 14 feet (4.3 m) in overall width, **as directed**, with overall length as dimensioned on Drawings.
   c. Mounting Hardware: Galvanized-steel spike, 1/2-inch (13-mm) diameter, 10-inch (254-mm) minimum length **OR** lag screw, shield, and washers; 1/2-inch (13-mm) diameter, 8-inch (203-mm) minimum length **OR** hardware as standard with device manufacturer, **as directed**.
   d. Adhesive: As recommended by device manufacturer.

E. Imprinted Asphalt Materials
1. Templates: Imprinted-asphalt manufacturer's standard flexible templates for imprinting pattern into hot asphalt paving.
   a. Pattern: Running bond brick **OR** Cobblestone **OR** Custom pattern indicated on Drawings, **as directed**.
2. Coating System: Imprinted-asphalt manufacturer's standard system formulated for exterior application on asphalt paving surfaces.
   a. Base Coating: Portland cement and epoxy-modified acrylic polymer blended with sand and aggregate, formulated for exterior application on asphalt paving surfaces.

b. Top Coating: Epoxy-modified acrylic polymer blended with sand and aggregate, formulated for exterior application on asphalt paving surfaces.
c. Colorant: UV-stable pigment blend, added to each coating layer.
d. Color: White **OR** Yellow, **as directed**.
3. Precut Marking Material: Imprinted-asphalt manufacturer's standard, reflectorized, thermoplastic, 90-mil (2.3-mm) minimum thickness, formulated for exterior application on asphalt paving surfaces, and matching the imprinted pattern of templates.

F. Mixes
1. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction; designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types"; and complying with the following requirements:
a. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
b. Base Course: In accordance with state or local DOT specifications.
c. Surface Course: In accordance with state or local DOT specifications.
2. Hot-Mix Asphalt Based on ASTM D 3515 Requirements: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types."
a. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
b. Provide mixes complying with composition, grading, and tolerance requirements in ASTM D 3515 for the following nominal, maximum aggregate sizes:
1) Base Course: 1 inch (25 mm).
2) Surface Course: 1/2 inch (13 mm).
3. Emulsified-Asphalt Slurry: ASTM D 3910, Type 1 **OR** Type 2 **OR** Type 3, **as directed**.

1.3 EXECUTION

A. Examination
1. Verify that subgrade is dry and in suitable condition to begin paving.
2. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
a. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).
b. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).
c. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by the Owner, and replace with compacted backfill or fill as directed.
3. Proceed with paving only after unsatisfactory conditions have been corrected.
4. Verify that utilities, traffic loop detectors, and other items requiring a cut and installation beneath the asphalt surface have been completed and that asphalt surface has been repaired flush with adjacent asphalt prior to beginning installation of imprinted asphalt.

B. Cold Milling
1. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.
a. Mill to a depth of 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**.
b. Mill to a uniform finished surface free of excessive gouges, grooves, and ridges.
c. Control rate of milling to prevent tearing of existing asphalt course.
d. Repair or replace curbs, manholes, and other construction damaged during cold milling.

e. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
f. Transport milled hot-mix asphalt to asphalt recycling facility.
g. Keep milled pavement surface free of loose material and dust.

C. Patching
1. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches (300 mm) into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.
2. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.
a. Pump hot undersealing asphalt under rocking slab until slab is stabilized or, if necessary, crack slab into pieces and roll to reseat pieces firmly.
b. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.
3. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).
a. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
b. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
4. Patching:
a. Fill excavated pavements with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.
OR
Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

D. Repairs
1. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch (25 mm) in existing pavements.
a. Install leveling wedges in compacted lifts not exceeding 3 inches (75 mm) thick.
2. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch (6 mm).
a. Clean cracks and joints in existing hot-mix asphalt pavement.
b. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch (6 mm) wide. Fill flush with surface of existing pavement and remove excess.
c. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch (6 mm) wide. Fill flush with surface of existing pavement and remove excess.

E. Surface Preparation
1. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
2. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
a. Mix herbicide with prime coat if formulated by manufacturer for that purpose.
3. Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd. (0.7 to 2.3 L/sq. m). Apply enough material to penetrate and seal but not flood surface. Allow prime coat to cure.
a. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.

b. Protect primed substrate from damage until ready to receive paving.

4. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).
   a. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
   b. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

F. Paving Geotextile Installation
1. Apply tack coat **OR** asphalt binder **OR** asphalt cement, **as directed**, uniformly to existing pavement surfaces at a rate of 0.20 to 0.30 gal./sq. yd. (0.8 to 1.2 L/sq. m).
2. Place paving geotextile promptly according to manufacturer's written instructions. Broom or roll geotextile smooth and free of wrinkles and folds. Overlap longitudinal joints 4 inches (100 mm) and transverse joints 6 inches (150 mm).
   a. Protect paving geotextile from traffic and other damage and place hot-mix asphalt paving overlay the same day.

G. Hot-Mix Asphalt Placing
1. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
   a. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
   b. Place hot-mix asphalt surface course in single lift.
   c. Spread mix at minimum temperature of 250 deg F (121 deg C).
   d. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
   e. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
2. Place paving in consecutive strips not less than 10 feet (3 m) wide unless infill edge strips of a lesser width are required.
   a. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.
3. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

H. Joints
1. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
   a. Clean contact surfaces and apply tack coat to joints.
   b. Offset longitudinal joints, in successive courses, a minimum of 6 inches (150 mm).
   c. Offset transverse joints, in successive courses, a minimum of 24 inches (600 mm).
   d. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations" **OR** as shown on Drawings, **as directed**.
   e. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
   f. Compact asphalt at joints to a density within 2 percent of specified course density.

I. Compaction
1. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

a. Complete compaction before mix temperature cools to 185 deg F (85 deg C).

2. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
3. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
   a. Average Density:
      1) 96 percent of reference laboratory density according to ASTM D 6927 or AASHTO T 245, but not less than 94 percent nor greater than 100 percent.
         OR
         92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.
4. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
5. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
6. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
7. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
8. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

J. Asphalt Curbs
1. Construct hot-mix asphalt curbs over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust. Spread mix at minimum temperature of 250 deg F (121 deg C).
   a. Asphalt Mix: Same as pavement surface-course mix.
2. Place hot-mix asphalt to curb cross section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

K. Asphalt Traffic-Calming Devices
1. Construct hot-mix asphalt speed bumps, humps, cushions, and tables over compacted pavement surfaces. Apply a tack coat unless pavement surface is still tacky and free from dust. Spread mix at minimum temperature of 250 deg F (121 deg C).
   a. Tack Coat Application: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).
   b. Asphalt Mix: Same as pavement surface-course mix.
   c. Before installation, mill pavement that will be in contact with bottom of traffic-calming device. Mill to a depth of 1 inch (25 mm) from top of pavement to a clean, rough profile.
2. Place hot-mix asphalt to cross section indicated, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

L. Installation Tolerances
1. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
   a. Base Course: Plus or minus 1/2 inch (13 mm).
   b. Surface Course: Plus 1/4 inch (6 mm), no minus.
2. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot (3-m) straightedge applied transversely or longitudinally to paved areas:
   a. Base Course: 1/4 inch (6 mm).

b. Surface Course: 1/8 inch (3 mm).
c. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch (6 mm).
3. Traffic-Calming Devices: Compact and form asphalt to produce the contour indicated and within a tolerance of plus or minus 1/8 inch (3 mm) of height indicated above pavement surface.

M. Surface Treatments
1. Fog Seals: Apply fog seal at a rate of 0.10 to 0.15 gal./sq. yd. (0.45 to 0.7 L/sq. m) to existing asphalt pavement and allow to cure. With fine sand, lightly dust areas receiving excess fog seal.
2. Slurry Seals: Apply slurry coat in a uniform thickness according to ASTM D 3910 and allow to cure.
a. Roll slurry seal to remove ridges and provide a uniform, smooth surface.
3. Chip Seals: Apply asphalt binder directly to the pavement followed by a layer of ¼ inch aggregate chips **OR** as directed, and roll to embed aggregate into the binder.
a. Can be applied as double **OR** triple layers, **as directed,** which are accomplished by applying additional layers of asphaltic material and aggregate. After applying each layer of aggregate, the surface is compacted using a roller to embed aggregates in the binder.
4. Sand Seals: Spray emulsion directly to the pavement followed by a layer of sand. The sand can be spread immediately for maximum stick, **OR** wait until after the emulsion breaks and be rolled with a pneumatic tire roller, **as directed**.

N. Pavement Marking
1. Do not apply pavement-marking paint until layout, colors, and placement have been verified with the Owner.
2. Allow paving to age for 30 **OR** 90, **as directed**, days before starting pavement marking.
3. Sweep and clean surface to eliminate loose material and dust.
4. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils (0.4 mm).
a. Broadcast glass beads uniformly into wet pavement markings at a rate of 6 lb/gal. (0.72 kg/L).

O. Wheel Stops
1. Install wheel stops in bed of adhesive as recommended by manufacturer.
2. Securely attach wheel stops to pavement with not less than two galvanized-steel dowels embedded at one-quarter to one-third points. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

P. Preformed Traffic-Calming Devices
1. Install preformed speed bumps **OR** humps **OR** cushions, **as directed**, in bed of adhesive as recommended by manufacturer for heavy traffic.
2. Securely attach preformed speed bumps **OR** humps **OR** cushions, **as directed**, to pavement with hardware spaced as recommended by manufacturer for heavy traffic. Recess head of hardware beneath top surface.

Q. Imprinting Asphalt
1. General: Imprint asphalt according to manufacturer's written instructions, using manufacturer's recommended equipment.
2. Freshly Laid Asphalt: Immediately after asphalt has been laid and compacted but still plastic, begin the surface imprinting process.
a. Monitor asphalt surface temperature in compliance with manufacturer's written recommendations to ensure required temperature to perform surface imprinting.
b. Reheat asphalt if surface temperature drops below that required.
3. Reheating Asphalt: Soften asphalt pavement surface by heating to a depth of at least 1/2 inch (13 mm) without burning asphalt.

a. Heat to a temperature of 300 to 325 deg F (149 to 163 deg C) immediately before applying templates.
b. Regularly monitor the pavement temperature to prevent overheating.
c. Direct flame heaters are not permitted.
d. If pavement is overheated and begins to emit black smoke, remove damaged pavement by milling down 1 inch (25 mm) and replace removed pavement with new, compacted surface course prior to resuming imprinting work.

4. Surface Imprinting: Apply and imprint templates to a minimum depth of 1/4 inch (6 mm) **OR** as required to embed precut marking material flush or barely beneath pavement surface, **as directed**.
5. Coating Application: After imprinted surface has cooled, apply two layers of base coating followed by two layers of top coating **OR** four layers of top coating, **as directed**. Do not allow traffic until coating has completely dried and cured.
6. Precut Marking Material Application: Position precut marking material aligned with imprinted pattern and slowly heat to a temperature no higher than 325 deg F (163 deg C) until marking material begins to liquefy and flow. Do not allow traffic until installed marking material has cooled to ambient temperature.

R. Field Quality Control

1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.
3. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
4. Traffic-Calming Devices: Finished height of asphalt speed bumps, humps, cushions, and tables above pavement will be measured for compliance with tolerances.
5. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979 or AASHTO T 168.
   a. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
   b. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
      1) One core sample will be taken for every 1000 sq. yd. (836 sq. m) or less of installed pavement, with no fewer than 3 cores taken.
      2) Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.
6. Replace and compact hot-mix asphalt where core tests were taken.
7. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

S. Disposal

1. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.
   a. Do not allow milled materials to accumulate on-site.

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SECTION 32 01 13 61a - CRACK SEALING OF BITUMINOUS PAVEMENTS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for crack sealing of bituminous pavements. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. Manufacturer's Recommendations: Where installation procedures, or any part thereof, are required to be in accordance with the manufacturer's recommendations, printed copies of these recommendations shall be submitted to the Owner. Installation of the material will not be allowed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.
   2. Schedules/Construction Equipment List: List of proposed equipment to be used in performance of construction work including descriptive data shall be submitted to the Owner.
   3. Samples: Samples of the materials (sealant, primer if required, and backup material), in sufficient quantity for testing and approval shall be submitted to the Owner. No material will be allowed to be used until it has been approved.

C. Safety: Joint sealant shall not be placed within 25 feet of any liquid oxygen (LOX) equipment, LOX storage, or LOX piping. Joints in this area shall be thoroughly cleaned and left unsealed.

D. Test Requirements: The joint sealant and backup or separating material shall be tested for conformance with the referenced applicable material specification. Testing of the materials shall be performed in an approved independent laboratory and certified copies of the test reports shall be submitted and approved prior to the use of the materials at the job site. Samples will be retained by the Owner for possible future testing should the materials appear defective during or after application. Conformance with the requirements of the laboratory tests specified will not constitute final acceptance of the materials. Final acceptance will be based on the performance of the in-place materials.

E. Equipment: Machines, tools, and equipment used in the performance of the work required by this section shall be approved before the work is started and shall be maintained in satisfactory condition at all times.

1.2 PRODUCTS

A. Materials
   1. Liquid Asphalt: ASTM D 2027, Grade MC-250.
   2. Emulsified Asphalt: ASTM D 977, Grade AS-2.
   3. Sealing Compound: ASTM D 3405.
   4. Backer Rod: ASTM D 5249.
   5. Fine Aggregate: Natural sand or crusher dust having a maximum size of not more than 1/8 inch and be free of clay or organic-matter.

1.3 EXECUTION

A. Preparation:
   1. All cracks to be sealed shall be cleaned of dirt and debris, and moisture shall be removed.

2. Crack Cleaning Equipment shall consist of a portable air compressor with hose and nozzles for directing air directly into cracks and stiff bristle brooms.
3. Heating Equipment for Liquid Asphalt shall be mobile and shall be equipped with an agitating device for stirring material during heating, a thermometer, regulating equipment for heat control, and a gravity-type draw-off valve.
4. Heating Equipment for Sealing Compound: Unless otherwise required by the manufacturer's recommendations, the equipment shall be mobile and shall consist of double-boiler, agitator-type kettles with oil medium in the outer space for heat transfer. The applicator unit shall be so designed that the sealant will circulate through the delivery hose and return to the inner kettle when not sealing cracks.
5. Application Equipment shall have a spout or nozzle of such size that the sealing material will be placed in the cracks without entrapping air in cracks or spreading material on adjacent pavement surface.

B. Installation:
1. Backer Rod: Install backer in accordance with manufacturer’s instructions where required under sealing compound.
2. Sealing Compound: All cracks 1/8 inch wide and wider shall be sealed. The application temperature for sealing compound shall comply with ASTM C 1193. Cracks 1/2 inch wide and wider shall be filled with a slurry of fine sand and an emulsified asphalt or liquid asphalt. After the slurry has cured, cracks shall be sealed with liquid asphalt or emulsified asphalt and lightly sanded.
3. Liquid and Emulsified Asphalt Sealer: The temperature shall be varied so that it flows freely into cracks and completely fills cracks without entrapping air. Cracks shall be free of moisture before filling and shall be filled slightly above the pavement surface. When excess sealer has been removed, the sealer shall be covered with fine sand.
4. Traffic Control: Traffic will not be permitted over sealed cracks until the sealer has cooled so that it is not picked up by vehicle tires. The Contractor will be responsible for all barricades and flagmen necessary to control traffic.

END OF SECTION 32 01 13 61a

SECTION 32 01 13 61b - SPRAY APPLICATIONS, SEAL COATS, AND SURFACE TREATMENTS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for the spray applications, seal coats, and surface treatments of asphalt concrete pavements. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Bituminous Material: Bituminous material shall be liquid asphalt complying with ASTM D 2028, Grade RC-25O, or tar complying with ASTM D 490, Grade RT-6.

B. Aggregate: Aggregates shall consist of crushed stone, crushed gravel, or crushed slag. The moisture content of the aggregate shall be such that the aggregate will be readily coated with the bituminous material. Aggregate gradations shall be in compliance with ASTM C 136.

C. Construction Equipment
1. Bituminous Distributor shall be designed and equipped to distribute the bituminous material uniformly at even heat on variable widths of surface at readily determined and controlled rates and pressures recommended by the manufacturer and with an allowable variation from any specified rate not exceeding 5 percent.
2. Single-Pass Surface Treatment Machine shall be capable of distributing the bituminous material and aggregates uniformly in controlled amounts in a single-pass operation over the surface to be sealed.
3. Heating Equipment for Storage Tanks shall consist of steam coils, hot oil coils, or electrical coils. If steam or hot oil coils are used, the coils must be so designed and maintained that the bituminous material cannot become contaminated.
4. Power Rollers shall be the self-propelled tandem and three-wheel type rollers, weighing not less than 5 tons and shall be suitable for rolling bituminous pavements.
5. Self-Propelled Pneumatic-Tired rollers shall have a total compacting width of not less than 60 inches. The gross weight shall be adjustable within the ranges of 200 to 350 lb/in. of compacting width.
6. Spreading Equipment: Aggregate spreading equipment shall be adjustable and capable of spreading aggregate at controlled amounts per square yard.
7. Drags: Broom drags shall consist of brooms mounted on a frame, designed to spread fine aggregate uniformly over the surface of a bituminous pavement. Towing equipment shall have pneumatic tires.
8. Brooms and Blowers shall be of the power type and shall be suitable for cleaning surfaces of bituminous pavements.

1.3 EXECUTION

A. Installation
1. Spreading Aggregate: Application of seal aggregate shall immediately follow the application of bituminous material, and in no case shall the time to application exceed 15 minutes.

2. Brooming and Rolling: Begin the rolling operations immediately following the application of cover aggregate. Rolling shall be accomplished with pneumatic-tired rollers; steel-wheeled rollers shall be used in a supplementary capacity only. All surplus aggregate shall be swept off the surface and removed not less than 26 hours or more than four days after rolling is completed.

END OF SECTION 32 01 13 61b

SECTION 32 01 16 71 - GRINDING/GROOVING PAVEMENT

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of grinding/grooving pavement. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS - Not Used

1.3 EXECUTION

A. Grinding: This covers grinding asphalt concrete or portland cement concrete pavement and roadway surfaces of structures as shown on the plans and as specified in these specifications and the special provisions
1. Grinding shall be performed with abrasive grinding equipment utilizing diamond cutting blades.
2. Existing portland cement concrete pavement not constructed as part of the project shall be ground as follows:
   a. Grinding shall be performed so that the pavement surface on both sides of all transverse joints and cracks has essentially the same depth of texture and does not vary from a true plane enough to permit a 1.9 mm thick shim 75 mm wide to pass under a one-meter straightedge adjacent to either side of the joint or crack when the straightedge is laid on the pavement parallel to centerline with its midpoint at the joint or crack. After grinding has been completed, the pavement shall conform to the straightedge and profile requirements specified in paving specification, paragraph "Final Finishing," except that pavement on tangent alignment and on horizontal curves of any radius shall have a profile index of 19 mm or less per 0.1-km.
   b. Abnormally depressed areas due to subsidence or other localized causes will be excluded from testing with the profilograph and 3.6-m±0.06-m straightedge. The accumulated total of the excluded areas shall not exceed 5 percent of the total area to be ground. Profilograph testing shall end 8 m prior to excluded areas and shall resume 8 m following the excluded areas.
3. Existing asphalt concrete pavement not constructed as part of the project shall be ground so that the finished surface shall not vary from a true plane enough to permit a 3-mm thick shim 75 mm wide to pass under a straightedge 3.6 m±0.06-m long when the straightedge is laid on the finished surface parallel with the centerline. The transverse slope of the finished surface shall be uniform to a degree such that a 6 mm thick shim 75 mm wide will not pass under a straightedge 3.6 m±0.06-m long when the straightedge is laid on the finished surface in a direction transverse to the centerline and extending from edge to edge of a 3.6-m traffic lane.
4. Ground areas on structures, approach slabs and the adjacent 15 m of approach pavement shall conform to the provisions for smoothness and concrete cover over reinforcing steel.
5. Ground surfaces shall not be smooth or polished and, except as otherwise specified, shall have a coefficient of friction of not less than 0.30.
6. Residue from grinding operations shall be picked up by means of a vacuum attachment to the grinding machine and shall not be allowed to flow across the pavement nor be left on the surface of the pavement. Residue from grinding portland cement concrete pavement shall be disposed of

as directed. Residue from grinding asphalt concrete shall be disposed of outside the highway right of way.

7. At the option of the Contractor, the residue from grinding portland cement concrete pavement may be disposed of as directed by the authorities having jurisdiction over the site. A copy of the approval shall be delivered to the Engineer before disposing of residue at the site.
8. The noise level created by the combined grinding operation shall not exceed 86 dBA at a distance of 15 m at right angles to the direction of travel.

B. Grooving: This work shall consist of grooving the surface of asphalt concrete or Portland cement concrete pavement and bridge decks as shown on the plans and as specified in these specifications and the special provisions

1. Grooved areas shall begin and end at lines normal to the pavement center line and shall be centered within the lane width. If new concrete pavement is grooved, the grooving in any lane shall cover the full lane width.
2. Grooving blades shall be 2.41 mm ± 0.13-mm wide and shall be spaced 19 mm on centers. The grooves shall be cut not less than 3 mm nor more than 7 mm deep. The grooves on bridge decks shall be cut not less than 3 mm nor more than 5 mm deep. Grooves over inductive loop detectors shall be cut not less than 2 mm nor more than 3 mm deep.
3. At the beginning of each work shift, all grooving machines shall be equipped with a full complement of grooving blades that are capable of cutting grooves of the specified width, depth and spacing.
4. If during the course of work a single grooving blade on any individual grooving machine becomes incapable of cutting a groove, work will be permitted to continue for the remainder of the work shift, and the Contractor will not be required to otherwise cut the groove omitted because of the failed blade. Should 2 or more grooving blades on any individual grooving machine become incapable of cutting grooves the Contractor shall either:
   a. Discontinue work with the affected grooving machine within 15 m of the location where more than one blade became incapable, in which event the Contractor will not be required to otherwise cut the grooves omitted because of the failed blades; **OR**
      Continue work with the affected grooving machine for the remainder of the work shift and by other means cut all grooves omitted, including grooves omitted because a single blade was incapable, by the affected grooving machine within that work shift. The omitted grooves shall be cut before any of the grooving work performed during the time the grooves were omitted will be accepted.
5. The actual grooved area of any selected 0.6-m by 30 m longitudinal area of pavement specified to be grooved shall be not less than 95 percent of the selected area. Grooves which are omitted as permitted for blades which become incapable will be measured as being actually grooved. No area will be measured until omitted grooves, which are required to be cut before the area is accepted, have been cut. Except as provided for omitted grooves due to an incapable blade, any area within the selected area not grooved shall be due only to irregularities in the pavement surface and for no other reason.
6. Residue from grooving operations shall be picked up by means of a vacuum attachment to the grooving machine and shall not be allowed to flow across the pavement nor be left on the surface of the pavement. Residue from grooving portland cement concrete pavement shall be disposed of as directed. Residue from grooving asphalt concrete shall be disposed of outside the highway right of way.
7. At the option of the Contractor, the residue from grooving portland cement concrete pavement may be disposed as directed by the authorities having jurisdiction over the site. A copy of the approval shall be delivered to the Engineer before disposing of residue at the site.
8. The noise level created by the combined grooving operation shall not exceed 86 dBA at a distance of 15 m at right angles to the direction of travel.

C. Highway or Street Grooving: AASHTO recommends the following groove specifications: 2.4 mm wide; depth of 3.2 to 4.8 mm, and a center-to-center spacing of 19.1 mm (0.75 inches) (7). The center 10-foot portion of a 12-foot lane is typically grooved, leaving a 1-foot strip ungrooved at the edge of each lane.

D. Boat Ramp Grooving: Grooves shall be non-skid V-grooves spaced 2 inches on center, 1/2-inch radius, 1/2-inch deep.

E. Runway Grooving
1. General
   a. The grooving dimensions shall be as follows:
      1) Depth - One-quarter (1/4) inch ± one sixteenth (1/16) inch
      2) Width - One-quarter (1/4) inch ± one sixteenth (1/16) inch
      3) Center to center - One and one-half (1 1/2) inch ± one eight (1/8) inch
   b. Grooving shall not begin until new pavement has properly cooled/cured and permission is given.
   c. In no case shall final painted pavement markings be applied prior to grooving.
2. The pavement must be grooved by approved diamond bladed saw-cutting equipment. Variations in the grooving contour will not be permitted without approval. All reasonable precautions shall be taken to avoid breaking or chipping the pavement surfaces between grooves. Excessive spalling of the grooved edges will not be permitted.
3. The Contractor shall groove bituminous concrete and portland cement concrete pavements according to the following specifications (from FAA Advisory Circular 150/5320-12B, Section IV):
   a. The depth of 90 percent or more of the groove shall not be less than 1/4 inch.
   b. The grooves shall be continuous for the entire runway length and transverse (perpendicular) to the direction of aircraft landing and takeoff operations.
   c. The grooves shall be continued to the end of the runway where the concrete meets the asphalt.
   d. The grooves shall not vary more than 3 inches in alignment for 75 feet, allowing for realignment every 500 feet.
   e. Grooves shall not be closer than 3 inches or more than 9 inches from transverse joints in concrete pavements.
   f. Grooving through longitudinal or diagonal saw kerfs where lighting cables are installed shall be avoided. Grooves may be continued through longitudinal construction joints.
   g. Grooves shall be sawed no closer than 6 inches and no more than 18 inches from inpavement light fixtures.
4. Cleanup is extremely important and should be continuous throughout the grooving operations. Accumulation of debris resulting from the grooving operations shall be cleaned from the grooves and removed from the pavement by air jets, high pressure water streams, or other approved methods, after each grooving operation at hourly intervals. The Contractor shall provide water for cleanup operations. The waste material shall not be flushed into the storm or sanitary sewer system. The waste material shall not be allowed to drain onto the shoulders or left on the runway surface in order to prevent foreign object damage.

END OF SECTION 32 01 16 71

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SECTION 32 01 16 71a - STEEL CURBS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of steel curbs. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Standard Steel Curb Sections: Noncorrosive steel sections as required to match existing.

B. Coating: Steel curb sections shall be zinc coated.

C. Joint Materials
   1. Expansion Joint Fillers: ASTM D 1751 or ASTM D 1752.
   2. Joint Sealers: ASTM D 1850.

D. Concrete: Concrete shall have a minimum compressive strength of 3,000 psi. The maximum size of aggregate shall be 1-1/2 inches. Concrete shall have a slump of not more than 3 inches and an air content by volume of concrete of 3 to 6 percent.

1.3 EXECUTION

A. Preparation: The subgrade shall be constructed to grade and cross section. The subgrade shall be of materials equal in bearing quality to the subgrade under the adjacent pavement and shall be compacted. The subgrade shall be maintained in a smooth, compacted condition, in conformity with the required section and established grade until the concrete is placed. The subgrade shall be in a moist condition when concrete is placed.

B. Installation
   1. Steel Curb Setting: Steel curbs shall be carefully set to alignment and grade and to conform to the dimensions of the curb.
   2. Concrete Placement And Finishing: Concrete shall be placed in layers not to exceed 6 inches. Concrete shall be thoroughly consolidated. Floated surfaces shall then be brushed with longitudinal strokes. The top surface of the entrance shall be finished to grade with a wood float. Expansion joints and contraction joints shall be constructed at right angles to the line of curb. Contraction joints shall be constructed by means of 1/8-inch thick separators, of a section conforming to the cross section of the curb and gutter. Contraction joints shall match joints in abutting Portland cement concrete pavement. At other pavements, construction joints shall be placed at not less than 5 feet nor greater than 15 feet apart. Expansion joints shall be formed by means of preformed expansion joint filler material cut and shaped to the cross section of curb. Expansion joints shall be provided in curb at the end of all returns. Expansion joints shall match expansion joints of abutting Portland cement concrete pavement. At other pavements, expansion joints at least 1/2 inch in width shall be provided at intervals not exceeding 45 feet. Exposed concrete surfaces shall be cured for not less than 7 days.

3. Backfilling: After curing, debris shall be removed and the area adjoining the concrete shall be backfilled, graded, and compacted.
4. Sealing Joints: Expansion joints and the top 1-inch depth of contraction joints shall be sealed with joint sealer. The joint opening shall be thoroughly cleaned before the sealing material is placed. Excess material on exposed surfaces of the concrete shall be removed immediately and exposed concrete surfaces cleaned.

END OF SECTION 32 01 16 71a

Task	Specification	Specification Description
32 01 16 71	03 31 13 00	Cement Concrete Pavement

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SECTION 32 01 16 73 - COLD MIX RECYCLING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of cold mix recycling of existing paving and the addition of new materials. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Aggregates:
1. General: Aggregates shall consist of material obtained from milling, or removing and crushing the existing in situ material, and/or new aggregate material as needed.
2. Aggregate Quality and Gradation: Aggregate for bituminous mixture shall be of such size that the material can be spread with a paver to the desired thickness and compacted to meet the specified smoothness, grade, and density requirements. New aggregates shall be approved and be equal to or better than the reclaimed aggregate in quality. Maximum size of new aggregate shall not exceed one-half of the layer thickness and in no case shall the maximum aggregate size exceed 1 inch.

B. Bituminous Materials: Bituminous materials, if required, shall be an emulsified asphalt conforming to ASTM D 977 or ASTM D 2397, grade as required.

C. Job-Mix Formula: The Job-Mix Formula (JMF) for the recycled mixture will be furnished by the Contractor to the Owner. The formula will indicate a definite percentage of water and asphalt to be added to the mixture. The JMF will be allowed an asphalt content tolerance of 0.3 percent. The asphalt content may be adjusted by the Owner to improve paving mixture, without adjustment in contract unit price. When asphalt is added, the optimum asphalt content will be selected to provide the following properties when samples are compacted at 250 F with 75 blows of standard Marshall hammer on each side of the specimen.

Property	Requirement
Stability minimum, pounds	1,800
Flow maximum, 1/100-inch units	16
Voids in total mix, percent	3-5
Voids filled with bitumen, percent	70-80

The water content will be selected to provide maximum density when samples are prepared at the optimum asphalt content and compacted with 75 blows of Marshall hammer at ambient temperature. When no asphalt binder is added to the mixture, the water content will be selected by the Owner to provide maximum density.

1.3 EXECUTION

A. Preparation of Bituminous Mixtures: The required amount of bituminous material for each batch, or calibrated amount of continuous mixing, shall be introduced into the mixer. Aggregates, asphalt emulsion, and water shall be mixed for 35 seconds or longer, as necessary, to thoroughly coat all particles with bituminous material. When longer mixing time is necessary, additional mixing time shall be determined by the Owner.

B. Conditioning of Existing Surface: Ruts or soft yielding spots that appear in the existing pavement areas and deviations of surface from requirements specified shall be corrected. An asphalt tack coat shall be applied to all contact surfaces in advance of the recycled overlayment. The asphalt tack shall be placed at an asphalt residue coverage rate of 0.05 gal/sq. yd.

C. Placing:
1. Layer Thickness and Curing: Each layer of compacted mixture shall be no more than 2-1/2 inches in thickness; each layer of bituminous mixture shall be allowed to cure for at least 5 days before placing a succeeding layer.
2. Compaction of Mixture: Bituminous mixtures shall be rolled until all roller marks are eliminated and a density of at least 86 percent of the theoretical maximum density has been obtained when tested in accordance with MIL-STD-620, Method 101 or ASTM D 2041. When bituminous material is not added to the cold recycled mixture, the material shall be compacted to 100 percent of density determined by MIL-STD-621, Method 100, compaction effort designation CE-55.
3. Joints: Longitudinal joints shall be offset at least 1 foot from existing joints. Transverse joints shall be offset at least 2 feet from existing transverse joints.
4. Surface Smoothness: After final rolling, the pavement surface shall not vary in excess of 1/8 inch from a straightedge laid on the surface.

END OF SECTION 32 01 16 73

Task	Specification	Specification Description
32 01 16 73	32 01 13 61	Asphalt Paving

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SECTION 32 01 16 74 - BITUMINOUS REJUVENATION

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of bituminous rejuvenation of airfield pavements, roads, streets, parking areas, and other general applications by the use of a chemical rejuvenator. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals

1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Rejuvenator: The asphalt rejuvenating agent shall be composed of a petroleum resin-oil base uniformly emulsified with water and shall conform to the following physical and chemical requirements:

B. Property Test Method Requirement

Viscosity, S.F. at 77 F, sec.	ASTM D 244	15-40
Residue, % (1)	ASTM D 244 (Mod.)	60-65(min.)
Sieve Test, %	ASTM D 244 (Mod.)	0.10 (max.)
Viscosity @ 140 F, centistokes (2)	ASTM D 2170	80-500
Flash Point, Cleveland Open Cup(COC), ºF (3)	ASTM D 92	350 (min.)

(1) ASTM D 244 Modified Evaporation Test for percent residue is made by heating 50 gm samples to 300ºF until foaming ceases; then cool immediately and calculate results.
(2) Viscosity on residue obtained from evaporation test.
(3) Flash point on residue from evaporation test.

C. Aggregate: Gradation of mineral aggregate shall meet the following requirements:

Sieve Percent by Designation	Weight Passing
No. 16	100
No. 30	40-75
No. 50	4-12
No. 100	0-5

1.3 EXECUTION

A. Bituminous Storage Tanks shall be capable of heating the bituminous material under effective and positive control at all times to the required temperature.

B. Bituminous Distributor shall be designed and equipped to spray the bituminous material in a uniform double to triple lap at the temperature recommended by the manufacturer, at variable widths, and at readily determined and controlled rates from 0.04 to 0.2 gallons per square yard, plus or minus 5 percent.

C. Brooms and Blowers shall be of the power type.

D. Preparation of Surface: Immediately before applying the rejuvenator, all loose material, dirt, clay, or other objectionable material shall be removed from the surface to be treated.

E. Application of Rejuvenator: The rejuvenator shall be uniformly applied over the surface at the approved rate with an allowable variation of plus or minus 20 percent. Materials shall be applied at the temperature recommended by the manufacturer.

F. Excess Rejuvenator Material: Approved mineral aggregate shall be provided by the Contractor and shall be spread in sufficient quantity to effectively blot up any excess rejuvenator material remaining on the treated pavement surface after 24 hours.

G. Insufficient Rejuvenator Material: When it is determined by the Owner that the actual application rate of the rejuvenator is more than 20 percent below the approved application rate, subsequent application(s) shall be made within 24 hours to ensure adequate penetration into the pavement surface.

END OF SECTION 32 01 16 74

SECTION 32 01 16 74a - CENTRAL PLANT HOT-MIX RECYCLING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of central plant hot-mix recycling of existing asphalt concrete intermediate and wearing courses for airfields, heliports, and heavy-duty pavements. The specification also includes the addition of new materials, as required to meet project requirements. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Aggregates:
1. General: Aggregates shall consist of material obtained from milling, or removing and crushing the existing in-situ material, and/or new aggregate material as needed.
2. Aggregate Quality and Gradation: Aggregate for the bituminous mixture shall be such size that the material can be spread with a paver to the desired thickness and compacted to meet the specified smoothness, grade, and density requirements. New aggregates shall be approved and shall be equal to or better than the reclaimed aggregate in quality. Maximum size of new aggregate shall not exceed one-half of the layer thickness, and in no case shall the maximum aggregate size exceed one inch. Aggregate gradations shall be as prescribed by local usage, with the approval of the Owner. In order to meet pollution requirements and ensure the recycled mixture is satisfactory, the amount of reclaimed asphalt pavement shall not exceed 60 percent for drum mixers or 50 percent for batch plants.

B. Mineral Filler shall conform to ASTM D 242.

C. Bituminous Materials:
1. New Asphalt Cement: The appropriate types and grades of bituminous materials for the anticipated use and climactic environment shall be used. Requirements of ASTM D 946 shall be used to specify penetration-graded asphalt cement, or ASTM D 3381 for viscosity-graded asphalt cement.
2. Recycled Asphalt Cement: The penetration of asphalt cement recovered from the recycled mixture shall be in accordance with ASTM D 1856 and shall have a penetration between 50 and 70 percent of that specified for the particular region for new asphalt cement, measured in accordance with ASTM D 5.

D. Job-Mix Formula (JMF): The JMF for the recycled mixture will be furnished by the Contractor to the Owner. The formula will indicate the percentage of reclaimed asphalt pavement, the percentage of bitumen, and the temperature of the completed mixture when discharged from the mixer. The requirements for stability, flow, and voids are shown in the following tables for nonabsorptive and absorptive mixtures, respectively.
1. Nonabsorptive-Aggregate Mixture

	Wearing Property Course	Intermediate Course
Stability minimum, lbs	1,800	1,800
Flow maximum, 1/100-inch units	16	16

Voids total mix, percent	3-5	5-7
Voids filled with bitumen, percent	70-80	50-70

2. Absorptive-Aggregate Mixture

	Wearing Property Course	Intermediate Course
Stability minimum, lbs.	1,800	1,800
Flow maximum, 1/100-inch units	16	16
Voids total mix, percent	2-4	4-6
Voids filled with bitumen, percent	75-80	55-75

When the water-absorption value of the entire blend of aggregate does not exceed 2.5 percent, the aggregate is designated as nonabsorptive. When the water-absorption value exceeds 2.5 percent as determined by ASTM C 127 and ASTM C 128, the aggregate is designated as absorptive.

1.3 EXECUTION

A. Preparation of Bituminous Mixtures: Aggregates, reclaimed asphalt pavement, mineral filler, bitumen, and recycling agent shall be conveyed into the mixer in proportionate quantities required to meet the JMF. Particles larger than 2 inches shall be removed from the reclaimed asphalt pavement prior to being added to the mixer. Mixing time shall be as required to obtain a uniform coating of the aggregate with the bituminous material. Temperature of bitumen at time of mixing will be as required to meet project requirements. Temperature of aggregate and mineral filler in the mixer shall not exceed 325 F when bitumen is added.

B. Surface Preparation of Underlying Course: Prior to placing of intermediate or wearing course, the underlying course shall be cleaned of all foreign or objectionable matter. The surface of previously constructed base course shall be sprayed with a prime coat at an asphalt residue coverage rate of 0.25 gal/sq. yd. Contact surfaces of previously constructed pavement, curbs, manholes, and other structures shall be sprayed with a thin tack coat at an asphalt residue coverage rate of 0.05 gal/sq. yd.

C. Placing:
1. Layer Thickness and Curing: A required uncompacted thickness of intermediate course, 7 inches or less, may be spread and compacted in one layer. Where the required thickness of base is more than 7 inches, the mixture shall be spread and compacted in two or more layers. Each layer of compacted mixture for the surface course shall be no more than 2-1/2 inches in thickness. Each layer of bituminous mixture shall be allowed to cure for at least 5 days before placing a succeeding layer.
2. Compaction of Mixture: Rolling shall begin as soon after placing as the mixture will bear roller without undue displacement. After the Contractor is assured of meeting crown, grade, and smoothness requirements, rolling shall be continued until a mat density of 98 to 100.0 percent and a joint density of 96.5 to 100.0 percent of density is obtained. Places inaccessible to rollers shall be thoroughly compacted with hot hand tampers.
3. Joints: Longitudinal joints shall be offset at least 1 foot from existing joints. Transverse joints shall be offset at least 2 feet from existing transverse joints.
4. Surface Smoothness: After final rolling, the pavement surface shall not vary in excess of 1/8 inch from a straightedge laid on the surface.

END OF SECTION 32 01 16 74a

Task	Specification	Specification Description
32 01 16 74	32 01 13 61	Asphalt Paving
32 01 16 74	32 01 16 73	Cold Mix Recycling
32 01 17 61	32 01 13 61	Asphalt Paving
32 01 17 61	32 01 13 61a	Crack Sealing Of Bituminous Pavements
32 01 17 61	32 01 13 61b	Spray Applications, Seal Coats, And Surface Treatments
32 01 17 63	32 01 13 61	Asphalt Paving
32 01 90 13	31 13 13 00	Tree Protection And Trimming
32 01 90 19	01 22 16 00	No Specification Required
32 01 90 23	31 13 13 00	Tree Protection And Trimming
32 01 90 26	31 13 13 00	Tree Protection And Trimming
32 01 90 36	31 13 13 00	Tree Protection And Trimming
32 01 90 36	31 31 19 13	Soil Sterilization
32 01 90 39	31 13 13 00	Tree Protection And Trimming
32 01 90 43	31 13 13 00	Tree Protection And Trimming
32 01 90 46	31 13 13 00	Tree Protection And Trimming
32 01 90 53	31 13 13 00	Tree Protection And Trimming

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SECTION 32 11 16 16 - CRUSHED STONE PAVING

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of crushed stone paving. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCTS

A. Aggregates: Aggregates shall consist of crushed stone or slag, crushed gravel, angular sand, or other approved materials. Aggregates shall be durable, sound, and free from foreign material.
   1. Coarse Aggregates, consisting of angular fragments of uniform density and quality, shall have a percentage of wear not to exceed 50 percent after 500 revolutions when tested in accordance with ASTM C131. The amount of flat and elongated particles (length to width greater than 3 to 1) shall not exceed 30 percent.
   2. Crushed Gravel shall be manufactured from gravel particles with the following gradation:

100% passing	2" sieve
25 - 60% passing	1/4" sieve
5 - 40% passing	#40 sieve
0 - 10%	#200 sieve

   3. Crushed Stone shall contain at least 50 percent by weight of crushed pieces having two or more freshly fractured faces for each range of sizes.
   4. Slag shall be an air-cooled blast-furnace product having a dry weight of not less than 65 pcf.

B. Binder Material shall consist of screenings, angular sand, or other finely divided mineral matter processed or naturally combined with the coarse aggregate.

1.3 EXECUTION

A. Installation:
   1. Mixing and Placing: Materials shall be mixed in such a manner as to obtain a uniform stabilized-aggregate material and a uniform optimum water content for compaction. Mixing and placing procedures shall produce true grades, minimize segregation and degradation, optimize water content, and ensure a satisfactory base course.
   2. Compaction: Each layer of stabilized-aggregate paving shall be compacted. Water content shall be maintained at optimum. Areas inaccessible to the rollers shall be compacted, with mechanical tampers and shall be shaped and finished by hand methods.
   3. Layer Thickness: No layer shall be in excess of 8 inches nor less than 3 inches in compacted thickness.
   4. Proof Rolling: Materials in paving or underlying materials that produce unsatisfactory results by rolling shall be removed and replaced with satisfactory materials and recompacted.
   5. Edges of Paving: Approved materials shall be placed along edges of stabilized-aggregate paving course in such quantities as will compact to thickness of the course being constructed, allowing at least a l-foot width of the shoulder to be rolled and compacted simultaneously with rolling and compacting of each layer of the paving course.
   6. Finishing: Finished surface shall be of uniform grade and texture.
   7. Thickness Control: Compacted thickness of the stabilized paving course shall be within 1/2 inch of the thickness required.

END OF SECTION 32 11 16 16

SECTION 32 11 16 16a - CRUSHED STONE

1.1 GENERAL

A. Description Of Work

1. The work under this section consists of furnishing, placing and compacting crushed stone where called for and as detailed, in conformance with lines, grades and typical as follows or as directed by the Owner.

1.2 PRODUCTS

A. Materials

1. Material shall consist of clean, coating free, durable, sharp angled fragments of crushed stone, crushed ledge rock, or blends thereof that conform to the specific requirements of the following table. Shale will not be acceptable.
2. Crushed Stone used in Absorption Beds shall be washed and free of fines.
3. Gradation: Crushed stone sizes shall meet the gradation requirements of Table 1-1.

TABLE 1-1 (1)GRADATION OF CRUSHED STONE

Size Desig-nation	4"	3"	2-1/2"	2"	1-1/2"	1"	1/2"	1/4"	1/8"	No.80 Sieve
Scree-ning (2)							100	90-100		
1B								100	90-100	0-15
1A							100	90-100	0-15	
1^{ST}							100	0-15		
1						100	90-100	0-15		
2					100	90-100	0-15			
3A				100	90-100	0-15				
3			100	90-100	5-70	0-15				
4A		100	90-100		0-20					
4	100	90-100		0-15						
5	90-100	0-15								

a. Percentage by weight passing the following square openings.
b. Screenings shall include all of the fine material passing a 1/4-inch screen.

4. All crushing plants shall be fitted with tailing chutes so that no aggregate will reach the bins other than that which passes through the proper screens

B. Soundness: Material furnished under this item shall be substantially free of shale or other soft, poor durability particles. A visual inspection of particle composition by the Owner will generally be the basis for acceptance. Where the State elects to test for this requirement, a Magnesium Sulfate Soundness Loss exceeding 35 percent will be cause for rejection.

C. Contamination: Contamination of the crushed stone with any deleterious material, such as silt, clay, mud, ice, snow or organic materials, through any cause whatsoever, shall be corrected by the Contractor by excavation and replacement of the material in the affected areas.

D. Sampling: Samples and certified gradations shall be furnished by the Contractor to the Owner and approval of these samples must be received prior to delivery or placement of the material.

1.3 EXECUTION

A. Compaction: All material shall be placed in uniform horizontal layers not exceeding 6-inches thickness before compaction. All portions of each layer shall be mechanically compacted to the satisfaction of the Owner. Compaction equipment shall be approved by the Owner.

END OF SECTION 32 11 16 16a

SECTION 32 11 16 16b - SELECT GRAVEL

1.1 GENERAL

A. Description Of Work

1. The work under this section consists of furnishing, placing and compacting select gravel where called for and as detailed, in conformance with lines, grades and typical sections as provided or directed by the Owner.

1.2 PRODUCTS

A. Materials

1. Material shall consist of clean, durable gravel or crushed stone free from coating.
2. Select Gravel used for stone paving shall be manufactured from crushed stone and contain no gravel.
3. Gradation of gravel or stone shall be as follows with percent passing calculated by weight:

Select Gravel

Sieve	Percent Passing
2"	100
1/4"	30 - 65
No. 40	5 - 40
No. 200	0 - 10

1.3 EXECUTION

A. Soundness: Materials furnished under this item shall be substantially free of shale, organic or other soft, poor durability particles. A visual inspection of particle composition by the Owner will generally be the basis for acceptance. Where the Owner elects to test for this requirement, a Magnesium Sulfate Soundness Loss exceeding 35 percent will be cause for rejection.

B. Contamination: Contamination of the Select Gravel with any deleterious material, such as silt, clay, mud, ice, snow or organic material, through any cause whatsoever, shall be corrected by the Contractor by excavation and replacement of the material in the affected area.

C. Sampling: Samples and certified gradations shall be furnished by the Contractor to the Owner and approval of these samples must be received prior to delivery or placement of the material.

D. Compaction:

1. All material shall be placed in uniform horizontal layers not exceeding 6-inches thickness before compaction. All portions of each layer shall be mechanically compacted to the percentage of the Standard Proctor Maximum Density (AASHTO T-99) as follows, unless noted otherwise. Compaction equipment approval shall be made by the Owner.
2. Density determination.
   a. Structures (entire area within 10 feet outside perimeter) 95%
   b. Building Slabs and Steps: 95%
   c. Lawn or Unpaved Areas: 90%
   d. Pavements and Walkways: 95%
   e. Pipes and Tunnels: 95%
   f. Pipe Bedding: 100%

END OF SECTION 32 11 16 16b

Task	Specification	Specification Description
32 11 23 16	32 11 16 16	Crushed Stone Paving
32 11 23 16	32 11 16 16a	Crushed Stone
32 11 23 16	32 11 16 16b	Select Gravel

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SECTION 32 12 13 13 - BITUMINOUS PAVING-REPAIR AND RESURFACING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials repair and resurfacing of bituminous pavements. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Reports: Copies of test results, within 24 hours after completion of tests.
2. Waybills and Delivery Tickets: Copies of waybills or delivery tickets, during the progress of the work.

1.2 PRODUCTS:

A. Asphaltic Concrete:
1. Hot-Mixed, Hot-Mixed Asphaltic Concrete and Emulsified asphalt shall comply with requirements of ASTM D 3515.
2. Plant-Mixed, Stockpiled Asphalt Cold Mixes shall comply with the requirements of Asphalt Institute Specification PM-2.

B. Bituminous Prime: Bituminous primer shall comply with ASTM D 2027.

C. Base Course: Base course material shall comply with State highway department specification for dense-graded, high-quality material.

D. Bituminous Tack Coat: Bituminous tack coat shall comply with ASTM D 2027.

1.3 EXECUTION:

A. Preparation of Areas for Patching:
1. Pot Holes: Trim the perimeter of each hole to a vertical face with a carborundum blade in a square or rectangular pattern at least 18 inches from ragged edge. Remove material to a depth that provides a uniform well-compacted bottom surface. Remove all loose material resulting from trimming or otherwise existing in the hole. If subbase is disturbed, reestablish in a like manner to adjacent substrate. Areas to be repaired shall be dry before repair is started.
2. Alligator-Cracked and Rutted Areas: The pavement shall be sawed or cut with pavement breakers to a smooth vertical face 18 inches outside of the alligator-cracked area. Unsatisfactory material shall be removed in a manner not to disturb the sides of the excavated area.
3. Slippage Areas: Saw a rectangular area around the slippage area that overlaps into the well-bonded material by at least 18 inches. The depth of the saw cut shall be equal to the thickness of the layer of material that is slipping. The surface where slipping is occurring shall be broomed clean and all loose material removed.

B. Installation:
1. Application Temperatures: Application temperatures for all asphalt material shall comply with provisions of the Asphalt Institute Publications and the applicable ASTM Standards.

2. Base Course: Place base course material in layers not exceeding a compacted thickness of 6 inches. After placing, compact each layer by mechanical compactors to a density of not less than the density of the corresponding layer of the adjacent pavement structure.
3. Prime Coat: Prime base course with MC-70 liquid asphalt at a rate of 0.20 to 0.30 gallon per sq. yd. Bolt excess prime with sand before the surfacing material is applied.
4. Tack Coat: Give the edges of existing asphaltic concrete or surfaces of Portland cement concrete and asphaltic concrete a tack coat of MC-70 liquid asphalt at a rate of 0.05 to 0.15 gallon per sq. yd. Allow the material to cure before placing the surfacing material.
5. Hot-Mixed Asphaltic Concrete: Place the material in layers not exceeding 2-1/2 inches in thickness and compact to a density equal to the density of the adjacent asphaltic concrete.
6. Stockpiled Cold Mixes: The compacted thickness of each layer of material shall not exceed 2 inches. Before compaction, the material shall be allowed to aerate, if necessary, until the proper amount of cohesion has developed to obtain adequate compaction. When more than one layer is used, each layer shall be thoroughly cured before the succeeding layer is placed.

END OF SECTION 32 12 13 13

SECTION 32 12 13 13a - ASPHALTIC CONCRETE OVERLAYS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of asphaltic concrete overlays. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Asphalt Cement: The asphalt cement shall comply with ASTM D 946 penetration grade 85-100 requirements and shall show a negative spot test when tested in compliance with AASHTO T 102.

B. Mineral Aggregates: Shall comply with ASTM D 3515 for 3/4-inch maximum aggregate mix.

C. Test Properties: The bituminous mixture shall meet the following requirements when tested in compliance with MIL-STD 620.

Stability minimum, lb	500
Flow maximum, 1/100-in. units	20
Voids total mix, %	3-5
Voids filled with bitumen, %	75-85

1.3 EXECUTION

A. Preparation of Existing Surface: The Contractor shall raise and reset all structures such as manhole frames, valve boxes, drainage structures, etc., to meet the required grade. An asphalt tack coat shall be applied to all contact surfaces in advance of the asphalt concrete overlay placement. The asphalt tack shall be placed at an asphalt residue coverage rate of 0.05 gal/sq yd.

B. Installation:
   1. Joints: Longitudinal joints of the overlay shall be offset at least 1 foot from existing joints. Transverse joints shall be offset at least 2 feet from existing transverse joints.
   2. All Asphalt Concrete Mixture and Pavement that are contaminated, damaged, or defective shall be removed and replaced by the Contractor. Skin patching of rolled pavement will not be permitted.
   3. Compaction of Mixture: The asphalt concrete mixture shall be rolled until a density of not less than 95 percent and not more than 100 percent of laboratory compacted specimen is obtained.
   4. Surface Smoothness: After final rolling, the pavement surface shall not vary in excess of 1/8 inch from a 10-foot straightedge laid on the surface.

END OF SECTION 32 12 13 13a

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Task	Specification	Specification Description
32 12 13 13	32 01 13 61	Asphalt Paving
32 12 13 19	32 01 13 61	Asphalt Paving
32 12 13 19	32 12 13 13	Bituminous Paving-Repair And Resurfacing
32 12 13 19	32 12 13 13a	Asphaltic Concrete Overlays
32 12 16 13	32 01 13 61	Asphalt Paving
32 12 16 13	32 12 13 13	Bituminous Paving-Repair And Resurfacing
32 12 16 13	32 12 13 13a	Asphaltic Concrete Overlays
32 12 16 19	32 12 13 13	Bituminous Paving-Repair And Resurfacing
32 12 16 19	32 12 13 13a	Asphaltic Concrete Overlays
32 12 16 39	31 32 13 16	Soil Stabilization-Lime
32 12 16 39	31 25 14 13	Geosynthetic Fabric
32 12 16 43	32 01 13 61	Asphalt Paving
32 12 16 43	32 01 13 61a	Crack Sealing Of Bituminous Pavements
32 12 16 43	32 01 13 61b	Spray Applications, Seal Coats, And Surface Treatments
32 12 33 00	32 01 13 61	Asphalt Paving
32 12 33 00	32 12 13 13	Bituminous Paving-Repair And Resurfacing
32 12 33 00	32 12 13 13a	Asphaltic Concrete Overlays
32 12 36 13	32 01 13 61	Asphalt Paving
32 12 36 13	32 01 13 61a	Crack Sealing Of Bituminous Pavements
32 12 36 16	32 01 13 61	Asphalt Paving
32 12 36 16	32 01 13 61a	Crack Sealing Of Bituminous Pavements
32 12 36 16	32 01 13 61b	Spray Applications, Seal Coats, And Surface Treatments
32 12 36 23	32 01 13 61	Asphalt Paving
32 12 36 23	32 01 13 61a	Crack Sealing Of Bituminous Pavements
32 12 36 23	32 01 13 61b	Spray Applications, Seal Coats, And Surface Treatments

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SECTION 32 13 13 33 - DECORATIVE CEMENT CONCRETE PAVEMENT

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for decorative cement concrete pavement. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section includes colored, stamped, stenciled, and stained concrete paving.

C. Definitions

1. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

D. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittals:
    a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
    b. Design Mixtures for Credit ID 1.1: For each concrete mixture containing fly ash as a replacement for portland cement or other portland cement replacements. For each design mixture submitted, include an equivalent concrete mixture that does not contain portland cement replacements, to determine amount of portland cement replaced.
3. Samples: For each type of exposed color, pattern, or texture indicated.
4. Other Action Submittals:
    a. Design Mixtures: For each decorative concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
5. Qualification Data: For qualified Installer, ready-mix concrete manufacturer, and testing agency.
6. Material Certificates: For the following, from manufacturer:
    a. Cementitious materials.
    b. Steel reinforcement and reinforcement accessories.
    c. Fiber reinforcement.
    d. Admixtures.
    e. Curing compounds.
    f. Applied finish materials.
    g. Bonding agent or epoxy adhesive.
    h. Joint fillers.
7. Material Test Reports: For each of the following:
    a. Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.
8. Field quality-control reports.

E. Quality Assurance

1. Installer Qualifications: An employer of workers trained and approved by manufacturer of decorative concrete paving systems.
2. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

a. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

3. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
   a. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
4. Source Limitations: Obtain decorative concrete paving products and each type or class of cementitious material of the same brand from same manufacturer's plant, and obtain each aggregate from single source.
5. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.
6. ACI Publications: Comply with ACI 301 (ACI 301M) unless otherwise indicated.
7. Preinstallation Conference: Conduct conference at Project site.

F. Project Conditions
1. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

1.2 PRODUCTS

A. Forms
1. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
   a. Use flexible or uniformly curved forms for curves of a radius of 100 feet (30.5 m) or less. Do not use notched and bent forms.
2. Forms for Textured Finish Concrete: Units of face design, size, arrangement, and configuration indicated. Provide solid backing and form supports to ensure stability of textured form liners.
3. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

B. Steel Reinforcement
1. Recycled Content: Provide steel reinforcement with an average recycled content of steel so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
2. Plain-Steel Welded Wire Reinforcement: ASTM A 1064/A 1064M, fabricated from as-drawn steel wire into flat sheets.
3. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420); deformed.
4. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60 (Grade 420), deformed bars; assembled with clips.
5. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.
6. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) plain-steel bars. Cut bars true to length with ends square and free of burrs.
7. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:
   a. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

C. Concrete Materials
1. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

a. Portland Cement: ASTM C 150, gray **OR** white, **as directed**, portland cement Type **I OR** Type **II OR** Type **I/II OR** Type **III OR** Type V, **as directed**. Supplement with the following, **as directed**:
   1) Fly Ash: ASTM C 618, Class C or F.
   2) Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

b. Blended Hydraulic Cement: ASTM C 595, Type IS, portland blast-furnace slag **OR** Type IP, portland-pozzolan, **as directed**, cement.

2. Normal-Weight Aggregates: ASTM C 33, Class 4S **OR** Class 4M **OR** Class 1N, **as directed**, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials, **as directed**.
   a. Maximum Aggregate Size: 1-1/2 inches (38 mm) **OR** 1 inch (25 mm) **OR** 3/4 inch (19 mm), **as directed**, nominal.
   b. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
3. Water: Potable and complying with ASTM C 94/C 94M.
4. Air-Entraining Admixture: ASTM C 260.
5. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
   a. Water-Reducing Admixture: ASTM C 494/C 494M, Type A, colored, **as directed**.
   b. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D, colored, **as directed**.
   c. Water-Reducing and Accelerating Admixture: ASTM C 494/C 494M, Type E.
6. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, **as directed**, nonfading, and resistant to lime and other alkalis.

D. Fiber Reinforcement
   1. Synthetic Fiber: Monofilament or fibrillated polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C 1116/C 1116M, Type **III**, 1/2 to 1-1/2 inches (13 to 38 mm) long.

E. Surface Coloring Materials
   1. Pigmented Mineral Dry-Shake Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.
   2. Pigmented Powder Release Agent: Factory-packaged, dry combination of surface-conditioning and dispersing agents interground with color pigments that facilitates release of stamp mats. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.
   3. Liquid Release Agent: Manufacturer's standard, clear, evaporating formulation that facilitates release of stamp mats and texture rollers.

F. Stamping Devices
   1. Stamp Mats: Semirigid polyurethane mats with projecting textured and ridged underside capable of imprinting texture and joint patterns on plastic concrete.
   2. Stamp Tools: Open-grid, aluminum or rigid-plastic stamp tool capable of imprinting joint patterns on plastic concrete.
   3. Rollers: Manually controlled, water-filled aluminum rollers with projecting ridges on drum capable of imprinting texture and joint patterns on plastic concrete.
   4. Texture Rollers: Manually controlled, abrasion-resistant polyurethane rollers capable of imprinting texture on plastic concrete.

G. Stencil Materials
   1. Stencils: Manufacturer's standard, moisture-resistant paper or reusable plastic stencils, designed for use on plastic concrete.

H. Stain Materials
1. Reactive Stain: Acidic-based stain with wetting agents and high-grade, UV-stable metallic salts that react with calcium hydroxide in cured concrete to produce permanent, variegated, or translucent color effects.
2. Penetrating Stain: Water-based, acrylic latex, penetrating stain with colorfast pigments.

I. Curing And Sealing Materials
1. Curing Paper: Nonstaining, waterproof paper, consisting of two layers of kraft paper cemented together and reinforced with fiber, and complying with ASTM C 171.
2. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
3. Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type I, Class B, manufactured for colored concrete.
   a. For integrally colored concrete, curing compound shall be pigmented type approved by coloring admixture manufacturer.
   b. For concrete indicated to be sealed, curing compound shall be compatible with sealer.
4. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type I, Class A, manufactured for use with colored concrete.
5. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type I, Class A, manufactured for use with colored concrete.
6. Clear Acrylic Sealer: Manufacturer's standard, waterborne, nonyellowing and UV-resistant, membrane-forming, medium-gloss, acrylic copolymer emulsion solution, manufactured for colored concrete, containing not less than 15 percent solids by volume.
7. Slip-Resistance-Enhancing Additive: Manufacturer's standard finely graded aggregate or polymer additive, designed to be added to clear acrylic sealer to enhance slip resistance of sealed paving surface.

J. Related Materials
1. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.
2. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
3. Epoxy Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:
   a. Types I and II, non-load bearing **OR** Types IV and V, load bearing, **as directed**, for bonding hardened or freshly mixed concrete to hardened concrete.
4. Polyethylene Film: ASTM D 4397, 1 mil (0.025 mm) thick, clear.

K. Concrete Mixtures
1. Prepare design mixtures, proportioned according to ACI 301 (ACI 301M), for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
   a. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
2. Proportion mixtures to provide normal-weight concrete with the following properties:
   a. Compressive Strength (28 Days): 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**.
   b. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45 **OR** 0.50, **as directed**.
   c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm), **as directed**, plus or minus 1 inch (25 mm).
3. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
   a. Air Content: 5-1/2 **OR** 4-1/2 **OR** 2-1/2, **as directed**, percent plus or minus 1.5 percent for 1-1/2-inch (38-mm) nominal maximum aggregate size.

b. Air Content: 6 **OR** 4-1/2 **OR** 3, **as directed**, percent plus or minus 1.5 percent for 1-inch (25-mm) nominal maximum aggregate size.
c. Air Content: 6 **OR** 5 **OR** 3-1/2, **as directed**, percent plus or minus 1.5 percent for 3/4-inch (19-mm) nominal maximum aggregate size.
4. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 **OR** 0.30, **as directed**, percent by weight of cement.
5. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
a. Use water-reducing admixture **OR** water-reducing and retarding admixture **OR** water-reducing and accelerating admixture, **as directed**, in concrete as required for placement and workability.
b. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
6. Cementitious Materials: Limit percentage by weight of cementitious materials other than portland cement according to ACI 301 (ACI 301M) requirements for concrete exposed to deicing chemicals **OR** as follows, **as directed**:
a. Fly Ash or Pozzolan: 25 percent.
b. Ground Granulated Blast-Furnace Slag: 50 percent.
c. Combined Fly Ash or Pozzolan, and Ground Granulated Blast-Furnace Slag: 50 percent, with fly ash or pozzolan not exceeding 25 percent.
7. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd. (0.60 kg/cu. m).
8. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

L. Concrete Mixing
1. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M, **as directed**. Furnish batch certificates for each batch discharged and used in the Work.
a. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.
2. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.
a. For concrete batches of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
b. For concrete batches larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).
c. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

1.3 EXECUTION

A. Examination
1. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
2. Proof-roll prepared subbase surface below decorative concrete paving to identify soft pockets and areas of excess yielding.
a. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph (5 km/h).
b. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).
c. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch (13 mm) according to requirements in Division 31 Section "Earth Moving".

3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Remove loose material from compacted subbase surface immediately before placing concrete.
2. Protect adjacent construction from discoloration and spillage during application of color hardeners, release agents, stains, curing compounds, and sealers.

C. Edge Forms And Screed Construction
1. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
2. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

D. Steel Reinforcement
1. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
2. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
3. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
4. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
5. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch (50-mm) overlap to adjacent mats.

E. Joints
1. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
   a. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.
2. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
   a. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
   b. Butt Joints: Use bonding agent **OR** epoxy bonding adhesive, **as directed**, at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
   c. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
   d. Dowelled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
3. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
   a. Locate expansion joints at intervals of 50 feet (15.25 m) unless otherwise indicated.
   b. Extend joint fillers full width and depth of joint.
   c. Terminate joint filler not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished surface if joint sealant is indicated.
   d. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
   e. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.

f. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

4. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent decorative concrete paving, **as directed**:
   a. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch (6-mm) **OR** 3/8-inch (10-mm), **as directed**, radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.
      1) Tolerance: Ensure that grooved joints are within 3 inches (75 mm) either way from centers of dowels.
   b. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
      1) Tolerance: Ensure that sawed joints are within 3 inches (75 mm) in both directions from center of dowels.
   c. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
5. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch (6-mm) **OR** 3/8-inch (10-mm), **as directed**, radius. Repeat tooling of edges after applying surface finishes. Eliminate edging tool marks on concrete surfaces.

F. Concrete Placement
1. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
2. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.
3. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
4. Comply with ACI 301 (ACI 301M) requirements for measuring, mixing, transporting, and placing concrete.
5. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.
6. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
7. Consolidate concrete according to ACI 301 (ACI 301M) by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
   a. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.
8. Screed paving surface with a straightedge and strike off.
9. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
10. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
    a. When air temperature has fallen to or is expected to fall below 40 deg F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture

temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
   b. Do not use frozen materials or materials containing ice or snow.
   c. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.
11. Hot-Weather Placement: Comply with ACI 301 (ACI 301M) and as follows when hot-weather conditions exist:
   a. Cool ingredients before mixing to maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
   b. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
   c. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

G. Float Finishing
1. General: Do not add water to concrete surfaces during finishing operations.
2. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

H. Integrally Colored Concrete Finish
1. Integrally Colored Concrete Finish: After final floating, apply the following finish:
   a. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
   b. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
   c. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch (1.6 to 3 mm) deep with a stiff-bristled broom, perpendicular to line of traffic.

I. Stenciling
1. Cut stencils to slab width and lay on wet concrete. Overlap "mortar joint" on trailing edge of each section of stencil onto leading "mortar joint" of previous section.
2. Trim stencils to fit slab and adjacent patterns.
3. Slightly embed stencil into concrete by rolling with stencil roller.
4. Apply pigmented mineral dry-shake hardener materials to concrete surfaces according to manufacturer's written instructions.
5. Stencil Rolling:
   a. Apply pigmented powder release agent **OR** liquid release agent, **as directed**, according to manufacturer's written instructions prior to applying texture roller to surface of concrete.
   b. Perform rolling operation to produce required texture on concrete surface.
6. Remove stencils when concrete has sufficiently cured to bear weight. Do not leave stencils in concrete overnight.
7. Remove debris with mechanical blower prior to application of curing compound. If release agent is applied, delay removal of debris for 24 hours, then flood area with low-pressure water hose, wetting release agent, and follow by cleaning surface with pressure washer.

J. Pigmented Mineral Dry-Shake Hardener
1. Pigmented Mineral Dry-Shake Hardener Finish: After initial floating, apply dry-shake materials to paving surfaces according to manufacturer's written instructions and as follows:

a. Uniformly apply dry-shake hardener at a rate of 100 lb/100 sq. ft. (49 kg/10 sq. m) unless greater amount is recommended by manufacturer to match paving color required.
b. Uniformly distribute approximately two-thirds of dry-shake hardener over the concrete surface with mechanical spreader; allow hardener to absorb moisture and embed it by power floating. Follow power floating with a second application of pigmented mineral dry-shake hardener, uniformly distributing remainder of material at right angles to first application to ensure uniform color, and embed hardener by final power floating.
c. After final power floating, apply the following finish:
   1) Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
   2) Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
   3) Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch (1.6 to 3 mm) deep with a stiff-bristled broom, perpendicular to line of traffic.

2. Pigmented Powder Release Agent: Uniformly distribute onto dry-shake-hardened and still-plastic concrete at a rate of 3 to 4 lb/100 sq. ft. (1.5 to 2 kg/10 sq. m).
3. Liquid Release Agent: Uniformly mist surface of dry-shake-hardened and still-plastic concrete at a rate of 5 gal/1000 sq. ft. (0.2 L/sq. m).

K. Stamping
1. Mat Stamping: After floating and while concrete is plastic, apply mat-stamped finish.
   a. Pigmented Powder Release Agent: Uniformly distribute onto concrete at a rate of 3 to 4 lb/100 sq. ft. (1.5 to 2 kg/10 sq. m).
   b. Liquid Release Agent: Apply liquid release agent to the concrete surface and the stamp mat. Uniformly mist surface of concrete at a rate of 5 gal/1000 sq. ft. (0.2 L/sq. m).
   c. After application of release agent, accurately align and place stamp mats in sequence.
   d. Uniformly load mats and press into concrete to produce required imprint pattern and depth of imprint on concrete surface. Gently remove stamp mats. Hand stamp edges and surfaces unable to be imprinted by stamp mats.
   e. Remove residual release agent according to manufacturer's written instructions, but no fewer than three days after stamping concrete. High-pressure-wash surface and joint patterns, taking care not to damage stamped concrete. Control, collect, and legally dispose of runoff.
2. Tool Stamping: After floating and while concrete is plastic, apply tool-stamped finish.
   a. Cover surface with polyethylene film, stretch taut to remove wrinkles, lap sides and ends 3 inches (75 mm), and secure to edge forms. Lightly broom surface to remove air bubbles.
   b. Accurately align and place stamp tools in sequence and tamp into concrete to produce required imprint pattern and depth of imprint on concrete surface. Gently remove stamp tools. Hand stamp edges and surfaces unable to be imprinted by stamp tools.
   c. Carefully remove polyethylene film immediately after tool stamping.
3. Roller Stamping: After floating and while concrete is plastic, apply roller-stamped finish.
   a. Cover surface with polyethylene film, stretch taut to remove wrinkles, lap sides and ends 3 inches (75 mm), and secure to edge forms. Lightly broom surface to remove air bubbles.
   b. Accurately align roller and perform rolling operation to produce required imprint pattern and depth of imprint on concrete surface. Hand stamp surfaces inaccessible to roller.
   c. Carefully remove polyethylene film immediately after roller stamping.

L. Concrete Protection And Curing
1. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
2. Comply with ACI 306.1 for cold-weather protection.
3. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during

finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

4. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
5. Curing Compound: Apply curing compound immediately after final finishing. Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas that have been subjected to heavy rainfall within three hours after application. Maintain continuity of coating, and repair damage during curing period.
   a. Cure integrally colored concrete with a pigmented, **as directed**, curing compound.
   b. Cure concrete finished with pigmented mineral dry-shake hardener with a pigmented, **as directed**, curing compound.
6. Curing and Sealing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.
7. Curing Paper: Cure with unwrinkled curing paper in pieces large enough to cover the entire width and edges of slab. Do not lap sheets. Fold curing paper down over paving edges and secure with continuous banks of earth to prevent displacement or billowing due to wind. Immediately repair holes or tears in paper.

M. Staining
1. Newly placed concrete paving shall be at least 14 **OR** 30, **as directed**, days old before staining.
2. Prepare surfaces according to manufacturer's written instructions and as follows:
   a. Clean concrete thoroughly by scraping, applying solvents or stripping agents, sweeping and pressure washing, or scrubbing with a rotary floor machine and detergents recommended by stain manufacturer. Rinse until water is clear and allow surface to dry.
      1) Do not use acidic solutions to clean surfaces.
   b. Test surfaces with droplets of water. If water beads and does not penetrate surface, or penetrates only in some areas, profile surfaces by acid etching, grinding, sanding, or abrasive blasting. Retest and continue profiling surface until water droplets immediately darken and uniformly penetrate concrete surfaces.
   c. Apply acidic solution to dampened concrete surfaces, scrubbing with uncolored, acid-resistant nylon-bristle brushes until bubbling stops and concrete surface has texture of 120-grit sandpaper. Do not allow solution to dry on concrete surfaces. Rinse until water is clear. Control, collect, and legally dispose of runoff.
   d. Neutralize concrete surfaces and rinse until water is clear. Test surface for residue with clean white cloth. Test surface according to ASTM F 710 to ensure pH is between 7 and 8.
3. Scoring: Score decorative jointing in paving surfaces 1/16 inch (1.6 mm) deep with diamond blades to match pattern indicated. Rinse until water is clear. Score after **OR** before, **as directed**, staining.
   a. Joint Width: 3/8 inch (10 mm).
4. Allow paving surface to dry before applying stain. Verify readiness of paving to receive stain according to ASTM D 4263 by tightly taping 18-by-18-inch (450-by-450-mm), 4-mil- (0.1-mm-) thick polyethylene sheet to a representative area of paving surface. Apply stain only if no evidence of moisture has accumulated under sheet after 16 hours.
5. Reactive Stain: Apply reactive stain to paving surfaces according to manufacturer's written instructions and as follows:
   a. Apply stain by uncolored bristle brush, roller, or high-volume, low-pressure sprayer and immediately scrub into concrete surface with uncolored, acid-resistant nylon-bristle brushes in continuous, circular motion. Do not spread stain after fizzing stops. Allow to dry four hours and repeat application of stain in sufficient quantity to obtain color consistent with approved mockup.
   b. Remove stain residue after four hours by wet scrubbing with commercial-grade detergent recommended by stain manufacturer. Rinse until water is clear. Control, collect, and legally dispose of runoff.

6. Penetrating Stain: Apply penetrating stain to paving surfaces according to manufacturer's written instructions and as follows:
   a. Apply first coat of stain to dry, clean surfaces by airless sprayer or by high-volume, low-pressure sprayer.
   b. Allow to dry four hours and repeat application of stain in sufficient quantity to obtain color consistent with approved mockup.
   c. Rinse until water is clear. Control, collect, and legally dispose of runoff.

N. Sealer
1. Clear Acrylic Sealer: Apply uniformly in two coats in continuous operations according to manufacturer's written instructions. Allow first coat to dry before applying second coat, at 90 degrees to the direction of the first coat using same application methods and rates.
   a. Begin sealing dry surface no sooner than 14 days after concrete placement.
   b. Allow stained concrete surfaces to dry before applying sealer.
   c. Thoroughly mix slip-resistance-enhancing additive into sealer before applying sealer according to manufacturer's written instructions. Stir sealer occasionally during application to maintain even distribution of additive.

O. Paving Tolerances
1. Comply with tolerances in ACI 117 and as follows:
   a. Elevation: 3/4 inch (19 mm).
   b. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
   c. Surface: Gap below 10-foot- (3-m-) long, unleveled straightedge not to exceed 1/2 inch (13 mm).
   d. Lateral Alignment and Spacing of Dowels: 1 inch (25 mm).
   e. Vertical Alignment of Dowels: 1/4 inch (6 mm).
   f. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches (6 mm per 300 mm) of dowel.
   g. Joint Spacing: 3 inches (75 mm).
   h. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
   i. Joint Width: Plus 1/8 inch (3 mm), no minus.

P. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
   a. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. (76 cu. m) **OR** 5000 sq. ft. (465 sq. m), **as directed**, or fraction thereof of each concrete mixture placed each day.
      1) When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
   b. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
   c. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
   d. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when it is 80 deg F (27 deg C) and above, and one test for each composite sample.
   e. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
   f. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.
      1) A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

3. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).
4. Test results shall be reported in writing to the Owner, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
5. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by the Owner but will not be used as sole basis for approval or rejection of concrete.
6. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by the Owner.
7. Decorative concrete paving will be considered defective if it does not pass tests and inspections.
8. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
9. Prepare test and inspection reports.

Q. Repairs And Protection
1. Remove and replace decorative concrete paving that is broken or damaged or does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by the Owner.
2. Detailing: Grind concrete "squeeze" left from tool placement. Color ground areas with slurry of color hardener mixed with water and bonding agent. Remove excess release agent with high-velocity blower.
3. Protect decorative concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
4. Maintain decorative concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Final Completion inspections.

END OF SECTION 32 13 13 33

Task	Specification	Specification Description
32 13 13 33	03 31 13 00	Cement Concrete Pavement
32 13 13 33	03 31 13 00a	Roller Compacted Concrete Pavement
32 13 13 33	03 31 13 00c	Steel Reinforced Portland Cement Concrete Overlays
32 13 13 33	03 31 13 00d	Fiber Reinforced Portland Cement Concrete Overlays
32 13 73 13	32 01 13 61	Asphalt Paving
32 13 73 13	32 01 13 61a	Crack Sealing Of Bituminous Pavements
32 13 73 13	32 01 13 61b	Spray Applications, Seal Coats, And Surface Treatments
32 13 73 16	32 01 13 61	Asphalt Paving
32 13 73 16	32 01 13 61a	Crack Sealing Of Bituminous Pavements
32 13 73 16	32 01 13 61b	Spray Applications, Seal Coats, And Surface Treatments
32 13 73 19	32 01 13 61	Asphalt Paving
32 13 73 19	32 01 13 61b	Spray Applications, Seal Coats, And Surface Treatments

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SECTION 32 14 09 00 - EXTERIOR PLANTS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for exterior plants. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Plants.
   b. Planting soils.
   c. Tree stabilization.
   d. Landscape edgings.
   e. Tree grates.

C. Definitions

1. Backfill: The earth used to replace or the act of replacing earth in an excavation.
2. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than sizes indicated **OR** diameter and depth recommended by ANSI Z60.1 for type and size of plant required, **as directed**; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
3. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than sizes indicated **OR** diameter and depth recommended by ANSI Z60.1 for type and size of plant required, **as directed**.
4. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than minimum root spread according to ANSI Z60.1 for type and size of plant required.
5. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
6. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
7. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.
8. Finish Grade: Elevation of finished surface of planting soil.
9. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
10. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
11. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
12. Planting Area: Areas to be planted.

13. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
14. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
15. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
16. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
17. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
18. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
19. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

D. Submittals
1. Product Data: For each type of product indicated, including soils.
2. Samples of mineral mulch.
3. Product certificates.
4. Maintenance Instructions: Recommended procedures to be established by the Owner for maintenance of plants during a calendar year.

E. Quality Assurance
1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
   a. Pesticide Applicator: State licensed, commercial.
2. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory.
   a. The soil-testing laboratory shall oversee soil sampling.
   b. Report suitability of tested soil for plant growth.
      1) State recommendations for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
      2) Report presence of problem salts, minerals, or heavy metals; if present, provide additional recommendations for corrective action.
3. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
4. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable.
2. Bulk Materials:
   a. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
   b. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
   c. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.
3. Deliver bare-root stock plants freshly dug. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting.

4. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
5. Handle planting stock by root ball.
6. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F (16 to 18 deg C) until planting.
7. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
   a. Heel-in bare-root stock. Soak roots that are in dry condition in water for two hours. Reject dried-out plants.
   b. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
   c. Do not remove container-grown stock from containers before time of planting.
   d. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly-wet condition.

G. Warranty
1. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by the Owner, or incidents that are beyond Contractor's control.
      2) Structural failures including plantings falling or blowing over.
      3) Faulty performance of tree stabilization, edgings, or tree grates.
      4) Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   b. Warranty Periods from Date of Planting Completion **OR** Final Completion, **as directed**:
      1) Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
      2) Ground Covers, Biennials, Perennials, and Other Plants: 12 **OR** Nine **OR** Six **OR** Three, **as directed**, months.
      3) Annuals: Three **OR** Two, **as directed**, months.

H. Maintenance Service
1. Initial Maintenance Service: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 1.3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.
   a. Maintenance Period for Trees and Shrubs: 12 **OR** Six **OR** Three, **as directed**, months from date of planting completion **OR** Final Completion, **as directed**.
   b. Maintenance Period for Ground Cover and Other Plants: Six **OR** Three, **as directed**, months from date of planting completion **OR** Final Completion, **as directed**.
2. Continuing Maintenance Proposal: From Installer to the Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.2 PRODUCTS

A. Plant Material

1. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
    a. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch (19 mm) in diameter; or with stem girdling roots will be rejected.
    b. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
2. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting.
3. Annuals and Biennials: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery and that are in bud but not yet in bloom.

B. Inorganic Soil Amendments
1. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
    a. Class: T, with a minimum of 99 percent passing through No. 8 (2.36-mm) sieve and a minimum of 75 percent passing through No. 60 (0.25-mm) sieve.
       OR
       Class: O, with a minimum of 95 percent passing through No. 8 (2.36-mm) sieve and a minimum of 55 percent passing through No. 60 (0.25-mm) sieve.
    b. Provide lime in form of ground dolomitic limestone **OR** calcitic limestone **OR** mollusk shells, **as directed**.
2. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent sulfur, with a minimum of 99 percent passing through No. 6 (3.35-mm) sieve and a maximum of 10 percent passing through No. 40 (0.425-mm) sieve.
3. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
4. Aluminum Sulfate: Commercial grade, unadulterated.
5. Perlite: Horticultural perlite, soil amendment grade.
6. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 (0.30-mm) sieve.
7. Sand: Clean, washed, natural or manufactured, and free of toxic materials.
8. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.
   OR
   Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

C. Organic Soil Amendments
1. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch (25-mm) **OR** 3/4-inch (19-mm) **OR** 1/2-inch (13-mm), **as directed**, sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
    a. Organic Matter Content: 50 to 60 percent of dry weight.
    b. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
2. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or granular texture, with a pH range of 3.4 to 4.8.

3. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.
4. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.
   a. In lieu of decomposed wood derivatives, mix partially decomposed wood derivatives with ammonium nitrate at a minimum rate of 0.15 lb/cu. ft. (2.4 kg/cu. m) of loose sawdust or ground bark, or with ammonium sulfate at a minimum rate of 0.25 lb/cu. ft. (4 kg/cu. m) of loose sawdust or ground bark.
5. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

D. Fertilizers
1. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 1 **OR** 4, **as directed**, percent nitrogen and 10 **OR** 20, **as directed**, percent phosphoric acid.
2. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
3. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
   a. Composition: 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
   b. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
4. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
   a. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
   b. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
5. Planting Tablets: Tightly compressed chip type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
   a. Size: 5-gram **OR** 10-gram **OR** 21-gram, **as directed**, tablets.
   b. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.
6. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

E. Planting Soils
1. Planting Soil: ASTM D 5268 topsoil, with pH range of 5.5 to 7, a minimum of 2 percent organic material content **OR** Existing, native surface topsoil formed under natural conditions with the duff layer retained during excavation process **OR** Existing, in-place surface soil **OR** Imported topsoil or manufactured topsoil from off-site sources; do not obtain from agricultural land, bogs or marshes, **as directed**. Verify suitability of soil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth. Mix soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
   a. Ratio of Loose Compost to Topsoil by Volume: 1:4 **OR** 1:3 **OR** 1:2, **as directed**.
   b. Ratio of Loose Sphagnum **OR** Muck, **as directed**, Peat to Topsoil by Volume: as directed by the Owner.
   c. Ratio of Loose Wood Derivatives to Topsoil by Volume: as directed by the Owner.
   d. Weight of Lime per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.

e. Weight of Sulfur **OR** Iron Sulfate **OR** Aluminum Sulfate, **as directed**, per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.
f. Weight of Agricultural Gypsum per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.
g. Volume of Sand Plus 10 Percent Diatomaceous Earth **OR** Zeolites, **as directed**, per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.
h. Weight of Bonemeal per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.
i. Weight of Superphosphate per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.
j. Weight of Commercial Fertilizer per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.
k. Weight of Slow-Release Fertilizer per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.

F. Mulches
1. Organic Mulch: Shredded hardwood **OR** Ground or shredded bark **OR** Wood and bark chips **OR** Pine straw **OR** Salt hay or threshed straw **OR** Pine needles **OR** Peanut, pecan, and cocoa-bean shells, **as directed**.
2. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch (25-mm) sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings.
3. Mineral Mulch: Rounded riverbed gravel or smooth-faced stone **OR** Crushed stone or gravel **OR** Marble chips **OR** Granite chips, **as directed**.
   a. Size Range: 1-1/2 inches (38 mm) maximum, 3/4 inch (19 mm) minimum **OR** 3/4 inch (19 mm) maximum, 1/4 inch (6.4 mm) minimum, **as directed**.
   b. Color: Uniform tan-beige color range acceptable to the Owner **OR** Readily available natural gravel color range, **as directed**.

G. Weed-Control Barriers
1. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. (101g/sq. m) minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally-encountered chemicals, alkalis, and acids.
2. Composite Fabric: Woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, 4.8 oz./sq. yd. (162 g/sq. m).

H. Pesticides
1. General: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
2. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
3. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

I. Tree Stabilization Materials
1. Stakes and Guys:
   a. Upright and Guy Stakes: Rough-sawn, sound, new hardwood **OR** softwood with specified wood pressure-preservative treatment, **as directed**, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal (38-by-38-mm actual) by length indicated, pointed at one end.
   b. Wood Deadmen: Timbers measuring 8 inches (200 mm) in diameter and 48 inches (1200 mm) long, treated with specified wood pressure-preservative treatment.
   c. Flexible Ties: Wide rubber or elastic bands or straps of length required to reach stakes or turnbuckles **OR** compression springs, **as directed**.
   d. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, galvanized-steel wire, two-strand, twisted, 0.106 inch (2.7 mm) in diameter.

e. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.
f. Guy Cables: Five-strand, 3/16-inch- (4.8-mm-) diameter, galvanized-steel cable, with zinc-coated turnbuckles **OR** compression springs, **as directed**, a minimum of 3 inches (75 mm) long, with two 3/8-inch (10-mm) galvanized eyebolts.
g. Flags: Standard surveyor's plastic flagging tape, white, 6 inches (150 mm) long.
h. Proprietary Staking-and-Guying Devices: Proprietary stake and adjustable tie systems to secure each new planting by plant stem; sized as indicated and per manufacturer's written recommendations.

2. Root-Ball Stabilization Materials:
   a. Upright Stakes and Horizontal Hold-Down: Rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal (38-by-38-mm actual) by length indicated; stakes pointed at one end.
   b. Wood Screws: ASME B18.6.1.
   c. Proprietary Root-Ball Stabilization Devices: Proprietary at- or below-grade stabilization systems to secure each new planting by root ball; sized per manufacturer's written recommendations unless otherwise indicated.
3. Palm Bracing: Battens or blocks, struts, straps, and protective padding as indicated.
   a. Battens or Blocks and Struts: Rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain, and other defects, 2-by-4-inch nominal (38-by-89-mm actual) by lengths indicated.
   b. Straps: Adjustable steel or plastic package banding straps.
   c. Padding: Burlap.
   d. Proprietary Palm-Bracing Devices: Proprietary systems to secure each new planting by trunk; sized per manufacturer's written recommendations unless otherwise indicated.

J. Landscape Edgings
1. Wood Edging: Of sizes shown on Drawings, and wood stakes as follows:
   a. Species: Western red cedar, all heart **OR** Southern pine with specified wood pressure-preservative treatment, **as directed**.
   b. Stakes: Same species as edging, 1-by-2-inch nominal (19-by-38-mm actual) by 18 inches (450 mm) long, with galvanized nails for anchoring edging.
2. Steel Edging: Standard commercial-steel edging, rolled edge, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.
   a. Edging Size: 3/16 inch (4.8 mm) wide by 4 inches (100 mm) deep **OR** 1/4 inch (6.4 mm) wide by 5 inches (125 mm) deep **OR** 1/4 inch (6.4 mm) wide by 4 inches (100 mm) deep **OR** 1/8 inch (3.2 mm) wide by 4 inches (100 mm) deep **OR** 1/8 inch (3.2 mm) wide by 6 inches (150 mm) deep **OR** 0.1 inch (2.5 mm) wide by 4 inches (100 mm) deep, **as directed**.
   b. Stakes: Tapered steel, a minimum of 12 inches (300 mm) **OR** 15 inches (380 mm), **as directed**, long.
   c. Accessories: Standard tapered ends, corners, and splicers.
   d. Finish: Standard paint **OR** Zinc coated **OR** Unfinished, **as directed**.
   e. Paint Color: Black **OR** Green **OR** Brown, **as directed**.
3. Aluminum Edging: Standard-profile extruded-aluminum edging, ASTM B 221 (ASTM B 221M), Alloy 6063-T6, fabricated in standard lengths with interlocking sections with loops stamped from face of sections to receive stakes.
   a. Edging Size: 3/16 inch (4.8 mm) wide by 5-1/2 inches (140 mm) deep **OR** 3/16 inch (4.8 mm) wide by 4 inches (100 mm) deep **OR** 1/8 inch (3.2 mm) wide by 5-1/2 inches (140 mm) deep **OR** 1/8 inch (3.2 mm) wide by 4 inches (100 mm) deep, **as directed**.
   b. Stakes: Aluminum, ASTM B 221 (ASTM B 221M), Alloy 6061-T6, approximately 1-1/2 inches (38 mm) wide by 12 inches (300 mm) long.
   c. Finish: Manufacturer's standard paint **OR** Powder-coat paint **OR** Mill (natural aluminum) **OR** Black anodized, **as directed**.
   d. Paint Color: Black **OR** Green **OR** Brown, **as directed**.

4. Plastic Edging: Standard black polyethylene or vinyl edging, V-lipped bottom **OR** horizontally grooved, **as directed**, extruded in standard lengths, with 9-inch (225-mm) steel angle **OR** plastic, **as directed**, stakes.
   a. Edging Size: 0.1 inch (2.5 mm) wide by 5 inches (125 mm) deep **OR** 0.07 inch (1.8 mm) wide by 5 inches (125 mm) deep, **as directed**.
   b. Top Profile: Straight, with top 2 inches (50 mm) being 1/4 inch (6.4 mm) thick.
   c. Top Profile: Round top, 1/2 inch (13 mm) **OR** 1 inch (25 mm), **as directed**, in diameter.
   d. Accessories: Manufacturer's standard alignment clips or plugs.

K. Tree Grates
1. Tree Grates and Frames: ASTM A 48/A 48M, Class 35 (Class 250) or better, gray-iron castings of shape, pattern, and size indicated.
   OR
   Tree Grates and Frames: ASTM A 48/A 48M, Class 35 (Class 250) or better, gray-iron castings and ASTM A 36/A 36M steel-angle frames of shape, pattern, and size indicated; steel frames hot-dip galvanized.
2. Shape and Size: As indicated **OR** Round, 36 inches (914 mm) in diameter **OR** Round, 72 inches (1828 mm) in diameter **OR** 48 inches (1219 mm) square **OR** 60 inches (1524 mm) square **OR** Rectangular, 36 by 60 inches (914 by 1524 mm) **OR** Rectangular, 48 by 72 inches (1219 by 1828 mm), **as directed**.
3. Finish: As fabricated **OR** Powder-coat finish, **as directed**.
   a. Color: Low-gloss black **OR** dark brown **OR** dark green **OR** dark gray, **as directed**.

L. Miscellaneous Products
1. Wood Pressure-Preservative Treatment: AWPA C2, with waterborne preservative for soil and freshwater use, acceptable to authorities having jurisdiction, and containing no arsenic; including ammoniacal copper arsenate, ammoniacal copper zinc arsenate, and chromated copper arsenate.
2. Root Barrier: Black, molded, modular panels manufactured with 50 percent recycled polyethylene plastic with ultraviolet inhibitors, 85 mils (2.2 mm) thick, with vertical root deflecting ribs protruding 3/4 inch (19 mm) out from panel, and each panel 18 inches (457 mm) **OR** 24 inches (610 mm), **as directed**, wide.
3. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.
4. Burlap: Non-synthetic, biodegradable.
5. Planter Drainage Gravel: Washed, sound crushed stone or gravel complying with ASTM D 448 for Size No. 8.
6. Planter Filter Fabric: Woven **OR** Nonwoven, **as directed**, geotextile manufactured for separation applications and made of polypropylene, polyolefin, or polyester fibers or combination of them.
7. Mycorrhizal Fungi: Dry, granular inoculant containing at least 5300 spores per lb (0.45 kg) of vesicular-arbuscular mycorrhizal fungi and 95 million spores per lb (0.45 kg) of ectomycorrhizal fungi, 33 percent hydrogel, and a maximum of 5.5 percent inert material.

1.3 EXECUTION

A. Preparation
1. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
2. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
3. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.

4. Lay out plants at locations directed by Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.
5. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
   a. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.
6. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

B. Planting Area Establishment
1. Loosen subgrade of planting areas to a minimum depth of 4 inches (100 mm) **OR** 6 inches (150 mm) **OR** 8 inches (200 mm) **OR** 12 inches (300 mm), **as directed**. Remove stones larger than 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off the Owner's property.
   a. Apply superphosphate fertilizer directly to subgrade before loosening.
   b. Thoroughly blend planting soil off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil.
      1) Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
      2) Mix lime with dry soil before mixing fertilizer.
   c. Spread planting soil to a depth of 4 inches (100 mm) **OR** 6 inches (150 mm) **OR** 8 inches (200 mm) **OR** 12 inches (300 mm), **as directed**, but not less than required to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
      1) Spread approximately one-half the thickness of planting soil over loosened subgrade. Mix thoroughly into top 2 inches (50 mm) **OR** 4 inches (100 mm), **as directed**, of subgrade. Spread remainder of planting soil.
2. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.
3. Before planting, obtain the Owner's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.
4. Application of Mycorrhizal Fungi: At time directed by the Owner, broadcast dry product uniformly over prepared soil at application rate indicated on Drawings.

C. Excavation For Trees And Shrubs
1. Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
   a. Excavate approximately three times as wide as ball diameter for balled and burlapped **OR** balled and potted **OR** container-grown **OR** fabric bag-grown, **as directed**, stock.
   b. Excavate at least 12 inches (300 mm) wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
   c. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
   d. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
   e. Maintain required angles of repose of adjacent materials as shown on the Drawings. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
   f. Maintain supervision of excavations during working hours.
   g. Keep excavations covered or otherwise protected overnight **OR** after working hours **OR** when unattended by Installer's personnel, **as directed**.

h. If drain tile is shown on Drawings or required under planting areas, excavate to top of porous backfill over tile.

2. Subsoil and topsoil removed from excavations may **OR** may not, **as directed**, be used as planting soil.
3. Obstructions: Notify the Owner if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
   a. Hardpan Layer: Drill 6-inch- (150-mm-) diameter holes, 24 inches (600 mm) apart, into free-draining strata or to a depth of 10 feet (3 m), whichever is less, and backfill with free-draining material.
4. Drainage: Notify the Owner if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.
5. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

D. Tree, Shrub, And Vine Planting

1. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
2. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
3. Set balled and burlapped stock plumb and in center of planting pit or trench with root flare 1 inch (25 mm) above **OR** 2 inches (50 mm) above, **as directed**, adjacent finish grades.
   a. Use planting soil for backfill.
   b. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
   c. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
   d. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.
   e. Continue backfilling process. Water again after placing and tamping final layer of soil.
4. Set balled and potted **OR** container-grown, **as directed**, stock plumb and in center of planting pit or trench with root flare 1 inch (25 mm) above **OR** 2 inches (50 mm) above, **as directed**, adjacent finish grades.
   a. Use planting soil for backfill.
   b. Carefully remove root ball from container without damaging root ball or plant.
   c. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
   d. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.
   e. Continue backfilling process. Water again after placing and tamping final layer of soil.
5. Set fabric bag-grown stock plumb and in center of planting pit or trench with root flare 1 inch (25 mm) above **OR** 2 inches (50 mm) above, **as directed**, adjacent finish grades.
   a. Use planting soil for backfill.
   b. Carefully remove root ball from fabric bag without damaging root ball or plant. Do not use planting stock if root ball is cracked or broken before or during planting operation.
   c. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.

d. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.
e. Continue backfilling process. Water again after placing and tamping final layer of soil.
f. Set and support bare-root stock in center of planting pit or trench with root flare 1 inch (25 mm) above **OR** 2 inches (50 mm) above, **as directed**, adjacent finish grade.

6. Use planting soil for backfill.
   a. Spread roots without tangling or turning toward surface, and carefully work backfill around roots by hand. Puddle with water until backfill layers are completely saturated. Plumb before backfilling, and maintain plumb while working backfill around roots and placing layers above roots.
   b. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside soil-covered roots about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole or touching the roots.
   c. Continue backfilling process. Water again after placing and tamping final layer of soil.
7. When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

E. Mechanized Tree Spade Planting
1. Trees shall **OR** may, **as directed**, be planted with an approved mechanized tree spade at the designated locations. Do not use tree spade to move trees larger than the maximum size allowed for a similar field-grown, balled-and-burlapped root-ball diameter according to ANSI Z60.1, or larger than the manufacturer's maximum size recommendation for the tree spade being used, whichever is smaller.
2. When extracting the tree, center the trunk within the tree spade and move tree with a solid ball of earth.
3. Cut exposed roots cleanly during transplanting operations.
4. Use the same tree spade to excavate the planting hole as was used to extract and transport the tree.
5. Plant trees as shown on Drawings, following procedures in "Tree, Shrub, and Vine Planting" Article.
6. Where possible, orient the tree in the same direction as in its original location.

F. Tree, Shrub, And Vine Pruning
1. Remove only dead, dying, or broken branches. Do not prune for shape.
2. Prune, thin, and shape trees, shrubs, and vines as directed by Architect.
3. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.
4. Do not apply pruning paint to wounds.

G. Tree Stabilization
1. Install trunk stabilization as follows unless otherwise indicated:
   a. Upright Staking and Tying: Stake trees of 2- through 5-inch (50- through 125-mm) caliper. Stake trees of less than 2-inch (50-mm) caliper only as required to prevent wind tip out. Use a minimum of two stakes of length required to penetrate at least 18 inches (450 mm) below bottom of backfilled excavation and to extend to the dimension shown on Drawings **OR** at least 72 inches (1830 mm) **OR** one-third of trunk height, **as directed**, above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
   b. Use two stakes for trees up to 12 feet (3.6 m) high and 2-1/2 inches (63 mm) or less in caliper; three stakes for trees less than 14 feet (4.2 m) high and up to 4 inches (100 mm) in caliper. Space stakes equally around trees.

c. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
OR
Support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

2. Staking and Guying: Stake and guy trees more than 14 feet (4.2 m) in height and more than 3 inches (75 mm) in caliper unless otherwise indicated. Securely attach no fewer than three guys to stakes 30 inches (760 mm) long, driven to grade.
   a. Site-Fabricated Staking-and-Guying Method:
      1) For trees more than 6 inches (150 mm) in caliper, anchor guys to wood deadmen buried at least 36 inches (900 mm) below grade. Provide turnbuckle **OR** compression spring, **as directed**, for each guy wire and tighten securely.
      2) Support trees with bands of flexible ties at contact points with tree trunk and reaching to turnbuckle **OR** compression spring, **as directed**. Allow enough slack to avoid rigid restraint of tree.
      3) Support trees with strands of cable or multiple strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk and reaching to turnbuckle **OR** compression spring, **as directed**. Allow enough slack to avoid rigid restraint of tree.
      4) Attach flags to each guy wire, 30 inches (760 mm) above finish grade.
      OR
      Paint turnbuckles **OR** compression springs, **as directed**, with luminescent white paint.
   b. Proprietary Staking and Guying Device: Install staking and guying system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.
3. Root-Ball Stabilization: Install at- or below-grade stabilization system to secure each new planting by the root ball unless otherwise indicated.
   a. Wood Hold-Down Method: Place vertical stakes against side of root ball and drive them into subsoil; place horizontal wood hold-down stake across top of root ball and screw at each end to one of the vertical stakes.
      1) Install stakes of length required to penetrate at least to the dimension shown on Drawings **OR** 18 inches (450 mm), **as directed**, below bottom of backfilled excavation. Saw stakes off at horizontal stake.
      2) Install screws through horizontal hold-down and penetrating at least 1 inch (25 mm) into stakes. Predrill holes if necessary to prevent splitting wood.
      3) Install second set of stakes on other side of root trunk for larger trees as indicated.
   b. Proprietary Root-Ball Stabilization Device: Install root-ball stabilization system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.
4. Palm Bracing: Install bracing system at three or more places equally spaced around perimeter of trunk to secure each palm until established unless otherwise indicated.
   a. Site-Fabricated Palm-Bracing Method:
      1) Place battens over padding and secure battens in place around trunk perimeter with at least two straps, tightened to prevent displacement. Ensure that straps do not contact trunk.
      2) Place diagonal braces and cut to length. Secure upper ends of diagonal braces with galvanized nails into battens or into nail-attached blocks on battens. Do not drive nails, screws, or other securing devices into palm trunk; do not penetrate palm trunk in any fashion. Secure lower ends of diagonal braces with stakes driven into ground to prevent outward slippage of braces.
   b. Proprietary Palm-Bracing Device: Install palm-bracing system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

H. Root-Barrier Installation
1. Install root barrier where trees are planted within 60 inches (1500 mm) **OR** 48 inches (1200 mm), **as directed**, of paving or other hardscape elements, such as walls, curbs, and walkways unless otherwise shown on Drawings.
2. Align root barrier vertically **OR** with bottom edge angled at 20 degrees away from the paving or other hardscape element, **as directed**, and run it linearly along and adjacent to the paving or other hardscape elements to be protected from invasive roots.
3. Install root barrier continuously for a distance of 60 inches (1500 mm) in each direction from the tree trunk, for a total distance of 10 feet (3 m) per tree. If trees are spaced closer, use a single continuous piece of root barrier.
   a. Position top of root barrier flush with finish grade **OR** 1/2 inch (13 mm) above finish grade **OR** per manufacturer's recommendations, **as directed**.
   b. Overlap root barrier a minimum of 12 inches (300 mm) at joints.
   c. Do not distort or bend root barrier during construction activities.
   d. Do not install root barrier surrounding the root ball of tree.

I. Planting In Planters
1. Place a layer of drainage gravel at least 4 inches (100 mm) thick in bottom of planter. Cover bottom with filter fabric and wrap filter fabric 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, up on all sides. Duct tape along the entire top edge of the filter fabric, to secure the filter fabric against the sides during the soil-filling process.
2. Fill planter with lightweight on-structure planting soil. Place soil in lightly compacted layers to an elevation of 1-1/2 inches (38 mm) below top of planter, allowing natural settlement.

J. Ground Cover And Plant Planting
1. Set out and space ground cover and plants other than trees, shrubs, and vines 9 inches (225 mm) apart **OR** 12 inches (300 mm) apart **OR** 18 inches (450 mm) apart **OR** 24 inches (600 mm) apart **OR** as indicated, **as directed**, in even rows with triangular spacing.
2. Use planting soil for backfill.
3. Dig holes large enough to allow spreading of roots.
4. For rooted cutting plants supplied in flats, plant each in a manner that will minimally disturb the root system but to a depth not less than two nodes.
5. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
6. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
7. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

K. Planting Area Mulching
1. Install weed-control barriers before mulching according to manufacturer's written instructions. Completely cover area to be mulched, overlapping edges a minimum of 6 inches (150 mm) **OR** 12 inches (300mm), **as directed**, and secure seams with galvanized pins.
2. Mulch backfilled surfaces of planting areas and other areas indicated.
   a. Trees and Tree-like Shrubs in Turf Areas: Apply organic **OR** mineral, **as directed**, mulch ring of 2-inch (50-mm) **OR** 3-inch (75-mm), **as directed**, average thickness, with 12-inch (300-mm) **OR** 24-inch (600-mm) **OR** 36-inch (900-mm), **as directed**, radius around trunks or stems. Do not place mulch within 3 inches (75 mm) **OR** 6 inches (150 mm), **as directed**, of trunks or stems.
   b. Organic Mulch in Planting Areas: Apply 2-inch (50-mm) **OR** 3-inch (75-mm), **as directed**, average thickness of organic mulch extending 12 inches (300 mm) beyond edge of individual planting pit or trench and over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches (75 mm) **OR** 6 inches (150 mm), **as directed**, of trunks or stems.
   c. Mineral Mulch in Planting Areas: Apply 2-inch (50-mm) **OR** 3-inch (75-mm), **as directed**, average thickness of mineral mulch extending 12 inches (300 mm) beyond edge of individual planting pit or trench and over whole surface of planting area, and finish level

with adjacent finish grades. Do not place mulch within 3 inches (75 mm) **OR** 6 inches (150 mm), **as directed**, of trunks or stems.

L. Edging Installation
1. Wood Edging: Install edging where indicated. Mitre cut joints and connections at a 45 degree angle. Fasten each cut joint or connection with two galvanized nails. Anchor with wood stakes spaced up to 36 inches (900 mm) apart, driven at least 1 inch (25 mm) below top elevation of edging. Use two galvanized nails per stake to fasten edging, of length as needed to penetrate both edging and stake and provide 1/2-inch (13-mm) clinch at point. Predrill stakes if needed to avoid splitting. Replace stakes that crack or split during installation process.
2. Steel Edging: Install steel edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 30 inches (760 mm) apart, driven below top elevation of edging.
3. Aluminum Edging: Install aluminum edging where indicated according to manufacturer's written instructions. Anchor with aluminum stakes spaced approximately 36 inches (900 mm) **OR** 48 inches (1200 mm), **as directed**, apart, driven below top elevation of edging.
4. Plastic Edging: Install plastic edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 36 inches (900 mm) **OR** 48 inches (1200 mm), **as directed**, apart, driven through upper base grooves or V-lip of edging.
5. Shovel-Cut Edging: Separate mulched areas from turf areas, curbs, and paving with a 45-degree, 4- to 6-inch- (100- to 150-mm-) deep, shovel-cut edge as shown on Drawings.

M. Tree Grate Installation
1. Tree Grates: Set grate segments flush with adjoining surfaces as shown on Drawings. Shim from supporting substrate with soil-resistant plastic. Maintain a 3-inch- (75-mm-) minimum growth radius around base of tree; break away units of casting, if necessary, according to manufacturer's written instructions.

N. Plant Maintenance
1. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.
2. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
3. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated past management practices whenever possible to minimize the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

O. Pesticide Application
1. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with the Owner's operations and others in proximity to the Work. Notify the Owner before each application is performed.
2. Pre-Emergent Herbicides (Selective and Non-Selective): Apply to tree, shrub, and ground-cover areas in accordance with manufacturer's written recommendations. Do not apply to seeded areas.
3. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

P. Cleanup And Protection
1. During planting, keep adjacent paving and construction clean and work area in an orderly condition.

2. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
3. After installation and before Final Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

Q. Disposal
1. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off the Owner's property.

END OF SECTION 32 14 09 00

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SECTION 32 14 11 00 - ASPHALT CONCRETE SIDEWALKS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of asphalt concrete sidewalks. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Asphaltic Concrete:
   1. Hot-Mixed, Hot-Laid Bituminous Paving Mixtures: ASTM D 3515.
   2. Plant-Mixed, Stockpiled Asphalt Cold Mixes: Asphalt Institute Manual MS-l4.

B. Bituminous Prime: ASTM D 2027, Grades MC-30 or MC-70; ASTM D 2028, Grade RC-70; or ASTM D 2026, Grade SC-70.

C. Base Course: ASTM D 2940.

D. Bituminous Tack Coat: ASTM D 977, Grades RS-1, MS-1 or SS-1h; ASTM D 2027, Grade MC-30; ASTM D 2028, Grade RC-70; ASTM D 2026, Grade SC-70; or ASTM D 2397, Grades CRS-1 or CSS-1.

E. Seal Coat: ASTM D 2027, Grade HC-250 or MC-800; or D 2028, Grade RC-250 or RC-800.

F. Slurry Coat Mixture shall be comprised of 70 percent sand or fine aggregate, 10 percent water, and 20 percent liquid or emulsified asphalt.
   1. Fine Aggregate: ASTM D 1073, Grade 2.
   2. Emulsified Asphalt: ASTM D 977, Grades SS-1 or SS-1h.

1.3 EXECUTION

A. Application Temperatures: Application temperatures for all asphalt materials shall comply with provisions of the Asphalt Institute publications and the applicable ASTM standards.

B. Subgrade: Construct the subgrade for walkway replacement true to grade and compact as required.

C. Base Course
   1. Placing: Spread the base course material evenly upon the prepared subgrade, in a layer of such depth that when compacted the layer will be uniform and of the thickness required.
   2. Compaction: Immediately following the spreading of the material, compact the base course with equipment to a density as required.

D. Surface Course
   1. Placing: Apply prime coat, and allow it to cure. The placing of the mixture shall be continuous. Paint all contact surfaces of previously constructed sidewalk with a tack coat of rapid-setting liquid asphalt just before the fresh mixture is placed.

2. Forms: Set forms with the upper edge true to line and hold grade rigidly in place by stakes placed on the outside of the forms and set flush with the top edge of the forms.
3. Compaction: Immediately following the placement of the asphalt concrete mixture, compact the surface course with equipment to a density as required.
4. Backfilling: After removing the forms and debris, backfill the exposed or excavated area adjoining the sidewalk with granular material, grade, and compact to conform to the surrounding area.

E. Patching
1. For Repair Operations Involving Raveling, Heaving, Spalling, and Alligatoring: Cut asphalt concrete paving back to solid material, making cut area rectangular with vertical sides. Remove deteriorated pavement including base material if required. Replace base course, compact, and tack coat the base material and the vertical surfaces of cut area. Fill area with new asphalt concrete and compact level with existing walkway. Dust patched area with sand or mineral dust.
2. Pothole Repair: Cut rectangular hole around pothole back to solid pavement leaving straight, vertical edges. Remove loose material and water to firm base. Fill holes and compact to within 3 inches of the surface in layers not exceeding 6 inches with either base material or asphalt mixture. Apply tack coat to base material and vertical edges. On the surface layer, fill with asphalt mixture and mound to such height that when compacted the mix will be level with surrounding walkway surface. Dust patched area with sand or mineral dust.
3. Low Spot or Depression Repair: Determine limits of depression with straightedge, and mark outline with crayon. Apply tack coat, 0.05 to 0.15 gallon per square yard, to the cleaned area, and allow to cure. Spread area with asphalt concrete mix and feather edge by raking and manipulation of the material. Roll and compact area to surrounding walkway level. Recheck with straightedge. Apply a sand seal to the patched area to prevent entrance of water.
4. Polished Aggregate Repair: Clean and dry area thoroughly. Apply tack coat at a rate of 0.05 to 0.15 gallon per square yard; overlay area with new asphalt concrete mix to a minimum 1-1/2 inch thickness and feather to adjoining walkway surfaces. Roll with pneumatic or steel rollers.
5. Damaged Edging Repair: Remove damaged or deteriorated edging materials and replace.
6. Prime Coat: Prime new base course with MC-70 liquid asphalt at a rate of 0.20 to 0.30 gallon per square yard. Take care to apply to more asphalt than will penetrate into the base course during curing. Blot excess prime with sand before the surfacing material is applied.
7. Tack Coat: Surfaces and cut edges of existing asphalt concrete shall be given a tack coat of MC-70 liquid asphalt at a rate of 0.05 to 0.15 gallon per square yard. After application of the tack coat, allow time for the material to cure before surfacing and patching material is placed.
8. Seal Coat Spray Application: Walkway surfaces that are to be sealed shall receive a liquid asphalt coat applied at a rate of 0.15 to 0.20 gallon per square yard, along with a fine aggregate at a rate of 15 to 20 pounds per square yard.

F. Crack Repair: Fill cracks after drying with liquid asphalt, sand asphalt emulsion water mixture, or slurry seal. After thorough cleaning, work the mixture into cracks by broom or squeegee. Cracks 1/8 to 1/2 inch width shall be slurry sealed and filled with liquid asphalt. Dust repaired cracks with fine aggregate or mineral dust to prevent cracking. Final thickness of the slurry seal shall be 1/8 inch minimum.

END OF SECTION 32 14 11 00

SECTION 32 14 11 00a - MISCELLANEOUS SIDEWALKS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of miscellaneous sidewalks. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Aggregate shall comply with the following:
   1. Surface Course Aggregates shall be well-graded, crushed stone, 3/4- to 1-1/4 inch size, consisting of clean, sound, durable particles.
   2. Masonry Grout Aggregate: ASTM C 404, Size 2.

B. Base Course: Base course material shall be a granular dense-graded, high-quality compactable material.

C. Ready-Mixed Concrete: Ready-mixed concrete shall comply with ASTM C 94. The concrete shall attain a minimum compressive strength of 3,000 psi at 28 days.

D. Portland Cement Concrete: Cement shall comply with ASTM C 150.

E. Joint Filler: Masonry joint filler shall be Portland cement concrete mix with cement complying with ASTM C 150.

F. Masonry Units: Color and texture shall match the existing as nearly as is practicable.

G. Wood and Preservatives: Footboards and supports shall be 1-1/2 inch thick Number 1 dense Douglas fir or yellow pine lumber, pressure-treated with chromated copper arsenate (CCA) preservative complying with applicable ASTM Standards. Retention shall be a minimum of 0.25 pounds per cubic foot.

1.3 EXECUTION

A. Base Course Repair: Remove material in soft spots to such depth required to provide a firm foundation for surface materials and fill with granular material of a quality that will compact when moistened. Roll or tamp this material to obtain the proper density.

B. Surface Repair
   1. Aggregate Walkways: Spread the surface material evenly on the base course in a layer of such depth that when compacted, the layer will be uniform with a minimum thickness of 4 inches.
   2. Joint Filling: Completely remove and clean the joint of all loose joint material, dirt, clay, or other foreign matter. Fill the joint flush with concrete to provide a uniform surface.
   3. Wood Walkways: Secure wood members with galvanized nails, screws, bolts, or other approved fasteners to ensure tight joints.

4. Masonry Walkways: New or salvaged masonry units will be placed on a 3/4-inch mortar setting bed with mortar joints matching the existing walkway. Place the setting bed on a fresh 3-inch thick Portland cement concrete slab.

END OF SECTION 32 14 11 00a

SECTION 32 14 11 00b - PRECAST SIDEWALKS AND PAVERS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of precast sidewalks and pavers. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. Product Data: For each type of product indicated.
      a. For stone varieties proposed for use on Project, include data on physical properties specified or required by referenced ASTM standards.
   2. Stone Samples: For each color, grade, finish, and variety of stone required.

1.2 PRODUCTS

A. Precast Concrete Patio Blocks: ASTM C 936. Natural or colored, minimum 2 inches thick.

B. Exposed Aggregate or Granite: ASTM C 615 and National Building Granite Quarries Association, Inc.
   1. Exposed Limestone: Limestone (Oolitic), ASTM C 568, Category II.
   2. Exposed White Tumblestone Aggregate: As required to meet project requirements.

C. Stone Pavers
   1. Bluestone Flagging Paver: Irregular cut, 1 inch thick.
   2. White Marble, Crushed Stone: ASTM C 503 and Marble Institute of America (MIA), 3 inches thick.
   3. Bluestone, Crushed Stone: 3 inches thick.
   4. Natural Cleft Slate: ASTM C 629, 3/4-inch irregular cut, 1/2-inch random rectangular cut, or 1/4-inch random rectangular butted joints.

D. Granite Blocks: Blocks shall be 3 to 5 inches thick and comply with requirements of ASTM C 615 and National Building Granite Quarries Association, Inc. Sizes shall be 3-1/2 inches square; 4 to 12 inches by 3 to 5 inches; and 6 to 15 inches by 3 to 6 inches.

E. Mortar and Grout
   1. Portland Cement: ASTM C 150 and the staining requirements of ASTM C 91.
   2. Masonry Cement: ASTM C 91, non-staining.
   3. Hydrated Lime: ASTM C 207, Type S.
   4. Sand: ASTM C 144.
      a. White Pointing Mortar: Natural white sand or ground white stone.
      b. Colored Pointing Mortar: Marble, granite, or sound stone.

1.3 EXECUTION

A. Preparation
   1. Clean stone or concrete block with clear water.
   2. Ferrous Metal: Apply a heavy coat of bituminous paint on metal surfaces in contact with block.

B. Installation
   1. Expansion Joints: Install continuous strips of preformed joint filler.

2. Clean sub-base and saturate with clean water.
3. Slush Coat: Apply 1/16-in. thick slush coat of cement grout over concrete sub-base about 15 minutes prior to placing setting bed.
4. Setting Bed: Mix one 94-lb. bag of cement to 3 cu. ft. of sand. Use only enough water to produce a moist surface when setting bed is ready for setting of stone. Spread and screed to a uniform thickness.
5. Set stone or concrete block before initial set of cement bed occurs. Wet stone or block thoroughly before setting. Apply a thin layer of neat cement paste 1/32-in. to 1/l6-in. thick to setting bed, or bottom of stone or block.
6. Grout joints as soon as possible after initial set of setting bed and tool slightly concave. Use grout mix of one bag Portland cement to 2 cu. ft. sand. Cure grout by maintaining in a moist condition for 7 days. Do not permit traffic on surface during setting of units or for at least 24 hours after final grouting of joints.

END OF SECTION 32 14 11 00b

Task	Specification	Specification Description
32 14 11 00	31 25 14 23	Unit Pavers
32 14 13 19	03 31 13 00	Cement Concrete Pavement
32 14 16 00	32 14 11 00	Asphalt Concrete Sidewalks
32 14 16 00	32 14 11 00a	Miscellaneous Sidewalks
32 14 16 00	32 14 11 00b	Precast Sidewalks And Pavers
32 14 16 00	31 25 14 23	Unit Pavers

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SECTION 32 14 33 13 - POROUS UNIT PAVING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for porous unit paving. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Porous paving consisting of concrete pavers set in aggregate setting beds.
   b. Edge restraints.
   c. Cast-in-place concrete edge restraints.
   d. Precast concrete curbs.
   e. Granite curbs.

C. Submittals
1. Product Data: For materials other than aggregates.
2. Sieve Analyses: For aggregate materials, according to ASTM C 136.
3. Samples:
   a. Full-size units of each type of unit paver indicated.
   b. Exposed edge restraints.
   c. Precast concrete curbs.
   d. Granite curbs.
   e. Aggregate fill.
4. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.

D. Quality Assurance
1. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
1. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
2. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

1.2 PRODUCTS

A. Concrete Unit Pavers
1. Concrete Grid Pavers: Grid paving units complying with ASTM C 1319, made from normal-weight aggregates.
2. Solid Concrete Pavers for Porous Paving: Solid interlocking paving units of shapes that provide openings between units, complying with ASTM C 936, resistant to freezing and thawing when tested according to ASTM C 67, **as directed**, and made from normal-weight aggregates.
   a. Thickness: 2-3/8 inches (60 mm) **OR** 3-1/8 inches (80 mm) **OR** 3-1/2 inches (90 mm) **OR** 4 inches (100 mm), **as directed**.
   b. Face Size and Shape: As indicated.
   c. Color: As indicated by manufacturer's designations **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.

B. Accessories
1. Plastic Edge Restraints: Triangular PVC extrusions, 1-3/4 inches (45 mm) high by 3-1/2 inches (90mm) wide **OR** 3-1/8 inches (80 mm) high by 9-1/2 inches (240 mm) wide, **as directed**, designed to serve as edge restraints for unit pavers; rigid type for straight edges and flexible type for curved edges, with pipe connectors and 3/8-inch- (9.5-mm-) diameter by 12-inch- (300-mm-) long steel spikes.
2. Steel Edge Restraints: Painted steel edging, 3/16 inch (4.8 mm) thick by 4 inches (100 mm) high **OR** 1/4 inch (6.4 mm) thick by 5 inches (125 mm) high, **as directed**, with loops pressed from or welded to face to receive stakes at 36 inches (900 mm) o.c., and with steel stakes 15 inches (380 mm) long for each loop.
   a. Color: As indicated by manufacturer's designations **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.
3. Aluminum Edge Restraints: Straight, 1/8-inch- (3.2-mm-) thick by 4-inch- (100-mm-) high **OR** Straight, 3/16-inch- (4.8-mm-) thick by 4-inch- (100-mm-) high **OR** L-shaped, 1/8-inch- (3.2-mm-) thick by 1-3/8-inch- (35-mm-) high **OR** L-shaped, 3/16-inch- (4.8-mm-) thick by 2-1/4-inch- (57-mm-) high, **as directed**, extruded-aluminum edging, with loops pressed from face to receive stakes at 12 inches (300 mm) o.c., and with aluminum stakes 12 inches (300 mm) long for each loop.
4. Precast Concrete Curbs: Made from normal-weight concrete with a compressive strength not less than 5000 psi (35 MPa) **OR** 6000 psi (41 MPa), **as directed**, and water absorption not more than 5 percent, in shapes and sizes indicated.
   a. Color and Texture: As indicated by manufacturer's designations **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.
5. Granite Curbs: Granite curbing, with face battered 1 inch per foot (1:12), produced in random lengths not less than 36 inches (900 mm) from granite complying with ASTM C 615.
   a. Granite Color and Grain: Light gray **OR** Dark gray **OR** Buff **OR** White **OR** Black **OR** Pink, **as directed**, with fine **OR** medium **OR** coarse, **as directed**, grain.
   b. Top Width: 4 inches (100 mm) **OR** 5 inches (125 mm) **OR** 6 inches (150 mm), **as directed**.
   c. Face Height: 4 inches (100 mm) **OR** 6 inches (150 mm) **OR** 8 inches (200 mm), **as directed**.
   d. Total Height: 12 inches (300 mm) **OR** 16 inches (400 mm) **OR** 18 inches (450 mm), **as directed**.
   e. Top Finish: Sawed **OR** Thermal **OR** Bushhammered, **as directed**.
   f. Face Finish: Split **OR** Sawed **OR** Thermal **OR** Bushhammered, **as directed**.

C. Aggregate Setting-Bed Materials
1. Graded Aggregate for Subbase: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 57 **OR** ASTM D 448 for Size No. 5 **OR** ASTM D 2940, subbase material **OR** requirements in Division 31 Section "Earth Moving" for subbase material, **as directed**.
2. Graded Aggregate for Base Course: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 8 **OR** ASTM D 448 for Size No. 57 **OR** ASTM D 2940, base-course material **OR** requirements in Division 31 Section "Earth Moving" for base-course material, **as directed**.
3. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate.
4. Soil Mix for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate blended with planting soil mix complying with requirements in Division 32 Section(s) "Turf And Grasses" OR "Plants", **as directed**. Use blend consisting of 1/2 sand and 1/2 soil mix **OR** 2/3 sand and 1/3 soil mix, **as directed**.
5. Graded Aggregate for Leveling Course: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 8 **OR** 9, **as directed**.
6. Soil for Porous Paver Fill: Planting soil mix complying with requirements in Division 32 Section(s) "Turf And Grasses" OR "Plants", **as directed**.

7. Graded Aggregate for Porous Paver Fill: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 8 **OR** 9, **as directed**.
   a. Provide stone of color indicated **OR** to match the Owner's sample, **as directed**.
8. Grass Seed: Comply with requirements in Division 32 Section "Turf And Grasses".
9. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications; made from polyolefins or polyesters, with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
   a. Survivability: Class 2; AASHTO M 288.
   b. Apparent Opening Size: No. 60 (0.250-mm) sieve, maximum; ASTM D 4751.
   c. Permittivity: 0.02 per second, minimum; ASTM D 4491.
   d. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.
10. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
   a. Survivability: Class 2; AASHTO M 288.
   b. Apparent Opening Size: No. 40 (0.425-mm) sieve, maximum; ASTM D 4751.
   c. Permittivity: 0.5 per second, minimum; ASTM D 4491.
   d. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

1.3 EXECUTION

A. Preparation
1. Proof-roll prepared subgrade according to requirements in Division 31 Section "Earth Moving" to identify soft pockets and areas of excess yielding. Proceed with porous paver installation only after deficient subgrades have been corrected and are ready to receive subbase and base **OR** base, **as directed**, course for porous paving.

B. Installation, General
1. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be structurally unsound or visible in finished work.
2. Cut unit pavers with motor-driven masonry saw equipment or a block splitter, **as directed**, to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
3. Tolerances:
   a. Variation in Plane between Adjacent Units (Lipping): Do not exceed 1/16-inch (1.5-mm) unit-to-unit offset from flush.
   b. Variation from Level or Indicated Slope: Do not exceed 1/8 inch in 24 inches (3 mm in 600 mm) and 1/4 inch in 10 feet (6 mm in 3 m) or a maximum of 1/2 inch (13 mm).
4. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.
   a. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after porous paver installation.
   b. For metal edge restraints with top edge exposed, drive stakes at least 1 inch (25 mm) below top edge.
   c. Install job-built concrete edge restraints to comply with requirements in Division 32 Section "Concrete Paving".
5. Provide curbs as indicated. Install curbs before placing unit pavers.
   a. Install precast concrete **OR** granite, **as directed**, curbs on a bedding of compacted base-course material over compacted subgrade. Install curbs before placing base course for pavers. Set curbs at elevations indicated, accurately aligned, and place and compact base-course material behind curbs as indicated.
   b. Install precast concrete curbs on aggregate base course after placing and compacting base course for pavers. Set curbs with top edge 1 inch (25 mm) below top of pavers. Anchor curbs with metal stakes driven through holes in curbs into base-course material.

c. Install precast concrete curbs on aggregate-base course after placing and compacting base course for pavers. Set curbs with top surface 1/2 inch (13 mm) **OR** 2 inches (50 mm) **OR** 4 inches (100 mm), **as directed**, above top of pavers. Anchor curbs with metal stakes driven behind curbs into base-course material.

C. Setting-Bed Installation

1. Compact soil subgrade uniformly to at least 95 percent of ASTM D 698 **OR** ASTM D 1557, **as directed**, laboratory density.
2. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by the Owner, and replace with compacted backfill or fill as directed.
3. Place separation **OR** drainage, **as directed**, geotextile over prepared subgrade, overlapping ends and edges at least 12 inches (300 mm).
4. For light-traffic uses, place aggregate subbase **OR** subbase and base, **as directed**, compact by tamping with plate vibrator, and screed to depth indicated.
5. For heavy-duty applications, place aggregate subbase **OR** subbase and base, **as directed**, compact to 100 percent of ASTM D 1557 maximum laboratory density, and screed to depth indicated.
6. Place drainage geotextile over compacted subbase, overlapping ends and edges at least 12 inches (300 mm).
7. Place drainage geotextile over compacted base course, overlapping ends and edges at least 12 inches (300 mm).
8. Place leveling course and screed to a thickness of 1 to 1-1/2 inches (25 to 38 mm) **OR** 2 to 2-1/2 inches (50 to 64 mm) **OR** 3 inches (76 mm), **as directed**, taking care that moisture content remains constant and density is loose and constant until pavers are set and compacted.

D. Paver Installation

1. Set unit pavers on leveling course, being careful not to disturb leveling base. If pavers have lugs or spacer bars to control spacing, place pavers hand tight against lugs or spacer bars. If pavers do not have lugs or spacer bars, place pavers with a 1/16-inch- (1.6-mm-) minimum and 1/8-inch- (3.2-mm-) maximum joint width. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8 inch (10 mm) with pieces cut to fit from full-size pavers.
    a. When installation is performed with mechanical equipment, use only unit pavers with lugs or spacer bars on sides of each unit.
2. Compact pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf (16- to 22-kN) compaction force at 80 to 90 Hz. Use vibrator with neoprene mat on face of plate or other means as needed to prevent cracking and chipping of pavers. Perform at least three passes across paving with vibrator.
    a. Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least 36 inches (900 mm) of uncompacted pavers adjacent to temporary edges.
    b. Before ending each day's work, compact installed concrete pavers except for 36-inch (900 mm) width of uncompacted pavers adjacent to temporary edges (laying faces).
    c. As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within 36 inches (90 mm) of laying face.
    d. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and leveling course on which pavers have not been placed with nonstaining plastic sheets to protect them from rain.
3. Place soil fill as follows, immediately after vibrating pavers into leveling course. Spread and screed soil fill level with tops of pavers. Vibrate pavers and add soil fill until porous paving is filled to about 3/4 inch (19 mm) from top surface; remove excess soil fill if any.
    a. Before ending each day's work, place soil fill in installed porous paving except for 42-inch (1067-mm) width of unfilled paving adjacent to temporary edges (laying faces).
    b. As work progresses to perimeter of installation, place soil fill in installed paving that is adjacent to permanent edges unless it is within 42 inches (1067 mm) of laying face.

c. Before ending each day's work and when rain interrupts work, cover paving that has not been filled with nonstaining plastic sheets to protect it from rain.

4. After filling pavers with soil, sow seed to comply with requirements in Division 32 Section "Turf And Grasses". except sow seed at half the rate specified for seeding lawns. Sweep seed from surfaces of pavers into voids and water with fine spray.
   a. Within 24 hours after sowing seed, spread an additional 3/16 inch (4.8 mm) of soil fill over seed and soak with water.
5. Place graded aggregate fill immediately after vibrating pavers into leveling course. Spread and screed aggregate fill level with tops of pavers.
   a. Before ending each day's work, place aggregate fill in installed porous paving except for 42-inch (1067-mm) width of unfilled paving adjacent to temporary edges (laying faces).
   b. As work progresses to perimeter of installation, place aggregate fill in installed paving that is adjacent to permanent edges unless it is within 42 inches (1067 mm) of laying face.
   c. Before ending each day's work and when rain interrupts work, cover paving that has not been filled with nonstaining plastic sheets to protect it from rain.
6. Remove and replace pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

E. Maintenance And Protection
   1. Water newly planted grass and keep moist until grass is established. Maintain grass that is planted in paving to comply with requirements in Division 32 Section "Turf And Grasses".
   2. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades for 60 days after planting.

END OF SECTION 32 14 33 13

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Task	Specification	Specification Description
32 14 33 13	10 14 00 00	Vitrified Brick Pavement Replacement
32 15 40 00	32 11 16 16	Crushed Stone Paving
32 15 40 00	32 11 16 16a	Crushed Stone
32 15 40 00	32 11 16 16b	Select Gravel
32 16 13 13	03 31 13 00	Cement Concrete Pavement
32 16 13 13	32 01 16 71a	Steel Curbs
32 16 13 14	03 31 13 00	Cement Concrete Pavement
32 16 13 14	32 01 16 71a	Steel Curbs
32 16 13 16	03 31 13 00	Cement Concrete Pavement
32 16 13 16	32 01 16 71a	Steel Curbs
32 16 13 19	03 31 13 00	Cement Concrete Pavement
32 16 13 23	03 31 13 00	Cement Concrete Pavement
32 16 13 23	32 01 16 71a	Steel Curbs
32 16 13 33	03 31 13 00	Cement Concrete Pavement
32 16 13 33	32 01 16 71a	Steel Curbs
32 16 13 43	03 31 13 00	Cement Concrete Pavement
32 16 13 43	32 14 33 13	Porous Unit Paving
32 16 23 00	01 22 16 00	No Specification Required
32 16 23 00	32 14 11 00	Asphalt Concrete Sidewalks
32 16 23 00	32 14 11 00a	Miscellaneous Sidewalks
32 16 23 00	32 14 11 00b	Precast Sidewalks And Pavers
32 16 23 00	31 25 14 23	Unit Pavers
32 16 43 00	32 01 13 61	Asphalt Paving
32 17 13 23	11 12 16 00	Parking Control Equipment
32 17 13 23	11 12 16 00a	Prefabricated Control Booths
32 17 13 26	11 12 16 00	Parking Control Equipment
32 17 13 26	11 12 16 00a	Prefabricated Control Booths
32 17 16 00	32 01 13 61	Asphalt Paving
32 17 16 00	23 05 66 00	Interlocking Resilient Flooring
32 17 23 13	32 01 13 61	Asphalt Paving
32 17 23 13	03 31 13 00	Cement Concrete Pavement
32 17 23 13	32 01 11 53	Traffic Coatings
32 17 23 23	32 01 13 61	Asphalt Paving
32 17 23 23	03 31 13 00	Cement Concrete Pavement
32 17 23 23	32 01 11 53	Traffic Coatings
32 17 23 33	32 01 13 61	Asphalt Paving
32 17 23 33	03 31 13 00	Cement Concrete Pavement
32 17 23 33	32 01 11 53	Traffic Coatings

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SECTION 32 17 26 00 - TACTILE/DETECTABLE WARNING TILE

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for tactile/detectable warning tile. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals

1. Product data for each specified product.
2. Shop drawings, showing detailed plans of tile profile, fastener locations, and installation methods
3. Two (2) tile samples, minimum size 6” x 8” of the kind proposed for use.
4. Material Test Reports: Submit test reports from qualified independent testing laboratory indicating that materials proposed for use are in compliance with requirements and meet the properties indicated. All test reports shall be conducted on a cast-in-place tactile panel system as certified by a qualified independent testing laboratory.
5. Maintenance Instructions: Submit copies of manufacturer’s specified maintenance practices for each type of tactile tile and accessory as required.

C. Quality Control

1. Americans with Disabilities Act (ADA): Provide tactile warning surfaces, which comply with the detectable warnings on walking surfaces, section of the Americans with Disabilities Act (Title 49 CFR TRANSPORTATION, PART 37.9 STANDARDS FOR ACCESSIBLE TRANSPORTATION FACILITIES, Appendix A, Section 4.29.2 DETECTABLE WARNINGS ON WALKING SURFACES.
2. California Code of Regulations (CCR): Provide only approved DSAAC detectable warning products as provided in the California Code of Regulations (CCR). Title 24, Part 1, Articles 2, 3 and 4 and Part 2, Section 205 definition of “Detectable Warning”. Section 1127B.5 for “Curb Ramps” and Section 1133B.8.5 for “Detectable Warnings at Hazardous Vehicle Area’s”.
3. Performance: Tiles shall meet or exceed the following criteria:
   a. Water Absorption: 0.35% maximum, when tested in accordance with ASTM D570.
   b. Slip Resistance: 0.90 minimum combined wet/ dry static coefficient of friction on top of domes and field area, when tested in accordance with ASTM C1028.
   c. Compressive Strength: 18,000 psi minimum, when tested in accordance with ASTM D695.
   d. Tensile Strength: 10,000 psi minimum, when tested in accordance with ASTM D638.
   e. Flexural Strength: 24,000 psi minimum, when tested in accordance with ASTM C293.
   f. Gardner Impact: 450 inch-pounds per inch minimum, when tested in accordance with Geometry “GE” of ASTM D5420.
   g. Chemical Stain Resistance: No reaction to 1% hydrochloric acid, urine, calcium chloride, stamp pad ink, gum and red aerosol paint, when tested in accordance with ASTM D543.
   h. Wear Depth: 0.03” maximum, after 1000 abrasion cycles of 40 grit Norton Metallite sandpaper, when tested in accordance with ASTM D2486-Modified.
   i. Flame Spread: 25 maximum, when tested in accordance with ASTM E84.
   j. Accelerated Weathering: No deterioration, fading or chalking for 2000 hours, when tested in accordance with ASTM D2565.
4. Tactile warning tiles embedded in or adhered to concrete shall meet or exceed the following performance criteria:
   a. Accelerated Aging and Freeze Thaw of Adhesive System: No cracking, delamination, warping, checking, blistering, color change, loosening, etc. when tested in accordance with ASTM D1037.
   b. Salt and Spray Performance: No deterioration after 100 hours of exposure, when tested in accordance with ASTM B117.

D. Delivery, Storage And Handling
1. Tiles shall be suitably packaged or crated to prevent damage in shipment or handling. Finished surfaces shall be protected by sturdy wrappings, and tile type shall be identified by part number.
2. Tiles shall be delivered to location at building site for storage prior to installation.

E. Warranty
1. Installed tiles shall be warranted for a minimum of five (5) years against failure of adhesives, fasteners and sealants.

1.2 PRODUCT

A. Materials
1. Vitrified Polymer Composite (VPC) tiles shall be an epoxy polymer composition with an ultra violet stabilized coating employing aluminum oxide particles in the truncated domes. The tile shall incorporate an in-line dome pattern of truncated domes. For wheelchair safety the field area shall consist of a non-slip surface with a minimum of 40 - 90° raised points 0.045" high, per square inch.
2. Color: Safety Yellow, (Federal Color # 33538) colorfast, UV stabilized coating. Color shall be homogeneous throughout the tile.

B. Cast-In-Place Tactile Tile
1. Tile shall be minimum 1-3/8" thick, with minimum 3/8" thick face and ribs designed for after-pour embedment in concrete.

C. Surface Applied Detectable Warning Surface Tile
1. The tile shall have with countersunk fastening holes and perimeter beveled edges.
2. Accessories:
   a. Fasteners: Color matched, corrosion resistant, flat head drive anchor, 1/4" diameter x 1-3/4" long.
   b. Adhesive: Urethane elastomeric adhesive.
   c. Sealants: Epoxy two component sealant.

D. Modular Paver Tactile Tile
1. Pre-cast with a 1-3/8" thick reinforced epoxy polymer concrete core.
   a. Polymer Concrete and/or epoxy resin properties shall meet or exceed the following criteria:

Tensile Strength of Resin:	greater than 7,000psi; ASTM D638
Modulus of Elasticity of Resin:	greater than 4,000psi; ASTM D638
Bond Strength of Polymeric Concrete:	greater than 8,000psi; ASTM C551

2. Accessories:
   a. Adhesive: Urethane elastomeric adhesive.
   b. Backer Rod: ASTM C 1330, Type C (closed-cell material with a surface skin) **OR** Type O (open-cell material) **OR** Type B (bicellular material with a surface skin), **as directed**, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance

E. Surface Applied Detectable Guidance Tiles
1. Accessories:
   a. Adhesive: Heavy-duty polyurethane elastomeric adhesive.
   b. Sealants: Heavy-duty polyurethane elastomeric sealant.

F. Surface Applied Detectable Directional Bar Tiles
1. Accessories:
   a. Fasteners: Stainless steel low profile expansion anchors, 3/16" diameter by 2" long.

b. Adhesive: Heavy-duty polyurethane elastomeric adhesive.
c. Sealants: Heavy-duty polyurethane elastomeric sealant.

1.3 EXECUTION

A. Installation
1. Installation shall be in strict compliance with manufacturer's printed instructions.

END OF SECTION 32 17 26 00

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SECTION 32 18 16 13 - PLAYGROUND SURFACE SYSTEMS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for playground surface systems. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Unitary synthetic seamless surface.
   b. Synthetic, dual-density tile surface.
   c. Organic loose-fill surface.
   d. Inorganic loose-fill surface.

C. Definitions
1. Critical Height: Standard measure of shock attenuation. According to CPSC No. 325, this means "the fall height below which a life-threatening head injury would not be expected to occur."
2. SBR: Styrene-butadiene rubber.

D. Performance Requirements
1. Impact Attenuation: According to ASTM F 1292.
2. Accessibility of Surface Systems: According to ASTM F 1951.
3. Minimum Characteristics for Organic Loose-Fill Surfaces: According to ASTM F 2075.

E. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Show the following:
   a. Installation details for curbs, ramps, and accessories.
   b. Colors and pattern of surfaces.
   c. Location of wear mats in organic loose-fill surfaces.
   d. Location of drainage accessories.
3. Samples: For each type of playground surface system indicated.
   a. Minimum 1-quart (0.95-L) loose-fill surface sealed in a container.
   b. Minimum 6-by-6-inch- (150-by-150-mm-) square Sample of unitary synthetic seamless **OR** synthetic tile **OR** synthetic, dual-density, tile, **as directed,** surface.
   c. 6-inch (150-mm) long by full-size cross section of border edging.
   d. Minimum 12-by-12-inch (300-by-300-mm) Sample of geosynthetic fabric.
   e. Minimum 6-by-6-inch (150-by-150-mm) Sample of geosynthetic, molded-sheet drainage panel.
4. Qualification Data: For Installer and testing agency.
5. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
   a. Unitary synthetic seamless surface.
   b. Synthetic tile surface.
   c. Organic loose-fill surface.
   d. Inorganic loose-fill surface.
6. Material Certificates: For each playground surface system product, signed by manufacturers.
7. Field quality-control test reports.
8. Maintenance Data: For playground surface system to include in maintenance manuals.
9. Warranty: Special warranty specified in this Section.

F. Quality Assurance

1. Installer Qualifications: An employer of workers trained and approved by manufacturer.
2. Testing Agency Qualifications: An independent agency qualified according to ANSI Z34.1 for testing indicated.
3. Source Limitations: Obtain playground surface system materials, including primers and binders, through one source from a single manufacturer.
   a. Provide secondary materials including adhesives, primers, geosynthetics, and repair materials of type and from source recommended by manufacturer of playground surface system materials.

G. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of playground surface system that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
   a. Reduction in impact attenuation.
   b. Deterioration of surface and other materials beyond normal weathering.
2. Warranty Period: Three **OR** Five **OR** 10, **as directed,** years from date of Final Completion.

1.2 PRODUCTS

A. Unitary Synthetic Seamless Surface
1. Surface System: Poured-in-place, single-layer system. Provide manufacturer's standard thickness as required for overall thickness indicated, tested for impact attenuation according to ASTM F 1292 and for accessibility according to ASTM F 1951.
   a. Cushion Course: Manufacturer's standard blend of recycled SBR and EPDM rubber, particles forming an integral wearing course and cushion course, site mixed and applied.
   b. Binder: Weather-resistant, UV-stabilized, flexible, nonhardening, 100 percent solids polyurethane complying with requirements of authorities having jurisdiction for nontoxic and low VOC content.
   c. Critical Height: 3 feet (1 m) **OR** 4 feet (1.2 m) **OR** 5 feet (1.5 m) **OR** 6 feet (1.8 m) **OR** 7 feet (2.1 m) **OR** 8 feet (2.4 m) **OR** 9 feet (2.7 m) **OR** 10 feet (3 m) **OR** 12 feet (3.7 m), **as directed**.
   d. Overall Thickness: Not less than as required for critical height indicated 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 2-1/2 inches (64 mm) **OR** 3 inches (75 mm) **OR** 3-1/2 inches (89 mm) **OR** 4 inches (100 mm), **as directed**.
   e. Primer/Adhesive: Manufacturer's standard primer and weather-resistant, moisture-cured polyurethane adhesive suitable for unit, substrate, and location indicated.
   f. Color(s): As selected from manufacturer's full range.
2. Leveling and Patching Material: Portland cement-based grout or epoxy- or polyurethane-based formulation suitable for exterior use and approved by playground surface system manufacturer.

B. Unitary Synthetic Dual-Density Seamless Surface
1. Surface System: Poured-in-place, two-layer system with wearing course over cushion course. Provide manufacturer's standard thickness for each layer as required for overall thickness indicated, tested for impact attenuation according to ASTM F 1292 and for accessibility according to ASTM F 1951.
   a. Wearing Course: Formulation of EPDM rubber particles, with minimum of 20 percent and maximum of 26 percent of ethylene propylene-diene-saturated polymethylene main chain along with other organic and inorganic components.
   b. Cushion Course: Manufacturer's standard formulation of recycled SBR particles and polyurethane, site mixed and applied.
   c. Binder: Weather-resistant, UV-stabilized, flexible, nonhardening, 100 percent solids polyurethane complying with requirements of authorities having jurisdiction for nontoxic and low VOC content.
   d. Lacquer Top Coat: Manufacturer's standard polyurethane-based formulation.

e. Critical Height: **3 feet (1 m) OR** [**4 feet (1.2 m) OR 5 feet (1.5 m) OR** [**6 feet (1.8 m) OR 7 feet (2.1 m) OR 8 feet (2.4 m) OR 9 feet (2.7 m) OR 10 feet (3 m) OR 12 feet (3.7 m), as directed.**

f. Overall Thickness: Not less than as required for critical height indicated **1-1/2 inches (38 mm) OR 2 inches (50 mm) OR 2-1/2 inches (64 mm) OR 3 inches (75 mm) OR 3-1/2 inches (89 mm) OR 4 inches (100 mm) OR 4-1/2 inches (114 mm) OR 5 inches (125 mm) OR 5-1/2 inches (140 mm), as directed**.

g. Primer/Adhesive: Manufacturer's standard primer and weather-resistant, moisture-cured polyurethane adhesive suitable for unit, substrate, and location indicated.

h. Wearing Course Color(s): As selected from manufacturer's full range.

1) Color **Pattern OR Graphics**: As directed.

2. Leveling and Patching Material: Portland cement-based grout or epoxy- or polyurethane-based formulation suitable for exterior use and approved by playground surface system manufacturer.

C. Unitary Synthetic Tile Surface

1. Tile System: Manufacturer's standard blend of recycled SBR, EPDM rubber, or PVC particles forming an integral wearing course and cushion course, tested for impact attenuation according to ASTM F 1292 and for accessibility according to ASTM F 1951.

a. Unit Size: **24 by 24 inches (600 by 600 mm)**.

b. Base Profile: With integral ribbed or grid-patterned underside forming channels for water drainage between surface and substrate.

c. Border Edge and Corner Units: Tapered, bevel-edged units that transition from the face of playground surface to the adjacent surface below it with a straight-sloped outside edge; size compatible with field units maintaining layout pattern continuity. Provide border edge and corner units where surface does not abut vertical surfaces.

d. Critical Height: **7 feet (2.1 m) OR 12 feet (3.7 m),** as directed.

e. Overall Thickness: Not less than as required for critical height indicated **1-3/4 inches (45 mm) OR 2-3/4 inches (70 mm) OR 4 inches (100 mm), as directed**.

f. Anchors: Manufacturer's standard.

g. Anchor Cement: Manufacturer's standard nonshrink grout or polymer resin.

h. Tile Color(s): **As directed**.

1) Color Pattern **OR** Graphics: As selected from manufacturer's full range.

i. Filler/Sealant: Manufacturer's standard clear silicone or polyurethane filler/sealant suitable for exterior use.

2. Leveling and Patching Material: Portland cement-based grout or epoxy- or polyurethane-based formulation suitable for exterior use and approved by playground surface system manufacturer.

D. Organic Loose-Fill Surface

1. Wood Chips: Random-sized wood chips suitable for mulching trees and shrubs.

2. Double-Shredded Bark Mulch: Random-sized bark, shredded twice, suitable for mulching trees and shrubs.

3. Engineered Wood Fibers: Random-sized wood fibers, in manufacturer's standard fiber size, approximately 10 times longer than wide; containing no bark, leaves, twigs, or foreign or toxic materials according to ASTM F 2075; graded according to manufacturer's standard specification for material consistency for playground surfaces and for accessibility according to ASTM F 1951.

a. Critical Height: 6 feet (1.8 m) **OR** 9 feet (2.7 m) **OR** 10 feet (3 m) **OR** 11 feet (3.4 m), **as directed**.

b. Uncompressed Material Depth: Not less than as required for critical height indicated **OR** 6 inches (150 mm) **OR** 9 inches (229 mm) **OR** 12 inches (305 mm), **as directed**.

E. Inorganic Loose-Fill Surface

1. Inorganic Aggregate Materials: Clean, washed, and free of loam, clay, organic matter, debris, and other foreign substances.

a. Fine Sand: Complying with ASTM C 136 for the following sieve analysis test results; provide minimum depth of material with critical height indicated according to CPSC No. 325:

1) Sieve Sizes and Percent Passing through Screen: No. 16 passing 100 percent, No. 30 passing 98 percent, No. 50 passing 62 percent, No. 100 passing 17 percent, and No. 200 passing 0 to 1 percent.

b. Coarse Sand: Complying with ASTM C 136 for the following sieve analysis test results; provide minimum depth of material with critical height indicated according to CPSC No. 325:

1) Sieve Sizes and Percent Passing through Screen: No. 4 passing 98 percent, No. 8 passing 73 percent, No. 16 passing 4 percent, No. 30 passing 1 percent, and No. 50 passing 0 to 1 percent.

c. Fine Gravel: Rounded, hard, durable stone, free of sand, with particle size less than 3/8 inch (9.5 mm) in diameter complying with ASTM C 136 for the following sieve analysis test results; provide minimum depth of material with critical height indicated according to CPSC No. 325:

1) Sieve Sizes and Percent Passing through Screen: 3/8 inch (9.5 mm) passing 100 percent, No. 3-1/2 passing 93 percent, No. 4 passing 65 percent, No. 8 passing 8 percent, No. 16 passing 5 percent, and No. 30 passing 4 percent.

d. Medium Gravel: Rounded, hard, durable, riverbed gravel or tumbled stone, free of sand, with particle size less than 1/2 inch (13 mm) in diameter complying with ASTM C 136 for the following sieve analysis test results; provide minimum depth of material with critical height indicated according to CPSC No. 325:

1) Sieve Sizes and Percent Passing through Screen: 1/2 inch (13 mm) passing 100 percent, 3/8 inch (9.5 mm) passing 80 percent, 5/16 inch (8 mm) passing 20 percent, No. 4 passing 8 percent, and No. 16 passing 3 percent.

2. Shredded Tires: Rubber particles from 100 percent recycled tires, free from steel wires, rubber dust, and other foreign substances, tested for impact attenuation according to ASTM F 1292 and for accessibility according to ASTM F 1951.

a. Critical Height: 6 feet (1.8 m) **OR** 9 feet (2.7 m) **OR** 10 feet (3 m) **OR** 11 feet (3.4 m), **as directed**.

b. Uncompressed Material Depth: Not less than as required for critical height indicated **OR** 6 inches (150 mm) **OR** 9 inches (229 mm) **OR** 12 inches (305 mm), **as directed**.

F. Loose-Fill Accessories

1. Edgings: Anchored-in-place, weather-resistant containment barrier designed to minimize sharp edges, protrusions, and tripping hazards; formed by interconnected, modular units.

a. Polyethylene Units: UV-light-stabilized, 100 percent recycled polyethylene, not less than 1/4-inch (6-mm) wall thickness; made into smooth-surfaced straight and curved units with radiused exposed edges and integral, molded-in color; in manufacturer's standard sizes.

1) Color: As selected from manufacturer's full range.

b. Metal Units: Steel fabricated with radiused exposed edges and finished with PVC plastisol coating, straight **OR** right-angled corner, **as directed,** and curved units, in manufacturer's standard sizes.

1) Color: As selected from manufacturer's full range.

c. Rubber Units: Compression molded from 100 percent recycled SBR, in manufacturer's standard sizes.

1) Color: As selected from manufacturer's full range.

d. Anchor Stakes: Manufacturer's standard, of corrosion-resistant-coated metal or noncorrodible material, designed to be nonprotruding when installed, for connecting units and securing in-place.

2. Stabilizing Mats: Manufacturer's standard, water-permeable PVC or rubber mats tested for impact attenuation according to ASTM F 1292, and rated for use in the following locations, with anchoring system designed to anchor mat securely to subgrade through engineered wood:

a. Location: At excessive wear areas and as follows:

1) On top of loose-fill surface.

2) Below top of loose-fill surface.

3) On subgrade below loose-fill surface.

4) Under and in front of slide exits.
5) Under and around swings.
6) At finished grade around transfer stations at accessible perimeter.
7) At high-traffic areas and playground equipment where indicated.
8) Where indicated.

b. Size: 36 by 36 inches (914 by 914 mm) **OR** 40 by 40 inches (1016 by 1016 mm) **OR** 48 by 48 inches (1200 by 1200 mm), **as directed**.
c. Color: As selected from manufacturer's full range.

G. Geosynthetics
1. Drainage/Separation Geotextile: Nonwoven, needle-punched geotextile, manufactured for subsurface drainage applications and made from polyolefins or polyesters; complying with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods:
a. Weight: 4 oz./sq. yd. (136 g/sq. m) according to ASTM D 5261.
b. Water Flow Rate: 100 gpm/sq. ft. (68 L/s per sq. m) **OR** 150 gpm/sq. ft. (102 L/s per sq. m), **as directed,** according to ASTM D 4491.
2. Molded-Sheet Drainage Panel: Prefabricated, composite drainage panels made with drainage core and filter fabric.
a. Drainage Core: Three-dimensional, nonbiodegradable, molded-plastic-sheet material designed to effectively drain water under maximum fill pressures.
b. Fabric: Nonwoven, needle-punched geotextile, specifically manufactured as a filter geotextile and made from polyolefins or polyesters; complying with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods:
1) Weight: 4 oz./sq. yd. (136 g/sq. m) according to ASTM D 5261.
2) Water Flow Rate: 100 gpm/sq. ft. (68 L/s per sq. m) **OR** 150 gpm/sq. ft. (102 L/s per sq. m), **as directed,** according to ASTM D 4491.
c. Minimum Flow Rate: 9 gpm/foot (1.9 L/s per m) according to ASTM D 4491.
3. Weed-Control Barrier: Composite fabric geotextile consisting of woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, weighing not less than 4.8 oz./sq. yd. (160 g/sq. m).

1.3 EXECUTION

A. Preparation
1. General: Prepare substrates to receive surfacing products according to playground surface system manufacturer's written instructions. Verify that substrates are sound and without high spots, ridges, holes, and depressions.
2. Concrete **OR** Asphalt, **as directed,** Substrates: Provide sound surface free of laitance, efflorescence, curing compounds, and other contaminants incompatible with playground surface system.
a. Repair unsatisfactory surfaces and fill holes and depressions.
b. Mechanically scarify or otherwise prepare concrete substrates to achieve recommended degree of roughness.
c. Saw cut concrete **OR** asphalt, **as directed,** for terminal edges of playground surface systems as indicated.
d. Treat control joints and other nonmoving substrate cracks to prevent telegraphing through playground surface system.

B. Installation, General
1. General: Comply with playground surface system manufacturer's written installation instructions. Install playground surface system over area and in thickness indicated.

C. Geosynthetic Installation

1. General: Install geosynthetics according to playground surface system manufacturer's and geosynthetic manufacturer's written instructions.
    a. Geotextiles: Completely cover area indicated, overlapping sides and edges a minimum of 4 inches (100 mm) **OR** 8 inches (200 mm), **as directed,** with manufacturer's standard treatment for **OR** overlapping loosely laid **OR** adhesively bonded, **as directed,** seams.
        1) Perimeter: Adhere edges on all sides to top of perimeter curb or footing.

D. Installation Of Seamless Playground Surface Systems
1. Seamless Surface: Mix and apply components of playground surface system according to manufacturer's written instructions.
    a. Substrate Primer: Apply over prepared substrate at manufacturer's standard spreading rate for type of substrate.
    b. Cushion Course: Spread evenly over primed substrate to form a uniform layer applied at manufacturer's standard spreading rate in one continuous operation, with a minimum of cold joints.
    c. Cushion Course: Lay out tile units from center marks established with principal perimeter edges, discounting minor offsets, so units at opposite edges of installation are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half of a unit at perimeter.
    d. Intercoat Primer: Over cured cushion course, apply primer at manufacturer's standard spreading rate.
    e. Wearing Course: Spread over primed base course to form a uniform layer applied at manufacturer's standard spreading rate in one continuous operation and, except where color changes, with no **OR** a minimum of, **as directed,** cold joints. Finish surface to produce manufacturer's standard wearing-surface texture.
        1) Where colored pattern is **OR** graphics are, **as directed,** indicated, place adjacent colored material as soon as placed colored material is sufficiently cured, using primer or adhesive if required by manufacturer's written instructions.
    f. Edge Treatment: Flush **OR** Extended surface course **OR** Saw-cut base and vertical pour, **as directed**.

E. Installation Of Tile Playground Surface Systems
1. Tile Units: Provide a uniform wearing surface with no unaligned units, raised edges, or surface imperfections.
    a. Lay out units from center marks established with principal perimeter edges, discounting minor offsets, so units at opposite edges of installation are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half of a unit at perimeter. Allow for border edge.
        1) Alignment Axis and Pattern: Lay units along axis and in grid pattern indicated.
        OR
        Alignment Axis: Lay units square **OR** at a 45-degree angle, **as directed,** with playground equipment axis.
        2) Pattern: Lay units in straight-line grid pattern with joints aligned.
        OR
        Pattern: Lay units in half-unit, offset grid pattern with staggered joints.
    b. Cut and fit units around playground equipment supports and vertical surfaces. Do not create voids greater than 3/8 inch (9.5 mm) wide.
        1) Do not stretch units during installation.
    c. Adhesively Applied Units: Adhere units to substrates using a full spread of adhesive applied to substrate or to unit and to each other.
    d. Mechanically Fastened Units: Anchor to substrates.
    e. Mechanically Attached Units (only for solid revulcanized rubber units): Mechanically attach all four sides of units, including border edge and corner units, to each other using number of fasteners per side as recommended by system manufacturer. Free lay sheet of attached units on substrate.

f. Mechanically Attached Units Retained by Adhesively Applied Perimeter Units: Mechanically attach all four sides of units to each other using number of fasteners per side as recommended by system manufacturer. Adhere not less than one course of perimeter units and border edge and corner units to substrates using a full spread of adhesive applied to substrate or to unit and to each other.
g. Edge Borders: Maintain fully cushioned thickness.
h. Filler/Sealant: Mask area surrounding cutouts around playground equipment supports and other obstructions. Apply a full bead of filler/sealant, filling cutouts immediately after laying tile with cutout.

F. Installation Of Loose-Fill Playground Surface Systems
1. Loose-Fill Edgings: Place as indicated, and permanently secure in place and attach to each other according to edging manufacturer's written instructions.
2. Loose Fill: Place playground surface system materials including manufacturer's standard amount of excess material for compacting naturally with time **OR** including manufacturer's standard amount of excess material for compacting mechanically, **as directed,** to required depths after Installation of playground equipment support posts and foundations.
3. Stabilizing Mats: Coordinate installation of mats and mat anchoring system with placing and compacting of loose-fill.
4. Compacting and Grading: Uniformly compact and grade loose-fill according to manufacturer's written instructions to an even surface free from irregular surface changes as indicated.
5. Finish Grading: Hand rake to a smooth finished surface and to required elevations.

G. Field Quality Control
1. Testing Services: Testing and inspecting of completed applications of playground surface system shall take place according to ASTM F 1292.
2. Remove and replace applications of playground surface system where test results indicate that it does not comply with requirements.
3. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with requirements.

H. Protection
1. Seamless **OR** Tile, **as directed,** Systems: Prevent traffic over system for not less than 48 hours after installation.

END OF SECTION 32 18 16 13

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SECTION 32 18 16 13a - TRACK, COURT, AND PLAYGROUND MARKINGS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing of materials and the installation of track, court, and playground markings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals

1. Submit product data and manufacturer's recommendations for each marking to be furnished.
2. Submit sample of each marking to be furnished.
3. Submit "Line Layout Drawing" prior to installation of marking and upon completion of markings, submit three (3) certified line layout drawings indicating all lines and colors.

C. Quality Assurance: Personnel shall have a minimum of three years marking experience.

D. Delivery, Storage and Handling: Deliver paint to site in original sealed containers or drums, with labels legible, intact and unbroken. Comply with all health and fire regulations.

E. Environmental Requirements: Do not install markings on wet or frozen surfaces. Comply with manufacturer's instructions for temperature requirements.

1.2 PRODUCTS

A. Manufacturers

1. Line Paint for Resilient Surface: Aliphatic polyurethane paint, such as Hi-Build Aliphatic Polyurethane paint by Sherwin-Williams, or approved equivalent.
2. Line Paint for Asphaltic Concrete Pavement: Latex traffic marking paint, such as Setfast Latex Traffic Marking paint by Sherwin-Williams, or approved equivalent.
3. Line Paint for Athletic Wearing Surface (Plexipave): 100% acrylic latex paint, such as Plexicolor by California Products, or approved equivalent.

1.3 EXECUTION

A. Application

1. Line Painting
   a. Accurately measure and layout line markings.
   b. Apply paint with mechanical equipment.
   c. Paint lines as specified below under "Track Marking".
   d. Provide uniform straight edges.
   e. Apply not less than two coats in accordance with manufacturer's recommended rates.
   f. Lines shall be 2 in. (50 mm) wide unless otherwise specified.
2. Track Marking
   a. Employ a licensed land surveyor to accurately measure and lay out line markings in accordance with National Federation of State High School Athletic Association Regulations or other Standards set forth by the Owner.
   b. Events:
      1) 100 meter dash
      2) 200 meter dash
      3) 400 meter dash

4) 800 meter run
5) 1600 meter run
6) 3200 meter run
7) One mile run
8) 4 x 100 meter relay
9) 4 x 200 meter relay
10) 4 x 400 meter relay
11) 4 x 800 meter relay
12) 110 meter high hurdles
13) 300 meter intermediate hurdles
14) Girls 100 meter hurdles
15) Girls 300 meter hurdles

c. Hurdle location markers: yellow hash marks.
d. Lane lines: white (min. 42 in. (105 cm) apart).
e. Exchange zones:
   1) 4 x100 m green
   2) 4 x 200 m blue
   3) 4 x 400 m yellow
   4) 12 in. (305 mm) across entire lane width.
f. Lane numbers: Stenciled in three locations from inside to outside. Numbers shall be 24 in. (60 cm) high and white in color.
g. Finish line to be located near bleachers.
h. All starts and finishes to be white.

B. Cleaning: Upon completion of work, remove containers and debris and leave site in clean orderly condition acceptable to the Owner.

C. Protection
   1. Erect temporary barriers to protect paint during drying period.
   2. Protect markings from damage until completion of project.

END OF SECTION 32 18 16 13a

SECTION 32 18 16 13b - SYNTHETIC RUNNING TRACK SURFACE

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of synthetic running track surface. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals: Submit the following:
1. Sample of the actual sport surface in the standard color(s) selected.
2. Technical data sheets of the product.
3. Adhesive product data sheets and manufacturer's certificate indicating approval for the proposed application.
4. Line paint data sheets and the manufacturer's certificate indicating approval for the proposed application.
5. Submit 3 copies of the maintenance instruction.

C. Delivery and Storage: Deliver and store the material in the original packaging with the labels intact in a controlled environment of a minimum temperature of 55°F (13°C) and under 50% relative humidity. Protect work until accepted by the Owner.

D. Warranty: Provide manufacturer's standard warranty.

1.2 PRODUCTS

A. Acrylic Color Coating System
1. Manufacturer: Copeland Coating Company or approved equivalent.
2. System shall consist of stone base, asphalt binder/top, cushion made of granulated rubber particles suspended in acrylic emulsions **(as directed)**, acrylic filler coat(s), acrylic finish coat, and acrylic line paint.
3. Design and construction shall be by materials manufacturer.

B. Polyurethane
1. Manufacturer: Conica Sports Surfaces or approved equivalent.
2. Impermeable, full polyurethane, 3 layer athletic track system. In-situ applied with a granular colored EPDM finish. IAAF certified as required.

C. Rubber Granule Surface
1. Manufacturer: Atlas Track & Tennis or approved equivalent.
2. Rubber granules applied “dry” to the surface and adhered by spray application of a resin binder. This process is repeated until the specified thickness is achieved, allowing sufficient curing time between each application. The process is then finished with a structural spray coating of highly pigmented polyurethane coating.

D. Prefabricated Rubber Surface
1. Manufacturer: Mondo USA, or approved equivalent.
2. Prefabricated rubber sport surface to be 6 mm (1/4”) **OR** 8mm (5/16") **OR** 10mm (3/8") **OR** 12mm (1/2") **OR** 14mm (9/16"), **as directed**, thickness, with a non-slip, non-reflecting, highly spike resistant top surface. Provided in manufacturer’s standard colors.
3. Prefabricated rubber surface to be sheet goods, double durometer or homogenous vulcanized and calandered, with a particular closed cell structure, based on special isoprenic rubbers, mineral fillers, vulcanizing and stabilizing agents and color pigments, highly resistant to UV rays

and atmospherical agents, with system of differentiated elasticity between top surface and base, supplied in rolls of suitable size and thickness. Surface shall have a special texture including adhesive and striping

4. Prefabricated rubber sport surface to be manufactured in two layers, which are vulcanized together. The shore hardness of the lower layer to be less than the upper layer, shore hardness of the respected layers to be recommended by the manufacturer and within the limits hereinafter specified. Field laminated triple durometer are unacceptable.
5. Adhesive: Rubber sport surface adhesive to be two part polyurethane adhesive suitable for adherence of a sheet good to asphalt, concrete or urethane substrate. Adhesive to be supplied or approved/recommended by sport surface manufacturer.

E. Patching Compound: Patching compound to be supplied or approved/recommended by sport surface manufacturer.

F. Line marking: Line marking paint to be supplied by sport surface manufacturer.

1.3 EXECUTION

A. Installation
1. Install sport flooring in accordance with manufacturer's printed instructions.
2. Prefabricated sport flooring shall be unrolled and allowed to relax.
3. Cut and adjust prefabricated sport flooring prior to adhesion.
4. Mix adhesive in accordance with manufacturer's instructions.
5. Hold all seams in place with suitable weights for a minimum of 12 hours.
6. Lines to be painted as per manufacturer's recommendations.
7. Surface to be protected before, during and after installation until project's acceptance by the the Owner or his agent.

END OF SECTION 32 18 16 13b

Task	Specification	Specification Description
32 18 16 13	11 66 13 00	Playground Equipment And Structures
32 18 16 13	11 68 13 00	Recreational Facilities

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SECTION 32 18 23 13 - LAWNS AND GRASSES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for lawns and grasses. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Seeding.
      b. Hydroseeding.
      c. Sodding.
      d. Plugging.
      e. Sprigging.
      f. Meadow grasses and wildflowers.
      g. Turf renovation.
      h. Erosion-control material(s).
      i. Grass paving.

C. Definitions
   1. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
   2. Finish Grade: Elevation of finished surface of planting soil.
   3. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
   4. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
   5. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
   6. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
   7. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.
   8. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
   9. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

D. Submittals
   1. Product Data: For each type of product indicated.
   2. Certification of Grass Seed.
      a. Certification of each seed mixture for turfgrass sod **OR** plugs, **as directed**.
   3. Product Certificates: For soil amendments and fertilizers, from manufacturer.
   4. Maintenance Instructions: Recommended procedures to be established by the Owner for maintenance of turf and meadows during a calendar year. Submit before expiration of required initial maintenance periods.

E. Quality Assurance
1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
   a. Pesticide Applicator: State licensed, commercial.
2. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory.
   a. The soil-testing laboratory shall oversee soil sampling.
   b. Report suitability of tested soil for turf growth.
      1) State recommendations for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
      2) Report presence of problem salts, minerals, or heavy metals; if present, provide additional recommendations for corrective action.

F. Delivery, Storage, And Handling
1. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.
2. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.
3. Bulk Materials:
   a. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
   b. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
   c. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

G. Maintenance Service
1. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 1.3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:
   a. Seeded Turf: 60 days from date of planting completion **OR** Final Completion, **as directed**.
      1) When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.
   b. Sodded Turf: 30 days from date of planting completion **OR** Final Completion, **as directed**.
   c. Plugged Turf: 30 days from date of planting completion **OR** Final Completion, **as directed**.
   d. Sprigged Turf: 30 days from date of planting completion **OR** Final Completion, **as directed**.
2. Initial Meadow Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 1.3. Begin maintenance immediately after each area is planted and continue until acceptable meadow is established, but for not less than 40 days from date of planting completion **OR** Final Completion, **as directed**.
3. Continuing Maintenance Proposal: From Installer to the Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.2 PRODUCTS

A. Seed
1. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.
2. Seed Species: If grass seed is required to be certified by the State Department of Agriculture, State-certified seed of grass species as follows:
OR
Seed Species: If grass seed is not required to be certified by the State Department of Agriculture, seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
a. Warm-season grass
1) Full Sun: Bermudagrass (Cynodon dactylon).
b. Cool-season grass
1) Full Sun: Kentucky bluegrass (Poa pratensis), a minimum of three cultivars.
2) Sun and Partial Shade: Proportioned by weight as follows:
a) 50 percent Kentucky bluegrass (Poa pratensis).
b) 30 percent chewings red fescue (Festuca rubra variety).
c) 10 percent perennial ryegrass (Lolium perenne).
d) 10 percent redtop (Agrostis alba).
3) Shade: Proportioned by weight as follows:
a) 50 percent chewings red fescue (Festuca rubra variety).
b) 35 percent rough bluegrass (Poa trivialis).
c) 15 percent redtop (Agrostis alba).
3. Grass Seed Mix: Proprietary seed mix as directed by the Owner.

B. Turfgrass Sod
1. Turfgrass Sod: Certified **OR** Approved **OR** Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, **as directed**, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.
2. Turfgrass Species (warm-season grass): Bermudagrass (Cynodon dactylon) **OR** Carpetgrass (Axonopus affinis) **OR** Centipedegrass (Eremochloa ophiuroides) **OR** St. Augustinegrass (Stenotaphrum secundatum) **OR** Zoysiagrass (Zoysia japonica) **OR** Zoysiagrass (Zoysia matrella), **as directed**.
3. Turfgrass Species (cool-season grass): Sod of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
a. Full Sun: Kentucky bluegrass (Poa pratensis), a minimum of three cultivars.
b. Sun and Partial Shade: Proportioned by weight as follows:
1) 50 percent Kentucky bluegrass (Poa pratensis).
2) 30 percent chewings red fescue (Festuca rubra variety).
3) 10 percent perennial ryegrass (Lolium perenne).
4) 10 percent redtop (Agrostis alba).
c. Shade: Proportioned by weight as follows:
1) 50 percent chewings red fescue (Festuca rubra variety).
2) 35 percent rough bluegrass (Poa trivialis).
3) 15 percent redtop (Agrostis alba).

C. Plugs
1. Plugs: Turfgrass sod, certified **OR** approved **OR** Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, **as directed**, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, cut into square or round plugs, strongly rooted,

and capable of vigorous growth and development when planted; of the following turfgrass species and plug size:

a. Turfgrass Species (warm-season grass): Bermudagrass (Cynodon dactylon) **OR** Carpetgrass (Axonopus affinis) **OR** Centipedegrass (Eremochloa ophiuroides) **OR** St. Augustinegrass (Stenotaphrum secundatum) **OR** Zoysiagrass (Zoysia japonica) **OR** Zoysiagrass (Zoysia matrella), **as directed**.

b. Plug Size: 2 inches (50 mm) **OR** 3 inches (75 mm) **OR** 4 inches (100 mm), **as directed**.

D. Sprigs

1. Sod Sprigs: Healthy living stems, rhizomes, or stolons with a minimum of two nodes and attached roots free of soil, of the following turfgrass species:

a. Turfgrass Species (warm-season grass): Bermudagrass (Cynodon dactylon) **OR** Carpetgrass (Axonopus affinis) **OR** Centipedegrass (Eremochloa ophiuroides) **OR** St. Augustinegrass (Stenotaphrum secundatum) **OR** Zoysiagrass (Zoysia japonica) **OR** Zoysiagrass (Zoysia matrella), **as directed**.

b. Turfgrass Species (cool-season grass): Creeping bentgrass (Agrostis palustris).

E. Meadow Grasses And Wildflowers

1. Wildflower Seed: Fresh, clean, and dry new seed, of mixed species as directed.
2. Native Grass Seed: Fresh, clean, and dry new seed, of mixed species as directed.
3. Wildflower and Native Grass Seed: Fresh, clean, and dry new seed, of mixed species as directed.
4. Seed Carrier: Inert material, sharp clean sand or perlite, mixed with seed at a ratio of not less than two parts seed carrier to one part seed.

F. Inorganic Soil Amendments

1. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

a. Class T, with a minimum of 99 percent passing through No. 8 (2.36-mm) sieve and a minimum of 75 percent passing through No. 60 (0.25-mm) sieve.

OR

Class O, with a minimum of 95 percent passing through No. 8 (2.36-mm) sieve and a minimum of 55 percent passing through No. 60 (0.25-mm) sieve.

b. Provide lime in form of ground dolomitic limestone **OR** calcitic limestone **OR** mollusk shells, **as directed**.

2. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, and with a minimum of 99 percent passing through No. 6 (3.35-mm) sieve and a maximum of 10 percent passing through No. 40 (0.425-mm) sieve.
3. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
4. Aluminum Sulfate: Commercial grade, unadulterated.
5. Perlite: Horticultural perlite, soil amendment grade.
6. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 (0.30-mm) sieve.
7. Sand: Clean, washed, natural or manufactured, and free of toxic materials.
8. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

OR

Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

G. Organic Soil Amendments

1. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch (25-mm) **OR** 3/4-inch (19-mm) **OR** 1/2-inch (12.5-mm), **as directed**, sieve; soluble salt content of 5 to 10

decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
   a. Organic Matter Content: 50 to 60 percent of dry weight.
   b. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
2. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture, with a pH range of 3.4 to 4.8.
3. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.
4. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.
   a. In lieu of decomposed wood derivatives, mix partially decomposed wood derivatives with ammonium nitrate at a minimum rate of 0.15 lb/cu. ft. (2.4 kg/cu. m) of loose sawdust or ground bark, or with ammonium sulfate at a minimum rate of 0.25 lb/cu. ft. (4 kg/cu. m) of loose sawdust or ground bark.
5. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

H. Fertilizers
1. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 1 **OR** 4, **as directed**, percent nitrogen and 10 **OR** 20, **as directed**, percent phosphoric acid.
2. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
3. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
   a. Composition: 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
   b. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
4. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
   a. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
      OR
      Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

I. Planting Soils
1. Planting Soil: ASTM D 5268 topsoil, with pH range of 5.5 to 7, a minimum of 2 percent organic material content **OR** Existing, native surface topsoil formed under natural conditions with the duff layer retained during excavation process **OR** Existing, in-place surface soil **OR** Imported topsoil or manufactured topsoil from off-site sources; do not obtain from agricultural land, bogs or marshes, **as directed**. Verify suitability of soil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth. Mix soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
   a. Ratio of Loose Compost to Topsoil by Volume: 1:4 **OR** 1:3 **OR** 1:2, **as directed**.
   b. Ratio of Loose Sphagnum **OR** Muck, **as directed**, Peat to Topsoil by Volume: as directed by the Owner .
   c. Ratio of Loose Wood Derivatives to Topsoil by Volume: as directed by the Owner.
   d. Weight of Lime per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.

e. Weight of Sulfur **OR** Iron Sulfate **OR** Aluminum Sulfate, **as directed**, per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.
f. Weight of Agricultural Gypsum per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.
g. Volume of Sand Plus 10 Percent Diatomaceous Earth **OR** Zeolites, **as directed**, per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.
h. Weight of Bonemeal per 1000 Sq. Ft. (92.9 Sq. m**):** as directed by the Owner.
i. Weight of Superphosphate per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.
j. Weight of Commercial Fertilizer per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.
k. Weight of Slow-Release Fertilizer per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.

J. Mulches
1. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
2. Sphagnum Peat Mulch: Partially decomposed sphagnum peat moss, finely divided or of granular texture, and with a pH range of 3.4 to 4.8.
3. Muck Peat Mulch: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.
4. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch (25-mm) sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
   a. Organic Matter Content: 50 to 60 percent of dry weight.
   b. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
5. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
6. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.
7. Asphalt Emulsion: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

K. Pesticides
1. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
2. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
3. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

L. Erosion-Control Materials
1. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches (150 mm) long.
2. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd. (0.5 kg/sq. m), with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches (150 mm) long.
3. Erosion-Control Mats: Cellular, non-biodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, of 3-inch (75-mm) **OR** 4-inch (100-mm) **OR** 6-inch (150-mm), **as directed**, nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.

M. Grass-Paving Materials
1. Grass Paving: Cellular, non-biodegradable plastic mats, designed to contain small areas of soil and enhance the ability of turf to support vehicular and pedestrian traffic, of 1-inch (25-mm) **OR** 1-3/4-inch (45-mm) **OR** 2-inch (50-mm) **OR** manufacturer's standard, **as directed**, nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.
2. Base Course: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 8 **OR** Division 31 Section "Earth Moving" for base-course material, **as directed**.
3. Sand: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate.
4. Proprietary Growing Mix: As submitted and acceptable to the Owner.
5. Sandy Loam Soil Mix: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate blended with planting soil as specified. Use blend consisting of 1/2 sand and 1/2 planting soil **OR** 2/3 sand and 1/3 planting soil, **as directed**.
6. Soil for Paving Fill: Planting soil as specified.

1.3 EXECUTION

A. Preparation
1. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
   a. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
   b. Protect grade stakes set by others until directed to remove them.
2. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

B. Turf Area Preparation
1. Limit turf subgrade preparation to areas to be planted.
2. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches (100 mm) **OR** 6 inches (150 mm) **OR** 8 inches (200 mm), **as directed**. Remove stones larger than 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off the Owner's property.
   a. Apply superphosphate fertilizer directly to subgrade before loosening.
   b. Thoroughly blend planting soil off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil.
      1) Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
      2) Mix lime with dry soil before mixing fertilizer.
   c. Spread planting soil to a depth of 4 inches (100 mm) **OR** 6 inches (150 mm) **OR** 8 inches (200 mm), **as directed**, but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
      1) Spread approximately 1/2 the thickness of planting soil over loosened subgrade. Mix thoroughly into top 2 inches (50 mm) **OR** 4 inches (100 mm), **as directed**, of subgrade. Spread remainder of planting soil.
      2) Reduce elevation of planting soil to allow for soil thickness of sod.
3. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:
   a. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
   b. Loosen surface soil to a depth of at least 6 inches (150 mm) **OR** 8 inches (200 mm), **as directed**. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, of soil. Till soil to a homogeneous mixture of fine texture.
      1) Apply superphosphate fertilizer directly to surface soil before loosening.
   c. Remove stones larger than 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, in any dimension and sticks, roots, trash, and other extraneous matter.

d. Legally dispose of waste material, including grass, vegetation, and turf, off the Owner's property.

4. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch (13 mm) of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.
5. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
6. Before planting, obtain the Owner's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

C. Preparation For Erosion-Control Materials
1. Prepare area as specified in "Turf Area Preparation" Article.
2. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.
3. Fill cells of erosion-control mat with planting soil and compact before planting.
4. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.
5. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

D. Preparation For Grass-Paving Materials
1. Reduce subgrade elevation soil to allow for thickness of grass-paving system. Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade so that installed paving is within plus or minus 1/2 inch (13 mm) of finish elevation. Roll and rake, remove ridges, and fill depressions.
2. Install base course **OR** sand course **OR** base course and sand course, **as directed**, and sandy loam soil mix **OR** proprietary growing mix **OR** soil for paving fill, **as directed**, as recommended by paving-material manufacturer for site conditions; comply with details shown on Drawings. Compact according to paving-material manufacturer's written instructions.
3. Install paving mat and fasten according to paving-material manufacturer's written instructions.
4. Before planting, fill cells of paving mat with planting soil **OR** sandy loam soil mix **OR** proprietary growing mix **OR** sand half full, **as directed**, and compact according to manufacturer's written instructions.
5. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

E. Seeding
1. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph (8 km/h). Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
   a. Do not use wet seed or seed that is moldy or otherwise damaged.
   b. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
2. Sow seed at a total rate of 2 lb/1000 sq. ft. (0.9 kg/92.9 sq. m) **OR** 3 to 4 lb/1000 sq. ft. (1.4 to 1.8 kg/92.9 sq. m) **OR** 5 to 8 lb/1000 sq. ft. (2.3 to 3.6 kg/92.9 sq. m), **as directed**.
3. Rake seed lightly into top 1/8 inch (3 mm) of soil, roll lightly, and water with fine spray.
4. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets and 1:6 with erosion-control fiber mesh installed and stapled according to manufacturer's written instructions.
5. Protect seeded areas with erosion-control mats where shown on Drawings; install and anchor according to manufacturer's written instructions.
6. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre (42 kg/92.9 sq. m) to form a continuous blanket 1-1/2 inches (38 mm) in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.

a. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
b. Bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gal./1000 sq. ft. (38 to 49 L/92.9 sq. m). Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

7. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch **OR** peat mulch **OR** planting soil, **as directed**, within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch (4.8 mm), and roll surface smooth.

F. Hydroseeding
1. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
   a. Mix slurry with nonasphaltic **OR** asphalt-emulsion **OR** fiber-mulch manufacturer's recommended, **as directed**, tackifier.
   b. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre (15.6-kg/92.9 sq. m) dry weight, and seed component is deposited at not less than the specified seed-sowing rate.
   OR
   Apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500-lb/acre (5.2-kg/92.9 sq. m) dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1000 lb/acre (10.4 kg/92.9 sq. m).

G. Sodding
1. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
2. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
   a. Lay sod across angle of slopes exceeding 1:3.
   b. Anchor sod on slopes exceeding 1:6 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.
3. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches (38 mm) below sod.

H. Plugging
1. Plant plugs in holes or furrows, spaced 12 inches (300 mm) **OR** 18 inches (450 mm), **as directed**, apart in both directions. On slopes, contour furrows to near level.

I. Sprigging
1. Plant freshly shredded sod sprigs in furrows 1 to 1-1/2 inches (25 to 38 mm) **OR** 1-1/2 to 2 inches (38 to 50 mm) **OR** 2-1/2 to 3 inches (64 to 75 mm), **as directed**, deep. Place individual sprigs with roots and portions of stem in moistened soil, 6 inches (150 mm) **OR** 12 inches (300 mm), **as directed**, apart in rows 10 inches (250 mm) **OR** 18 inches (450 mm), **as directed**, apart, and fill furrows without covering growing tips. Lightly roll and firm soil around sprigs after planting.
2. Broadcast sprigs uniformly over prepared surface at a rate of 10 cu. ft./1000 sq. ft. (0.28 cu. m/92.9 sq. m) and mechanically force sprigs into lightly moistened soil.
   a. Spread a 1/4-inch- (6-mm-) thick layer of compost mulch **OR** peat mulch **OR** planting soil, **as directed**, on sprigs.
   b. Lightly roll and firm soil around sprigs after planting.

c. Water sprigs immediately after planting and keep moist by frequent watering until well rooted.

J. Turf Renovation
1. Renovate existing turf.
2. Renovate existing turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
   a. Reestablish turf where settlement or washouts occur or where minor regrading is required.
   b. Install new planting soil as required.
3. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.
4. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.
5. Mow, dethatch, core aerate, and rake existing turf.
6. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.
7. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off the Owner's property.
8. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches (150 mm).
9. Apply soil amendments and initial fertilizers required for establishing new turf and mix thoroughly into top 4 inches (100 mm) of existing soil. Install new planting soil to fill low spots and meet finish grades.
10. Apply seed and protect with straw mulch **OR** sod, **as directed**, as required for new turf.
11. Water newly planted areas and keep moist until new turf is established.

K. Turf Maintenance
1. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
   a. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
   b. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
   c. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
2. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches (100 mm).
   a. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
   b. Water turf with fine spray at a minimum rate of 1 inch (25 mm) per week unless rainfall precipitation is adequate.
3. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
   a. Mow bentgrass to a height of 1/2 inch (13 mm) or less.
   b. Mow bermudagrass to a height of 1/2 to 1 inch (13 to 25 mm).
   c. Mow carpetgrass, centipedegrass, perennial ryegrass, and zoysiagrass to a height of 1 to 2 inches (25 to 50 mm).
   d. Mow Kentucky bluegrass, buffalograss, annual ryegrass, and chewings red fescue to a height of 1-1/2 to 2 inches (38 to 50 mm).

   e. Mow bahiagrass, turf-type tall fescue, and St. Augustinegrass to a height of 2 to 3 inches (50 to 75 mm).
 4. Turf Postfertilization: Apply fertilizer after initial mowing and when grass is dry.
   a. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) to turf area.

L. Satisfactory Turf
 1. Turf installations shall meet the following criteria as determined by Architect:
   a. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. (0.92 sq. m) and bare spots not exceeding 5 by 5 inches (125 by 125 mm).
   b. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
   c. Satisfactory Plugged Turf: At end of maintenance period, the required number of plugs has been established as well-rooted, viable patches of grass, and areas between plugs are free of weeds and other undesirable vegetation.
   d. Satisfactory Sprigged Turf: At end of maintenance period, the required number of sprigs has been established as well-rooted, viable plants, and areas between sprigs are free of weeds and other undesirable vegetation.
 2. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

M. Meadow
 1. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph (8 km/h). Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
   a. Do not use wet seed or seed that is moldy or otherwise damaged.
 2. Sow seed at a total rate of 4 oz./1000 sq. ft. (113 g/92.9 sq. m) **OR** 5 oz./1000 sq. ft. (142 g/92.9 sq. m) **OR** 6 oz./1000 sq. ft. (170 g/92.9 sq. m), **as directed**.
 3. Brush seed into top 1/16 inch (1.6 mm) of soil, roll lightly, and water with fine spray.
 4. Protect seeded areas from hot, dry weather or drying winds by applying peat or compost mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch (4.8 mm), and roll surface smooth.
 5. Water newly planted areas and keep moist until meadow is established.

N. Meadow Maintenance
 1. Maintain and establish meadow by watering, weeding, mowing, trimming, replanting, and performing other operations as required to establish a healthy, viable meadow. Roll, regrade, and replant bare or eroded areas and remulch. Provide materials and installation the same as those used in the original installation.
   a. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and meadow damaged or lost in areas of subsidence.
   b. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
   c. Apply treatments as required to keep meadow and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
 2. Watering: Install and maintain temporary piping, hoses, and meadow-watering equipment to convey water from sources and to keep meadow uniformly moist.
   a. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
   b. Water meadow with fine spray at a minimum rate of 1/2 inch (13 mm) per week for four **OR** six **OR** eight, **as directed**, weeks after planting unless rainfall precipitation is adequate.

O. Pesticide Application
1. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with the Owner's operations and others in proximity to the Work. Notify the Owner before each application is performed.
2. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

P. Cleanup And Protection
1. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
2. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
3. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION 32 18 23 13

Task	Specification	Specification Description
32 18 23 23	32 18 23 13	Lawns And Grasses

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SECTION 32 18 23 29 - COLORED ATHLETIC WEARING SURFACE

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of colored athletic wearing surface on asphaltic concrete base. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals: Submit product data and manufacturer's application instruction.

1.2 PRODUCTS

A. Manufacturer: Athletic wearing surface shall be the "Plexipave" system by California Products Corporation, 169 Waverly Street, Cambridge Ma. 02139 or approved equal.

B. Plexipave Court Patch Binder prepared as per manufacturers recommendations.

C. California Acrylic Resurfacer prepared as per manufacturers recommendations.

D. Fortified Plexipave Job Mix prepared as per manufacturers recommendations.

E. Plexipave Color Base as required to meet project requirements.

F. Plexichrome Color as required to meet project requirements.

1.3 EXECUTION:

A. Personnel used to install athletic wearing surface must have a minimum of three years experience and at least three jobs with similar square footage of placement.

B. When required, asphaltic concrete base shall be placed to conform to manufacturer’s planarity requirements.

C. Protect adjacent surfaces not to receive coating during application.

D. All finished surfaces must have a uniform appearance and be free of ridges and tool marks and shall not vary more than 1/8" in 10 feet measured in any direction.

END OF SECTION 32 18 23 29

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SECTION 32 18 23 29a - SYNTHETIC TURF

1.1 GENERAL

A. Description Of Work
1. This section covers the furnishing and/or installation of: synthetic turf with covers for cut-outs; paint lines and markings for football, soccer and baseball fields; the painting of a logo at midfield; line painter equipment, portable blower for ground clean-up, turf vacuum cleaner, and pylon markers. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals:
1. Turf covers for baseball infield cutouts.
2. Painting template for a logo.
3. Layouts for lines and markings of game fields.
4. Maintenance Manual: 2 copies, providing a full description of materials to be used for maintaining Synthetic Turf System.
5. Manufacturer's literature for line painter equipment, turf vacuum cleaner, and portable blowers.
6. Warranties: For synthetic turf, for line painter equipment, for turf vacuum cleaner, and for portable blowers.
7. Synthetic turf: Sample, technical data and manufacturer's directions for installation and maintenance.
8. Line Paint: Manufacturer's literature and application directions.

C. Warranties: The warranty submitted shall have the following characteristics:
1. Shall provide full coverage for eight (8) years, from date of first use.
2. Shall warrant materials and workmanship.
3. Shall warrant that the materials installed meet or exceed the product specifications.
4. Shall have a provision to either: (a) make repairs or (b) replace such portions of the installed materials that are no longer serviceable, to maintain a serviceable and playable surface, and make good without cost or expense to the Owner.
5. Shall state all limitations and exclusions.
6. Shall be a warranty from a single source covering workmanship and all self-manufactured or procured materials.
7. Warranty shall be for full value, not prorated.

1.2 PRODUCTS

A. Synthetic Turf
1. Synthetic turf shall be Astro Turf-8, by Astro Turf Industries, Inc., 809 Kenner Street, Dalton, Georgia 30720, or approved equivalent.
2. Turf fabric: Knitted of nylon 6.6 ribbon with a polyester filament backing yarns and weighing approximately 63 ounces per square yard.
3. Pile material: 500 denier, textured nylon, 6.6 ribbon with a 1/2-inch pile height to give the appearance of mown grass; weight 50 ounces per square yard; pigmented green and stabilized for outdoor exposure.
4. Backing Yarns: High strength polyester fiber yarns, heat set for maximum dimensional stability.

B. Underpad
1. Underpad: 5/8-inch thick, energy-absorbing, made of closed cell foam, reinforced with carbon black, and perforated for drainage.
2. Pad density: 7.5 pounds per cubic foot.
3. Compression module: 25%, 8 pounds per square inch.

4. Perforations: 3/8-inch holes, 3 on center in a staggered pattern, factory perforated.

C. Adhesives for bonding the synthetic turf to the pad shall be weather-resistant to withstand the climate of the site and shall be compatible with the materials of the turf and pad.

D. All butt seams of the turf surface shall be sewn and glued.

E. Paint shall be Sherwin-Williams "Watch-Guard System Metalex" semi-gloss enamel, or approved equivalent.

F. Line painter shall be Model 98-331, as manufactured by Binks Co., or approved equivalent, with 5 gallon pressure-tested tank, adjustable line marker, quick disconnect for ease of cleaning, 12" front pneumatic wheels, 5HP 4-cycle air-cooled gasoline engine, air-actuated spray gun, dual cylinder compressor.

G. Turf vacuum cleaner shall be Model BT-80-VIC, manufactured by the Billy Goat Industries, Inc., Lees Summit, MO, or approved equivalent. Vacuum shall be 8 HP Push-gasoline Big Wheel model complete with 5" intake hose kit (Part No. 800521) exhaust hose kit (Part No. 800077), and caster assembly (Part No. 800065).

H. Portable Blower for Ground Cleanup
   1. Windmill "Fast-Blo", Model No. 22B hand-held gas power blower as supplied by A.M. Leonard Inc., Piqua, Ohio, or approved equivalent.
   2. Variable speed control, 2-cycle gas engine type, weighing 10 pounds.

I. Football Pylons: Model No. "WP-12"
   1. "Ethafoam", water and mildew resistant, size 4" x 4" x18", of standard bright color.
   2. Weighted: Springs back upon impact.
   3. Provide two (2) sets of twelve (12) pylons for a total of 24, for football field.

J. Soccer Flags
   1. Soccer Flags: Model "WSF" as manufactured by Marty Gilman, Inc., Gilman, CT. 06336, or approved equivalent.
   2. Provide two (2) sets of four (4) flags for a total of eight, for soccer field.

K. Baseball Infield Conversion System
   1. Submit Shop Drawings indicating method of detailing conversion panels for approval.
   2. Panels shall be removable in conversion area.
   3. Cut panels from same synthetic turf material as football field, to match.
   4. Provide spacers and pad wedges.

1.3 EXECUTION

A. Before any synthetic turf is installed, the Contractor shall inspect the asphaltic concrete base and, when satisfied with its condition, shall notify the Owner in writing of acceptance of the base.

B. A manufacturer's representative shall be present at the job site when the synthetic turf is installed. Turf shall be laid in strict accordance with the manufacturer's instructions by workmen who are skilled in this type of work.

C. Turf material shall be protected before, during and after installation.

D. Installed work and materials of other trades shall be protected.

E. Assurance
1. Qualified bidders must have successfully installed at least five (5) other outdoor installations of synthetic stadium surface within the last three (3) years of a type described herein.
2. The field installation shall be made under the direct, active, personal supervision of technical representatives of the synthetic turf manufacturer. All key positions shall be manned by experienced employees of the installer.
3. The synthetic turf contractor shall keep a full-time superintendent on the project during the installation of the synthetic turf.
4. The synthetic turf system supplied shall be of previous acceptance at all levels of competition, including University and Professional.

F. Underpad Installation
1. At "float drain" system: strip glue underpad at all joints.
2. At "vertical drain" system: provide intermittent gluing at a spread rate of 150-160 sq. ft./gal.
3. Sew Pad joints, using thread and stitching recommended by the synthetic turf manufacturer.
4. Lay out work so that seams of the underpad are offset from the seams of turf, but not less than 12".

G. Turf Installation
1. The synthetic turf shall be bonded to the pad with no wrinkles, ripples or bubbles. Slits in the fabric to relieve such defects are not permitted. Joints in the turf shall be offset from joints of the pad by not less than 12".
2. Side seams in the fabric shall be at 15'-0" intervals, at 5-yard lines for the football field. There shall be no cross or head seams.
3. Sew seams with high strength polyester fiber cord and lay with a bed of adhesive. Seams shall be flat, tight and permanent, with no separation or fraying.
4. Covers for the baseball infield cut-outs shall be flush and tight. Install covers and check for proper fittings.
5. Insert edges of turf in trench drain receptor at perimeter of field for "float drain" systems; terminated edges at concrete curb and wood nailer at "vertical drain" systems.
6. Provide covering caps for football and soccer goal posts and markers within the playing fields.
7. At completion, remove all excess materials and all debris resulting from operations of Work in this Section. Leave entire Work in neat, clean condition.

H. Painting
1. Lines and markings for game fields shall be painted in accordance with the approved Shop Drawings.
2. Any logo shall be painted at midfield in accordance with the approved Shop Drawings.

I. Maintenance
1. Manual shall describe the materials, devices and procedures to be followed for use and maintenance or the synthetic turf system, including the cleaning, paint application and removal, and conversion techniques. Include any precautions required by the warranty.
2. Training: Give demonstrations and training sessions, devoting a sufficient amount of time to thoroughly instruct the Owner's personnel in operation and maintenance (for cleaning, conversion of baseball-to-football, and line striping) of the synthetic turf system and equipment.

J. Acceptance
1. Before the acceptance of the work, should any imperfect areas or spots develop in the surface, such areas shall be removed and replaced with new materials.
2. All such repair work shall be done at no additional cost to the Owner.

K. At the completion of the Work, remove all material scraps, debris, and equipment from the site and leave the synthetic turf area ready for use.

END OF SECTION 32 18 23 29a

Task	Specification	Specification Description
32 18 23 29	32 18 16 13a	Track, Court, And Playground Markings
32 18 23 29	11 68 23 13	Playing Fields
32 18 23 33	32 18 23 29	Colored Athletic Wearing Surface
32 18 23 33	32 18 23 29a	Synthetic Turf
32 18 23 33	32 18 16 13a	Track, Court, And Playground Markings
32 18 23 33	32 18 16 13b	Synthetic Running Track Surface
32 18 23 39	32 18 23 29	Colored Athletic Wearing Surface
32 18 23 39	32 18 23 29a	Synthetic Turf
32 18 23 39	32 18 16 13a	Track, Court, And Playground Markings
32 18 23 39	32 18 16 13b	Synthetic Running Track Surface
32 18 23 53	32 18 16 13a	Track, Court, And Playground Markings
32 18 23 53	11 68 23 13	Playing Fields
32 18 23 56	32 18 23 29	Colored Athletic Wearing Surface
32 18 23 56	32 18 23 29a	Synthetic Turf
32 18 23 56	32 18 16 13a	Track, Court, And Playground Markings
32 18 23 56	11 68 23 13	Playing Fields
32 18 23 61	32 18 23 29	Colored Athletic Wearing Surface
32 18 23 61	32 18 23 29a	Synthetic Turf
32 18 23 61	32 18 16 13a	Track, Court, And Playground Markings
32 31 11 00	31 23 16 16	Chain-Link Fences And Gates

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SECTION 32 31 13 13 - HIGH-SECURITY CHAIN-LINK FENCES AND GATES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for high-security chain-link fences and gates. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. High-security chain-link fences.
      b. Gates: Motor operated, horizontal slide and swing.

C. Performance Requirements
   1. Delegated-Design Submittal: For chain-link fences and gate framework indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   2. Structural Performance: Chain-link fences and gate framework shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to ASCE/SEI 7:
      a. Minimum Post Size: Determine according to ASTM F 1043 for framework up to 12 feet (3.66 m) high, and post spacing not to exceed 10 feet (3 m) for Material Group IA, ASTM F 1043, Schedule 40 steel pipe **OR** Group IC, electric-resistance-welded round steel pipe, **as directed**.
      OR
      Minimum Post Size and Maximum Spacing: Provide line posts of size and in spacing indicated, but not less than sizes and spacings determined according to ASTM F 1916, including Appendix **OR** CLFMI WLG 2445, **as directed**, based on mesh size and pattern specified and the following:
         1) Wind Loads: Determine design wind loads applicable to Project from basic wind speed and exposure category according to CLFMI WLG 2445.
         2) Exposure Category: B **OR** C **OR** D, **as directed**.
         3) Fence Height: 10 feet (3 m).
         4) Material Group: IA, ASTM F 1043, Schedule 40 steel pipe **OR** IC, electric-resistance-welded round steel pipe, **as directed**.
      b. Fabric Tension: Provide fences in which fabric deflections do not exceed those indicated in Table X1.1 of ASTM F 1916 when tested by applying a 30-lbf (133-N) force at midpoint between rails and horizontally between posts for every eighth lower panel along the fence line.
      c. Fence Post Rigidity: Provide fences in which post deflections do not exceed 3/4 inch (19 mm) when tested according to ASTM F 1916 by applying a 50-lbf (222-N) force at midheight of every eighth post along the fence line.
   3. Lightning Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

D. Submittals
   1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chain-link fences and gates, **as directed**.
      a. Fence and gate posts, rails, and fittings.
      b. Chain-link fabric, reinforcements, and attachments.
      c. Accessories: Barbed wire **OR** Barbed tape, **as directed**.

d. Gates and hardware.
e. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
f. Wiring Diagrams: For power, signal, and control wiring.

2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show accessories, hardware, gate operation, and operational clearances.
   a. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
   b. Wiring Diagrams: For power, signal, and control wiring.
3. Samples: Prepared on Samples of size indicated below:
   a. Polymer-Coated Components: In 6-inch (150-mm) lengths for components and on full-sized units for accessories.
4. Delegated-Design Submittal: For chain-link fences and gate framework indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
5. Qualification Data: For qualified professional engineer **OR** testing agency **OR** factory-authorized service representative, **as directed**.
6. Product Certificates: For each type of chain-link fence, operator, **as directed**, and gate, from manufacturer.
7. Product Test Reports: For framing strength according to ASTM F 1043.
8. Field quality-control reports.
9. Soil sterilization certificate of treatment stating materials and quantities used, and date of application.
10. Operation and Maintenance Data: For the following to include in emergency, operation, and maintenance manuals:
    a. Polymer finishes.
    b. Gate hardware.
    c. Gate operator.
11. Warranty: Sample of special warranty.

E. Quality Assurance
1. Testing Agency Qualifications: For testing fence grounding. Member company of NETA or an NRTL **OR** one who meets the requirements necessary for certification, **as directed**.
   a. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing **OR** one who meets the requirements necessary for certification, **as directed**.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for automatic gate operators serving as a required means of access.
4. Preinstallation Conference: Conduct conference at Project site.

F. Project Conditions
1. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer **OR** Installer, **as directed**, agrees to repair or replace components of high-security chain-link fences and gates that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Deflection of fence fabric beyond design limits.

2) Deterioration of metals, metal finishes, and other materials beyond normal weathering.
3) Faulty operation of gate operators and controls.
b. Warranty Period: Five **OR** 15, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Chain-Link Fence Fabric
1. Chain-Link Fence Fabric: Provide fabric in one **OR** two, **as directed**,-piece heights measured between top and bottom of outer edge of selvage. Comply with CLFMI Product Manual and with requirements indicated below:
a. Fabric Height: As indicated on Drawings **OR** As directed.
1) Steel Wire Fabric: Wire with a diameter of 0.192 inch (4.88 mm) **OR** 0.148 inch (3.76 mm) **OR** 0.120 inch (3.05 mm) **OR** 0.113 inch (2.87 mm), **as directed**.
a) Mesh Size: 2 inches (51 mm) **OR** 1 inch (25.4 mm) **OR** 3/8 inch (9.5 mm), **as directed**.
b. Fabric Heights and Overlap: As indicated on Drawings **OR** As directed.
1) Steel Wire Lower Fabric: Wire with a diameter of 0.192 inch (4.88 mm) **OR** 0.148 inch (3.76 mm) **OR** 0.120 inch (3.05 mm) **OR** 0.113 inch (2.87 mm), **as directed**.
a) Mesh Size: 2 inches (51 mm) **OR** 1 inch (25.4 mm) **OR** 3/8 inch (9.5 mm), **as directed**.
2) Steel Wire Upper Fabric: Wire with a diameter of 0.120 inch (3.05 mm).
a) Mesh Size: 3/8 inch (9.5 mm).
c. Aluminum-Coated Fabric: ASTM A 491, Type I, 0.40 oz./sq. ft. (122 g/sq. m) **OR** 0.35 oz./sq. ft. (107 g/sq. m) **OR** 0.30 oz./sq. ft. (92 g/sq. m), **as directed**.
d. Zinc-Coated Fabric: ASTM A 392, Type II, Class 1, 1.2 oz./sq. ft. (366 g/sq. m) **OR** Class 2, 2.0 oz./sq. ft. (610 g/sq. m), **as directed**, with zinc coating applied before **OR** after, **as directed**, weaving.
e. Zn-5-Al-MM Aluminum-Mischmetal-Coated Fabric: ASTM F 1345, Type III, Class 2, 1.0 oz./sq. ft. (305 g/sq. m).
f. Polymer-Coated Fabric: ASTM F 668, Class 2b over aluminum **OR** zinc **OR** Zn-5-Al-MM-alloy, **as directed**,-coated steel wire.
1) Color: Dark green **OR** Olive green **OR** Brown **OR** Black **OR** As selected by the Owner from manufacturer's full range, **as directed**, complying with ASTM F 934.
g. Coat selvage ends of fabric that is metallic coated before the weaving process with manufacturer's standard clear protective coating.
h. Selvage: Twisted and barbed top and bottom.

B. Security Fence Framing
1. Posts and Rails: Comply with ASTM F 1043 for framing, including rails, braces, and line; terminal; and corner posts.
a. Fence Height: 96 inches (2440 mm) **OR** 12 feet (3.66 m) **OR** As indicated on Drawings, **as directed**.
b. Heavy **OR** Light, **as directed**, Industrial Strength: Material Group IA, round steel pipe, Schedule 40 **OR** Group IC, round steel pipe, electric resistance-welded pipe, **as directed**.
1) Line Post: 2.375 inches (60 mm) in diameter **OR** 2.875 inches (73 mm) in diameter **OR** 4 inches (100-mm) in diameter **OR** 6.625 inches (168 mm) in diameter **OR** 8.625 inches (168 mm) in diameter **OR** 2.25 by 1.70 inches (67 by 43 mm) **OR** 3.25 by 2.50 inches (83 by 64 mm), **as directed**.
2) End, Corner, and Pull Post: 2.875 inches (73 mm) in diameter **OR** 4.0 inches (102 mm) in diameter **OR** 6.625 inches (168 mm) in diameter **OR** 8.625 inches (168 mm) in diameter, **as directed**.
c. Rail Members: Intermediate, top, and brace, **as directed**, rails complying with ASTM F 1043 for Heavy Industrial.
d. Metallic Coating for Steel Framing:

1) Type A, consisting of not less than minimum 2.0-oz./sq. ft. (0.61-kg/sq. m) average zinc coating per ASTM A 123/A 123M or 4.0-oz./sq. ft. (1.22-kg/sq. m) zinc coating per ASTM A 653/A 653M.
2) Type B, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film.
3) External, Type B, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film. Internal, Type D, consisting of 81 percent, not less than 0.3-mil- (0.0076-mm-) thick, zinc-pigmented coating.
4) Type C, Zn-5-Al-MM alloy, consisting of not less than 1.8-oz./sq. ft. (0.55-kg/sq. m) coating.
5) Coatings: Any coating above.

e. Polymer coating over metallic coating.
1) Color: Match chain-link fabric **OR** Dark green **OR** Olive green **OR** Brown **OR** Black **OR** As selected from manufacturer's full range, **as directed**, complying with ASTM F 934.

C. Tension Wire
1. Metallic-Coated Steel Wire: 0.177-inch- (4.5-mm-) diameter, marcelled tension wire complying with ASTM A 817 and ASTM A 824, with the following metallic coating:
a. Type I, aluminum coated (aluminized).
b. Type II, zinc coated (galvanized) by hot-dip **OR** electrolytic, **as directed**, process, with Class 5 minimum coating weight of not less than 2.0 oz./sq. ft. (610 g/sq. m) of uncoated wire surface.
2. Polymer-Coated Steel Wire: 0.177-inch- (4.5-mm-) diameter, tension wire complying with ASTM F 1664, Class 1 **OR** Class 2a **OR** Class 2b, **as directed**, over aluminum **OR** zinc **OR** Zn-5-Al-MM-alloy, **as directed**,-coated steel wire.
a. Color: Match chain-link fabric **OR** Dark green **OR** Olive green **OR** Brown **OR** Black **OR** As selected from manufacturer's full range, **as directed**, complying with ASTM F 934.

D. Swing Gates
1. General: Comply with ASTM F 900 for gate posts and single **OR** double, **as directed**, swing gate types. Provide automated vehicular gates that comply with ASTM F 2200, **as directed**.
a. Gate Leaf Width: 36 inches (914 mm) **OR** As indicated, **as directed**.
b. Gate Fabric Height: 72 inches (1830 mm) or less **OR** More than 72 inches (1830 mm) **OR** As indicated, **as directed**.
2. Pipe and Tubing:
a. Zinc-Coated Steel: Comply with ASTM F 1043 and ASTM F 1083; protective coating and finish to match fence framing **OR** manufacturer's standard protective coating and finish, **as directed**.
b. Aluminum: Comply with ASTM B 429/B 429M; mill **OR** manufacturer's standard, **as directed**, finish.
c. Gate Post Size and Weight: Not less than required by ASTM F 900 **OR** ASTM F 1916, **as directed**.
d. Gate Posts: Round tubular steel **OR** Rectangular tubular steel **OR** Round tubular aluminum **OR** Rectangular tubular aluminum, **as directed**.
e. Gate Frames and Bracing: Round tubular steel **OR** Rectangular tubular steel **OR** Round tubular aluminum **OR** Rectangular tubular aluminum, **as directed**.
3. Frame Corner Construction: Welded **OR** Assembled with corner fittings, **as directed**, and 3/8-inch- (9.5-mm-) diameter, adjustable truss rods for panels 5 feet (1.52 m) or wider.
4. Extended Gate Posts and Frame Members: Extend above top of chain-link fabric at both ends of gate frame 12 inches (300 mm) **OR** as indicated, **as directed**, as required to attach barbed wire **OR** tape, **as directed**, assemblies.
5. Provide separate isolated gate frame according to ASTM F 1916 and as indicated.

a. Separation between Hinge and Latch Post and Fence Termination Post: 2 inches (51 mm) minimum, 2-1/2 inches (63.5 mm) maximum.
6. Hardware: Comply with ASTM F 1916.
a. Hinges: 180-degree inward **OR** 180-degree outward **OR** 360-degree inward and outward, **as directed**, swing.
b. Latches permitting operation from one side **OR** both sides, **as directed**, of gate with provision for padlocking accessible from both sides of gate, **as directed-**.
c. Padlock and Chain: the Owner furnished.
d. Lock: Manufacturer's standard, **as directed**, internal device furnished in lieu of gate latch, **as directed**.
e. Closer: Manufacturer's standard, **as directed**.
f. For gates 14 feet (4.27 m) and higher, add locking device to transom.

E. Horizontal-Slide Gates
1. General: Comply with ASTM F 1184 for gate posts and single **OR** double, **as directed**, sliding gate types. Provide automated vehicular gates that comply with ASTM F 2200, **as directed**.
a. Classification: Type **I** Overhead Slide.
1) Gate Leaf Width: As indicated.
2) Gate Fabric Height: 72 inches (1830 mm) or less **OR** More than 72 inches (1830 mm) **OR** As indicated, **as directed**.
b. Classification: Type **II** Cantilever Slide, Class 1 with external **OR** Class 2 with internal, **as directed**, roller assemblies.
1) Gate Frame Width and Height: 48 inches (1200 mm) wide or less by 72 inches (1830 mm) high or less **OR** More than 48 inches (1200 mm) wide by any height **OR** As indicated, **as directed**.
2. Pipe and Tubing:
a. Zinc-Coated Steel: Protective coating and finish to match fence framing **OR** Manufacturer's standard protective coating and finish, **as directed**.
b. Aluminum: Comply with ASTM B 429/B 429M; mill **OR** manufacturer's standard, **as directed**, finish.
c. Gate Post Size and Weight: Not less than required by ASTM F 1184 **OR** ASTM F 1916, **as directed**.
d. Gate Frames and Bracing: Round tubular steel **OR** Rectangular tubular steel **OR** Round tubular aluminum **OR** Rectangular tubular aluminum, **as directed**.
3. Frame Corner Construction: Welded **OR** Assembled with corner fittings, **as directed**, and 3/8-inch- (9.5-mm-) diameter, adjustable truss rods for panels 5 feet (1.52 m) or wider.
4. Extended Gate Posts and Frame Members: Extend above top of chain-link fabric at both ends of gate frame 12 inches (300 mm) **OR** as indicated, **as directed**, as required to attach barbed wire **OR** tape, **as directed**, assemblies.
5. Overhead Track Assembly: Manufacturer's standard track, with overhead framing supports, bracing, and accessories, engineered to support size, weight, width, operation, and design of gate and roller assemblies.
6. Hardware:
a. Latches permitting operation from one side **OR** both sides, **as directed**, of gate with provision for padlocking accessible from both sides of gate, **as directed**.
b. Padlock and Chain: the Owner furnished.
c. Lock: Manufacturer's standard, **as directed**, internal device furnished in lieu of gate latch, **as directed**.
d. Hangers, roller assemblies, and stops fabricated from galvanized steel **OR** galvanized malleable iron **OR** mill-finished Grade 319 aluminum-alloy casting with stainless-steel fasteners, **as directed**.

F. Fittings
1. General: Comply with ASTM F 626.
2. Post Caps: Provide for each post.
a. Provide line post caps with loop to receive tension wire or top rail.

3. Rail and Brace Ends: For each gate, corner, pull, and end post.
4. Rail Fittings: Provide the following:
   a. Top-Rail Sleeves: Pressed steel or round steel tubing not less than 6 inches (152 mm) long.
   b. Rail Clamps: Line and corner boulevard clamps for connecting intermediate and bottom, **as directed**, rails in the fence line to line posts.
5. Tension and Brace Bands, Tension Bars, and Truss Rod Assemblies: Comply with ASTM F 2611.
6. Barbed Wire Arms: Pressed steel or cast iron **OR** Aluminum, **as directed**, with clips, slots, or other means for attaching strands of barbed wire, and means for attaching to posts **OR** integral with post cap, **as directed**; for each post unless otherwise indicated, and as follows:
   a. Provide line posts with arms that accommodate top rail or tension wire.
   b. Provide corner arms at fence corner posts, unless extended posts are indicated.
   c. Type I, single slanted arm.
   d. Type II, single vertical arm.
   e. Type III, V-shaped arm.
   f. Type IV, A-shaped arm.
   g. Bolts or rivets for connection to post.
7. Tie Wires, Clips, and Fasteners: Comply with ASTM F 626 and ASTM F 1916.
   a. High-Security Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:
      1) Metallic-Coated Steel: 0.148-inch- (3.76-mm-) **OR** 0.192-inch- (4.88-mm-), **as directed**, diameter wire; zinc **OR** aluminum, **as directed**, coating.
      2) Stainless steel.
8. Power-Driven Fabric Fasteners: Comply with ASTM F 1916.
9. Finish:
   a. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz. /sq. ft. (366 g/sq. m) of zinc.
      1) Polymer coating over metallic coating.
   b. Aluminum: Mill finish.

G. Barbed Wire
1. Steel Barbed Wire: Comply with ASTM A 121, High Security Grade, for two-strand barbed wire; 0.099-inch- (2.51-mm-) diameter line wire with 0.080-inch- (2.03-mm-) diameter, four-point round barbs spaced not more than 3 inches (76 mm) o.c.
   a. Aluminum Coating: Type A.
2. Polymer-Coated, Galvanized-Steel Barbed Wire: Comply with ASTM F 1665, Type II, for two-strand barbed wire; 0.080-inch- (2.03-mm-) diameter line wire with 0.080-inch- (2.03-mm-) diameter, four-point round aluminum-alloy **OR** galvanized-steel, **as directed**, barbs spaced not more than 3 inches (76 mm) o.c.
   a. Polymer Coating: Class 1 **OR** Class 2a **OR** Class 2b, **as directed**, over aluminum **OR** zinc **OR** Zn-5-Al-MM-alloy, **as directed**,-coated steel wire.
      1) Color: Match chain-link fabric **OR** Dark green **OR** Olive green **OR** Brown **OR** Black **OR** As selected from manufacturer's full range, **as directed**, complying with ASTM F 934.

H. Barbed Tape
1. Wire-Reinforced Tape: ASTM F 1910; with four-point, needle-sharp barbs permanently cold clenched around a core wire.
   a. Core Wire: High-tensile-strength, zinc-coated steel or stainless steel.
2. Clips: Stainless steel, 0.065 inch (1.65 mm) thick by 0.375 inch (9.5 mm) wide; capable of withstanding a minimum 150-lbf (667-N) pull load to limit extension of coil, resulting in a concertina pattern when deployed.
3. Tie Wires: Stainless steel, 0.065 inch (1.65 mm) in diameter.

4. Fabrication: Continuous coils of barbed tape as defined in ASTM F 1379 for the following characteristics:
   a. Configuration: Single **OR** Double, **as directed**, coil.
   b. Style: Helical **OR** Concertina, **as directed**, pattern.
   c. Coil Diameter(s): 18 inches (457 mm) **OR** 24 inches (610 mm) **OR** 24-inch (610-mm) inner coil and 30-inch (762-mm) outer coil **OR** As indicated on Drawings, **as directed**.
   d. Coil Loop Spacing(s): 12 inches (305 mm) **OR** Manufacturer's standard **OR** As indicated on Drawings, **as directed**.
   e. Barb Length Classification: Long, 1.2-inch (30.5-mm) **OR** Medium, 0.4-inch (10.2-mm) **OR** Short, 0.1875-inch (4.76-mm), **as directed**, barb.
   f. Barb Spacing: 4 inches (102 mm) o.c.
   g. Barb Set: Straight **OR** Offset **OR** Manufacturer's standard, **as directed**.
5. Ground Barrier Stakes: 3/8-inch- (9.5-mm-) diameter galvanized reinforcing bar, 18 inches (457 mm) long with 180-degree end hook 3-1/2 inches (89 mm) long.

I. Gate Operators
1. General: Provide factory-assembled automatic operating system designed for gate size, type, weight, and operation frequency. Provide operation control system with characteristics suitable for Project conditions, with remote-control stations, safety devices, and weatherproof enclosures; coordinate electrical requirements with building electrical system.
   a. Provide operator designed so motor may be removed without disturbing limit-switch adjustment and without affecting auxiliary emergency operator.
   b. Provide operator with UL approval **OR** UL-approved components, **as directed**.
   c. Provide electronic components with built-in troubleshooting diagnostic feature.
   d. Provide unit designed and wired for both right-hand/left-hand opening, permitting universal installation.
2. Comply with NFPA 70.
3. UL Standard: Manufacturer and label gate operators to comply with UL 325.
4. Motor Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, within installed environment, with indicated operating sequence, and without exceeding nameplate rating or considering service factor. Comply with NEMA MG 1 and the following:
   a. Voltage: 12-V dc **OR** 120 V **OR** 208-220 V **OR** NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected, **as directed**.
   b. Horsepower: 1/4 **OR** 1/3 **OR** 3/4, **as directed**.
   c. Enclosure: Open dripproof **OR** Totally enclosed **OR** Manufacturer's standard, **as directed**.
   d. Duty: Continuous duty at ambient temperature of 105 deg F (40 deg C) and at altitude of 3300 feet (1005 m) above sea level.
   e. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.
   f. Phase: One **OR** Polyphase, **as directed**.
5. Gate Operators: Gate **OR** Equipment base/pad **OR** Pedestal post **OR** In ground, **as directed**, mounted and as follows:
   a. Hydraulic Swing **OR** Slide, **as directed**, Gate Operators:
      1) Duty: Medium **OR** Heavy, **as directed**.
      2) Gate Speed: Minimum 45 feet (13.7 m) **OR** 60 feet (18.2 m), **as directed**, per minute.
      3) Maximum Gate Weight: 800 lb (363 kg).
      4) Frequency of Use: 10 cycles per hour **OR** 25 cycles per hour **OR** Continuous duty, **as directed**.
      5) Operating Type: Wheel and rail drive with manual release, **as directed**.
      6) Hydraulic Fluid: Of viscosity required for gate operation at ambient temperature range for Project.
      7) Locking: Hydraulic in both directions.
      8) Heater: Manufacturer's standard track and roller heater with thermostatic control.
   b. Mechanical Swing **OR** Slide, **as directed**, Gate Operators:
      1) Duty: Medium **OR** Heavy **OR** Maximum security, **as directed**.

2) Gate Speed: Minimum 45 feet (13.7 m) per minute **OR** 60 feet (18.2 m) per minute **OR** variable speed, **as directed**.
3) Maximum Gate Weight: 800 lb (363 kg) **OR** 3000 lb (1360 kg), **as directed**.
4) Frequency of Use: 10 cycles per hour **OR** 25 cycles per hour **OR** 60 cycles per hour **OR** Continuous duty, **as directed**.
5) Operating Type: Crank arm **OR** Enclosed **OR** Wheel and rail drive **OR** Roller chain, **as directed**, with manual release, **as directed**.
6) Drive Type: Enclosed worm gear and chain-and-sprocket, **as directed**, reducers, roller-chain drive.
OR
Drive Type: V-belt and worm gear **OR** chain-and-sprocket, **as directed**, reducers, roller-chain drive.

6. Remote Controls: Electric controls separated from gate and motor and drive mechanism, with NEMA ICS 6, Type 1 **OR** NEMA ICS 6, Type 4, **as directed**, enclosure for surface **OR** recessed or flush **OR** equipment base/pad **OR** pedestal, **as directed**, mounting and with space for additional optional equipment. Provide the following remote-control device(s):
a. Control Station: Keyed, two **OR** three, **as directed**,-position switch, located remotely from gate. Provide two keys per station.
OR
Control Station: Momentary contact, single **OR** three, **as directed**,-button operated, located remotely from gate. Key switch to lock out open and close buttons, **as directed**.
1) Function: Open, stop, **as directed**, and close.
b. Card Reader: Functions only when authorized card is presented. Programmable, magnetic multiple **OR** single, **as directed**,-code system, permitting four different access time periods, **as directed**; face-lighted unit fully visible at night, **as directed**.
1) Reader Type: Touch plate **OR** Swipe **OR** Insertion **OR** Proximity, **as directed**.
2) Features: Timed anti-passback **OR** Limited-time usage **OR** Capable of monitoring and auditing gate activity, **as directed**.
c. Digital Keypad Entry Unit: Multiple-code capability **OR** Multiple-programmable code capability, **as directed**, of not less than five **OR** 500 **OR** 2500, **as directed**, possible individual codes, consisting of one- to seven **OR** four **OR** five, **as directed**,-digit codes and permitting four different access time periods, **as directed**.
1) Features: Timed anti-passback **OR** Limited-time usage **OR** Capable of monitoring and auditing gate activity, **as directed**.
2) Face-lighted unit with metal-keyed **OR** keyless-membrane, **as directed**, keypad fully visible at night.
d. Radio Control: Digital system consisting of code-compatible universal receiver for each gate, located where indicated, with remote antenna with coaxial cable and mounting brackets designed to operate gates. Provide one **OR** two, **as directed**, programmable transmitter(s) with multiple-code capability permitting validating or voiding of not less than 1000 **OR** 10,000, **as directed**, codes per channel configured for the following functions:
1) Transmitters: Single **OR** Three, **as directed**,-button operated, with open **OR** open and close, **as directed**, function.
2) Channel Settings: Two **OR** Three **OR** Four, **as directed**, independent channel settings controlling separate receivers for operating more than one gate from each transmitter.
e. Telephone Entry System: Hands-free voice-communication system for connection to building telephone system with digital-entry code activation of gate operator and auxiliary keypad entry, **as directed**.
1) System: Designed to be wired to same line with telephone.
OR
Multiunit System: Designed to be wired to a dedicated telephone line, with capacity to access 20 **OR** 100, **as directed**, telephones and with electronic directory, **as directed**.

f. Vehicle Loop Detector: System including automatic closing timer with adjustable time delay before closing, timer cut-off switch, **as directed**, and loop detector designed to open and close gate **OR** hold gate open until traffic clears **OR** reverse gate, **as directed**. Provide electronic detector with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light designed to detect presence or transit of a vehicle over an embedded loop of wire and to emit a signal activating the gate operator. Provide number of loops consisting of multiple strands of wire, number of turns, loop size, and method of placement at location shown on Drawings, as recommended in writing by detection system manufacturer for function indicated.
   1) Loop: Wire, in size indicated for field assembly, for pave-over **OR** saw-cut with epoxy-grouted, **as directed**, installation.
      OR
      Loop: Factory preformed in size indicated; style for pave-over **OR** saw-cut with epoxy-grouted, **as directed**, installation.

g. Vehicle Presence Detector: System including automatic closing timer with adjustable time delay before closing, timer cut-off switch, **as directed**, and presence detector designed to open and close gate **OR** hold gate open until traffic clears **OR** reverse gate, **as directed**. Provide retroreflective **OR** emitter/receiver, **as directed**, detector with adjustable detection zone pattern and sensitivity, designed to detect presence or transit of a vehicle in gate pathway when an infrared beam in zone pattern is interrupted, and to emit a signal activating the gate operator.

7. Obstruction Detection Devices: Provide each motorized gate with automatic safety sensor(s). Activation of sensor(s) causes operator to immediately function as follows:
   a. Action: Reverse gate in both opening and closing cycles and hold until clear of obstruction **OR** Stop gate in opening cycle and reverse gate in closing cycle and hold until clear of obstruction, **as directed**.
   b. Internal Sensor: Built-in torque or current monitor senses gate is obstructed.
   c. Sensor Edge: Contact-pressure-sensitive safety edge, profile, and sensitivity designed for type of gate and component indicated, in locations as follows. Connect to control circuit using take-up cable reel **OR** self-coiling cable **OR** gate edge transmitter and operator receiver system, **as directed**.
      1) Along entire gate leaf leading edge (for swing gates and slide gates).
      2) Along entire gate leaf trailing edge (for slide gates).
      3) Across entire gate leaf bottom edge (for vehicular swing and slide gates complying with UL 325 or to suit Project; consider retaining for pedestrian gates).
      4) Along entire length of gate posts (for slide gates; revise for sensor edge at pinch point post of swing gates).
      5) Along entire length of gate guide posts (for Type II Cantilever Slide, Class 1 gates).
      6) Where indicated on Drawings.
   d. Photoelectric/Infrared Sensor: System designed to detect an obstruction in gate's path when infrared beam in the zone pattern is interrupted.

8. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop gate at fully retracted and fully extended positions.

9. Emergency Release Mechanism: Quick-disconnect release of operator drive system of the following type of mechanism, permitting manual operation if operator fails. Design system so control circuit power is disconnected during manual operation.
   a. Type: Integral fail-safe release, allowing gate to be pushed open without mechanical devices, keys, cranks, or special knowledge **OR** Mechanical device, key, or crank-activated release, **as directed**.

10. Operating Features:
   a. Digital Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features with capability of monitoring and auditing gate activity, **as directed**. Provide unit that is isolated from voltage spikes and surges.
   b. System Integration: With controlling circuit board capable of accepting any type of input from external devices.
   c. Master/Slave Capability: Control stations designed and wired for gate pair operation.

d. Automatic Closing Timer: With adjustable time delay before closing and timer cut-off switch, **as directed**.
e. Open Override Circuit: Designed to override closing commands.
f. Reversal Time Delay: Designed to protect gate system from shock load on reversal in both directions.
g. Maximum Run Timer: Designed to prevent damage to gate system by shutting down system if normal time to open gate is exceeded.
h. Clock Timer: 24-hour **OR** Seven-day, **as directed**, programmable for regular events.

11. Accessories:
   a. Warning Module: Audio **OR** Visual, **as directed**, constant **OR** strobe, **as directed**,-light alarm sounding three to five seconds in advance of gate operation and continuing until gate stops moving; compliant with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.
   b. Battery Backup System: Battery-powered drive and access-control system, independent of primary drive system.
      1) Fail Safe: Gate opens and remains open until power is restored.
      2) Fail Secure: Gate cycles on battery power, then fail safe when battery is discharged.
   c. External electric-powered solenoid **OR** magnetic, **as directed**, lock with delay timer allowing time for lock to release before gate operates.
   d. Fire **OR** Postal, **as directed**, box.
   e. Fire strobe **OR** siren, **as directed**, sensor.
   f. Intercom System: As required to meet Project requirements.
   g. Instructional, Safety, and Warning Labels and Signs: According to UL 325 **OR** Manufacturer's standard for components and features specified **OR** As indicated on Drawings, **as directed**.
   h. Equipment Bases/Pads: Precast concrete, depth not less than 12 inches (305 mm), dimensioned and reinforced according to gate operator component manufacturer's written instructions and as indicated on Drawings.

J. Grout And Anchoring Cement
   1. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.
   2. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer for exterior applications.

K. Fence Grounding
   1. Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.
      a. Material above Finished Grade: Copper **OR** Aluminum, **as directed**.
      b. Material on or below Finished Grade: Copper.
      c. Bonding Jumpers: Braided copper tape, 1 inch (25.4 mm) wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.
   2. Connectors and Grounding Rods: Listed in UL 467.
      a. Connectors for Below-Grade Use: Exothermic welded type.
      b. Grounding Rods: Copper-clad steel, 5/8 by 96 inches (16 by 2440 mm).

L. Soil Sterilization
   1. Soil Sterilant: Type approved by authorities having jurisdiction.
   2. Polyethylene Sheeting: 6 mils (0.15 mm) thick, black, and serving as soil separation fabric.
   3. Stone Ground Cover: 3/4- to 2-inch (19- to 51-mm) crushed stone or washed gravel.

1.3 EXECUTION

A. Examination
1. Examine areas and conditions, with Installer present, for compliance with requirements for a verified survey of property lines and legal boundaries, **as directed**, site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
a. Do not begin installation before final grading is completed unless otherwise permitted by the Owner.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (152 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

C. Installation, General
1. Install chain-link fencing to comply with ASTM F 567 **OR** ASTM F 1916, **as directed**, and more stringent requirements specified.
a. Install fencing on established boundary lines inside property line.

D. Chain-Link Fence Installation
1. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.
2. Post Setting: Set posts in concrete **OR** with mechanical anchors **OR** by mechanically driving into soil, **as directed**, at indicated spacing into firm, undisturbed soil.
a. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
b. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
1) Exposed Concrete: Extend 2 inches (51 mm) above grade or to same elevation as concrete grade beam, **as directed**; shape and smooth to shed water.
2) Concealed Concrete: Top 2 inches (51 mm) below grade as indicated on Drawings to allow covering with surface material.
3) Posts Set into Concrete in Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout **OR** anchoring cement, **as directed**, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.
4) Posts Set into Voids in Concrete: Form or core drill holes not less than 5 inches (127 mm) deep and 3/4 inch (19 mm) larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout **OR** anchoring cement, **as directed**, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.
3. Terminal Posts: Locate and install terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more, at any abrupt change in grade, and at intervals not greater than 500 feet (152 m). For runs exceeding 500 feet (152 m), space pull posts an equal distance between corner or end posts.
4. Line Posts: Space line posts uniformly at 96 inches (2440 mm) **OR** 10 feet (3 m), **as directed**, o.c.
5. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

a. Locate horizontal braces at midheight of fabric 72 inches (1830 mm) or higher, on fences with top rail and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

6. Barbed Wire Arms: Bolt or rivet to top of post. Angle single arms away from approach side of fence.
7. Tension Wire: Install according to ASTM F 567 and ASTM F 1916, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch- (3.05-mm-) diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches (610 mm) o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:
   a. Extended along top and bottom, **as directed**, of fence fabric. Install top tension wire through post cap loops. Install bottom tension wire within 6 inches (152 mm) of bottom of fabric and tie to each post with not less than same diameter and type of wire.
   b. Extended along top of barbed wire arms **OR** extended posts, **as directed**, and top of fence fabric for supporting barbed tape.
   c. As indicated.
8. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended by fencing manufacturer.
9. Bottom Rails: Install and secure to posts with fittings; anchor rail at midspan to concrete footing **OR** continuous grade beam, **as directed**.
10. Chain-Link Fabric: Apply fabric on the approach side of fence, inside of enclosing framework. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
    a. Leave 1-1/2 inches (38 mm) **OR** 2 inches (51 mm), **as directed**, between finish grade or surface and bottom selvage unless otherwise indicated.
    b. Where indicated, bury an 18-inch- (457-mm-) wide, polymer-coated fabric 12 inches (305 mm) into trench; overlap above-grade fabric 6 inches (152 mm) and secure to bottom rail with tie wires. Backfill and compact trench.
    c. Overlapping Fabric: At or between post or rail according to ASTM F 1916, with wire ties or steel strap method.
11. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches (381 mm) o.c.
12. Tie Wires: Power-fastened or manually fastened ties configured to wrap a full 360 degrees around rail or post and a minimum of one complete diamond of fabric. Twist ends one and one-half machine twists or three full manual twists, and cut off protruding ends to preclude untwisting by hand.
    a. Maximum Spacing: Tie fabric to line posts at 12 inches (305 mm) o.c. and to braces at 24 inches (610 mm) o.c.
13. Power-Driven Fasteners: Fasten 0.192- or 0.148-inch (4.87- or 3.76-mm) wire fabric with 2- or 1-inch (51- or 25.4-mm) mesh size.
    a. Fasten fabric to line posts 12 inches (305 mm) o.c. and to braces 24 inches (610 mm) o.c.
14. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts, **as directed**.
15. Barbed Wire: Install barbed wire uniformly spaced as indicated on Drawings **OR** as directed. Pull wire taut, install securely to extension arms, and secure to end post or terminal arms.
16. Barbed Tape: Comply with ASTM F 1911. Install barbed tape uniformly in configurations indicated and fasten securely to prevent movement or displacement.
17. Ground Barrier Stakes: Stake coils at 10 feet (3 m) o.c., driven to full depth.

E. Gate Installation

1. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-

resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

F. Gate Operator Installation
1. General: Install gate operators according to manufacturer's written instructions, aligned and true to fence line and grade.
2. Excavation for Support Posts **OR** Pedestals **OR** Equipment Bases/Pads, **as directed**: Hand-excavate holes for bases/pads, in firm, undisturbed soil to dimensions and depths and at locations as required by gate operator component manufacturer's written instructions and as indicated.
3. Vehicle Loop Detector System: Cut grooves in pavement and bury **OR** Bury, **as directed**, and seal wire loop according to manufacturer's written instructions. Connect to equipment operated by detector.
4. Comply with NFPA 70 and manufacturer's written instructions for grounding of electric-powered motors, controls, and other devices.

G. Grounding And Bonding
1. Fence Grounding: Install at maximum intervals of 100 feet (30 m) except as follows:
   a. Gates and Other Fence Openings: Ground fence on each side of opening.
      1) Bond metal gates to gate posts.
      2) Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches (457 mm) below finished grade.
2. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet (45 m) on each side of crossing.
3. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.
4. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches (152 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location, including the following:
   a. Make grounding connections to each barbed wire strand with wire-to-wire connectors designed for this purpose.
   b. Make grounding connections to each barbed tape coil with connectors designed for this purpose.
5. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.
6. Connections: Make connections to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
   a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
   b. Make connections with clean, bare metal at points of contact.
   c. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
   d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
   e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
7. Bonding to Lightning Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor complying with NFPA 780.

H. Soil Sterilization
1. General: Comply with ASTM F 1916.
2. Apply sterilant after completing grounding and other below-grade electrical work along fence line and within zone between double-row chain-link fence installation.

3. Install soil separation fabric continuously between double-row chain-link fence installation, overlapping punctures and joints 6 inches (152 mm).
4. Lay continuous 3-inch- (75-mm-) deep bed of crushed stone or washed gravel over soil separation fabric.
5. Extend soil sterilization 4 feet (1.2 m) **OR** 6 feet (1.8 m), **as directed**, beyond outside and inside of fence.

I. Field Quality Control
1. Fabric Testing: Test fabric tension according to ASTM F 1916.
2. Fence Post Rigidity Testing: Test line posts for rigidity according to ASTM F 1916.
3. Grounding-Resistance Testing: Engage a qualified testing agency to perform tests and inspections.
   a. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance no fewer than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method according to IEEE 81.
   b. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify the Owner promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.
   c. Report: Prepare test reports, certified by testing agency, of grounding resistance at each test location. Include observations of weather and other phenomena that may affect test results.

J. Adjusting
1. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
2. Automatic Gate Operator: Energize circuits to electrical equipment and devices. Adjust operators, controls, safety devices, alarms, **as directed**, and limit switches.
   a. Hydraulic Operator: Purge operating system, adjust pressure and fluid levels, and check for leaks.
   b. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   c. Test and adjust controls, alarms, **as directed**, and safeties. Replace damaged and malfunctioning controls and equipment.
3. Lubricate hardware, gate operator, **as directed**, and other moving parts.

K. Demonstration
1. Train the Owner's personnel to adjust, operate, and maintain high-security chain-link fences and gates.

END OF SECTION 32 31 13 13

Task	Specification	Specification Description
32 31 13 13	01 22 16 00	No Specification Required
32 31 13 13	31 13 13 00	Tree Protection And Trimming
32 31 13 13	31 23 16 16	Chain-Link Fences And Gates

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SECTION 32 31 19 00 - ORNAMENTAL METAL FENCES AND GATES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of ornamental metal fences and gates. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Decorative metallic-coated steel tubular picket fences.
      b. Decorative metallic-coated steel wire fences.
      c. Decorative metallic-coated steel security fences.
      d. Decorative steel fences.
      e. Decorative aluminum fences.
      f. Swing gates.
      g. Horizontal-slide gates.
      h. Gate operators, including controls.

C. Performance Requirements
   1. Lightning-Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

D. Submittals
   1. Product Data: For each type of product indicated.
   2. Shop Drawings: For gates. Include plans, elevations, sections, details, and attachments to other work.
      a. Wiring Diagrams: For power, signal, and control wiring.
   3. Samples: For each fence material and for each color specified.
      a. Provide Samples 12 inches (300 mm) in length for linear materials.
      b. Provide Samples 12 inches (300 mm) square for wire mesh, bar grating, and sheet or plate materials.
   4. Welding certificates.
   5. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for decorative metallic-coated steel tubular picket fences, including finish, indicating compliance with referenced standard and other specified requirements.
   6. Maintenance Data: For gate operators to include in maintenance manuals.

E. Quality Assurance
   1. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel **OR** AWS D1.2/D1.2M, "Structural Welding Code - Aluminum", **as directed**.
   2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   3. UL Standard: Provide gate operators that comply with UL 325.
   4. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for automatic gate operators on gates that must provide emergency access.
   5. Preinstallation Conference: Conduct conference at Project site.

1.2 PRODUCTS

A. Aluminum
1. Aluminum, General: Provide alloys and tempers with not less than the strength and durability properties of alloy and temper designated in paragraphs below for each aluminum form required.
2. Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T5.
3. Tubing: ASTM B 429, Alloy 6063-T6.
4. Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 6061-T6.
5. Die and Hand Forgings: ASTM B 247 (ASTM B 247M), Alloy 6061-T6.
6. Castings: ASTM B 26/B 26M, Alloy A356.0-T6.

B. Steel And Iron
1. Plates, Shapes, and Bars: ASTM A 36/A 36M.
2. Bars (Pickets): Hot-rolled, carbon steel complying with ASTM A 29/A 29M, Grade 1010.
3. Tubing: ASTM A 500, cold formed steel tubing.
4. Bar Grating: NAAMM MBG 531.
   a. Bars: Hot-rolled steel strip, ASTM A 1011/A 1011M, Commercial Steel, Type B.
   b. Wire Rods: ASTM A 510 (ASTM A 510M).
5. Uncoated Steel Sheet: Hot-rolled steel sheet, ASTM A 1011/A 1011M, Structural Steel, Grade 45 (Grade 310) or cold-rolled steel sheet, ASTM A 1008/A 1008M, Structural Steel, Grade 50 (Grade 340).
6. Galvanized-Steel Sheet: ASTM A 653/A 653M, structural quality, Grade 50 (Grade 340), with G90 (Z275) **OR** G60 (Z180), **as directed**, coating.
7. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, structural quality, Grade 50 (Grade 340), with AZ60 (AZM180) coating.
8. Castings: Either gray or malleable iron unless otherwise indicated.
   a. Gray Iron: ASTM A 48/A 48M, Class 30.
   b. Malleable Iron: ASTM A 47/A 47M.

C. Coating Materials
1. Shop Primers for Steel: Provide primers that comply with Division 09 Section(s) "Exterior Painting" OR "High-performance Coatings", **as directed**.
2. Epoxy Zinc-Rich Primer for Steel: Complying with MPI #20 and compatible with coating specified to be applied over it.
   a. Use primer with a VOC content of 420 g/L **OR** 400 g/L **OR** 340 g/L, **as directed**, or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Epoxy Primer for Galvanized Steel: Complying with MPI #101 and compatible with coating specified to be applied over it.
   a. Use primer with a VOC content of 420 g/L **OR** 400 g/L **OR** 300 g/L, **as directed**, or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
4. Epoxy Intermediate Coat: Complying with MPI #77 and compatible with primer and topcoat.
   a. Use product with a VOC content of 420 g/L **OR** 400 g/L **OR** 250 g/L, **as directed**, or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
5. Polyurethane Topcoat: Complying with MPI #72 and compatible with undercoat.
   a. Use product with a VOC content of 420 g/L **OR** 400 g/L **OR** 250 g/L, **as directed**, or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Miscellaneous Materials
1. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
   a. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for strength and compatibility in fabricated items.
2. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Division 03 Section "Miscellaneous Cast-in-place Applications) Concrete" with a minimum 28-day compressive strength of 3000 psi (20 MPa), 3-inch (75-mm) slump, and 1-inch (25-mm)

maximum aggregate size or dry, packaged, normal-weight concrete mix complying with ASTM C 387 mixed with potable water according to manufacturer's written instructions.

3. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107 and specifically recommended by manufacturer for exterior applications.

E. Grounding Materials
1. Grounding Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.
    a. Material above Finished Grade: Copper **OR** Aluminum, **as directed**.
    b. Material on or below Finished Grade: Copper.
    c. Bonding Jumpers: Braided copper tape, 1 inch (25 mm) wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.
2. Grounding Connectors and Grounding Rods: Comply with UL 467.
    a. Connectors for Below-Grade Use: Exothermic-welded type.
    b. Grounding Rods: Copper-clad steel.
        1) Size: 5/8 by 96 inches (16 by 2440 mm).

F. Decorative Metallic-Coated Steel Tubular Picket Fences
1. Decorative Metallic-Coated Steel Tubular Picket Fences: Comply with ASTM F 2408, for residential **OR** light industrial (commercial) **OR** industrial, **as directed**, application (class) unless otherwise indicated.
2. Metallic-Coated Steel Sheet: Galvanized-steel sheet or aluminum-zinc alloy-coated steel sheet.
3. Interior surface of tubes formed from uncoated steel sheet shall be hot-dip zinc coated same as exterior or coated with zinc-rich thermosetting coating to comply with ASTM F 2408.
4. Posts:
    a. End and Corner Posts: Square tubes 2-1/2 by 2-1/2 inches (64 by 64 mm) **OR** 3 by 3 inches (76 by 76 mm), **as directed**, formed from 0.108-inch (2.74-mm) nominal-thickness, metallic-coated steel sheet or formed from 0.105-inch (2.66-mm) nominal-thickness steel sheet and hot-dip galvanized after fabrication.
    b. Swing Gate Posts:
        1) Square tubes 3 by 3 inches (76 by 76 mm) formed from 0.108-inch (2.74-mm) nominal-thickness, metallic-coated steel sheet or formed from 0.105-inch (2.66-mm) nominal-thickness steel sheet and hot-dip galvanized after fabrication.
        OR
        Square steel tubing 3 by 3 inches (76 by 76 mm) **OR** 4 by 4 inches (102 by 102 mm), **as directed**, with 3/16-inch (4.76-mm) wall thickness, hot-dip galvanized.
    c. Horizontal-Slide Gate Post, Openings up to 12 Feet (3.7 m): Square steel tubing 3 by 3 inches (76 by 76 mm) **OR** 4 by 4 inches (102 by 102 mm), **as directed**, with 3/16-inch (4.76-mm) wall thickness, hot-dip galvanized.
    d. Horizontal-Slide Gate Post, Openings Wider Than 12 Feet (3.7 m): Square steel tubing 4 by 4 inches (102 by 102 mm) with 3/16-inch (4.76-mm) wall thickness, hot-dip galvanized.
    e. Guide Posts for Class 1 Horizontal-Slide Gates:
        1) Square tubes 3 by 3 inches (76 by 76 mm) formed from 0.108-inch (2.74-mm) nominal-thickness, metallic-coated steel sheet or formed from 0.105-inch (2.66-mm) nominal-thickness steel sheet and hot-dip galvanized after fabrication; installed adjacent to gate post to permit gate to slide in space between.
        OR
        Square steel tubing 3 by 3 inches (76 by 76 mm) **OR** 4 by 4 inches (102 by 102 mm), **as directed**, with 3/16-inch (4.76-mm) wall thickness, hot-dip galvanized; installed adjacent to gate post to permit gate to slide in space between.
5. Post Caps: Formed from steel sheet and hot-dip galvanized after forming **OR** UV-resistant plastic **OR** Aluminum castings **OR** Aluminum castings with round ball finials, **as directed**.
6. Rails: Square tubes **OR** Double-wall channels, **as directed**.
    a. Size: 1-1/2 by 1-1/2 inches (38 by 38 mm) **OR** 1-3/4 by 1-3/4 inches (45 by 45 mm), **as directed**.

b. Metal and Thickness: 0.079-inch (2.01-mm) nominal-thickness, metallic-coated steel sheet or 0.075-inch (1.90-mm) nominal-thickness, uncoated steel sheet, hot-dip galvanized after fabrication.

7. Pickets: Square tubes.
   a. Terminate tops of pickets at top rail for flush top appearance **OR** Extend pickets beyond top rail as indicated and terminate with UV-resistant plastic caps **OR** Extend pickets beyond top rail as indicated and terminate with galvanized-steel caps **OR** Extend pickets beyond top rail as indicated and press flat and trim to produce spear point shape, **as directed**.
   b. Picket Spacing: 6 inches (152.4 mm) **OR** 4 inches (101.6 mm) **OR** 1-3/4 inches (44 mm), **as directed**, clear, maximum.
8. Fasteners: Manufacturer's standard concealed fastening system.
9. Fasteners: Manufacturer's standard tamperproof, **as directed**, corrosion-resistant, color-coated fasteners matching fence components, with resilient polymer washers, **as directed**.
10. Galvanizing: For components indicated to be galvanized and for which galvanized coating is not specified in ASTM F 2408, hot-dip galvanize to comply with ASTM A 123/A 123M. For hardware items, hot-dip galvanize to comply with ASTM A 153/A 153M.
11. Finish: Organic coating complying with requirements in ASTM F 2408 **OR** Powder coating, **as directed**.

G. Decorative Metallic-Coated Steel Wire Fences

1. Metallic-Coated Steel Wire: Welded-wire fence fabric, hot-dip galvanized after fabrication. Weight of zinc coating shall be not less than 1.0 oz./sq. ft. (305 g/sq. m).
   a. Spacing of Vertical Wires: 1-3/4 inches (44 mm) **OR** 2 inches (51 mm) **OR** 3-1/2 inches (89 mm) **OR** 4 inches (102 mm) **OR** As indicated, **as directed**.
   b. Vertical Wire Size: 0.187 inch (4.76 mm) **OR** 0.192 inch (4.88 mm) **OR** 0.225 inch (5.72 mm) **OR** 0.25 inch (6.35 mm) **OR** 0.262 inch (6.67 mm), **as directed**.
   c. Spacing of Horizontal Wires: 1-3/4 inches (44 mm) **OR** 2 inches (51 mm) **OR** 4 inches (102 mm) **OR** 8 inches (203 mm) **OR** As indicated, **as directed**.
   d. Horizontal Wire Size: 0.187 inch (4.76 mm) **OR** 0.192 inch (4.88 mm) **OR** 0.225 inch (5.72 mm) **OR** 0.25 inch (6.35 mm) **OR** 0.312 inch (7.94 mm), **as directed**.
2. Metallic-Coated Steel Sheet: Galvanized-steel sheet or aluminum-zinc alloy-coated steel sheet.
3. Interior surface of tubes formed from uncoated steel sheet shall be hot-dip zinc coated same as exterior or coated with zinc-rich thermosetting coating to comply with ASTM F 2408.
4. Posts:
   a. Line Posts: Square tubes 2 by 2 inches (50 by 50 mm) **OR** 2-1/2 by 2-1/2 inches (64 by 64 mm) **OR** 3 by 3 inches (76 by 76 mm), **as directed**, formed from 0.064-inch (1.63-mm) **OR** 0.079-inch (2.01-mm) **OR** 0.108-inch (2.74-mm), **as directed**, nominal-thickness, metallic-coated steel sheet or formed from 0.060-inch (1.52-mm) **OR** 0.075-inch (1.90-mm) **OR** 0.105-inch (2.66-mm), **as directed**, nominal-thickness steel sheet and hot-dip galvanized after fabrication.
   b. End and Corner Posts: Square tubes 2-1/2 by 2-1/2 inches (64 by 64 mm) **OR** 3 by 3 inches (76 by 76 mm), **as directed**, formed from 0.108-inch (2.74-mm) nominal-thickness, metallic-coated steel sheet or formed from 0.105-inch (2.66-mm) nominal-thickness steel sheet and hot-dip galvanized after fabrication.
   c. Swing Gate Posts:
      1) Square tubes 3 by 3 inches (76 by 76 mm) formed from 0.108-inch (2.74-mm) nominal-thickness, metallic-coated steel sheet or formed from 0.105-inch (2.66-mm) nominal-thickness steel sheet and hot-dip galvanized after fabrication.

         OR

         Square steel tubing 3 by 3 inches (76 by 76 mm) **OR** 4 by 4 inches (102 by 102 mm), **as directed**, with 3/16-inch (4.76-mm) wall thickness, hot-dip galvanized.
   d. Horizontal-Slide Gate Post, Openings up to 12 Feet (3.7 m): Square steel tubing 3 by 3 inches (76 by 76 mm) **OR** 4 by 4 inches (102 by 102 mm), **as directed**, with 3/16-inch (4.76-mm) wall thickness, hot-dip galvanized.

e. Horizontal-Slide Gate Post, Openings Wider Than 12 Feet (3.7 m): Square steel tubing 4 by 4 inches (102 by 102 mm) with 3/16-inch (4.76-mm) wall thickness, hot-dip galvanized.

f. Guide Posts for Class 1 Horizontal-Slide Gates:

1) Square tubes 3 by 3 inches (76 by 76 mm) formed from 0.108-inch (2.74-mm) nominal-thickness, metallic-coated steel sheet or formed from 0.105-inch (2.66-mm) nominal-thickness steel sheet and hot-dip galvanized after fabrication; installed adjacent to gate post to permit gate to slide in space between.

OR

Square steel tubing 3 by 3 inches (76 by 76 mm) **OR** 4 by 4 inches (102 by 102 mm), **as directed**, with 3/16-inch (4.76-mm) wall thickness, hot-dip galvanized; installed adjacent to gate post to permit gate to slide in space between.

5. Post Caps: Formed from steel sheet and hot-dip galvanized after forming **OR** UV-resistant plastic **OR** Aluminum castings **OR** Aluminum castings with round ball finials, **as directed**.

6. Rails: Square tubes.

a. Size: 1-3/16 by 1-1/2 inches (30 by 38 mm) **OR** 1-3/8 by 1-1/2 inches (35 by 38 mm) **OR** 1-1/2 by 1-1/2 inches (38 by 38 mm), **as directed**.

b. Metal and Thickness: 0.064-inch (1.63-mm) **OR** 0.079-inch (2.01-mm), **as directed**, nominal-thickness, metallic-coated steel sheet or 0.060-inch (1.52-mm) **OR** 0.075-inch (1.90-mm), **as directed**, nominal-thickness, uncoated steel sheet, hot-dip galvanized after fabrication.

7. Fasteners: Manufacturer's standard tamperproof, **as directed**, corrosion-resistant, color-coated fasteners matching fence components with resilient polymer washers or clips, **as directed**.

8. Galvanizing: For components indicated to be galvanized and for which galvanized coating is not specified, hot-dip galvanize to comply with ASTM A 123/A 123M. For hardware items, hot-dip galvanize to comply with ASTM A 153/A 153M.

9. Finish: Organic coating complying with requirements in ASTM F 2408 **OR** Powder coating, **as directed**.

H. Decorative Metallic-Coated Steel Security Fences

1. Posts: 1-3/4-by-4-inch (45-by-102-mm) double-thickness, I-shaped sections.

a. Metal and Thickness: 0.108-inch (2.74-mm) nominal-thickness, metallic-coated steel sheet or 0.105-inch (2.66-mm) nominal-thickness, uncoated steel sheet, hot-dip galvanized after fabrication.

2. Post Caps: Aluminum castings.

3. Rails: 2-by-2-1/2-inch (50-by-64-mm) pentagon-shaped box channel designed to shed water and to enclose wire rope reinforcement.

a. Metal and Thickness: 0.108-inch (2.74-mm) nominal-thickness, metallic-coated steel sheet or 0.105-inch (2.66-mm) nominal-thickness, uncoated steel sheet, hot-dip galvanized after fabrication.

b. Wire Rope Reinforcement: 3/4-inch (19-mm) zinc-coated steel wire rope.

4. Pickets: 3/4-by-2-3/4-inch (19-by-70-mm) M-shaped pales.

a. Metal and Thickness: 0.079-inch (2.01-mm) nominal-thickness, metallic-coated steel sheet or 0.075-inch (1.90-mm) nominal-thickness, uncoated steel sheet, hot-dip galvanized after fabrication.

b. Extend pickets beyond top rail as indicated and terminate with rounded edge **OR** cut and split to form three points, **as directed**.

c. Picket Spacing: 6 inches (152.4 mm) o.c.

5. Fasteners: Stainless-steel carriage bolts with tamperproof nuts.

6. Galvanizing: For components indicated to be galvanized, hot-dip galvanize to comply with ASTM A 123/A 123M unless otherwise indicated. For hardware items, hot-dip galvanize to comply with ASTM A 153/A 153M.

7. Finish: Powder coating.

I. Decorative Steel Fences

1. Decorative Steel Fences: Fences made from steel tubing bars, **as directed**, and shapes, hot-dip galvanized, **as directed**.

2. Posts: Square steel tubing.
   a. Line Posts: 2 by 2 inches (50 by 50 mm) **OR** 2-1/2 by 2-1/2 inches (64 by 64 mm) **OR** 3 by 3 inches (76 by 76 mm), **as directed**, with 1/8-inch (3.2-mm) **OR** 3/16-inch (4.76-mm), **as directed**, wall thickness.
   b. End and Corner Posts: 2-1/2 by 2-1/2 inches (64 by 64 mm) **OR** 3 by 3 inches (76 by 76 mm) **OR** 4 by 4 inches (102 by 102 mm), **as directed**, with 1/8-inch (3.2-mm) **OR** 3/16-inch (4.76-mm), **as directed**, wall thickness.
   c. Swing Gate Posts: 3 by 3 inches (76 by 76 mm) **OR** 4 by 4 inches (102 by 102 mm), **as directed**, with 3/16-inch (4.76-mm) wall thickness.
   d. Horizontal-Slide Gate Post, Openings up to 12 Feet (3.7 m): 3 by 3 inches (76 by 76 mm) **OR** 4 by 4 inches (102 by 102 mm), **as directed**, with 3/16-inch (4.76-mm) wall thickness.
   e. Horizontal-Slide Gate Post, Openings Wider Than 12 Feet (3.7 m): 4 by 4 inches (102 by 102 mm) with 3/16-inch (4.76-mm) wall thickness.
   f. Guide Posts for Class 1 Horizontal-Slide Gates: 3 by 3 inches (76 by 76 mm) **OR** 4 by 4 inches (102 by 102 mm), **as directed**, with 3/16-inch (4.76-mm) wall thickness; installed adjacent to gate post to permit gate to slide in space between.
3. Post Caps: Formed from steel sheet **OR** Formed from steel sheet and hot-dip galvanized after forming **OR** Aluminum castings **OR** Aluminum castings with round ball finials, **as directed**.
4. Rails:
   a. Steel Tube Rails: Square steel tubing 2 by 2 inches (50 by 50 mm) **OR** 2-1/2 by 2-1/2 inches (64 by 64 mm), **as directed**, with 1/8-inch (3.2-mm) wall thickness.
   b. Steel Channel Rails: Steel channels 2 by 1 inch (50 by 25 mm) **OR** 1-1/2 by 3/4 inch (38 by 19 mm) **OR** 1-1/2 by 1/2 inch (38 by 13 mm), **as directed**.
5. Pickets: 1/2-inch- (13-mm-) square steel bars **OR** 3/4-inch- (19-mm-) square steel bars **OR** Decorative steel bars of pattern and size indicated **OR** 5/8 inch (16 mm) square by 0.065-inch (1.65-mm) steel tubes **OR** 5/8 inch (16 mm) square by 0.083-inch (2.11-mm) steel tubes **OR** 3/4 inch (19 mm) square by 0.065-inch (1.65-mm) steel tubes **OR** 3/4 inch (19 mm) square by 0.083-inch (2.11-mm) steel tubes **OR** 1 inch (25 mm) square by 0.065-inch (1.65-mm) steel tubes **OR** 1 inch (25 mm) square by 0.083-inch (2.11-mm) steel tubes, **as directed**.
   a. Terminate tops of pickets at top rail for flush top appearance **OR** Extend pickets beyond top rail as indicated and mill ends to pyramid shaped points **OR** Extend pickets beyond top rail as indicated and press flat and trim to produce spear point shape **OR** Extend pickets beyond top rail as indicated and cap with metal spear point finial **OR** Extend pickets beyond top rail as indicated and cap with metal tripoint finial, **as directed**.
   b. Picket Spacing: 6 inches (152.4 mm) **OR** 4 inches (101.6 mm) **OR** 1-3/4 inches (44 mm), **as directed**, clear, maximum.
   c. Treillage: Provide iron castings of pattern indicated between each pair of pickets.
6. Infill: Forge-welded steel bar grating.
   a. Perimeter Bars: Steel flat bars 1 by 1/8 inch (25 by 3.2 mm).
   b. Vertical Main Bars: Steel flat bars 1 by 1/8 inch (25 by 3.2 mm) **OR** 1-3/16 by 5/32 inch (30 by 4 mm), **as directed**.
   c. Vertical Main Bar Spacing: 1-21/32 inches (42 mm) **OR** 1-7/8 inches (48 mm) **OR** 2-7/16 inches (62 mm), **as directed**, o.c.
   d. Horizontal Cross Rods: 3/16-inch- (4.8-mm-) **OR** 1/4-inch- (6.4-mm-), **as directed,** diameter, steel rods.
   e. Horizontal Cross Rod Spacing: 1-3/4 inches (45 mm) **OR** 2-19/32 inches (66 mm) **OR** 5-3/16 inches (132 mm), **as directed**, o.c.
7. Infill: Custom design as indicated on Drawings.
   a. Bars: 1/2-inch- (12.7 -mm-) square steel bars **OR** 3/4-inch- (19-mm-) square steel bars **OR** 1/2-inch- (12.7 -mm-) diameter, round steel bars **OR** 3/4-inch- (19-mm-) diameter, round steel bars **OR** 1-by-1/8-inch (25-by-3.2-mm) steel flat bars **OR** 1-by-1/4-inch (25-by-6.4-mm) steel flat bars **OR** 1-by-1/2-inch (25-by-12.7 -mm) steel flat bars, **as directed**, unless otherwise indicated.

b. Square Tubes: Square steel tubing 2 by 2 inches (50 by 50 mm) **OR** 2-1/2 by 2-1/2 inches (64 by 64 mm), **as directed**, with 1/8-inch (3.2-mm) wall thickness unless otherwise indicated.
c. Round Tubes: 1-inch- (25-mm-) **OR** 1-1/2-inch- (38-mm-) **OR** 2-inch- (50-mm-) **OR** 2-1/2-inch- (64-mm-), **as directed**, diameter, round steel tubing with 1/8-inch (3.2-mm) wall thickness unless otherwise indicated.
d. Steel Plate: 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm), **as directed**, thick unless otherwise indicated.
e. Perforated Metal Sheet: Uncoated steel sheet, perforated as indicated, 0.060-inch (1.52-mm) **OR** 0.075-inch (1.90-mm) **OR** 0.105-inch (2.66-mm), **as directed**, nominal thickness.

8. Fasteners: Stainless-steel carriage bolts and tamperproof, **as directed**, nuts.
9. Fabrication:
   a. Assemble fences into sections by welding pickets to rails.
      1) Fabricate sections with clips welded to rails for fastening to posts in field.
      2) Drill posts and clips for fasteners before finishing to maximum extent possible.
   b. Fabricate bar grating infill into sections of size indicated.
      1) Fabricate rails with clips welded to rails for fastening to posts in field.
      2) Drill posts, clips, **as directed**, and bar grating for fasteners before finishing to maximum extent possible.
10. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay **OR** Finish #3 - partially dressed weld with splatter removed **OR** Finish #4 - good-quality, uniform undressed weld with minimal splatter, **as directed**.
11. Galvanizing: For items other than hardware that are indicated to be galvanized, hot-dip galvanize to comply with ASTM A 123/A 123M. For hardware items, hot-dip galvanize to comply with ASTM A 153/A 153M.
    a. Hot-dip galvanize posts and rails, **as directed**.
    b. Hot-dip galvanize rail and picket assemblies after fabrication.
    c. Hot-dip galvanize bar grating infill after fabrication.
    d. Hot-dip galvanize custom-design rail and infill assemblies after fabrication.
12. Finish for Bar Grating Infill: Powder coating.
13. Finish for Steel Items Other than Bar Grating Infill: Primed **OR** Shop painted **OR** High-performance coating, **as directed**.
14. Finish for Metallic-Coated Steel Items Other than Bar Grating Infill: High-performance coating **OR** Galvanized finish, **as directed**.

J. Decorative Aluminum Fences
1. Decorative Aluminum Fences: Fences made from aluminum extrusions.
2. Posts: Square extruded tubes.
   a. Line Posts: 2 by 2 inches (50 by 50 mm) **OR** 2-1/2 by 2-1/2 inches (64 by 64 mm) **OR** 3 by 3 inches (76 by 76 mm), **as directed**, with 0.062-inch (1.57-mm) **OR** 0.080-inch (2.03-mm) **OR** 0.093-inch (2.36-mm) **OR** 0.100-inch (2.54-mm) **OR** 0.125-inch (3.18-mm), **as directed**, wall thickness.
   b. End and Corner Posts: 2 by 2 inches (50 by 50 mm) **OR** 2-1/2 by 2-1/2 inches (64 by 64 mm) **OR** 3 by 3 inches (76 by 76 mm), **as directed**, with 0.062-inch (1.57-mm) **OR** 0.080-inch (2.03-mm) **OR** 0.093-inch (2.36-mm) **OR** 0.100-inch (2.54-mm) **OR** 0.125-inch (3.18-mm), **as directed**, wall thickness.
   c. Swing Gate Posts: 2-1/2 by 2-1/2 inches (64 by 64 mm) **OR** 3 by 3 inches (76 by 76 mm) **OR** 4 by 4 inches (102 by 102 mm), **as directed**, with 0.125-inch (3.18-mm) **OR** 0.250-inch (6.35-mm), **as directed**, wall thickness.
   d. Horizontal-Slide Gate Post, Openings up to 12 Feet (3.7 m): 2-1/2 by 2-1/2 inches (64 by 64 mm) **OR** 3 by 3 inches (76 by 76 mm) **OR** 4 by 4 inches (102 by 102 mm), **as directed**, with 0.125-inch (3.18-mm) **OR** 0.250-inch (6.35-mm), **as directed**, wall thickness.
   e. Horizontal-Slide Gate Post, Openings Wider Than 12 Feet (3.7 m): 3 by 3 inches (76 by 76 mm) **OR** 4 by 4 inches (102 by 102 mm) **OR** 6 by 6 inches (152 by 152 mm), **as directed**, with 0.125-inch (3.18-mm) **OR** 0.250-inch (6.35-mm), **as directed**, wall thickness.

f. Guide Posts for Class 1 Horizontal-Slide Gates: 2 by 2 inches (50 by 50 mm) **OR** 2-1/2 by 2-1/2 inches (64 by 64 mm) **OR** 3 by 3 inches (76 by 76 mm), **as directed**, with 0.062-inch (1.57-mm) **OR** 0.093-inch (2.36-mm) **OR** 0.125-inch (3.18-mm), **as directed**, wall thickness; installed adjacent to gate post to permit gate to slide in space between.

3. Post Caps: Aluminum castings that cover entire top of posts **OR** project at least 1/4 inch (6 mm) beyond posts, **as directed**, with round ball finial, **as directed**.
4. Rails: Extruded-aluminum channels, 1-1/2 by 1-1/2 inches (38 by 38 mm), with 0.100-inch- (2.54-mm-) thick sidewalls and 0.070-inch- (1.78-mm-) thick top **OR** 1 by 1-1/2 inches (25 by 38 mm), with 0.082-inch- (2.08-mm-) thick sidewalls and 0.055-inch- (1.40-mm-) thick top **OR** 1-1/4 by 1-1/4 inches (32 by 32 mm), with 0.078-inch- (1.98-mm-) thick sidewalls and 0.062-inch- (1.57-mm-) thick top **OR** 1 by 1 inch (25 by 25 mm), with 0.080-inch- (2.03-mm-) thick sidewalls and 0.055-inch- (1.40-mm-) thick top **OR** 1 by 1 inch (25 by 25 mm), with 0.078-inch- (1.98-mm-) thick sidewalls and 0.062-inch- (1.57-mm-) thick top, **as directed**.
5. Pickets: Extruded-aluminum tubes, 1 inch (25 mm) square, with 0.062-inch (1.57-mm) wall thickness **OR** 1 inch (25 mm) square, with 0.060-inch (1.52-mm) wall thickness **OR** 3/4 inch (19 mm) square, with 0.050-inch (1.27-mm) wall thickness **OR** 1 by 5/8 inch (25 by 16 mm), with 0.050-inch (1.27-mm) wall thickness **OR** 5/8 inch (16 mm) square, with 0.050-inch (1.27-mm) wall thickness, **as directed**.
   a. Terminate tops of pickets at top rail for flush top appearance **OR** Extend pickets beyond top rail as indicated and terminate with UV-resistant plastic caps **OR** Extend pickets beyond top rail as indicated and terminate with cast-aluminum caps **OR** Extend pickets beyond top rail as indicated and press flat and trim to produce spear point shape **OR** Extend pickets beyond top rail as indicated and terminate with cast-aluminum spear point finial **OR** Extend pickets beyond top rail as indicated and terminate with cast-aluminum tripoint finial, **as directed**.
   b. Picket Spacing: 6 inches (152.4 mm) **OR** 4 inches (101.6 mm) **OR** 1-3/4 inches (44 mm), **as directed**, clear, maximum.
6. Fasteners:
   a. Manufacturer's standard concealed fastening system.
      OR
      Manufacturer's standard tamperproof, **as directed**, corrosion-resistant, color-coated fasteners matching fence components with resilient polymer washers, **as directed**.
7. Fabrication: Assemble fences into sections by welding **OR** fastening, **as directed**, pickets to rails.
   a. Fabricate sections with clips welded to rails for fastening to posts in field.
   b. Drill clips for fasteners before finishing.
8. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay **OR** Finish #3 - partially dressed weld with splatter removed **OR** Finish #4 - good-quality, uniform undressed weld with minimal splatter, **as directed**.
9. Finish: Baked enamel or powder coating.

K. Swing Gates
1. Gate Configuration: Single leaf **OR** Double leaf, **unless directed otherwise**.
2. Gate Frame Height: 72 inches (1830 mm), **unless directed otherwise**.
3. Gate Opening Width: 36 inches (914 mm), **unless directed otherwise**.
4. Galvanized-Steel Frames and Bracing: Fabricate members from square tubes 1-1/2 by 1-1/2 inches (38 by 38 mm) **OR** 1-3/4 by 1-3/4 inches (45 by 45 mm) **OR** 2 by 2 inches (50 by 50 mm) **OR** 2-1/2 by 2-1/2 inches (64 by 64 mm), **as directed**, formed from 0.108-inch (2.74-mm) nominal-thickness, metallic-coated steel sheet or formed from 0.105-inch (2.66-mm) nominal-thickness steel sheet and hot-dip galvanized after fabrication.
5. Steel Frames and Bracing: Fabricate members from square steel tubing 1-1/2 by 1-1/2 inches (38 by 38 mm) **OR** 2 by 2 inches (50 by 50 mm) **OR** 2-1/2 by 2-1/2 inches (64 by 64 mm), **as directed**, with 1/8-inch (3.2-mm) wall thickness. Hot-dip galvanize frames after fabrication, **as directed**.

6. Aluminum Frames and Bracing: Fabricate members from square extruded-aluminum tubes 1-1/2 by 1-1/2 inches (38 by 38 mm) **OR** 2 by 2 inches (50 by 50 mm) **OR** 2-1/2 by 2-1/2 inches (64 by 64 mm), **as directed**, with 0.100-inch (2.54-mm) **OR** 0.125-inch (3.18-mm) **OR** 0.140-inch (3.56-mm) **OR** 0.154-inch (3.91-mm), **as directed**, wall thickness.
7. Frame Corner Construction: Welded or assembled with corner fittings and 5/16-inch- (7.9-mm-) diameter, adjustable truss rods for panels 5 feet (1.52 m) wide or wider.
8. Additional Rails: Provide as indicated, complying with requirements for fence rails.
9. Infill: Comply with requirements for adjacent fence.
10. Picket Size, Configuration, and Spacing: Comply with requirements for adjacent fence.
    a. Treillage: Provide iron castings of pattern indicated between each pair of pickets. Finish as specified for adjacent fence **OR** gates, **as directed**.
11. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 5 feet (1.52 m) wide. Provide center gate stops and cane bolts for pairs of gates. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate, **as directed**.
12. Spring Hinges: BHMA A156.17, Grade 1, suitable for exterior use.
    a. Function: 320 - Gate spring pivot hinge. Adjustable tension **OR** 321 - Gate spring pivot hinge. Fixed tension, **as directed**.
    b. Material: Malleable iron.
13. Hinges: BHMA A156.1, Grade 1, suitable for exterior use.
    a. Function: 39 - Full surface, triple weight, antifriction bearing.
    b. Material: Wrought steel, forged steel, cast steel, or malleable iron.
14. Rim Locks: BHMA A156.5, Grade 1, suitable for exterior use.
    a. Function: 621 - Latchbolt by key from outside and by turn from inside. Latchbolt is held retracted by device from inside **OR** 622 - Deadbolt by key from outside and by turn from inside **OR** 629 - Deadlocking latchbolt by key from outside and by turn from inside **OR** 626 - Interlocking deadbolt operated by key from either side **OR** 627 - Interlocking deadbolt operated by key from outside and by turn from inside, **as directed**.
    b. Material: Cast, forged, or extruded brass or bronze.
    c. Mounting Plate: Configuration necessary for mounting locks. Fabricate from 1/8-inch- (3.2-mm-) thick, steel **OR** aluminum, **as directed**, plate.
15. Mortise Locks: BHMA A156.13, Grade 1, suitable for exterior use.
    a. Function: F06 - Holdback lock **OR** F07 - Storeroom or closet lock **OR** F09 - Apartment, exit, or public toilet lock **OR** F16 - Double-cylinder dead lock **OR** F17 - Dead lock, **as directed**.
    b. Material: Brass or bronze.
    c. Levers: Cast, forged, or extruded brass or bronze.
    d. Mounting Box: Configuration necessary to enclose locks. Fabricate from 1/8-inch- (3.2-mm-) thick, steel **OR** aluminum, **as directed**, plate.
16. Electric Strikes: BHMA A156.31, Grade 1, of configuration required for use with lock specified, fail safe **OR** fail secure, **as directed**, and suitable for exterior use.
    a. Mounting Plate: Configuration necessary for mounting electric strikes. Fabricate from 1/8-inch- (3.2-mm-) thick, steel **OR** aluminum, **as directed**, plate.
    b. Mounting: Mortise into post.
17. Exit Hardware: BHMA A156.3, Grade 1, Type 1 (rim exit device), with push pad actuating bar, suitable for exterior use.
    a. Function: 01 - Exit only, no trim or blank escutcheon **OR** 04 - Entrance by trim when latch bolt is released by key or set in a retracted position by key **OR** 08 - Entrance by lever. Key locks or unlocks lever **OR** 09 - Entrance by lever only when released by key. Key removable only when locked, **as directed**.
    b. Mounting Channel: Bent-plate channel formed from 1/8-inch- (3.2-mm-) thick, steel **OR** aluminum, **as directed**, plate. Channel spans gate frame. Exit device is mounted on channel web, recessed between flanges, with flanges extending 1/8 inch (3.2 mm) beyond push pad surface.
18. Cane Bolts: Provide for inactive leaf of pairs of gates. Fabricated from 1/2-inch- (12.7 -mm-) **OR** 3/4-inch- (19-mm-), **as directed**, diameter, round steel bars, hot-dip galvanized after fabrication.

Finish to match gates. Provide galvanized-steel pipe strikes to receive cane bolts in closed position **OR** both open and closed positions, **as directed**.

19. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay **OR** Finish #3 - partially dressed weld with splatter removed **OR** Finish #4 - good-quality, uniform undressed weld with minimal splatter, **as directed**.
20. Galvanizing: For items other than hardware that are indicated to be galvanized, hot-dip galvanize to comply with ASTM A 123/A 123M unless otherwise indicated. For hardware items, hot-dip galvanize to comply with ASTM A 153/A 153M.
21. Metallic-Coated Steel Finish: High-performance coating **OR** Galvanized finish, **as directed**.
22. Steel Finish: Primed **OR** Shop painted **OR** High-performance coating, **as directed**.
23. Aluminum Finish: Baked enamel or powder coating.

L. Horizontal-Slide Gates

1. Gate Configuration: Single leaf **OR** Double leaf **OR** As indicated, **as directed**.
   a. Type:
      1) Overhead slide.
         OR
         Cantilever slide, with external **OR** internal, **as directed**, roller assemblies.
2. Gate Frame Height: 72 inches (1830 mm), **unless directed otherwise**.
3. Gate Opening Width: 36 inches (914 mm), **unless directed otherwise**.
4. Galvanized-Steel Frames and Bracing: Fabricate members from square tubing.
   a. Frame Members: Square tubes 1-1/2 by 1-1/2 inches (38 by 38 mm) **OR** 1-3/4 by 1-3/4 inches (45 by 45 mm) **OR** 2 by 2 inches (50 by 50 mm) **OR** 2-1/2 by 2-1/2 inches (64 by 64 mm), **as directed**, formed from 0.108-inch (2.74-mm) nominal-thickness, metallic-coated steel sheet or formed from 0.105-inch (2.66-mm) nominal-thickness steel sheet and hot-dip galvanized after fabrication.
   b. Bracing Members: Square tubes 1-1/2 by 1-1/2 inches (38 by 38 mm) **OR** 1-3/4 by 1-3/4 inches (45 by 45 mm) **OR** 2 by 2 inches (50 by 50 mm) **OR** 2-1/2 by 2-1/2 inches (64 by 64 mm), **as directed**, formed from 0.108-inch (2.74-mm) nominal-thickness, metallic-coated steel sheet or formed from 0.105-inch (2.66-mm) nominal-thickness steel sheet and hot-dip galvanized after fabrication.
5. Steel Frames and Bracing: Fabricate members from square tubing. Hot-dip galvanize frames after fabrication, **as directed**.
   a. Frame Members: Steel tubing 1-1/2 by 1-1/2 inches (38 by 38 mm) **OR** 2 by 2 inches (50 by 50 mm) **OR** 2-1/2 by 2-1/2 inches (64 by 64 mm), **as directed**, with 1/8-inch (3.2-mm) wall thickness.
   b. Bracing Members: Steel tubing 1-1/2 by 1-1/2 inches (38 by 38 mm) **OR** 2 by 2 inches (50 by 50 mm) **OR** 2-1/2 by 2-1/2 inches (64 by 64 mm), **as directed**, with 1/8-inch (3.2-mm) wall thickness.
6. Aluminum Frames and Bracing: Fabricate members from square tubing.
   a. Frame Members: Extruded-aluminum tubes 1-1/2 by 1-1/2 inches (38 by 38 mm) **OR** 2 by 2 inches (50 by 50 mm) **OR** 2-1/2 by 2-1/2 inches (64 by 64 mm), **as directed**, with 0.100-inch (2.54-mm) **OR** 0.125-inch (3.18-mm) **OR** 0.140-inch (3.56-mm) **OR** 0.154-inch (3.91-mm), **as directed**, wall thickness.
   b. Bracing Members: Extruded-aluminum tubes 1-1/2 by 1-1/2 inches (38 by 38 mm) **OR** 2 by 2 inches (50 by 50 mm) **OR** 2-1/2 by 2-1/2 inches (64 by 64 mm), **as directed,** with 0.100-inch (2.54-mm) **OR** 0.125-inch (3.18-mm) **OR** 0.140-inch (3.56-mm) **OR** 0.154-inch (3.91-mm), **as directed**, wall thickness.
7. Frame Corner Construction:
   a. Welded frame with panels assembled with bolted or riveted corner fittings and 5/16-inch- (7.9-mm-) diameter, adjustable truss rods for panels 5 feet (1.52 m) wide or wider.
   b. Overhead Slide Gates: Welded or assembled with corner fittings including 5/16-inch- (7.9-mm-) diameter, adjustable truss rods for panels 5 feet (1.52 m) wide or wider.
8. Additional Rails: Provide as indicated, complying with requirements for fence rails.
9. Infill: Comply with requirements for adjacent fence.

10. Picket Size, Configuration, and Spacing: Comply with requirements for adjacent fence.
    a. Treillage: Provide iron castings of pattern indicated between each pair of pickets. Finish as specified for adjacent fence **OR** gates, **as directed**.
11. Overhead Track Assembly: Manufacturer's standard track, with overhead framing supports, bracing, and accessories, engineered to support size, weight, width, operation, and design of gate and roller assemblies.
12. Hardware: Latches permitting operation from both sides of gate, locking devices, hangers, roller assemblies, and stops fabricated from galvanized steel **OR** galvanized malleable iron **OR** mill-finished, Grade 319 aluminum-alloy casting with stainless-steel fasteners, **as directed**. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate, **as directed**.
13. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay **OR** Finish #3 - partially dressed weld with splatter removed **OR** Finish #4 - good-quality, uniform undressed weld with minimal splatter, **as directed**.
14. Galvanizing: For items other than hardware that are indicated to be galvanized, hot-dip galvanize to comply with ASTM A 123/A 123M unless otherwise indicated. For hardware items, hot-dip galvanize to comply with ASTM A 153/A 153M.
15. Metallic-Coated Steel Finish: High-performance coating **OR** Galvanized finish, **as directed**.
16. Steel Finish: Primed **OR** Shop painted **OR** High-performance coating, **as directed**.
17. Aluminum Finish: Baked enamel or powder coating.

M. Gate Operators
1. General: Provide factory-assembled automatic operating system designed for gate size, type, weight, and operation frequency. Provide operation control system with characteristics suitable for Project conditions, with remote-control stations, safety devices, and weatherproof enclosures; coordinate electrical requirements with building electrical system.
    a. Provide operator designed so motor may be removed without disturbing limit-switch adjustment and without affecting auxiliary emergency operator.
    b. Provide operator with UL approval **OR** UL-approved components, **as directed**.
    c. Provide electronic components with built-in troubleshooting diagnostic feature.
    d. Provide unit designed and wired for both right-hand/left-hand opening, permitting universal installation.
    e. Provide controllers, electrical devices, and wiring that comply with requirements specified in Division 22.
2. Motors: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 11 Section "Common Motor Requirements For Equipment".
    a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
    b. Horsepower: Not less than 1/4 **OR** 1/3 **OR** 1/2 **OR** 3/4, **as directed**.
    c. Enclosure: Open dripproof **OR** Totally enclosed **OR** Manufacturer's standard, **as directed**.
    d. Duty: Continuous duty at ambient temperature of 105 deg F (40 deg C) and at altitude of 3300 feet (1005 m) above sea level.
    e. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.
    f. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 22.
3. Gate Operators: Gate **OR** Concrete base **OR** Post **OR** In-ground, **as directed**, mounted and as follows:
    a. Hydraulic Swing **OR** Slide, **as directed**, Gate Operators:
        1) Duty: Light **OR** Medium **OR** Heavy, **as directed**, duty, residential **OR** commercial/industrial, **as directed**.
        2) Gate Speed: Minimum 45 feet (13.7 m) **OR** 60 feet (18.2 m), **as directed**, per minute.
        3) Maximum Gate Weight: Not to exceed operator manufacturer's recommendations.
        4) Frequency of Use: 10 cycles per hour **OR** 25 cycles per hour **OR** Continuous duty, **as directed**.

5) Locking: Hydraulic in both directions.
6) Heater: Manufacturer's standard track and roller heater with thermostatic control, as directed.
7) Operating Type: Crank arm **OR** Wheel and rail drive **OR** Roller chain, **as directed**, with manual release, **as directed**.

b. Mechanical Swing **OR** Slide, **as directed**, Gate Operators:
1) Duty: Light **OR** Medium **OR** Heavy, **as directed**, duty, residential **OR** commercial/industrial, **as directed**.
2) Gate Speed: Minimum 45 feet (13.7 m) per minute **OR** 60 feet (18.2 m) per minute **OR** variable speed, **as directed**.
3) Maximum Gate Weight: 600 lb (272 kg) **OR** 800 lb (363 kg), **as directed**.
4) Frequency of Use: 10 cycles per hour **OR** 25 cycles per hour **OR** 60 cycles per hour **OR** Continuous duty, **as directed**.
5) Operating Type: Crank arm **OR** Wheel and rail drive **OR** Roller chain, **as directed**, with manual release, **as directed**.
6) Drive Type:
a) Enclosed worm gear and chain-and-sprocket, **as directed**, reducers, roller-chain drive.
OR
V-belt and worm gear **OR** chain-and-sprocket, **as directed**, reducers, roller-chain drive.

4. Remote Controls: Electric controls separated from gate and motor and drive mechanism, with NEMA ICS 6, Type 1 **OR** NEMA ICS 6, Type 4, **as directed**, enclosure for surface **OR** recessed or flush, **as directed**, concrete base **OR** pedestal, **as directed**, mounting, and with space for additional optional equipment. Provide the following remote-control device(s):

a. Control Station:
1) Keyed, two-position **OR** three-position, **as directed**, switch with open, stop, **as directed**, and close function; located remotely from gate. Provide two keys per station.
OR
Momentary-contact, single-button-operated **OR** three-button-operated, **as directed**, with open, stop, **as directed**, and close function; located remotely from gate. Key switch to lock out open and close buttons, **as directed**.

b. Card Reader: Functions only when authorized card is presented. Programmable, multiple-code **OR** single-code, **as directed**, system, permitting four different access time periods, **as directed**, face-lighted unit fully visible at night, **as directed**.
1) Reader Type: Touch plate **OR** Swipe **OR** Insertion **OR** Proximity, **as directed**.
2) Features: Timed antipassback **OR** Limited-time usage **OR** Capable of monitoring and auditing gate activity, **as directed**.

c. Digital Keypad Entry Unit: Multiple-programmable **OR** Multiple-code, **as directed**, capability of not less than 5 **OR** 500 **OR** 2500, **as directed**, possible individual codes, consisting of 1- to 7 **OR** 4 **OR** 5, **as directed**,-digit codes, and permitting 4 different access time periods, **as directed**.
1) Features: Timed antipassback **OR** Limited-time usage **OR** Capable of monitoring and auditing gate activity, **as directed**.
2) Face-lighted unit with metal-keyed **OR** keyless-membrane, **as directed**, keypad fully visible at night.

d. Radio Control: Digital system consisting of code-compatible universal receiver for each gate, located where indicated, with remote antenna with coaxial cable and mounting brackets designed to operate gates. Provide 1 **OR** 2, **as directed**, programmable transmitter(s) with multiple-code capability permitting validating or voiding of not less than 1000 **OR** 10,000, **as directed**, codes per channel configured for the following functions:
1) Transmitters: Single **OR** Three, **as directed**,-button operated, with open and close, **as directed**, function.

2) Channel Settings: Two **OR** Three **OR** Four, **as directed**, independent channel settings controlling separate receivers for operating more than one gate from each transmitter.

e. Telephone Entry System: Hands-free, voice-communication system for connection to building telephone system with digital-entry code activation of gate operator and auxiliary keypad entry, **as directed**.
1) Residential System: Designed to be wired to same line with telephone.
2) Multiunit System: Designed to be wired to a dedicated telephone line, with capacity to access 20 **OR** 100, **as directed**, telephones, and with electronic directory, **as directed**.

f. Vehicle Loop Detector: System including automatic closing timer with adjustable time delay before closing, timer cutoff switch, **as directed**, and loop detector designed to open and close gate **OR** hold gate open until traffic clears **OR** reverse gate, **as directed**. Provide electronic detector with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light designed to detect presence or transit of a vehicle over an embedded loop of wire and to emit a signal activating the gate operator. Provide number of loops consisting of multiple strands of wire, number of turns, loop size, and method of placement at location shown on Drawings, as recommended in writing by detection system manufacturer for function indicated.
1) Loop:
a) Wire, in size indicated for field assembly, for pave-over **OR** saw cut with epoxy-grouted, **as directed**, installation.
OR
Loop: Factory preformed in size indicated; style for pave-over **OR** saw cut with epoxy-grouted, **as directed**, installation.

g. Vehicle Presence Detector: System including automatic closing timer with adjustable time delay before closing, timer cutoff switch, **as directed**, and presence detector designed to open and close gate **OR** hold gate open until traffic clears **OR** reverse gate, **as directed**. Provide retroreflective **OR** emitter/receiver, **as directed**, detector with adjustable detection zone pattern and sensitivity, designed to detect the presence or transit of a vehicle in gate pathway when infrared beam in zone pattern is interrupted, and to emit a signal activating the gate operator.

5. Obstruction Detection Devices: Provide each motorized gate with automatic safety sensor(s). Activation of sensor(s) causes operator to immediately function as follows:
a. Action:
1) Reverse gate in both opening and closing cycles and hold until clear of obstruction.
OR
Stop gate in opening cycle and reverse gate in closing cycle and hold until clear of obstruction.
b. Internal Sensor: Built-in torque or current monitor senses gate is obstructed.
c. Sensor Edge: Contact-pressure-sensitive safety edge, profile, and sensitivity designed for type of gate and component indicated, in locations as follows. Connect to control circuit using take-up cable reel **OR** self-coiling cable **OR** gate edge transmitter and operator receiver system, **as directed**.
1) Along entire gate leaf leading edge **OR** Along entire gate leaf trailing edge **OR** Across entire gate leaf bottom edge **OR** Along entire length of gate posts **OR** Along entire length of gate guide posts **OR** Where indicated on Drawings, **as directed**.
d. Photoelectric/Infrared Sensor System: Designed to detect an obstruction in gate's path when infrared beam in the zone pattern is interrupted.

6. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop gate at fully retracted and fully extended positions.

7. Emergency Release Mechanism: Quick-disconnect release of operator drive system of the following type of mechanism, permitting manual operation if operator fails. Design system so control-circuit power is disconnected during manual operation.
a. Type:

1) Integral fail-safe release, allowing gate to be pushed open without mechanical devices, keys, cranks, or special knowledge.
OR
Mechanical device, key, or crank-activated release.

8. Operating Features:
   a. Digital Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features with capability for monitoring and auditing gate activity, **as directed**. Provide unit that is isolated from voltage spikes and surges.
   b. System Integration: With controlling circuit board capable of accepting any type of input from external devices.
   c. Master/Slave Capability: Control stations designed and wired for gate pair operation.
   d. Automatic Closing Timer: With adjustable time delay before closing and timer cutoff switch, **as directed**.
   e. Open Override Circuit: Designed to override closing commands.
   f. Reversal Time Delay: Designed to protect gate system from shock load on reversal in both directions.
   g. Maximum Run Timer: Designed to prevent damage to gate system by shutting down system if normal time to open gate is exceeded.
   h. Clock Timer: 24-hour **OR** Seven-day, **as directed**, programmable for regular events.
9. Accessories:
   a. Warning Module: Audio **OR** Visual, **as directed**, ADA/ABA-compliant, constant-light **OR** strobe-light, **as directed**, alarm sounding three to five seconds in advance of gate operation and continuing until gate stops moving.
   b. Battery Backup System: Battery-powered drive and access-control system, independent of primary drive system:
      1) Fail Safe: Gate opens and remains open until power is restored.
      2) Fail Secure: Gate cycles on battery power, then fail safe when battery is discharged.
   c. External electric-powered solenoid **OR** magnetic, **as directed**, lock with delay timer allowing time for lock to release before gate operates.
   d. Fire **OR** Postal, **as directed**, box.
   e. Fire strobe **OR** siren, **as directed**, alarm.
   f. Intercom System: as directed by the Owner.
   g. Instructional, Safety, and Warning Labels and Signs: According to UL 325 **OR** Manufacturer's standard for components and features specified **OR** As indicated on Drawings, **as directed**.

N. Aluminum Finishes
1. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 2 mils (0.05 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
   a. Color and Gloss: As selected from manufacturer's full range.

O. Steel Finishes
1. Surface Preparation: Clean surfaces according to SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning **OR** SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning", **as directed**.
   a. After cleaning, apply a conversion coating suited to the organic coating to be applied over it.
2. Powder Coating: Immediately after cleaning, apply 2-coat finish consisting of epoxy primer and TGIC polyester topcoat, with a minimum total dry film thickness of not less than 8 mils (0.20 mm). Comply with coating manufacturer's written instructions.
   a. Color and Gloss: As selected from manufacturer's full range.
3. Primer Application: Apply zinc-rich epoxy primer immediately after cleaning, to provide a minimum dry film thickness of 2 mils (0.05 mm) per applied coat, to surfaces that will be exposed after assembly and installation, and to concealed surfaces.

4. Shop-Painted Finish: Comply with Division 09 Section(s) "Exterior Painting" OR "High-performance Coatings", **as directed**.
5. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.
   a. Match approved Samples for color, texture, and coverage. Remove and refinish, or recoat work that does not comply with specified requirements.

P. Metallic-Coated Steel Finishes
1. Galvanized Finish: Clean welds, mechanical connections, and abraded areas and repair galvanizing to comply with ASTM A 780.
2. Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a zinc-phosphate, **as directed**, conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and repair galvanizing to comply with ASTM A 780.
3. Powder Coating: Immediately after cleaning and pretreating, apply TGIC polyester powder-coat finish, with a minimum dry film thickness of 2 mils (0.05 mm).
   a. Color and Gloss: As selected from manufacturer's full range.
4. Powder Coating: Immediately after cleaning and pretreating, apply 2-coat finish consisting of zinc-rich, **as directed**, epoxy prime coat and TGIC polyester topcoat, with a minimum dry film thickness of 2 mils (0.05 mm) for topcoat. Comply with coating manufacturer's written instructions to achieve a minimum total dry film thickness of 4 mils (0.10 mm).
   a. Color and Gloss: As selected from manufacturer's full range.
   b. Comply with surface finish testing requirements in ASTM F 2408 except change corrosion-resistance requirement to 3000 hours without failure, **as directed**.
5. High-Performance Coating: Apply epoxy primer, epoxy intermediate coat, and polyurethane topcoat to prepared surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.
   a. Match approved Samples for color, texture, and coverage. Remove and refinish, or recoat work that does not comply with specified requirements.

1.3 EXECUTION

A. Examination
1. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.
2. Do not begin installation before final grading is completed unless otherwise permitted by the Owner.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (152.5 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

C. Decorative Fence Installation
1. Install fences according to manufacturer's written instructions.
   OR
   Install fences by setting posts as indicated and fastening rails and infill panels to posts. Peen threads of bolts after assembly to prevent removal, **as directed**.

2. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than 24 inches (600 mm) plus 3 inches (75 mm) for each foot (300 mm) or fraction of a foot (300 mm) that fence height exceeds 4 feet (1200 mm).
3. Post Setting: Set posts in concrete **OR** with mechanical anchors **OR** by mechanically driving into soil, **as directed**, at indicated spacing into firm, undisturbed soil.
   a. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
   b. Concrete Fill: Place concrete around posts and sleeves, **as directed**, and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
      1) Exposed Concrete: Extend 2 inches (50 mm) above grade. Finish and slope top surface to drain water away from post.
      2) Concealed Concrete: Top 2 inches (50 mm) below grade as indicated on Drawings to allow covering with surface material. Slope top surface of concrete to drain water away from post.
   c. Posts Set in Concrete: Extend post to within 6 inches (150 mm) of specified excavation depth, but not closer than 3 inches (75 mm) to bottom of concrete.
   d. Posts Set into Concrete in Sleeves: Use galvanized-steel pipe sleeves with inside diameter at least 3/4 inch (20 mm) larger than outside diagonal dimension of post, preset and anchored into concrete for installing posts.
      1) Extend posts at least 5 inches (125 mm) into sleeve.
      2) After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink grout, mixed and placed to comply with grout manufacturer's written instructions; shape and smooth to shed water. Finish and slope top surface of grout to drain water away from post.
   e. Posts Set into Voids in Concrete: Form or core drill holes not less than 3/4 inch (20 mm) larger than outside diagonal dimension of post.
      1) Extend posts at least 5 inches (125 mm) into concrete.
      2) Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink grout, mixed and placed to comply with grout manufacturer's written instructions. Finish and slope top surface of grout to drain water away from post.
   f. Mechanically Driven Posts: Drive into soil to depth of 30 inches (762 mm) **OR** 36 inches (914 mm), **as directed**. Protect post top to prevent distortion.
   g. Space posts uniformly at 6 feet (1.83 m) **OR** 8 feet (2.44 m), **as directed**, o.c.

D. Gate Installation
1. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

E. Gate Operator Installation
1. General: Install gate operators according to manufacturer's written instructions, aligned and true to fence line and grade.
2. Excavation for Support Posts **OR** Pedestals **OR** Concrete Bases, **as directed**: Hand-excavate holes for bases, in firm, undisturbed soil to dimensions and depths and at locations as required by gate operator component manufacturer's written instructions and as indicated.
3. Concrete Bases: Cast-in-place or precast concrete, depth not less than 12 inches (300 mm) **OR** 6 to 12 inches (150 to 300 mm) below frost line, **as directed**, dimensioned and reinforced according to gate operator component manufacturer's written instructions and as indicated on Drawings.
4. Vehicle Loop Detector System: Cut grooves in pavement, **as directed**, and bury and seal wire loop according to manufacturer's written instructions. Connect to equipment operated by detector.

5. Comply with NFPA 70 and manufacturer's written instructions for grounding of electric-powered motors, controls, and other devices.

F. Grounding And Bonding
1. Fence Grounding: Install at maximum intervals of 1500 feet (450 m) except as follows:
a. Fences within 100 Feet (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet (225 m).
1) Gates and Other Fence Openings: Ground fence on each side of opening.
a) Bond metal gates to gate posts.
b) Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches (460 mm) below finished grade.
2. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet (45 m) on each side of crossing.
3. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.
4. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches (150 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at the grounding location.
5. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.
6. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
b. Make connections with clean, bare metal at points of contact.
c. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
7. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

G. Field Quality Control
1. Grounding-Resistance Testing: Engage a qualified testing agency to perform tests and inspections.
a. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance not less than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method according to IEEE 81.
b. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify the Owner promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.
c. Report: Prepare test reports certified by a testing agency of grounding resistance at each test location. Include observations of weather and other phenomena that may affect test results.

H. Adjusting
1. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire

operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

2. Automatic Gate Operators: Energize circuits to electrical equipment and devices. Adjust operators, controls, safety devices, alarms, **as directed**, and limit switches.
   a. Hydraulic Operators: Purge Operating System, Adjust Pressure And Fluid Levels, And Check For Leaks.
   b. Operational Test: After Electrical Circuitry Has Been Energized, Start Units To Confirm Proper Motor Rotation And Unit Operation.
   c. Test And Adjust Controls, Alarms, **as directed**, And Safeties. Replace Damaged And Malfunctioning Controls And Equipment.
3. Lubricate hardware, gate operators, **as directed**, and other moving parts.

I. Demonstration
   1. Train Owner's personnel to adjust, operate, and maintain gates.

END OF SECTION 32 31 19 00

Task	Specification	Specification Description
32 31 19 00	01 22 16 00	No Specification Required
32 31 19 00	32 31 13 13	High-Security Chain-Link Fences And Gates
32 31 23 00	01 22 16 00	No Specification Required

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SECTION 32 31 29 00 - PERMANENT WOOD FENCING

1.1 GENERAL

A. Description Of Work
   1. The specification covers the furnishing and installation of materials for repair and maintenance of permanent wood fencing. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals: Shop drawings shall be submitted for approval.

1.2 PRODUCTS

A. Review MSDS and Manufacturers Application Instructions.

B. Pickets:
   1. Size: Wood For picket shall match the existing fencing in material, configuration, dimensions, texture, and finishes,
   2. Attachment: Hot-dipped galvanized nails complying with Fed. Spec. FF-N-105 shall be used to fasten pickets to rails.

C. Framework:
   1. Line Posts: 4 x 4 of required length to match existing post height and extend into the ground as required to ensure rigid installation.
   2. Terminal and Corner Posts: 4 x 4 of required length.
   3. Gate Posts: 4 x 6 and of the length required for firm embedment to resist gate action.
   4. Top Rail: 2 x 4 of length required to span between posts.
   5. Where bracing is required, it shall match top and bottom rails in dimension and finish.
   6. Metal Posts and Rails: Solid mild steel galvanized in compliance with ASTM A 123 of the length and style required to match existing.

D. Gates:
   1. Frame: 2 x 4 members with attached pickets. Configuration of gate shall match that of existing gates.
   2. Bracing: Single 2 x 4 running diagonally across the gate to opposite corners of the frame.
   3. Hardware: Hinges, latches, and other hardware shall be hot dipped galvanized and of configurations to match existing hardware. Bolts and nuts shall comply with ASTM A 307 and galvanized in compliance with ASTM A 153.

E. Finish: All wood fence members shall be given a pressure preservative treatment in a closed retort. The treatment shall comply with Fed. Spec. TT-W-571. Wood cut or sawed after treatment shall have the cut surfaces well brush-coated with the preservative used in the treatment. Paint to match existing after treatment and installation.

1.3 EXECUTION

A. Posts: Hold in line in a true vertical position by temporary bracing until backfilling is completed. Compact by hand tamping or other suitable methods to a density comparable to that of adjacent ground. Posts of fencing that are higher than four feet and exposed to strong winds and posts at all gates shall be of heavy construction and shall be embedded in concrete.

B. Rails: Install at the height and in the manner required to match existing fencing, and secure to post with fasteners similar to existing.

C. Pickets: Space, attach, and position to match existing pattern and attachment methods.

D. Accessories: Install to match existing conditions.

END OF SECTION 32 31 29 00

Task	Specification	Specification Description
32 31 29 00	01 22 16 00	No Specification Required
32 31 34 00	01 22 16 00	No Specification Required
32 31 34 00	31 23 16 16	Chain-Link Fences And Gates

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SECTION 32 32 13 00 - SEGMENTAL RETAINING WALLS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for segmental retaining walls. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes single- and multiple- depth segmental retaining walls with and without soil reinforcement.

C. Performance Requirements
1. Basis of Design: Design of segmental retaining walls is based on products indicated. If comparable products of other manufacturers are proposed, provide engineering design for proposed products, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Delegated Design: Design segmental retaining walls, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
3. Structural Performance: Engineering design shall be based on the following loads and be according to NCMA's "Design Manual for Segmental Retaining Walls."
4. Gravity loads due to soil pressures resulting from grades and sloped backfill indicated.
   a. Superimposed loads (surcharge) indicated on Drawings.
5. Seismic Performance: Engineering design shall be based on the following loads and factors and be according to NCMA's "Segmental Retaining Walls - Seismic Design Manual."
   a. Gravity loads due to soil pressures resulting from grades and sloped backfill indicated.
   b. Superimposed loads (surcharge) indicated on Drawings.
   c. Horizontal Peak Ground Acceleration (A) for Project: **As directed**.

D. Preconstruction Testing
1. Preconstruction Testing Service: Engage a qualified testing agency to perform the following preconstruction testing:
   a. Test soil reinforcement and backfill materials for pullout resistance according to ASTM D 6706.
   b. Test soil reinforcement and backfill materials for coefficient of friction according to ASTM D 5321.

E. Submittals
1. Product Data: For each type of product indicated.
2. Samples: For each color and texture of concrete unit required. Submit full-size units **OR** sections of units not less than 3 inches (75 mm) square, **as directed**.
   a. Include one full-size unit for each type of concrete unit required.
3. Delegated-Design Submittal: For segmental retaining walls indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   a. Compliance Review: Qualified professional engineer responsible for segmental retaining wall design shall review and approve submittals and source and field quality-control reports for compliance of materials and construction with design.
4. Product Certificates: For segmental retaining wall units and soil reinforcement, from manufacturer.

a. Include test data for shear strength between segmental retaining wall units according to ASTM D 6916.
b. Include test data for connection strength between segmental retaining wall units and soil reinforcement according to ASTM D 6638.
5. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for segmental retaining wall units and soil reinforcement.
a. Include test data for freeze-thaw durability of segmental retaining wall units.
b. Include test data for shear strength between segmental retaining wall units according to ASTM D 6916.
c. Include test data for connection strength between segmental retaining wall units and soil reinforcement according to ASTM D 6638.

F. Quality Assurance
1. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
2. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects.
a. Build mockup of segmental retaining wall as shown on Drawings **OR** approximately 72 inches (1800 mm) long by not less than 36 inches (900 mm) high above finished grade at front of wall, **as directed**.
1) Include typical soil reinforcement.
2) Include typical base and cap or finished top construction.
3) Include backfill to typical finished grades at both sides of wall.
4) Include typical end construction at one end of mockup.
5) Include 36-inch (900-mm) return at 1 end of mockup, with typical corner construction.
b. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
3. Preinstallation Conference: Conduct conference at Project site.
a. Review methods and procedures related to segmental retaining walls including, but not limited to, the following:
1) Structural load limitations.
2) Construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3) Field quality-control procedures.

G. Delivery, Storage, And Handling
1. Store and handle concrete units and accessories to prevent deterioration or damage due to contaminants, breaking, chipping, or other causes.
2. Store geosynthetics in manufacturer's original packaging with labels intact. Store and handle geosynthetics to prevent deterioration or damage due to sunlight, chemicals, flames, temperatures above 160 deg F (71 deg C) or below 32 deg F (0 deg C), and other conditions that might damage them. Verify identification of geosynthetics before using and examine them for defects as material is placed.

1.2 PRODUCTS

A. Segmental Retaining Wall Units
1. Concrete Units: ASTM C 1372, Normal Weight, except that maximum water absorption shall not exceed 7 percent by weight and units shall not differ in height more than plus or minus 1/16 inch (1.6 mm) from specified dimension.
a. Provide units that comply with requirements for freeze-thaw durability.
b. Provide units that interlock with courses above and below by means of integral lugs or lips, pins, clips, or hollow cores filled with drainage fill.
2. Color: As selected from manufacturer's full range.

3. Shape and Texture: Provide units of basic shape and dimensions indicated with machine-split textured **OR** smooth, **as directed**, exposed faces.
4. Shape and Texture: Provide units matching basic shape, dimensions, and face texture indicated by referencing manufacturer's pattern designation.
5. Shape and Texture: Provide units of any basic shape and dimensions that will produce segmental retaining walls of dimensions and profiles indicated without interfering with other elements of the Work and with machine-split textured, flat exposed face **OR** shaped exposed face with deeply beveled vertical edges, **as directed**.
6. Batter: Provide units that offset from course below to provide at least 1:24 **OR** 1:16 **OR** 1:14 **OR** 1:8 **OR** 1:5, **as directed**, batter.
7. Cap Units: Provide cap units of shape indicated **OR** same shape as other units, **as directed**, with smooth, as-cast top surfaces without holes or lugs.
8. Special Units: Provide corner units, end units, and other shapes as needed to produce segmental retaining walls of dimensions and profiles indicated and to provide texture on exposed surfaces matching face **OR** as indicated, **as directed**.

B. Installation Materials
1. Pins: Product supplied by segmental retaining wall unit manufacturer for use with units provided, made from nondegrading polymer reinforced with glass fibers.
2. Clips: Product supplied by segmental retaining wall unit manufacturer for use with units provided, made from nondegrading polymer reinforced with glass fibers.
3. Cap Adhesive: Product supplied or recommended by segmental retaining wall unit manufacturer for adhering cap units to units below.
4. Leveling Base: Comply with requirements in Division 31 Section "Earth Moving" for base material **OR** Division 33 Section "Subdrainage" for drainage fill, **as directed**.
   a. Leveling Course: Lean concrete with a compressive strength of not more than 500 psi (3.4 MPa).
5. Drainage Fill: Comply with requirements in Division 33 Section "Subdrainage".
6. Reinforced-Soil Fill: ASTM D 2487; GW, GP, SW, SP, and SM soil classification groups or a combination of these groups; free of debris, waste, frozen materials, vegetation, and other deleterious matter; meeting the following gradation according to ASTM C 136: 20 to 100 percent passing No. 4 (4.75-mm) sieve, 0 to 60 percent passing No. 40 (0.425-mm) sieve, 0 to 35 percent passing No. 200 (0.075-mm) sieve, and with fine fraction having a plasticity index of less than 20.
7. Nonreinforced-Soil Fill: Comply with requirements in Division 31 Section "Earth Moving" for satisfactory soils.
8. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent.
   a. Apparent Opening Size: No. 70 to 100 (0.212- to 0.150-mm) sieve, maximum; ASTM D 4751.
   b. Minimum Grab Tensile Strength: 110 lb (49.9 kg); ASTM D 4632.
   c. Minimum Weight: 4 oz./sq. yd. (132 g/sq. m).
9. Subdrainage Pipe and Filter Fabric: Comply with requirements in Division 33 Section "Subdrainage".
   a. Product Type: Knitted or woven geogrid made from polyester yarns with a protective coating **OR** Molded geogrid made from high-density polyethylene **OR** Woven geotextile made from polyamides, polyesters, or polyolefins, **as directed**.

C. Source Quality Control
1. Direct manufacturer to test and inspect each roll of soil reinforcement at the factory for minimum average roll values for geosynthetic index property tests, including the following:
   a. Weight.
   b. Roll size.
   c. Grab or single-rib strength.
   d. Aperture opening.
   e. Rib or yarn size.

1.3 EXECUTION

A. Examination
1. Examine areas and conditions, with Installer present, for compliance with requirements for excavation tolerances, condition of subgrades, and other conditions affecting performance of segmental retaining walls.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Retaining Wall Installation
1. General: Place units according to NCMA's "Segmental Retaining Wall Installation Guide" and segmental retaining wall unit manufacturer's written instructions.
    a. Lay units in running bond **OR** bond pattern indicated, **as directed**.
    b. Form corners and ends by using special units **OR** cutting units with motor-driven saw **OR** splitting units with mason's hammer and chisel, **as directed**.
2. Leveling Base: Place and compact base material to thickness indicated and with not less than 95 percent maximum dry unit weight according to ASTM D 698.
    a. Leveling Course: At Contractor's option, unreinforced lean concrete may be substituted for upper 1 to 2 inches (25 to 50 mm) of base **OR** Place unreinforced lean concrete over leveling base 1 to 2 inches (25 to 50 mm) thick, **as directed**. Compact and screed concrete to a smooth, level surface.
3. First Course: Place first course of segmental retaining wall units for full length of wall. Place units in firm contact with each other, properly aligned and level.
    a. Tamp units into leveling base as necessary to bring tops of units into a level plane.
4. Subsequent Courses: Remove excess fill and debris from tops of units in course below. Place units in firm contact, properly aligned, and directly on course below.
    a. For units with lugs designed to fit into holes in adjacent units, lay units so lugs are accurately aligned with holes, and bedding surfaces are firmly seated on beds of units below.
    b. For units with lips at front of units, slide units as far forward as possible for firm contact with lips of units below.
    c. For units with lips at bottom rear of units, slide units as far forward as possible for firm contact of lips with units below.
    d. For units with pins, install pins and align units.
    e. For units with clips, install clips and align units.
5. Cap Units: Place cap units and secure with cap adhesive.

C. Fill Placement
1. General: Comply with requirements in Division 31 Section "Earth Moving", NCMA's "Segmental Retaining Wall Installation Guide," and segmental retaining wall unit manufacturer's written instructions.
2. Fill voids between and within units with drainage fill. Place fill as each course of units is laid.
3. Place, spread, and compact drainage fill and soil fill in uniform lifts for full width and length of embankment as wall is laid. Place and compact fills without disturbing alignment of units. Where both sides of wall are indicated to be filled, place fills on both sides at same time. Begin at wall and place and spread fills toward embankment.
    a. Use only hand-operated compaction equipment within 48 inches (1200 mm) of wall, or one-half of height above bottom of wall, whichever is greater.
    b. Compact reinforced-soil fill to not less than 95 percent maximum dry unit weight according to ASTM D 698.
        1) In areas where only hand-operated compaction equipment is allowed, compact fills to not less than 90 percent maximum dry unit weight according to ASTM D 698.
        2) In areas where fill height exceeds 15 feet (4.5 m), compact reinforced-soil fill that will be more than 15 feet (4.5 m) below finished grade to not less than 98 percent maximum dry unit weight according to ASTM D 698.

3) In areas where fill height exceeds 30 feet (9 m), compact reinforced-soil fill that will be more than 30 feet (9 m) below finished grade to not less than 100 percent maximum dry unit weight according to ASTM D 698.

c. Compact nonreinforced-soil fill to comply with Division 31 Section "Earth Moving".

4. Place drainage geotextile against back of wall and place layer of drainage fill at least 12 inches (300 mm) **OR** 6 inches (150 mm), **as directed**, wide behind drainage geotextile to within 12 inches (300 mm) of finished grade. Place another layer of drainage geotextile between drainage fill and soil fill.
5. Place a layer of drainage fill at least 12 inches (300 mm) **OR** 6 inches (150 mm), **as directed**, wide behind wall to within 12 inches (300 mm) of finished grade. Place a layer of drainage geotextile between drainage fill and soil fill.
6. Wrap subdrainage pipe with filter fabric and place in drainage fill as indicated, sloped not less than 0.5 percent to drain.
7. Place impervious fill over top edge of drainage fill layer.
8. Slope grade at top of wall away from wall unless otherwise indicated. Slope grade at base of wall away from wall. Provide uniform slopes that will prevent ponding.
9. Place soil reinforcement in horizontal joints of retaining wall where indicated and according to soil-reinforcement manufacturer's written instructions. Embed reinforcement a minimum of 8 inches (200 mm) into retaining wall and stretch tight over compacted backfill. Anchor soil reinforcement before placing fill.
   a. Place additional soil reinforcement at corners and curved walls to provide continuous reinforcement.
   b. Place geosynthetics with seams, if any, oriented perpendicular to segmental retaining walls.
   c. Do not dump fill material directly from trucks onto geosynthetics.
   d. Place at least 6 inches (150 mm) of fill over reinforcement before compacting with tracked vehicles or 4 inches (100 mm) before compacting with rubber-tired vehicles.
   e. Do not turn vehicles on fill until first layer of fill is compacted and second layer is placed over each soil-reinforcement layer.

D. Construction Tolerances
1. Variation from Level: For bed-joint lines along walls, do not exceed 1-1/4 inches in 10 feet (32 mm in 3 m), 3 inches (75 mm) maximum.
2. Variation from Indicated Batter: For slope of wall face, do not vary from indicated slope by more than 1-1/4 inches in 10 feet (32 mm in 3 m).
3. Variation from Indicated Wall Line: For walls indicated as straight, do not vary from straight line by more than 1-1/4 inches in 10 feet (32 mm in 3 m).

E. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Comply with requirements in Division 31 Section "Earth Moving" for field quality control.
   a. In each compacted backfill layer, perform at least 1 field in-place compaction test for each 150 feet (45 m) or less of segmental retaining wall length.
   b. In each compacted backfill layer, perform at least 1 field in-place compaction test for each 24 inches (600 mm) of fill depth and each 50 feet (15 m) or less of segmental retaining wall length.

F. Adjusting
1. Remove and replace segmental retaining wall construction of the following descriptions:
   a. Broken, chipped, stained, or otherwise damaged units. Units may be repaired if the Owner approves methods and results.
   b. Segmental retaining walls that do not match approved Samples.
   c. Segmental retaining walls that do not comply with other requirements indicated.
2. Replace units so segmental retaining wall matches approved Samples and mockups, complies with other requirements, and shows no evidence of replacement.

END OF SECTION 32 32 13 00

Task	Specification	Specification Description
32 32 16 00	03 41 23 00	Plant-Precast Structural Concrete
32 32 23 13	32 32 13 00	Segmental Retaining Walls
32 32 26 00	32 32 13 00	Segmental Retaining Walls
32 32 29 00	32 32 13 00	Segmental Retaining Walls
32 32 53 00	32 32 13 00	Segmental Retaining Walls

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SECTION 32 33 13 00 - MISCELLANEOUS SITE AND STREET FURNISHINGS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of miscellaneous site and street furnishings. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals

1. Shop Drawings: Fabrication and installation drawings for each type of product indicated.
2. Product Data: For each type of product indicated.

C. Qualification Of Welders

1. Qualify welders in accordance with AWS D1.1 using procedures, materials, and equipment of the type required for the work.

D. Delivery, Storage, And Protection

1. Protect from corrosion, staining, and other types of damage. Store items in an enclosed area free from contact with soil and weather. Remove and replace damaged items with new items.

1.2 PRODUCTS

A. Precast Benches

1. Design precast benches in accordance with manufacturer's standards, size as indicated. Finish and color as indicated selected from manufacturer's standards.
2. Glass Fiber Reinforced Concrete (GFRC) Benches
   a. Provide glass fiber reinforced concrete (GFRC) benches at locations as directed. Comply with PCI MNL-128 recommended practice for glass fiber reinforced concrete, including Appendix G, Polymer Modified Glass Fiber Reinforced Concrete Panels.
   b. Design precast benches to sustain a live load of not less than 200 pounds per square foot (10 kPa), constructed of minimum 3000 psi concrete with ASTM C 150 cement, white or grey color consistent with final finish, using alkali resistant (AR) glass fibers produced specifically for use in glass fiber reinforced concrete, minimum three percent glass fiber content. Aggregate shall be clear silica sand aggregate; washed, dried and free from deleterious materials. Provide type with successful history of uses in GFRC fabrication standard with the manufacturer. Provide manufacturer's standard acrylic thermoplastic copolymer admixture.
   c. Provide factory finished units standard with the manufacturer; texture and color as selected.
3. Precast Concrete/Cast Stone Benches
   a. Provide reinforced precast concrete benches consisting of a mixture of cement, aggregates and mineral colors suitable for exterior use, located as directed.
   b. Design benches to sustain a live load of not less than 200 pounds per square foot (10 kPa).
      1) Portland cement: ASTM C150 Type I, II, or III.
      2) Aggregate: ASTM C33, maximum size 3/4 inch (19 mm).
      3) Reinforcing steel: ASTM A615/A615M
      4) Galvanized wire mesh: ASTM A1064
      5) Integral color: ASTM C979, pure mineral oxide, limeproof and non-fading.
      6) Provide minimum 5000 psi (35 MPa) 28 day compressive strength concrete, maximum five percent absorption.

7) Admixture: ASTM C260 for air-entraining.

B. Precast Concrete Bicycle Rack
1. Provide one-piece precast concrete bicycle rack base with embedded galvanized metal hitching loops. Design bicycle rack with wheel notches for bike support and wheel locking device.

C. Precast Concrete Bollards
1. Provide reinforced concrete bollards 12 inch (300 mm) **OR** 18 inch (450 mm), **as directed**, square **OR** round, **as directed**, height as indicated, suitable for ground mount installation. Provide exposed aggregate or sandblast finish as indicated; manufacturer's standard clear acrylic sealer.
a. Portland cement: ASTM C150, Type I II or III.
b. Aggregate: ASTM C33, maximum size 3/4 inch (19 mm).
c. Reinforcing steel: ASTM A615/A615M.
d. Integral color: ASTM C979, pure mineral oxide, limeproof and non-fading.
e. Concrete strength: 5000 psi (35 MPa), 28 day minimum compressive strength.
f. Admixture: ASTM C260 for air-entraining.

D. Planters, Receptacles, Ash Receptacles
1. Provide for waste receptacles spun aluminum **OR** reinforced fiberglass, **as directed**, flat **OR** domed, **as directed**, tops and removable semi-rigid plastic liner insert. Provide top-mounted ash trays for ash receptacles.
2. Glass Fiber Reinforced Concrete (GFRC) Precast:
a. Provide glass fiber reinforced concrete (GFRC) precast planters/waste receptacles/ash receptacles at locations as directed. Comply with PCI MNL-117 and PCI MNL-128.
b. Materials: Provide manufacturer's standard shell thickness of 3/8 to 5/8 inch (9 to 16 mm).
1) Cement: ASTM C150, use only one brand and type of cement throughout the Project.
2) Glass Fibers: Alkali resistant (AR) glass fibers produced specifically for use in glass fiber reinforced concrete. Glass content of GFRC unit to be a minimum of three percent.
3) Aggregates: clear silica sand; washed, dried, and free from deleterious materials; provide type with successful history of use in GFRC and as standard with the manufacturer.
4) Compressive Strength: Minimum 3000 psi (20/25 MPa) 28 day strength.
5) Density: Approximately 120 pcf (1921 kg/cu. m).
6) Polymer Admixture: Manufacturer's standard acrylic thermoplastic copolymer.
c. Finishes: Provide factory finished units with manufacturer's standard texture or sandblasted finish as selected.
1) Cement: White or grey as consistent with final finish.
3. Precast Concrete/Cast Stone Planters
a. Provide reinforced precast concrete planters/waste receptacles/ash receptacles consisting of a mixture of cement, aggregates, and mineral colors suitable for exterior use as located on the drawings. Provide manufacturer's standard exposed aggregate or sandblast finish (with clear acrylic coating) as selected.
1) Portland Cement: ASTM C150, gray, Type I.
2) Aggregate: ASTM C33, crushed limestone and sand.
3) Galvanized Steel Mesh: ASTM A1064.
4) Integral Color: ASTM C979, pure mineral oxide, limeproof and non-fading.
5) Concrete Strength: 4000 psi (30 MPa) minimum compressive strength at 28 days.
6) Admixture: ASTM C260 for air-entraining.
4. Wood Planters
a. Provide manufacturer's standard wood planter/waste receptacle/ash receptacles fabricated of 3/4 inch (19 mm) thick tongue and grooved wood slats permanently bonded with

fiberglass interior shell. Provide wood top trim for square planters and fiberglass top trim for round planters.
1) Wood Species: As directed.
2) Fiberglass: Molded with multiple laminations of glass fiber impregnated with polyester isophthalic thermosetting resins with a finish of 12-15 mil (0.30-0.38 mm) color impregnated polyester gel coat.
3) Metal Frame: Black color-coated steel frame.

5. Wood Planters with Metal Frames
a. Provide manufacturer's standard wood planter/waste receptacle/ash receptacle with galvanized steel welded frames, and nominal 2 inch (50 mm) tongue and grooved, beveled or square cut wood staves. Attach wood staves to metal frame from inside with steel plated screws.
1) Wood species: Kiln dried, maximum 19 percent moisture content, species as directed.
2) Metal frame: Reinforced with steel bars as per manufacture's standard construction, black color factory finish coated.
3) Bottom: 1/4 inch (6.25 mm) exterior grade redwood with drain holes.
4) Liners: Removable galvanized steel or manufacturer's standard.
5) Tops: Hinged top opening, spun aluminum open top with molded rim, ash top.

6. Fiberglass Planters/Waste Receptacles/Ash Receptacles
a. Provide reinforced fiberglass planters/waste receptacles/ash receptacles molded with multiple laminations of glass fiber impregnated with polyester isophthalic thermosetting resins; with 12-15 mil (0.30-0.38 mm) color impregnated polyester gel coat finish; minimum thickness of 1/4 inch (6.25 mm); color as selected.
b. Receptacles:
1) Shall be manufactured by Maglin,
2) Color: Malaga Green

E. Shelters
1. AISC S342L; AISC S335. Provide prefabricated shelter systems to meet design conditions indicated. Shelter design shall conform to all applicable State and Local Building Codes and shall meet manufacturer's standards of construction and materials. Shelter systems shall be preglazed, pre-drilled and pre-cut, shipped with all hardware and accessories necessary for complete field assembly.
2. Framing Systems: Framing system; columns, rafters, ridge, purlins and other structural framing members shall be aluminum/steel/wood as indicated. Manufacturer shall provide shop drawings and calculations prepared by a structural engineer.
a. Extruded aluminum alloy tubing shall conform to ASTM B429 6063-T5 or 3003-H14, anodized or powder coat finish, color as directed. Framing sizes and configurations shall be as required for size of structure indicated meeting manufacturer's standards and applicable building codes.
b. Structural steel shall conform to ASTM A36/A36M or ASTM A500, 36,000 psi (248 MPa) yield strength and 58,000 psi (400 MPa) tensile strength, factory finished with rust inhibited primer and powder coat conforming to ASTM D3451. Framing sizes and configurations shall be as required for size of structure indicated meeting manufacturer's standard and applicable building codes.
c. Wood framing system shall consist of surfaced four sides (S4S), #2 grade southern yellow pine solid timber columns with eased edges, pressure treated CCA (Copper Chrome Arsinate) 0.6 PCF (9.6 kg/cu.m) against decay, fungi and insect infestation, surfaced four sides (S4S), #1 grade, southern pine, glue-laminated columns manufactured in accordance with ANSI/AITC A190.1 and AITC certified glue-laminated structural grade southern yellow pine beams, rafters and purlins, factory sealed and individually wrapped for protection during shipment. Factory stain all wood members prior to shipment.
3. Roof Panels/Decking: Provide manufacturer's standard molded acrylic translucent roof panel, OR standing seam metal roof panel, OR wood decking, OR V-beam aluminum roof panels, OR

FRP roof panels, as indicated. Materials shall be factory finished and shipped with all necessary fasteners and accessories as required for complete site assembly.

4. Glazing: Factory installed in separate structural window frames, gasketed and glazed as per manufacturer's standard, interchangeable, glazing system. Provide 1/4 inch (6.25 mm) acrylic sheet, OR tempered glass, OR polycarbonate plastic sheet OR mar-resistant polycarbonate plastic sheet, clear OR color.

F. Tables

1. Precast Concrete Tables: Provide reinforced precast concrete tables with smooth tops; minimum 4500 psi (35 MPa) concrete, 28 day minimum compressive strength, consisting of a mixture of cement, aggregates, and mineral colors suitable for exterior use as located on the drawings. Provide manufacturer's standard exposed aggregate or sandblast finish with clear acrylic coating.
   a. Portland cement: ASTM C150, gray, Type I.
   b. Aggregate: ASTM C33, washed limestone and sand.
   c. Galvanized wire mesh: 14 gage (1.9 mm), 2 by two inch (50 by 50 mm).
   d. Welded wire fabric: ASTM A1064.
   e. Reinforcing steel: ASTM A615/A615M.
   f. Integral color: ASTM C979, pure mineral oxide, limeproof and non-fading.
   g. Admixture: ASTM C260 for air-entraining..
2. Fiberglass Tables: Provide reinforced fiberglass table tops molded with multiple laminations of glass fiber impregnated with polyester isophthalic thermosetting resins, minimum thickness of 1/4 inch (6.25 mm) with 12-15 mil (0.30-0.38 mm) thickness color impregnated polyester gel coat, color as selected.
   a. Steel pedestal base: ASTM A53 Schedule 40 steel pipe.
   b. Mounting: Type as indicated.
   c. Metal finish: Powder coating conforming to ASTM D3451 testing.
3. Perforated Steel Tables: Provide 14 gage (1.9 mm) **OR** 16 gage (1.6 mm), **as directed**, perforated steel sheet table tops with solid metal edges as per manufacturer's standard. Weld tops to base as required for frame support.
   a. Steel pedestal base: ASTM A53 Schedule 40 steel pipe, 2 3/8 inch (60 mm) O.D.
   b. Mounting: Type as indicated.
   c. Hardware: Zinc or cadium plated nuts, bolts, screws, and lock washers.
   d. Metal finish: Powder coating conforming to ASTM D3451 testing.
4. Wood Seats and Tables
   a. Provide manufacturer's standard wood seats and tables, minimum 1-5/8 inches (40 mm) thick with rounded edges, with wood or metal bases as indicated. Provide fasteners and accessories required for on site assembly. Kiln dry and pressure treat wood components to manufacturer's standard, maximum 19 percent moisture content. Pre-treat metal components and provide manufacturer's standard primer and powder coat finish complying with ASTM D3451, color as selected.
      1) Design wood tables to sustain a live load of not less than 200 pounds per square foot (10 kPa).
      2) Provide kiln dried, surfaced four sides (S4S), clear all sides wood slats of species and sizes indicated.
         a) Species: As directed.
         b) Nominal wood slat sizes: As directed.
   b. Support Base: Provide wood or metal support bases as per manufacturer's standard.
      1) Wood: Match in species, grade, grain, color and finish of the wood slats.
      2) Steel: ASTM A653/A653M.
      3) Cast grey iron: ASTM A 48/A48M, Class 30 or recycled cast grey iron ASTM A48/A48M, Class 25.
      4) Cast aluminum: ASTM B26/B26M or ASTM B108 as applicable.
      5) Design bases to support the loads imposed in the design of the tables.

G. Grates

1. Provide cast aluminum **OR** cast iron **OR** cast bronze **OR** punched steel **OR** stainless steel, **as directed**, tree grates in round **OR** square, **as directed**, model of sizes indicated on the drawings. Furnish complete with angle steel frames with finish to match tree grates.

H. Fabrication Finishes
1. Galvanizing: Hot-dip galvanize items specified to be zinc-coated, after fabrication where practicable. Galvanizing: ASTM A123/A123M, ASTM A153/A153M or ASTM A653/A653M, as applicable.
2. Galvanize: Anchor bolts, grating fasteners, washers, and parts or devices necessary for proper installation, unless indicated otherwise.
3. Repair of Zinc-Coated Surfaces: Repair damaged surfaces with galvanizing repair method and paint conforming to ASTM A780 or by the application of stick or thick paste material specifically designed for repair of galvanizing, as approved. Clean areas to be repaired and remove the slag from the welds. Heat surfaces to which stick or paste material is applied, with a torch to a temperature sufficient to melt the metallics in stick or paste; spread the molten material uniformly over surfaces to be coated and wipe the excess material off.
4. Pretreatment, Priming and Painting: Apply pretreatment, primer, and paint in accordance with manufacturer's printed instructions. On surfaces concealed in the finished construction or not accessible for finish painting, apply an additional prime coat to a minimum dry film thickness of 1.0 mil (0.03 mm). Tint additional prime coat with a small amount of tinting pigment.
5. Nonferrous Metal Surfaces: Protect by plating, anodic, or organic coatings.
6. Aluminum Surfaces
   a. Surface Condition: Before finishes are applied, remove roll marks, scratches, rolled-in scratches, kinks, stains, pits, orange peel, die marks, structural streaks, and other defects which will affect uniform appearance of finished surfaces.

1.3 EXECUTION

A. Installation
1. Install items at locations indicated, according to manufacturer's instructions. Items listed below require additional procedures.
   a. Assembly and Erection of Components: Items shall be shipped knocked-down (KD) ready for site assembly. Packaged components shall be complete including all accessories and hardware. Follow manufacturer's instructions for assembly and erection. Provide mounting bolts or hardware for mounting items to substrate.

B. Anchorage, Fastenings, And Connections
1. Provide anchorage where necessary for fastening furniture or furnishings securely in place. Include for anchorage not otherwise specified or indicated slotted inserts, expansion shields, and powder-driven fasteners, when approved for concrete; toggle bolts and through bolts for masonry; machine and carriage bolts for steel; through bolts, lag bolts, and screws for wood. Do not use wood plugs in any material. Provide non-ferrous attachments for non-ferrous metal. Make exposed fastenings of compatible materials, generally matching in color and finish, to which fastenings are applied. Conceal fastenings where practicable.

C. Built-In-Work
1. Form for anchorage metal work built-in with concrete or masonry, or provide with suitable anchoring devices as indicated or as required. Furnish metal work in ample time for securing in place as the work progresses.

D. Welding
1. Perform welding, welding inspection, and corrective welding, in accordance with AWS D1.1. Use continuous welds on all exposed connections. Grind visible welds smooth in the finished installation.

E. Finishes: Dissimilar Materials
   1. Where dissimilar metals are in contact, protect surfaces with a coat conforming to FS TT-P-664 to prevent galvanic or corrosive action. Where aluminum is in contact with concrete, mortar, masonry, wood, or absorptive materials subject to wetting, protect with ASTM D1187, asphalt-base emulsion.

F. Bollards
   1. Install in pipe sleeves embedded in concrete and filled with non-shrink grout or quick setting anchoring cement.

G. Shelters
   1. Secure to the adjacent construction with the clip angles attached to the concrete. Secure to concrete with not less than two 1/2 inch (12 mm) diameter expansion bolts.
      a. Glazing: Factory install windows into separate structural frame. Miter corners and connect internally by extruded aluminum corner keys or screw bosses with tamper-proof stainless steel screws. Provide continuous gasketing around windows set to metal frames. Provide 1/2 to 3/4 inch (13 to 19 mm) deep pocket for polycarbonate glazing. Fully gasket and frame in independent interchangable factory assembled units. Affix to shelter frame with 3/16 inch (5 mm) shallow head aluminum rivets at approximately 13 1/4 inches (331 mm) on centers for full 360 degrees (6.28 rad), rivet from inside of shelter.
      b. Roof: Provide manufacturer's standard roof system including facia **OR** gutter, **as directed**, assembly, ensuring a weather-tight seal and installation.

END OF SECTION 32 33 13 00

Task	Specification	Specification Description
32 33 13 00	01 22 16 00	No Specification Required

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SECTION 32 33 23 00 - SITE FURNISHINGS

1.1 GENERAL

A. Description Of Work
  1. This specification covers the furnishing and installation of materials for site furnishings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
  1. This Section includes the following:
     a. Seating.
     b. Tables.
     c. Bicycle racks.
     d. Bicycle lockers.
     e. Trash receptacles.
     f. Ash receptacles.
     g. Planters.
     h. Bollards.

C. Submittals
  1. Product Data: For each type of product indicated.
  2. Samples: For each type of exposed finish required.
  3. Product Schedule: For site furnishings. Use same designations indicated on Drawings.
  4. Material Certificates: For site furnishings, signed by manufacturers.
     a. Wood Preservative Treatment: Include certification by treating plant stating type of preservative solution and pressure process used, net amount of preservative retained, and compliance with applicable standards.
     b. Sustainably Harvested Wood: Include certification by manufacturer and from sources that participate in sustained yield programs.
     c. Recycled plastic.
  5. Maintenance Data: For site furnishings to include in maintenance manuals.

1.2 PRODUCTS

A. Materials
  1. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated; free of surface blemishes and complying with the following:
     a. Rolled or Cold-Finished Bars, Rods, and Wire: ASTM B 211 (ASTM B 211M).
     b. Extruded Bars, Rods, Wire, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
     c. Structural Pipe and Tube: ASTM B 429.
     d. Sheet and Plate: ASTM B 209 (ASTM B 209M).
     e. Castings: ASTM B 26/B 26M.
  2. Steel and Iron: Free of surface blemishes and complying with the following:
     a. Plates, Shapes, and Bars: ASTM A 36/A 36M.
     b. Steel Pipe: Standard-weight steel pipe complying with ASTM A 53, or electric-resistance-welded pipe complying with ASTM A 135.
     c. Tubing: Cold-formed steel tubing complying with ASTM A 500.
     d. Mechanical Tubing: Cold-rolled, electric-resistance-welded carbon or alloy steel tubing complying with ASTM A 513, or steel tubing fabricated from steel complying with ASTM A 1011/A 1011M and complying with dimensional tolerances in ASTM A 500; zinc coated internally and externally.

e. Sheet: Commercial steel sheet complying with ASTM A 1011/A 1011M.
f. Perforated Metal: From steel sheet not less than 0.0747-inch (1.9-mm) **OR** 0.0897-inch (2.3-mm) **OR** 0.1196-inch (3.0-mm), **as directed**, nominal thickness; manufacturer's standard perforation pattern.
g. Expanded Metal: Carbon-steel sheets, deburred after expansion, and complying with ASTM F 1267.
h. Malleable-Iron Castings: ASTM A 47/A 47M, grade as recommended by fabricator for type of use intended.
i. Gray-Iron Castings: ASTM A 48/A 48M, Class 200.

3. Stainless Steel: Free of surface blemishes and complying with the following:
   a. Sheet, Strip, Plate, and Flat Bars: ASTM A 666.
   b. Pipe: Schedule 40 steel pipe complying with ASTM A 312/A 312M.
   c. Tubing: ASTM A 554.
4. Wood: Surfaced smooth on four sides with eased edges; kiln dried, free of knots, solid stock of species indicated.
   a. Wood Species: Manufacturer's standard.
      1) Douglas Fir: Clear Grade, vertical grain.
      2) Pine: Southern pine; No. 2 or better; preservative treated, kiln dried after treatment.
      3) Eastern White **OR** Red **OR** Yellow **OR** Cedar, **as directed**: Select Grade or better.
      4) Redwood: Clear all heart **OR** Construction heart or better, **as directed**, free-of-heart center.
      5) Teak (Tectona Grandis): Clear Grade. Provide wood obtained from sources that participate in a well-managed forest and chain-of-custody program certified by an independent agency accredited by FSC.
      6) Finish: Manufacturer's standard stain and transparent sealer **OR** transparent wood preservative treatment and sealer, **as directed**.
5. Fiberglass: Multiple laminations of glass-fiber-reinforced polyester resin with UV-light stable, colorfast, nonfading, weather- and stain-resistant, colored polyester gel coat, and manufacturer's standard finish.
6. Plastic: Color impregnated, color and UV-light stabilized, and mold resistant.
   a. Polyethylene: Fabricated from virgin plastic HDPE resin.
   b. Recycled Polyethylene: Fabricated from not less than 96 percent recycled, purified, fractional-melt plastic resin with not less than 90 percent recycled postconsumer waste by weight HDPE.
7. Anchors, Fasteners, Fittings, and Hardware: Stainless steel **OR** Brass **OR** Galvanized steel **OR** Zinc-plated steel **OR** Manufacturer's standard, corrosion-resistant-coated or noncorrodible materials, **as directed**; commercial quality, tamperproof, vandal and theft resistant **OR** concealed, recessed, and capped or plugged, **as directed**.
   a. Angle Anchors: For inconspicuously bolting legs of site furnishings to on **OR** below, **as directed** -grade substrate; one per leg **OR** extent as indicated, **as directed**.
   b. Antitheft Hold-Down Brackets: For securing site furnishings to substrate; two per unit **OR** extent as indicated on Drawings, **as directed**.
8. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107; recommended in writing by manufacturer, for exterior applications.
9. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound; resistant to erosion from water exposure without needing protection by a sealer or waterproof coating; recommended in writing by manufacturer, for exterior applications.
10. Galvanizing: Where indicated for steel and iron components, provide the following protective zinc coating applied to components after fabrication:
    a. Zinc-Coated Tubing: External, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear,

polymer film. Internal, same as external or consisting of 81 percent zinc pigmented coating, not less than 0.3 mil (0.0076 mm) thick.

b. Hot-Dip Galvanizing: According to ASTM A 123/A 123M, ASTM A 153/A 153M, or ASTM A 924/A 924M.

B. Seating And Tables

1. Frame: Cast aluminum **OR** Cast iron **OR** Steel **OR** Stainless steel **OR** Wrought iron **OR** Cedar **OR** Teak, **as directed**.
2. Seat **OR** Seat and Back, **as directed**:
    a. Material:
        1) Aluminum Sheet: Perforated **OR** Expanded, **as directed**, metal.
        2) Steel **OR** Painted Steel, **as directed**: Perforated metal **OR** Expanded metal **OR** Evenly spaced, parallel flat straps or bars **OR** Evenly woven, flat straps or bars **OR** Edge framed, evenly spaced, parallel rods or rolled bars, **as directed**.
        3) Stainless Steel: Perforated metal **OR** Expanded metal **OR** Evenly spaced, parallel flat straps or bars **OR** Evenly woven, flat straps or bars **OR** Edge framed, evenly spaced, parallel rods or rolled bars, **as directed**.
        4) Wood: Douglas fir **OR** Pine **OR** Cedar **OR** Redwood **OR** Teak, **as directed**; formed into evenly spaced parallel slats **OR** planks, **as directed**.
        5) Recycled **OR** Plastic **OR** iberglass, **as directed**, Planks: Evenly spaced, parallel.
        6) Recycled **OR** Plastic **OR** Fiberglass, **as directed**, Sheet: Solid **OR** Perforated, **as directed**.
    b. Seat Height: As indicated.
    c. Seat Surface Shape: Flat **OR** Contoured or dished, **as directed**.
    d. Overall Height: As indicated.
    e. Overall Width: As indicated.
    f. Overall Depth: As indicated.
    g. Arms: None **OR** One, as indicated **OR** Two, one at each end **OR** Three, one at each end and in center, **as directed**.
        1) Arm Material: Match frame **OR** seat, **as directed**.
    h. Seating Configuration: Multiple units as indicated.
        1) Straight **OR** Angled **OR** Curved, **as directed**, shape.
        2) Closed hexagon **OR** circle **OR** shape indicated, **as directed**, around a tree trunk **OR** planter **OR** light post, **as directed**.
3. Table Top:
    a. Material:
        1) Aluminum Sheet: Perforated **OR** Expanded**, as directed,** metal.
        2) Steel **OR** Painted Steel, **as directed**: Perforated metal **OR** Expanded metal **OR** Evenly spaced, parallel flat straps or bars **OR** Evenly woven, flat straps or bars **OR** Edge framed, evenly spaced, parallel rods or rolled bars, **as directed**.
        3) Stainless Steel: Perforated metal **OR** Expanded metal **OR** Evenly spaced, parallel flat straps or bars **OR** Evenly woven, flat straps or bars **OR** Edge framed, evenly spaced, parallel rods or rolled bars, **as directed**.
        4) Wood: Douglas fir **OR** Pine **OR** Cedar **OR** Redwood **OR** Teak, **as directed**; formed into evenly spaced parallel slats **OR** planks, **as directed**.
        5) Recycled **OR** Plastic **OR** Fiberglass, **as directed**, Planks: Evenly spaced, parallel.
        6) Recycled **OR** Plastic **OR** Fiberglass, **as directed**, Sheet: Solid **OR** Perforated, **as directed**.
    b. Surface Shape: Round **OR** Hexagon **OR** Shape indicated, **as directed**.
    c. Feature: Center umbrella hole.
4. Aluminum Finish: Mill finish **OR** Color coated, **as directed**.
    a. Color: As selected from manufacturer's full range.
5. Steel Finish: Galvanized and color **OR** PVC-color, **as directed**, coated.
    a. Color: As selected from manufacturer's full range.
6. Stainless-Steel Finish: Dull Satin No. 6.

7. Wood Finish: Unfinished **OR** Factory-applied transparent finish **OR** Factory-applied stain and transparent finish **OR** Factory-applied opaque finish **OR** Manufacturer's standard finish, **as directed**.
   a. Stain: Manufacturer's standard.
8. Fiberglass **OR** HDPE, **as directed**, Color: As selected from manufacturer's full range.
9. Graphics: Surface-applied **OR** Engraved **OR** Attached brass plaque with engraved, **as directed**, copy, content, and style per manufacturer's standard **OR** as indicated on Drawings, **as directed**.

C. Bicycle Racks
1. Bicycle Rack Construction:
   a. Frame: Aluminum **OR** Steel **OR** Galvanized steel **OR** Stainless steel **OR** Steel and redwood **OR** Steel and pine, **as directed**.
      1) Pipe **OR** Tubing, **as directed**, OD: Not less than 1-5/8 inches (41 mm) **OR** 2-3/8 inches (60 mm) **OR** 2-7/8 inches (73 mm) **OR** 4-1/2 inches (115 mm), **as directed**.
      2) Locking Bars: Solid round bar, not less than 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, in diameter.
   b. Style: Single-side parking **OR** Double-side parking **OR** Bollard **OR** As indicated, **as directed**.
      1) Capacity: Designed to accommodate no fewer than two **OR** three **OR** four, **as directed**, bicycles.
   c. Security: Designed to lock wheel and frame.
   d. Accessories: Base covers for each pipe and tubing anchored end **OR** Wheel stops, **as directed**.
   e. Installation Method: Freestanding **OR** Surface flange anchored at finished grade to substrate indicated **OR** Surface flange anchored below finished grade to substrate indicated **OR** Cast in concrete **OR** Bolted to cast-in anchor bolts **OR** Wall mounted **OR** As indicated, **as directed**.
2. Aluminum Finish: Mill finish **OR** Color coated, **as directed**.
   a. Color: As selected from manufacturer's full range.
3. Steel Finish: Galvanized **OR** Color coated, **as directed**.
   a. Color: As selected from manufacturer's full range.
4. Stainless-Steel Finish: Directional Satin No. 4.
5. Wood Finish: Unfinished **OR** Manufacturer's standard finish, **as directed**.

D. Bicycle Lockers
1. Bicycle Locker Construction:
   a. Locker: Molded one-piece fiberglass **OR** Sheet steel, 0.053 inch (1.4 mm) thick, **OR** Sheet steel, 0.053 inch (1.4 mm) thick, with perforated metal sides, **as directed,** with welded tubular steel frame.
   b. Door: Molded one-piece fiberglass **OR** Sheet steel, 0.053 inch (1.4 mm) thick, **as directed,** with tubular steel frame **OR** Match locker, **as directed**.
   c. View Window **OR** Grille, **as directed**: Lexan, 12 inches (305 mm) square **OR** Perforated metal, **as directed**.
   d. Lock: Manufacturer's standard **OR** Key lock with internal locking bar **OR** Coin/token lock, **as directed**.
      1) Provide four keys.
   e. Overall Height: As indicated.
   f. Overall Width: As indicated.
   g. Overall Depth: As indicated.
   h. Capacity: Designed to accommodate one **OR** two, **as directed**, bicycle(s).
   i. Installation Method: Locker anchored at finished grade to substrate indicated **OR** Locker anchored below finished grade to substrate indicated **OR** As indicated, **as directed**.
   j. Locker Configuration: Multiple **OR** Four, **as directed**, units as indicated, in straight row **OR** curved shape **OR** shape indicated, **as directed**.
2. Steel Finish: Color coated.

a. Color: As selected from manufacturer's full range.
3. Fiberglass Color: As selected from manufacturer's full range.

E. Trash And Ash Receptacles
1. Aluminum Facing Surrounds: Aluminum sheet **OR** Perforated aluminum sheet **OR** Grid in tubular frame **OR** Evenly patterned, parallel flat aluminum straps, bars, or tubular shapes **OR** Match benches, **as directed**.
2. Steel Facing Surrounds: Steel sheet **OR** Perforated-steel sheet **OR** Evenly patterned, parallel flat steel straps, bars, or tubular shapes **OR** Evenly patterned, parallel round steel rods, bars, or tubular shapes **OR** Grid in tubular frame **OR** Match benches, **as directed**.
3. Stainless-Steel Facing Surrounds: Steel sheet **OR** Perforated-steel sheet **OR** Evenly patterned, parallel flat steel straps, bars, or tubular shapes **OR** Evenly patterned, parallel round steel rods, bars, or tubular shapes **OR** Grid in tubular frame **OR** Match benches, **as directed**.
4. Wood Facing Surrounds: Evenly spaced, Douglas fir slats **OR** Evenly spaced pine slats **OR** Evenly spaced cedar slats **OR** Redwood panels **OR** Evenly spaced redwood slats **OR** Teak panels **OR** Evenly spaced teak slats **OR** Match benches, **as directed**.
5. Fiberglass Facing Surrounds: Molded fiberglass shape.
6. Plastic Facing Surrounds: Molded HDPE shape **OR** Evenly spaced HDPE slats **OR** Evenly spaced, recycled HDPE slats **OR** Match benches, **as directed**.
7. Support Frames: Steel **OR** Galvanized steel, **as directed**; welded.
8. Trash and Ash Receptacles:
   a. Receptacle Shape and Form: Round cylinder **OR** Round cylinder with tapered funnel top **OR** Round, tapered column **OR** Square column **OR** Rectangular column **OR** As indicated, **as directed**; with opening for depositing trash in lid or top **OR** side of lid or top **OR** receptacle side, **as directed**.
   b. Ash Receptacle Function: Uncovered receptacle with sand pan **OR** Uncovered receptacle with bowl and funnel **OR** Covered receptacle with sand pan **OR** Covered receptacle with bowl and screen **OR** Covered receptacle with slots **OR** Uncovered receptacle with sand pan attaching to side of trash receptacle, **as directed**, for depositing cigarette butts; fire-proof design; bowl and pan removable for cleaning.
   c. Lids and Tops: Matching facing panels **OR** Aluminum **OR** Steel **OR** HDPE **OR** Recycled HDPE, **as directed,** secured by cable or chain, hinged, swiveled, or permanently secured.
      1) Description: Flat rim ring lid with center opening **OR** Dome top **OR** Arched top **OR** Elevated flat or shallow dome rain-cap lid **OR** Combination ash sand pan and rim lid **OR** Combination ash sand pan and dome top **OR** Combination ash sand pan and elevated flat or shallow dome rain-cap lid, **as directed**.
      2) Opening for depositing trash covered by self-closing, spring-loaded-hinged, push-in **OR** rotating, **as directed**, weather flap.
   d. Inner Container: Aluminum **OR** Galvanized steel sheet **OR** Perforated-metal OR Fiberglass **OR** Rigid plastic, **as directed**, container with drain holes **OR** lift-out handles, **as directed**; designed to be removable and reusable.
   e. Disposable Liners: Provide receptacle designed to accommodate disposable liners.
   f. Capacity: Not less than 22 gal. (83 L) **OR** 28 gal. (106 L) **OR** 30 gal. (114 L) **OR** 32 gal. (121 L) **OR** 40 gal. (151 L) **OR** 55 gal. (208 L), **as directed**.
   g. Service Access: Removable lid or top **OR** Fixed lid or top, side access, **as directed**; inner container and disposable liner lift or slide out for emptying; lockable with padlock hasps **OR** keyed lock with two keys per receptacle **OR** self-latching hinge, **as directed**.
   h. Post Mount: Color-coated steel pipe; color to match receptacle **OR** Galvanized steel pipe **OR** Wood, **as directed**; for mounting one **OR** two **OR** three, **as directed,** receptacle(s).
   i. Ash Receptacle Accessories: Sand sifter **OR** Butt stub-out, **as directed**.
9. Aluminum Finish: Mill finish **OR** Color coated, **as directed**.
   a. Color: As selected from manufacturer's full range.
10. Steel Finish: Galvanized and color **OR** PVC-color, **as directed**, coated.
   a. Color: As selected from manufacturer's full range.
11. Stainless-Steel Finish: Dull Satin No. 6.

12. Wood Finish: Unfinished **OR** Factory-applied transparent finish **OR** Factory-applied stain and transparent finish **OR** Factory-applied opaque finish **OR** Manufacturer's standard finish, **as directed**.
    a. Stain: Manufacturer's standard.
13. Fiberglass **OR** HDPE, **as directed**, Color: As selected from manufacturer's full range.
14. Graphics: Surface-applied **OR** Engraved **OR** Attached brass plaque with engraved, **as directed**, copy, content, and style per manufacturer's standard **OR** as indicated on Drawings, **as directed**.
    a. Copy: Litter **OR** Trash **OR** Waste **OR** Recycle, **as directed**.

F. Planters
1. Aluminum Facing Surrounds: Aluminum sheet **OR** Perforated aluminum sheet **OR** Grid in tubular frame **OR** Evenly patterned, parallel flat aluminum, **as directed**, straps, bars, or tubular shapes **OR** Match benches, **as directed**.
2. Steel Facing Surrounds: Steel sheet **OR** Perforated-steel sheet **OR** Evenly patterned, parallel flat steel straps, bars, or tubular shapes **OR** Evenly patterned, parallel round steel rods, bars, or tubular shapes **OR** Grid in tubular frame **OR** Match benches, **as directed.**
3. Stainless-Steel Facing Surrounds: Steel sheet **OR** Perforated-steel sheet **OR** Evenly patterned, parallel flat steel straps, bars, or tubular shapes **OR** Evenly patterned, parallel round steel rods, bars, or tubular shapes **OR** Grid in tubular frame **OR** Match benches, **as directed.**
4. Wood Facing Surrounds: Evenly spaced, Douglas fir slats **OR** Evenly spaced pine slats **OR** Evenly spaced cedar slats **OR** Redwood panels **OR** Evenly spaced redwood slats **OR** Teak panels **OR** Evenly spaced teak slats **OR** Match benches, **as directed**.
5. Fiberglass Facing Surrounds: Molded fiberglass shape.
6. Plastic Facing Surrounds: Molded HDPE shape **OR** Evenly spaced HDPE slats **OR** Evenly spaced, recycled HDPE slats **OR** Match benches, **as directed**.
7. Support Frames: Steel **OR** Galvanized steel, **as directed**; welded.
8. Planter Shape and Form: Round cylinder **OR** Round cylinder with tapered funnel top **OR** Round, tapered column **OR** Square column **OR** Rectangular column **OR** As indicated, **as directed**.
9. Style: To match benches **OR** As indicated by manufacturer's designation, **as directed**.
10. Inner Container: Aluminum **OR** Galvanized steel sheet **OR** Fiberglass **OR** Rigid plastic, **as directed**, container with drain holes.
11. Capacity: Not less than 22 gal. (83 L) **OR** 28 gal. (106 L) **OR** 30 gal. (114 L) **OR** 32 gal. (121 L) **OR** 40 gal. (151 L) **OR** 55 gal. (208 L), **as directed**.
12. Installation Method: Freestanding **OR** Freestanding with weighted base **OR** Anchored to substrate indicated on Drawings **OR** Wall mounted **OR** Post mounted **OR** Mounted on elevated leg angles anchored at finished grade to substrate indicated on Drawings **OR** Mounted on elevated leg angles anchored below finished grade to substrate indicated on Drawings **OR** As indicated on Drawings, **as directed.**
    a. Post Mount: Color-coated steel pipe; color to match receptacle **OR** Galvanized steel pipe **OR** Wood, **as directed**; for mounting one **OR** two **OR** three, **as directed**, planter(s).
13. Aluminum Finish: Color coated.
    a. Color: As selected from manufacturer's full range.
14. Steel Finish: Galvanized and color **OR** PVC-color, **as directed**, coated.
    a. Color: As selected from manufacturer's full range.
15. Stainless-Steel Finish: Dull Satin No. 6.
16. Wood Finish: Unfinished **OR** Factory-applied transparent finish **OR** Factory-applied stained and transparent finish, **as directed**.
17. Fiberglass **OR** HDPE, **as directed**, Color: As selected from manufacturer's full range.
    a. Finish: Smooth **OR** Textured, **as directed**.

G. Bollards
1. Bollard Construction:
    a. Pipe **OR** Tubing **OR** Cast, **as directed** OD: Not less than 4-1/2 inches (115 mm), fluted, **as directed**.
        1) Steel: Schedule 40 **OR** 80, **as directed**, pipe.

2) Aluminum: Extruded pipe and tubes **OR** Castings, **as directed**.
3) Stainless Steel: Tubes **OR** Pipe, **as directed**.
4) Cast Iron: Tapered **OR** As indicated, **as directed**.

b. Round **OR** Square, **as directed**, Wood: Cedar, 8 inches (203 mm) square **OR** 10 inches (254 mm) in diameter, **as directed**.
c. Style: Manufacturer's standard **OR** Chamfered top **OR** Dome top **OR** Ornamental cap **OR** As indicated, **as directed**.
d. Accessories: Eye bolts.
e. Installation Method: Surface flange anchored at finished grade to substrate indicated **OR** Surface flange anchored below finished grade to substrate indicated **OR** Cast in concrete **OR** Bolted to cast-in anchor bolts **OR** As indicated, **as directed**.

2. Aluminum Finish: Mill finish **OR** Color coated, **as directed**.
   a. Color: As selected from manufacturer's full range.
3. Steel Finish: Galvanized **OR** Color coated, **as directed**.
   a. Color: As selected from manufacturer's full range.
4. Cast-Iron Finish: Manufacturer's standard **OR** Galvanized **OR** Color coated, **as directed**.
   a. Color: As selected from manufacturer's full range.
5. Stainless-Steel Finish: Directional Satin No. 4.
6. Wood Finish: Unfinished **OR** Manufacturer's standard finish, **as directed**.

H. Fabrication
1. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.
2. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections, finish surfaces smooth and blended so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.
3. Pipes and Tubes: Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.
4. Preservative-Treated Wood Components: Complete fabrication of treated items before treatment if possible. If cut after treatment, apply field treatment complying with AWPA M4 to cut surfaces.
5. Exposed Surfaces: Polished, sanded, or otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.
6. Factory Assembly: Assemble components in the factory to greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

I. Finishes, General
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

J. Aluminum Finishes
1. Baked-Enamel, Powder-Coat Finish: Manufacturer's standard, baked, polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

K. Steel And Galvanized Steel Finishes
1. Baked-Enamel, Powder-Coat Finish: Manufacturer's standard, baked, polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

2. PVC Finish: Manufacturer's standard, UV-light stabilized, mold-resistant, slip-resistant, matte-textured, dipped or sprayed-on, PVC-plastisol finish, with flame retardant added; complying with coating manufacturer's written instructions for pretreatment, application, and minimum dry film thickness.

L. Iron Finishes
1. Baked-Enamel, Powder-Coat Finish: Manufacturer's standard, baked, polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

M. Stainless-Steel Finishes
1. Remove tool and die marks and stretch lines or blend into finish.
2. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

1.3 EXECUTION

A. Installation, General
1. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.
2. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.
3. Install site furnishings level, plumb, true, and securely anchored **OR** positioned, **as directed**, at locations indicated on Drawings.
4. Post Setting: Set cast-in support posts in concrete footing with smooth top, shaped to shed water. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.
5. Posts Set into Voids in Concrete: Form or core-drill holes for installing posts in concrete to depth recommended in writing by manufacturer of site furnishings and 3/4 inch (19 mm) larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.
6. Pipe Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

B. Cleaning
1. After completing site furnishing installation, inspect components. Remove spots, dirt, and debris. Repair damaged finishes to match original finish or replace component.

END OF SECTION 32 33 23 00

Task	Specification	Specification Description
32 33 23 00	01 22 16 00	No Specification Required
32 33 23 00	32 33 13 00	Miscellaneous Site and Street Furnishings
32 33 33 00	32 33 23 00	Site Furnishings
32 33 33 00	32 33 13 00	Miscellaneous Site and Street Furnishings
32 33 43 13	32 33 23 00	Site Furnishings
32 33 43 53	32 33 13 00	Miscellaneous Site and Street Furnishings
32 33 53 00	01 22 16 00	No Specification Required
32 39 23 00	32 33 13 00	Miscellaneous Site and Street Furnishings
32 84 00 00	07 21 13 13	Modified Bitumous Protected Membrane Roofing

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SECTION 32 84 13 00 - IRRIGATION SYSTEMS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for irrigation systems. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Piping.
b. Encasement for piping.
c. Manual valves.
d. Pressure-reducing valves.
e. Automatic control valves.
f. Automatic drain valves.
g. Transition fittings.
h. Dielectric fittings.
i. Miscellaneous piping specialties.
j. Sprinklers.
k. Quick couplers.
l. Drip irrigation specialties.
m. Controllers.
n. Boxes for automatic control valves.

C. Definitions
1. Circuit Piping: Downstream from control valves to sprinklers, specialties, and drain valves. Piping is under pressure during flow.
2. Drain Piping: Downstream from circuit-piping drain valves. Piping is not under pressure.
3. Main Piping: Downstream from point of connection to water distribution piping to, and including, control valves. Piping is under water-distribution-system pressure.
4. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

D. Performance Requirements
1. Irrigation zone control shall be automatic operation with controller and automatic control **OR** manual operation with manual, **as directed**, valves.
2. Location of Sprinklers and Specialties: Design location is approximate. Make minor adjustments necessary to avoid plantings and obstructions such as signs and light standards. Maintain 100 percent irrigation coverage of areas indicated.
3. Delegated Design: Design 100 percent coverage irrigation system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
a. Available land records indicate the following soil conditions:
1) Type: Coarse **OR** Medium **OR** Fine, **as directed**.
2) Texture:
a) Sand: as directed by the Owner.
b) Silt: as directed by the Owner .
c) Clay: as directed by the Owner.
3) Particle Size:
a) Sand: as directed by the Owner.
b) Silt: as directed by the Owner.

c) Clay: as directed by the Owner.
4) Structure: Single grained **OR** Granular **OR** Platy **OR** Blocky, **as directed**.
5) Density: as directed by the Owner.
6) Moisture Content: as directed by the Owner.
7) Infiltration Rate: as directed by the Owner.

4. Minimum Working Pressures: The following are minimum pressure requirements for piping, valves, and specialties unless otherwise indicated:
   a. Irrigation Main Piping: 200 psig (1380 kPa).
   b. Circuit Piping: 150 psig (1035 kPa).

E. Submittals
1. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Wiring Diagrams: For power, signal, and control wiring.
3. Delegated-Design Submittal: For irrigation systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
4. Zoning Chart: Show each irrigation zone and its control valve.
5. Controller Timing Schedule: Indicate timing settings for each automatic controller zone.
6. Field quality-control reports.
7. Operation and maintenance data.

F. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Delivery, Storage, And Handling
1. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
2. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

H. Project Conditions
1. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
   a. Notify the Owner no fewer than two days in advance of proposed interruption of water service.
   b. Do not proceed with interruption of water service without the Owner’s written permission.

1.2 PRODUCTS

A. Pipes, Tubes, And Fittings
1. Comply with requirements in the piping schedule for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.
2. Galvanized-Steel Pipe: ASTM A 53/A 53M, Standard Weight, Type E, Grade B.
   a. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Standard Weight, seamless-steel pipe with threaded ends.
   b. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
   c. Malleable-Iron Unions: ASME B16.39, Class 150, hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface, and female threaded ends.
   d. Cast-Iron Flanges: ASME B16.1, Class 125.
3. Ductile-Iron Pipe with Mechanical Joints: AWWA C151, with mechanical-joint bell and spigot ends.

a. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   1) Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

4. Ductile-Iron Pipe with Push-on Joint: AWWA C151, with push-on-joint bell and spigot ends.
   a. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
      1) Gaskets: AWWA C111, rubber.
5. Soft Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B), water tube, annealed temper.
   a. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper solder-joint fittings. Furnish wrought-copper fittings if indicated.
   b. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end.
   c. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
6. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B), and ASTM B 88, Type M (ASTM B 88M, Type C), water tube, drawn temper.
   a. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper solder-joint fittings. Furnish wrought-copper fittings if indicated.
   b. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end.
   c. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
7. PE Pipe with Controlled ID: ASTM F 771, PE 3408 compound; SIDR 11.5 and SIDR 15.
   a. Insert Fittings for PE Pipe: ASTM D 2609, nylon or propylene plastic with barbed ends. Include bands or other fasteners.
8. PE Pipe with Controlled OD: ASTM F 771, PE 3408 compound, SDR 11.
   a. PE Butt, Heat-Fusion Fittings: ASTM D 3261.
   b. PE Socket-Type Fittings: ASTM D 2683.
9. PE Pressure Pipe: AWWA C906, with DR of 7.3, 9, or 9.3 and PE compound number required to give pressure rating not less than 160 psig (1100 kPa) **OR** 200 psig (1380 kPa), **as directed**.
   a. PE Butt, Heat-Fusion Fittings: ASTM D 3261.
   b. PE Socket-Type Fittings: ASTM D 2683.
10. PVC Pipe: ASTM D 1785, PVC 1120 compound, Schedule 40 **OR** Schedule 80, **as directed**.
    a. PVC Socket Fittings: ASTM D 2466, Schedule 40 **OR** Schedule 80, **as directed**.
    b. PVC Threaded Fittings: ASTM D 2464, Schedule 80.
    c. PVC Socket Unions: Construction similar to MSS SP-107, except both headpiece and tailpiece shall be PVC with socket ends.
11. PVC Pipe, Pressure Rated: ASTM D 2241, PVC 1120 compound, SDR 21 and SDR 26.
    a. PVC Socket Fittings: ASTM D 2467, Schedule 80.
    b. PVC Socket Unions: Construction similar to MSS SP-107, except both headpiece and tailpiece shall be PVC with socket or threaded ends.

B. Piping Joining Materials
   1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick unless otherwise indicated; full-face or ring type unless otherwise indicated.
   2. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
   3. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
   4. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
   5. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
   6. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

C. Encasement For Piping
   1. Standard: ASTM A 674 or AWWA C105.

2. Form: Sheet **OR** Tube, **as directed**.
3. Material: LLDPE film of 0.008-inch (0.20-mm) **OR** LLDPE film of 0.008-inch (0.20-mm) minimum thickness or high-density, cross-laminated PE film of 0.004-inch (0.10-mm) **OR** High-density, cross-laminated PE film of 0.004-inch (0.10-mm), **as directed**, minimum thickness.
4. Color: Black **OR** Natural, **as directed**.

D. Manual Valves
1. Curb Valves:
   a. Description:
      1) Standard: AWWA C800.
      2) NPS 1 (DN 25) and Smaller Pressure Rating: 100 psig (690 kPa) minimum **OR** 150 psig (1035 kPa), **as directed**.
      3) NPS 1-1/4 to NPS 2 (DN 32 to DN 50) Pressure Rating: 80 psig (550 kPa) minimum **OR** 150 psig (1035 kPa), **as directed**.
      4) Body Material: Brass or bronze with ball or ground-key plug.
      5) End Connections: Matching piping.
      6) Stem: With wide-tee head.
2. Curb-Valve Casing:
   a. Standard: Similar to AWWA M44 for cast-iron valve casings.
   b. Top Section: Telescoping, of length required for depth of burial of curb valve.
   c. Barrel: Approximately 3-inch (75-mm) diameter.
   d. Plug: With lettering "WATER."
   e. Bottom Section: With base of size to fit over valve.
   f. Base Support: Concrete collar **OR** wood frame, **as directed**.
3. Shutoff Rods for Curb-Valve Casings: Furnish one **OR** two, **as directed**, steel, tee-handle shutoff rod(s) with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve for Project.
4. Brass Ball Valves:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Two piece.
      5) Body Material: Forged brass.
      6) Ends: Threaded or solder joint if indicated.
      7) Seats: PTFE or TFE.
      8) Stem: Brass.
      9) Ball: Chrome-plated brass.
      10) Port: Full **OR** regular, but not reduced, **as directed**.
5. Bronze Ball Valves:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Two piece.
      5) Body Material: Bronze.
      6) Ends: Threaded or solder joint if indicated.
      7) Seats: PTFE or TFE.
      8) Stem: Bronze.
      9) Ball: Chrome-plated brass.
      10) Port: Full **OR** regular, but not reduced, **as directed**.
6. Iron Ball Valves:
   a. Description:
      1) Standard: MSS SP-72.
      2) CWP Rating: 200 psig (1380 kPa).

3) Body Design: Split body.
4) Body Material: ASTM A 126, gray iron.
5) Ends: Flanged.
6) Seats: PTFE or TFE.
7) Stem: Stainless steel.
8) Ball: Stainless steel.
9) Port: Full.

7. Plastic Ball Valves:
   a. Description:
      1) Standard: MSS SP-122.
      2) Pressure Rating: 125 psig (860 kPa) minimum **OR** 150 psig (1035 kPa), **as directed**.
      3) Body Material: PVC.
      4) Type: Union.
      5) End Connections: Socket or threaded.
      6) Port: Full.
8. Bronze Gate Valves:
   a. Description:
      1) Standard: MSS SP-80, Type 2.
      2) Class: 125.
      3) CWP Rating: 200 psig (1380 kPa).
      4) Body Material: ASTM B 62 bronze with integral seat and screw-in bonnet.
      5) Ends: Threaded or solder joint.
      6) Stem: Bronze, nonrising.
      7) Disc: Solid wedge; bronze.
      8) Packing: Asbestos free.
      9) Handwheel: Malleable iron, bronze, or aluminum.
9. Iron Gate Valves, Resilient Seated:
   a. Description:
      1) Standard: AWWA C509.
      2) Pressure Rating: 200 psig (1380 kPa) **OR** 250 psig (1725 kPa), **as directed**, minimum.
      3) Body Material: Ductile or gray iron with bronze trim.
      4) End Connections: Mechanical joint or push-on joint.
      5) Interior Coating: Comply with AWWA C550.
      6) Body Design: Nonrising stem.
      7) Operator: Stem nut.
      8) Disc: Solid wedge with resilient coating.
10. Iron Gate Valve Casings:
    a. Standard: AWWA M44 for cast-iron valve casings.
    b. Top Section: Adjustable extension of length required for depth of burial of valve.
    c. Barrel: Approximately 5-inch (125-mm) diameter.
    d. Plug: With lettering "WATER."
    e. Bottom Section: With base of size to fit over valve.
    f. Base Support: Concrete collar **OR** wood frame, **as directed**.
11. Operating Wrenches for Iron Gate Valve Casings: Furnish one **OR** two, **as directed**, steel, tee-handle operating wrench(es) with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut for Project.
12. Iron Gate Valves, NRS:
    a. Description:
       1) Standard: MSS SP-70, Type I.
       2) CWP Rating: 200 psig (1380 kPa).
       3) Body Material: ASTM A 126, gray iron with bolted bonnet.
       4) Ends: Flanged.
       5) Trim: All bronze.
       6) Disc: Solid wedge.

7) Packing and Gasket: Asbestos free.

13. Iron Gate Valves, OS&Y:
   a. Description:
      1) Standard: MSS SP-70, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Material: ASTM A 126, gray iron with bolted bonnet.
      4) Ends: Flanged.
      5) Trim: All bronze.
      6) Disc: Solid wedge.
      7) Packing and Gasket: Asbestos free.

E. Pressure-Reducing Valves
1. Water Regulators:
   a. Description:
      1) Standard: ASSE 1003.
      2) Body Material: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).
      3) Pressure Rating: Initial pressure of 150 psig (1035 kPa).
      4) End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).
2. Water Control Valves:
   a. Description: Pilot-operation, diaphragm-type, single-seated main water control valve. Include small pilot control valve, restrictor device, specialty fittings, and sensor piping.
      1) Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.
      2) Pattern: Angle-valve **OR** Globe-valve, **as directed**, design.
      3) Trim: Stainless steel.
      4) Pressure Rating: Initial pressure of 150 psig (1035 kPa) minimum.
      5) End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.

F. Automatic Control Valves
1. Bronze, Automatic Control Valves:
   a. Description: Cast-bronze body, normally closed, diaphragm type with manual-flow adjustment, and operated by 24-V ac solenoid.
2. Plastic, Automatic Control Valves:
   a. Description: Molded-plastic body, normally closed, diaphragm type with manual-flow adjustment, and operated by 24-V ac solenoid.

G. Automatic Drain Valves
1. Description: Spring-loaded-ball type of corrosion-resistant construction and designed to open for drainage if line pressure drops below 2-1/2 to 3 psig (17 to 20 kPa).

H. Transition Fittings
1. General Requirements: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
2. Transition Couplings:
   a. Description: AWWA C219, metal sleeve-type coupling for underground pressure piping.
3. Plastic-to-Metal Transition Fittings:
   a. Description: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-socket or threaded end.
4. Plastic-to-Metal Transition Unions:

a. Description: MSS SP-107, PVC four-part union. Include one brass or stainless-steel threaded end, one solvent-cement-joint or threaded plastic end, rubber O-ring, and union nut.

I. Dielectric Fittings
1. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.
2. Dielectric Unions:
   a. Description: Factory-fabricated union, NPS 2 (DN 50) and smaller.
      1) Pressure Rating: 150 psig (1035 kPa) minimum **OR** 250 psig (1725 kPa), **as directed**, at 180 deg F (82 deg C).
      2) End Connections: Solder-joint copper alloy and threaded ferrous; threaded ferrous.
3. Dielectric Flanges:
   a. Description: Factory-fabricated, bolted, companion-flange assembly, NPS 2-1/2 to NPS 4 (DN 65 to DN 100) and larger.
      1) Pressure Rating: 150 psig (1035 kPa) minimum **OR** 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
      2) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
4. Dielectric-Flange Kits:
   a. Description: Nonconducting materials for field assembly of companion flanges, NPS 2-1/2 (DN 65) and larger.
      1) Pressure Rating: 150 psig (1035 kPa) minimum.
      2) Gasket: Neoprene or phenolic.
      3) Bolt Sleeves: Phenolic or polyethylene.
      4) Washers: Phenolic with steel backing washers.
5. Dielectric Couplings:
   a. Description: Galvanized-steel coupling.
      1) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
      2) End Connections: Female threaded.
      3) Lining: Inert and noncorrosive, thermoplastic lining.
6. Dielectric Nipples:
   a. Description: Electroplated steel nipple complying with ASTM F 1545.
      1) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
      2) End Connections: Male threaded or grooved.
      3) Lining: Inert and noncorrosive, propylene.

J. Miscellaneous Piping Specialties
1. Water Hammer Arresters: ASSE 1010 or PDI WH 201, with bellows or piston-type pressurized cushioning chamber and in sizes complying with PDI WH 201, Sizes A to F.
2. Pressure Gages: ASME B40.1. Include 4-1/2-inch- (115-mm-) diameter dial, dial range of two times system operating pressure, and bottom outlet.

K. Sprinklers
1. General Requirements: Designed for uniform coverage over entire spray area indicated at available water pressure.
2. Metal, Exposed, Impact-Drive Rotary Sprinklers:
   a. Description:
      1) Construction: Brass and other corrosion-resistant metals.
      2) Mounting: Aboveground, exposed on riser.
3. Plastic, Exposed, Impact-Drive Rotary Sprinklers:
   a. Description:
      1) Construction: ABS and corrosion-resistant metals.
      2) Mounting: Aboveground, exposed on riser.
4. Plastic, Pop-up, Gear-Drive Rotary Sprinklers:

a. Description:
   1) Body Material: ABS.
   2) Nozzle: ABS **OR** Brass, **as directed**.
   3) Retraction Spring: Stainless steel.
   4) Internal Parts: Corrosion resistant.
5. Metal, Pop-up, Impact-Drive Rotary Sprinklers:
   a. Description:
      1) Case: Brass.
      2) Body Material: Brass.
      3) Pop-up Height: Approximately 3 inches (75 mm).
      4) Sprinkler Construction: Brass and other corrosion-resistant metals.
6. Plastic, Pop-up, Impact-Drive Rotary Sprinklers:
   a. Description:
      1) Case: ABS.
      2) Pop-up Height: Approximately 3 inches (75 mm).
      3) Sprinkler Construction: ABS and other corrosion-resistant metals.
7. Metal, Surface Spray Sprinklers:
   a. Description:
      1) Body Material and Flange: Brass.
      2) Nozzle: Brass.
      3) Pattern: Fixed, with flow adjustment.
8. Plastic, Surface Spray Sprinklers:
   a. Description:
      1) Body Material and Flange: ABS.
      2) Pattern: Fixed, with flow adjustment.
9. Metal, Surface, Pop-up Spray Sprinklers:
   a. Description:
      1) Body Material and Flange: Brass.
      2) Nozzle: Brass.
      3) Pattern: Fixed, with flow adjustment.
10. Plastic, Surface, Pop-up Spray Sprinklers:
   a. Description:
      1) Body Material and Flange: ABS.
      2) Pattern: Fixed, with flow adjustment.
11. Plastic, Pop-up Spray Sprinklers:
   a. Description:
      1) Body Material: ABS.
      2) Nozzle: ABS **OR** Brass, **as directed**.
      3) Retraction Spring: Stainless steel.
      4) Internal Parts: Corrosion resistant.
      5) Pattern: Fixed, with flow adjustment.
12. Metal Shrub Sprinklers:
   a. Description:
      1) Body Material: Brass.
      2) Nozzle: Brass.
      3) Pattern: Fixed, with flow adjustment.
13. Plastic Shrub Sprinklers:
   a. Description:
      1) Body Material: ABS or other plastic.
      2) Pattern: Fixed, with flow adjustment.

L. Quick Couplers
1. Description: Factory-fabricated, bronze or brass, two-piece assembly. Include coupler water-seal valve; removable upper body with spring-loaded or weighted, rubber-covered cap; hose swivel with ASME B1.20.7, 3/4-11.5NH threads for garden hose on outlet; and operating key.

a. Locking-Top Option: Vandal-resistant locking feature. Include one **OR** two, **as directed**, matching key(s).

M. Drip Irrigation Specialties
1. Freestanding Emitters: Device to deliver water at approximately 20 psig (138 kPa).
   a. Body Material: PE or vinyl, with flow control.
   b. Riser to Emitter: PE or PVC flexible tubing.
2. Manifold Emitter Systems: Manifold with tubing and emitters.
   a. Manifold: With multiple outlets to deliver water to emitters.
      1) Body Material: Plastic.
      2) Outlet Caps: Plastic, for outlets without installed tubing.
      3) Operation: Automatic pressure compensating.
   b. Tubing: PE or PVC; 1/8-inch (3-mm) minimum ID.
   c. Emitter: Device to deliver water at approximately 20 psig (138 kPa).
      1) Body Material: PE or vinyl, with flow control.
3. Multiple-Outlet Emitter Systems: Emitter with tubing and button-type outlets.
   a. Emitter: With multiple outlets to deliver water to remote outlets.
      1) Body Material: Plastic, with flow control.
      2) Outlet Caps: Plastic, for outlets without installed tubing.
      3) Operation: Automatic pressure compensating.
      4) Emitters: Devices to deliver water at approximately 20 psig (138 kPa).
   b. Tubing: PE or PVC; 1/8-inch (3-mm) minimum ID.
4. Drip Tubes with Direct-Attached Emitters:
   a. Tubing: Flexible PE or PVC with plugged end.
   b. Emitters: Devices to deliver water at approximately 20 psig (138 kPa).
      1) Body Material: PE or vinyl, with flow control.
      2) Mounting: Inserted into tubing at set intervals.
5. Drip Tubes with Remote Discharge:
   a. Tubing: Flexible PE or PVC with plugged end.
   b. Emitters: Devices to deliver water at approximately 20 psig (138 kPa).
      1) Body Material: PE or vinyl, with flow control.
      2) Mounting: Inserted into tubing at set intervals.
6. Off-Ground Supports: Plastic stakes.
7. Application Pressure Regulators: Brass or plastic housing, NPS 3/4 (DN 20), with corrosion-resistant internal parts; capable of controlling outlet pressure to approximately 20 psig (138 kPa).
8. Filter Units: Brass or plastic housing, with corrosion-resistant internal parts; of size and capacity required for devices downstream from unit.
9. Air Relief Valves: Brass or plastic housing, with corrosion-resistant internal parts.
10. Vacuum Relief Valves: Brass or plastic housing, with corrosion-resistant internal parts.

N. Controllers
1. Description:
   a. Controller Stations for Automatic Control Valves: Each station is variable from approximately 5 to 60 minutes. Include switch for manual or automatic operation of each station.
   b. Exterior Control Enclosures: NEMA 250, Type 4, weatherproof, with locking cover and two matching keys; include provision for grounding.
      1) Body Material: Enameled-steel sheet metal **OR** Stainless-steel sheet metal **OR** Molded plastic, **as directed**.
      2) Mounting: Freestanding type for concrete base **OR** Surface type for wall, **as directed**.
   c. Interior Control Enclosures: NEMA 250, Type 12, dripproof, with locking cover and two matching keys.
      1) Body Material: Enameled-steel sheet metal **OR** Stainless-steel sheet metal **OR** Molded plastic, **as directed**.

2) Mounting: Freestanding type for concrete base **OR** Surface type for wall, **as directed**.

d. Control Transformer: 24-V secondary, with primary fuse.

e. Timing Device: Adjustable, 24-hour, 14-day clock, with automatic operations to skip operation any day in timer period, to operate every other day, or to operate two or more times daily.

1) Manual or Semiautomatic Operation: Allows this mode without disturbing preset automatic operation.

2) Nickel-Cadmium Battery and Trickle Charger: Automatically powers timing device during power outages.

3) Surge Protection: Metal-oxide-varistor type on each station and primary power.

f. Moisture Sensor: Adjustable from one to seven days, to shut off water flow during rain.

g. Wiring: UL 493, Type UF multiconductor, with solid-copper conductors; insulated cable; suitable for direct burial.

1) Feeder-Circuit Cables: No. 12 AWG minimum, between building and controllers.

2) Low-Voltage, Branch-Circuit Cables: No. 14 AWG minimum, between controllers and automatic control valves; color-coded different from feeder-circuit-cable jacket color; with jackets of different colors for multiple-cable installation in same trench.

3) Splicing Materials: Manufacturer's packaged kit consisting of insulating, spring-type connector or crimped joint and epoxy resin moisture seal; suitable for direct burial.

h. Concrete Base: Reinforced precast concrete not less than 36 by 24 by 4 inches (900 by 600 by 100 mm) thick, and 6 inches (150 mm) greater in each direction than overall dimensions of controller. Include opening for wiring.

O. Boxes For Automatic Control Valves

1. Plastic Boxes:

a. Description: Box and cover, with open bottom and openings for piping; designed for installing flush with grade.

1) Size: As required for valves and service.

2) Shape: Round **OR** Square **OR** Rectangular, **as directed**.

3) Sidewall Material: PE **OR** PE, ABS, or FRP, **as directed**.

4) Cover Material: PE **OR** PE, ABS, or FRP, **as directed**.

a) Lettering: "VALVE BOX" **OR** "IRRIGATION," **as directed**.

2. Polymer-Concrete Boxes:

a. Description: Box and cover, with open bottom and openings for piping; designed for installing flush with grade.

1) Size: As required for valves and service.

2) Shape: Round **OR** Square **OR** Rectangular, **as directed**.

3) Sidewall Material: Polymer concrete with lateral and vertical sidewall design loading of 5000 lb (2268 kg) **OR** 10,000 lb (4536 kg) **OR** 15,000 lb (6800 kg), **as directed**, minimum over 10 by 10 inches (254 by 254 mm) square.

4) Cover Material: Polymer concrete **OR** Reinforced polymer concrete, **as directed**, with cover design loading of 5000 lb (2268 kg) **OR** 10,000 lb (4536 kg) **OR** 15,000 lb (6800 kg), **as directed**, minimum over 10 by 10 inches (254 by 254 mm) square.

a) Lettering: "VALVE BOX" **OR** "IRRIGATION," **as directed**.

3. Drainage Backfill: Cleaned gravel or crushed stone, graded from 3/4 inch (19 mm) minimum to 3 inches (75 mm) maximum.

1.3 EXECUTION

A. Earthwork

1. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving".

2. Install warning tape directly above pressure piping, 12 inches (300 mm) below finished grades, except 6 inches (150 mm) below subgrade under pavement and slabs.

3. Drain Pockets: Excavate to sizes indicated. Backfill with cleaned gravel or crushed stone, graded from 3/4 to 3 inches (19 to 75 mm), to 12 inches (300 mm) below grade. Cover gravel or crushed stone with sheet of asphalt-saturated felt and backfill remainder with excavated material.
4. Provide minimum cover over top of underground piping according to the following:
    a. Irrigation Main Piping: Minimum depth of 36 inches (900 mm) below finished grade, or not less than 18 inches (450 mm) below average local frost depth, whichever is deeper.
    b. Circuit Piping: 12 inches (300 mm).
    c. Drain Piping: 12 inches (300 mm)
    d. Sleeves: 24 inches (600 mm).

B. Piping Installation
1. Location and Arrangement: Drawings indicate location and arrangement of piping systems. Install piping as indicated unless deviations are approved on Coordination Drawings.
2. Install piping at minimum uniform slope of 0.5 percent down toward drain valves.
3. Install piping free of sags and bends.
4. Install groups of pipes parallel to each other, spaced to permit valve servicing.
5. Install fittings for changes in direction and branch connections.
6. Install unions adjacent to valves and to final connections to other components with NPS 2 (DN 50) or smaller pipe connection.
7. Install flanges adjacent to valves and to final connections to other components with NPS 2-1/2 (DN 65) or larger pipe connection.
8. Install underground thermoplastic piping according to ASTM D 2774 and ASTM F 690.
9. Install expansion loops in control-valve boxes for plastic piping.
10. Lay piping on solid subbase, uniformly sloped without humps or depressions.
11. Install ductile-iron piping according to AWWA C600.
12. Install PVC piping in dry weather when temperature is above 40 deg F (5 deg C). Allow joints to cure at least 24 hours at temperatures above 40 deg F (5 deg C) before testing.
13. Install water regulators with shutoff valve and strainer on inlet and pressure gage on outlet. Install shutoff valve on outlet. Install aboveground or in control-valve boxes.
14. Water Hammer Arresters: Install between connection to building main and circuit valves aboveground or in control-valve boxes.
15. Install piping in sleeves under parking lots, roadways, and sidewalks.
16. Install sleeves made of Schedule 40 **OR** Schedule 80, **as directed**, PVC pipe and socket fittings, and solvent-cemented joints.
17. Install transition fittings for plastic-to-metal pipe connections according to the following:
    a. Underground Piping:
        1) NPS 1-1/2 (DN 40) and Smaller: Plastic-to-metal transition fittings.
        2) NPS 2 (DN 50) and Larger: AWWA transition couplings.
    b. Aboveground Piping:
        1) NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings **OR** unions, **as directed**.
        2) NPS 2 (DN 50) and Larger: Use dielectric flange kits with one plastic flange.
18. Install dielectric fittings for dissimilar-metal pipe connections according to the following:
    a. Underground Piping:
        1) NPS 2 (DN 50) and Smaller: Dielectric coupling or dielectric nipple.
        2) NPS 2-1/2 (DN 65) and Larger: Prohibited except in control-valve box.
    b. Aboveground Piping:
        1) NPS 2 (DN 50) and Smaller: Dielectric union.
        2) NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Dielectric flange.
        3) NPS 5 (DN 125) and Larger: Dielectric flange kit.
    c. Piping in Control-Valve Boxes:
        1) NPS 2 (DN 50) and Smaller: Dielectric union.
        2) NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Dielectric flange.
        3) NPS 5 (DN 125) and Larger: Dielectric flange kit.

C. Joint Construction

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
4. Flanged Joints: Select rubber gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
5. Ductile-Iron Piping Gasketed Joints: Comply with AWWA C600 and AWWA M41.
6. Copper-Tubing Brazed Joints: Construct joints according to CDA's "Copper Tube Handbook," using copper-phosphorus brazing filler metal.
7. Copper-Tubing Soldered Joints: Apply ASTM B 813 water-flushable flux to tube end unless otherwise indicated. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B 32.
8. PE Piping Fastener Joints: Join with insert fittings and bands or fasteners according to piping manufacturer's written instructions.
9. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
   a. Plain-End PE Pipe and Fittings: Use butt fusion.
   b. Plain-End PE Pipe and Socket Fittings: Use socket fusion.
10. PVC Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   b. PVC Pressure Piping: Join schedule number, ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
   c. PVC Nonpressure Piping: Join according to ASTM D 2855.

D. Valve Installation
1. Underground Curb Valves: Install in curb-valve casings with tops flush with grade.
2. Underground Iron Gate Valves, Resilient Seat: Comply with AWWA C600 and AWWA M44. Install in valve casing with top flush with grade.
   a. Install valves and PVC pipe with restrained, gasketed joints.
3. Aboveground Valves: Install as components of connected piping system.
4. Pressure-Reducing Valves: Install in boxes for automatic control valves or aboveground between shutoff valves. Install full-size valved bypass, **as directed**.
5. Throttling Valves: Install in underground piping in boxes for automatic control valves.
6. Drain Valves: Install in underground piping in boxes for automatic control valves.

E. Sprinkler Installation
1. Install sprinklers after hydrostatic test is completed.
2. Install sprinklers at manufacturer's recommended heights.
3. Locate part-circle sprinklers to maintain a minimum distance of 4 inches (100 mm) from walls and 2 inches (50 mm) from other boundaries unless otherwise indicated.

F. Drip Irrigation Specialty Installation
1. Install freestanding emitters on pipe riser to mounting height indicated.
2. Install manifold emitter systems with tubing to emitters. Plug unused manifold outlets. Install emitters on off-ground supports at height indicated.

3. Install multiple-outlet emitter systems with tubing to outlets. Plug unused emitter outlets. Install outlets on off-ground supports at height indicated.
4. Install drip tubes with direct-attached emitters on ground.
5. Install drip tubes with remote-discharge on ground with outlets on off-ground supports at height indicated.
6. Install off-ground supports of length required for indicated mounted height of device.
7. Install application pressure regulators and filter units in piping near device being protected, and aboveground **OR** in control-valve boxes, **as directed**.
8. Install air relief valves and vacuum relief valves in piping, and aboveground **OR** in control-valve boxes, **as directed**.

G. Automatic Irrigation-Control System Installation
1. Equipment Mounting: Install interior controllers on floor **OR** concrete bases **OR** wall, **as directed**.
   a. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   b. Install anchor bolts to elevations required for proper attachment to supported equipment.
2. Equipment Mounting: Install exterior freestanding controllers on precast concrete bases.
   a. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   b. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install control cable in same trench as irrigation piping and at least 2 inches (51 mm) below or beside piping. Provide conductors of size not smaller than recommended by controller manufacturer. Install cable in separate sleeve under paved areas.

H. Connections
1. Comply with requirements for piping specified in Division 22 Section "Facility Water Distribution Piping" for water supply from exterior water service piping, water meters, protective enclosures, and backflow preventers. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to equipment, valves, and devices to allow service and maintenance.
3. Connect wiring between controllers and automatic control valves.

I. Identification
1. Identify system components. Comply with requirements for identification specified in Division 22 Section "Identification For Plumbing Piping And Equipment".
2. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplates and signs on each automatic controller.
   a. Text: In addition to identifying unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
3. Warning Tapes: Arrange for installation of continuous, underground, detectable warning tapes over underground piping during backfilling of trenches. See Division 31 Section "Earth Moving" for warning tapes.

J. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
   a. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   b. Operational Test: After electrical circuitry has been energized, operate controllers and automatic control valves to confirm proper system operation.
   c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Any irrigation product will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

K. Adjusting
1. Adjust settings of controllers.
2. Adjust automatic control valves to provide flow rate at rated operating pressure required for each sprinkler circuit.
3. Adjust sprinklers and devices, except those intended to be mounted aboveground, so they will be flush with, or not more than 1/2 inch (13 mm) above, finish grade.

L. Cleaning
1. Flush dirt and debris from piping before installing sprinklers and other devices.

M. Piping Schedule
1. Install components having pressure rating equal to or greater than system operating pressure.
2. Piping in control-valve boxes and aboveground may be joined with flanges or unions instead of joints indicated.
3. Aboveground irrigation main piping, NPS 4 (DN 100) and smaller, shall be one of the following:
   a. Galvanized-steel pipe and galvanized-steel pipe nipples; galvanized, gray-iron threaded fittings; and threaded joints.
   b. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube, wrought- or cast-copper fittings, and brazed **OR** soldered, **as directed**, joints.
   c. Schedule 40 **OR** Schedule 80, **as directed**, PVC pipe; socket-type PVC fittings; and solvent-cemented joints.
   d. Schedule 80, PVC pipe; Schedule 80, threaded PVC fittings; and threaded joints.
4. Aboveground irrigation main piping, NPS 5 (DN 125) and larger, shall be one of the following:
   a. Galvanized-steel pipe and galvanized-steel pipe nipples; galvanized, gray-iron threaded fittings; and threaded joints.
   b. Schedule 40 **OR** Schedule 80, **as directed**, PVC pipe and socket fittings; and solvent-cemented joints.
   c. Schedule 80, PVC pipe; Schedule 80, threaded PVC fittings; and threaded joints.
5. Underground irrigation main piping, NPS 4 (DN 100) and smaller, shall be one of the following:
   a. NPS 3 and NPS 4 (DN 80 and DN 100) ductile-iron, mechanical-joint pipe; ductile-iron, mechanical-joint fittings, glands, bolts, and nuts; and gasketed joints.
   b. NPS 3 and NPS 4 (DN 80 and DN 100) ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings and gaskets; and gasketed joints.
   c. Type L (Type B) soft copper tube, wrought-copper fittings, and brazed joints.
   d. NPS 4 (DN 100) PE pressure pipe; PE butt, heat-fusion or socket-type fittings; and heat-fusion joints.
   e. Schedule 40 **OR** Schedule 80, **as directed**, PVC pipe and socket fittings, and solvent-cemented joints.
   f. Schedule 80, PVC pipe; Schedule 80, threaded PVC fittings; and threaded joints.
   g. SDR 21, PVC, pressure-rated pipe; Schedule 80, PVC socket fittings; and solvent-cemented joints.
6. Underground irrigation main piping, NPS 5 (DN 125) and larger, shall be one of the following:
   a. NPS 6 (DN 150) and larger ductile-iron, mechanical-joint pipe; ductile-iron, mechanical-joint fittings, glands, bolts, and nuts; and gasketed joints.
   b. NPS 6 (DN 150) and larger ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings and gaskets; and gasketed joints.
   c. PE pressure pipe; PE butt, heat-fusion fittings; and heat-fusion joints.
   d. Schedule 40 **OR** Schedule 80, **as directed**, PVC pipe and socket fittings; and solvent-cemented joints.
   e. SDR 21, PVC, pressure-rated pipe; Schedule 80, PVC socket fittings; and solvent-cemented joints.
7. Circuit piping, NPS 2 (DN 50) and smaller, shall be one of the following:
   a. SIDR 7 **OR** SIDR 9, **as directed**, PE, controlled ID pipe; insert fittings for PE pipe; and fastener joints.

b. DR 9 **OR** DR 11, **as directed**, PE, controlled OD pipe; PE butt, heat-fusion, or PE socket-type fittings; and heat-fusion joints.
c. Schedule 40, PVC pipe and socket fittings; and solvent-cemented joints.
d. SDR 26, PVC, pressure-rated pipe; Schedule 40, PVC socket fittings; and solvent-cemented joints.

8. Circuit piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:
a. SIDR 7 **OR** SIDR 9, **as directed**, PE, controlled ID pipe; insert fittings for PE pipe; and banded or fastener joints.
b. DR 9 **OR** DR 11, **as directed**, PE, controlled OD pipe; PE socket or butt-fusion fittings; and heat-fusion joints. NPS 3 (DN 80) pipe and fittings if NPS 2-1/2 (DN 65) pipe and fittings are not available.
c. Schedule 40, PVC pipe and socket fittings; and solvent-cemented joints.
d. SDR 26, PVC, pressure-rated pipe; Schedule 40, PVC socket fittings; and solvent-cemented joints.

9. Underground Branches and Offsets at Sprinklers and Devices: Schedule 80, PVC pipe; threaded PVC fittings; and threaded joints.
a. Option: Plastic swing-joint assemblies, with offsets for flexible joints, manufactured for this application.

10. Risers to Aboveground Sprinklers and Specialties: Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube, wrought-copper fittings, and brazed **OR** soldered, **as directed**, joints.

11. Risers to Aboveground Sprinklers and Specialties: Schedule 80, PVC pipe and socket fittings; and solvent-cemented joints.

12. Drain piping shall be one of the following:
a. SIDR 9, 11.5, or 15, PE, controlled ID pipe; insert fittings for PE pipe; and banded or fastener joints.
b. Schedule 40, PVC pipe and socket fittings; and solvent-cemented joints.
c. SDR 21, 26, or 32.5, PVC, pressure-rated pipe; Schedule 40, PVC socket fittings; and solvent-cemented joints.

N. Valve Schedule

1. Underground, Shutoff-Duty Valves: Use the following:
a. NPS 2 (DN 50) and Smaller: Curb valve, curb-valve casing, and shutoff rod.
b. NPS 3 (DN 80) and Larger: Iron gate valve, resilient seated; iron gate valve casing; and operating wrench(es).

2. Aboveground, Shutoff-Duty Valves:
a. NPS 2 (DN 50) and Smaller: Brass **OR** Bronze **OR** Plastic, **as directed**, ball valve.
b. NPS 2 (DN 50) and Smaller: Bronze gate valve.
c. NPS 2-1/2 (DN 65) and Larger: Iron ball valve.
d. NPS 2-1/2 (DN 65) and Larger: Iron gate valve, NRS **OR** OS&Y, **as directed**.

3. Throttling-Duty Valves:
a. NPS 2 (DN 50) and Smaller: Bronze **OR** Plastic, **as directed**, automatic control valve.
b. NPS 2 (DN 50) and Smaller: Brass **OR** Bronze **OR** Plastic, **as directed**, ball valve.
c. NPS 2-1/2 and NPS 3 (DN 65 and DN 80): Bronze **OR** Plastic, **as directed**, automatic control valve.
d. NPS 2-1/2 and NPS 3 (DN 65 and DN 80): Iron ball valve.

4. Drain Valves:
a. NPS 1/2 and NPS 3/4 (DN 15 and DN 20): Automatic drain valve.
b. NPS 1/2 and NPS 3/4 (DN 15 and DN 20): Brass **OR** Bronze **OR** Plastic, **as directed**, ball valve.
c. NPS 1/2 and NPS 3/4 (DN 15 and DN 20): Bronze gate valve.
d. NPS 1 to NPS 2 (DN 25 to DN 50): Brass **OR** Bronze **OR** Plastic, **as directed**, ball valve.
e. NPS 1 to NPS 2 (DN 25 to DN 50): Bronze gate valve.

END OF SECTION 32 84 13 00

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Task	Specification	Specification Description
32 84 13 00	07 21 13 13	Modified Bitumous Protected Membrane Roofing
32 84 23 00	01 22 16 00	No Specification Required
32 84 23 00	32 84 13 00	Irrigation Systems
32 84 23 00	03 05 13 00	Cast-In-Place Concrete
32 84 23 00	07 21 13 13	Modified Bitumous Protected Membrane Roofing
32 84 23 00	07 63 00 00	Common Work Results for Fire Suppression
32 84 23 00	07 63 00 00a	Common Work Results for Plumbing
32 84 23 00	07 63 00 00b	Common Work Results for HVAC

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SECTION 32 91 13 16 - TREE RELOCATION

1.1 GENERAL

A. Description Of Work
   1. This specification covers labor, materials, necessary equipment and services to complete the tree relocation work. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.
   2. Before tree excavation, pruning, removal, or relocation of existing trees, contractor shall notify:
      a. the Owner of schedule of operation.
      b. Appropriate utility companies and the Owner for flagging and coordination of service disconnection as necessary to complete work.
      c. Coordinate work with other trades.

B. Definitions
   1. Toxic Substances: Do not deliver any toxic substance or item as defined by the state, to the site without furnishing to the Owner a Material Safety Data Sheet (MSDS). Provide current MSDS information with each initial shipment.
      a. The MSDS shall contain the following information:
         1) The chemical name and the common name of the toxic substance.
         2) The hazards or other risks in the use of the toxic substance, including:
            a) The potential for fire, explosion, corrosivity and reactivity.
            b) The known acute and chronic health effects of risks from exposure, including the medical conditions which are generally recognized as being aggravated by exposure to the toxic substance.
            c) The primary routes of entry and symptoms of overexposure.
         3) The proper precautions, handling practices, necessary personal protective equipment, any other safety precautions in the use of or exposure to the toxic substance including appropriate emergency treatment in case of overexposure.
         4) The emergency procedure for spills, fire disposal, and first aid.
         5) A description in lay terms of the known specific potential health risks posed by the toxic substance intended to alert any person reading this information.
         6) The year and month, if available, that the information was compiled and the name, address, and emergency telephone number of the manufacturer responsible for preparing the information.

C. Description
   1. Protect existing trees to remain during construction phases. Provide tree protection barriers for those existing trees adjacent to tree transplantation operations. Any trees scarred or destroyed, designated to remain, will be replaced at the Contractor's expense, with similar species, size, and quality.
   2. Remove other vegetation as necessary and as required to meet project requirements to accommodate new plantings. Prepare areas to be planted according to Division 32 Section "Plants".
   3. Resulting tree pits of relocated material shall be backfilled with clean fill and brought back flush with surrounding grade, unless the pits are to be immediately replanted. Stabilize grade if required. Correct problems caused by erosion, wind, etc., in the reclaimed area. Pits to be quickly replanted shall be surrounded by safety barricades to prevent accidental falls into pits.
      a. In areas where new plant material will replace relocated plant material, appropriate planting soil mix shall be used as backfill.

D. Submittals

1. Submit a list of equipment, procedure, and labor force anticipated for use for tree relocation for approval by the Owner.
2. Submit a schedule by day indicating units to be dug and relocated. Note materials requiring root pruning, and that the relocation schedule is to begin at the end of the specified root pruning period.
3. Obtain permits required by authority having jurisdiction.
4. Submit written certification that trees indicated to remain have been protected during the course of construction according to recognized standards of the industry. Certify that where damage did occur:
   a. Trees were promptly and properly treated.
   b. Indicate which damaged trees (if any) are incapable of retaining full growth potential and are recommended to be replaced.
5. Submit for approval, proposed methods, and schedule for effecting tree and plant protection.

E. Quality Assurance
1. Unless otherwise specified, tree transplanting shall comply with NAA Ref.1.
2. Comply with NAA standards for pruning and remove branches from trees to remain to clear new construction.
3. Recommend procedures to compensate for loss of roots (if any) and perform initial pruning of branches and stimulation of root growth where removed to accommodate new construction.
4. Perform tree repair work for damage incurred by new construction.
5. Provide routine progress evaluation reports on relocated trees until the end of the maintenance period.
6. Evaluate existing trees and verify trees are free of disease and ready to survive relocation from the site to their new location on-site or off-site.

F. Delivery, Storage, and Handling
1. Properly handle trees and palms during moving so trunks will not be scarred or damaged and to avoid broken limbs. Broken limbs not causing the tree to be rejected shall be repaired as follows:
   a. Properly prune dead, dying, or damaged branches with clean, sharp equipment.
   b. Remove injured bark and wood of a tree would with a clean, sharp knife to a point where healthy bark and wood make contact at their margins.
   c. Inspect and treat wound for insect and disease.
   d. Seal wounds with bituminous base wound paint for all oak limbs greater than 3 inch diameter.
2. Transport trees on vehicles of adequate size to prevent overcrowding, broken limbs, foliage damage, or root ball damage.
3. Keep root balls moist during relocation.
4. Protect tree crowns with shade cloth to prevent desiccation and wind burn. Crowns shall be periodically sprayed with water to help ensure against desiccation.
5. Handle plant material only in ways and means accepted by the landscaping industry and accepted by the Owner.
6. Plant material shall be planted the same day it is dug. Coordinate preparation of planting pits or beds to ensure this schedule.

G. Warranty
1. Relocated plant material does not fall under the standard 12 month guarantee.
2. For relocated trees or palms that die, replace their canopy area with new trees as specified.
   a. Canopy spread for all palms and trees shall be listed on proposal when submitted for relocation work.
   b. Replacements (mitigation plantings) shall be provided at no additional cost to the Owner.
   c. Submit the attached form to the Owner for review and approval.
   d. Proposed replacement canopy tree species shall be the Owner accepted trees and palms.
3. Repair damage to other plants and lawn or construction work within the relocation area during tree transplantation at no cost to the Owner. This includes, but is not limited to, damage to curbs,

walks, roads, fences, site furnishings, etc. Replacing and replanting of damaged trees or shrubs shall be according to Division 32 Section "Plants" Replacing and replanting of damaged turf shall be according to Division 32 Section "Turf And Grasses".

H. Maintenance
1. Maintain relocated plant materials immediately after each item is planted and continued until the 90 day watering period is completed, upon which time the Owner will take over maintenance of materials following procedures and recommendations of contractor and specifications.
2. During the maintenance period, maintain relocated plant materials.

1.2 PRODUCT

A. Materials
1. Bone meal shall be readily available steamed bone meal, useable as a natural organic nitrogen fertilizer.
2. Peat moss, topsoil, planting soil, mulch, staking, and guying shall be as specified in Division 32 Section "Plants".

1.3 EXECUTION

A. Transplantation
1. Transplanting shall consist of on-site or off-site transplanting of existing trees or palms from proposed construction areas to permanent positions.
2. Digging, Wrapping, and Handling: Plants shall be dug and prepared for moving in a manner that will not cause damage to branches, shape, root system, and development.
3. Balled and Burlapped Plants:
   a. Balls shall be firmly wrapped with burlap or accepted cloth substitute.
   b. No balled plant will be acceptable if the ball is cracked and broken or if the stem or trunk is loose in the ball, either before or during transplanting.
   c. Balled plants shall be lifted and handled from the bottom of the ball.
   d. Protect ball and deliver to the site, plant immediately, and water thoroughly.
   e. Ball sizes shall be as recommended in ANSI Z 60.1.

B. Planting
1. Relocated Material
   a. Relocated trees/palms shall be planted according to procedures described for new material, Division 32 Section "Plants". Verify final grades have been established before planting operations. Ensure proposed planting pits drain by test-filling with water before transplantation.
   b. Continue watering and caring for relocated material as specified.
   c. Mulch tree pit areas to reduce weeds, discourage foot traffic, conserve moisture, and minimize temperature fluctuations.
   d. Brace trunk and leave in place for approximately one year until trees are wind firm.
   e. Wrap trunks and structural branches of thin-barked trees to protect against sun scald and dehydration. Retain through at least one growing season, and through cold season.
   f. Feed with a diluted solution of N-P-K in solution form with a soil needle, providing water, air, and nutrients.
   g. Where foliage is retarded, spray with one of the soluble types of foliage feeders.
   h. At time of planting, fill air pockets and keep roots, especially feeder roots, moist, live, and healthy. Use soil needles for watering new transplants. Direct fine spray at foliage to help harden-off new leaves.

C. Staking And Guying: Stake and guy designated material according to procedures described for new plant materials, Division 32 Section "Plants".

D. Watering
1. Following transplantation, water trees daily for the first two weeks, every other day for the next three weeks, and every third day for the balance of the three month watering/maintenance period. Such watering shall thoroughly saturate the root ball to its full depth.
2. Following relocation, trees designated for transplanting shall be watered as specified in this section. Such watering shall thoroughly saturate the root ball to its full depth.
3. Provide manual watering of relocated plant materials for 90 days. If used, after watering period, Contractor shall be responsible for the complete removal of all temporary watering systems.

E. Tagging: Trees within the designated areas for relocation shall be clearly marked by means of yellow plastic surveyor's ribbons and coordinated with, inspected, and accepted by the Owner before root pruning and digging.

F. Root Preparation
1. Trees to be relocated shall be root pruned at least 45 days before digging with clean, sharp equipment.
    a. Maintain root pruned materials by watering, weeding, mowing, spraying, fertilizing, and other horticulture practices.
    b. After root pruning, backfill with good rooting medium, fertilize with organic fertilizer to promote root growth.
    c. Mulch to reduce weeds, discourage foot traffic, conserve moisture, and minimize temperature fluctuation.
2. Root Ball Size Chart: Root ball sizes shall be according to minimum standards set forth in Grades and Standards for Nursery Plants Part II, Palms and Trees, local state Department of Agriculture.
    a. Trees-Minimum Ball Sizes:

Caliper	Minimum Ball Diameter
3-1/2" to 4"	28"
4" to 4-1/2"	30"
4-1/2" to 5"	32"
5" to 5-1/2"	34"

Larger sizes increase proportionally.

    b. Minimum Ball Depth:

Ball Diameter	Depth
Less than 20"	Not less than 75 percent of diameter.
20" to 30"	Not less than 65 percent of diameter.
30" to 48"	Not less than 60 percent of diameter.

G. Crown Preparation
1. Shade and Flowering Trees
    a. Shade Trees: Selectively prune and thin crown to remove approximately one third of the branches. Preserve the basic shape and form of the tree, eliminate cross-branching and dead or diseased branches.
    b. Hand strip selected species of all leaves following pruning and before moving.
2. Palms: Follow standard procedure for transplantation of palms.

H. Hand Digging: Burlapping is required. Trees that are burlapped for relocation shall comply and be handled in same manner as new plant material specified in Section “Exterior Plants.”

I. Special Conditions
   1. Multi-Trunk Trees: Relocate multi-trunk tree as one unit. Measure unit by taking the aggregate total of all DBH measurements.
   2. Multi-Trunk Palms: Relocate multi-trunk palms as one unit. Unit shall be measured as follows:
      a. 50 percent of the value in dollars of the largest trunk in the grouping times the number of trunks in the clump.
   3. On-site relocation
      a. On-site relocation shall include root pruning, canopy pruning, on-site transportation, hauling and dumping of debris, and 90-day maintenance.
      b. If the tree or palm should die within the 90-day maintenance period, remove the tree, replace the material, and restore the site at no additional cost to the Owner.

J. Cleaning
   1. Cleaning up the Site
      a. Upon completion of the work, thoroughly clean up the project site.
      b. In addition to removing equipment, unused materials, deleterious material, and surplus excavated material, the Contractor shall fine grade all disturbed areas and the areas adjacent to the transplanted material to provide a neat and uniform site.
      c. All damaged or altered existing structures, as a result of the landscape work, shall be corrected.

END OF SECTION 32 91 13 16

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Task	Specification	Specification Description
32 91 13 26	32 91 13 16	Tree Relocation
32 91 13 33	31 13 13 00	Tree Protection And Trimming
32 91 13 33	31 01 20 00	Earthwork
32 91 13 33	31 23 16 26	Embankment
32 91 13 33	32 18 23 13	Lawns And Grasses
32 91 13 36	32 91 13 16	Tree Relocation
32 91 13 36	32 18 23 13	Lawns And Grasses

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SECTION 32 91 19 13 - CONCRETE REVETMENT

1.1 GENERAL

A. Description Of Work

1. This specification covers installation of a concrete revetment. Work includes but is not limited to furnishing all labor, materials, equipment and supervision necessary to construct concrete revetment as follows or as directed by the Owner.

1.2 PRODUCTS

A. The Concrete Revetment shall be an articulating cellular concrete block system, as manufactured by American Excelsior Company, or approved equal, (800-713-8245), is a block structure installed over a geotextile fabric as described herein. The cellular blocks are made of Portland Cement Concrete cast into “lock” blocks and “key” blocks to provide a three directional interlock to resist lateral movement. The articulating cellular concrete block system is a “flexible” concrete revetment which allows the blocks to traverse changes in terrain without disruption of the placement pattern and interlock feature.

1. The minimum concrete strength shall be 3,000 psi. Nominal block thickness shall be either 4 inches, 6 inches or 8 inches, as required to meet project requirements. Block weights, per pair of “key” and “lock” blocks, shall be approximately 50, 70 and 90 pounds for #4010-4 inch, #4015-6 inch and #4020-8 inch thick blocks, respectively. Each pair of “key” and “lock” blocks shall cover approximately 1.54 square feet, including uncovered openings between the blocks. The system shall provide approximately 80 percent coverage of the area with blocks, leaving approximately 20 percent, but not less than 16 percent, uncovered area at the ground surface.

B. Filter fabric shall be Tri-Lock Fabric #792 as supplied by American Excelsior Company, or approved equal, (800) 713-8245; roll values:

Property	Specification	Test Method
Weight	7.4 oz/sy	ASTM D3776
Thickness	25 mils	ASTM D1777
Permeability	0.5 cm/sec	ASTM D4491
Abrasion Resistance	Warp: 58 percent	ASTM N3884
(% strength retained)	Fill: 81 percent	
Tensile Grab Strength	350 lbs. x 395 lbs	ASTM D4632
Grab Elongation	24% x 24%	ASTM D4632
Burst Strength	780 psi	ASTM D3786
Trapezoid Tear	120 lbs x 110 lbs.	ASTM D4533
Puncture Strength	165 lbs.	ASTM D4833
Apparent Opening Size	40-70	ASTM D-4751
UV Resistance @ 500 hours	90 percent	ASTM D-4355

C. Tri-Lock block size selection shall be determined from documented hydraulic characteristics, derived from test procedures outlined in: “Hydraulic Stability of Articulating Concrete block Revetment Systems During Overtopping Flow.” Report No. FHWA-RD-89-199, and “Minimizing Embankment Damage During Overtopping Flow.” Report No. FHWA-RD-88-181.

D. Backfill: Topsoil and seeding shall be as per Division 31 Section(s) "Earth Moving" AND Division 32 Section(s) "Turf And Grasses".

1.3 EXECUTION

A. Excavation shall be made so that the placement of the geotextile and concrete blocks shall be in conformity with the lines and grades shown on the plans or as required to meet project requirements. The area for placement shall be free from obstructions such as tree roots, projecting stones or other foreign matter and graded smooth. Voids or soft areas shall be filled with suitable materials and compacted to non-movement. Place the geotextile on the prepared subgrade. Lock the edges into a key trench as required to meet project requirements. The concrete blocks shall be assembled overlaying a geotextile in a manner that allows maximum flexibility but discourages vertical movement of any single component. Fill open areas of the blocks with concrete at the interface to concrete structure. After placement, the open areas of the block system shall be backfilled with topsoil to the top of the blocks. The backfilling shall be completed within 14 days of placement of the geotextile.

END OF SECTION 32 91 19 13

SECTION 32 91 19 13a - SEPTIC TANK SYSTEMS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for septic tank systems. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Septic tanks.
      b. Distribution boxes.
      c. Pipe and fittings.
      d. Absorption systems

C. Submittals
   1. Product Data: For each type of product indicated.
      a. Include construction details, material descriptions, dimensions of individual components, and profiles.
      b. Include manhole openings, covers, and pipe connections.
   2. Shop Drawings: For [trench absorption systems] [bed absorption systems].
      a. Include manhole openings, covers, pipe connections, and accessories.
      b. Include piping with sizes and invert elevations.
      c. Include underground structures.
      d. Include other utilities.

1.2 PRODUCTS

A. Septic Tanks
   1. Precast Concrete Septic Tanks: ASTM C 1227, single-chamber **OR** two-chamber, **as directed**, precast, reinforced-concrete tank with internal baffle, **as directed**, and covers.
      a. Design: For A-8 (H10-44) **OR** A-12 (HS15-44) **OR** A-16 (HS20-44), **as directed,** traffic loading according to ASTM C 890.
      b. Manholes: 20-inch- (508-mm-) **OR** 22-inch- (559-mm-) **OR** 24-inch- (610-mm-), **as directed,** minimum diameter opening with reinforced-concrete risers to grade and access lid with steel lift rings. Include manhole in center of each septic tank compartment top.
      c. Filter Access: Reinforced-concrete access hole, large enough to remove filter, over filter position.
      d. Inlet and Outlet Access: 12-inch- (300-mm-) minimum diameter, reinforced-concrete access lids with steel lift rings. Include access centered over inlet and outlet.
      e. Resilient Connectors: ASTM C 923 (ASTM C 923M), of size required for piping, fitted into inlet and outlet openings.
   2. Fiberglass Septic Tanks: UL 1316, single-chamber, FRP construction; fabricated for septic tank application with at least one access riser and manhole.
      a. Manholes: 22-inch- (559-mm-) **OR** 24-inch- (610-mm-), **as directed,** minimum diameter opening with FRP access risers to grade and cover.
      b. Filter Access: Include access hole, large enough to remove filter, over filter position.
      c. Resilient Connectors: ASTM C 923 (ASTM C 923M) or other watertight seal, of size required for piping, fitted into inlet and outlet openings.
   3. Polyethylene Septic Tanks: Single-chamber, molded, HDPE or PE construction; fabricated for septic tank application, with baffle, **as directed**, and at least one access riser and manhole.

4. Polyethylene Septic Tanks: Two-chamber, molded, HDPE or PE construction; fabricated for septic tank application, with access risers and manholes.
   a. Manholes: 18-inch- (457-mm-) **OR** 20-inch- (508-mm-) **OR** 22-inch- (559-mm-), **as directed,** minimum diameter opening with HDPE or PE access risers to grade and cover.
   b. Filter Access: Include access hole, large enough to remove filter, over filter position.
   c. Resilient Connectors: ASTM C 923 (ASTM C 923M) or other watertight seal, of size required for piping, fitted into inlet and outlet openings.

B. Filters
1. Description: Removable, septic-tank-outlet filter that restricts discharge solids to 1/8 inch (3.2 mm).
   a. Housing: HDPE or PVC.
   b. Outlet Size: NPS 4 (DN 100) **OR** NPS 6 (DN 150), **as directed.**

C. Dosing Tanks
1. Dosing Tanks: Comply with ASTM C 913 for precast, reinforced-concrete tank and cover; designed for structural loading according to ASTM C 890.
   a. Design: For effluent pump, **OR** automatic siphon, **as directed,** installation and A-8 (H10-44) **OR** A-12 (HS15-44) **OR** A-16 (HS20-44), **as directed,** traffic loading according to ASTM C 890.
   b. Manholes: 20-inch- (508-mm-) **OR** 22-inch- (559-mm-) **OR** 24-inch- (610-mm-), **as directed,** minimum diameter opening with reinforced-concrete risers to grade and access lid with steel lift rings. Include manhole in center of each septic tank compartment top.
   c. Resilient Connectors: ASTM C 923 (ASTM C 923M), of size required for piping, fitted into inlet and outlet openings.

D. Automatic Siphons
1. Description: Manufactured siphon assembly of molded-HDPE trap, pipe, and bell, with PVC vent piping and stainless-steel bolts.

E. Distribution Boxes
1. Description: Precast concrete, single-chamber box and cover.
   a. Design: Made according to ASTM C 913, and for A-8 (H10-44) **OR** A-12 (HS15-44) **OR** A-16 (HS20-44), **as directed,** traffic loading according to ASTM C 890. Include baffle opposite inlet.
   b. Manholes: 20-inch- (508-mm-) **OR** 22-inch- (559-mm-) **OR** 24-inch- (610-mm-), **as directed,** minimum diameter opening with reinforced-concrete risers to grade and cover with steel lift rings in center of distribution box cover.
   c. Pipe Connections: ASTM C 923 (ASTM C 923M) resilient connectors, of size required for piping, fitted into inlet and outlet openings. Include watertight plugs in outlets not required.
2. Description: Molded-HDPE or -PE, single-chamber box and cover.
   a. Manholes: 18-inch- (457-mm-) **OR** 20-inch- (508-mm-) **OR** 22-inch- (559-mm-), **as directed,** minimum diameter opening with HDPE or PE access risers to grade and cover. Access for PE distribution boxes may be a removable plastic cover and is usually small.
      OR
      Manufacturer's standard cover or other access opening of size that permits access to distribution-box inlet and outlets.
   b. Pipe Connections: With seal that prevents leakage. Include watertight plugs in outlets not required.

F. Leaching Pipes And Fittings
1. Pipe: PE, complying with ASTM F 810, perforated.
   a. Fittings: ASTM D 2729 PVC for loose joints; ASTM D 3034, PVC for gasketed joints; or ASTM D 2751, ABS for gasketed joints.

2. Tube and Fittings: PE, complying with ASTM F 405, perforated corrugated tube with solid-wall fittings.
   a. Couplings: PE band, matching tube and fitting dimensions.
3. Pipe and Fittings: PVC, complying with ASTM D 2729, perforated, for solvent-cement joints.
   a. Solvent Cement: ASTM D 2564. Include primer according to ASTM F 656
4. Drainage Tile: Clay drain tile, complying with ASTM C 4, Standard class, drain tile with regular and smooth ends, for open joints.

G. Nonpressure-Type Pipe Couplings
1. Description: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.
   a. Sleeve Materials:
      1) For Concrete Pipes: ASTM C 443 (ASTM C 443M), rubber.
      2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
      3) For Vitrified-Clay Pipes: ASTM C 425, rubber.
      4) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

H. Leaching Chambers
1. Description: Arched, molded-PE structures with solid top, perforated sides, open ends, and open bottom.
   a. End Pieces: Solid and solid with pipe opening types.
   b. Effluent Distribution Piping: PE or PVC pipe, with holes or slots along pipe, attached to underside of top of chambers.

I. Trench **OR** Bed, **as directed,** Absorption-System Materials
1. Filtering Material: ASTM D 448, Size No. 24, 3/4 to 2-1/2 inches (19 to 63 mm), washed, crushed stone or gravel; or broken, hard-burned clay brick.
2. Filter Mat: Geotextile woven or spun filter fabric, in 1 or more layers, for minimum total unit weight of 3 oz./sq. yd. (101 g/sq. m) **OR** Untreated building paper or similar porous material, **as directed**.
3. Cover for Distribution Pipe: Geotextile woven filter fabric, in 1 or more layers, for minimum total unit weight of 3 oz./sq. yd. (101 g/sq. m).
4. Fill Material: Soil removed from trench.

J. Mound Absorption-System Materials
1. Sand Filtering Material: 25 percent or more of very coarse, coarse, or medium sand or combination; maximum of 50 percent fine or very fine sand or combination; and silt and clay combination not to exceed 25 percent. If clay exceeds 60 percent in combination with silt, mixture cannot exceed 15 percent of sand filtering material.
2. Aggregate Filtering Material: Coarse, 1/2 to 2-1/2 inches (13 to 63 mm).
3. Cap: Clay, silt, or combination of clay and silt.
4. Topsoil: Good quality, free of stones, metal, and glass.
5. Vegetation Cover: Grass compatible with adjacent ground cover. No shrubs or trees.
6. Filter Mat: Geotextile woven or spun filter fabric, in 1 or more layers, for minimum total unit weight of 3 oz./sq. yd. (101 g/sq. m) **OR** Untreated building paper or similar porous material, **as directed**.
7. Cover for Distribution Pipe: Geotextile woven filter fabric, in 1 or more layers, for minimum total unit weight of 3 oz./sq. yd. (101 g/sq. m).

K. Chamber Absorption-System Materials
1. Chamber: Arched, molded-PE structures with solid top, perforated sides, open ends, and open bottom.
2. End Pieces: Blank without opening for distribution pipe at end of last chamber in row, and with opening for distribution pipe where pipe penetrates chamber.

3. Retain first paragraph below to run piping through chambers to improve distribution.
4. Effluent Distribution Piping: PE or PVC pipe, with holes or slots along pipe, attached to underside of top of chambers.

L. Seepage Pit Absorption-System Materials
1. Constructed-in-Place-Type Seepage Pit: Include the following materials.
a. Pit Lining: ASTM C 62, Type SW, clay bricks; ASTM C 55, concrete bricks; ASTM C 90, hollow, concrete masonry units; or precast concrete rings with notches or weep holes.
b. Filtering Material: ASTM D 448, Size No. 24, 3/4 to 2-1/2 inches (19 to 63 mm), washed, crushed stone or gravel; or broken, hard-burned clay brick.
c. Cover: Precast concrete slab; designed for A-8 (H10-44) **OR** A-12 (HS15-44) **OR** A-16 (HS20-44), **as directed,** traffic loading according to ASTM C 890 and made according to ASTM C 913. Include slab dimensions that will extend minimum of 12 inches (300 mm) beyond edge of excavation. Cast cover with opening for manhole in center.
d. Manholes: 20-inch- (508-mm-) **OR** 22-inch- (559-mm-) **OR** 24-inch- (610-mm-), **as directed,** minimum diameter opening with reinforced-concrete risers to grade and access lid with steel lift rings.

1.3 EXECUTION

A. Earthwork
1. Excavating, trenching, and backfilling for piping and seepage pits are specified in Division 31 Section "Earth Moving".
a. Stockpile topsoil for reuse in finish grading without intermixing with other excavated material. Stockpile materials away from edge of excavation and do not store within drip line of remaining trees.
b. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
2. Excavating and Backfilling for Septic and Dosing Tanks:
a. Excavate sufficient width and length for tanks to depth determined by tank inlet elevation. Provide level bottom.
b. Backfill with excavated soil, mounding soil above original grade without compacting.
3. Excavating and Backfilling for Trench **OR** Bed, **as directed,** Absorption Fields:
a. Excavate for trench absorption fields 30 inches (760 mm) wide and 24 inches (600 mm) deep, minimum.
b. Backfill trench absorption fields with excavated soil, mounding soil above original grade without compacting.
c. Excavate for bed absorption fields of width indicated and 24 inches (600 mm) deep, minimum.
d. Backfill bed absorption fields with excavated soil, mounding soil above original grade without compacting.

B. Excavating and Backfilling for Chamber Absorption Systems:
1. Excavate for trench-type chamber absorption systems **30 inches (762 mm)** wide and **24 inches (610 mm)** deep, minimum.
2. Excavate for bed-type chamber absorption systems of width indicated and **24 inches (610 mm)**deep, minimum.
3. Backfill chamber absorption systems with excavated soil, mounding soil above original grade without compacting.

C. Excavating and Backfilling for Seepage-Pit Absorption Systems:
1. Excavate sufficient hole diameter for pits to depth determined by tank inlet and bottom elevations. Provide level bottom.
2. Backfill with excavated soil, mounding soil above original grade without compacting.

D. Septic Tank Installation
1. Install precast concrete septic tanks level according to ASTM C 891.
2. Install septic tanks level.
3. Connect septic tank to concrete ballast pad.
4. Install filter in septic tank outlet. Secure filter to septic tank wall. Make direct connections to distribution piping.
5. Install insulation on exterior sides and top of septic tank.
6. Fill septic tank with water.

E. Dosing Tank Installation
1. Install dosing tanks level and according to ASTM C 891.
2. Install automatic siphons embedded in precast concrete dosing tank. Make direct connections to distribution piping.
3. Set submersible effluent pumps on dosing tank floor. Make direct connections to distribution piping.
4. Fill dosing tanks with water.

F. Distribution Box Installation
1. Install precast concrete distribution boxes according to ASTM C 891 and at invert elevations indicated. Set level and plumb.
2. Install PE distribution boxes at invert elevations indicated and according to manufacturer's written instructions. Set level and plumb.

G. Piping Installation
1. Install leaching piping according to the following:
   a. Use perforated pipe and fittings for trench **OR** bed **OR** mound, **as directed,** absorption fields with perforations at bottom.
   b. PE Tube and Fittings: ASTM F 481.
   c. PVC Sewer Pipe and Fittings: ASTM F 481.

H. Pipe Joint Construction
1. Basic piping joint construction is specified in Division 33 Section "Common Work Results For Utilities". Where specific joint construction is not indicated, follow piping manufacturer's written instructions.
2. Join distribution piping with or according to the following:
   a. Install leaching pipe and fittings for trench OR bed OR mound, as directed, absorption fields with closed joints, unless otherwise indicated.
   b. PE Tube and Fittings: With PE band couplings.
   c. PVC Sewer Pipe and Fittings: With solvent-cemented joints according to ASTM F 402 and ASTM D 2321.
3. Join dissimilar pipe materials according to ASTM D 5926, with couplings and gaskets compatible with pipe materials being joined.

I. Cleanout Installation
1. Install cleanouts according to the following:
   a. Inlet and Outlet of Septic Tanks: Cast-iron cleanouts.
   b. Inlet and Outlet of Dosing Tanks: Cast-iron cleanouts.
   c. Inlet and Outlet of Distribution Boxes: Cast-iron **OR** PVC cleanouts.
   d. At Each Change in Direction of Sewer Piping: Cast-iron **OR** PVC cleanouts.
   e. At Ends of Each Row and at Each Change in Direction of Distribution Piping: Cast-iron **OR** PVC cleanouts.
2. Cast-Iron Cleanouts: Install with PVC fitting riser from distribution and leaching piping to cast-iron cleanout housing at grade. Use NPS 4 (DN 100) PVC sewer pipe and fittings with solvent-cemented joints for risers. Attach riser to cleanout housing with rubber gasket or coupling.

3. PVC Cleanouts: Install with PVC riser from distribution and leaching piping to PVC cleanout at grade. Use NPS 4 (DN 100) PVC sewer pipe and fittings with solvent-cemented joints for risers and cleanout fitting.
4. Cleanout Support: Set cleanouts in concrete blocks 18 by 18 by 12 inches (457 by 457 by 305 mm) deep, unless location is in concrete pavement. Formwork, reinforcement, and concrete are specified in Division 03 Section "Cast-in-place Concrete".
5. Set top of cleanout 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed,** above surrounding rough grade, or set flush with grade if installed in pavement.

J. Trench **OR** Bed **OR** Absorption-Field, **as directed,** Installation
1. Filtering Material: Place supporting layer of filtering material over the compacted trench **OR** bed, **as directed,** base to a compacted depth not less than 6 inches (150 mm) below bottom of pipe.
2. Refer to Part 1.3 "Piping Installation" and "Pipe Joint Construction" articles for specific piping material installation.
3. Install distribution piping at minimum slope of 1 percent and maximum slope of 2 percent.
4. Install leaching piping solidly bedded in filtering material, with full bearing for each pipe section throughout its length. Maintain pipe alignment with no slope.
   a. Install perforated pipe with perforations down and joints tightly closed. Install collars and couplings as required.
   b. Install open-joint pipe with 1/2-inch (13-mm) space, maximum, between ends, unless otherwise indicated. Cover top two-thirds of joint opening with joint cover, and tie with corrosion-resistant wire. Commercial joint-cover assemblies may be provided.
   c. Install elbow fittings with tight joints.
   d. Place additional filtering material around sides to a minimum compacted depth of 8 inches (200 mm) above the top of leaching piping.
5. Install filter mat over filter material before backfilling.
6. Install leaching chambers with no slope in bottom of trench **OR** bed, **as directed**.
   a. Install leaching chamber distribution piping with tight joints throughout chambers.
7. Backfill according to Part 1.3 "Earthwork" Article.

K. Mound Absorption-Field Installation
1. Plow top 6 inches (150 mm) of surface.
2. Place layers of sand, aggregate, **as directed**, cap, and topsoil above plowed area. Provide grass topping to match adjacent vegetation. Provide side slope not steeper than 3:1. Tie slope toe smoothly into existing grade.
3. Refer to Part 1.3 "Piping Installation" and "Pipe Joint Construction" articles for specific piping material installation.
4. Provide solid vent pipe with vent cap extending 12 inches (300 mm) above top of mounds.
5. Install distribution piping with no slope for pressurized effluent system.
6. Install distribution piping at a minimum slope of 1 percent and a maximum slope of 2 percent for gravity effluent system.
7. Install leaching piping solidly bedded in filtering material, with full bearing for each pipe section throughout its length. Maintain pipe alignment with no slope.
   a. Install perforated pipe with perforations down and joints tightly closed. Install collars and couplings as required.
   b. Install open-joint pipe with 1/2-inch (13-mm) space, maximum, between ends, unless otherwise indicated. Cover top two-thirds of joint opening with joint cover, and tie with corrosion-resistant wire. Commercial joint-cover assemblies may be provided.
   c. Install elbow fittings with tight joints.
8. Install leaching chambers with no slope above plowed area.
   a. Install leaching chamber distribution piping with tight joints throughout chambers.
9. Provide adequate grading around mound absorption field to prevent storm runoff from washing away a portion of mound absorption field and to prevent exposing pipes.

L. Seepage Pit Installation

1. Excavate hole to minimum diameter of 6 inches (150 mm) greater than outside of pit lining.
2. Do not extend pit depth into ground-water table.
3. Install constructed-in-place seepage pits according to the following procedure if no requirements of authorities having jurisdiction apply:
   a. Install brick pit lining material dry and laid flat with staggered joints for seepage.
   b. Install block pit lining material dry with staggered joints and a minimum of 20 percent of blocks on side for seepage. Install precast concrete rings with notches or weep holes for seepage.
   c. Extend pit lining material so top of manhole will be approximately 8 inches (200 mm) below finished grade.
   d. Backfill bottom of inside of pit with filtering material at least 12 inches (300 mm) above bottom of lining material.
   e. Extend effluent inlet pipe 12 inches (300 mm) into seepage pit and terminate into side of tee fitting.
   f. Backfill around outside of pit lining with filtering material to top of lining.
   g. Install manhole risers from top of pit to grade. Support cover on undisturbed soil. Do not support cover on pit lining.

M. Identification
1. Identification materials and their installation are specified in Division 31 Section "Earth Moving". Arrange for installation of green warning tape directly over piping (including absorption-field piping), at outside edges of underground structures, and at outside edges of absorption fields.
2. Use detectable warning tape over piping, over edges of underground structures, and over edges of absorption fields.

N. Field Quality Control
1. System Tests: Perform testing of completed septic tank system piping and structures according to authorities having jurisdiction.
2. Additional Tests: Fill underground structures with water and let stand overnight. If water level recedes, locate and repair leaks and retest. Repeat tests and repairs until no leaks exist.

O. Cleaning
1. Clear interior of piping and structures of dirt and other superfluous material as work progresses.
2. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of workday or when work stops.

END OF SECTION 32 91 19 13a

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Task	Specification	Specification Description
32 91 19 13	02 41 13 13a	Portland Cement Concrete Removal
32 91 19 13	31 11 00 00	Site Clearing
32 91 19 13	31 13 13 00	Tree Protection And Trimming
32 91 19 13	31 01 20 00	Earthwork
32 91 19 13	31 23 16 26	Embankment
32 91 19 13	32 18 23 13	Lawns And Grasses
32 92 16 00	32 18 23 13	Lawns And Grasses
32 92 19 13	32 18 23 13	Lawns And Grasses
32 92 19 19	32 18 23 13	Lawns And Grasses
32 92 23 00	32 18 23 13	Lawns And Grasses
32 93 13 00	32 14 09 00	Exterior Plants
32 93 23 00	32 14 09 00	Exterior Plants
32 93 33 00	31 11 00 00	Site Clearing
32 93 33 00	32 14 09 00	Exterior Plants
32 93 43 00	32 14 09 00	Exterior Plants
32 93 63 00	32 14 09 00	Exterior Plants
32 93 83 00	31 13 13 00	Tree Protection And Trimming
32 93 83 00	32 91 13 16	Tree Relocation
32 93 83 00	32 14 09 00	Exterior Plants
32 94 13 00	32 14 09 00	Exterior Plants
32 94 16 00	32 14 09 00	Exterior Plants
32 94 43 00	01 22 16 00	No Specification Required
32 94 43 00	32 33 13 00	Miscellaneous Site and Street Furnishings
32 94 49 00	01 22 16 00	No Specification Required
32 94 49 00	31 13 13 00	Tree Protection And Trimming
32 94 49 00	32 14 09 00	Exterior Plants
32 96 33 00	32 91 13 16	Tree Relocation
32 96 43 00	32 91 13 16	Tree Relocation

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SECTION 33 01 10 58 - REPAIR AND MAINTENANCE OF IMHOFF TANKS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for repair and maintenance of sewage treatment plant Imhoff tanks. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Coatings:
   1. Epoxy-Filler Compound for concrete surfaces shall comply with Fed. Spec. MMM-A-001993.
   2. Coal-Tar Epoxy shall comply with SSPC-PAINT 16.
   3. Epoxy Paint shall comply with Mil. Spec. MIL-P-24441.
   4. Red-Lead Base Paint shall comply with Fed. Spec. TT-P-86, Type I.
   5. Aluminum Finish Paint shall comply with Fed. Spec. TT-P-38.

B. Steel Tank Repair Material for minor leaks shall be a two-component epoxy sealing compound. For badly corroded areas, a steel plate of the same composition and thickness as the original tank shall be used.

C. Pipe and Fittings for replacement shall be equivalent to the existing pipe and fittings.

1.3 EXECUTION

A. Preparation: Drain the contents of the tank and dispose of the sludge and sewage.

B. Leak Repair:
   1. Concrete Tanks: Repair concrete tank leaks by cleaning and chipping or sandblasting the area of the leak and applying two-component epoxy concrete sealant.
   2. Steel Tanks: Repair steel tank leaks by cleaning, scraping, chipping, or sandblasting the area of the leak and applying epoxy steel sealant. Repair badly corroded areas of steel tanks by cutting out the corroded area and welding a section of new steel plate in place. Welding shall be in compliance with AWS D1.1.

C. Pipe and Fittings: Replace pipe and fittings as required.

D. Cleaning and Coatings:
   1. Interior Concrete Surfaces of the tank shall be cleaned with high pressure water or steam to remove dirt and residue, allowed to dry, and brush sandblasted.
   2. Holes and Voids in the concrete surfaces left from the blast cleaning shall be filled by means of troweling and squeeze application of epoxy filler. Two coats of coal-tar epoxy shall be applied to the surface after the epoxy has cured.
   3. Submerged Ferrous Metal Surfaces such as piping and equipment that are exposed to the sewage shall be sandblasted and coated with two coats of coal-tar epoxy.

4. Exterior Concrete Surfaces of the tank shall be cleaned by means of brush sandblast. The surfaces shall be blown down with air to remove the blasting residue and dust, and two coats of epoxy-polyamide paint shall be applied.
5. Ferrous Metal Surfaces that are not submerged shall be cleaned by means of sandblasting. Coat surfaces with one coat of red-lead base paint. After the base paint has dried sufficiently, apply two coats of aluminum finish paint.

END OF SECTION 33 01 10 58

SECTION 33 01 10 58a - SEWER LINE CLEANING

1.1 GENERAL

A. Description Of Work
   1. This specification covers sewer line cleaning. Cleaning procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals: Submit product data and manufacturer's instruction.

1.2 PRODUCTS

A. All materials shall be clean, free of defects, corrosion, and damage. All items shall be of proper type, size, design, and characteristics for the use intended. Unless otherwise specified, all items shall be factory-made.

B. Portable Cleaning Equipment: Equipment used in the cleaning of sewer lines shall be as required to complete the work for the size, length, and conditions of the sewer. Portable and mobile equipment shall comply with Water Pollution Control Federation Manual No. 7.

C. Chemicals shall be of the strength required to perform the work. The chemicals shall not be damaging to pipe materials, manholes, pumping equipment, nor treatment process and shall not be contaminated by foreign substances.

1.3 EXECUTION

A. Preparation
   1. Protection required to prevent damage to adjacent materials, equipment, fixtures, and finishes shall be provided. Necessary protective clothing and accessories for personnel working with chemicals shall be provided.
   2. Ventilation of Sewers: Contractor shall provide proper ventilation for personnel working in the sewer.
   3. Alternate Sewage Discharge: Contractor shall provide an alternate routing of sewage discharge to a downstream manhole.
   4. Traffic: Contractor shall provide all traffic signs required to safely direct traffic at and around work areas.

B. Installation
   1. Direction of Work: Sewer line cleaning work, with the exception of hydraulic scouring, shall proceed in the downstream direction. Cleaning by hydraulic scouring shall proceed in the upstream direction.
   2. Testing: Upon completion of cleaning operation, test sewer lines for proper operation and observe for a period of 24 hours. Clean out all stoppages and the retest the line for proper operation.

END OF SECTION 33 01 10 58a

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Task	Specification	Specification Description
33 01 10 58	21 05 23 00	Piped Utilities Basic Materials And Methods

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SECTION 33 01 10 71 - PIPE LINING

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of pipe lining. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCTS

A. Lining Material:
   1. Polyethylene Pipe: Extruded, flexible industrial grade, high density (Type 3 or 4) in 40 foot lengths, complying with ASTM D 2239 and D 2447.
      a. Diameter: Outside diameter shall be as large as possible while allowing for ease of pulling into the existing pipes. Pipe dimensions shall comply with ASTM D 2447 and D 2837.
      b. Liner Thickness and Class shall be suitable for the use intended. The tolerance on the pipe wall thickness shall be as noted in Table 2 of ASTM D 2447.
      c. Gravity Sanitary, Gravity Storm, and Gravity Industrial Sewers shall be Schedule 40.
      d. Gravity Thermal Discharge Sewers shall be Schedule 80.
      e. Low Pressure Sewers shall be Schedule 40, complying with ASTM D 2239.
      f. High Pressure Sewers shall be Schedule 80, complying with ASTM D 2239 and D 2837.
      g. Chemical Resistance: Pipe liner shall be resistant to chemical attack, erosion, and corrosion.
      h. Fittings shall be fabricated from polyethylene pipe. The polyethylene fittings shall have the same pressure rating as the pipe and shall comply with ASTM D 3261.
   2. Cement-Mortar Lining:
      a. Portland Cement shall comply with ASTM C 150, Type 1.
      b. Pozzolan Cement shall comply with ASTM C 618 and shall not comprise more than 20 percent of total cement amount, by weight.
      c. Sand shall be well graded, clean, free from organic and extraneous matter. One hundred percent shall pass the 16-mesh size screen.
      d. Lining Thickness: Cement lining shall be not less than 1/8 inch for pipe sizes 4 to 14 inches, not less than 3/16 inch for pipe sized 16 inches and larger, and not less than 1/4 inch for steel pipe 16 inches and larger.
   3. Reinforced Mortar Pipe Slip-Lining:
      a. Gravity Sewers: Slip-lining shall be of glass fiber reinforced polyester mortar pipe, complying with ASTM D 3262.
      b. Pressure Sewers (Force Mains): Slip-lining shall be of glass fiber reinforced polyester mortar pipe complying with ASTM D 2517.
      c. Diameter: Outside diameter shall be as large as possible while allowing for ease of pulling into existing pipes, as recommended by the manufacturer.
      d. Chemical Resistance: Pipe liner shall be resistant to chemical attack, erosion, and corrosion.
   4. Fittings: Fittings shall be manufactured of the same materials as is the glass fiber reinforced polyester mortar pipe.
   5. Epoxy-Mortar Lining:
      a. Epoxy compound shall comply with ASTM D 1763.
      b. Admixtures shall be well graded with one hundred percent passing. The 16-mesh size screen. All admixtures shall improve the workability, density, and strength of the mortar.

c. Lining Thickness: For pipe sizes 4 to 14 inches, epoxy mortar lining thickness shall be not less than 1/8 inch. For pipe sizes 16 inches and larger, epoxy mortar lining shall be not less than 3/16 inch.

B. Joint:
1. Slip-Lining:
a. Polyethylene Pipe Butt Joints: Pipe lengths, fittings, and flanged connections to be joined by thermal butt fusion shall be of the same time, grade, and class of polyethylene compound and supplied by pipe supplier.
b. Flanged Joints shall consist of a polyethylene flange, thermally butt fused to the ends of the pipe. The companion flange shall be steel or cast iron and nylon-coated.
c. Lateral Service Connections: Sidewall connections shall be made with polyethylene pipe sections of the same material, grade, and class as the liner material and shall have the same pressure ratings. Lateral connections shall be watertight.
2. Reinforced Mortar Lining:
a. Bell and spigot joints shall be the inverted type.
b. Manhole Joints and Connections shall be oakum ring and grout as required.

1.3 EXECUTION:

A. Slip-Lining, Polyethylene Pipe:
1. Insertion of Liner: Liner shall be laid at a constant line and grade as the existing pipe, without undulations or damage. Where the existing pipe is not at constant grade, the liner shall follow as true a constant grade as possible.
2. Grouting: At manholes, annular space shall be packed with oakum and expansion grout or nonshrink grout as required. At existing line, after liner has been inserted, grout wherever existing pipe has failed structurally.
3. Concrete Encasement: Crown of liner shall be encased in concrete a minimum thickness of 6 inches for the entire length of the excavated trench and out at least 6 inches each side of the bottom half of the original pipe remaining down to firm soil. Wherever existing concrete encasement has been removed, the liner shall be encased in the same manner as the original pipe.
4. Thrust Blocks: Concrete thrust blocks shall be provided as required.

B. Cement Mortar and Epoxy Mortar Lining:
1. Cement Mortar Mixing: One part cement to one and one-half parts of sand by volume.
2. Application of Lining: The lining shall be applied to produce a smooth, uniform thickness throughout the interior of the pipe line.
3. Curing of the Cement Mortar Lining: Immediately upon completion of the lining of a length of pipe between access openings or at the end of a day's run, the section of pipe shall be closed at each end, the access openings covered to prevent the circulation of air, and the atmosphere kept moist.
4. Reconnection of Pipes After Lining: Close and make watertight all openings in the lines.
5. Pressure Test and Leaks: Hydrostatic and leakage tests shall be conducted on all pipe that is cleaned and lined.

C. Reinforced Mortar Pipe Lining:
1. Joining of Pipe Ends: Liner sections containing bell and spigot joints shall be joined using an O-ring.
2. Grouting Work shall be accomplished following the same techniques as described in paragraph Slip-Lining, Polyethylene Pipe.

D. Cement Mortar Lining:

1. Epoxy Mortar Lining: Excessive mortar shall be removed from the manhole walls and bottom. Manhole bottom shall receive special care in making all transitions smooth.
2. Work at Service Connections: Plugs or caps shall be placed at the access point of the service connection to the lines and shall be removed once the mortar has set. The completed lining shall not be damaged.
3. Reinforced Mortar Pipe Lining: Joining of fiberglass reinforced polyester mortar pipe shall be carried out in the trench, with the first section of liner already inserted.
4. Lateral Connections: Service to connections shall be provided for and continued after installation of the lining.
5. Testing: Upon completion of lining operation, the sewer line shall be tested for proper operation and shall be observed for a period of 24 hours. All deficiencies shall be corrected.
6. Pavement Restoration: All disturbed pavement shall be restored to its original condition and shall match existing adjacent.
7. Inspection: Large diameter sewers shall be inspected from inside to ensure that all lateral connections and joints are in proper order. Sewers that have been cement-lined may be inspected for a smooth finish, while plugs and caps are being removed.

END OF SECTION 33 01 10 71

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Task	Specification	Specification Description
33 01 10 71	01 22 16 00	No Specification Required
33 01 10 71	21 05 23 00	Piped Utilities Basic Materials And Methods
33 01 30 11	01 22 16 00	No Specification Required
33 01 30 41	33 01 10 58a	Sewer Line Cleaning
33 01 30 42	21 05 23 00	Piped Utilities Basic Materials And Methods
33 01 30 42	33 01 10 58	Repair And Maintenance Of Imhoff Tanks
33 01 30 42	33 01 10 58a	Sewer Line Cleaning

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SECTION 33 01 30 51 - REPAIR AND MAINTENANCE OF SIPHON TANK AND SIPHONS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for the repair and maintenance of sewage treatment plant dosing siphon tanks. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Tank Repair Material shall be epoxy type grout complying with Fed. Spec. MMM-A-001993.

B. Concrete Coatings:
   1. Outside and Above Grade shall be epoxy type in compliance with Mil. Spec. MIL-P-24441.
   2. Inside and Below Grade shall be coal-tar epoxy type in compliance with SSPC-PAINT 16.

C. Steel Repair Material shall be steel plate or epoxy cement and fiberglass cloth.

D. Corroded or Defective Siphons: Replace those parts corroded or defective with new parts compatible with the unit, as recommended by the manufacturer.

E. Steel Coatings:
   1. Red-Lead Base Coat shall comply with Fed. Spec. TT-P-86, Type I.
   2. Aluminum Paint shall comply with Fed. Spec. TT-P-38.

1.3 EXECUTION

A. Corroded or Broken Pipe and Fittings: Replace as required.

B. Minor Leaks: Repair minor leaks in the tank using material and surface preparation and application methods recommended by the material manufacturer.

C. Spalled Areas: Repair as required.

D. Cleaning and Coating:
   1. Interior Concrete Surfaces of the tank shall be cleaned with high pressure water or steam to remove all dirt and residue, allowed to dry, and brush sandblasted in compliance with SSPC-SP 7.
   2. The Exterior Concrete Surfaces of the tank shall be cleaned by means of brush sandblasting in compliance with SSPC-SP 7. The surfaces shall be blown down with air to remove the blasting residue and dust, and two coats of epoxy-polyamide paint shall be applied.
   3. Holes and Voids in the concrete surfaces left from the blast cleaning shall be filled by means of troweling and squeeze application of an epoxy filler. The surfacing material shall be allowed to cure overnight, and then two coats of coal-tar epoxy complying with SSPC-PAINT 16 shall be applied.

4. Submerged Ferrous Metal Surfaces that are exposed to the sewage shall be sandblasted in compliance with SSPC-SP 10 and coated with two coats of coal-tar epoxy.
5. Ferrous Metal Surfaces that are not submerged shall be cleaned by means of sandblasting in compliance with SSPC-SP 6. Surfaces inaccessible to sandblasting shall be power tool cleaned in compliance with SSPC-SP 3. Surfaces shall be coated with one coat of red-lead base paint. After the base paint has dried sufficiently, two coats of aluminum finish paint shall be applied.

END OF SECTION 33 01 30 51

Task	Specification	Specification Description
33 01 30 51	01 22 16 00	No Specification Required
33 01 30 51	21 05 23 00	Piped Utilities Basic Materials And Methods
33 01 30 51	33 01 10 58	Repair And Maintenance Of Imhoff Tanks
33 01 30 63	01 22 16 00	No Specification Required
33 01 30 74	01 22 16 00	No Specification Required

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SECTION 33 01 30 81 - UNDERGROUND DUCTS AND UTILITY STRUCTURES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for underground ducts and utility structures. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks, and in single duct runs\.
   b. Handholes and pull boxes.
   c. Manholes.

C. Definition
1. RNC: Rigid nonmetallic conduit.

D. Submittals
1. Product Data: For the following:
   a. Duct-bank materials, including separators and miscellaneous components.
   b. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
   c. Accessories for manholes, handholes, pull boxes, and other utility structures.
   d. Warning tape.
   e. Warning planks.
2. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
   a. Duct entry provisions, including locations and duct sizes.
   b. Reinforcement details.
   c. Frame and cover design and manhole frame support rings.
   d. Ladder **OR** Step, **as directed,** details.
   e. Grounding details.
   f. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
   g. Joint details.
3. Shop Drawings for Factory-Fabricated Handholes and Pull Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
   a. Duct entry provisions, including locations and duct sizes.
   b. Cover design.
   c. Grounding details.
   d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
4. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
   a. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
   b. Drawings shall be signed and sealed by a qualified professional engineer.
5. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.
6. Qualification Data: For qualified professional engineer and testing agency.
7. Source quality-control reports
8. Field quality-control test reports.

E. Quality Assurance
1. Comply with IEEE C2.
2. Comply with NFPA 70.

F. Delivery, Storage, And Handling
1. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
2. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
3. Lift and support precast concrete units only at designated lifting or supporting points.

G. Project Conditions
1. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
a. Notify the Owner no fewer than two days in advance of proposed interruption of electrical service.
b. Do not proceed with interruption of electrical service without the Owner's written permission.

1.2 PRODUCTS

A. Conduit
1. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
2. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

B. Nonmetallic Ducts And Duct Accessories
1. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type EB-20-PVC, ASTM F 512, UL 651A, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.
2. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type DB-60-PVC and Type DB-120-PVC, ASTM F 512, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.
3. Duct Accessories:
a. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
b. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification For Electrical Systems".
c. Concrete Warning Planks: Nominal 12 by 24 by 3 inches (300 by 600 by 76 mm) in size, manufactured from 6000-psi (41-MPa) concrete.
1) Color: Red dye added to concrete during batching.
2) Mark each plank with "ELECTRIC" in 2-inch- (50-mm-) high, 3/8-inch- (10-mm-) deep letters.

C. Precast Concrete Handholes And Pull Boxes
1. Comply with ASTM C 858 for design and manufacturing processes.
2. Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A153 (ASTM A153M) and ASTM A123 (ASTM A123M).
3. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or pull box.

a. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
b. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
c. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
   1) Cover Hinges: Concealed, with hold-open ratchet assembly.
   2) Cover Handle: Recessed.
d. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing stainless-steel bolts.
   1) Cover Hinges: Concealed, with hold-open ratchet assembly.
   2) Cover Handle: Recessed.
e. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
f. Cover Legend: Molded lettering, "ELECTRIC" **OR** "TELEPHONE" **OR** As indicated for each service, **as directed**.
g. Configuration: Units shall be designed for flush burial and have open **OR** closed **OR** integral closed, **as directed,** bottom, unless otherwise indicated.
h. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
   1) Extension shall provide increased depth of 12 inches (300 mm).
   2) Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
i. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.
   1) Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
   2) Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
   3) Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
j. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
   1) Type and size shall match fittings to duct or conduit to be terminated.
   2) Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
k. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

D. Handholes and Pull Boxes Other Than Precast Concrete
1. Description: Comply with SCTE 77.
   a. Color: Gray **OR** Green, **as directed**.
   b. Configuration: Units shall be designed for flush burial and have open **OR** closed **OR** integral closed, **as directed,** bottom, unless otherwise indicated.
   c. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
   d. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   e. Cover Legend: Molded lettering, "ELECTRIC" **OR** "TELEPHONE" **OR** As indicated for each service, **as directed**.
   f. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
   g. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
   h. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2. Polymer Concrete Handholes and Pull Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
3. Fiberglass Handholes and Pull Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
4. Fiberglass Handholes and Pull Boxes: Molded of fiberglass-reinforced polyester resin, with covers of polymer concrete **OR** reinforced concrete **OR** cast iron **OR** hot-dip galvanized-steel diamond plate **OR** fiberglass, **as directed**.
5. High-Density Plastic Pull Boxes: Injection molded of high-density polyethylene or copolymer-polypropylene. Cover shall be polymer concrete **OR** hot-dip galvanized-steel diamond plate **OR** plastic, **as directed**.

E. Precast Manholes
1. Comply with ASTM C 858, with structural design loading as specified in Para. 1.3 "Underground Enclosure Application" Article and with interlocking mating sections, complete with accessories, hardware, and features.
   a. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.
      1) Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
      2) Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
      3) Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
   b. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
      1) Type and size shall match fittings to duct or conduit to be terminated.
      2) Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.
2. Concrete Knockout Panels: 1-1/2 to 2 inches (38 to 50 mm) thick, for future conduit entrance and sleeve for ground rod.
3. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

F. Cast-In-Place Manholes
1. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for conduit entrance and sleeve for ground rod.
2. Materials: Comply with ASTM C 858 and with Division 03 Section "Cast-in-place Concrete".
   a. Concrete shall have a minimum compressive strength of 3000 psi (20 MPa).
3. Structural Design Loading: As specified in "Underground Enclosure Application" Article.

G. Utility Structure Accessories
1. Ferrous metal hardware, where indicated, shall be hot-dip galvanized complying with ASTM A 153 (A 153M) and A 123 (A 123M).
2. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
   a. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B **OR** cast aluminum, **as directed,** with milled cover-to-frame bearing surfaces; diameter, 26 inches (660 mm) **OR** 29 inches (737 mm), **as directed**.
      1) Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

2) Special Covers: Recess in face of cover designed to accept finish material in paved areas.

b. Cover Legend: Cast in. Selected to suit system.

1) Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.

2) Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.

3) Legend: "SIGNAL" for communications, data, and telephone duct systems.

c. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.

1) Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. (60 L) where packaged mix complying with ASTM C 387, Type M, may be used.

3. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.

4. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- (50-mm-) diameter eye, and 1-by-4-inch (25-by-100-mm) bolt.

a. Working Load Embedded in 6-Inch (150-mm), 4000-psi (27.6-MPa) Concrete: 13,000-lbf (58-kN) minimum tension.

5. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch- (32-mm-) diameter eye, rated 2500-lbf (11-kN) minimum tension.

6. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- (22-mm-) diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.

a. Ultimate Yield Strength: 40,000-lbf (180-kN) shear and 60,000-lbf (270-kN) tension.

7. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch (13-mm) ID by 2-3/4 inches (69 mm) deep, flared to 1-1/4 inches (32 mm) minimum at base.

a. Tested Ultimate Pullout Strength: 12,000 lbf (53 kN) minimum.

8. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch (13-mm) bolt, 5300-lbf (24-kN) rated pullout strength, and minimum 6800-lbf (30-kN) rated shear strength.

9. Cable Rack Assembly: Steel, hot-rolled **OR** hot-dip, **as directed,** galvanized, except insulators.

a. Stanchions: T-section or channel; 2-1/4-inch (57-mm) nominal size; punched with 14 holes on 1-1/2-inch (38-mm) centers for cable-arm attachment.

b. Arms: 1-1/2 inches (38 mm) wide, lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 18 inches (460 mm) with 250-lb (114-kg) minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.

c. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

10. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.

a. Stanchions: Nominal 36 inches (900 mm) high by 4 inches (100 mm) wide, with minimum of 9 holes for arm attachment.

b. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 20 inches (508 mm) with 250-lb (114-kg) minimum capacity. Top of arm shall be nominally 4 inches (100 mm) wide, and arm shall have slots along full length for cable ties.

11. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

12. Fixed Manhole Ladders: Arranged for attachment to roof or wall **OR** and floor, **as directed,** of manhole. Ladder and mounting brackets and braces shall be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin **OR** hot-dip galvanized steel, **as directed**.

13. Portable Manhole Ladders: UL-listed, heavy-duty wood **OR** fiberglass, **as directed,** specifically designed for portable use for access to electrical manholes. Minimum length equal to distance from deepest manhole floor to grade plus 36 inches (900 mm). One required.
14. Cover Hooks: Heavy duty, designed for lifts 60 lbf (270 N) and greater **OR** Light duty, designed for lifts less than 60 lbf (270 N), **as directed**. Two required.

H. Source Quality Control
1. Test and inspect precast concrete utility structures according to ASTM C 1037.
2. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and pull boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
   a. Engage a qualified testing agency to evaluate nonconcrete handholes and pull boxes.
   b. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

1.3 EXECUTION

A. Corrosion Protection
1. Aluminum shall not be installed in contact with earth or concrete.

B. Underground Duct Application
1. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-80 **OR** EPC-40 **OR** EB-20, **as directed,**-PVC, in concrete-encased duct bank, unless otherwise indicated.
2. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-80 **OR** EPC-40 **OR** EB-20, **as directed,**-PVC, in concrete-encased duct bank, unless otherwise indicated.
3. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-80 **OR** EPC-40 **as directed,**-PVC, in direct-buried duct bank, unless otherwise indicated.
4. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-80 **OR** EPC-40, **as directed,**-PVC, in direct-buried duct bank, unless otherwise indicated.
5. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40 **OR** EB-20, **as directed,**-PVC, in concrete-encased duct bank, unless otherwise indicated.
6. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC **OR** Underground plastic utilities duct, NEMA Type DB-60-PVC **OR** Underground plastic utilities duct, NEMA Type DB-120-PVC, **as directed,** installed in direct-buried **OR** concrete-encased, **as directed,** duct bank, unless otherwise indicated.
7. Underground Ducts for Telephone, Communications, or Data Circuits: RNC, NEMA Type EPC-40 **OR** DB-60 **OR** DB-120, **as directed,**-PVC, in direct-buried duct bank, unless otherwise indicated.
8. Underground Ducts for Telephone, Communications, or Data Circuits: RNC, NEMA Type EB-20-PVC, in concrete-encased duct bank, unless otherwise indicated.
9. Underground Ducts Crossing Paved Paths **OR** Walks and Driveways **OR** Roadways and Railroads, **as directed**: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

C. Underground Enclosure Application
1. Handholes and Pull Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:
   a. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-10 **OR** H-20, **as directed,** structural load rating.
   b. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 **OR** Polymer concrete, SCTE 77, Tier 15 **OR** Fiberglass enclosures with polymer concrete frame and cover, SCTE 77, Tier 15 **OR** Fiberglass-reinforced polyester resin, SCTE 77, Tier 15 **OR** High-density plastic, SCTE 77, Tier 15, **as directed,** structural load rating.

c. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 **OR** Polymer concrete units, SCTE 77, Tier 8 **OR** Heavy-duty fiberglass units with polymer concrete frame and cover, SCTE 77, Tier 8 **OR** High-density plastic, SCTE 77, Tier 8, **as directed,** structural load rating.
d. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin **OR** High-density plastic, **as directed**, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.

2. Manholes: Precast or cast-in-place concrete.
   a. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
   b. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

D. Earthwork
1. Excavation and Backfill: Comply with Division 31 Section "Earth Moving", but do not use heavy-duty, hydraulic-operated, compaction equipment.
2. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
3. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Section(s) "Turf And Grasses" AND "Plants".
4. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting And Patching".

E. Duct Installation
1. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.
2. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches (1220 mm) **OR** 12.5 feet (4 m) **OR** 25 feet (7.5 m), **as directed**, both horizontally and vertically, at other locations, unless otherwise indicated.
3. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
4. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) ducts, and vary proportionately for other duct sizes.
   a. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.
   b. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
   c. Grout end bells into structure walls from both sides to provide watertight entrances.
5. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet (3 m) outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results For Electrical".
6. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.
7. Pulling Cord: Install 100-lbf- (445-N-) test nylon cord in ducts, including spares.
8. Concrete-Encased Ducts: Support ducts on duct separators.
   a. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 **OR** 5, **as directed,** spacers per 20 feet (6 m) of duct. Secure

separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

b. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
   1) Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
   2) If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (19-mm) reinforcing rod dowels extending 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.

c. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

d. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.

e. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

f. Minimum Space between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and signal ducts.

g. Depth: Install top of duct bank at least 24 inches (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.

h. Stub-Ups:
   1) Use manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Extend concrete encasement throughout the length of the elbow.
      OR
      Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
      a) Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
      b) Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.

i. Warning Tape: Bury warning tape approximately 12 inches (300 mm) above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches (75 mm) of the centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

9. Direct-Buried Duct Banks:

a. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.

b. Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 **OR** 5, **as directed,** spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches (150 mm) between tiers.

c. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6 inches (150 mm) in nominal diameter.

d. Install backfill as specified in Division 31 Section "Earth Moving".

e. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches (100 mm) over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving".

f. Install ducts with a minimum of 3 inches (75 mm) between ducts for like services and 6 inches (150 mm) between power and signal ducts.

g. Depth: Install top of duct bank at least 36 inches (900 mm) below finished grade, unless otherwise indicated.

h. Set elevation of bottom of duct bank below the frost line.

i. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.

OR

Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

1) Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.

2) For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

j. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried ducts and duct banks, placing them 24 inches (600 mm) o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional planks 12 inches (300 mm) apart, horizontally.

F. Installation Of Concrete Manholes, Handholes, And Pull Boxes

1. Cast-in-Place Manhole Installation:

a. Finish interior surfaces with a smooth-troweled finish.

b. Windows for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches (38 to 50 mm) thick, arranged as indicated.

c. Cast-in-place concrete, formwork, and reinforcement are specified in Division 03 Section "Cast-in-place Concrete".

2. Precast Concrete Handhole and Manhole Installation:

a. Comply with ASTM C 891, unless otherwise indicated.

b. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.

c. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

3. Elevations:

a. Manhole Roof: Install with rooftop at least 15 inches (380 mm) below finished grade.

b. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch (25 mm) above finished grade.

c. Install handholes with bottom below the frost line, below grade.

d. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
e. Where indicated, cast handhole cover frame integrally with handhole structure.

4. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
5. Manhole Access: Circular opening in manhole roof; sized to match cover size.
   a. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
   b. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.
6. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Division 07 Section(s) "Elastomeric Sheet Waterproofing" OR "Thermoplastic Sheet Waterproofing", **as directed.** After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.
7. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Division 07 Section "Bituminous Dampproofing". After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
8. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
9. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
10. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches (98 mm) for manholes and 2 inches (50 mm) for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
11. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

G. Installation Of Handholes And Pull Boxes Other Than Precast Concrete

1. Install handholes and pull boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.
2. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.7-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
3. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
4. Install handholes and pull boxes with bottom below the frost line, below grade.
5. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
6. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
7. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
   a. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Division 03 Section "Cast-in-place Concrete", with a troweled finish.

b. Dimensions: 10 inches wide by 12 inches deep (250 mm wide by 300 mm deep).

H. Grounding
1. Ground underground ducts and utility structures according to Division 26 Section "Grounding And Bonding For Electrical Systems".

I. Field Quality Control
1. Perform the following tests and inspections:
   a. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
   b. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
   c. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding And Bonding For Electrical Systems".
2. Correct deficiencies and retest as specified above to demonstrate compliance.
3. Prepare test and inspection reports.

J. Cleaning
1. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
2. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 33 01 30 81

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Task	Specification	Specification Description
33 01 30 81	01 22 16 00	No Specification Required
33 01 30 81	21 05 23 00	Piped Utilities Basic Materials And Methods
33 01 30 81	22 05 76 00	Sanitary Sewerage
33 01 30 81	33 01 10 58	Repair And Maintenance Of Imhoff Tanks
33 01 30 81	33 01 30 51	Repair And Maintenance Of Siphon Tank And Siphons
33 01 30 81	33 42 11 00	Storm Drainage
33 01 30 81	31 32 19 16	Sewage Treatment Lagoons
33 01 30 82	01 22 16 00	No Specification Required
33 01 30 83	01 22 16 00	No Specification Required
33 01 30 83	21 05 23 00	Piped Utilities Basic Materials And Methods
33 01 30 83	33 01 10 58	Repair And Maintenance Of Imhoff Tanks
33 01 30 83	33 01 30 51	Repair And Maintenance Of Siphon Tank And Siphons
33 01 30 86	01 22 16 00	No Specification Required
33 01 30 86	21 05 23 00	Piped Utilities Basic Materials And Methods
33 01 30 86	33 01 10 58	Repair And Maintenance Of Imhoff Tanks
33 01 30 86	33 01 30 51	Repair And Maintenance Of Siphon Tank And Siphons
33 01 30 89	01 22 16 00	No Specification Required
33 01 34 13	21 05 23 00	Piped Utilities Basic Materials And Methods
33 01 34 13	33 01 30 51	Repair And Maintenance Of Siphon Tank And Siphons
33 01 40 00	33 42 11 00	Storm Drainage

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SECTION 33 05 07 13 - TRENCHLESS EXCAVATION USING MICROTUNNELING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of trenchless excavation using microtunneling. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Design Requirements
1. Pipe Casing: Provide pipe casing in thickness indicated of polyvinyl chloride (PVC) plastic **OR** clay tile **OR** concrete **OR** steel, **as directed,** pipe. Provide utility line accessories, valves, connections, and manholes as specified and where indicated. Submit design calculations of pipe casing.

C. Submittals: Submit the following:
1. Preconstruction Submittals: Microtunneling Boring Machine equipment to be used.
2. Product Data
   a. Piping casing, joints, fittings, valves, and couplings
   b. Bentonite
   c. Submit manufacturer's standard drawings or catalog cuts, except submit both drawings and cuts for push-on and rubber-gasketed bell-and-spigot joints. Include information concerning gaskets with submittal for joints and couplings.
3. Design Data: Design calculations of pipe casing
4. Certificates
   a. Piping casing piping, fittings, joints, valves, and coupling
   b. Shop-applied linings
   c. Certificates shall attest that tests set forth in each applicable referenced publication have been performed, whether specified in that publication to be mandatory or otherwise and that production control tests have been performed at the intervals or frequency specified in the publication. Other tests shall have been performed within 3 years of the date of submittal or certificates on the same type, class, grade, and size of material as is being provided for the project.
5. Manufacturer's Instructions: Installation procedures for pipe casing

D. Delivery, Storage, and Handling:
1. Inspect materials delivered to site for damage. Unload and store with minimum handling. Store materials on site in enclosures or under protective covering. Store plastic piping, jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes, fittings, and valves free of dirt and debris.
2. Handle pipe, fittings, valves, hydrants, and other accessories in a manner to ensure delivery to the excavation in sound undamaged condition. Take special care to avoid injury to coatings and linings on pipe and fittings; make satisfactory repairs if coatings or linings are damaged. Carry, do not drag pipe to the excavation. Store plastic piping, jointing materials and rubber gaskets that are not to be installed immediately, under cover out of direct sunlight. Handle steel pipe with coal-tar enamel **OR** coal-tar epoxy, **as directed**, coating in accordance with the provisions for handling coal-tar enamel coated pipe in AWWA C203.

E. Quality Assurance
1. Design Calculations of Pipe Casing: Submit design calculations of pipe casing demonstrating that the pipe casing selected has been designed to support the maximum anticipated earth loads and superimposed live loads, both static and dynamic, which may be imposed on the pipe casing.

1.2 PRODUCTS

A. Piping Casing Materials

1. Ductile-Iron Piping

a. Pipe and Fittings: Pipe, except flanged pipe, ANSI/AWWA C151/A21.51 Pressure Class and/or Thickness Class as required to meet Project requirements. The outside diameter of ductile iron microtunneling pipe shall be in accordance with AWWA C150/A21.50.

b. Joints and Jointing Material: Joints: Pressure and gravity microtunneling pipe shall have either an integral-bell push-on or rubber gasket coupled joint meeting the following criteria:

1) Integral-bell push-on joint microtunneling pile shall consist of a rubber-gasket joint manufactured to conform with AWWA C111/A21.11 and the dimensions shown in ANSI/AWWA C151/A21.51. The exterior of the pipe shall be coated with a durable cement-mortar or concrete coating applied in such a manner as to provide a uniform outside diameter.

2) Cement-mortar or concrete strength, reinforcement and method of placement shall be in accordance with manufacturer's recommendations. Durable Coatings of other types may be substituted provided they maintain a uniform outside diameter and they are approved by the designer. Rubber gasket coupled microtunneling joint shall be manufactured so as to provide a joint which has the same nominal outside diameter as the pipe barrel.

2. Polyvinyl Chloride Pipe (PVC): ASTM F 794. ASTM D 3212 for gasketed joint systems. ASTM F 477 for gasket materials.

3. Reinforced Concrete Pipe

a. Nominal dimensions: Typical nominal dimensions for reinforced concrete pipe are detailed in ASTM standards ASTM C 76 (ASTM C 76M), ASTM C 361 (ASTM C361M), ASTM C 655 (ASTM C 655M), ASTM C 822. Pipe meeting these requirements is generally acceptable for jacking. The permissible variation allowed with respect to these and other dimensions shall be in accordance with the variations listed in the section.

b. Joints and Jointing Material: Joint shall be formed entirely of concrete and as detailed in the contract drawings, may **OR** shall, **as directed**, utilize a rubber gasket or mastic to provide the seal. Incorporate an assembly of steel bands or steel bell ends and spigot rings and rubber gaskets in accordance with contract drawings.

4. Steel Pipe

a. Steel pipe shall be in conformance with ASTM A 139, Grade B with a minimum yield strength of 35,000 psi (242 MPa) **OR** AWWA C200 **OR** API SPEC 5L Grade B **OR** ASTM A 53 **OR** ASTM A 716 **OR** ASTM A 746, **as directed**. Steel pipe shall be welded, seamless, square cut with even lengths and shall comply of Articles 4.2, 4.3, and 4.4 of the API SPEC 5L.

b. Joints: The connection of adjacent pieces of microtunneling steel pipe may be accomplished by field buttwelding, internal weld sleeves, integral press fit connectors, as long as loading and installation design criteria are met.

5. Fiberglass Pipe

a. Pipe: Fiberglass pipe shall meet the requirements of ASTM D 3262, Type 1, Liner 2, Grade 3. The method of the manufacture shall be centrifugal casting resulting in a controlled outside diameter. Minimum wall thickness shall be +1.5 inches (+38 mm).

b. Joints: The pipes shall be connected by gasket-sealed bell-spigot joints. The gasket material shall meet requirements of ASTM F 477. The joint shall meet the requirements of ASTM D 4161 and shall be leak-free under the following conditions:

1) External pressures up to 2 bars, 29 psi (200 kPa) from bentonite injection, slurry system operation or groundwater head.

2) Internal air testing up to 5 psi (35 kPa).

3) Gaps between the pipe ends up to two percent of the diameter (maximum of 1-inch (25 mm)).

c. The liner shall consist of a minimum thickness of 0.04 inch (1.2 mm) of reinforced polyester resin. The outside pipe coating shall have a minimum thickness of 0.03 inches (one mm) and shall consist of thermosetting polyester resin and sand.

6. Vitrified Clay Pipe: ASTM C 700.
   a. Pipe: Vitrified clay pipe shall be manufactured from fire clay, shale, surface clay, or a combination that can meet three edge bearing strength for nominal diameters ranging from 4 inches 2000 lb/linear foot (100 mm 2980 kg/m) to 42 inches 7000 lb/linear foot (1050 mm 10430 kg/m).
   b. Joints: Joints shall be capable of supporting a shear load of 50 pounds per inch (8755 N/m) of nominal diameter uniformly applied over an arc of not less than 120 degrees (2.09 rad) and along a distance of 12 inches (300 mm) adjacent to the joint. Apply an internal 10 foot (3 m) head 4.3 psi (30 kPa) of water pressure for a period of one hour. Joints shall fully comply with ASTM C 1208 (ASTM C 1208M).
7. Concrete: Concrete shall be 3000 psi (25 MPa) and conform with Division 03 Section "Cast-in-place Concrete".
8. Bentonite: Bentonite shall conform with API SPEC 13A and have the capacity of mixing with water to form a stable and homogeneous suspension.
9. Backfill: Reuse excavated sand for backfill that conforms with Division 31 Section "Earth Moving".

1.3 EXECUTION

A. Preparation

1. Access Shafts
   a. Construction methods required to provide access shafts for microtunneling shall be subject to approval of the Owner. Acceptable construction methods may include the use of interlocked steel sheet piling or precast circular concrete segments lowered in place during excavation.
   b. Final dimensions of access shafts selected by the Contractor shall be modified as required following installation of pipe casings to the size and shape of acceptable manhole designs shown on the Contract Drawings to permit installation of conveyance piping.
   c. Shafts shall be of a size commensurate with safe working practices and located as shown on plans. With the approval of the Owner, the Contractor may relocate shafts to better suit the capabilities of the microtunneling method proposed. Where no locations are given, the Contractor shall determine suchfficer.
   d. Shaft locations shall, where possible, be kept clear of road intersections and within a single traffic lane, in order to minimize disruption to the flow of traffic. Support equipment, spoil piles, and materials shall also be located such as to minimize disruption to traffic and are subject to the approval of the Owner.
   e. The Contractor shall properly support all excavations and prevent movement of the soil, pavement, utilities or structures outside of the excavation. The Contractor shall furnish, place and maintain sheeting, bracing, and lining required to support the sides and floor of all pits and to provide adequate protection of the work, personnel, and the general public. Design loads on the sides of the jacking and receiving pit walls are dependent on the construction method and flexibility of the wall systems.
   f. Construct a starter shaft to accommodate the installation of pipe casings, slurry shield and piping jacking device. Install thrust block as required and consolidate the ground (grout) where the casings exit the shaft.
   g. Construct a receiver shaft to accommodate the installation of pipe casings and the slurry shield. Consolidate the ground (grout) where the casings enter the shaft.
   h. The Contractor shall furnish, install, and maintain equipment to keep the jacking shaft free of excess water. The Contractor shall also provide surface protection during the period of construction to ensure that surface runoff does not enter driving shaft(s). Groundwater dewatering shall comply with the approved dewatering plan and shall not affect

surrounding soils or structures beyond the tolerances stated in paragraph entitled "Settlement, Alignment and Tolerances."

i. Provide security fence around all access shaft areas and provide shaft cover(s) when the shaft area is not in use.

j. Design of the jacking and receiving pit supports should also take into account the loading from shield or pipe jacking where appropriate, as well as special provisions and reinforcement around the breakout location. The base of the pits shall be designed to withstand uplift forces from the full design head of water, unless approved dewatering or other ground modification methods are employed.

k. Where a thrust block is required to transfer jacking loads into the soil, it shall be properly designed and constructed by the Contractor. The backstop shall be normal (square) with the proposed pipe alignment and shall be designed to withstand the maximum jacking pressure to be used with a factor of safety of at least 2.0. It shall also be designed to minimize excessive deflections in such a manner as to avoid disturbance of adjacent structures or utilities or excessive ground movement. If a concrete thrust block or treated soil zone is utilized to transfer jacking loads into the soil, the tunnel boring is not to be jacked until the concrete or other materials have attained the required strength.

l. Pit Backfill and Compaction: Upon completion of the pipe drive and approval of the installed pipeline by the Owner, remove all equipment, debris, and unacceptable materials from the pits and commence backfilling operation. Backfilling, compaction and pavement repairs shall be completed in accordance with Division 31 Section "Earth Moving".

m. If tremie concrete sealing slabs are placed within the earth support system to prevent groundwater inflow when access shafts are dewatered, the sealing slabs shall be of sufficient thickness to provide a factor of safety equal to 1.2 against hydrostatic uplift in order to prevent bottom blowout when the excavation is completely dewatered.

B. Installation

1. Installation of Tracer Wire: Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe. Attach wire to top of pipe in such a manner that will not be displaced during construction operations.

2. Connections to Existing Lines: Make connections to existing lines after the Owner approval is obtained and with a minimum interruption of service on the existing line. Make connections to existing lines under pressure in accordance with the recommended procedures of the manufacturer of the pipe being tapped.

3. Minimum depth of cover over the pipe being installed shall be 6 feet (1.8 m) or 1.5 times the outer diameter of the pipe being installed.

4. Settlement, Alignment and Tolerances

a. Settlement or heave of ground surface along centerline of microtunneling alignments during and after installation of pipe casings shall not exceed 1 inch (25 mm).

b. No more than 1 inch (25 mm) lateral and 1 inch (25 mm) vertical deviation shall be permitted in the position of the completed jacked pipe casings. Water shall be free draining between any two points at the pipe invert. No reverse grades will be allowed.

c. Overcut shall not exceed 1 inch (25 mm) on the radius of the pipe being installed. The annular space created by the overcut must be filled with the lubrication material that is used to reduce soil friction drag on the pipe.

5. Microtunneling

a. Using Unmanned Tunneling Machine

1) The microtunneling boring machine shall be an unmanned mechanical type earth pressure counter-balanced bentonite slurry shield system. The machine shall be laser guided and monitored continuously, with a closed circuit television system. The machine shall be capable of fully supporting the face both during excavation and during shutdown and shall have the capability, of positively measuring the earth pressure at the face. Excavation face pressure shall be maintained at all times between the measured active earth pressure and 50 percent of the computed passive earth pressure. Fluid pressure applied at the face to stabilize the

excavation shall be maintained at a level slightly in excess of normal hydrostatic pressure and shall be monitored continuously. The machine shall be operated so as to prevent either surface heave or loss of ground during tunneling and shall be steerable and capable of controlling the advance of the heading to maintain line and grade within the tolerances specified in paragraph entitled "Settlement, Alignment and Tolerances." The machine shall be capable of handling and removing materials of high water content from the machine head.

2) Each pipe casing section shall be jacked forward as the excavation progresses in such a way to provide complete and adequate, ground support at all times. A bentonite slurry (driller's mud) shall be applied to the external surface of the pipe to reduce skin friction. A jacking frame shall be provided for developing a uniform distribution of jacking forces around the periphery of the pipe. A plywood spacer shall be placed on the outer shoulder of the pipe casing joint. The thrust reaction backstop shall be properly designed and constructed.

3) The backstop shall be normal (square) with the proposed pipe casing alignment and shall be designed to support the maximum obtainable jacking pressure with a safety factor at least 2.0.

4) The jacking system shall be capable of continuously monitoring the jacking pressure and rate of advancement. Special care shall be taken when setting the pipe guard rails in the starter shaft to ensure correctness of the alignment, grade and stability.

b. Using Tunneling Shields

1) Only tunneling equipment capable of fully supporting the face of the tunnel shall be used for pipe jacking work described.

2) Tunneling equipment selected for the project shall be compatible with the geotechnical information contained in this contract. The tunneling equipment shall be capable of tunneling through mixed face conditions without exceeding the settlement tolerances specified in paragraph "Settlement, Alignment and Tolerances."

3) Face pressure exerted at the heading by the tunneling machine shall be maintained as required to prevent loss of ground, groundwater inflows, and settlement or heave of the ground surface by balancing soils and groundwater pressures present.

4) Dewatering for groundwater control shall be allowed at the jacking and receiving pits only.

c. Do not jack pipe casing until the concrete thrust block and tremie seal (if selected), and grouted soil zone in starter and receiving shafts have attained the required strength.

d. The pipe casing shall be jacked in place without damaging the pipe casing joints or completed pipe casing section.

e. After completion of the jacking operation between starter and receiver shafts, the lubricate material shall be displaced from between the pipe casing exterior and the surrounding ground by a cement grout. Pressure and the amount of grout shall be controlled to avoid pipe damage and displacement of the pipe and soil beyond the tolerances specified in paragraph "Settlement, Alignment and Tolerances." Grouting shall be accomplished promptly after pipe installation has been completed to prevent any surface settlement due to movement of soil material into the void space or loosened zone around the pipe casing.

f. Any pipe casing which has been damaged during installation shall be replaced by the Contractor at no additional cost. If a new replacement pipe casing is required extending from the starter to the receiver shaft, it shall be installed in conformance with the contract drawings and this section.

g. Steel pipe casing joints shall be continuously welded with butt joint per AWS D1.1. The welds shall attain the full strength of the pipe and shall result in a full watertight section. The inner face of internal weld seam shall be flush with the pipe to facilitate the installation of the conveyance pipe in the pipe casing.

h. Perform all welding in accordance with requirements for shielded metal arc welding of AWS D1.5 for bridges and AWS D1.1 for buildings and other structures.

i. Fiberglass pipe casing joints shall be fully watertight and shall attain the full strength of the pipe. Casing joints shall be field connected with sleeve couplings or bell and spigot type joints that utilize elastomeric sealing gaskets as the sole means to maintain joint water tightness.

j. The joint shall have the same outside diameter as the pipe so when the pipelines are assembled such that the joints are flush with the pipe inside and outside surface to facilitate installation of it conveyance pipe in the pipe casing.

k. All excavated material from tunnel and shaft construction shall be disposed of away from the construction site. On-site storage of material must comply with Division 01 requirements and must be stored in areas shown on site drawings or as directed. Stockpiling shall be permitted on the construction site and material shall be removed at regular intervals as directed by the Owner.

l. Monitor ground movements associated with the project and make suitable changes in the construction methods that control ground movements and prevent damage or detrimental movement to the work and adjacent structures and pavements.

m. Install instrumentation, take readings and provide the Owner with weekly reports containing measurements data with weekly reports to inspector. These actions are meant to supplement the Contractor's monitoring system and do not relieve the Contractor of its responsibility, nor place on the Owner, responsibility for control of ground movement and protection of the project and adjacent structures. Instrumentation readings shall be continued for a period of time as directed by the Owner after pipe casings have been installed to establish that detrimental settlement has not occurred.

n. Unprotected mining of the tunnel bore is not permitted. The tunnel face and bore shall be fully supported at all times.

o. A topographic survey will be performed by the Contractor before and after microtunneling and at intervals as directed by the Owner. Survey markers will be installed by the contractor at grid points located as directed by the Owner centered on the proposed tunnel alignments. Perform all remedial work including repaired if heave or settlement greater than 1 inch (25 mm) is recorded.

p. Approval by the Owner of the topographic survey and final set of readings provided by the Contractor will constitute partial approval of the microtunneling phase of work.

6. Ventilation: Adequate ventilation shall be provided for all cased tunnels and shafts. Follow confined space entry procedures. Local burn permit regulations must be obeyed and complied with. The design of ventilating system shall include such factors as the volume required to furnish fresh air in the shafts, and the volume to remove dust that may be caused by the cutting of the face and other operations which may impact the laser guidance system.

7. Lighting: Adequate lighting shall be provided for the nature of the activity being conducted by workers for the microtunneling. Both power and lighting circuits shall be separated and thoroughly insulated with ground fault interrupters are required. Lights shall comply with requirements with regards to shatter resistance and illumination requirements.

8. Spoil Transportation: The soil transportation system shall match the excavation rate with rate of spoil removal. The system must also be capable of balancing groundwater pressures and adjustment to maintain face stability for the particular soil conditions of this project.

9. Pipe Jacking Equipment: The main jacking equipment installed must have a capacity greater than the anticipated jacking load. Intermediate jacking stations shall be provided by the Contractor when the total anticipated jacking force needed to complete the installation may exceed the capacity of the main jacks or the designed maximum jacking force for the pipe. The jacking system shall develop a uniform distribution of jacking forces on the end of the pipe by use of thruster rings and cushioning material.

10. Jacking Pipe: In general, pipe used for jacking shall be smooth, round, have an even outer surface, and joints that allow for easy connections between pipes. Pipe ends shall be square and smooth so that jacking loads are minimized when the pipe is jacking. Pipe used for pipe jacking shall be capable of withstanding the jacking forces that will be imposed by the process or installation, as well as the final place loading conditions. The driving ends of the pipe and intermediate joints shall be protected from damage.

a. Any pipe showing signs of failure may be jacked through to the receiving shaft and removed. Other methods of repairing the damaged pipe may be used, as recommended by the manufacturer and subject to approval by the Owner.

b. The pipe manufacturer's design jacking loads shall not be exceeded during the installation process. The pipe shall be designed to take full account of all temporary installation loads.

C. Field Quality Control

1. Field Tests and Inspections: The Contractor shall perform field tests, and provide labor, equipment, and incidentals required for testing. The Contractor shall product evidence, when required, that any item of work has been constructed in accordance with drawings and specifications.

2. Testing Requirements: For pressure test, use a hydrostatic pressure 50 percent greater than the maximum working pressure of the system. Hold this pressure for not less than 2 hours. For leakage test, use a hydrostatic pressure not less than the maximum working pressure of the system. Leakage test may be performed at the same time and at the same test pressure as the pressure test.

END OF SECTION 33 05 07 13

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Task	Specification	Specification Description
33 05 07 23	01 22 16 00	No Specification Required
33 05 07 23	33 05 07 13	Trenchless Excavation Using Microtunneling
33 05 07 24	33 05 07 13	Trenchless Excavation Using Microtunneling
33 05 61 00	22 05 76 00	Sanitary Sewerage
33 05 61 00	33 42 11 00	Storm Drainage
33 05 63 00	33 01 30 81	Underground Ducts And Utility Structures
33 05 81 00	01 22 16 00	No Specification Required
33 05 81 00	22 05 76 00	Sanitary Sewerage
33 05 81 00	33 01 30 81	Underground Ducts And Utility Structures
33 05 81 00	33 42 11 00	Storm Drainage
33 05 81 00	31 32 19 16	Sewage Treatment Lagoons
33 05 83 00	22 05 76 00	Sanitary Sewerage
33 05 83 00	33 01 30 81	Underground Ducts And Utility Structures
33 05 83 00	33 42 11 00	Storm Drainage
33 05 83 00	31 32 19 16	Sewage Treatment Lagoons
33 05 84 00	01 22 16 00	No Specification Required
33 05 84 00	21 05 23 00	Piped Utilities Basic Materials And Methods
33 05 84 00	22 05 76 00	Sanitary Sewerage
33 05 84 00	33 42 11 00	Storm Drainage
33 05 84 00	31 32 19 16	Sewage Treatment Lagoons
33 05 97 16	01 22 16 00	No Specification Required

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SECTION 33 11 13 00 - WELL REPAIR

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for repair and maintenance of water wells. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals

1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Repair and Replacement Parts shall be clean, free of rust and scale, and of proper size and design for the specific well repair to be made.

1.3 EXECUTION

A. Cement Grout may be hand mixed at the site.

B. Level and Re-Sod Area, after heavy equipment has been used or if chemicals have been spilled.

C. Abandoned Wells shall be sealed in accordance with AWWA A100.

D. Disinfect well, after repair, in accordance with AWWA A100.

END OF SECTION 33 11 13 00

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Task	Specification	Specification Description
33 11 13 00	01 22 16 00	No Specification Required
33 11 13 00	21 05 23 00	Piped Utilities Basic Materials And Methods
33 11 13 00	23 11 23 00a	Monitoring Wells
33 11 13 00	22 11 23 23	Water Supply Wells
33 14 00 00	13 12 13 00	Water Distribution
33 14 11 00	13 12 13 00	Water Distribution
33 14 13 00	13 12 13 00	Water Distribution
33 14 13 13	01 22 16 00	No Specification Required
33 14 13 13	21 05 23 00	Piped Utilities Basic Materials And Methods
33 14 13 13	31 62 16 19	Concrete-Filled Steel Piles
33 14 13 13	13 12 13 00	Water Distribution
33 14 13 13	22 05 76 00	Sanitary Sewerage
33 14 13 13	33 42 11 00	Storm Drainage

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SECTION 33 14 13 23 - SAND DRAINS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of sand drains. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Galvanized Perforated Corrugated Metal Pipe: AASHTO M36.

B. Perforated Polyvinyl Chloride (PVC) Plastic Pipe: ASTM D 1784.

C. Aggregate shall be sand, gravel, crushed rock, or chat that is clean, sound, and of a good quality. Gradation shall conform to the following table:
Retained on the 1-inch sieve 0%
Retained on the 3/8-inch sieve 0-15%
Retained on the No. 8 sieve 40-60%
Retained on the No. 30 sieve 70-95%
Retained on the No. 100 sieve 98-100%

1.3 EXECUTION

A. Pipe Bedding: Aggregate shall be placed in uniform layers on level excavation.

B. Perforated Pipe shall be installed with securely aligned joints to lines and grades, which will allow proper drainage.

C. Perforated Pipe shall be embedded with a minimum coverage of two feet of aggregate or as directed.

END OF SECTION 33 14 13 23

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SECTION 33 14 13 23a - HYDRONIC DISTRIBUTION

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for hydronic distribution. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes underground piping outside the building for distribution of heating hot and chilled water.

C. Performance Requirements
   1. Provide components and installation capable of producing hydronic piping systems with the following minimum working-pressure ratings:
      a. Hot-Water Piping: 100 psig (690 kPa) **OR** 150 psig (1035 kPa), **as directed**.
      b. Chilled-Water Piping: 100 psig (690 kPa) **OR** 150 psig (1035 kPa), **as directed**.
      c. Condenser-Water Piping: 100 psig (690 kPa) **OR** 150 psig (1035 kPa), **as directed**.

D. Submittals
   1. Product Data
   2. Shop Drawings
   3. Welding certificates.
   4. Source quality-control test reports.
   5. Field quality-control test reports.

E. Quality Assurance
   1. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.
   2. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

F. Project Conditions
   1. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
      a. Notify the Owner no fewer than two days in advance of proposed utility interruptions.
      b. Do not proceed with utility interruptions without the Owner‘s written permission.

1.2 PRODUCTS

A. Piping Materials
   1. Refer to Part 1.3 "Piping Application" Article for applications of pipes, tubes, fittings, and joining methods.
   2. Refer to Division 33 Section "Common Work Results For Utilities" for commonly used joining materials.

B. Steel Pipes And Fittings
   1. Steel Pipe: ASTM A 53/A 53M, Type E, Grade B, Standard Weight; with plain ends.
   2. Nipples: ASTM A 733, Standard Weight, seamless, carbon-steel pipe complying with ASTM A 53/A 53M.

3. Malleable-Iron, Threaded Fittings: ASME B16.3, Classes 150 **OR** 300, **as directed**, with threads according to ASME B1.20.1.
4. Cast-Iron, Threaded Fittings: ASME B16.4, Classes 125 **OR** 250, **as directed**, standard pattern, with threads according to ASME B1.20.1.
5. Steel Welding Fittings: ASME B16.9 **OR** ASTM A 234/A 234M, **as directed**, seamless or welded.
6. Ductile-Iron, Grooved-End Fittings: ASTM A 536, ductile-iron casting with dimensions matching piping.
7. Steel-Pipe, Keyed Couplings: AWWA C606 for steel-pipe dimensions. Include ferrous housing sections, gasket suitable for hot water, and bolts and nuts.

C. Conduit Piping
1. Description: Factory-fabricated and -assembled, airtight and watertight, drainable, pressure-tested piping with conduit, inner pipe supports, and insulated carrier piping. Fabricate so insulation can be dried in place by forcing dry air through conduit.
2. Carrier Pipe: Steel pipe complying with ASTM A 53/A 53M, Type E, Grade B with beveled **OR** socket, **as directed**, ends for welded joints.
3. Carrier Pipe Insulation:
   a. Mineral-Wool Pipe Insulation: ASTM C 547, Type I, molded.
      1) Apparent Thermal Conductivity (k-Value): 0.31 at 200 deg F (0.044 at 93 deg C) mean temperature.
      2) Density: Maximum 10 lb/cu. ft. (160 kg/cu. m) average.
      3) Compressive Strength: 10 psig (69 kPa) minimum at 5 percent deformation.
      4) Bands: ASTM A 666, Type 304, stainless steel, 3/4 inch (19 mm) wide, 0.020 inch (0.5 mm) thick.
   b. Calcium Silicate Pipe Insulation: ASTM C 533, Type I; preformed, incombustible, inorganic, with non-asbestos fibrous reinforcement.
      1) Thermal Conductivity (k-Value): 0.60 at 500 deg F (0.087 at 260 deg C).
      2) Dry Density: 15 lb/cu. ft. (240 kg/cu. m) maximum.
      3) Compressive Strength: 60 psig (414 kPa) minimum at 5 percent deformation.
      4) Bands: ASTM A 666, Type 304, stainless steel, 3/4 inch (19 mm) wide, 0.020 inch (0.5 mm) thick.
   c. Polyisocyanurate Foam Pipe Insulation: ASTM C 591, preformed, rigid, cellular.
      1) Thermal Conductivity (k-Value): 0.14 at 75 deg F (0.020 at 24 deg C).
      2) Service Temperature: Minus 250 to plus 400 deg F (Minus 156 to plus 204 deg C).
      3) Moisture Absorption: ASTM D 2842, maximum 0.054 percent by volume.
      4) Minimum 90 percent closed cell.
      5) Dry Density: 2 lb/cu. ft. (32 kg/cu. m) maximum.
      6) Compressive Strength: 35 psig (242 kPa) minimum at 5 percent deformation.
      7) Water-Vapor Transmission: 1.26 perm inches (1.83 ng/Pa x s x m) according to ASTM E 96.
   d. Polyurethane Foam Pipe Insulation: ASTM C 591, preformed, rigid, cellular.
      1) Thermal Conductivity (k-Value): 0.13 at 75 deg F (0.019 at 24 deg C).
      2) Service Temperature: Minus 250 to plus 200 deg F (Minus 156 to plus 93 deg C).
      3) Moisture Absorption: ASTM D 2842, maximum 0.054 percent by volume.
      4) Minimum 90 percent closed cell.
      5) Dry Density: 2 lb/cu. ft. (32 kg/cu. m) maximum.
      6) Compressive Strength: 35 psig (242 kPa) minimum at 5 percent deformation.
      7) Water-Vapor Transmission: 1.26 perm inches (1.83 ng/Pa x s x m) according to ASTM E 96.
4. Minimum Clearance:
   a. Between Carrier Pipe Insulation and Conduit: 1 inch (25 mm).
   b. Between Insulation of Multiple Carrier Pipes: 3/16 inch (4.75 mm).
   c. Between Bottom of Carrier Pipe Insulation and Conduit: 1 inch (25 mm).
   d. Between Bottom of Bare, Carrier Pipe and Casing: 1-3/8 inches (35 mm).

5. Conduit: Spiral wound, steel. Finish conduit with 2 coats of fusion-bonded epoxy, minimum 20 mils (0.50 mm) thick. Cover with polyurethane foam insulation with a high-density polyethylene jacket; thickness indicated in Part 1.3 “Piping Application" Article, **as directed**.
   OR
   Conduit: Spiral wound, bare steel. Cover with polyurethane foam insulation with a high-density polyethylene jacket; thickness indicated in Part 1.3 "Piping Application" Article.
6. Carrier Piping Supports within Conduit: Corrugated galvanized steel with a maximum spacing of 10 feet (3 m).
7. Fittings: Factory-fabricated and -insulated elbows and tees. Elbows may be bent pipe equal to carrier pipe. Tees shall be factory fabricated and insulated, and shall be compatible with the carrier pipe.
8. Expansion Offsets and Loops: Size casing to contain piping expansion.
9. Conduit accessories include the following:
   a. Water Shed: Terminal end protector for carrier pipes entering building through floor, 3 inches (75 mm) deep and 2 inches (50 mm) larger than casing; terminate casing 20 inches (500 mm) above the floor level.
   b. Guides and Anchors: Steel plate welded to carrier pipes and to casing, complete with vent and drainage openings inside casing.
   c. End Seals: Steel plate welded to carrier pipes and to casing, complete with drain and vent openings on vertical centerline.
   d. Gland Seals: Packed stuffing box and gland follower mounted on steel plate, welded to end of casing, permitting axial movement of carrier piping, with drain and vent connections on vertical centerline.
   e. Joint Kit: Half-shell, pourable or split insulation and shrink-wrap sleeve.
10. Source Quality Control: Factory test the conduit to 15 psig (105 kPa) for a minimum of 2 minutes with no change in pressure. Factory test the carrier pipe to 150 percent of the operating pressure of system. Furnish test certificates.

D. Cased Piping
1. Description: Factory-fabricated piping with carrier pipe, insulation, and casing.
2. Carrier Pipe: Steel pipe complying with ASTM A 53/A 53M, Type E, Grade B with beveled **OR** socket, **as directed**, ends for welded joints.
3. Carrier Pipe Insulation:
   a. Polyurethane Foam Pipe Insulation: ASTM C 591, preformed, rigid, cellular.
      1) Thermal Conductivity (k-Value): 0.13 at 75 deg F (0.019 at 24 deg C).
      2) Service Temperature: Minus 250 to plus 200 deg F (Minus 156 to plus 93 deg C).
      3) Moisture Absorption: ASTM D 2842, maximum 0.054 percent by volume.
      4) Minimum 90 percent closed cell.
      5) Dry Density: 2 lb/cu. ft. (32 kg/cu. m) maximum.
      6) Compressive Strength: 35 psig (242 kPa) minimum at 5 percent deformation.
      7) Water-Vapor Transmission: 1.26 perm inches (1.83 ng/Pa x s x m) according to ASTM E 96.
4. Casing: High-density polyethylene **OR** Filament-wound, fiberglass-reinforced polyester resin **OR** PVC, **as directed**.
5. Casing accessories include the following:
   a. Joint Kit: Half-shell, pourable or split insulation, casing sleeve, and shrink-wrap sleeve.
   b. Expansion Blanket: Elastomeric foam, formed to fit over piping.
   c. End Seals: Shrink wrap the casing material to seal watertight around casing and carrier pipe.
6. Source Quality Control: Factory test the carrier pipe to 150 percent of the operating pressure of system. Furnish test certificates.

E. Loose-Fill Insulation
1. Granular, Loose-Fill Insulation: Inorganic, nontoxic, nonflammable, sodium potassium aluminum silicate with calcium carbonate filler. Include chemical treatment that renders insulation hydrophobic.

a. Thermal Conductivity (k-Value): 0.60 at 175 deg F (0.087 at 79 deg C) and 0.65 at 300 deg F (0.094 at 149 deg C).
b. Application Temperature Range: 35 to 800 deg F (2 to 426 deg C).
c. Dry Density: 40 to 42 lb/cu. ft. (640 to 672 kg/cu. m).
d. Strength: 12,000 lb/sq. ft. (58 600 kg/sq. m).

2. Powder, Loose-Fill Insulation: Inert, nontoxic, nonflammable, calcium carbonate particles. Include chemical treatment that renders insulation hydrophobic.
a. Thermal Conductivity (k-Value): ASTM C 177, 0.58 at 100 deg F (0.084 at 37 deg C) and 0.68 at 300 deg F (0.098 at 149 deg C).
b. Application Temperature Range: Minus 273 to plus 480 deg F (Minus 169 to plus 250 deg C).
c. Dry Density: Approximately 60 lb/cu. ft. (960 kg/cu. m).
d. Strength: 12,000 lb/sq. ft. (58 600 kg/sq. m).

1.3 EXECUTION

A. Earthwork: Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

B. Piping Application

1. Hot-Water Piping: Schedule 40 **OR** Schedule 80, **as directed**, steel pipe with cast-iron, threaded fittings and threaded **OR** steel fittings and welded **OR** ductile-iron, grooved-end fittings and mechanical, **as directed**, joints; granular **OR** powder, loose-fill insulation.
OR
Hot-Water Piping: Conduit piping with mineral-wool **OR** calcium silicate **OR** polyisocyanurate **OR** polyurethane, **as directed**, carrier-pipe insulation and with coated **OR** coated and insulated, **as directed**, conduit.
a. Insulation Thickness: 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**.
OR
Hot-Water Piping: Cased piping with polyurethane carrier-pipe insulation.

2. Chilled-Water Piping: Schedule 40 **OR** Schedule 80, **as directed**, steel pipe with cast-iron, threaded fittings and threaded **OR** steel welding fittings and welded **OR** ductile-iron, grooved-end fittings and mechanical, **as directed**, joints; granular **OR** powder, **as directed**, loose-fill insulation.
OR
Chilled-Water Piping: Conduit piping with mineral-wool **OR** calcium silicate **OR** polyisocyanurate **OR** polyurethane, **as directed**, carrier-pipe insulation and with coated **OR** coated and insulated, **as directed**, conduit.
a. Insulation Thickness: 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**.
OR
Chilled-Water Piping: Cased piping with polyurethane carrier-pipe insulation.

3. Condenser-Water Piping: Schedule 40 **OR** Schedule 80, **as directed**, steel pipe with cast-iron, threaded fittings and threaded **OR** steel welding fittings and welded **OR** ductile-iron, grooved-end fittings and mechanical, **as directed**, joints; granular **OR** powder, **as directed**, loose-fill insulation.
OR
Condenser-Water Piping: Conduit piping with mineral-wool **OR** calcium silicate **OR** polyisocyanurate **OR** polyurethane, **as directed**, carrier-pipe insulation and with coated **OR** coated and insulated, **as directed**, conduit.
a. Insulation Thickness: 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**.
OR
Condenser-Water Piping: Cased piping with polyurethane carrier-pipe insulation.

C. Piping Installation

1. General Locations and Arrangements: Drawings indicate general location and arrangement of piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, unless deviations to layout are approved.
2. Remove any standing water in the bottom of trench.
3. Bed the pipe on a minimum 6-inch (150-mm) layer of granular fill material with a minimum 6-inch (150-mm) clearance between the pipes.
4. Do not insulate piping or backfill piping trench until field quality-control testing has been completed and results approved.
5. Install piping at uniform grade of 0.2 percent upward in direction of flow or as indicated.
6. Install components with pressure rating equal to or greater than system operating pressure.
7. Install piping free of sags and bends.
8. Install fittings for changes in direction and branch connections.
9. Refer to Division 23 Section "Common Work Results For Hvac" for sleeves and mechanical sleeve seals through exterior building walls.
10. Secure anchors with concrete thrust blocks. Concrete is specified in Division 03 Section "Cast-in-place Concrete".
11. Connect to hydronic piping where it passes through the building wall. Hydronic piping inside the building is specified in Division 23 Section "Hydronic Piping".

D. Loose-Fill Insulation Installation
1. Do not disturb the bottom of trench, or compact and stabilize it to ensure proper support.
2. Remove any standing water in the bottom of trench.
3. Form insulation trench by excavation or by installing drywall side forms to establish required height and width of the insulation.
4. Support piping with proper pitch, separation, and clearance to backfill or side forms using temporary supporting devices that can be removed after back filling with insulation.
5. Place insulation and backfill after field quality-control testing has been completed and results approved.
6. Apply bitumastic coating to carbon-steel anchors and guides. Pour concrete thrust blocks and anchors. Refer to Division 03 Section "Cast-in-place Concrete" for concrete and reinforcement.
7. Wrap piping at expansion loops and offsets with mineral-wool insulation of thickness appropriate for calculated expansion amount.
8. Pour loose-fill insulation to required dimension agitating insulation to eliminate voids around piping.
9. Remove temporary hangers and supports.
10. Cover loose-fill insulation with polyethylene sheet a minimum of 4 mils (0.10 mm) thick, and empty loose-fill insulation bags on top.
11. Manually backfill 6 inches (150 mm) of clean backfill. If mechanical compaction is required, manually backfill to 12 inches (300 mm) before using mechanical-compaction equipment.

E. Joint Construction
1. Refer to Division 33 Section "Common Work Results For Utilities" for basic piping joint construction.
2. Keyed-Coupling Joints: Cut- or roll-groove pipes. Assemble joints with keyed couplings, gaskets, lubricant, and bolts.
3. Conduit and Cased Piping Joints: Assemble sections and finish joints with pourable or split insulation, exterior jacket sleeve, and apply shrink-wrap seals as required by manufacturer's written installation instructions.

F. Identification: Install continuous plastic underground warning tapes during back filling of trenches for underground hydronic distribution piping. Locate 6 to 8 inches (150 to 200 mm) below finished grade, directly over piping. Refer to Division 31 Section "Earth Moving" for warning-tape materials and devices and their installation.

G. Field Quality Control

1. Prepare hydronic piping for testing according to ASME B31.9 and as follows:
    a. Leave joints, including welds, uninsulated and exposed for examination during test.
    b. Isolate equipment. Do not subject equipment to test pressure.
    c. Install relief valve set at pressure no more than one-third higher than test pressure.
    d. Fill system with water. Where there is risk of freezing, air or a safe, compatible liquid may be used.
    e. Use vents installed at high points to release trapped air while filling system.
2. Test hydronic piping as follows:
    a. Subject hydronic piping to hydrostatic test pressure that is not less than 1.5 times the design pressure.
    b. After hydrostatic test pressure has been applied for 10 minutes, examine joints for leakage. Remake leaking joints using new materials and repeat hydrostatic test until no leaks exist.
3. Test conduit as follows:
    a. Seal vents and drains and subject conduit to 15 psig (105 kPa) for 4 hours with no loss of pressure. Repair leaks and retest as required.
4. Prepare a written report of testing.

END OF SECTION 33 14 13 23a

SECTION 33 14 13 23b - GROUND-LOOP HEAT-PUMP PIPING

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for ground-loop, heat-pump piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes piping for horizontal or vertical, direct-buried, ground-loop, heat-pump systems that operate between 23 and 104 deg F (minus 5 and plus 40 deg C).

C. Performance Requirements
   1. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
      a. Ground-Loop, Heat-Pump Piping: 160 psig (1100 kPa) **OR** 200 psig (1380 kPa), **as directed**

D. Submittals
   1. Product Data: For the following:
      a. Pipe and fittings.
      b. Joining method and equipment.
      c. Propylene glycol solution.
   2. Field quality-control test reports.

1.2 PRODUCTS

A. Pipes And Fittings
   1. PE Pipe: ASTM D 2239, SIDR Numbers 5.3, 7, 9, or 11.5; with PE compound number required to achieve required system working pressure.
      a. Molded PE Fittings: ASTM D 2683 or ASTM D 3261, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.
   2. U-Bend Assembly: Factory fabricated with embossed depth stamp every 24 inches (600 mm) **OR** 36 inches (900 mm), **as directed** from U-bend.

B. Borehole Backfill
   1. Surface Seal: Bentonite **OR** Cement, **as directed,** with thermal conductivity greater than 1.2 Btu/h x sq. ft. x deg F (0.7 W/sq. m x K).
   2. Backfill below Surface Seal: Natural or manufactured sand specified in Division 31 Section "Earth Moving".

C. Antifreeze Solution
   1. Propylene Glycol: Minimum 99 percent propylene glycol with corrosion inhibitors and environmental stabilizer additives to be mixed with water to protect the piping circuit and connected equipment from physical damage from freezing or corrosion.
   2. Quantity: Sufficient solution for initial system startup and for preventive maintenance for one year from date of Final Completion.
   3. Dilution Water: Chloride content shall be less than 25 ppm, sulfate less than 25 ppm, and hardness less than 100 ppm.

1.3 EXECUTION

A. Earthwork

1. Excavating, trenching, warning tape, and backfilling are specified in Division 31 Section "Earth Moving".

B. Horizontal Piping Installation

1. Separate trenches by 10 feet (3 m) minimum, unless otherwise indicated. Remove rocks in trenches that could contact pipe.
2. Backfill to 24 inches (600 mm) above pipe with mud developed from excavated rock-free soil or with sand, pea gravel, or fly ash. Backfill from slurry level to grade with excavated soil, compacting as specified for pipe burial in Division 31 Section "Earth Moving".
3. Extend pipe from trench onto the bottom of the body of water at an elevation that is at least 12 inches (300 mm) below frost line. Seal membrane or impervious liner under the body of water after installing piping.
4. Install PE piping in trenches according to ASTM D 2774 or ASTM F 645.
   a. Clean PE pipe and fittings and make heat-fusion joints according to ASTM D 2657. Minimize number of joints.
5. Purge, flush, and pressure test piping before backfilling trenches.
6. Install continuous detectable warning tape for underground piping. Locate tape a minimum of 24 inches (600 mm) below finished grade, directly over piping. Underground warning tapes are specified in Division 31 Section "Earth Moving".
7. Common piping installation requirements are specified in Division 23 Section "Common Work Results For Hvac".

C. Vertical Piping Installation

1. Install PE piping in boreholes according to ASTM D 2774 or ASTM F 645.
   a. Clean PE pipe and fittings and make heat-fusion joints according to ASTM D 2657. Minimize number of joints.
2. Purge, flush, and pressure test piping before backfilling boreholes.
3. After installation of loop pipe in borehole, fill piping loop with water or antifreeze solution, and pump backfill into borehole to discharge at base of borehole.
4. Fill borehole with backfill to a point at least 60 inches (1524 mm) below grade and backfill remainder with surface seal material.
5. Extend piping and connect to water-source, ground-loop, heat-pump piping systems at outside face of building wall in locations and pipe sizes indicated.
   a. Terminate water-service piping at building wall until building water-source, ground-loop, heat-pump piping systems are installed. Terminate piping with caps. Make connections to building water-source, ground-loop, heat-pump piping systems when those systems are installed.
6. Wall sleeves are specified in Division 23 Section "Common Work Results For Hvac".
7. Mechanical sleeve seals are specified in Division 22 Section "Common Work Results For Plumbing".

D. Antifreeze Solution Fill

1. Fill system with required quantity of propylene glycol and water to provide minus 10 deg F (minus 23 deg C) freezing temperature.
2. Test the dilute solution using gas chromatography to verity concentration of propylene glycol, and forward report to the Owner.

E. Connections

1. Drawings indicate general arrangement of piping, fittings, and specialties.

F. Field Quality Control

1. Piping Tests: Fill piping 24 hours before testing and apply test pressure to stabilize piping. Use potable water only.
2. Hydrostatic Tests: Test at not less than 1-1/2 times the pipe working-pressure rating allowing for static pressure of borehole depth.
   a. Increase pressure in 50-psig (345-kPa) increments and inspect each joint between increments. Hold at test pressure for 30 minutes. Slowly increase to next test pressure increment and hold for 30 minutes. After testing at maximum test pressure, reduce pressure to 30 psig (207 kPa). Hold for 90 minutes, and measure pressure at 30-minute intervals. Repair leaks and retest until no leaks exist.
3. Prepare reports of testing activity.

END OF SECTION 33 14 13 23b

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Task	Specification	Specification Description
33 14 13 23	01 22 16 00	No Specification Required
33 14 13 23	21 05 23 00	Piped Utilities Basic Materials And Methods
33 14 13 23	13 12 13 00	Water Distribution
33 14 13 23	23 11 23 00a	Monitoring Wells
33 14 13 23	22 11 23 23	Water Supply Wells
33 14 13 23	22 05 76 00	Sanitary Sewerage
33 14 13 23	32 91 19 13a	Septic Tank Systems
33 14 13 23	31 05 13 00	Subdrainage
33 14 13 23	33 42 11 00	Storm Drainage
33 14 13 36	21 05 23 00	Piped Utilities Basic Materials And Methods
33 14 13 36	22 11 23 23	Water Supply Wells
33 14 13 36	33 14 13 23a	Hydronic Distribution
33 14 13 36	23 05 29 00	Steam Distribution
33 14 13 39	21 05 23 00	Piped Utilities Basic Materials And Methods
33 14 13 39	13 12 13 00	Water Distribution
33 14 13 43	01 22 16 00	No Specification Required
33 14 13 43	21 05 23 00	Piped Utilities Basic Materials And Methods
33 14 13 43	13 12 13 00	Water Distribution
33 14 13 43	22 11 23 23	Water Supply Wells
33 14 13 43	22 05 76 00	Sanitary Sewerage
33 14 13 43	33 14 13 23a	Hydronic Distribution
33 14 13 43	23 05 29 00	Steam Distribution
33 14 13 53	01 22 16 00	No Specification Required
33 14 13 53	07 63 00 00	Common Work Results for Fire Suppression
33 14 13 53	07 63 00 00a	Common Work Results for Plumbing
33 14 13 53	07 63 00 00b	Common Work Results for HVAC
33 14 13 53	22 11 16 00	Domestic Water Piping
33 14 13 53	22 11 16 00a	Sanitary Waste And Vent Piping
33 14 13 53	22 11 16 00b	Storm Drainage Piping
33 14 13 53	22 11 16 00c	Hydronic Piping
33 14 13 53	22 11 16 00d	Steam And Condensate Piping
33 14 13 53	22 11 16 00e	Refrigerant Piping
33 14 13 53	22 11 16 00f	General-Service Compressed-Air Piping
33 14 19 00	01 22 16 00	No Specification Required
33 14 19 00	21 05 23 00	Piped Utilities Basic Materials And Methods
33 14 19 00	13 12 13 00	Water Distribution
33 14 19 00	21 05 23 00a	General-Duty Valves for Plumbing Piping
33 14 19 00	21 05 23 00b	General-Duty Valves for HVAC Piping
33 14 23 00	01 22 16 00	No Specification Required
33 14 23 00	21 05 23 00	Piped Utilities Basic Materials And Methods
33 14 23 00	13 12 13 00	Water Distribution
33 19 13 23	13 12 13 00	Water Distribution
33 19 13 23	21 05 19 00	Meters and Gages for Plumbing Piping
33 19 13 23	21 05 19 00a	Meters and Gages for HVAC Piping
33 19 16 23	01 22 16 00	No Specification Required
33 19 16 23	13 12 13 00	Water Distribution
33 19 16 23	21 05 19 00	Meters and Gages for Plumbing Piping
33 19 16 23	21 05 19 00a	Meters and Gages for HVAC Piping
33 19 19 00	01 22 16 00	No Specification Required
33 19 19 00	13 12 13 00	Water Distribution
33 19 19 00	21 05 19 00	Meters and Gages for Plumbing Piping
33 19 19 00	21 05 19 00a	Meters and Gages for HVAC Piping
33 31 11 00	01 22 16 00	No Specification Required
33 31 11 00	21 05 23 00	Piped Utilities Basic Materials And Methods
33 31 11 00	33 14 13 23	Sand Drains

33 31 11 00	13 12 13 00	Water Distribution
33 31 11 00	23 11 23 00a	Monitoring Wells
33 31 11 00	22 11 23 23	Water Supply Wells
33 31 11 00	22 05 76 00	Sanitary Sewerage
33 31 11 00	32 91 19 13a	Septic Tank Systems
33 31 11 00	33 14 13 23a	Hydronic Distribution
33 31 11 00	31 05 13 00	Subdrainage
33 31 11 00	33 42 11 00	Storm Drainage
33 32 16 00	01 22 16 00	No Specification Required
33 32 16 00	22 13 29 13b	Sewage Pumps
33 34 13 13	32 91 19 13a	Septic Tank Systems
33 34 13 23	32 91 19 13a	Septic Tank Systems
33 34 13 33	32 91 19 13a	Septic Tank Systems
33 34 51 00	32 91 19 13a	Septic Tank Systems
33 34 53 13	32 91 19 13a	Septic Tank Systems
33 34 56 00	32 91 19 13a	Septic Tank Systems
33 41 16 13	01 22 16 00	No Specification Required
33 41 16 13	21 05 23 00	Piped Utilities Basic Materials And Methods
33 41 16 13	22 05 76 00	Sanitary Sewerage
33 41 16 13	32 91 19 13a	Septic Tank Systems
33 41 16 13	31 05 13 00	Subdrainage
33 41 16 13	33 42 11 00	Storm Drainage
33 41 16 13	22 11 16 00b	Storm Drainage Piping
33 41 16 13	22 05 76 00a	Storm Drainage Piping Specialties
33 41 19 13	21 05 23 00	Piped Utilities Basic Materials And Methods
33 41 19 13	31 05 13 00	Subdrainage

SECTION 33 42 11 00 - STORM DRAINAGE

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for storm drainage. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Pipe and fittings.
      b. Nonpressure transition couplings.
      c. Pressure pipe couplings.
      d. Expansion joints and deflection fittings.
      e. Backwater valves.
      f. Cleanouts.
      g. Drains.
      h. Encasement for piping.
      i. Manholes.
      j. Channel drainage systems.
      k. Catch basins.
      l. Stormwater inlets.
      m. Stormwater detention structures.
      n. Pipe outlets.
      o. Dry wells.
      p. Stormwater disposal systems.

C. Definitions
   1. FRP: Fiberglass-reinforced plastic.

D. Submittals
   1. Product Data: For each type of product indicated.
   2. Shop Drawings:
      a. Manholes: Include plans, elevations, sections, details, frames, and covers.
      b. Catch basins, stormwater inlets, and dry wells. Include plans, elevations, sections, details, frames, covers, and grates.
      c. Stormwater Detention Structures: Include plans, elevations, sections, details, frames, covers, design calculations, and concrete design-mix reports.
   3. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
   4. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet (1:500) and vertical scale of not less than 1 inch equals 5 feet (1:50). Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.
   5. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.
   6. Field quality-control reports.

E. Delivery, Storage, And Handling
   1. Do not store plastic manholes, pipe, and fittings in direct sunlight.
   2. Protect pipe, pipe fittings, and seals from dirt and damage.
   3. Handle manholes according to manufacturer's written rigging instructions.

4. Handle catch basins and stormwater inlets according to manufacturer's written rigging instructions.

F. Project Conditions
1. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   a. Notify the Owner no fewer than two days in advance of proposed interruption of service.
   b. Do not proceed with interruption of service without the Owner written permission.

1.2 PRODUCTS

A. Hub-And-Spigot, Cast-Iron Soil Pipe And Fittings
1. Pipe and Fittings: ASTM A 74, Service class **OR** Extra-Heavy class, **as directed**.
2. Gaskets: ASTM C 564, rubber.
3. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

B. Hubless Cast-Iron Soil Pipe And Fittings
1. Pipe and Fittings: ASTM A 888 or CISPI 301.
2. CISPI-Trademarked, Shielded Couplings:
   a. Description: ASTM C 1277 and CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
3. Heavy-Duty, Shielded Couplings:
   a. Description: ASTM C 1277 and ASTM C 1540, with stainless-steel shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
4. Cast-Iron, Shielded Couplings:
   a. Description: ASTM C 1277 and ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Ductile-Iron, Culvert Pipe And Fittings
1. Pipe: ASTM A 716, for push-on joints.
2. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.
3. Compact Fittings: AWWA C153, for push-on joints.
4. Gaskets: AWWA C111, rubber.

D. Ductile-Iron, Pressure Pipe And Fittings
1. Push-on-Joint Piping:
   a. Pipe: AWWA C151, for push-on joints.
   b. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.
   c. Compact Fittings: AWWA C153, for push-on joints.
   d. Gaskets: AWWA C111, rubber, of shape matching pipe and fittings.
2. Mechanical-Joint Piping:
   a. Pipe: AWWA C151, with bolt holes in bell.
   b. Standard Fittings: AWWA C110, ductile or gray iron, with bolt holes in bell.
   c. Compact Fittings: AWWA C153, with bolt holes in bells.
   d. Glands: Cast or ductile iron, with bolt holes and high-strength, cast-iron or high-strength, low-alloy steel bolts and nuts.
   e. Gaskets: AWWA C111, rubber, of shape matching pipe, fittings, and glands.

E. Steel Pipe And Fittings

1. Corrugated-Steel Pipe and Fittings: ASTM A 760/A 760M, Type I with fittings of similar form and construction as pipe.
   a. Special-Joint Bands: Corrugated steel with O-ring seals.
   b. Standard-Joint Bands: Corrugated steel.
   c. Coating: Aluminum **OR** Zinc, **as directed**.

F. Aluminum Pipe And Fittings
1. Corrugated Aluminum Pipe and Fittings: ASTM B 745/B 745M, Type I with fittings of similar form and construction as pipe.
   a. Special-Joint Bands: Corrugated steel with O-ring seals.
   b. Standard-Joint Bands: Corrugated steel.

G. ABS Pipe And Fittings
1. ABS Sewer Pipe and Fittings: ASTM D 2751, with bell-and-spigot ends for gasketed joints.
   a. NPS 3 to NPS 6 (DN 80 to DN 150): SDR 35.
   b. NPS 8 to NPS 12 (DN 200 to DN 300): SDR 42.
2. Gaskets: ASTM F 477, elastomeric seals.

H. PE Pipe And Fittings
1. Corrugated PE Drainage Pipe and Fittings NPS 3 to NPS 10 (DN 80 to DN 250): AASHTO M 252M, Type S, with smooth waterway for coupling joints.
   a. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings.
   b. Soiltight Couplings: AASHTO M 252M, corrugated, matching tube and fittings.
2. Corrugated PE Pipe and Fittings NPS 12 to NPS 60 (DN 300 to DN 1500): AASHTO M 294M, Type S, with smooth waterway for coupling joints.
   a. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.
   b. Soiltight Couplings: AASHTO M 294M, corrugated, matching pipe and fittings.

I. PVC Pipe And Fittings
1. PVC Cellular-Core Piping:
   a. PVC Cellular-Core Pipe and Fittings: ASTM F 891, Sewer and Drain Series, PS 50 minimum stiffness, PVC cellular-core pipe with plain ends for solvent-cemented joints.
   b. Fittings: ASTM D 3034, SDR 35, PVC socket-type fittings.
2. PVC Corrugated Sewer Piping:
   a. Pipe: ASTM F 949, PVC, corrugated pipe with bell-and-spigot ends for gasketed joints.
   b. Fittings: ASTM F 949, PVC molded or fabricated, socket type.
   c. Gaskets: ASTM F 477, elastomeric seals.
3. PVC Profile Sewer Piping:
   a. Pipe: ASTM F 794, PVC profile, gravity sewer pipe with bell-and-spigot ends for gasketed joints.
   b. Fittings: ASTM D 3034, PVC with bell ends.
   c. Gaskets: ASTM F 477, elastomeric seals.
4. PVC Type PSM Sewer Piping:
   a. Pipe: ASTM D 3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
   b. Fittings: ASTM D 3034, PVC with bell ends.
   c. Gaskets: ASTM F 477, elastomeric seals.
5. PVC Gravity Sewer Piping:
   a. Pipe and Fittings: ASTM F 679, T-1 **OR** T-2, **as directed**, wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.
6. PVC Pressure Piping:
   a. Pipe: AWWA C900, Class 100 **OR** Class 150 **OR** Class 200, **as directed**, PVC pipe with bell-and-spigot ends for gasketed joints.

b. Fittings: AWWA C900, Class 100 **OR** Class 150 **OR** Class 200, **as directed**, PVC pipe with bell ends
c. Gaskets: ASTM F 477, elastomeric seals.
7. PVC Water-Service Piping:
a. Pipe: ASTM D 1785, Schedule 40 **OR** Schedule 80, **as directed**, PVC, with plain ends for solvent-cemented joints.
b. Fittings: ASTM D 2466, Schedule 40 **OR** ASTM D 2467, Schedule 80, **as directed**, PVC, socket type.

J. Fiberglass Pipe And Fittings
1. Fiberglass Sewer Pipe: ASTM D 3262, RTRP for gasketed joints fabricated with Type 2, polyester **OR** Type 4, epoxy, **as directed**, resin.
a. Liner: Reinforced thermoset **OR** Nonreinforced thermoset **OR** Thermoplastic **OR** No liner, **as directed**.
b. Grade: Reinforced, surface layer matching pipe resin **OR** Nonreinforced, surface layer matching pipe resin **OR** No surface layer, **as directed**.
c. Stiffness: 9 psig (62 kPa) **OR** 18 psig (124 kPa) **OR** 36 psig (248 kPa) **OR** 72 psig (496 kPa), **as directed**.
2. Fiberglass Nonpressure Fittings: ASTM D 3840, RTRF for gasketed joints.
a. Laminating Resin: Type 1, polyester **OR** Type 2, epoxy, **as directed**, resin.
b. Reinforcement: Grade with finish compatible with resin.
3. Gaskets: ASTM F 477, elastomeric seals.

K. Concrete Pipe And Fittings
1. Nonreinforced-Concrete Sewer Pipe and Fittings: ASTM C 14 (ASTM C 14M), Class 1 **OR** Class 2 **OR** Class 3, **as directed**, with bell-and-spigot **OR** tongue-and-groove, **as directed** ends and gasketed joints with ASTM C 443 (ASTM C 443M), rubber gaskets **OR** sealant joints with ASTM C 990 (ASTM C 990M), bitumen or butyl-rubber sealant, **as directed**.
2. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76 (ASTM C 76M).
a. Bell-and-spigot **OR** Tongue-and-groove, **as directed**, ends and gasketed joints with ASTM C 443 (ASTM C 443M), rubber gaskets **OR** sealant joints with ASTM C 990 (ASTM C 990M), bitumen or butyl-rubber sealant, **as directed**.
b. Class I, Wall A **OR** Wall B, **as directed**.
c. Class II, Wall A **OR** Wall B **OR** Wall C, **as directed**.
d. Class III, Wall A **OR** Wall B **OR** Wall C, **as directed**.
e. Class IV, Wall A **OR** Wall B **OR** Wall C, **as directed**.
f. Class V, Wall B **OR** Wall C, **as directed**.

L. Nonpressure Transition Couplings
1. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
2. Sleeve Materials:
a. For Concrete Pipes: ASTM C 443 (ASTM C 443M), rubber.
b. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
c. For Fiberglass Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
d. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
e. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
3. Unshielded, Flexible Couplings:
a. Description: Elastomeric sleeve, with stainless-steel shear ring, **as directed**, and corrosion-resistant-metal tension band and tightening mechanism on each end.
4. Shielded, Flexible Couplings:

a. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

5. Ring-Type, Flexible Couplings:
   a. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

M. Pressure Pipe Couplings
1. Description: AWWA C219, tubular-sleeve coupling, with center sleeve, gaskets, end rings, and bolt fasteners.
2. Metal, bolted, sleeve-type, reducing or transition coupling, for joining underground pressure piping. Include 150-psig (1035-kPa) **OR** 200-psig (1380-kPa), **as directed**, minimum pressure rating and ends sized to fit adjoining pipes.
3. Center-Sleeve Material: Manufacturer's standard **OR** Carbon steel **OR** Stainless steel **OR** Ductile iron **OR** Malleable iron, **as directed**.
4. Gasket Material: Natural or synthetic rubber.
5. Metal Component Finish: Corrosion-resistant coating or material.

N. Expansion Joints And Deflection Fittings
1. Ductile-Iron Flexible Expansion Joints:
   a. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig (1725-kPa) minimum working pressure and for offset and expansion indicated.
2. Ductile-Iron Expansion Joints:
   a. Description: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile-iron or steel with protective coating, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Include rating for 250-psig (1725-kPa) minimum working pressure and for expansion indicated.
3. Ductile-Iron Deflection Fittings:
   a. Description: Compound-coupling fitting, with ball joint, flexing section, gaskets, and restrained-joint ends, complying with AWWA C110 or AWWA C153. Include rating for 250-psig (1725-kPa) minimum working pressure and for up to 15 degrees of deflection.

O. Backwater Valves
1. Cast-Iron Backwater Valves:
   a. Description: ASME A112.14.1, gray-iron body and bolted cover, with bronze seat.
   b. Horizontal type; with swing check valve and hub-and-spigot ends.
   c. Combination horizontal and manual gate-valve type; with swing check valve, integral gate valve, and hub-and-spigot ends.
   d. Terminal type; with bronze seat, swing check valve, and hub inlet.
2. Plastic Backwater Valves:
   a. Description: Horizontal type; with PVC body, PVC removable cover, and PVC swing check valve.

P. Cleanouts
1. Cast-Iron Cleanouts:
   a. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
   b. Top-Loading Classification(s): Light Duty **OR** Medium Duty **OR** Heavy Duty **OR** Extra-Heavy Duty, **as directed**.
   c. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.
2. Plastic Cleanouts:

a. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

Q. Drains
1. Cast-Iron Area Drains:
a. Description: ASME A112.6.3 gray-iron round body with anchor flange and round secured **OR** non-secured, **as directed**, grate. Include bottom outlet with inside calk or spigot connection, of sizes indicated.
b. Top-Loading Classification(s): Medium Duty **OR** Heavy Duty, **as directed**.
2. Cast-Iron Trench Drains:
a. Description: ASME A112.6.3, 6-inch- (150-mm-) wide top surface, rectangular body with anchor flange or other anchoring device, and rectangular secured **OR** non-secured, **as directed**, grate. Include units of total length indicated and quantity of bottom outlets with inside calk or spigot connections, of sizes indicated.
b. Top-Loading Classification(s): Medium Duty **OR** Heavy Duty **OR** Extra-Heavy Duty **OR** Medium and Heavy Duty **OR** Medium and Extra-Heavy Duty **OR** Heavy and Extra-Heavy Duty **OR** Medium, Heavy, and Extra-Heavy Duty, **as directed**.
3. Steel Trench Drains:
a. Description: Factory fabricated from ASTM A 242/A 242M, welded steel plate, to form rectangular body with uniform bottom downward slope of 2 percent toward outlet, anchor flange, and grate. Include units of total length indicated, bottom outlet of size indicated, outlet strainer, acid-resistant enamel coating on inside and outside surfaces, and grate with openings of total free area at least two times cross-sectional area of outlet.
b. Plate Thicknesses: 1/8 inch (3.2 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
c. Overall Widths: 7-1/2 inches (190 mm) **OR** 12-1/3 inches (313 mm), **as directed**.
1) Grate Openings: 1/4 inch (6.4 mm) circular **OR** 3/8 inch (9.5 mm) circular **OR** 3/8-by-3-inch (9.5-by-76-mm) slots, **as directed**.

R. Encasement For Piping
1. Standard: ASTM A 674 or AWWA C105.
2. Material: Linear low-density polyethylene film of 0.008-inch (0.20-mm) **OR** high-density, cross-laminated polyethylene film of 0.004-inch (0.10-mm), **as directed**, minimum thickness.
3. Form: Sheet **OR** Tube, **as directed**.
4. Color: Black **OR** Natural, **as directed**.

S. Manholes
1. Standard Precast Concrete Manholes:
a. Description: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
b. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
c. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
d. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (102-mm) minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
e. Riser Sections: 4-inch (102-mm) minimum thickness, and lengths to provide depth indicated.
f. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
g. Joint Sealant: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.
h. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
i. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps; FRP ladder; or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing

rods encased in ASTM D 4101, PP, **as directed**, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).

j. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.

OR

Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

2. Designed Precast Concrete Manholes:
   a. Description: ASTM C 913; designed according to ASTM C 890 for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
   b. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.
   c. Joint Sealant: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.
   d. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
   e. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps; FRP ladder; or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, **as directed**, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).
   f. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.

      OR

      Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, to match diameter of manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope.
3. Fiberglass Manholes:
   a. Description: ASTM D 3753.
   b. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
   c. Ballast: Increase thickness of concrete base as required to prevent flotation.
   d. Base Section: Concrete, 6-inch (150-mm) minimum thickness.
   e. Resilient Pipe Connectors (if required): ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
   f. Steps: Individual FRP steps or FRP ladder, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).
   g. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.

      OR

      Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.
4. Manhole Frames and Covers:

a. Description: Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch- (102-mm-) minimum width flange and 26-inch- (660-mm-) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."

b. Material: ASTM A 536, Grade 60-40-18 ductile **OR** ASTM A 48/A 48M, Class 35 gray, **as directed**, iron unless otherwise indicated.

T. Concrete

1. General: Cast-in-place concrete according to ACI 318, ACI 350/350R (ACI 350M/350RM), and the following:
   a. Cement: ASTM C 150, Type II.
   b. Fine Aggregate: ASTM C 33, sand.
   c. Coarse Aggregate: ASTM C 33, crushed gravel.
   d. Water: Potable.
2. Portland Cement Design Mix: 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio.
   a. Reinforcing Fabric: ASTM A 1064/A 1064M, steel, welded wire fabric, plain.
   b. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.
3. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
   a. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
      1) Invert Slope: 1 **OR** 2, **as directed**, percent through manhole.
   b. Benches: Concrete, sloped to drain into channel.
      1) Slope: 4 **OR** 8, **as directed**, percent.
4. Ballast and Pipe Supports: Portland cement design mix, 3000 psi (20.7 MPa) minimum, with 0.58 maximum water/cementitious materials ratio.
   a. Reinforcing Fabric: ASTM A 1064/A 1064M, steel, welded wire fabric, plain.
   b. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

U. Polymer-Concrete, Channel Drainage Systems

1. General Requirements for Polymer-Concrete, Channel Drainage Systems: Modular system of precast, polymer-concrete channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling. Include quantity of units required to form total lengths indicated.
2. Sloped-Invert, Polymer-Concrete Systems:
   a. Channel Sections:
      1) Interlocking-joint, precast, modular units with end caps.
      2) 4-inch (102-mm) inside width and deep, rounded bottom, with built-in invert slope of 0.6 percent and with outlets in quantities, sizes, and locations indicated.
      3) Extension sections necessary for required depth.
      4) Frame: Include gray-iron or steel frame for grate.
   b. Grates:
      1) Manufacturer's designation "Heavy **OR** “Medium, **as directed**, Duty," with slots or perforations that fit recesses in channels.
      2) Material: Fiberglass **OR** Galvanized steel **OR** Gray iron **OR** Stainless steel, **as directed**.
   c. Covers: Solid gray iron if indicated.
   d. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
3. Narrow-Width, Level-Invert, Polymer-Concrete Systems:
   a. Channel Sections:
      1) Interlocking-joint, precast, modular units with end caps.

2) 5-inch (127-mm) inside width and 9-3/4-inch- (248-mm-) deep, rounded bottom, with level invert and with NPS 4 (DN 100) outlets in quantities, sizes, and locations indicated.

b. Grates:

1) Slots or perforations that fit recesses in channels.

2) Material: Fiberglass **OR** Galvanized steel **OR** Gray iron **OR** Stainless steel, **as directed**.

c. Covers: Solid gray iron if indicated.

d. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.

4. Wide-Width, Level-Invert, Polymer-Concrete Systems:

a. Channel Sections:

1) Interlocking-joint, precast, modular units with end caps.

2) 8-inch (203-mm) inside width and 13-3/4-inch- (350-mm-) deep, rounded bottom, with level invert and with outlets in quantities, sizes, and locations indicated.

b. Grates:

1) Slots or other openings that fit recesses in channels.

2) Material: Fiberglass **OR** Gray iron, **as directed**.

c. Covers: Solid gray iron if indicated.

d. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.

5. Drainage Specialties: Precast, polymer-concrete units.

a. Large Catch Basins:

1) 24-by-12-inch (610-by-305-mm) polymer-concrete body, with outlets in quantities and sizes indicated.

2) Gray-iron slotted grate.

3) Frame: Include gray-iron or steel frame for grate.

b. Small Catch Basins:

1) 19- to 24-inch by approximately 6-inch (483- to 610-mm by approximately 150-mm) polymer-concrete body, with outlets in quantities and sizes indicated.

2) Gray-iron slotted grate.

3) Frame: Include gray-iron or steel frame for grate.

c. Oil Interceptors:

1) Polymer-concrete body with interior baffle and four steel support channels and two 1/4-inch- (6.4-mm-) thick, steel-plate covers.

2) Steel-plate covers.

3) Capacity: 140 gal. (530 L) **OR** 200 gal. (757 L) **OR** 260 gal. (984 L), **as directed**.

4) Inlet and Outlet: NPS 4 (DN 100) **OR** NPS 6 (DN 150), **as directed**.

d. Sediment Interceptors:

1) 27-inch- (686-mm-) square, polymer-concrete body, with outlets in quantities and sizes indicated.

2) 24-inch- (610-mm-) square, gray-iron frame and slotted grate.

6. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.

7. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

V. Plastic, Channel Drainage Systems

1. General Requirements for Plastic, Channel Drainage Systems:

a. Modular system of plastic channel sections, grates, and appurtenances.

b. Designed so grates fit into frames without rocking or rattling.

c. Number of units required to form total lengths indicated.

2. Fiberglass Systems:

a. Channel Sections:

1) Interlocking-joint, fiberglass modular units, with built-in invert slope of approximately 1 percent and with end caps.

2) Rounded or inclined inside bottom surface, with outlets in quantities, sizes, and locations indicated.

3) Width: 6 inches (150 mm) **OR** 6 or 8 inches (150 or 203 mm) **OR** 8 inches (203 mm), **as directed**.

b. Factory- or field-attached frames that fit channel sections and grates.

1) Material: Galvanized steel **OR** Stainless steel **OR** Manufacturer's standard metal, **as directed**.

c. Grates with slots or perforations that fit frames.

1) Material: Fiberglass **OR** Galvanized steel **OR** Gray iron **OR** Stainless steel, **as directed**.

d. Covers: Solid gray iron if indicated.

e. Drainage Specialties:

1) Large Catch Basins: 24-inch- (610-mm-) square plastic body, with outlets in quantities and sizes indicated. Include gray-iron frame and slotted grate.

2) Small Catch Basins: 12-by-24-inch (305-by-610-mm) plastic body, with outlets in quantities and sizes indicated. Include gray-iron frame and slotted grate.

3. PE Systems:

a. Channel Sections: Interlocking-joint, PE modular units, 4 inches (102 mm) wide, with end caps. Include rounded bottom, with level invert and with outlets in quantities, sizes, and locations indicated.

b. Grates: PE, ladder shaped; with stainless-steel screws.

c. Color: Gray unless otherwise indicated.

d. Drainage Specialties: Include the following PE components:

1) Drains: 4-inch- (102-mm-) diameter, round, slotted top; with NPS 4 (DN 100) bottom outlet.

OR

Drains: 8-inch- (203-mm-) diameter, round, slotted top; with NPS 6 (DN 150) bottom outlet.

OR

Drains: 4-inch- (102-mm-) square, slotted top; with NPS 3 (DN 80) bottom outlet.

OR

Drains: 8-inch- (203-mm-) square, slotted top; with NPS 6 (DN 150) bottom outlet.

OR

Catch Basins: 12-inch- (305-mm-) square plastic body, with outlets in quantities and sizes indicated. Include PE slotted grate 11-3/4 inches (298 mm) square by 1-1/8 inches (28.6 mm) thick.

4. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.

5. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

W. Catch Basins

1. Standard Precast Concrete Catch Basins:

a. Description: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.

b. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (102-mm) minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.

c. Riser Sections: 4-inch (102-mm) minimum thickness, 48-inch (1200-mm) diameter, and lengths to provide depth indicated.

d. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.

e. Joint Sealant: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.

f. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.

OR

Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch (150- to 225-mm) total thickness, that match 24-inch- (610-mm-) diameter frame and grate.

g. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps; FRP ladder; or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, **as directed**, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 60 inches (1500 mm).

h. Pipe Connectors: ASTM C 923 (ASTM C 923M), resilient, of size required, for each pipe connecting to base section.

2. Designed Precast Concrete Catch Basins: ASTM C 913, precast, reinforced concrete; designed according to ASTM C 890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for joint sealants.
   a. Joint Sealants: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.
   b. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
      OR
      Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch (150- to 225-mm) total thickness, that match 24-inch- (610-mm-) diameter frame and grate.
   c. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps; FRP ladder; or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, **as directed**, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 60 inches (1500 mm).
   d. Pipe Connectors: ASTM C 923 (ASTM C 923M), resilient, of size required, for each pipe connecting to base section.
3. Frames and Grates (for rectangular structures): ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include flat grate with small square or short-slotted drainage openings.
   a. Size: 24 by 24 inches (610 by 610 mm) minimum unless otherwise indicated.
   b. Grate Free Area: Approximately 50 percent unless otherwise indicated.
4. Frames and Grates (for round, manhole-type structures): ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch (102-mm) minimum width flange, and 26-inch- (660-mm-) diameter flat grate with small square or short-slotted drainage openings.
   a. Grate Free Area: Approximately 50 percent unless otherwise indicated.

X. Stormwater Inlets
1. Curb Inlets: Made with vertical curb opening, of materials and dimensions according to utility standards.
2. Gutter Inlets: Made with horizontal gutter opening, of materials and dimensions according to utility standards. Include heavy-duty frames and grates.
3. Combination Inlets: Made with vertical curb and horizontal gutter openings, of materials and dimensions according to utility standards. Include heavy-duty frames and grates.
4. Frames and Grates: Heavy duty, according to utility standards.

Y. Stormwater Detention Structures
1. Cast-in-Place Concrete, Stormwater Detention Structures: Constructed of reinforced-concrete bottom, walls, and top; designed according to ASTM C 890 for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, dimensions, and appurtenances indicated.
   a. Ballast: Increase thickness of concrete as required to prevent flotation.
   b. Grade Rings (if required): Include two or three reinforced-concrete rings, of 6- to 9-inch (150- to 229-mm) total thickness, that match 24-inch- (610-mm-) diameter frame and cover.

c. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps; FRP ladder; or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, **as directed**, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of structure to finished grade is less than 60 inches (1500 mm).

2. Manhole Frames and Covers: ASTM A 536, Grade 60-40-18, ductile-iron castings designed for heavy-duty service. Include 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch (102-mm) minimum width flange, and 26-inch- (660-mm-) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."

Z. Pipe Outlets
1. Head Walls: Cast-in-place reinforced concrete, with apron and tapered sides.
2. Riprap Basins: Broken, irregularly sized and shaped, graded stone according to NSSGA's "Quarried Stone for Erosion and Sediment Control."
   a. Average Size: NSSGA No. R-3, screen opening 2 inches (51 mm).
   b. Average Size: NSSGA No. R-4, screen opening 3 inches (76 mm).
   c. Average Size: NSSGA No. R-5, screen opening 5 inches (127 mm).
3. Filter Stone: According to NSSGA's "Quarried Stone for Erosion and Sediment Control," No. FS-2, No. 4 screen opening, average-size graded stone.
4. Energy Dissipaters: According to NSSGA's "Quarried Stone for Erosion and Sediment Control," No. A-1, 3-ton (2721-kg) average weight armor stone, unless otherwise indicated.

AA. Dry Wells
1. Description: ASTM C 913, precast, reinforced, perforated concrete rings. Include the following:
   a. Floor: Cast-in-place concrete.
   b. Cover: Liftoff-type concrete cover with cast-in lift rings.
   c. Wall Thickness: 4 inches (102 mm) minimum with 1-inch (25-mm) diameter or 1-by-3-inch- (25-by-76-mm-) maximum slotted perforations arranged in rows parallel to axis of ring.
      1) Total Free Area of Perforations: Approximately 15 percent of ring interior surface.
      2) Ring Construction: Designed to be self-aligning.
   d. Filtering Material: ASTM D 448, Size No. 24, 3/4- to 2-1/2-inch (19- to 63-mm) washed, crushed stone or gravel.

   OR

   Description: Manufactured PE side panels and top cover that assemble into 50-gal. (190-L) storage capacity units.
   a. Side Panels: With knockout ports for piping and seepage holes.
   b. Top Cover: With knockout port for drain.
   c. Filter Fabric: As recommended by unit manufacturer.
   d. Filtering Material: ASTM D 448, Size No. 24, 3/4- to 2-1/2-inch (19- to 63-mm) washed, crushed stone or gravel.

   OR

   Description: Constructed-in-place aggregate type. Include the following:
   a. Lining: Clay or concrete bricks.

      OR

      Lining: Concrete blocks or precast concrete rings with notches or weep holes.
   b. Filtering Material: ASTM D 448, Size No. 24, 3/4- to 2-1/2-inch (19- to 63-mm) washed, crushed stone or gravel.
   c. Cover: Precast, reinforced-concrete slab, designed for structural loading according to ASTM C 890 and made according to ASTM C 913. Include slab dimensions that will extend 12 inches (300 mm) minimum beyond edge of excavation, with bituminous coating over entire surface. Cast cover with opening for manhole in center.
   d. Manhole: 24-inch- (610-mm-) diameter, reinforced-concrete access lid with steel lift rings. Include bituminous coating over entire surface.

BB. Stormwater Disposal Systems
1. Chamber Systems:
a. Storage and Leaching Chambers: Molded PE with perforated sides and open bottom. Include number of chambers, distribution piping, end plates, and other standard components as required for system total capacity.
b. Filtering Material: ASTM D 448, Size No. 24, 3/4- to 2-1/2-inch (19- to 63-mm) washed, crushed stone or gravel.
c. Filter Mat: Geotextile woven or spun filter fabric, in one or more layers, for minimum total unit weight of 4 oz./sq. yd. (135 g/sq. m).

OR

Pipe Systems: Perforated manifold, header, and lateral piping complying with AASHTO M 252M for NPS 10 (DN 250) and smaller, AASHTO M 294M for NPS 12 to NPS 60 (DN 300 to DN 1500). Include proprietary fittings, couplings, seals, and filter fabric.

1.3 EXECUTION

1.4 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving".

B. Piping Installation
1. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
2. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
4. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
5. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
6. Install gravity-flow, nonpressure drainage piping according to the following:
a. Install piping pitched down in direction of flow.
b. Install piping NPS 6 (DN 150) and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
c. Install piping with 36-inch (915-mm) **OR** 48-inch (1220-mm) **OR** 60-inch (1520-mm) **OR** 72-inch (1830-mm), **as directed**, minimum cover.
d. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
e. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
f. Install ductile-iron piping and special fittings according to AWWA C600 or AWWA M41.
g. Install corrugated steel piping according to ASTM A 798/A 798M.
h. Install corrugated aluminum piping according to ASTM B 788/B 788M.
i. Install ABS sewer piping according to ASTM D 2321 and ASTM F 1668.
j. Install PE corrugated sewer piping according to ASTM D 2321.
k. Install PVC cellular-core piping according to ASTM D 2321 and ASTM F 1668.
l. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
m. Install PVC profile gravity sewer piping according to ASTM D 2321 and ASTM F 1668.

n. Install PVC water-service piping according to ASTM D 2321 and ASTM F 1668.
o. Install fiberglass sewer piping according to ASTM D 3839 and ASTM F 1668.
p. Install nonreinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
q. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

7. Install force-main pressure piping according to the following:
a. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
b. Install piping with 36-inch (915-mm) **OR** 48-inch (1220-mm) **OR** 60-inch (1520-mm) **OR** 72-inch (1830-mm), **as directed**, minimum cover.
c. Install **ductile**-iron pressure piping according to AWWA C600 or AWWA M41.
d. Install ductile-iron special fittings according to AWWA C600.
e. Install PVC pressure piping according to AWWA M23, or ASTM D 2774 and ASTM F 1668.
f. Install PVC water-service piping according to ASTM D 2774 and ASTM F 1668.

8. Install corrosion-protection piping encasement over the following underground metal piping according to ASTM A 674 or AWWA C105:
a. Hub-and-spigot, cast-iron soil pipe and fittings.
b. Hubless cast-iron soil pipe and fittings.
c. Ductile-iron pipe and fittings.
d. Expansion joints and deflection fittings.

C. Pipe Joint Construction

1. Join gravity-flow, nonpressure drainage piping according to the following:
a. Join hub-and-spigot, cast-iron soil piping with gasketed joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
b. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
c. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
d. Join ductile-iron culvert piping according to AWWA C600 for push-on joints.
e. Join ductile-iron piping and special fittings according to AWWA C600 or AWWA M41.
f. Join corrugated steel sewer piping according to ASTM A 798/A 798M.
g. Join corrugated aluminum sewer piping according to ASTM B 788/B 788M.
h. Join ABS sewer piping according to ASTM D 2321 and ASTM D 2751 for elastomeric-seal joints.
i. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
j. Join PVC cellular-core piping according to ASTM D 2321 and ASTM F 891 for solvent-cemented joints.
k. Join PVC corrugated sewer piping according to ASTM D 2321 for elastomeric-seal joints.
l. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasketed joints.
m. Join PVC profile gravity sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
n. Join fiberglass sewer piping according to ASTM D 3839 for elastomeric-seal joints.
o. Join nonreinforced-concrete sewer piping according to ASTM C 14 (ASTM C 14M) and ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
p. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
q. Join dissimilar pipe materials with nonpressure-type flexible couplings.

2. Join force-main pressure piping according to the following:
a. Join ductile-iron pressure piping according to AWWA C600 or AWWA M41 for push-on joints.

b. Join ductile-iron special fittings according to AWWA C600 or AWWA M41 for push-on joints.
c. Join PVC pressure piping according to AWWA M23 for gasketed joints.
d. Join PVC water-service piping according to ASTM D 2855 for solvent-cemented joints.
e. Join dissimilar pipe materials with pressure-type couplings.

D. Backwater Valve Installation
1. Install horizontal-type backwater valves in piping where indicated.
2. Install combination horizontal and manual gate-valve type in piping and in manholes where indicated.
3. Install terminal-type backwater valves on end of piping and in manholes where indicated.

E. Cleanout Installation
1. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
a. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
b. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
c. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
d. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.
e. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches (450 by 450 by 300 mm) deep. Set with tops 1 inch (25 mm) above surrounding earth grade.
f. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

F. Drain Installation
1. Install type of drains in locations indicated.
a. Use Light-Duty, top-loading classification drains in earth or unpaved foot-traffic areas.
b. Use Medium-Duty, top-loading classification drains in paved foot-traffic areas.
c. Use Heavy-Duty, top-loading classification drains in vehicle-traffic service areas.
d. Use Extra-Heavy-Duty, top-loading classification drains in roads.
2. Embed drains in 4-inch (102-mm) minimum concrete around bottom and sides.
3. Fasten grates to drains if indicated.
4. Set drain frames and covers with tops flush with pavement surface.
5. Assemble trench sections with flanged joints.
6. Embed trench sections in 4-inch (102-mm) minimum concrete around bottom and sides.

G. Manhole Installation
1. General: Install manholes, complete with appurtenances and accessories indicated.
2. Install precast concrete manhole sections with sealants according to ASTM C 891.
3. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.
4. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches (76 mm) above finished surface elsewhere unless otherwise indicated.

H. Catch Basin Installation
1. Construct catch basins to sizes and shapes indicated.
2. Set frames and grates to elevations indicated.

I. Stormwater Inlet And Outlet Installation
1. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.
2. Construct riprap of broken stone, as indicated.
3. Install outlets that spill onto grade, anchored with concrete, where indicated.
4. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.
5. Construct energy dissipaters at outlets, as indicated.

J. Dry Well Installation
1. Excavate hole to diameter of at least 6 inches (150 mm) greater than outside of dry well. Do not extend excavation into ground-water table.
2. Install precast, concrete-ring dry wells according to the following:
   a. Assemble rings to depth indicated.
   b. Extend rings to height where top of cover will be approximately 8 inches (203 mm) below finished grade.
   c. Backfill bottom of inside of rings with filtering material to level at least 12 inches (300 mm) above bottom.
   d. Extend effluent inlet pipe 12 inches (300 mm) into rings and terminate into side of tee fitting.
   e. Backfill around outside of rings with filtering material to top level of rings.
   f. Install cover over top of rings.
3. Install manufactured, PE dry wells according to manufacturer's written instructions and the following:
   a. Assemble and install panels and cover.
   b. Backfill bottom of inside of unit with filtering material to level at least 12 inches (300 mm) above bottom.
   c. Extend effluent inlet pipe 12 inches (300 mm) into unit and terminate into side of tee fitting.
   d. Install filter fabric around outside of unit.
   e. Install filtering material around outside of unit.
4. Install constructed-in-place dry wells according to the following:
   a. Install brick lining material dry and laid flat, with staggered joints for seepage. Build to diameter and depth indicated.
   b. Install block lining material dry, with staggered joints and 20 percent minimum of blocks on side for seepage. Install precast concrete rings with notches or weep holes for seepage. Build to diameter and depth indicated.
   c. Extend lining material to height where top of manhole will be approximately 8 inches (203 mm) below finished grade.
   d. Backfill bottom of inside of lining with filtering material to level at least 12 inches (300 mm) above bottom.
   e. Extend effluent inlet pipe 12 inches (300 mm) into lining and terminate into side of tee fitting.
   f. Backfill around outside of lining with filtering material to top level of lining.
   g. Install manhole over top of dry well. Support cover on undisturbed soil. Do not support cover on lining.

K. Concrete Placement
1. Place cast-in-place concrete according to ACI 318.

L. Channel Drainage System Installation
1. Install with top surfaces of components, except piping, flush with finished surface.
2. Assemble channel sections to form slope down toward drain outlets. Use sealants, adhesives, fasteners, and other materials recommended by system manufacturer.
3. Embed channel sections and drainage specialties in 4-inch (102-mm) minimum concrete around bottom and sides.
4. Fasten grates to channel sections if indicated.
5. Assemble channel sections with flanged or interlocking joints.
6. Embed channel sections in 4-inch (102-mm) minimum concrete around bottom and sides.

M. Stormwater Disposal System Installation
1. Chamber Systems: Excavate trenches of width and depth, and install system and backfill according to chamber manufacturer's written instructions. Include storage and leaching chambers, filtering material, and filter mat.
   OR

Piping Systems: Excavate trenches of width and depth, and install piping system, filter fabric, and backfill, according to piping manufacturer's written instructions.

N. Connections
1. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Division 22 Section "Facility Storm Drainage Piping".
2. Connect force-main piping to building's storm drainage force mains specified in Division 22 Section "Facility Storm Drainage Piping". Terminate piping where indicated.
3. Make connections to existing piping and underground manholes.
   a. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch (150-mm) overlap, with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
   b. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500). Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
   c. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches (76 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches (150 mm) of concrete for minimum length of 12 inches (300 mm) to provide additional support of collar from connection to undisturbed ground.
      1) Use concrete that will attain a minimum 28-day compressive strength of 3000 psi (20.7 MPa) unless otherwise indicated.
      2) Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
   d. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
4. Connect to sediment interceptors specified in Division 22 Section "Sanitary Waste Interceptors".
5. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
   a. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
      1) Unshielded **OR** Shielded, **as directed**, flexible couplings for same or minor difference OD pipes.
      2) Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
      3) Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
   b. Use pressure-type pipe couplings for force-main joints.

O. Closing Abandoned Storm Drainage Systems
1. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
   a. Close open ends of piping with at least 8-inch- (203-mm-) thick, brick masonry bulkheads.
   b. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
2. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:
   a. Remove manhole or structure and close open ends of remaining piping.

b. Remove top of manhole or structure down to at least 36 inches (915 mm) below final grade. Fill to within 12 inches (300 mm) of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

3. Backfill to grade according to Division 31 Section "Earth Moving".

P. Identification

1. Materials and their installation are specified in Division 31 Section "Earth Moving". Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.
   a. Use warning tape **OR** detectable warning tape, **as directed**, over ferrous piping.
   b. Use detectable warning tape over nonferrous piping and over edges of underground structures.

Q. Field Quality Control

1. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (610 mm) of backfill is in place, and again at completion of Project.
   a. Submit separate reports for each system inspection.
   b. Defects requiring correction include the following:
      1) Alignment: Less than full diameter of inside of pipe is visible between structures.
      2) Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
      3) Damage: Crushed, broken, cracked, or otherwise damaged piping.
      4) Infiltration: Water leakage into piping.
      5) Exfiltration: Water leakage from or around piping.
   c. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
   d. Reinspect and repeat procedure until results are satisfactory.
2. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
   a. Do not enclose, cover, or put into service before inspection and approval.
   b. Test completed piping systems according to requirements of authorities having jurisdiction.
   c. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
   d. Submit separate report for each test.
   e. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
      1) Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
      2) Option: Test plastic piping according to ASTM F 1417.
      3) Option: Test concrete piping according to ASTM C 924 (ASTM C 924M).
   f. Force-Main Storm Drainage Piping: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 150 psig (1035 kPa).
      1) Ductile-Iron Piping: Test according to AWWA C600, "Hydraulic Testing" Section.
      2) PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.
3. Leaks and loss in test pressure constitute defects that must be repaired.
4. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

R. Cleaning

1. Clean interior of piping of dirt and superfluous materials. Flush with potable water **OR** Flush with water, **as directed**.

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SECTION 33 42 13 13 - CULVERTS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for culverts. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. Product Data: For each type of product indicated.

C. Delivery, Storage, And Handling
   1. Delivery and Storage: Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. The Contractor shall have a copy of the manufacturer's instructions available at the construction site at all times and shall follow these instructions unless directed otherwise by the the Owner. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install plastic pipe shall be stored in accordance with the manufacturer's recommendations and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.
   2. Handling: Materials shall be handled in a manner that ensures delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not dragged.

1.2 PRODUCTS

A. Pipe For Culverts
   1. Pipe for culverts and storm drains shall be of the sizes indicated and shall conform to the requirements specified.
   2. Concrete Pipe
      a. ASTM C76/ASTM C76M, Class I **OR** II **OR** III **OR** IV **OR** V, **as directed**, or ASTM C655 D-Load. Note: D-load is defined as the minimum required three-edge test load on a pipe to produce a 0.01 inch crack and/or ultimate failure in pounds per linear foot per foot (no metric definition) of inside diameter.
      b. Reinforced Arch Culvert and Storm Drainpipe: ASTM C506/ASTM C506M, Class A-II **OR** A-III **OR** A-IV, **as directed**.
      c. Reinforced Elliptical Culvert and Storm Drainpipe: ASTM C507/ASTM C507M. Horizontal elliptical pipe shall be Class HE-A **OR** HE-I **OR** HE-II **OR** HE-III **OR** HE-IV, **as directed**. Vertical elliptical pipe shall be Class VE-II **OR** VE-III **OR** VE-IV **OR** VE-V **OR** VE-VI, **as directed**.
      d. Nonreinforced Pipe: ASTM C14/ASTM C14M, Class 1 **OR** 2 **OR** 3, **as directed**.
         1) Cast-In-Place Nonreinforced Conduit: ACI 346, except that testing shall be the responsibility of and at the expense of the Contractor. In the case of other conflicts between ACI 346 and project specifications, requirements of ACI 346 shall govern.
            NOTE: This type conduit should not be used beneath structures, for drain crossings, adjacent to paved areas, or under high fills.
   3. Clay Pipe: Standard or extra strength, as indicated, conforming to ASTM C700.
      NOTE: "Bell-and-spigot piping only" in areas where corrosion problems may be anticipated with the stainless steel parts of the couplings used for plain-end piping.

4. Corrugated Steel Pipe
   a. ASTM A760/A760M, zinc or aluminum (Type 2) coated pipe of either:
      1) Type I **OR** II, **as directed**, pipe with annular **OR** helical, **as directed**, 2-2/3 by 1/2 inch (68 by 13 mm) corrugations.
      2) Type IR **OR** IIR, **as directed**, pipe with helical 3/4 by 3/4 by 7-1/2 inch (19 by 19 by 190 mm) corrugations.
   b. Fully Bituminous Coated
      1) AASHTO M190 Type A and ASTM A760/A 760M zinc or aluminum (Type 2) coated pipe of either:
         a) Type I **OR** II, **as directed**, pipe with annular **OR** helical, **as directed**, 2-2/3 by 1/2 inch (68 by 13 mm) corrugations.
         b) Type IR **OR** IIR, **as directed**, pipe with helical 3/4 by 3/4 by 7-1/2 inch (19 by 19 by 190 mm) corrugations.
   c. Half Bituminous Coated, Part Paved: AASHTO M190 Type B and ASTM A760/A 760M zinc or aluminum (Type 2) coated Type I **OR** II, **as directed**, pipe with annular **OR** helical, **as directed**, 2-2/3 by 1/2 inch (68 by 13 mm) corrugations.
   d. Fully Bituminous Coated, Part Paved: AASHTO M190 Type C and ASTM A760/A 760M zinc or aluminum (Type 2) coated Type I **OR** II, **as directed**, pipe with annular **OR** helical, **as directed**, 2-2/3 by 1/2 inch (68 by 13 mm) corrugations.
   e. Fully Bituminous Coated, Fully Paved: AASHTO M190 Type D and ASTM A760/A 760M zinc or aluminum (Type 2) coated Type I **OR** II, **as directed**, pipe with annular **OR** helical, **as directed**, 2-2/3 by 1/2 inch (68 by 13 mm) corrugations.
   f. Concrete-Lined: ASTM A760/A760M zinc coated Type I corrugated steel pipe with annular **OR** helical, **as directed**, 2-2/3 by 1/2 inch (68 by 13 mm) corrugations and a concrete lining in accordance with ASTM A849.
   g. Polymer Precoated: ASTM A 762/A 762M corrugated steel pipe fabricated from ASTM A742/A742M Grade 250/250 10/10 polymer precoated sheet of either:
      1) Type I **OR** II, **as directed**, pipe with annular **OR** helical, **as directed**, 2-2/3 by 1/2 inch (68 by 13 mm) corrugations.
      2) Type IR **OR** IIR, **as directed**, pipe with helical 3/4 by 3/4 by 7-1/2 inch (19 by 19 by 190 mm) corrugations.
   h. Polymer Precoated, Part Paved: ASTM A762/A762M Type I **OR** II, **as directed**, corrugated steel pipe and AASHTO M190 Type B (modified) paved invert only, fabricated from ASTM A742/A742M Grade 250/250 10/10 polymer precoated sheet with annular **OR** helical, **as directed**, 2-2/3 by 1/2 inch (68 by 13 mm) corrugations.
   i. Polymer Precoated, Fully Paved: ASTM A762/A762M Type I **OR** II, **as directed**, corrugated steel pipe and AASHTO M190 Type D (modified), fully paved only, fabricated from ASTM A 742/A 742M Grade 250/250 10/10 polymer precoated sheet with annular **OR** helical, **as directed**, 2-2/3 by 1/2 inch (68 by 13 mm) corrugations.
5. Corrugated Aluminum Alloy Pipe: ASTM B745/B745M corrugated aluminum alloy pipe of either:
      1) Type I **OR** II, **as directed**, pipe with annular **OR** helical, **as directed**, corrugations.
      2) Type IA **OR** IR **OR** IIA **OR** IIR, **as directed**, pipe with helical corrugations.
   b. Aluminum Fully Bituminous Coated: Bituminous coating shall conform to ASTM A849. Piping shall conform to AASHTO M190 Type A and ASTM B745/B745M corrugated aluminum alloy pipe of either:
      1) Type I **OR** II, **as directed**, pipe with annular **OR** helical, **as directed**, corrugations.
      2) Type IA **OR** IR **OR** IIA **OR** IIR, **as directed**, pipe with helical corrugations.
   c. Aluminum Fully Bituminous Coated, Part Paved: Bituminous coating shall conform to ASTM A849. Piping shall conform to AASHTO M190 Type C and ASTM B 745/B 745M corrugated aluminum alloy pipe of either:
      1) Type I **OR** II, **as directed**, pipe with annular **OR** helical, **as directed**, corrugations.
      2) Type IR **OR** IIR, **as directed**, pipe with helical corrugations.
6. Structural Plate, Steel Pipe, Pipe Arches and Arches

a. Assembled with galvanized steel nuts and bolts, from galvanized corrugated steel plates conforming to AASHTO M167. Pipe coating, when required, shall conform to the requirements of AASHTO M190 Type A **OR** AASHTO M243, **as directed**.
b. Thickness of plates shall be as indicated.

7. Structural Plate, Aluminum Pipe, Pipe Arches and Arches
   a. Assembled with either aluminum alloy, aluminum coated steel, stainless steel or zinc coated steel nuts and bolts. Nuts and bolts, and aluminum alloy plates shall conform to AASHTO M219. Pipe coating, when required, shall conform to the requirements of AASHTO M190, Type A **OR** AASHTO M 243, **as directed**.
   b. Thickness of plates shall be as indicated.
8. Ductile Iron Culvert Pipe: ASTM A716.
9. Cast-Iron Soil Piping: Cast-Iron Soil Pipe shall conform to ASTM A74, service-weight; gaskets shall be compression-type rubber conforming to ASTM C564.
10. PVC Pipe
    a. The pipe manufacturer's resin certification, indicating the cell classification of PVC used to manufacture the pipe, shall be submitted prior to installation of the pipe.
    b. Type PSM PVC Pipe: ASTM D3034, Type PSM, maximum SDR 35, produced from PVC certified by the compounder as meeting the requirements of ASTM D1784, minimum cell class 12454-B.
    c. Profile PVC Pipe: ASTM F794, Series 46, produced from PVC certified by the compounder as meeting the requirements of ASTM D1784, minimum cell class 12454-B.
    d. Smooth Wall PVC Pipe: ASTM F679 produced from PVC certified by the compounder as meeting the requirements of ASTM D1784, minimum cell class 12454-B.
    e. Corrugated PVC Pipe: ASTM F949 produced from PVC certified by the compounder as meeting the requirements of ASTMD 1784, minimum cell class 12454-B.
11. PE Pipe
    a. The pipe manufacturer's resin certification indicating the cell classification of PE used to manufacture the pipe shall be submitted prior to installation of the pipe. The minimum cell classification for polyethylene plastic shall apply to each of the seven primary properties of the cell classification limits in accordance with ASTM D3350.
    b. Smooth Wall PE Pipe: ASTM F714, maximum DR of 21 for pipes 3 to 24 inches (80 to 600 mm) in diameter and maximum DR of 26 for pipes 26 to 48 inches (650 to 1200 mm) in diameter. Pipe shall be produced from PE certified by the resin producer as meeting the requirements of ASTM D3350, minimum cell class 335434C.
    c. Corrugated PE Pipe: AASHTO M294, Type S or D, for pipes 12 to 48 inches (300 to 1200 mm) and AASHTO MP 7, Type S or D, for pipes 54 to 60 inches (1350 to 1500 mm) produced from PE certified by the resin producer as meeting the requirements of ASTM D3350, minimum cell class in accordance with AASHTO M294. Pipe walls shall have the following properties:
       NOTE: Corrugated PE pipe culverts and storm drains shall not be installed beneath airfield pavements, Class A, B, or C roads, or road pavements with a design index of 6 or greater. Type S pipe has a full circular cross-section, with an outer corrugated pipe wall and a smooth inner liner. Type C pipe has a full circular cross-section, with a corrugated surface both inside and outside. Corrugations may be either annular or helical.

Nominal Size (in.)	Minimum Wall Area (square in/ft)	Minimum Moment of Inertia of Wall Section (in to the 4th/in)
12	1.50	0.024
15	1.91	0.053
18	2.34	0.062
24	3.14	0.116
30	3.92	0.163
36	4.50	0.222
42	4.69	0.543

48	5.15	0.543
54	5.67	0.800
60	6.45	0.800

Nominal Size (mm)	Minimum Wall Area (square mm/m)	Minimum Moment of Inertia of Wall Section (mm to the 4th/mm)
300	3200	390
375	4000	870
450	4900	1020
600	6600	1900
750	8300	2670
900	9500	3640
1050	9900	8900
1200	10900	8900
1350	12000	13110
1500	13650	13110

d. Profile Wall PE Pipe: ASTM F894, RSC 160, produced from PE certified by the resin producer as meeting the requirements of ASTM D3350, minimum cell class 334433C. Pipe walls shall have the following properties:

		Minimum Moment Of Inertia of Wall Section (in to the 4th/in)	
Nominal Size (in.)	Minimum Wall Area (square in/ft)	Cell Class 334433C	Cell Class 335434C
18	2.96	0.052	0.038
21	4.15	0.070	0.051
24	4.66	0.081	0.059
27	5.91	0.125	0.091
30	5.91	0.125	0.091
33	6.99	0.161	0.132
36	8.08	0.202	0.165
42	7.81	0.277	0.227
48	8.82	0.338	0.277

		Minimum Moment Of Inertia of Wall Section (mm to the 4th/mm)	
Nominal Size (mm)	Minimum Wall Area (square mm/m)	Cell Class 334433C	Cell Class 335434C
450	6300	850	620
525	8800	1150	840
600	9900	1330	970
675	12500	2050	1490
750	12500	2050	1490

825	14800	2640	2160
900	17100	3310	2700
1050	16500	4540	3720
1200	18700	5540	4540

B. Drainage Structures
1. Flared End Sections: Sections shall be of a standard design fabricated from zinc coated steel sheets meeting requirements of ASTM A929/A929M.
2. Precast Reinforced Concrete Box: Four-sided box section with open ends to be monolithically cast of reinforced concrete, smooth inside surfaces. Each box section shall be manufactured with chamfered inside corners. Design and manufacture shall conform to ASTM C890.
   a. Design References: ACI 318.
      1) Boxes subjected to highway loadings shall conform to requirements of AASHTO M259 or M273, as applicable, and ASTM C789, C850, C1433, and PS62.
      2) Boxes subjected to aircraft loadings shall conform to requirements of FAA specifications.
      3) Boxes subjected to railway loadings shall conform to requirements of AREMA specifications.
   b. Concrete: 5,000 psi @ 30 days, unless otherwise directed.
   c. Entrained Air: 5 to 9 percent.
   d. Steel Reinforcing: ASTM A1064, A615, A616, Grade 60, 60 ksi.
   e. Design Loading: AASHTO HS-20-44 or HS-25-44 with 30 percent impact and equivalent soil pressure of 130 psf. Floatation forces not accounted for.
   f. Joints: Each section shall have a male and female end with no less than 1-1/2-inch of concrete overlap and shall include a 1-inch square neoprene gasket, cemented to male surface of section during manufacture.
   g. End Sections: As required for the individual installation, provide:
      1) Doweled end for 1-inch diameter x 12-inch deep steel dowels, keyway slot.
      2) Keyway slot, a shear connection between the precast and field cast sections.
      3) Plain end, for use where wing and end walls act independently of precast box.
   h. Lifting Pins: Each section shall be equipped with 4 OSHA approved lifting pins.
   i. For multi-cell installations, fill 1-inch spacing between cells with granular material to assume proper load distribution.
3. Three-Sided Structures for Culverts or Short Span Bridge System
   a. Structures shall conform to requirements of ASTM C1504 and ACI 318. For structures subjected to roadway loadings, conform to requirements of AASHTO specifications.

C. Miscellaneous Materials
1. Concrete
   a. Unless otherwise specified, concrete and reinforced concrete shall conform to the requirements concrete under Division 03 Section "Cast-in-place Concrete". The concrete mixture shall have air content by volume of concrete, based on measurements made immediately after discharge from the mixer, of 5 to 7 percent when maximum size of coarse aggregate exceeds 1-1/2 inches (37.5 mm).
   b. Air content shall be determined in accordance with ASTM C231. The concrete covering over steel reinforcing shall not be less than 1 inch (25 mm) thick for covers and not less than 1-1/2 inches (40 mm) thick for walls and flooring. Concrete covering deposited directly against the ground shall have a thickness of at least 3 inches (75 mm) between steel and ground.
   c. Expansion-joint filler material shall conform to ASTM D1751, or ASTM D1752, or shall be resin-impregnated fiberboard conforming to the physical requirements of ASTM D1752.
2. Mortar: Mortar for pipe joints, connections to other drainage structures, and brick or block construction shall conform to ASTM C270, Type M, except that the maximum placement time shall be 1 hour. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar. Water shall be clean and free of harmful acids, alkalies, and organic impurities. The mortar shall be used within 30 minutes after the ingredients are mixed with water. The inside of

the joint shall be wiped clean and finished smooth. The mortar head on the outside shall be protected from air and sun with a proper covering until satisfactorily cured.

3. Precast Concrete Segmental Blocks: Precast concrete segmental block shall conform to ASTM C139, not more than 8 inches (200 mm) thick, not less than 8 inches (200 mm) long, and of such shape that joints can be sealed effectively and bonded with cement mortar.
4. Brick
   a. Brick shall conform to ASTM C62, Grade SW; ASTM C55, Grade S-I or S-II; or ASTM C32, Grade MS. Mortar for jointing and plastering shall consist of one part portland cement and two parts fine sand. Lime may be added to the mortar in a quantity not more than 25 percent of the volume of cement.
   b. The joints shall be filled completely and shall be smooth and free from surplus mortar on the inside of the structure. Brick structures shall be plastered with 1/2 inch (10 mm) of mortar over the entire outside surface of the walls. For square or rectangular structures, brick shall be laid in stretcher courses with a header course every sixth course. For round structures, brick shall be laid radially with every sixth course a stretcher course.
5. Precast Reinforced Concrete Manholes
   a. Precast reinforced concrete manholes shall conform to ASTM C478/ASTM C478M.
   b. Joints between precast concrete risers and tops shall be full-bedded in cement mortar and shall be smoothed to a uniform surface on both interior and exterior of the structure **OR** made with flexible watertight, rubber-type gaskets meeting the requirements of paragraph JOINTS, **as directed**.
6. Prefabricated Corrugated Metal Manholes
   a. Manholes shall be of the type and design recommended by the manufacturer.
   b. Manholes shall be complete with frames and cover, or frames and gratings.
7. Frame and Cover for Gratings
   a. Frame and cover for gratings shall be cast gray iron, ASTM A48/A48M,
   b. Class 35B; cast ductile iron, ASTM A536, Grade 65-45-12; or cast aluminum, ASTM B26M/B26, Alloy 356.OT6. Weight, shape, size, and waterway openings for grates and curb inlets shall be as indicated on the plans.
8. Joints
   a. Flexible Watertight Joints
      1) Materials: Flexible watertight joints shall be made with plastic or rubber-type gaskets for concrete pipe and with factory-fabricated resilient materials for clay pipe. The design of joints and the physical requirements for plastic gaskets shall conform to AASHTO M198, and rubber-type gaskets shall conform to ASTM C443/ASTM C443M. Factory-fabricated resilient joint materials shall conform to ASTM C425. Gaskets shall have not more than one factory-fabricated splice, except that two factory-fabricated splices of the rubber-type gasket are permitted if the nominal diameter of the pipe being gasketed exceeds 54 inches (1.35 m).
      2) Test Requirements: Watertight joints shall be tested and shall meet test requirements of paragraph HYDROSTATIC TEST ON WATERTIGHT JOINTS. Rubber gaskets shall comply with the oil resistant gasket requirements of ASTM C443/ASTM C443M. Certified copies of test results shall be delivered to the the Owner before gaskets or jointing materials are installed. Alternate types of watertight joint may be furnished, if specifically approved.
   b. External Sealing Bands: Requirements for external sealing bands shall conform to ASTM C877/ASTM C877M.
   c. Flexible Watertight, Gasketed Joints
      1) Gaskets: When infiltration or exfiltration is a concern for pipe lines, the couplings may be required to have gaskets. The closed-cell expanded rubber gaskets shall be a continuous band approximately 7 inches (178 mm) wide and approximately 3/8 inch (10 mm) thick, meeting the requirements of ASTM D1056, Type 2 A1 **OR** B3, **as directed**, and shall have a quality retention rating of not less than 70 percent when tested for weather resistance by ozone chamber exposure, Method B of ASTM D1171. Rubber O-ring gaskets shall be 13/16 inch (21 mm) in diameter for pipe

diameters of 36 inches (914 mm) or smaller and 7/8 inch (22 mm) in diameter for larger pipe having 1/2 inch (13 mm) deep end corrugation. Rubber O-ring gaskets shall be 1-3/8 inches (35 mm) in diameter for pipe having 1 inch (25 mm) deep end corrugations. O-rings shall meet the requirements of AASHTO M198 or ASTM C443/ASTM C443M. Flexible plastic gaskets shall conform to requirements of AASHTO M198, Type B.

2) Connecting Bands: Connecting bands shall be of the type, size and sheet thickness of band, and the size of angles, bolts, rods and lugs as indicated or where not indicated as specified in the applicable standards or specifications for the pipe. Exterior rivet heads in the longitudinal seam under the connecting band shall be countersunk or the rivets shall be omitted and the seam welded. Watertight joints shall be tested and shall meet the test requirements of paragraph HYDROSTATIC TEST ON WATERTIGHT JOINTS.

d. PVC Plastic Pipes: Joints shall be solvent cement or elastomeric gasket type in accordance with the specification for the pipe and as recommended by the pipe manufacturer.

e. Smooth Wall PE Plastic Pipe: Pipe shall be joined using butt fusion method as recommended by the pipe manufacturer.

f. Corrugated PE Plastic Pipe: Water tight joints shall be made using a PVC or PE coupling and rubber gaskets as recommended by the pipe manufacturer. Rubber gaskets shall conform to ASTM F477. Soil tight joints shall conform to the requirements in AASHTO HB-17, Division II, Section 26.4.2.4.(e) for soil tightness and shall be as recommended by the pipe manufacturer.

g. Profile Wall PE Plastic Pipe: Joints shall be gasketed or thermal weld type with integral bell in accordance with ASTM F894.

h. Ductile Iron Pipe: Couplings and fittings shall be as recommended by the pipe manufacturer.

D. Steel Ladder

1. Steel ladder shall be provided where the depth of the manhole exceeds 12 feet (3.66 m). These ladders shall be not less than 16 inches (406 mm) in width, with 3/4 inch (19 mm) diameter rungs spaced 12 inches (305 mm) apart. The two stringers shall be a minimum 3/8 inch (10 mm) thick and 2-1/2 inches (63 mm) wide. Ladders and inserts shall be galvanized after fabrication in conformance with ASTM A123/A123M.

E. Resilient Connectors

1. Flexible, watertight connectors used for connecting pipe to manholes and inlets shall conform to ASTM C923/ASTM C923M.

F. Hydrostatic Test On Watertight Joints

1. Concrete, Clay, PVC and PE Pipe: A hydrostatic test shall be made on the watertight joint types as proposed. Only one sample joint of each type needs testing; however, if the sample joint fails because of faulty design or workmanship, an additional sample joint may be tested. During the test period, gaskets or other jointing material shall be protected from extreme temperatures which might adversely affect the performance of such materials. Performance requirements for joints in reinforced and nonreinforced concrete pipe shall conform to AASHTO M198 or ASTM C443M ASTM C443. Test requirements for joints in clay pipe shall conform to ASTM C425. Test requirements for joints in PVC and PE plastic pipe shall conform to ASTM D3212.

2. Corrugated Steel and Aluminum Pipe: A hydrostatic test shall be made on the watertight joint system or coupling band type proposed. The moment strength required of the joint is expressed as 15 percent of the calculated moment capacity of the pipe on a transverse section remote from the joint by the AASHTO HB-17 (Division II, Section 26). The pipe shall be supported for the hydrostatic test with the joint located at the point which develops 15 percent of the moment capacity of the pipe based on the allowable span in meters feet for the pipe flowing full or 40,000 foot-pounds (54,233 Newton meters), whichever is less. Performance requirements shall be met

at an internal hydrostatic pressure of 10 psi (69 kPa) for a 10 minute period for both annular corrugated metal pipe and helical corrugated metal pipe with factory reformed ends.

G. Erosion Control Riprap
1. Provide nonerodible rock not exceeding 15 inches (375 mm) in its greatest dimension and choked with sufficient small rocks to provide a dense mass with a minimum thickness of 8 inches (200 mm) or as indicated.

1.3 EXECUTION

A. Excavation for Pipe Culverts and Drainage Structures
1. Excavation of trenches, and for appurtenances and backfilling for culverts and storm drains, shall be in accordance with the applicable portions of Division 31 Section "Earth Moving" and the requirements specified below.
2. Trenching: The width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus 12-inches (300 mm) each side of pipe to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Sheeting and bracing, where required, shall be placed within the trench width as specified. Contractor shall not overexcavate. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures will be necessary. Cost of this redesign and increased cost of pipe or installation shall be borne by the Contractor without additional cost to the Owner.
3. Removal of Rock: Rock in either ledge or boulder formation shall be replaced with suitable materials to provide a compacted earth cushion having a thickness between unremoved rock and the pipe of at least 8 inches (200 mm) or 1/2 inch (13 mm) for each meter foot of fill over the top of the pipe, whichever is greater, but not more than three-fourths the nominal diameter of the pipe. Where bell-and-spigot pipe is used, the cushion shall be maintained under the bell as well as under the straight portion of the pipe. Rock excavation shall be as specified and defined in Division 31 Section "Earth Moving".
4. Removal of Unstable Material: Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the the Owner, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with select granular material, compacted as provided in paragraph BACKFILLING. When removal of unstable material is due to the fault or neglect of the Contractor while performing shoring and sheeting, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the Owner.

B. Bedding
1. The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe.
2. Concrete Pipe Requirements: When no bedding class is specified or detailed on the drawings, concrete pipe shall be bedded in a soil foundation accurately shaped and rounded to conform to the lowest one-fourth of the outside portion of circular pipe or to the lower curved portion of pipe arch for the entire length of the pipe or pipe arch. When necessary, the bedding shall be tamped. Bell holes and depressions for joints shall be not more than the length, depth, and width required for properly making the particular type of joint.
3. Clay Pipe Requirements: Bedding for clay pipe shall be as specified by ASTM C12.
4. Corrugated Metal Pipe: Bedding for corrugated metal pipe and pipe arch shall be in accordance with ASTM A798/A798M. It is not required to shape the bedding to the pipe geometry. However, for pipe arches, the Contractor shall either shape the bedding to the relatively flat bottom arc or fine grade the foundation to a shallow v-shape. Bedding for corrugated structural plate pipe shall meet requirements of ASTM A807/A807M.
5. Ductile Iron and Cast-Iron Pipe: Bedding for ductile iron and cast-iron pipe shall be as shown on the drawings.

6. Plastic Pipe: Bedding for PVC and PE pipe shall meet the requirements of ASTM D2321. Bedding, haunching, and initial backfill shall be either Class IB or II material.

C. Placing Pipe

1. Each pipe shall be thoroughly examined before being laid; defective or damaged pipe shall not be used. Plastic pipe shall be protected from exposure to direct sunlight prior to laying, if necessary to maintain adequate pipe stiffness and meet installation deflection requirements. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Lifting lugs in vertically elongated metal pipe shall be placed in the same vertical plane as the major axis of the pipe. Pipe shall not be laid in water, and pipe shall not be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. Deflection of installed flexible pipe shall not exceed the following limits:

TYPE OF PIPE	MAXIMUM ALLOWABLE DEFLECTION (%)
Corrugated Steel and Aluminum Alloy	5
Concrete-Lined Corrugated Steel	3
Ductile Iron Culvert	3
Plastic	7.5

Not less than 30 days after the completion of backfilling, the Owner may perform a deflection test on the entire length of installed flexible pipe using a mandrel or other suitable device. Installed flexible pipe showing deflections greater than those indicated above shall be retested by a run from the opposite direction. If the retest also fails, the suspect pipe shall be replaced.

2. Concrete, Clay, PVC, Ribbed PVC, Ductile Iron and Cast-Iron Pipe: Laying shall proceed upgrade with spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow.
3. Elliptical and Elliptical Reinforced Concrete Pipe: The manufacturer's reference lines, designating the top of the pipe, shall be within 5 degrees of a vertical plane through the longitudinal axis of the pipe, during placement. Damage to or misalignment of the pipe shall be prevented in all backfilling operations.
4. Corrugated PE Pipe: Laying shall be with the separate sections joined firmly on a bed shaped to line and grade and shall follow manufacturer's recommendations.
5. Corrugated Metal Pipe and Pipe Arch: Laying shall be with the separate sections joined firmly together, with the outside laps of circumferential joints pointing upstream, and with longitudinal laps on the sides. Part paved pipe shall be installed so that the centerline of bituminous pavement in the pipe, indicated by suitable markings on the top at each end of the pipe sections, coincides with the specified alignment of pipe. Fully paved steel pipe or pipe arch shall have a painted or otherwise applied label inside the pipe or pipe arch indicating sheet thickness of pipe or pipe arch. Any unprotected metal in the joints shall be coated with bituminous material as specified in AASHTO M190 or AASHTO M243. Interior coating shall be protected against damage from insertion or removal of struts or tie wires. Lifting lugs shall be used to facilitate moving pipe without damage to exterior or interior coatings. During transportation and installation, pipe or pipe arch and coupling bands shall be handled with care to preclude damage to the coating, paving or lining. Damaged coatings, pavings and linings shall be repaired in accordance with the manufacturer's recommendations prior to placing backfill. Pipe on which coating, paving or lining has been damaged to such an extent that satisfactory field repairs cannot be made shall be removed and replaced. Vertical elongation, where indicated, shall be accomplished by factory elongation. Suitable markings or properly placed lifting lugs shall be provided to ensure placement of factory elongated pipe in a vertical plane.
6. Structural-Plate Steel: Structural plate shall be installed in accordance with ASTM A807/A807M. Structural plate shall be assembled in accordance with instructions furnished by the manufacturer. Instructions shall show the position of each plate and the order of assembly. Bolts shall be tightened progressively and uniformly, starting at one end of the structure after all plates are in place. The operation shall be repeated to ensure that all bolts are tightened to meet the torque requirements of 200 foot-pounds (270 Newton meters) plus or minus 50 foot-pounds (68 Newton meters). Any power wrenches used shall be checked by the use of hand torque

wrenches or long-handled socket or structural wrenches for amount of torque produced. Power wrenches shall be checked and adjusted frequently as needed, according to type or condition, to ensure proper adjustment to supply the required torque.

7. Structural-Plate Aluminum: Structural plate shall be assembled in accordance with instructions furnished by the manufacturer. Instructions shall show the position of each plate and the order of assembly. Bolts shall be tightened progressively and uniformly, starting at one end of the structure after all plates are in place. The operation shall be repeated to ensure that all bolts are torqued to a minimum of 100 foot-pounds (136 Newton meters) on aluminum alloy bolts and a minimum of 150 foot-pounds (203 Newton meters) on galvanized steel bolts. Any power wrenches used shall be checked by the use of hand torque wrenches or long-handled socket or structural wrenches for the amount of torque produced. Power wrenches shall be checked and adjusted as frequently as needed, according to type or condition, to ensure that they are in proper adjustment to supply the required torque.
8. Multiple Culverts: Where multiple lines of pipe are installed, adjacent sides of pipe shall be at least half the nominal pipe diameter or 1 meter 3 feet apart, whichever is less.
9. Jacking Pipe Through Fills: Methods of operation and installation for jacking pipe through fills shall conform to requirements specified in Volume 1, Chapter 1, Part 4 of AREMA Manual.

D. Jointing
1. Concrete and Clay Pipe
a. Cement-Mortar Bell-and-Spigot Joint: The first pipe shall be bedded to the established gradeline, with the bell end placed upstream. The interior surface of the bell shall be thoroughly cleaned with a wet brush and the lower portion of the bell filled with mortar as required to bring inner surfaces of abutting pipes flush and even. The spigot end of each subsequent pipe shall be cleaned with a wet brush and uniformly matched into a bell so that sections are closely fitted. After each section is laid, the remainder of the joint shall be filled with mortar, and a bead shall be formed around the outside of the joint with sufficient additional mortar. If mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint shall be wrapped or bandaged with cheesecloth to hold mortar in place.
b. Cement-Mortar Oakum Joint for Bell-and-Spigot Pipe: A closely twisted gasket shall be made of jute or oakum of the diameter required to support the spigot end of the pipe at the proper grade and to make the joint concentric. Joint packing shall be in one piece of sufficient length to pass around the pipe and lap at top. This gasket shall be thoroughly saturated with neat cement grout. The bell of the pipe shall be thoroughly cleaned with a wet brush, and the gasket shall be laid in the bell for the lower third of the circumference and covered with mortar. The spigot of the pipe shall be thoroughly cleaned with a wet brush, inserted in the bell, and carefully driven home. A small amount of mortar shall be inserted in the annular space for the upper two-thirds of the circumference. The gasket shall be lapped at the top of the pipe and driven home in the annular space with a caulking tool. The remainder of the annular space shall be filled completely with mortar and beveled at an angle of approximately 45 degrees with the outside of the bell. If mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint thus made shall be wrapped with cheesecloth. Placing of this type of joint shall be kept at least five joints behind laying operations.
c. Cement-Mortar Diaper Joint for Bell-and-Spigot Pipe: The pipe shall be centered so that the annular space is uniform. The annular space shall be caulked with jute or oakum. Before caulking, the inside of the bell and the outside of the spigot shall be cleaned.
1) Diaper Bands: Diaper bands shall consist of heavy cloth fabric to hold grout in place at joints and shall be cut in lengths that extend one-eighth of the circumference of pipe above the spring line on one side of the pipe and up to the spring line on the other side of the pipe. Longitudinal edges of fabric bands shall be rolled and stitched around two pieces of wire. Width of fabric bands shall be such that after fabric has been securely stitched around both edges on wires, the wires will be uniformly spaced not less than 200 mm 8 inches apart. Wires shall be cut into

lengths to pass around pipe with sufficient extra length for the ends to be twisted at top of pipe to hold the band securely in place; bands shall be accurately centered around lower portion of joint.

2) Grout: Grout shall be poured between band and pipe from the high side of band only, until grout rises to the top of band at the spring line of pipe, or as nearly so as possible, on the opposite side of pipe, to ensure a thorough sealing of joint around the portion of pipe covered by the band. Silt, slush, water, or polluted mortar grout forced up on the lower side shall be forced out by pouring, and removed.

3) Remainder of Joint: The remaining unfilled upper portion of the joint shall be filled with mortar and a bead formed around the outside of this upper portion of the joint with a sufficient amount of additional mortar. The diaper shall be left in place. Placing of this type of joint shall be kept at least five joints behind actual laying of pipe. No backfilling around joints shall be done until joints have been fully inspected and approved.

d. Cement-Mortar Tongue-and-Groove Joint: The first pipe shall be bedded carefully to the established gradeline with the groove upstream. A shallow excavation shall be made underneath the pipe at the joint and filled with mortar to provide a bed for the pipe. The grooved end of the first pipe shall be thoroughly cleaned with a wet brush, and a layer of soft mortar applied to the lower half of the groove. The tongue of the second pipe shall be cleaned with a wet brush; while in horizontal position, a layer of soft mortar shall be applied to the upper half of the tongue. The tongue end of the second pipe shall be inserted in the grooved end of the first pipe until mortar is squeezed out on interior and exterior surfaces. Sufficient mortar shall be used to fill the joint completely and to form a bead on the outside.

e. Cement-Mortar Diaper Joint for Tongue-and-Groove Pipe: The joint shall be of the type described for cement-mortar tongue-and-groove joint in this paragraph, except that the shallow excavation directly beneath the joint shall not be filled with mortar until after a gauze or cheesecloth band dipped in cement mortar has been wrapped around the outside of the joint. The cement-mortar bead at the joint shall be at least 1/2 inch (15 mm), thick and the width of the diaper band shall be at least 8 inches (200 mm). The diaper shall be left in place. Placing of this type of joint shall be kept at least five joints behind the actual laying of the pipe. Backfilling around the joints shall not be done until the joints have been fully inspected and approved.

f. Plastic Sealing Compound Joints for Tongue-and-Grooved Pipe: Sealing compounds shall follow the recommendation of the particular manufacturer in regard to special installation requirements. Surfaces to receive lubricants, primers, or adhesives shall be dry and clean. Sealing compounds shall be affixed to the pipe not more than 3 hours prior to installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Sealing compounds shall be inspected before installation of the pipe, and any loose or improperly affixed sealing compound shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pulled together. If, while making the joint with mastic-type sealant, a slight protrusion of the material is not visible along the entire inner and outer circumference of the joint when the joint is pulled up, the pipe shall be removed and the joint remade. After the joint is made, all inner protrusions shall be cut off flush with the inner surface of the pipe. If nonmastic-type sealant material is used, the "Squeeze-Out" requirement above will be waived.

g. Flexible Watertight Joints: Gaskets and jointing materials shall be as recommended by the particular manufacturer in regard to use of lubricants, cements, adhesives, and other special installation requirements. Surfaces to receive lubricants, cements, or adhesives shall be clean and dry. Gaskets and jointing materials shall be affixed to the pipe not more than 24 hours prior to the installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Gaskets and jointing materials shall be inspected before installing the pipe; any loose or improperly affixed gaskets and jointing materials shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pushed home. If, while the joint is being made the gasket becomes visibly dislocated the pipe shall be removed and the joint remade.

h. External Sealing Band Joint for Noncircular Pipe: Surfaces to receive sealing bands shall be dry and clean. Bands shall be installed in accordance with manufacturer's recommendations.

2. Corrugated Metal Pipe

a. Field Joints: Transverse field joints shall be designed so that the successive connection of pipe sections will form a continuous line free of appreciable irregularities in the flow line. In addition, the joints shall meet the general performance requirements described in ASTM A798/A798M. Suitable transverse field joints which satisfy the requirements for one or more of the joint performance categories can be obtained with the following types of connecting bands furnished with suitable band-end fastening devices: corrugated bands, bands with projections, flat bands, and bands of special design that engage factory reformed ends of corrugated pipe. The space between the pipe and connecting bands shall be kept free from dirt and grit so that corrugations fit snugly. The connecting band, while being tightened, shall be tapped with a soft-head mallet of wood, rubber or plastic, to take up slack and ensure a tight joint. The annular space between abutting sections of part paved, and fully paved pipe and pipe arch, in sizes 30 inches (750 mm) or larger, shall be filled with a bituminous material after jointing. Field joints for each type of corrugated metal pipe shall maintain pipe alignment during construction and prevent infiltration of fill material during the life of the installations. The type, size, and sheet thickness of the band and the size of angles or lugs and bolts shall be as indicated or where not indicated, shall be as specified in the applicable standards or specifications for the pipe.

b. Flexible Watertight, Gasketed Joints: Installation shall be as recommended by the gasket manufacturer for use of lubricants and cements and other special installation requirements. The gasket shall be placed over one end of a section of pipe for half the width of the gasket. The other half shall be doubled over the end of the same pipe. When the adjoining section of pipe is in place, the doubled-over half of the gasket shall then be rolled over the adjoining section. Any unevenness in overlap shall be corrected so that the gasket covers the end of pipe sections equally. Connecting bands shall be centered over adjoining sections of pipe, and rods or bolts placed in position and nuts tightened. Band Tightening: The band shall be tightened evenly, even tension being kept on the rods or bolts, and the gasket; the gasket shall seat properly in the corrugations. Watertight joints shall remain uncovered for a period of time designated, and before being covered, tightness of the nuts shall be measured with a torque wrench. If the nut has tended to loosen its grip on the bolts or rods, the nut shall be retightened with a torque wrench and remain uncovered until a tight, permanent joint is assured.

E. Concrete Placement

1. Place cast-in-place concrete according to ACI 318/318R.

F. Drainage Structures

1. Manholes and Inlets: Construction shall be of reinforced concrete, plain concrete, brick, precast reinforced concrete, precast concrete segmental blocks, prefabricated corrugated metal, or bituminous coated corrugated metal; complete with frames and covers or gratings; and with fixed galvanized steel ladders where indicated. Pipe studs and junction chambers of prefabricated corrugated metal manholes shall be fully bituminous-coated and paved when the connecting branch lines are so treated. Pipe connections to concrete manholes and inlets shall be made with flexible, watertight connectors.

2. Walls and Headwalls: Construction shall be as indicated.

G. Steel Ladder Installation

1. Ladder shall be adequately anchored to the wall by means of steel inserts spaced not more than 6 feet (1.83 m) vertically, and shall be installed to provide at least 6 inches (152 mm) of space between the wall and the rungs. The wall along the line of the ladder shall be vertical for its entire length.

H. Backfilling

1. Backfilling Pipe in Trenches: After the pipe has been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layers not exceeding 6 inches (150 mm) in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. The fill shall be thoroughly compacted under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation of at least 12 inches (300 mm) above the top of the pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding 8 inches (200 mm). Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified below. Where it is necessary, in the opinion of the the Owner, that sheeting or portions of bracing used be left in place, the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.
2. Backfilling Pipe in Fill Sections: For pipe placed in fill sections, backfill material and the placement and compaction procedures shall be as specified below. The fill material shall be uniformly spread in layers longitudinally on both sides of the pipe, not exceeding 6 inches (150 mm) in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 12 inches (300 mm) above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 12 feet (4 m), whichever is less. After the backfill has reached at least 12 inches (300 mm) above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 8 inches (200 mm).
3. Movement of Construction Machinery: When compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert or storm drain at any stage of construction shall be at the Contractor's risk. Any damaged pipe shall be repaired or replaced.
4. Compaction
   a. General Requirements: Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Cohesive materials include clayey and silty gravels, gravel-silt mixtures, clayey and silty sands, sand-clay mixtures, clays, silts, and very fine sands. When results of compaction tests for moisture-density relations are recorded on graphs, cohesionless soils will show straight lines or reverse-shaped moisture-density curves, and cohesive soils will show normal moisture-density curves.
   b. Minimum Density: Backfill over and around the pipe and backfill around and adjacent to drainage structures shall be compacted at the approved moisture content to the following applicable minimum density, which will be determined as specified below.
      1) Under airfield and heliport pavements, paved roads, streets, parking areas, and similar-use pavements including adjacent shoulder areas, the density shall be not less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material, up to the elevation where requirements for pavement subgrade materials and compaction shall control.
      2) Under unpaved or turfed traffic areas, density shall not be less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material.
      3) Under nontraffic areas, density shall be not less than that of the surrounding material.
5. Determination of Density: Testing shall be the responsibility of the Contractor and performed at no additional cost to the Owner. Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. Tests shall be performed in sufficient number to ensure that specified density is being obtained. Laboratory tests for moisture-density relations shall be made in accordance with ASTM D1557 except that mechanical tampers may be used provided the results are correlated with those obtained with the specified hand tamper. Field density tests shall be determined in accordance with ASTM D2167 or ASTM D2922. When ASTM D2922 is used, the calibration curves shall be checked and adjusted, if necessary, using the sand cone method as described in paragraph Calibration of the referenced publications.

ASTM D2922 results in a wet unit weight of soil and when using this method ASTM D3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D3017 or ASTM D2922. Test results shall be furnished the the Owner. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed.

I. Pipeline Testing

1. Leakage Tests: Lines shall be tested for leakage by low pressure air or water testing or exfiltration tests, as appropriate. Low pressure air testing for vitrified clay pipes shall conform to ASTM C828. Low pressure air testing for concrete pipes shall conform to ASTM C924/ASTM C924M. Low pressure air testing for plastic pipe shall conform to ASTM F1417. Low pressure air testing procedures for other pipe materials shall use the pressures and testing times prescribed in ASTM C828 or ASTM C924/ASTM C924M, after consultation with the pipe manufacturer. Testing of individual joints for leakage by low pressure air or water shall conform to ASTM C1103/ASTM C1103M. Prior to exfiltration tests, the trench shall be backfilled up to at least the lower half of the pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When the water table is 600 mm 2 feet or more above the top of the pipe at the upper end of the pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to the the Owner. An exfiltration test shall be made by filling the line to be tested with water so that a head of at least 2 feet (600 mm) is provided above both the water table and the top of the pipe at the upper end of the pipeline to be tested. The filled line shall be allowed to stand until the pipe has reached its maximum absorption, but not less than 4 hours. After absorption, the head shall be reestablished. The amount of water required to maintain this water level during a 2-hour test period shall be measured. Leakage as measured by the exfiltration test shall not exceed 250 gallons per inch in diameter per mile (60 liters per mm in diameter per kilometer) of pipeline per day **OR** 0.2 gallons per inch in diameter per 100 feet (9 mL per mm in diameter per 100 meters), **as directed**, of pipeline per hour. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished.
2. Deflection Testing: Perform a deflection test on entire length of installed plastic pipeline on completion of work adjacent to and over the pipeline, including leakage tests, backfilling, placement of fill, grading, paving, concreting, and any other superimposed loads. Deflection of pipe in the installed pipeline under external loads shall not exceed 4.5 percent of the average inside diameter of pipe. Determine whether the allowable deflection has been exceeded by use of a pull-through device or a deflection measuring device.
   a. Pull-through device: This device shall be a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Circular sections shall be so spaced on the shaft that distance from external faces of front and back sections will equal or exceed diameter of the circular section. Pull-through device may also be of a design promulgated by the Uni-Bell Plastic Pipe Association, provided that the device meets the applicable requirements specified in this paragraph, including those for diameter of the device. Ball, cylinder, or circular sections shall conform to the following:
      1) A diameter, or minor diameter as applicable, of 95 percent of the average inside diameter of the pipe; tolerance of plus 0.5 percent will be permitted.
      2) A homogeneous material throughout, with a density greater than 1.0 as related to water at 39.2 degrees F (4 degrees C), and a surface Brinell hardness of not less than 150.
      3) Center bored and through bolted with a 1/4 inch (6 mm) minimum diameter steel shaft having a yield strength of not less than 70,000 psi (483 MPa), with eyes or loops at each end for attaching pulling cables.
      4) Each eye or loop shall be suitably backed with a flange or heavy washer such that a pull exerted on opposite end of shaft will produce compression throughout remote end.

b. Deflection measuring device: Sensitive to 1.0 percent of the diameter of the pipe being tested and accurate to 1.0 percent of the indicated dimension. Deflection measuring device shall be approved by the the Owner prior to use.

c. Pull-through device: Pass the pull-through device through each run of pipe, either by pulling it through or flushing it through with water. If the device fails to pass freely through a pipe run, replace pipe which has the excessive deflection and completely retest in same manner and under same conditions as specified.

d. Deflection measuring device procedure: Measure deflections through each run of installed pipe. If deflection readings in excess of 4.5 percent of average inside diameter of pipe are obtained, retest pipe by a run from the opposite direction. If retest continues to show a deflection in excess of 4.5 percent of average inside diameter of pipe, remove pipe which has excessive deflection, replace with new pipe, and completely retest in same manner and under same conditions.

e. Warranty period test: Pipe found to have a deflection of greater than 5 percent of average inside diameter when deflection test is performed just prior to end of one-year warranty period shall be replaced with new pipe and tested as specified for leakage and deflection.

J. Field Painting

1. After installation, clean cast-iron frames, covers, gratings, and steps not buried in masonry or concrete to bare metal of mortar, rust, grease, dirt, and other deleterious materials and apply a coat of bituminous paint **OR** After installation, clean steel covers and steel or concrete frames not buried in masonry or concrete to bare metal of mortar, dirt, grease, and other deleterious materials. Apply a coat of primer and apply a top coat as specified in Division 09 Section "Exterior Painting", **as directed.** Do not paint surfaces subject to abrasion.

END OF SECTION 33 42 13 13

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Task	Specification	Specification Description
33 42 13 13	01 22 16 00	No Specification Required
33 42 13 13	21 05 23 00	Piped Utilities Basic Materials And Methods
33 42 13 13	22 05 76 00	Sanitary Sewerage
33 42 13 13	33 42 11 00	Storm Drainage
33 42 23 00	21 05 23 00	Piped Utilities Basic Materials And Methods
33 42 23 00	33 42 11 00	Storm Drainage
33 42 23 00	31 32 19 16	Sewage Treatment Lagoons
33 42 26 16	21 05 23 00	Piped Utilities Basic Materials And Methods
33 42 26 16	33 14 13 23	Sand Drains
33 42 26 16	33 42 11 00	Storm Drainage
33 42 26 19	21 05 23 00	Piped Utilities Basic Materials And Methods
33 42 26 19	33 42 11 00	Storm Drainage
33 42 26 23	33 42 11 00	Storm Drainage
33 42 31 00	21 05 23 00	Piped Utilities Basic Materials And Methods
33 42 31 00	33 42 11 00	Storm Drainage
33 42 31 00	31 32 19 16	Sewage Treatment Lagoons
33 42 33 00	21 05 23 00	Piped Utilities Basic Materials And Methods
33 42 33 00	33 42 11 00	Storm Drainage
33 42 33 00	31 32 19 16	Sewage Treatment Lagoons
33 42 36 00	21 05 23 00	Piped Utilities Basic Materials And Methods
33 42 36 00	33 42 11 00	Storm Drainage
33 42 36 00	31 32 19 16	Sewage Treatment Lagoons
33 44 36 00	22 13 19 26	Interceptors
33 44 36 00	28 46 00 00	Oil/Water Separator
33 46 53 00	21 05 23 00	Piped Utilities Basic Materials And Methods
33 46 53 00	33 14 13 23	Sand Drains
33 46 53 00	23 11 23 00	Relief Wells
33 52 16 13	01 22 16 00	No Specification Required
33 52 16 13	21 05 23 00	Piped Utilities Basic Materials And Methods
33 52 16 13	07 63 00 00	Common Work Results for Fire Suppression
33 52 16 13	07 63 00 00a	Common Work Results for Plumbing
33 52 16 13	07 63 00 00b	Common Work Results for HVAC
33 52 16 13	23 11 23 00b	Facility Natural-Gas Piping
33 52 16 13	23 11 23 00c	Facility Liquefied-Petroleum Gas Piping
33 52 16 23	23 11 23 00b	Facility Natural-Gas Piping
33 52 16 23	23 11 23 00c	Facility Liquefied-Petroleum Gas Piping
33 52 16 26	23 11 23 00b	Facility Natural-Gas Piping
33 52 16 26	23 11 23 00c	Facility Liquefied-Petroleum Gas Piping
33 53 16 00	21 05 23 00	Piped Utilities Basic Materials And Methods
33 59 11 00	21 05 23 00	Piped Utilities Basic Materials And Methods
33 59 16 00	21 05 23 00	Piped Utilities Basic Materials And Methods
33 61 13 00	21 05 23 00	Piped Utilities Basic Materials And Methods
33 61 13 00	33 14 13 23a	Hydronic Distribution
33 71 19 23	26 05 00 00	Common Work Results for Electrical
33 71 19 23	26 05 19 16	Common Work Results for Communications
33 71 19 23	26 05 19 16a	Common Work Results for Electronic Safety and Security
33 71 19 23	26 05 19 16d	Communications Equipment Room Fittings
33 71 19 23	26 05 19 16e	Communications Backbone Cabling
33 71 19 23	26 05 19 16f	Communications Horizontal Cabling
33 71 19 23	26 05 19 16g	Conductors and Cables for Electronic Safety and Security

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Task	Specification	Specification Description
34 01 43 00	01 22 16 00	No Specification Required
34 05 43 00	32 01 13 61	Asphalt Paving
34 05 43 00	32 12 13 13	Bituminous Paving-Repair And Resurfacing
34 05 43 00	32 12 13 13a	Asphaltic Concrete Overlays
34 05 43 00	03 41 23 00	Plant-Precast Structural Concrete
34 05 43 00	03 01 30 71	Concrete Rehabilitation
34 05 43 00	05 05 21 00	Structural Steel
34 05 43 00	05 12 23 00	Cold-Formed Metal Framing
34 05 43 00	05 50 00 00	Metal Fabrications

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SECTION 34 41 13 00 - ELECTRICAL TRAFFIC CONTROL SIGNALS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of electrical traffic control signals. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCT

A. General: Replacement equipment items shall be regularly manufactured products.

B. Concrete Poles: Cement ASTM C 150; aggregate ASTM C 33; minimum compressive strength 6,000 psi when tested in compliance with AASHTO T22. Tensioning steel shall comply with ASTM A 603. Strands shall not be tensioned above 70 percent of the rated ultimate strength. Epoxy compound for sealing hollow cores shall comply with ASTM D 1763.

C. Galvanized Conduit Nipples: UL 514B.

D. Ground Wire: Cast-in-concrete pole, No. 6 stranded bare wire, ASTM A 603.

E. Wood Poles: ANSI 05.1, waterborne preservative-treated in compliance with AWPA C3, Retention Zone 1.

F. Structural Steel: ASTM A 36.

G. Steel Pipe: ASTM A 53.

H. Steel Bars: ASTM A 576.

I. Wire Strand: ASTM A 475.

J. Zinc Coatings: Members, ASTM A 123; fasteners, ASTM A 153.

K. Mast Arms for Supporting Traffic Signals: ASTM A 36; aluminum alloy 3003, or alloy alcad 3004 complying with ASTM B 209.

L. Concrete for Pull Boxes: ASTM C 94, 3,000 psi.

M. Cast-Iron Covers: ASTM A 48.

N. Signal Lens: Manufactured in compliance with Article 5 and 6, ITE Technical Report Number 1.

O. Loop Wire for Vehicle Detectors: No. 14 AWG or No. 12 AWG, stranded copper wire, type TTHN, THWN, or THW, ASTM B3.

P. Grout: One part cement complying with ASTM C 150 and two parts sand complying with ASTM C 33.

Q. Conduit: Polyvinyl chloride, UL 651, Schedule 40 or galvanized rigid metal, ASTM B 3.

R. Ground Wire: Soft drawn copper, bare, stranded, ANSI C7.1.

S. Electrical Work: NFPA No. 70.

1.3 EXECUTION

A. Scheduling and Coordination: The Contractor shall ensure that required notices have been given and that power interruptions have been scheduled and approved.

B. Traffic: Provide temporary traffic signs at and around work area. Signs and locations shall be as approved by the the Owner.

C. Vehicle Detector Assemblies, Loop Type: Saw out existing loops to be replaced to their full depth. Install and seal loop wire. Splice and solder loop wire and lead-in cable and wrap a minimum of two wraps with silicone tape and heavy-duty electrical tape. Install sealant in compliance with the manufacturer's recommendations. Excavate and remove existing lead-in cable to be replaced, and install new lead-in cable in place and connect to cabinet ground.

END OF SECTION 34 41 13 00

Task	Specification	Specification Description
34 41 13 00	01 22 16 00	No Specification Required
34 41 13 00	05 15 16 00	Ornamental Metal
34 41 13 00	27 11 19 00	Loose-Tube Gel-Filled Fiber Optic Cables
34 41 13 00	26 05 33 16a	Wiring Devices
34 41 16 00	34 41 13 00	Electrical Traffic Control Signals
34 43 13 16	26 05 13 16a	Undercarpet Cables
34 43 13 16	26 05 13 16b	Medium-Voltage Cables

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SECTION 34 71 13 13 - BEAM-TYPE GUARDRAIL

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for beam-type guardrail. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.
2. Shop drawings shall be submitted for approval.

1.2 PRODUCTS

A. Rail Elements, End Sections, and Fasteners
1. ARTBA technical bulletin No. 268-B.
2. Provide galvanized steel W-beam in accordance with AASHTO M-180, class A, type 1.
3. Shop curve rail elements when required radius of installation on horizontal curve is 150 ft (46 m) or less. Provide W-beam rail (ARTBA RE-3) with a flared end section (ARTBA RE-5), rounded end section (ARTBA RE-6) at each end of installations.
4. Provide standard back-up plates behind rail elements at all intermediate, non-splice posts when steel posts and blocks are used.
5. Galvanize the rail sections, including end sections, in accordance with ASTM A 525, coating G-210.

B. Posts
1. Wood: Provide wood posts with blocks, size as required by State DOT. Rough sawn or S4S timber of Douglas Fir or any other locally approved species that is either No. 1 grade or Select Structural grade when graded in accordance with the requirements for Timber and Posts as set forth in WWPA-01 may be used. Give all wood posts and blocks a preservative treatment in accordance with the requirements of AASHTO M-133. Cut to length and bore posts and blocks for bolt holes before treatment.
2. Steel: Provide steel posts with blocks. Fabricate posts and blocks from W6X9 structural steel shapes complying with the requirements of ASTM A 36. Fabricate in the shop, grind smooth all corners and edges, galvanize posts and blocks after fabrication in accordance with ASTM A 123.

C. Bolts, Nuts, and Washers
1. Provide galvanized bolts, nuts, and washers that meet common ARTBA standards, designed to develop the required joint strength. Provide bolts with rounded heads to provide minimum obstruction.
2. Provide galvanized steel bolts conforming to the requirements of ASTM A 307, nuts conforming to the requirements of ASTM A 563, Grade A or better and galvanized steel washers, all galvanized in accordance with the requirements of ASTM A 153. Provide high strength bolts conforming to the requirements of ASTM A 325 where needed.

D. Reflectors: Provide guardrail reflectors as indicated. Place the galvanized steel tabs with reflective sheeting at every post except no reflectors are to be placed along the guardrail end flares.

E. Breakaway Cable Terminal (BCT) Assemblies: Provide BCT assemblies in accordance with the ARTBA details and standards referenced on the details.

F. Concrete and Reinforcement for the Post Footings: In accordance with applicable sections of Division 03 Section "Cast-in-place Concrete".

1.3 EXECUTION

A. Guardrail: Erect steel beam-type guardrail in locations and to lines and grades as directed and in accordance with details indicated.

B. Erection
1. Firmly set posts spaced at 6 ft. 3 in. (1.9 m) centers to the required depth. Set posts by placing in hand or mechanically dug holes or by driving, with or without pilot holes. Backfill gaps around posts with approved material that is moistened and thoroughly compacted. Repair damaged roadway surfacing where pavement is disturbed.
2. Position the top of W-beam rail at 27 in. (0.69 m) above the finished roadway surface. Align rail both vertically and horizontally within 1/4-in. (6 mm) from the theoretical alignments. Lap the rail sections at posts, in the direction of traffic in the adjacent lane, and lap end sections on the face of the rail.
3. Exercise care to avoid damage to treated wood and galvanized steel parts. Repair or replace damaged parts at the Contractor's expense. Securely tighten all bolts in the finished guardrail. Toenail the wood blocks to wood posts with two 16 penny galvanized nails, one on each side of the top of the block.

END OF SECTION 34 71 13 13

SECTION 34 71 13 16 - ACTIVE VEHICLE BARRIERS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for active vehicle barriers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. Shop Drawings: Installation, Equipment, and Electrical Work
      a. Detail drawings containing complete wiring and schematic diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including foundation and clearances for maintenance and operation. For Federal work, detail drawings shall include a copy of the Department of State certificate of barrier performance.
   2. Product Data:
      a. Vehicle Barriers: A complete list of equipment, materials, including industrial standards used and how they apply to the applicable component and manufacturer's descriptive data and technical literature, catalog cuts, and installation instructions. Information necessary to document a minimum 1-year successful field operation performance history for each type of vehicle barrier installed.
      b. Spare Parts: Spare parts data for each different item of material and equipment used, after approval of the detail drawings. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.
   3. Test Reports
      a. Field Testing: Test reports in booklet form showing all field tests, including component adjustments and demonstration of compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of controls.
   4. Operation and Maintenance Data
      a. Vehicle Barriers: Operating and Maintenance Instructions
         1) Six copies of operation and maintenance manuals, a minimum of 2 weeks prior to field training. One complete set prior to performance testing and the remainder upon acceptance. Manuals shall be approved prior to acceptance. Operation manuals shall outline the step-by-step procedures required for system startup, operation, and shutdown. The manuals shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall include routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals shall include piping layout, equipment layout, and simplified wiring and control diagrams of the system as installed. The manuals shall also include synthetic biodegradable hydraulic oil types to be used for ambient temperature ranges of minus 30 degrees F (minus 34 degrees C) to 150 degrees F (plus 66 degrees C) to cover winter operation, summer operation, and ambient temperature ranges in between.

C. General Requirements
   1. Performance levels shall be based on the following:
      a. The Department of State (DOS) publication SD-SDT-02.01 Specification for Vehicle Crash Testing of Perimeter Barriers and Gates (April 1985) in which:
         1) Impact Conditions:

Condition Designation	Vehicle Weight	Impact Speed	Kinetic Energy
K4	15,000 lb (6,800 kg)	30 mph (48 km/h)	450,000 ft-lb (610 kJ)
K8	15,000 lb (6,800 kg)	40 mph (65 km/h)	800,000 ft-lb (1084 kJ)
K12	15,000 lb (6,800 kg)	50 mph (80 km/h)	1,250,000 ft-lb (1695 kJ)

2) Performance Levels:
   a) L 3.0 Vehicle and cargo are to be stopped although vehicle partial penetration and/or barrier deflection of up to 3 feet (1 m) permitted.
   b) L 2.0 Vehicle and cargo are to be stopped although vehicle partial penetration and/or barrier deflection of up to 20 feet (6 m) is permitted.
   c) L 1.0 Vehicle is disabled and does not travel more than 50 feet (15 m) after impact.

2. Vehicle Barriers furnished shall in all respects be identical to the unit tested and certified except for the width of the vehicle barrier, which is as indicated and except for bollards which have a diameter based on a required crash rating. Crash test shall be performed and data compiled by an approved independent testing agency. Test vehicle shall not vault or penetrate the barrier during the test. The design and structural materials of the vehicle barrier furnished shall be the same as those used in the crash tested barrier.

D. Nameplates
1. Nameplate data shall be permanently attached to each vehicle barrier. The data shall be legibly marked on corrosion-resistant metal plates and shall consist of at least the following:
   a. Manufacturer's name.
   b. Model number.
   c. Serial number.
   d. Date of manufacture.

E. Delivery And Storage
1. Components placed in storage shall be protected from the weather, humidity, and temperature variation, dirt and dust, or other contaminants. Structural materials shall be stored on sleepers or pallets and shall be protected from rust and objectionable materials such as dirt, grease, or oil.

F. Spare Parts
1. A manufacturer's standard recommended spare parts package, with current unit prices and source of supply complete with detailed manuals on parts replacement, shall be provided with each barrier to facilitate 1 year of normal operation. Particular consideration shall be given to system components which are not readily available from local or commercial sources and which are critical to the operation of the system.

G. Manufacturer's Services
1. Services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment supplied shall be available. The representative shall supervise the installation, adjustment, and testing of the equipment.

1.2 PRODUCT

A. Retractable Barriers: When in the raised position, the total retractable barrier heights shall be no less than 28 inches (711 mm) above the roadway surface and shall be 144 inches (3.66 m) wide. When in the lowered position, the retractable barrier shall extend no more than 5/8 inch (16 mm) above the roadway surface. Retractable barriers in the lowered position shall be capable of supporting a 32,000 pound (142 kN) axle load or a 16,000 (71 kN) wheel load. Design for this load shall be in accordance with AASHTO HB-17.
1. Powered Retractable Barrier: The retractable barrier shall be capable of 300 complete up/down cycles per hour. The retractable barrier motion shall be instantly reversible and shall be capable

of raising the barrier from the lowered position to the raised position within 8 seconds during normal use, and within 2 seconds during an emergency. Also, the barrier shall be capable of being lowered from the raised position to the lowered position in not more than 3 seconds. Retractable barrier shall withstand a K4 **OR** K8 **OR** K12, **as directed**, impact condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**.

a. Failure Modes of Operation: The system shall be designed to remain in the last commanded position in the event of hydraulic, electrical, or mechanical failure. A manual pump, or other system, shall be included for operation of hydraulic barriers without power.

b. Electric Motors: Unless otherwise indicated, electric motors shall have drip-proof **OR** totally enclosed **OR** totally enclosed fan cooled, **as directed**, enclosures. All couplings, motor shafts, gears, and other moving parts shall be fully guarded in accordance with 29 CFR 1910 Subpart O. Guards shall be removable without disassembling the guarded unit. For multiple barriers operated from a single hydraulic unit it is highly recommended that the electric motor be 3-phase.

c. System: The system shall be designed to maintain the barriers in the raised position, without inspection, for periods of time of up to 1 week. If a hydraulic system is used, it shall be equipped with pressure relief valves to prevent overpressure. The system shall not require continuous running of the motor to stay in the raised position, excluding the use of manual pinning to do so.

d. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Buried hydraulic lines for the connection of the hydraulic power unit to the barrier shall be flexible or carbon steel pipe, or a combination of flexible and carbon steel pipe. Flexible and rigid hydraulic line working pressures shall exceed the maximum system relief pressure. PVC pipe and fittings for burial of hydraulic lines shall be in accordance with ASTM D 3034 Type PS 46 with minimum pipe stiffness of 46.

   1) Flexible hydraulic lines shall be in accordance with SAE J517.
   2) Rigid hydraulic lines shall be seamless carbon steel pipe in accordance with ASTM A 106.

e. Hydraulic Power Unit Enclosure: A NEMA Type 3R enclosure as specified in NEMA 250 shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable/lockable (exterior) door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.

2. Manual Retractable Barriers: The manual barrier shall be capable of being raised and lowered by manual means such as levers or hydraulics requiring a maximum 60 pounds (267 N) of force. The manual mechanism shall contain a locking pin which accepts a padlock for securing the barrier when it is in the "UP" position. Retractable barrier shall withstand a K4 **OR** K8 **OR** K12, **as directed**, impact condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**. Barrier should be capable of being locked in the down position.

B. Retractable Bollards: The total bollard height when in the raised position shall be no less than 30 inches (750 mm) above the roadway surface and shall have an outside diameter of no less than 8 inches (200 mm). A bollard system shall consist of a minimum of 3 bollards spaced no more than 36 inches (915 mm) from centerline to centerline of bollards across a 10 foot (3.0 m) roadway. Bollards in the lowered position shall be capable of supporting a 16,000 pound (71 kN) wheel load each. Design for this load shall be in accordance with AASHTO HB-17. Retractable bollards shall withstand a K4 **OR** K8 **OR** K12, **as directed**, Impact Condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**.

1. Powered Retractable Bollards: The retractable bollard shall be capable of 300 complete up/down cycles per hour. Bollards shall be capable of being raised or lowered within a 3 to 15-second range during normal use and within 2.5 seconds for emergency operations.
   a. Failure Modes of Operation: The system shall be designed to prevent lowering of the barrier in the event of hydraulic, electrical, or mechanical failure. A manual pump, or other system, shall be included for operation of hydraulic and/or mechanical barriers without power.
   b. Electric Motors: Unless otherwise indicated, electric motors shall have drip-proof **OR** totally enclosed, **as directed**, enclosures. For multiple barriers being operated from a hydraulic power unit it is highly recommended that the electric motor be 3-phase.
   c. System: The system shall be designed to maintain the barriers in the raised position, without inspection, for period of time of up to 1 week. If a hydraulic system is used, it shall be equipped with pressure relief valves to prevent overpressure.
   d. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range, if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Buried hydraulic lines for the connection of the hydraulic power unit to the barrier shall be flexible or carbon steel pipe, or a combination of flexible and carbon steel pipe. Flexible and rigid hydraulic line working pressures shall exceed the maximum system relief pressure. PVC pipe and fittings for burial of hydraulic lines shall be in accordance with ASTM D 3034 Type PS 46 with minimum pipe stiffness of 46.
      1) Flexible hydraulic lines shall be in accordance with SAE J517.
      2) Rigid hydraulic lines shall be seamless carbon steel pipe in accordance with ASTM A 106.
   e. Hydraulic Power Unit Enclosure: A NEMA Type 3R enclosure as specified in NEMA 250 shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable/lockable (exterior) door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.
2. Manual Retractable Bollards: Manual bollards shall be capable of being raised and lowered utilizing a recessed handle on the top surface of the bollard or a manual hydraulic pump, either requiring a maximum 60 pounds (267 N) of force. A mechanism, that is lockable, shall be provided to secure the bollard in either the full "UP" or full "DOWN" position.

C. Crash Gate: The crash gate shall consist of steel buttresses anchored into the ground and an above grade assembly consisting of a heavy steel structure or a combination of heavy steel and structural aluminum capable of being opened and closed. The height of the gate shall be a minimum of 84 inches (2.1 m) from the road surface to the top of the gate frame. The length shall close and protect a minimum 120 inch (3.0 m) clear opening. The maximum clear opening between the gate frame and end posts, between the bottom of the gate and finished grade, and between any grill work shall be 3 inches (75 mm).

1. Powered Crash Gate: The gate movement shall be controlled by an electro-mechanical gate operator **OR** a hydraulic gate operator, **as directed**, consisting of an operator unit with required control circuits and operator station. The control and operating voltage shall be 24 vac (nominal) or, as an option 24 vdc. A remote control master station shall be capable of driving the gate at minimum 48 fpm (14.6 m per minute) for a slide gate or 6 degrees per second for a swing gate. Unless otherwise indicated, motors shall have drip-proof **OR** totally enclosed, **as directed**, enclosures. Crash gate shall withstand a 15,000 pound (6804 kg) vehicle at impact speed of 30 **OR** 40 **OR** 50, **as directed**, mph (48 **OR** 64 **OR** 80, **as directed**, km/hour), with maximum barrier deflection or vehicle penetration of 3 feet (1 m).

a. Failure Mode of Operation: The system shall be designed to prevent opening of the crash gate in the event of electrical or mechanical failure. A disconnect system for the gate drive shall be provided to allow manual operation of the barrier in the event of a power outage.

b. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity within its operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Buried hydraulic lines for the connection of the hydraulic power unit to the barrier shall be flexible or carbon steel pipe, or a combination of flexible and carbon steel. Flexible and rigid hydraulic line working pressures shall exceed the maximum system relief pressure. PVC pipe and fittings for burial of hydraulic lines shall be in accordance with ASTM D 3034 Type PS 46 with minimum pipe stiffness of 46.

1) Flexible hydraulic lines shall be in accordance with SAE J517.

2) Rigid hydraulic lines shall be seamless carbon steel pipe in accordance with ASTM A 106.

c. Hydraulic Power Unit Enclosure: A NEMA Type 3R enclosure as specified in NEMA 250 shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable/lockable (exterior) door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.

2. Manual Crash Gate: The manual crash gate shall be capable of being hinged from either side. Hinge points of both buttresses shall each contain a locking pin with padlock acceptance for securing the crash gate in the closed position. The crash gate shall withstand a 10,000 pound (4535 kg) vehicle at impact speed of 50 mph (80 km/hour), with maximum gate deflection or vehicle penetration of 10 feet (3 m) 15,000 pound (6804 kg) vehicle traveling at impact speed of 30 **OR** 40 **OR** 50, **as directed**, mph (48 **OR** 64 **OR** 80, **as directed**, km/hour), with a maximum gate deflection or vehicle penetration of up to 3 feet (1 m).

D. Crash Beam: The crash beam shall be an above-grade assembly that, in the "DOWN" position, shall present a visible obstacle to approaching vehicles. The height of the barrier shall be a minimum of 30 inches (750 mm) as measured from the roadway surface to the centerline of the crash beam. The crash beam shall be capable of blocking a minimum road width of 120 inches (3.0 m). The crash beam end shall contain a locking pin with padlock acceptance for securing the crash beam when it is in the "DOWN" position. Crash beam shall withstand a 15,000 pound (6804 kg) vehicle traveling at 30 **OR** 40 **OR** 50, **as directed**, mph (48 **OR** 64 **OR** 80, **as directed**, km/hour), with maximum vehicle penetration of 20 feet (6 m) 10,000 pound (4535 kg) vehicle at impact speed of 15 mph (24 km/hour), with a maximum vehicle penetration of 10 feet (3 m).

1. Powered Crash Beam: The crash beam shall be operated by means of a hydraulic power system. The crash beam shall be capable of being raised or lowered within an 8 to 15 second time range.

a. Failure Mode of Operation: A disconnect system for the crash beam shall be provided to allow manual operation of the barrier in the event of an electrical or mechanical failure.

b. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Buried hydraulic lines for the connection of the hydraulic power unit to the barrier shall be flexible or carbon steel pipe or a combination of flexible and carbon steel pipe. Flexible and rigid hydraulic line working pressures shall exceed the maximum system relief pressure. PVC pipe and fittings for burial of hydraulic lines shall be in accordance with ASTM D 3034 Type PS 46 with minimum pipe stiffness of 46.

1) Flexible hydraulic lines shall be in accordance with SAE J517.
2) Rigid hydraulic lines shall be seamless carbon steel pipe in accordance with ASTM A 106.

c. Hydraulic Power Unit Enclosure: A NEMA Type 3R enclosure as specified in NEMA 250 shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit components and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable/lockable exterior door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.

2. Manual Crash Beam: The crash beam shall be manually raised and lowered with the aid of a counterbalanced end requiring approximately 60 pounds (267 N) of force.

E. Portable Retractable Barrier: The portable retractable barrier shall be transportable and capable of manual and/or electro-mechanical operation. When in the raised position, the total barrier heights shall be no less than 28 inches (711 mm) above the roadway surface and shall be up to 144 inches (3.66 m wide). The barrier shall be equipped with entrance/exit ramps when the barrier extends more than 5/8 inch (16 mm) above the roadway surface. Retractable barriers in the lowered position shall be capable of supporting a 32,000 pound (142 kN) axle load or a 16,000 (71 kN) pound wheel load. Design for this load shall be accordance with AASHTO HB-17.

1. Powered Portable Retractable Barrier: The portable retractable barrier shall be capable of 300 complete up/down cycles per hour. The retractable barrier motion shall be instantly reversible and shall be capable of raising the barrier from the lowered position to the raised position within 8 seconds during normal use, and within 2 seconds during an emergency. Also, the barrier shall be capable of being closed from the raised position to the lowered position in not more than 3 seconds. Retractable barrier shall withstand a K4 **OR** K8 **OR** K12, **as directed**, impact condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**. Portable retractable barrier, when impacted by a 15,000 pound (6,800 kg) vehicle at impact speed of 50 mph (80 km/hour) shall disable the vehicle and allow it to travel no more than 50 feet (15.2 m) after impact. Portable power assisted retractable barriers shall be equipped with on and off ramps for smooth transition between surfaces when the barrier extends more than 5/8 inch (16 mm) above the roadway surface.

a. Failure Modes of Operation: The system shall be designed to prevent lowering of the barrier in the event of hydraulic, electric, or mechanical failure. A manual pump shall be included for operation of hydraulic and/or mechanical barriers without power.

b. Electric Motors: Unless otherwise indicated, electric motors shall have drip-proof **OR** totally enclosed, **as directed**, enclosures.

c. System: The system shall be designed to maintain the barriers in the raised position, without inspection, for periods of time of up to 1 week. If a hydraulic system is used, it shall be equipped with pressure relief valves to prevent overpressure.

d. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Flexible hydraulic lines shall be used for the connection of the hydraulic power unit to the barrier. Flexible hydraulic line working pressures shall exceed the maximum system relief pressure; flexible hydraulic lines shall be in accordance with SAE J517.

2. Manual Retractable Portable Barriers: The manual barrier shall be capable of being raised and lowered by manual means such as levers or hydraulics requiring a maximum 60 pounds (267 N) of force. The manual mechanism shall contain a locking pin which accepts a padlock for securing the barrier when it is in the "UP" position and shall also be capable of being locked in the

"DOWN" position. Retractable barrier shall withstand a K4 **OR** K8 **OR** K12, **as directed**, impact condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**

F. Portable Crash Beam: The portable crash beam shall be an above-grade assembly that, in the "DOWN" position, shall present a visible obstacle to approaching vehicles. The height of the barrier shall be a minimum of 30 inches (750 mm) as measured from the roadway surface to the centerline of the crash beam. The crash beam shall be capable of blocking a minimum road width of 120 inches (3.0 m). The crash beam end shall contain a locking pin with padlock acceptance for securing the crash beam when it is in the "DOWN" position. Crash beam shall withstand a 15,000 pound (6804 kg) vehicle traveling at 30 mph (48 km/hour), with maximum vehicle penetration and/or barrier deflection of 20 feet (6 m).
   1. Powered Portable Crash Beam: The portable crash beam shall be operated by means of a hydraulic power system. The crash beam shall be capable of being raised or lowered within an 8 to 15 second time range.
      a. Failure Mode of Operation: A disconnect system for the portable crash beam shall be provided to allow manual operation of the barrier in the event of an electrical or mechanical failure.
      b. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Flexible hydraulic lines shall be used for the connection of the hydraulic power unit to the barrier. Flexible hydraulic line working pressures shall exceed the maximum system relief pressure; flexible hydraulic lines shall be in accordance with SAE J517.
      c. Hydraulic Power Unit Enclosure: A weather resistant enclosure shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit components and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable lockable (exterior) door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.
   2. Manual Portable Crash Beam: The crash beam shall be manually operated by means of a counter balanced system requiring approximately 60 pounds (267 N) of force.

G. Electrical Work: Motors, manual or automatic motor control equipment except where installed in motor control centers and protective or signal devices required for the operation specified herein shall be provided in accordance with Division 22. All field wiring for loop detectors, communication lines, and power circuits shall have surge protection. Any wiring required for the operation specified herein, but not shown on the electrical plans, shall be provided under this section in accordance with Division 22.

H. Control Panel: A control panel and control circuit shall be provided to interface between all barrier control stations and the power unit. A control panel shall be provided for the inbound lanes and a separate one for the outbound lanes where the barriers are located. The control station is defined as the main control panel and the remote control panel as shown. The control circuit shall contain all relays, timers, and other devices or an industrial programmable controller programmed as necessary for the barrier operation. The control panel shall allow direct interface with auxiliary equipment such as card readers, remote switches, loop detectors, infrared sensors, and sliding **OR** swinging, **as directed**, gate limit switches. Loop controllers shall not cause an automatic barrier raise following power loss or restoration. The enclosure shall be as indicated on the drawings. All device interconnect lines shall be run to terminal strips.
   1. Voltage: The control circuit shall operate from a 120 volt 60 **OR** 50, **as directed**, Hz supply. The control circuit voltage shall be 12 **OR** 24, **as directed**, ac **OR** dc, **as directed**, for all external control panels.

2. Main Control Panel: A main control panel shall be supplied to control barrier function. This panel shall have a key-lockable main switch with main power "ON" and panel "ON" lights. Buttons to raise and lower each barrier **OR** set of barriers, **as directed**, shall be provided. Barrier "UP" and "DOWN" indicator lights shall be included for each barrier **OR** set of barriers, **as directed**. An emergency fast operate circuit (EFO) shall be operated from a push button larger than the normal controls and have a flip safety cover installed over the push button or toggle switch. The EFO shall also be furnished with an EFO-active light and reset button. The main control panel shall have a key lockable switch to arm or disable the remote control panel. An indicator light shall show if the remote control panel is enabled.
3. Remote Control Panel: A remote control panel, one panel for the inbound lane(s) and a separate panel for the outbound lane(s), shall have a panel "ON" light that is lit when enabled by a key lockable switch on the main control panel. Buttons to raise and lower each barrier shall be provided. Barrier "UP" and "DOWN" indicator lights shall be included for each barrier. The EFO shall be operated from a push button larger than the normal controls and have a flip safety cover installed over the push button or toggle switch. Activation of either EFO will operate all barriers. The EFO shall be interconnected with an EFO-active light. When the remote control panel EFO is pushed, operation of the barrier will not be possible from this panel until reset at the main control panel.

I. Miscellaneous Equipment
1. Safety Equipment
   a. Barrier Systems Sensors: The sensors shall be compatible with the barrier controller and shall function as part of a complete barrier control system. The barrier system sensors shall consist of the following:
      1) Suppression Loops - Two inductive loops whose outputs shall be used to prevent barriers raising when a vehicle is within a prescribed distance of the barrier. The output of the loops shall override all barrier rise signals until one second after a vehicle clears the suppression loop.
      2) Speed Loops - Two inductive loops whose output shall be used to signal the barrier controller of a vehicle approaching at a speed greater than the posted speed (25 mph (11.2 m/sec) or less (recommended)). The speed loops shall cause the barrier control panel to annunciate a warning sound alerting the guard to make a decision as to whether the barrier should be raised or not.
      3) Wrong Way Loops - Two inductive loops whose output shall be used to signal the barrier control panel to ennunciate a warning sound if a vehicle is attempting to enter the facility through the exit lane. The warning sound will alert the guard to make a decision as to whether the barrier should be raised or not.
   b. Traffic Lights: Red/yellow 8 inch (200 mm) traffic lights shall be supplied for each entrance and exit to alert motorists of the barrier position. Traffic lights are not required for manual barriers. The yellow flashing light shall indicate that the barrier is fully open. All other positions shall cause the light to show red. Brackets shall be supplied to allow the light to be mounted a minimum 4.5 feet (1.4 m) above the roadway pavement on a 3.5 inch (90 mm) outside diameter metal post or mounted directly on the crash gate.
2. Warning Annunciator: Provide a warning annunciator built into the barrier control panel that produces a pulsing audible sound when the speed loop detects a vehicle entering the facility with excess speed. Provide a warning annunciator built into the barrier control panel that produces a continuous sound whenever a wrong way loop detects a vehicle entering from the exit. The warning annunciator shall sound until a warning annunciator silence reset button is pressed.
3. Heater: A waterproof barrier heater with a thermostat control and NEMA 4 junction box connection point shall be provided for de-icing and snow melting. The heater shall provide barrier operation to an ambient temperature of minus 40 degrees F (minus 40 degrees C). For retractable bollards, a 250-watt heater shall be provided for each bollard.
4. Signage: Signage shall read "Axle Weight Limit 9 Tons" and shall conform to FHWA SA-89-006 sign (R12.2).

5. Vertical Arm Gates (Traffic Arms): Vertical arm gates shall have an opening and closing time of less than or equal to 5 seconds. The gates shall be capable of 500 duty cycles per hour as a minimum. Gate shall operate the arm through 90 degrees. Gate operators shall be supplied with single phase 120 volt motors. Each entry lane shall be provided with a vertical arm gate. Each gate shall be capable of being operated from a remote open-close push button station in each guard booth and the gatehouse for the respective entry lane. Gates shall have a hand-crank, or other means, which will allow manual operation during power failures. Gate arms shall be constructed out of wood, steel, fiberglass, or aluminum, as specified by the manufacturer for the given lengths as shown on the drawings. Gate arms shall be covered with 16 inch (406 mm) wide reflectorized red and white sheeting. Each gate shall be furnished with a spare gate arm. Gate operator cabinets shall be constructed of galvanized steel, or aluminum and shall be painted manufacturers standard color as approved. Each gate operator shall be provided with an obstruction detector that will automatically reverse the gate motor when an obstruction is detected. The obstruction detector shall be any of the following 3 types: An electronic loop vehicle detector buried in the road, a photocell electric eye mounted on the gate operator, or a safety strip mounted on the lower edge of the arm. The detector system shall be automatically deactivated when the arm reaches the fully lowered position. Slab size and anchorage for gate operator shall be per manufacturer requirements.
6. Vehicle Barrier Vertical Arm Gate (Traffic Arm): A traffic arm, as a separate piece of equipment, will be included with each non-portable active vehicle barrier as part of the barrier safety operating system. This traffic arm shall automatically deploy (close) when the emergency up button is activated and open when the vehicle barrier is reset. This traffic arm will not be equipped with an automatic obstruction detector.

J. Finish: Surfaces shall be painted in accordance with requirements of Division 09 Section(s) "Exterior Painting" OR "Interior Painting", as applicable. The roadway plate shall have a nonskid surface painted white with reflective red 4 **OR** 6, **as directed**, inch (100 **OR** 150, **as directed**, mm) wide red reflective stripes 4 inches (100 mm) apart. The barrier front shall be painted white and have 4 **OR** 6, **as directed**, inch (100 **OR** 150, **as directed**, mm) wide reflective red stripes 4 inches (100 mm) apart. The diagonal striping should point down and outward from the center of the device. Bollards shall be painted white with 2 **OR** 3, **as directed**, inch (50 **OR** 75, **as directed**, mm) wide reflective red diagonal stripes. The barrier crash gate shall be painted as specified by purchaser and the crash beam shall be painted white with 3 inch (75 mm) wide reflective red diagonal stripes.

K. Concrete: The concrete shall conform to Division 03 Section "Cast-in-place Concrete".

L. Welding: Welding shall be in accordance with AWS D1.1/D1.1M.

M. Pavement: After placement of the vehicle barrier, the pavement sections shall be replaced to match the section and depth of the surrounding pavement. Pavement shall be warped to match the elevations of existing pavement. Positive surface drainage, away from the vehicle barrier, shall be provided by pavement slope.

1.3 EXECUTION

A. Installation: Installation shall be in accordance with manufacturer’s instructions and in the presence of a representative of the manufacturer. Manufacturer's representative shall be experienced in the installation, adjustment, and operation of the equipment provided. The representative shall also be present during adjustment and testing of the equipment.

B. Hydraulic Lines: Buried hydraulic lines shall be placed in polyvinyl chloride (PVC) sleeves. Positive drainage shall be provided from the hydraulic power unit to the barrier for drainage of condensation within the PVC sleeve.

C. Pit Drainage: A drain connection and oil/water separator, **as directed**, shall be provided in each barrier that requires pit/vault type construction. Hookups between the storm drains shall be made. The self-priming sump pump shall have the capacity to remove minimum 150 gallons per minute (34 cubic meters per hour).

D. Electrical: All control power wiring requiring compression terminals shall use ring-style terminals. Terminals and compression tools shall conform to UL 486A. Roundhead screws and lockwashers shall be used to provide vibration-resistant connections. Connections between any printed circuit cards and the chassis shall be made with screw connections or other locking means to prevent shock or vibration separation of the card from its chassis. The electrical power supply breaker for the hydraulic power unit shall be capable of being locked in the power on and power off positions.

E. Field Testing: Upon completion of construction, a field test shall be performed for each vehicle barrier. The test shall include raising and lowering the barrier, both electrically and manually, through its complete range of operation. Each vehicle barrier shall then be continuously cycled for not less than 30 minutes to test for heat build-up in the hydraulic system. the Owner shall be notified at least 7 days prior to the beginning of the field test. The Contractor shall furnish all equipment and make all necessary corrections and adjustments prior to tests witnessed by the Owner. Any conditions that interfere with the proper operation of the barrier disclosed by the test shall be corrected at no additional cost to the Owner. Adjustments and repairs shall be done by the Contractor under the direction of the Owner. After adjustments are made to assure correct functioning of components, applicable tests shall be completed.

F. Field Training: A field training course shall be provided for designated operating staff members. Training shall be provided for a total period of not less than 8 hours (for electrical/hydraulic operated units) or 1 hour (for manually operated units) of normal working time and shall start after the system is functionally complete but prior to final acceptance tests. Field training shall cover all of the items contained in the operating and maintenance instructions.

END OF SECTION 34 71 13 16

Task	Specification	Specification Description
34 71 13 16	34 71 13 13	Beam-Type Guardrail
34 71 13 26	01 22 16 00	No Specification Required
34 71 13 26	34 71 13 13	Beam-Type Guardrail
34 71 16 00	01 22 16 00	No Specification Required
34 71 16 00	34 71 13 16	Active Vehicle Barriers
34 71 16 00	34 71 13 13	Beam-Type Guardrail
34 71 19 16	11 12 16 00	Parking Control Equipment
34 71 19 16	11 12 16 00a	Prefabricated Control Booths
34 82 23 00	01 22 16 00	No Specification Required
34 82 26 00	01 22 16 00	No Specification Required

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Task	Specification	Specification Description
35 05 70 00	01 22 16 00	No Specification Required

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SECTION 35 22 26 00 - SLUICE GATE

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of sluice gate. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCTS

A. Sluice Gates: The sluice gate shall conform to the latest edition of AWWA 501 Sluice Gate Standards. Gate and accessories shall be as manufactured by Rodney Hunt Company or Hydrogate, or approved equal.
   1. Sluice gates shall be cast iron, fully bronze mounted, and will have side wedges for seating head conditions and side, top and bottom wedges for unseating head conditions, where scheduled.
   2. Liberal safety factors shall be used in the design of all the equipment. Working stresses shall not exceed the lower value of one-third (1/3) of the yield strength or one-fifth (1/5) of the ultimate strength of the material. The slide or disc shall be designed with a minimum safety factor of six (6). The sluice gates and operators shall be completely shop-assembled, inspected and tested to ensure proper fit and adjustment of all parts.
   3. The sluice gate shall be substantially watertight under the design head conditions. The leakage shall not exceed 0.10 gallons per minute per foot of periphery for either the rated seating or unseating of the gate. The gate shall be rated for 60 feet of seating head and 35 feet of unseating head.
   4. All materials used in the construction of the gates and appurtenances shall be designed for the application and shall conform to the following specifications.
   5. Iron casting for wall thimbles, frame, disc, and guides, stem guides, floor stands and other items - ASTM A 126, Class B.
   6. Bronze castings for wedges, thrust nut, and lift nut - ASTM B 584, Alloy 86500 or 87200.
   7. Bronze for seat facings in frame and disc - ASTM B 21, Alloy 48200, extruded or ASTM B 139, Alloy 510, extruded.
   8. Stainless steel for stems, stem couplings and fasteners - ASTM A 276, Type 304.
   9. Silicon bronze for fasteners - ASTM B 98, Alloy 651, or 661.
   10. Rubber for flush bottom seal - ASTM D 2000, grade AA625.

B. Frame: The frame shall be of cast iron, one-piece construction, flanged with rectangular or circular. All contact surfaces of the frame shall be machined. The frame shall have machined dovetailed grooves on the front face into which bronze seat facings shall be driven and machined to a 63 micro-inch finish. The back flange of the frame shall be machined to bolt directly to the machined face of the “F” type wall thimble. Frames for the sluice gates subject to unseating heads shall have integrally cast pads machined with keyways to receive top and bottom wedge seats.

C. Disc: The disc shall be of cast iron, one-piece construction rectangular with integrally cast vertical and horizontal ribs. The disc shall have a minimum thickness of 3/4 inch on gates which are 18 inches in diameter or larger. A heavy vertical reinforcing rib along each side shall be provided to ensure rigidity between the side wedges. All interior vertical ribs shall be of equal depth and shall not have any horizontal jogs along their entire length. Spacing of horizontal ribs shall not exceed 12 inches. The maximum deflection of horizontal ribs based on a working stress of 6,000 pounds per square inch for cast iron shall not exceed 0.07 inch under design pressure. The disc shall have machined dovetailed grooves on the seating face into which bronze seat facings shall be driven and machined to a 63 micro-inch finish. A tongue on each side, extending the full length of the disc, shall be machined on all sides with a 1/8 inch clearance maintained between the disc tongue and the gate guide groove. Wedge pads for side wedges and for top and bottom wedges when required, shall be cast integrally on the disc and machined to receive the adjustable bronze wedges. A heavily reinforced nut pocket shall be cast integrally on the vertical centerline and above the horizontal center and be of such shape as to receive the square backed bronze thrust nut.

D. Guides: The guides shall be one piece, integrally cast type, designed to withstand the total thrust due to the water pressure and the wedging action. The guides shall be either bolted onto or integrally cast with the frame. The guides shall be machined on all contact surfaces and a groove shall be machined along the entire length of the guide to allow not more than 1/8 inch clearance between the disc tongue and the guide groove. The guides shall be of such length as to retain and support at least one-half (1/2) of the disc in the full open position. The bolt-on guides shall be attached to the frame with silicon bronze or stainless steel studs and nuts and shall be doweled to prevent any relative motion between the guides and the frame. The integrally cast guides shall have wedge blocks which are attached to the guide with silicon bronze fasteners. Gates having integrally cast frames, guides and wedge blocks shall be unacceptable. Both the integrally cast and bolt-on blocks shall have machined dove-tailed grooves in which the bronze wedge seats shall be driven and machined. Wedge seats which are bolted onto the wedge block or guide shall be unacceptable.

E. Wedges: Each gate shall be provided with a sufficient number of wedging devices to assure its compliance with the leakage requirements. Side wedges shall be designed to make full metal-to-metal contact with the wedge seats mounted on the guide wedge blocks. The wedges shall be solid cast bronze, machined on all contact surfaces, and keyed to the cast iron pads on the disc to prevent rotation and lateral motion. The wedges shall be attached to the disc with silicon bronze studs and nuts to lock them securely in position after they have been adjusted.

1. Adjustable top and bottom wedges, where applicable, shall be attached to the disc either by tongue-and-groove arrangement with a signal fastener or by two fasteners. All mating and contact surfaces on the wedging devices shall be fully machined.

F. Seat Facings: The extruded seat facings shall be of a special shape to fill and permanently lock in the machined dovetail grooves on the frame and disc when pneumatically impacted into place. Attaching pins and screws shall not be acceptable. The installed seat facings shall be machined to a 63 micro-inch finish or better. Maximum clearance between seating faces shall not exceed 0.004 inch when the disc is in the fully closed position.

G. Stem

1. The operating stem shall be of a size to safely withstand the stresses induced by normal operating forces without buckling or permanent distortion. The stem shall be designed to transmit in compression at least two (2) times the rated output of the floorstand or benchstand with a 40-pound effort on the crank or handwheel. The sluice gate manufacturer shall submit these calculations, if required by the Owner. The threaded portion of the stem shall have machined cut or rolled threads.
2. Acme type. The contact surfaces of the threads shall have a maximum 16 micro-inch finish. Stems of more than one (1) section shall be jointed by stainless steel couplings threaded and keyed or bored and pinned to the stems. All threaded and keyed couplings of the same size shall be interchangeable. Manually operated, rising stem gates shall be provided with an adjustable bronze stop collar on the stem above the floorstand lift nut.

H. Stem Guides: Stem guides shall be cast iron, bronze brushed, mounted on cast iron brackets. They shall be adjustable in two (2) directions and shall be spaced at sufficient intervals to adequately support the stem. Stem guide spacing shall not exceed 10 feet, or an L/R ratio of 200.

I. Pipe Covers: Provide fabricated galvanized steel stem cover w/position indication on all rising stems.

J. Crank Operators: All gates shall have crank-operated floorstands or benchstands. Crank handle shall be removable. Crank operated type shall be geared and shall have a weatherproof housing with a solid bronze operating nut mounted on high-strength cast iron pedestals or base plates. The operating nut shall be internally threaded with threads corresponding to stem threading. Tapered roller or ball bearings shall be provided above and below a flange on the operating nut to support both opening and closing thrusts. All gears shall be constructed of steel and shall be accurately machine cut and of proper design to provide smooth operation and to support load conditions. Lubrication fittings shall be provided in the gear housing to permit lubrication of all gears and bearings. All reduction gear cases shall be precision machined and equipped with tapered rolled or needle bearings and sealed about all reduction shafts. Geared hoists shall have a 4:1 ratio. Each hoist shall be supplied with a 2-inch square operating nut, and a removable cast iron crank arm with revolving brass grip. Floorstands shall include a cast iron pedestal designed to position the input shaft approximately 36 inches above the operating floor. Where called for, the floorstand shall be mounted on a cast iron wall bracket which is specifically designed for the particular operator being used. An arrow with the word “Open” will be permanently attached or cast in the floorstand indicating the direction of rotation to open the gate.

K. All geared and handwheel floorstands shall operate with a maximum effort not to exceed 40 pounds on the crank or handwheel.

L. Painting - All submerged ferrous metal components (i.e., gate and frame, thimble, stem guides) shall be shop painted as follows: prepare surfaces to SSPC-SP-6; Primer - Amer Lock 400 by Ameron International Inc. Performance Coatings and Finishes Group, or approved equal, 5.0 mil dry film thickness; Top Coat - Amer Lock 400, or approved equal, 5.0 mil dry film thickness.

M. All exposed ferrous metal components (i.e., crank operator and floor stand) shall be shop painted as follows: prepare surfaces to SSPC-SP-3; Primer - Amer Lock 400, or approved equal, 5.0 mil dry film thickness, Top Coat - Amer Lock 450 HS, or approved equal, 2.0 mil dry film thickness

N. All bolts, studs and nuts required for setting the sluice gates, frames and operating stands shall be stainless steel and shall be supplied by the manufacturer.

1.3 EXECUTION

A. Provide and deliver cast iron thimble to be cast into wall as per manufacturer’s recommendations and as specified herein. Install the sluice gate with all appurtenances in strict conformance with manufacturer’s instructions.

END OF SECTION 35 22 26 00

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Task	Specification	Specification Description
35 22 59 00	35 22 26 00	Sluice Gate
35 22 63 00	35 22 26 00	Sluice Gate

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SECTION 35 24 23 00 - DREDGING

1.1 GENERAL

A. Description Of Work

1. This specification covers dredging. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Definition

1. Hard material is defined as material requiring blasting or the use of special equipment for economical removal, and includes boulders or fragments too large to be removed in one piece by the dredge.

C. Submittals: Submit the following:

1. Shop Drawings: Indicate pipeline location and installation details. Submit drawings of surveys during progress of work by soundings or sweepings.
2. Protection plan: If blasting will be allowed, submit a plan for protection of surrounding structures, equipment, and vessels.

D. Material to be Removed

1. The material to be removed is silt and mud **OR** new material, **as directed**, applicable to the specific project.
   a. Hard Material: Remove hard material. Blasting will not be permitted **OR** Blasting shall be performed only by experienced persons, **as directed**. Conduct operations in strict accordance with applicable regulations. Protect exposed structures from the effects of the blast in accordance with the protection plan

E. Artificial Obstructions

1. Except as indicated, the Owner has no knowledge of cables, pipes, or other artificial obstructions or of any wrecks, wreckage, or other material that would necessitate the use of explosives or the employment of additional equipment for economical removal. If actual conditions differ from those stated or shown, or both, an adjustment in contract price or time for completion, or both, will be made.
   OR
   The Owner has knowledge of debris such as, but not limited to, metal bands, pallets, pieces of broken cable, rope, fire hose, and broken piles. The Owner has no knowledge of existing wrecks, wreckage, or other material of such size or character as to require the use of explosives or special or additional plant for its economical removal. Prior to dredging, the Contractor shall rake the dredge areas and shall remove debris encountered. Debris removed from the dredged area shall be removed from the water. Disposal shall be the responsibility of the Contractor and disposal shall be outside the limits of government property. In case the actual conditions differ from those stated or shown, or both, an adjustment in contract price or time of completion, or both, will be made.

F. Side Slopes

1. Dredging on side slopes shall follow, as closely as practicable, the lines indicated or specified. An allowance will be made for dredging beyond the lines indicated or specified for side slopes. The allowance will be determined by projecting a line upwards, paralleling the project design side slopes, from the intersection of the overdepth dredging limit (at a point located vertically below the limit of dredging at the top of slope). The amount of material excavated from side slopes will be determined by either cross-sections or computer, or both.

G. Permit
1. The Contractor shall comply with conditions and requirements of State or Federal permits. the Owner will secure the permit for dredging and disposal of material as indicated. Make arrangements for disposal of excavated materials.

H. Environmental Protection Requirements
1. Provide and maintain during the life of the contract, environmental protective measures. Also, provide environmental protective measures required to correct conditions, such as oil spills or debris, that occur during the dredging operations. Comply with Federal, State, and local regulations pertaining to water, air, and noise pollution.

1.2 PRODUCTS - (Not Used)

1.3 EXECUTION

A. Conduct Of Dredging Work
1. Order of Work Interference with Navigation: Minimize interference with the use of channels and passages. the Owner will direct the shifting or moving of dredges or the interruption of dredging operations to accommodate the movement of vessels and floating equipment, if necessary.
2. Compensation for Interruption of Operations: If dredging operations are interrupted due to the movement of vessels or floating equipment, an adjustment in the contract price or time for completion, or both, will be made as provided by the contract. the Owner will notify the Contractor 7 days prior to ship movements that will affect dredging operations.
3. Lights: Each night, between sunset and sunrise and during periods of restricted visibility, provide lights for floating plants, pipelines, ranges, and markers. Also, provide lights for buoys that could endanger or obstruct navigation. When night work is in progress, maintain lights from sunset to sunrise for the observation of dredging operations. Lighting shall conform to United States Coast Guard requirements for visibility and color.
4. Ranges, Gages, and Lines: Furnish, set, and maintain ranges, buoys, and markers needed to define the work and to facilitate inspection. Establish and maintain gages in locations observable from each part of the work so that the depth may be determined. Suspend dredging when the gages or ranges cannot be seen or followed. the Owner will furnish, upon request by the Contractor, survey lines, points, and elevations necessary for the setting of ranges, gages, and buoys.
5. Plant: Maintain the plant, scows, coamings, barges, pipelines, and associated equipment to meet the requirements of the work. Promptly repair leaks or breaks along pipelines. Remove dredged material placed due to leaks and breaks.
6. Disposal of Excavated Material: Provide for safe transportation and disposal of dredged materials. Transport and dispose of dredged material in the area designated for disposal of dredged material.
OR
The Contractor may, at his option, dispose of dredge material at an approved disposal area. The deposit of dredged materials in unauthorized places is forbidden. Comply with rules and regulations of local port and harbor governing authorities.
    a. Method of Disposal: Deposit dredged material by the hydraulic process **OR** hopper dredge **OR** self-dumping scow or barge, **as directed**. Pipeline for hydraulic dredging shall discharge into the disposal area.
    b. Disposal in Indicated Fill Areas: In depositing excavated material for fill, uniformly grade and allow for shrinkage. Provide and maintain necessary bulkheads, dikes, ditches, weirs, spillways, and other construction necessary to confine and retain the fill in the dredge fill area.
    c. Operation of Sluiceways: Sluiceways on the disposal area levees will be operated and maintained by the Owner. The Contractor will be relieved of operations thereof.

d. Submerged Pipeline: If a leak occurs in the discharge pipeline, immediately discontinue using the line until leaks are repaired. Remove material placed due to leaks or breaks.

7. Navigation Warnings: Furnish and maintain navigation warning signs along the pipeline.
8. Method of Communication: Provide a system of communication between the dredge crew and the crew at the disposal area. A portable two-way radio is acceptable.
9. Salvaged Material: Anchors, chains, firearms, and other articles of value, which are brought to the surface during dredging operations, shall remain or become the property of the Owner and shall be deposited on shore at a convenient location near the site of the work, as directed.
10. Safety of Structures: The prosecution of work shall ensure the stability of piers, bulkheads, and other structures lying on or adjacent to the site of the work, insofar as structures may be jeopardized by dredging operations. Repair damage resulting from dredging operations, insofar as such damage may be caused by variation in locations or depth of dredging, or both, from that indicated or permitted under the contract.
11. Plant Removal: Upon completion of the work, promptly remove plant, including ranges, buoys, piles, and other markers or obstructions.

B. Measurement

1. Contractor shall take soundings before and after dredging.
   a. Method of Measurement: The material removed will be measured by means of soundings taken before and after dredging. The drawings represent existing conditions based on current available information, but will be verified and corrected, if necessary, by soundings taken before dredging in each locality. Soundings will be taken by lead line or 200 kHz sonic methods, or both, as determined by the Owner; results of soundings by either or both methods will be the basis for payment. Areas sounded more than 30 days prior to dredging will be re-sounded when requested by the Contractor. The Contractor has the option of being present when such soundings are made.
   b. Surveys During Progress of Work: Contract depth will be determined by soundings or sweepings taken behind the dredge as work progresses. The Contractor shall take progress soundings or sweepings.

C. Final Examination And Acceptance

1. As soon as practicable after the completion of areas, which in the opinion of the Owner, will not be affected by further dredging operations, each area will be examined by the Owner by sounding or sweeping, or both. Remove shoals and lumps by dragging the bottom or by dredging. However, if the bottom is soft and the shoal areas form no material obstruction to navigation, removal may be waived at the discretion of the Owner. The Contractor will be notified when soundings or sweepings are to be made and will be permitted to accompany the sounding or sweeping party and to inspect the data and methods used in preparing the final estimate. When areas are found to be in a satisfactory condition, the work therein will be accepted as complete. Final estimates will be subject to deductions or correction of deductions previously made because of excessive overdepth, dredging outside or authorized areas, or disposal of material in an unauthorized manner.

END OF SECTION 35 24 23 00

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Task	Specification	Specification Description
35 24 26 00	01 22 16 00	No Specification Required

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Task	Specification	Specification Description
40 05 23 23	21 05 23 00	Piped Utilities Basic Materials And Methods
40 05 23 23	23 11 23 00	Relief Wells
40 05 23 23	23 11 23 00a	Monitoring Wells
40 05 23 23	22 11 23 23	Water Supply Wells
40 05 23 23	22 05 76 00	Sanitary Sewerage
40 05 23 23	07 63 00 00	Common Work Results for Fire Suppression
40 05 23 23	07 63 00 00a	Common Work Results for Plumbing
40 05 23 23	07 63 00 00b	Common Work Results for HVAC
40 05 41 00	07 63 00 00	Common Work Results for Fire Suppression
40 05 41 00	07 63 00 00a	Common Work Results for Plumbing
40 05 41 00	07 63 00 00b	Common Work Results for HVAC

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SECTION 41 22 23 13 - MATERIAL HANDLING HOISTS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of material handling hoists. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals

1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Electric Chain Hoists

1. Hoist motors shall be H4 duty classification. Class F insulation shall be used in hoist motor for 30 minute operation. Load chain shall be grade 80 alloy, case hardened and zinc plated sized for the intended load. Hoists shall employ AC motor brakes employing single or multiple all-steel disks. Controls shall be hand-held, low voltage electrical, with emergency shut off and enclosed in NEMA 3R rated weatherproof enclosure. Hoist shall include fail safe limit switches in the hoist enclosure. Hoist shall meet requirements of ANSI B30.16 standard. Load hook shall be heavy-duty drop forged with safety latch. Hoist shall have swivel top and bottom hooks.

B. Manual Chain Hoists

1. Load capacity of hoist shall be as specified. Load chain shall be grade 80 alloy, case hardened and zinc plated sized for the intended load. Load hook shall be heavy-duty drop forged with safety latch. Hoist mechanism shall be double pawl ratchet system with Weston type brake using a non-asbestos friction disk. Hoist shall have swivel top and bottom hooks. Hoist shall require between 50 and 80 pounds effort to move load.

C. Electric Wire Rope Hoists

1. Hoist motors shall be H4 duty classification. Class F insulation shall be used in hoist motor for 30 minute operation. Lift range shall be between 20 and 150 feet. Lifting cable shall be pre-formed wire rope, of hoisting service construction, made of extra improved steel (XIP) with an independent wire rope center. Load hook shall be heavy-duty drop forged with safety latch. Hoist shall have swivel top and bottom hooks. Controls shall be hand held, low voltage electrical, with emergency shut off and enclosed in NEMA 3R rated weatherproof enclosure. Hoist shall include fail-safe limit switches in the hoist enclosure. Hoist shall meet requirements of ANSI B30.16 standard.

1.3 EXECUTION

A. Installation

1. The Contractor shall complete the assembly of any equipment furnished partially assembled and place the items in position as directed. The hoists shall be assembled and securely bolted in position, hoisting chain or wire rope installed, and the hoist made ready for regular operation. The Contractor shall furnish all miscellaneous hardware items required to complete the installation of all equipment and components. Equipment shall be primed and finish painted with a suitable corrosion-resistant paint on all parts and components not made of corrosion-resistant materials or otherwise protected.

END OF SECTION 41 22 23 13

SECTION 41 22 23 13a - MONORAILS WITH AIR MOTOR POWERED HOIST

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for monorails with air motor powered hoist. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Verification Of Dimensions

1. The Contractor shall be responsible for the coordination of his work with the work of all trades involved and as it relates to the building structure. The Contractor shall verify all building dimensions that relate to fabrication of the monorail system, and shall notify the the Owner of any discrepancy before order to the monorail manufacturer is finalized.

C. Submittals

1. Shop Drawings
2. Design Data
3. Test Reports
4. Certificates
5. Operation and Maintenance Data

D. Quality Assurance

1. Drawings: Submit drawings showing the general arrangement of the track beam system, including curves and switches, clearances, principal dimensions, details of structural connections, air system details, and all component details. Manufacturer's catalog data will suffice for items of standard manufacturer.
2. Certificates: Submit certification of minimum wire rope breaking strength for each hoist. Where applicable, submit factory certification of the load chain rated capacity.
3. Design Data: Submit design calculations verifying the size of structural members, structural supports (fittings, rods, brackets, and components), and lifting beams for the track beam system. The calculations shall include stress and loading diagrams. Submit calculations with monorail drawings.

E. Maintenance: Submit data package for the entire monorail system.

1.2 PRODUCTS

A. Fabrication And Construction

1. The hoist and trolley shall conform to ANSI/ASME HST-5M or ANSI/ASME HST-6M, **2 OR 3 OR** 5, **as directed**, ton (2 **OR** 3 **OR** 5, **as directed**, metric ton), for general service **OR** protected indoor **OR** all weather outdoor, **as directed**, (0 degrees to 100 degrees F (-18 to 38 degrees C)) working conditions. 2 ton (2 metric ton) design criteria shall apply to hoists of 2 ton (2 metric ton), or less, rated lifting capacity. Hoists of 2, 3, or 5 ton (2, 3, or 5 metric ton) rated capacity, shall be equipped with an automatic mechanical load lowering brake.
2. Capacity: The hoist shall have a minimum rated capacity as required to meet project requirements. The monorail system shall have a minimum rated capacity as required to meet project requirements.
3. Hook Lift and Speed: Shall be the manufacturer's standard within the limits specified in ANSI/ASME HST-5M or ANSI/ASME HST-6M. The hook lift shall be at its highest point a minimum height as required to meet project requirements above the finished floor and at its lowest point a minimum as required to meet project requirements below the finished floor.

OR

B. Fabrication And Construction

1. The 1/4 **OR** 1/2 **OR** 1, **as directed**, ton (1/4 **OR** 1/2 **OR** 1, **as directed**, metric ton) hoist and trolley shall meet the design requirements specified in ANSI/ASME HST-5M or ANSI/ASME HST-6M for the 2 ton (2 metric ton) hoist trolley.
2. Capacity: The hoist shall have a minimum rated capacity as required to meet project requirements. The monorail system shall have a minimum rated capacity as required to meet project requirements.
3. Hook Lift and Speed: For 1/4 **OR** 1/2 **OR** 1, **as directed**, ton (1/4 **OR** 1/2 **OR** 1, **as directed**, metric ton) hoist(s), the hook lift shall be at its highest point a minimum height as required to meet project requirements above the finished floor and at its lowest point a maximum **OR** minimum, **as directed**, as required to meet project requirements above **OR** below, **as directed**, the finished floor. The hook lift and speed limits for 1/4 **OR** 1/2, **OR** 1 ton, **as directed**, (1/4 **OR** 1/2 **OR** 1, **as directed**, metric ton) rated capacity hoists shall be within the limits shown in the following table.

Standardized hoist lift ranges and rated lifting speed ranges for 1/4, 1/2, and 1 metric ton rated capacity

Rated load Capacity (metric tons)	Hoist lift range (meter)	Hoist lifting speed range (mm/s) Low	High
1/4	3 to 15	120	350
1/2	3 to 12	80	250
1	3 to 10	40	225

Standardized hoist lift ranges and rated lifting speed ranges for 1/4-, 1/2-, and 1-ton rated capacity

Rated load capacity (tons)	Hoist lift range (feet)	Hoist lifting speed range (feet per minute) Low	High
1/4	10 to 50	24	70
1/2	10 to 40	16	50
1	10 to 30	8	45

4. Hooks: Shall be of the safety type with hook nuts keyed to hook shanks by means of a setscrew installed in a plane parallel to the longitudinal axis of the hook shank, or by any other similar easily removable securing device. All hook components shall be magnetic-particle inspected over the entire area in accordance with ASTM A 275/A 275M. The acceptance standard shall be one of no defects. A defect is defined as a linear indication revealed by magnetic-particle inspection that is greater than 1/8 inch (3 mm) long whose length is equal to or is greater than three times its width.
5. Hoist Wire Rope: Rope lengths shall be sufficient to maintain a minimum of two full wraps of rope at the dead end(s) of the drum, with the block in its lowest indicated position.
6. Hoist Chain: Chain hoists of 10 foot (3 m) lift or more shall be equipped with a load chain bucket.
7. Hoist Limit Switch: Hoists shall be equipped with upper and lower hoist limit switches/devices.
8. Control Pendant: Shall extend as required to meet project requirements below the underside of the track beam.
9. Trolley: Shall have a manual **OR** geared manual **OR** air motor powered, **as directed**, drive and shall be designed to operate from track beam section. Where two or more hoists are located on the same monorail beam, the trolleys shall be equipped with rubber bumper devices designed to prevent contact of any part or parts of the hoists.

C. Monorail Track Beam System
1. Shall conform to MMA MH27.1, for powered hoists. The maximum allowable deflection shall not exceed 1/600 of the unsupported span, with the hoist(s) at rated load(s) and at any location(s). The track beam system shall have trolley stops at all open end locations. The stops shall be designed to retain the hoist on the track. Wheel stops shall interface with the trolley wheel treads on both sides of the track web simultaneously and shall not interface with the trolley wheel flanges. The air supply valve specified shall be of the quick shutoff type, readily accessible from the floor, and located within proximity to the monorail system.
2. Color of Finished Equipment: Shall be the manufacturer's standard brilliant yellow.
3. Identification Plates: The manufacturer shall furnish and install identification plates of noncorrosive metal. Information and data on the plates shall include, in clearly legible permanent lettering, the manufacturer's name, model number, capacity rating, and other essential information. In addition, the monorail track beam system shall be furnished with identification plates showing the capacity of the system, which shall be legible from the floor and from either side of the monorail track beam.

1.3 EXECUTION

A. Erection And Installation
1. The Contractor shall erect and install the hoist and monorail system in accordance with of MMA MH27.1. The monorail supplier shall provide supervisory erection services.

B. Field Inspection And Tests
1. Pre-Erection Inspection: Before erection, the Contractor and the manufacturer's representative shall jointly inspect the monorail and hoist systems and components at the job site to determine compliance with specifications and manufacturer's data and detail drawings as approved. The Contractor shall notify the the Owner 3 days before the inspection.
2. Load Tests: Upon completion, and before final acceptance, the hoist, trolley, and monorail shall be tested in operation as specified, carrying 125 percent of the rated capacity, and with the units spaced to obtain maximum possible loads in the monorail track beam systems. The air equipment will not necessarily operate at rated speed with a 125 percent overload. For hoists that incorporate mechanical load brakes, the mechanical load brake shall hold a static, as well as control a dynamic, 125 percent rated load. The systems shall be thoroughly tested in service to determine that each component of the system operates as specified, is properly installed and adjusted, and is free from defects in material, manufacture, installation, and workmanship. The Contractor shall furnish test loads, operating personnel, instruments, and other apparatus as necessary to conduct field tests on hoist and monorail. The test and final adjustments of the equipment shall be under the supervision of the the Owner. The Contractor shall rectify any deficiencies found and completely retest work affected by such deficiencies.

END OF SECTION 41 22 23 13a

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SECTION 41 22 23 13b - MONORAILS WITH ELECTRIC POWERED HOISTS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for monorails with electric powered hoists. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. System Description

1. Provide a monorail system with electric powered hoist(s) and plain type (hand operated) **OR** hand chain operated **OR** electric powered, **as directed**, trolley(s) complete, tested and ready for operation. Monorails, hoist(s), trolley(s), equipment, materials, installation, examination, inspection, and workmanship shall be in accordance with the applicable requirements of NFPA 70, ASME/ANSI B30.11, ASME/ANSI B30.16, ASME HST-1M, ANSI/ASME HST-4M, and MMA MH27.1, with modifications specified herein. Reference in these publications to the "authority having jurisdiction" shall be interpreted to mean the "the Owner."

C. Submittals

1. Shop Drawings: Monorail system
2. Product Data: Monorail track system including switches, suspension system and other components; Electric wire rope hoist; Electric chain hoist; Trolley; Pendant pushbutton station; Electrification.
3. Design Data: Load and sizing calculations.
4. Test Reports
5. Certificates
6. Operation and Maintenance Data

D. Delivery, Storage, and Handling

1. Delivery and Storage: Inspect materials delivered to site for damage; unload and store with minimum handling. Store materials on-site in enclosures or under protective coverings. Protect materials not suitable for outdoor storage to prevent damage during periods of inclement weather, including subfreezing temperatures, precipitation, and high winds. Store materials susceptible to deterioration by direct sunlight under cover and avoid damage due to high temperatures. Do not store materials directly on ground. When special precautions are required, prominently and legibly stencil instructions for such precautions on outside of equipment or its crating.
2. Handling: Handle materials in such a manner as to ensure delivery to final location in undamaged condition. Make repairs to damaged materials at no cost to the Owner.

E. Quality Assurance

1. Certificates: Overload Test Certificate: Submit a statement that the monorail system can be periodically load tested to 125 percent (plus 5 minus 0) of rated load.
2. Drawings: Monorail System: Show the general arrangement of all components, clearances and principal dimensions, assemblies of hoist, trolley, track, track suspension system, and electrical schematic drawings.
3. Design Data: Load and Sizing Calculations: Submit calculations verifying the sizing of any track, track suspension device and additional supports which are not the monorail system manufacturer's standard cataloged product.

1.2 PRODUCTS

A. Overhead Monorail System: Provide overhead monorail system conforming to MMA MH27.1, Class C, for indoor **OR** outdoor, **as directed**, service, with an electric wire rope or chain hoist mounted on a movable trolley. Trolley shall be plain type (hand operated) **OR** hand chain operated **OR** motor operated, **as directed**. Monorail system shall operate on AC voltage as required to meet project requirements, 60 Hz, single **OR** three, **as directed**, phase power source.

1. Capacity: The monorail system shall have a minimum rated capacity as required to meet project requirements. Mark the hoist capacity in pounds (kg) on both sides of the hoist or load block.
2. Speeds: The hoist shall have two operating speeds, **unless directed otherwise,** and shall be capable of hoisting and lowering the rated load at a high speed of 20 feet per minute (fpm) (100 mm/s). The trolley shall have two operating speeds, **unless directed otherwise,** and shall be capable of moving the rated load at a high speed of 50 fpm **OR** 100 fpm, **as directed**, (250 mm/s **OR** 500 mm/s, **as directed**,). Low speed(s) shall be one quarter to one third of high speed(s). Actual speed(s) shall be within plus or minus 15 percent of those specified.
3. Material Limitations: Shafts, keys, couplings, sprockets, and chains shall be steel. All gears shall be steel except for worm gears, which shall be bronze or steel. Cast iron and aluminum used to support components of the hoist power transmission train shall be ductile.
4. Safety: Comply with the mandatory and advisory safety requirements of ASME/ANSI B30.11, ASME/ANSI B30.16, and 29 CFR 1910.179.

B. Monorail Track System: MMA MH27.1. Track beams shall be patented track sections fabricated by a manufacturer regularly engaged in production of this type of beam.

1. Track Suspension System: Monorail suspension shall be flexible **OR** rigid, **as directed**, type. Make bolted connections to supporting structure, excluding hanger rods, with ASTM A 325/A 325M bolts, ASTM A 563/A 563M nuts, and ASTM F 959/F 959M load indicator washers. ASTM A 325/A 325M bolts shall be fully pre-tensioned in accordance with AISC S329. Support monorail track system from the structural members shown. Provide additional supports as required to carry monorail track system loads to the structural members shown. Materials for additional supports shall conform to the material requirements contained in Division 05 Section "Structural Steel Framing".

C. Electric Wire Rope Hoist: ANSI/ASME HST-4M, Class H3, except as modified herein. Hoist shall be double reeved, **unless directed otherwise**.

1. Hoisting Ropes: FS RR-W-410, improved or extra improved plow steel, regular lay, uncoated, 6 by 37 class construction, with an independent wire rope core. Provide proof of wire rope breaking strength test report.
2. Sheaves: Sheaves shall be steel or ductile cast iron. Pitch diameter of running sheaves shall not be less than 16 times the rope diameter. Pitch diameter of non running sheaves shall not be less than 12 times the rope diameter.
3. Drum: Drum shall be steel or ductile cast iron. Pitch diameter of the drum shall not be less than 18 times the rope diameter. Not less than two dead wraps of the hoisting rope shall remain on each anchorage when the hook is in its extreme low position.

D. Electric Chain Hoist: ASME HST-1M, Class H3, except as modified herein. Provide load chain proof test.

E. Trolley: Trolley shall meet all applicable requirements of MMA MH27.1, ASME HST-1M and ANSI/ASME HST-4M. Trolley shall have elastomeric bumpers to engage runway stops.

F. Motors: NEMA MG 1. Hoist motor shall be single **OR** two, **as directed**, speed AC squirrel cage induction type. Trolley motor shall be single **OR** two, **as directed**, speed AC squirrel cage induction type. Motor insulation shall be Class B minimum. Provide totally enclosed non-ventilated (TENV) motor enclosures. Maximum motor speed shall not exceed 1800 RPM.

G. Controls: Provide single **OR** two, **as directed**, speed magnetic control for the hoist. Provide single **OR** two, **as directed**, speed magnetic controls for the trolley. Provide reduced voltage starting, acceleration and deceleration for the trolley drive.

H. Limit Switches: Provide upper and lower limit switches which de-energize the hoist motor.

I. Brakes: Provide hoist with an electro-mechanical holding brake and a mechanical load brake, each capable of holding 130 percent of the rated hoist capacity. Hoist holding brake shall be capable of being released to test the load brake. Provide trolley with an electro-mechanical brake. Provide trolley brake with a minimum torque rating of 100 percent (for outdoor monorails) or 50 percent (for indoor monorails) of the drive motor rated torque. Trolley brake torque shall be adjustable down to 85 percent of its torque rating.

J. Load Block And Hook: Construct load blocks of steel. Provide forged steel, swivel type hook, with hook nut keyed to hook shank by means of a setscrew installed in a plane parallel to the longitudinal axis of the hook shank, or other similar easily removable securing device. Hook throat opening shall not be less than as required to meet project requirements. Provide hook with spring loaded steel safety latch for closing the hook throat opening. The hook and hook nut shall be unpainted. Permanently mark hook and hook nut with an identification number.
   1. Hook and Hook Nut Magnetic Particle Inspection: Magnetic particle inspect the hook and nut over the entire area in accordance with ASTM A 275/A 275M. Acceptance standard shall be no defects. A defect is defined as a linear indication that is greater than 1/8 inch (3 mm) long whose length is equal to or greater than three times it width.

K. Bearings: All bearings except those subject to a small rocker motion shall be anti-friction type. Bearings not considered lifetime lubricated by the manufacturer shall be provided with a means for lubrication.

L. Pendant Pushbutton Station: Hoist and trolley, **unless directed otherwise,** shall be controlled from a pendant pushbutton station. Arrange pushbuttons in accordance with ASME/ANSI B30.11recommendations. Locate station 4 feet (1.2 m) above the finished floor

M. Electrification: Runway electrification shall be of the flat festooned type **OR** enclosed safety bar type, **as directed**, with four continuous copper conductors. Provide electrical work for the monorail system in accordance with NFPA 70.

N. Identification Plates: Provide identification plates of noncorrosive metal with clearly legible permanent lettering giving the manufacturer's name, model number, capacity in pounds, and other essential information or identification.

O. Painting System: Painting shall be manufacturers standard. Provide a primer and a finish coat. For outdoor monorail systems, blast clean all components prior to painting and prime with inorganic zinc type primer; finish coat shall be an epoxy formulated for marine environments. Paint coats shall be smooth and even, free of runs, sags, orange peel, or other defects.

1.3 EXECUTION:

A. Erection And Installation: Erect and install the monorail system, complete in accordance with the approved submittals and in condition to perform the operational and acceptance tests.

B. Erection Services: Provide supervisory erection services from the monorail system manufacturer.

C. Field Quality Control
   1. Post-Erection Inspection: After erection, the Contractor and the the Owner shall jointly inspect the monorail and hoist systems and components to determine compliance with specifications and

approved submittals. The Contractor shall notify the the Owner 3 days before the inspection. Provide a report of the inspection indicating the monorail system is considered ready for operational tests

2. Operational Tests: After erection and inspection, test the hoist, and trolley as specified herein. Test the systems in service to determine that each component of the system operates as specified, is properly installed and adjusted, and is free from defects in material, manufacturer, installation, and workmanship. Rectify all deficiencies disclosed by testing and retest the system or component to prove the monorail system is operational. The Contractor shall furnish loads for testing, operating personnel, instruments, and all other necessary apparatus. The the Owner will furnish loads for testing; the Contractor shall receive and transport the loads from a location not more than 100 miles (161 km) from the job site and shall return them to that location after the tests have been completed.
3. Test Data: Record test data on appropriate test record forms suitable for retention for the life of the monorail system. Record operating and startup current measurements for electrical equipment (motors and coils) using appropriate instrumentation (i.e., clamp-on ammeters). Compare recorded values with design specifications or manufacturer's recommended values; abnormal differences (i.e., greater than 10 percent from manufacturer's or design values) shall be justified or appropriate adjustments performed. In addition, high temperatures or abnormal operation of any equipment or machinery shall be noted, investigated, and corrected. Record hoist and trolley speeds during each test cycle.
4. Hook Test: Measure hook for hook throat spread before and after load test. Establish a throat dimension base measurement by installing two tram points and measuring the distance between these tram points (plus or minus 1/64 inch (0.4 mm)). Record this base dimension. Measure the distance between tram points before and after load test. An increase in the throat opening by more than 5 percent from the base measurement shall be cause for rejection.
5. No-Load Test
   a. Hoist: Raise the load hook the full operating lift distance and verify satisfactory operation of hoist, upper limit switch, lower limit switch, and the hoisting and lowering speeds. Operate the hoist at low and high speed in both directions.
   b. Trolley: Operate trolley assembly the full length of the monorail in both directions. Operate trolley at low and high speed in each direction. Verify satisfactory operation and verify trolley speed. Operate all rail switches.
6. Load Test: 125 Percent (plus 5 percent minus 0) of rated capacity
   a. Hoist Static Test: Raise test load approximately one foot above the floor and hold for 10 minutes. Observe load lowering that may occur which will indicate malfunction of hoisting component or brake. Lower the test load to the floor until the hoist line is slack.
   b. Hoist Dynamic Test: Raise the test load to approximately 5 feet (1.5 m) above the floor using both speed points in the process. Lower the load back to the floor using both speed points. Stop the test load at least once while lowering at high speed and observe proper brake operation. Wait 5 minutes, then repeat the above cycle.
   c. Load Brake Test: Raise test load approximately 5 feet (1.5 m). With the hoist controller in the neutral position, release the holding brake. The load brake should hold the test load. Again with the holding brake in the released position, start the test load down at low speed and return the controller to off position as the test load lowers. The load brake should prevent the test load from accelerating. NOTE: It is not necessary for the load brake to halt the downward motion of the test load.
   d. Loss of Power Test: Raise the test load approximately 3 feet (1 m) and while lowering test load at low speed, cut main power to hoist. Load should stop.
   e. Trolley Test: With test load hoisted to a height of one foot (300 mm) above the floor, operate trolley the full distance of the monorail in both directions using both speed points in the process. Observe for any malfunctioning of the trolley assembly and monorail system. Operate all rail switches.
   f. Rated Load Speed Test: With the hoist loaded to rated capacity, raise and lower the load verifying that the hoisting and lowering speeds are provided as specified. With the hoist loaded to rated capacity, operate trolley along the monorail beam verifying that the trolley

speed is provided as specified. Further, verify that the trolley stops in each direction within a distance (in feet) equal to 10 percent of rated capacity high speed (in feet per minute) when initially travelling at high speed and carrying the rated capacity load. Record voltage, amperage, hoisting and lowering speeds, trolley travel speed, and motor speed for each motor.

END OF SECTION 41 22 23 13b

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SECTION 41 22 23 13c - MONORAILS WITH MANUAL HOIST

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for monorails with manual hoist. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Verification Of Dimensions:

1. The Contractor shall verify all building dimensions that relate to fabrication of the monorail system, and shall notify the Owner of any discrepancy before the order to the monorail manufacturer is finalized.

C. Submittals

1. Shop Drawings: Submit drawings showing the general arrangement of the track beam system, including curves and switches, clearances, principal dimensions, details of structural connections, and all component details. Manufacturer's catalog data will suffice for items of standard manufacturer.
2. Design Data: Structural design calculations.
3. Test Reports
   a. Hook and hook nut magnetic-particle tests.
   b. Monorail system load tests
4. Certificates: Manual hoist load chain
5. Operation and Maintenance Data
   a. Track beam system
   b. Hoist and trolley

D. Quality Assurance

1. Certifications: Submit factory certification of load chain rated capacity.
2. Design Data: Submit design calculations verifying the size of structural members, structural support fittings, rods, brackets, components, and lifting beams for the track beam system. The calculations shall include stress and loading diagrams. Submit calculations with monorail drawings.

1.2 PRODUCTS

A. Fabrication And Construction: Provide manual hoist and trolley, ANSI/ASME HST-2M, ANSI/ASME HST-3M, trolley suspension. Trolley and wheels shall be suitable for operation on the steel monorail track beam provided, and shall have not less than four wheels.

1. Capacity: The hoist shall have a minimum rated capacity as required to meet project requirements. The monorail system shall have a minimum rated capacity as required to meet project requirements.
2. Hook Lift: Shall be the manufacturer's standard. The hoist lift shall be at its highest point a minimum of 8 feet (2400 mm) above the finished floor and at its lowest point a minimum of 2 feet (600 mm) below the finished floor.
3. Hooks: Shall be of the safety type with hook nuts keyed to hook shanks by means of a setscrew installed in a plane parallel to the longitudinal axis of the hook shank, or by any other similar easily removable securing device. All hook components shall be magnetic-particle inspected over the entire area in accordance with ASTM A 275/A 275M. The acceptance standard shall be one of no defects. A defect is defined as a linear indication revealed by magnetic-particle

inspection that is greater than 1/8 inch (3 mm) long whose length is equal to or is greater than three times its width.

4. Trolley: Shall be designed to operate from track beam section. Where two or more hoists are located on the same monorail beam, the trolleys shall be equipped with rubber bumper devices designed to prevent contact of any part or parts of the hoists.
5. Load Chain: High strength steel links, flexible; minimum safety factor of 5 to 1 based on ratio of minimum chain breaking load to the calculated load on the chain when the hoist is assumed loaded to rated capacity. Certification from hoist manufacturer of provided chain's breaking strength shall be submitted to the Owner and approved prior to final acceptance of hoist. Do not paint or coat the load chain.
6. Load Hooks and Load Hook Components
   a. Hook: Forged steel; complete with spring-loaded steel throat opening safety device. The hook shall be carried on suitably sealed or shielded anti-friction thrust bearings and shall swivel freely through 360 degrees rotation with full load without twisting chain.
      1) Disassembly. Hook and hook nut shall be capable of complete disassembly that enables access to all surfaces of the hook, including shank and hook nut for inspection purposes. Provision shall be made for the hook nut, or other hook-to-block fastener, to be keyed to hook shank by means of a set screw or similar, easily removable, securing device.
      2) Hook Non-Destructive Test. Each hook, including shank and hook nut, shall be inspected over the entire surface areas by magnetic particle inspection. If hook nut is not used, any device that functions the same as the hook nut shall be inspected by magnetic particle inspection.
         a) Procedure: Magnetic particle inspection shall be conducted in accordance with ASTM A 275/A 275M. This inspection shall be conducted at the factory of the hook manufacturer or hoist manufacturer. Alternately, a recognized independent testing lab may conduct the inspections if equipped and competent to perform such a service, and if approved by the the Owner.
         b) Acceptance Criteria: Defects found on the hook or hook nut shall result in rejection of defective items for use on furnished hoist. For this inspection, a defect is defined as a linear or non-linear indication for which the largest dimension is greater than 1/8 inch (3 mm). Weld repairs for defects on hook or hook nut will not be permitted.
         c) Test Report: A test report of the magnetic particle inspection of each hook and hook nut provided shall be submitted to and approved by the the Owner prior to final acceptance of hoist installation. Test reports shall be certified by the testing organization.

B. Monorail Track Beam System: Comply with MMA MH27.1 except as modified and supplemented herein.

1. Patented Track: Provide specially designed trackage, e.g., patented track beam, curves, and switches constructed from welded steel components. The lower flange of the track section shall have flat wheel treads; minimum lower flange width of 3.25 inches (80 mm); chemical composition of 0.45 to 0.60 percent carbon content, 0.60 to 1.1 percent manganese content; and wheel treads shall be hardened to a minimum Brinell Hardness Number of 225. Upper flange and web of the track section shall be steel, continuously welded together or provided as one monolithic piece.
2. Track Suspension: Provide means of suspending the monorail track system, including curves and switches from the structural supports. The suspension system shall be the sole responsibility of the track supplier; however, design shall be subject to the requirements specified herein.
   a. Cataloged Products: If possible, provide track manufacturer's standard cataloged devices for connection of the track to the indicated supporting structures. If track manufacturer's cataloged devices are not provided for this suspension system, complete shop drawings and calculations for the custom suspension device shall be submitted for review and approval by the the Owner. Track suspension devices which are not the track

manufacturer's cataloged products shall meet the additional requirements specified in Division 05 Section "Metal Fabrications".

b. Design: The suspension system shall be designed and constructed to ensure no impairment of the strength of track or the structural support. A hanger or suspension shall be located at each rack splice joint. Provide bracing to hold track sections in rigid alignment at all joints.

c. Suspension of Curves and Switches: Provide steel framing (structural supports), in addition to that indicated, as required by monorail curve and switch manufacturer to support curves and switches. The additional steel framing shall be the sole responsibility of the monorail supplier. Submit shop drawings and framing design calculations to the the Owner for approval.

d. Sway Bracing: Where the track is suspended from hanger rods, track shall be braced laterally and longitudinally to prevent sway.

e. Lock Nuts: Where the track is suspended from hanger rods, lock nuts or other means shall be provided to prevent the nuts from backing off the rods.

f. Multiple Suspension Devices: Where more than one suspension device attached to the track at a single point, the suspension devices shall be provided so that the loads shall be induced in each in proportion to the device's size.

3. Identification Plates: Provide identification plates of noncorrosive metal. Information and data on the plates shall include, in clearly legible permanent lettering, the manufacturer's name, model number, capacity rating, and other essential information. In addition, the monorail track beam system shall be furnished with identification plates showing the capacity of the system, which shall be legible from the floor and from either side of the monorail track beam.

C. Painting Of System: Provide manufacturer's standard painting or shop painting of components specified in this section; comply with the requirements specified in Division 07. Do not paint, coat, or galvanize load chain, load, hook nut, or load chain sheave.

1.3 EXECUTION

A. Erection And Installation: The Contractor shall erect and install the hoist trolley and monorail system in accordance with manufacturers written instructions, MMA MH27.1, and the contract drawings. The monorail supplier shall provide supervisory erection services. Welding new sections of monorail track to existing shall conform to AWS D1.1.

B. Field Inspection And Tests

1. Pre-Erection Inspection: Before erection, the Contractor and the manufacturer's representative shall jointly inspect the monorail and hoist systems and components at the job site to determine compliance with specifications and manufacturer's data and shop drawings as approved. The Contractor shall notify the the Owner 3 days before the inspection.

2. Operational Inspection and Load Tests: Upon completion, and before final acceptance, the hoist, trolley, and monorail shall be given the rated load test specified in ASME/ANSI B30.11, carrying 125 percent (plus 5 percent, minus 0 percent) of the rated capacity, and with the units spaced to obtain maximum possible loads in the monorail track beam systems. Hoists shall hold a static, as well as control a dynamic, 125 percent rated load. The systems shall be thoroughly tested in service to determine that each component of the system operates as specified, is properly installed and adjusted, and is free from defects in material, manufacture, installation, and workmanship. The Contractor shall furnish test loads, operating personnel, instruments, and all other necessary apparatus at no additional cost to the Owner. The test and final adjustments of the equipment will be under the supervision of the Owner. The Contractor shall rectify any deficiencies found and completely retest work affected by such deficiencies.

END OF SECTION 41 22 23 13c

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SECTION 14623 - MONORAILS WITH MANUAL HOIST

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for monorails with manual hoist. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Verification Of Dimensions:
1. The Contractor shall verify all building dimensions that relate to fabrication of the monorail system, and shall notify the Owner of any discrepancy before the order to the monorail manufacturer is finalized.

C. Submittals
1. Shop Drawings: Submit drawings showing the general arrangement of the track beam system, including curves and switches, clearances, principal dimensions, details of structural connections, and all component details. Manufacturer's catalog data will suffice for items of standard manufacturer.
2. Design Data: Structural design calculations.
3. Test Reports
   a. Hook and hook nut magnetic-particle tests.
   b. Monorail system load tests
4. Certificates: Manual hoist load chain
5. Operation and Maintenance Data
   a. Track beam system
   b. Hoist and trolley

D. Quality Assurance
1. Certifications: Submit factory certification of load chain rated capacity.
2. Design Data: Submit design calculations verifying the size of structural members, structural support fittings, rods, brackets, components, and lifting beams for the track beam system. The calculations shall include stress and loading diagrams. Submit calculations with monorail drawings.

1.2 PRODUCTS

A. Fabrication And Construction: Provide manual hoist and trolley, ANSI/ASME HST-2M, ANSI/ASME HST-3M, trolley suspension. Trolley and wheels shall be suitable for operation on the steel monorail track beam provided, and shall have not less than four wheels.
1. Capacity: The hoist shall have a minimum rated capacity as required to meet project requirements. The monorail system shall have a minimum rated capacity as required to meet project requirements.
2. Hook Lift: Shall be the manufacturer's standard. The hoist lift shall be at its highest point a minimum of 8 feet (2400 mm) above the finished floor and at its lowest point a minimum of 2 feet (600 mm) below the finished floor.
3. Hooks: Shall be of the safety type with hook nuts keyed to hook shanks by means of a setscrew installed in a plane parallel to the longitudinal axis of the hook shank, or by any other similar easily removable securing device. All hook components shall be magnetic-particle inspected over the entire area in accordance with ASTM A 275/A 275M. The acceptance standard shall be one of no defects. A defect is defined as a linear indication revealed by magnetic-particle

inspection that is greater than 1/8 inch (3 mm) long whose length is equal to or is greater than three times its width.

4. Trolley: Shall be designed to operate from track beam section. Where two or more hoists are located on the same monorail beam, the trolleys shall be equipped with rubber bumper devices designed to prevent contact of any part or parts of the hoists.
5. Load Chain: High strength steel links, flexible; minimum safety factor of 5 to 1 based on ratio of minimum chain breaking load to the calculated load on the chain when the hoist is assumed loaded to rated capacity. Certification from hoist manufacturer of provided chain's breaking strength shall be submitted to the Owner and approved prior to final acceptance of hoist. Do not paint or coat the load chain.
6. Load Hooks and Load Hook Components
    a. Hook: Forged steel; complete with spring-loaded steel throat opening safety device. The hook shall be carried on suitably sealed or shielded anti-friction thrust bearings and shall swivel freely through 360 degrees rotation with full load without twisting chain.
        1) Disassembly. Hook and hook nut shall be capable of complete disassembly that enables access to all surfaces of the hook, including shank and hook nut for inspection purposes. Provision shall be made for the hook nut, or other hook-to-block fastener, to be keyed to hook shank by means of a set screw or similar, easily removable, securing device.
        2) Hook Non-Destructive Test. Each hook, including shank and hook nut, shall be inspected over the entire surface areas by magnetic particle inspection. If hook nut is not used, any device that functions the same as the hook nut shall be inspected by magnetic particle inspection.
            a) Procedure: Magnetic particle inspection shall be conducted in accordance with ASTM A 275/A 275M. This inspection shall be conducted at the factory of the hook manufacturer or hoist manufacturer. Alternately, a recognized independent testing lab may conduct the inspections if equipped and competent to perform such a service, and if approved by the the Owner.
            b) Acceptance Criteria: Defects found on the hook or hook nut shall result in rejection of defective items for use on furnished hoist. For this inspection, a defect is defined as a linear or non-linear indication for which the largest dimension is greater than 1/8 inch (3 mm). Weld repairs for defects on hook or hook nut will not be permitted.
            c) Test Report: A test report of the magnetic particle inspection of each hook and hook nut provided shall be submitted to and approved by the the Owner prior to final acceptance of hoist installation. Test reports shall be certified by the testing organization.

B. Monorail Track Beam System: Comply with MMA MH27.1 except as modified and supplemented herein.

1. Patented Track: Provide specially designed trackage, e.g., patented track beam, curves, and switches constructed from welded steel components. The lower flange of the track section shall have flat wheel treads; minimum lower flange width of 3.25 inches (80 mm); chemical composition of 0.45 to 0.60 percent carbon content, 0.60 to 1.1 percent manganese content; and wheel treads shall be hardened to a minimum Brinell Hardness Number of 225. Upper flange and web of the track section shall be steel, continuously welded together or provided as one monolithic piece.
2. Track Suspension: Provide means of suspending the monorail track system, including curves and switches from the structural supports. The suspension system shall be the sole responsibility of the track supplier; however, design shall be subject to the requirements specified herein.
    a. Cataloged Products: If possible, provide track manufacturer's standard cataloged devices for connection of the track to the indicated supporting structures. If track manufacturer's cataloged devices are not provided for this suspension system, complete shop drawings and calculations for the custom suspension device shall be submitted for review and approval by the the Owner. Track suspension devices which are not the track

manufacturer's cataloged products shall meet the additional requirements specified in Division 05 Section "Metal Fabrications".

b. Design: The suspension system shall be designed and constructed to ensure no impairment of the strength of track or the structural support. A hanger or suspension shall be located at each rack splice joint. Provide bracing to hold track sections in rigid alignment at all joints.

c. Suspension of Curves and Switches: Provide steel framing (structural supports), in addition to that indicated, as required by monorail curve and switch manufacturer to support curves and switches. The additional steel framing shall be the sole responsibility of the monorail supplier. Submit shop drawings and framing design calculations to the the Owner for approval.

d. Sway Bracing: Where the track is suspended from hanger rods, track shall be braced laterally and longitudinally to prevent sway.

e. Lock Nuts: Where the track is suspended from hanger rods, lock nuts or other means shall be provided to prevent the nuts from backing off the rods.

f. Multiple Suspension Devices: Where more than one suspension device attached to the track at a single point, the suspension devices shall be provided so that the loads shall be induced in each in proportion to the device's size.

3. Identification Plates: Provide identification plates of noncorrosive metal. Information and data on the plates shall include, in clearly legible permanent lettering, the manufacturer's name, model number, capacity rating, and other essential information. In addition, the monorail track beam system shall be furnished with identification plates showing the capacity of the system, which shall be legible from the floor and from either side of the monorail track beam.

C. Painting Of System: Provide manufacturer's standard painting or shop painting of components specified in this section; comply with the requirements specified in Division 07. Do not paint, coat, or galvanize load chain, load, hook nut, or load chain sheave.

1.3 EXECUTION

A. Erection And Installation: The Contractor shall erect and install the hoist trolley and monorail system in accordance with manufacturers written instructions, MMA MH27.1, and the contract drawings. The monorail supplier shall provide supervisory erection services. Welding new sections of monorail track to existing shall conform to AWS D1.1.

B. Field Inspection And Tests

1. Pre-Erection Inspection: Before erection, the Contractor and the manufacturer's representative shall jointly inspect the monorail and hoist systems and components at the job site to determine compliance with specifications and manufacturer's data and shop drawings as approved. The Contractor shall notify the the Owner 3 days before the inspection.

2. Operational Inspection and Load Tests: Upon completion, and before final acceptance, the hoist, trolley, and monorail shall be given the rated load test specified in ASME/ANSI B30.11, carrying 125 percent (plus 5 percent, minus 0 percent) of the rated capacity, and with the units spaced to obtain maximum possible loads in the monorail track beam systems. Hoists shall hold a static, as well as control a dynamic, 125 percent rated load. The systems shall be thoroughly tested in service to determine that each component of the system operates as specified, is properly installed and adjusted, and is free from defects in material, manufacture, installation, and workmanship. The Contractor shall furnish test loads, operating personnel, instruments, and all other necessary apparatus at no additional cost to the Owner. The test and final adjustments of the equipment will be under the supervision of the Owner. The Contractor shall rectify any deficiencies found and completely retest work affected by such deficiencies.

END OF SECTION 14623

PART 2 -

2.1

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B.

Task	Specification	Specification Description
43 23 78 31	21 05 23 00	Piped Utilities Basic Materials And Methods
43 24 41 23	21 05 23 00	Piped Utilities Basic Materials And Methods
43 42 41 00	01 22 16 00	No Specification Required

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Task	Specification(s)
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Task	Specification(s)
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04 05 23 13	01 54 23 00a
04 05 23 16	04 05 23 16, 01 22 16 00
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04 22 23 23	01 54 23 00a

Task	Specification(s)
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04 51 00 00	01 54 23 00a
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Task	Specification(s)
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Task	Specification(s)
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Task	Specification(s)
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Task	Specification(s)
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Task	Specification(s)
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Task	Specification(s)
09 93 23 13	09 93 23 13, 09 91 13 00a
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Task	Specification(s)
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Task	Specification(s)
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Task	Specification(s)
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Task	Specification(s)
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22 34 46 11	22 12 23 13a
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Task	Specification(s)
23 01 10 91	23 01 10 91, 23 01 10 91a
23 01 20 91	23 01 10 91, 23 01 10 91a
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23 01 50 61	23 01 50 61, 01 22 16 00, 22 11 16 00c
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Task	Specification(s)
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Task	Specification(s)
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26 05 19 16	26 05 19 16, 26 05 19 16a, 26 05 19 16b, 26 05 19 16c, 26 05 19 16d, 26 05 19 16e,

Task	Specification(s)
	26 05 19 16f, 26 05 19 16g, 01 22 16 00, 26 05 00 00, 26 05 13 16, 26 05 13 16a, 26 05 13 16b
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26 27 26 00	01 22 16 00, 26 05 33 16, 26 05 33 16a, 26 09 23 00b, 23 09 23 53
26 27 33 00	26 24 19 00
26 27 73 00	26 05 33 16a
26 28 13 00	26 28 13 00, 26 11 16 11
26 28 16 13	01 51 13 00
26 29 13 13	01 22 16 00, 23 09 23 53
26 29 23 00	26 29 23 00
26 29 33 13	21 30 00 00a, 21 31 13 00, 21 31 13 00a
26 31 00 00	26 31 00 00, 01 22 16 00
26 32 13 13	26 32 13 13
26 32 13 19	26 32 13 13
26 32 29 00	26 32 13 13
26 33 43 00	26 33 43 00, 26 33 43 00a, 27 52 23 00
26 33 53 00	26 33 53 00, 26 33 43 00
26 35 33 16	26 35 33 16, 26 09 23 00b
26 35 53 00	26 32 13 13

Task	Specification(s)
26 36 13 00	26 36 13 00, 26 24 13 00a
26 36 23 00	26 24 13 00a, 26 36 13 00
26 43 13 00	26 43 13 00
26 51 13 00	02 84 16 00a
26 51 16 00	02 84 16 00a
26 51 19 00	02 84 16 00a
26 51 23 00	02 84 16 00a
26 51 33 00	02 84 16 00, 02 84 16 00a, 02 84 16 00b
26 52 13 16	02 84 16 00a
26 55 13 00	01 22 16 00, 02 84 16 00b
26 55 16 00	02 84 16 00a, 02 84 16 00b
26 55 29 00	02 84 16 00b
26 55 53 11	02 84 16 00b
26 55 61 00	26 55 61 00
26 55 68 00	26 55 68 00
26 55 70 00	02 84 16 00a
26 56 13 00	01 22 16 00, 02 41 13 13, 02 84 33 00, 02 84 16 00b
26 56 18 00	02 84 16 00b
26 56 19 00	02 84 16 00a, 02 84 16 00b
26 56 21 00	01 22 16 00, 02 84 33 00, 02 84 16 00b
27 05 26 00	26 05 53 00a
27 11 16 00	26 05 53 00a
27 11 19 00	27 11 19 00, 26 05 53 00a
27 11 23 00	26 05 53 00a
27 13 13 13	26 05 13 16, 26 05 13 16a, 26 05 13 16b, 26 05 53 00a
27 13 23 13	27 11 19 00
27 15 13 00	26 05 13 16, 26 05 13 16a, 26 05 19 16c, 26 05 13 16b
27 15 33 00	26 05 13 16, 26 05 13 16a, 26 05 19 16c, 26 05 13 16b
27 15 43 00	26 05 53 00a
27 15 53 00	27 11 19 00
27 16 16 00	27 11 19 00
27 16 19 00	26 05 13 16, 27 11 19 00
27 21 16 00	27 11 19 00, 26 05 53 00a
27 31 13 00	26 05 53 00a
27 32 13 00	26 05 33 16a, 26 05 53 00a
27 32 26 00	26 05 53 00a
27 51 43 00	27 51 43 00, 26 33 43 00a
27 52 23 00	27 52 23 00
27 53 13 13	27 53 13 13
27 53 13 16	27 53 13 13
28 16 11 00	28 16 11 00, 28 16 11 00a, 28 16 11 00b, 27 51 43 00, 26 33 43 00a
28 21 31 00	28 21 31 00, 01 22 16 00, 28 16 11 00a, 28 16 11 00b, 26 09 23 00b
28 42 11 00	22 12 23 26
28 46 00 00	28 46 00 00
28 46 13 31	28 46 13 31, 28 46 13 31a
28 49 11 00	28 16 11 00, 28 16 11 00a, 28 16 11 00b
31 01 20 00	31 01 20 00
31 05 13 00	31 05 13 00, 31 01 20 00
31 05 16 00	31 01 20 00, 31 05 13 00
31 11 00 00	31 11 00 00
31 13 13 00	31 13 13 00, 31 11 00 00
31 13 16 00	31 11 00 00, 31 13 13 00
31 23 16 13	31 23 16 13, 31 01 20 00

Task	Specification(s)
31 23 16 16	31 23 16 16, 31 13 13 00
31 23 16 26	31 23 16 26, 31 01 20 00
31 23 16 33	31 01 20 00
31 23 16 36	31 23 16 13, 31 01 20 00
31 23 16 46	31 23 16 13, 31 01 20 00
31 23 19 00	31 23 19 00, 21 05 23 00
31 23 23 23	31 01 20 00
31 23 23 33	31 23 16 13, 31 01 20 00
31 24 13 00	31 24 13 00, 31 01 20 00, 31 23 16 26
31 25 14 13	31 25 14 13, 01 56 26 00, 01 56 26 00a
31 25 14 16	01 56 26 00, 31 25 14 13, 01 56 26 00a
31 25 14 23	31 25 14 23, 01 56 26 00, 31 25 14 13, 01 56 26 00a
31 25 14 26	31 25 14 26, 01 56 26 00, 01 56 26 00a
31 31 16 13	31 31 16 13
31 31 19 13	31 31 19 13
31 32 13 16	31 32 13 16
31 32 13 19	31 32 13 19, 31 32 13 16
31 32 13 29	31 32 13 16
31 32 19 13	31 32 13 16, 31 25 14 13
31 32 19 16	31 32 19 16, 31 32 19 16a, 21 05 23 00, 31 32 13 16, 31 25 14 13
31 36 13 00	31 36 13 00
31 37 13 00	31 37 13 00, 01 22 16 00, 31 32 19 16
31 37 16 13	31 37 13 00, 31 32 19 16
31 41 16 13	31 23 16 13
31 45 13 00	31 32 13 19
31 62 13 23	31 62 13 23
31 62 16 16	31 62 16 16
31 62 16 19	31 62 16 19
31 62 19 00	31 62 19 00
31 62 23 13	31 62 16 19
31 64 13 00	31 64 13 00
31 66 15 00	31 66 15 00
32 01 11 53	32 01 11 53, 03 31 13 00
32 01 13 61	32 01 13 61, 32 01 13 61a, 32 01 13 61b
32 01 16 71	32 01 16 71, 32 01 16 71a, 03 31 13 00
32 01 16 73	32 01 16 73, 32 01 13 61
32 01 16 74	32 01 16 74, 32 01 16 74a, 32 01 13 61, 32 01 16 73
32 01 17 61	32 01 13 61, 32 01 13 61a, 32 01 13 61b
32 01 17 63	32 01 13 61
32 01 90 13	31 13 13 00
32 01 90 19	01 22 16 00
32 01 90 23	31 13 13 00
32 01 90 26	31 13 13 00
32 01 90 36	31 13 13 00, 31 31 19 13
32 01 90 39	31 13 13 00
32 01 90 43	31 13 13 00
32 01 90 46	31 13 13 00
32 01 90 53	31 13 13 00
32 11 16 16	32 11 16 16, 32 11 16 16a, 32 11 16 16b
32 11 23 16	32 11 16 16, 32 11 16 16a, 32 11 16 16b
32 12 13 13	32 12 13 13, 32 12 13 13a, 32 01 13 61
32 12 13 19	32 01 13 61, 32 12 13 13, 32 12 13 13a
32 12 16 13	32 01 13 61, 32 12 13 13, 32 12 13 13a
32 12 16 19	32 12 13 13, 32 12 13 13a

Task	Specification(s)
32 12 16 39	31 32 13 16, 31 25 14 13
32 12 16 43	32 01 13 61, 32 01 13 61a, 32 01 13 61b
32 12 33 00	32 01 13 61, 32 12 13 13, 32 12 13 13a
32 12 36 13	32 01 13 61, 32 01 13 61a
32 12 36 16	32 01 13 61, 32 01 13 61a, 32 01 13 61b
32 12 36 23	32 01 13 61, 32 01 13 61a, 32 01 13 61b
32 13 13 33	32 13 13 33, 03 31 13 00, 03 31 13 00a, 03 31 13 00c, 03 31 13 00d
32 13 73 13	32 01 13 61, 32 01 13 61a, 32 01 13 61b
32 13 73 16	32 01 13 61, 32 01 13 61a, 32 01 13 61b
32 13 73 19	32 01 13 61, 32 01 13 61b
32 14 09 00	32 14 09 00
32 14 11 00	32 14 11 00, 32 14 11 00a, 32 14 11 00b, 31 25 14 23
32 14 13 19	03 31 13 00
32 14 16 00	32 14 11 00, 32 14 11 00a, 32 14 11 00b, 31 25 14 23
32 14 33 13	32 14 33 13, 10 14 00 00
32 15 40 00	32 11 16 16, 32 11 16 16a, 32 11 16 16b
32 16 13 13	03 31 13 00, 32 01 16 71a
32 16 13 14	03 31 13 00, 32 01 16 71a
32 16 13 16	03 31 13 00, 32 01 16 71a
32 16 13 19	03 31 13 00
32 16 13 23	03 31 13 00, 32 01 16 71a
32 16 13 33	03 31 13 00, 32 01 16 71a
32 16 13 43	03 31 13 00, 32 14 33 13
32 16 23 00	01 22 16 00, 32 14 11 00, 32 14 11 00a, 32 14 11 00b, 31 25 14 23
32 16 43 00	32 01 13 61
32 17 13 23	11 12 16 00, 11 12 16 00a
32 17 13 26	11 12 16 00, 11 12 16 00a
32 17 16 00	32 01 13 61, 23 05 66 00
32 17 23 13	32 01 13 61, 03 31 13 00, 32 01 11 53
32 17 23 23	32 01 13 61, 03 31 13 00, 32 01 11 53
32 17 23 33	32 01 13 61, 03 31 13 00, 32 01 11 53
32 17 26 00	32 17 26 00
32 18 16 13	32 18 16 13, 32 18 16 13a, 32 18 16 13b, 11 66 13 00, 11 68 13 00
32 18 23 13	32 18 23 13
32 18 23 23	32 18 23 13
32 18 23 29	32 18 23 29, 32 18 23 29a, 32 18 16 13a, 11 68 23 13
32 18 23 33	32 18 23 29, 32 18 23 29a, 32 18 16 13a, 32 18 16 13b
32 18 23 39	32 18 23 29, 32 18 23 29a, 32 18 16 13a, 32 18 16 13b
32 18 23 53	32 18 16 13a, 11 68 23 13
32 18 23 56	32 18 23 29, 32 18 23 29a, 32 18 16 13a, 11 68 23 13
32 18 23 61	32 18 23 29, 32 18 23 29a, 32 18 16 13a
32 31 11 00	31 23 16 16
32 31 13 13	32 31 13 13, 01 22 16 00, 31 13 13 00, 31 23 16 16
32 31 19 00	32 31 19 00, 01 22 16 00, 32 31 13 13
32 31 23 00	01 22 16 00
32 31 29 00	32 31 29 00, 01 22 16 00
32 31 34 00	01 22 16 00, 31 23 16 16
32 32 13 00	32 32 13 00
32 32 16 00	03 41 23 00
32 32 23 13	32 32 13 00
32 32 26 00	32 32 13 00
32 32 29 00	32 32 13 00
32 32 53 00	32 32 13 00

Task	Specification(s)
32 33 13 00	32 33 13 00, 01 22 16 00
32 33 23 00	32 33 23 00, 01 22 16 00, 32 33 13 00
32 33 33 00	32 33 23 00, 32 33 13 00
32 33 43 13	32 33 23 00
32 33 43 53	32 33 13 00
32 33 53 00	01 22 16 00
32 39 23 00	32 33 13 00
32 84 00 00	07 21 13 13
32 84 13 00	32 84 13 00, 07 21 13 13
32 84 23 00	01 22 16 00, 32 84 13 00, 03 05 13 00, 07 21 13 13, 07 63 00 00, 07 63 00 00a, 07 63 00 00b
32 91 13 16	32 91 13 16
32 91 13 26	32 91 13 16
32 91 13 33	31 13 13 00, 31 01 20 00, 31 23 16 26, 32 18 23 13
32 91 13 36	32 91 13 16, 32 18 23 13
32 91 19 13	32 91 19 13, 32 91 19 13a, 02 41 13 13a, 31 11 00 00, 31 13 13 00, 31 01 20 00, 31 23 16 26, 32 18 23 13
32 92 16 00	32 18 23 13
32 92 19 13	32 18 23 13
32 92 19 19	32 18 23 13
32 92 23 00	32 18 23 13
32 93 13 00	32 14 09 00
32 93 23 00	32 14 09 00
32 93 33 00	31 11 00 00, 32 14 09 00
32 93 43 00	32 14 09 00
32 93 63 00	32 14 09 00
32 93 83 00	31 13 13 00, 32 91 13 16, 32 14 09 00
32 94 13 00	32 14 09 00
32 94 16 00	32 14 09 00
32 94 43 00	01 22 16 00, 32 33 13 00
32 94 49 00	01 22 16 00, 31 13 13 00, 32 14 09 00
32 96 33 00	32 91 13 16
32 96 43 00	32 91 13 16
33 01 10 58	33 01 10 58, 33 01 10 58a, 21 05 23 00
33 01 10 71	33 01 10 71, 01 22 16 00, 21 05 23 00
33 01 30 11	01 22 16 00
33 01 30 41	33 01 10 58a
33 01 30 42	21 05 23 00, 33 01 10 58, 33 01 10 58a
33 01 30 51	33 01 30 51, 01 22 16 00, 21 05 23 00, 33 01 10 58
33 01 30 63	01 22 16 00
33 01 30 74	01 22 16 00
33 01 30 81	33 01 30 81, 01 22 16 00, 21 05 23 00, 22 05 76 00, 33 01 10 58, 33 01 30 51, 33 42 11 00, 31 32 19 16
33 01 30 82	01 22 16 00
33 01 30 83	01 22 16 00, 21 05 23 00, 33 01 10 58, 33 01 30 51
33 01 30 86	01 22 16 00, 21 05 23 00, 33 01 10 58, 33 01 30 51
33 01 30 89	01 22 16 00
33 01 34 13	21 05 23 00, 33 01 30 51
33 01 40 00	33 42 11 00
33 05 07 13	33 05 07 13
33 05 07 23	01 22 16 00, 33 05 07 13
33 05 07 24	33 05 07 13
33 05 61 00	22 05 76 00, 33 42 11 00
33 05 63 00	33 01 30 81
33 05 81 00	01 22 16 00, 22 05 76 00, 33 01 30 81, 33 42 11 00, 31 32 19 16

Task	Specification(s)
33 05 83 00	22 05 76 00, 33 01 30 81, 33 42 11 00, 31 32 19 16
33 05 84 00	01 22 16 00, 21 05 23 00, 22 05 76 00, 33 42 11 00, 31 32 19 16
33 05 97 16	01 22 16 00
33 11 13 00	33 11 13 00, 01 22 16 00, 21 05 23 00, 23 11 23 00a, 22 11 23 23
33 14 00 00	13 12 13 00
33 14 11 00	13 12 13 00
33 14 13 00	13 12 13 00
33 14 13 13	01 22 16 00, 21 05 23 00, 31 62 16 19, 13 12 13 00, 22 05 76 00, 33 42 11 00
33 14 13 23	33 14 13 23, 33 14 13 23a, 33 14 13 23b, 01 22 16 00, 21 05 23 00, 13 12 13 00, 23 11 23 00a, 22 11 23 23, 22 05 76 00, 32 91 19 13a, 31 05 13 00, 33 42 11 00
33 14 13 36	21 05 23 00, 22 11 23 23, 33 14 13 23a, 23 05 29 00
33 14 13 39	21 05 23 00, 13 12 13 00
33 14 13 43	01 22 16 00, 21 05 23 00, 13 12 13 00, 22 11 23 23, 22 05 76 00, 33 14 13 23a, 23 05 29 00
33 14 13 53	01 22 16 00, 07 63 00 00, 07 63 00 00a, 07 63 00 00b, 22 11 16 00, 22 11 16 00a, 22 11 16 00b, 22 11 16 00c, 22 11 16 00d, 22 11 16 00e, 22 11 16 00f
33 14 19 00	01 22 16 00, 21 05 23 00, 13 12 13 00, 21 05 23 00a, 21 05 23 00b
33 14 23 00	01 22 16 00, 21 05 23 00, 13 12 13 00
33 19 13 23	13 12 13 00, 21 05 19 00, 21 05 19 00a
33 19 16 23	01 22 16 00, 13 12 13 00, 21 05 19 00, 21 05 19 00a
33 19 19 00	01 22 16 00, 13 12 13 00, 21 05 19 00, 21 05 19 00a
33 31 11 00	01 22 16 00, 21 05 23 00, 33 14 13 23, 13 12 13 00, 23 11 23 00a, 22 11 23 23, 22 05 76 00, 32 91 19 13a, 33 14 13 23a, 31 05 13 00, 33 42 11 00
33 32 16 00	01 22 16 00, 22 13 29 13b
33 34 13 13	32 91 19 13a
33 34 13 23	32 91 19 13a
33 34 13 33	32 91 19 13a
33 34 51 00	32 91 19 13a
33 34 53 13	32 91 19 13a
33 34 56 00	32 91 19 13a
33 41 16 13	01 22 16 00, 21 05 23 00, 22 05 76 00, 32 91 19 13a, 31 05 13 00, 33 42 11 00, 22 11 16 00b, 22 05 76 00a
33 41 19 13	21 05 23 00, 31 05 13 00
33 42 11 00	33 42 11 00, 21 05 23 00, 33 14 13 23, 13 12 13 00, 22 05 76 00, 33 14 13 23b, 31 05 13 00, 22 11 16 00b, 22 05 76 00a
33 42 13 13	33 42 13 13, 01 22 16 00, 21 05 23 00, 22 05 76 00, 33 42 11 00
33 42 23 00	21 05 23 00, 33 42 11 00, 31 32 19 16
33 42 26 16	21 05 23 00, 33 14 13 23, 33 42 11 00
33 42 26 19	21 05 23 00, 33 42 11 00
33 42 26 23	33 42 11 00
33 42 31 00	21 05 23 00, 33 42 11 00, 31 32 19 16
33 42 33 00	21 05 23 00, 33 42 11 00, 31 32 19 16
33 42 36 00	21 05 23 00, 33 42 11 00, 31 32 19 16
33 44 36 00	22 13 19 26, 28 46 00 00
33 46 53 00	21 05 23 00, 33 14 13 23, 23 11 23 00
33 52 16 13	01 22 16 00, 21 05 23 00, 07 63 00 00, 07 63 00 00a, 07 63 00 00b, 23 11 23 00b, 23 11 23 00c
33 52 16 23	23 11 23 00b, 23 11 23 00c
33 52 16 26	23 11 23 00b, 23 11 23 00c
33 53 16 00	21 05 23 00
33 59 11 00	21 05 23 00
33 59 16 00	21 05 23 00
33 61 13 00	21 05 23 00, 33 14 13 23a
33 71 19 23	26 05 00 00, 26 05 19 16, 26 05 19 16a, 26 05 19 16d, 26 05 19 16e, 26 05 19 16f, 26 05 19 16g

Task	Specification(s)
34 01 43 00	01 22 16 00
34 05 43 00	32 01 13 61, 32 12 13 13, 32 12 13 13a, 03 41 23 00, 03 01 30 71, 05 05 21 00, 05 12 23 00, 05 50 00 00
34 41 13 00	34 41 13 00, 01 22 16 00, 05 15 16 00, 27 11 19 00, 26 05 33 16a
34 41 16 00	34 41 13 00
34 43 13 16	26 05 13 16a, 26 05 13 16b
34 71 13 13	34 71 13 13
34 71 13 16	34 71 13 16, 34 71 13 13
34 71 13 26	01 22 16 00, 34 71 13 13
34 71 16 00	01 22 16 00, 34 71 13 16, 34 71 13 13
34 71 19 16	11 12 16 00, 11 12 16 00a
34 82 23 00	01 22 16 00
34 82 26 00	01 22 16 00
35 05 70 00	01 22 16 00
35 22 26 00	35 22 26 00
35 22 59 00	35 22 26 00
35 22 63 00	35 22 26 00
35 24 23 00	35 24 23 00
35 24 26 00	01 22 16 00
40 05 23 23	21 05 23 00, 23 11 23 00, 23 11 23 00a, 22 11 23 23, 22 05 76 00, 07 63 00 00, 07 63 00 00a, 07 63 00 00b
40 05 41 00	07 63 00 00, 07 63 00 00a, 07 63 00 00b
41 22 23 13	41 22 23 13, 41 22 23 13a, 41 22 23 13b, 41 22 23 13c
43 23 78 31	21 05 23 00
43 24 41 23	21 05 23 00
43 42 41 00	01 22 16 00

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